Science Together

KNAUER

4000 MiD®

Mass spectrometer

Instructions

Document No. V6695

HPLC

Note: For your own safety, read the instructions and observe the warnings and safety information on the device and in the instructions. Keep the instructions for future reference.

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For latest version of the instructions, check our website:
https://www.knauer.net/en/Support/User-manuals

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1. Symbols and signs

1.1 Terms and abbreviations

Term	Definition
ESI	Electrospray Ionisation
LC	Liquid Chromatography
DFI	Direct Flow Interface
SFI	Split Flow Interface
MiD	Molecular iD
m/z ratio	Mass-to-charge ratio
MSDS	Material Safety Data Sheet
RF	Radio Frequency
SFD	Source, Filter, Detector (assembly)
TIC	Total Ion Current

1.2 Warning symbols (ENG)

The warning symbols described in the table below are used on the MiD and within these Instructions. All warnings and cautions must be observed at all times during operation and maintenance of the MiD. Failure to comply with the warning instructions violates safety standards associated with the proper use of the system and its design. KNAUER assumes no liability for the failure to comply with these requirements.

Symbol	Description
	Alternating Current
CE	Conformité Européenne
	Read the Instructions
	**CAUTION** A Safety Alert symbol with the **CAUTION** notice denotes a potential hazard. Pay particular attention to the procedure or operation described. If performed incorrectly or without caution, the procedure may result in damage to hardware or the software. **DO NOT** proceed beyond a **CAUTION** notice without fully understanding the notice, its implications and how to meet the conditions stated.

Symbol	Description
	**WARNING SERIOUS HAZARD** A Safety Alert symbol with the **WARNING** notice denotes a serious hazard. The operation or suggested action may result in personal injury or death. **DO NOT** proceed beyond a **WARNING** notice without fully understanding the notice, its implications and how to meet the conditions stated. Warning notices are also displayed with symbols representing specific hazards.
	**CAUTION, POSSIBILITY OF ELECTRIC SHOCK** This symbol denotes a risk of electric shock. It indicates areas on the MiD system where hazardous voltages are present.
	**WARNING HAZARDOUS VOLTAGE** This symbol highlights actions or procedures which, if not performed correctly, could lead to electric shock from hazardous voltages.
	**WARNING CORROSIVE CHEMICAL** This symbol with the **WARNING** notice denotes corrosive chemicals. A corrosive chemical may be present. Exposure may result in serious injury. Use appropriate skin protection**.**

Note: A Note indicates important information necessary for the correct or optimal operation of the software or hardware. Read the information carefully and follow any instructions.

1.3 Pictogrammes de sécurité (FRA)

Les pictogrammes de sécurité présents dans la table en dessous sont utilisés sur le MiD et dans ce guide. **AVERTISSEMENT** et **ATTENTION** doivent êtres suivit en tout temps lors de l'entretien, l'installation, la réparation et l'opération du MiD. Tous default d'application de ces règles de sécurité serait considéré comme une violation des normes de sécurité. KNAUER ne saurait voir sa responsabilité engagée en cas de manquement de l'utilisateur à respecter les consignes de sécurité.

Symbole	Description
	**Courant Alternatif**
	**Conformité Européenne**
	**Lisez le Guide de l'utilisateur**

Symbole	Description
	**ATTENTION** Un symbole de sécurité avec la mention **ATTENTION** dénote un risque potentiel. Soyez particulièrement attentif à la procédure décrite. Si celle-ci est exécutée de manière incorrecte, elle peut engendrer un dommage de l'équipement et/ou une erreur de programme avec la conséquence probable de perdre des données. Ne continuer pas après un signal d'**ATTENTION** sans comprendre totalement sa signification et les conditions décrites.
	**AVERTISSEMENT DE DANGER SÉRIEUX** Un symbole de sécurité avec la mention **AVERTISSEMENT** dénote un danger sérieux. La procédure décrite peut entrainer un risque de blessure ou de mort. Ne continuer pas après un signal d'**AVERTISSEMENT** sans comprendre totalement sa signification et les conditions décrites. Des notices d'avertissement sont aussi associées avec des pictogrammes représentant des dangers spécifiques.
	**ATTENTION, POSSIBILITÉ DE CHOC ELECTRIQUÉ** Ce pictogramme dénote la possibilité de choc électrique. Ce pictogramme peut êtres trouvé sur le MiD. Il indique une région du MiD où des tensions électriques sont présentes.
	**AVERTISSEMENT DE TENSIONS DANGEREUSES** Ce pictogramme avec la mention **AVERTISSEMENT** dénote des tensions dangereuses. Ce pictogramme peut êtres trouvé sur le MiD. Il indique une région du MiD ou des tensions dangereuses sont présentes.
	**AVERTISSEMENT DE SUBSTANCES CORROSIVES** Ce symbole met en évidence des actions ou des procédures qui, si elles ne sont pas effectuées correctement, peut entraîner l'exposition à des substances corrosives. Utilisez des protections corporelles adéquates.

Note: Une Note indique des informations importantes pour l'utilisation du software et/ou de l'équipement. Veuillez lire les informations avec attention et suivez les instructions.

Units

Imperial and metric units.

Both imperial and metric units are used in this document. The unit of measurement chosen reflects historical use. Please note that the unit symbol for inches is given as ″; for example: 6″ means 6 inches.

Pressures in the vacuum system of the MiD are measured in Torr. For example, a typical pressure reading in the user interface of the software would be 2.0 E-5 Torr: this is equivalent to 2.0×10^{-5} Torr.

2. Important safety information

The safety information given in this section is important; always observe all safety precautions when operating, maintaining, or servicing the 4000 MiD®.

To avoid personal injury or damage to the instrument, **DO NOT** perform servicing or maintenance unless you are qualified and authorised to do so. **DO NOT** perform any servicing or maintenance procedures that are not described in these Instructions.

WARNING If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

AVERTISSEMENT Si l'équipement est utilisé d'une manière non spécifiée par le fabricant, la protection fournie par l'équipement peut être altérée.

CAUTION The MiD should only be used with accessories that meet the manufacturers specifications. Failure to do so may result in damage to the instrument and lead to the loss of liability and warranty entitlements.

ATTENTION Le MID ne doit être utilisé qu'avec les accessoires qui répondent aux spécifications du fabricant. Le cas contraire peut causer des dommages à l'appareil et entraîner la perte de responsabilité et de droits de garantie.

2.1 Electrical hazards

Dangerous high voltages

Several internal parts of the MiD can supply dangerous voltages. When the MiD is connected to the mains supply dangerous high voltages can be present even if the power is switched off.

WARNING Unless specifically instructed, **DO NOT** remove any protective covers. The product is sealed at the factory. Damage or removal of the warranty seals leads to the loss of liability and warranty entitlements.

AVERTISSEMENT Sauf mention contraire, **NE PAS** retirer les couvercles de protection. Le produit est scellé à l'usine. Les dommages ou levée des scellés de garantie entraîne la perte de la responsabilité et droits de garantie.

2.2 Chemical hazards

Any chemicals used for analysis should be handled according to good laboratory practice. They should also be stored, used, and disposed of in accordance with the manufacturer's specifications, as well as local and national regulations.

The responsible individual must ensure that personnel are not exposed to hazardous levels of toxic substances as outlined in the Material Safety Data Sheets (MSDS), or any documentation provided by local governing bodies such as The Health Protection Agency (UK) or The Occupational Safety and Health Administration (US).

	**WARNING** Potentially hazardous chemicals can be used with the MiD. Use care when handling chemicals and wear appropriate PPE. **AVERTISSEMENT** Des produits chimiques potentiellement dangereux peuvent être utilisés avec le MiD. Faire preuve de prudence lors de la manipulation des produits chimiques et porter des EPI appropriés.
	**WARNING** The pump exhausts from the MiD must be connected to a suitable extraction system. Appropriate extraction must also be provided to the microspray area when analysing hazardous chemicals. **AVERTISSEMENT** Les gaz d'échappement de la pompe du MiD doit être connecté à un système d'extraction approprié. Une extraction adéquate doit également être fournie à la zone microspray lors de l'analyse de produits chimiques dangereux.
	**CAUTION** This system operates using high voltages. This can introduce additional hazards when certain solvents are used. Ensure all solvents and instruments are properly connected, vented, or set up with manufacturer approved settings. **ATTENTION** Ce système fonctionne avec des tensions électriques élevées. Cela peut présenter des dangers supplémentaires lorsque certains solvants sont utilisés. S'assurer que tous les solvants et les instruments sont correctement connectés, ventilé, ou mis en place avec les paramètres homologués par le constructeur.

2.3 Compressed gas hazards

The MiD requires a source of dry nitrogen gas for correct operation. Always follow local health and safety regulations if handling cylinders of compressed gas. Environmental monitoring must be deployed to detect and alert the user to the occurrence of a reduction of oxygen due to a nitrogen leak in the environment. In case of oxygen reduction, all personnel need to leave the room and alert the proper health and safety representative.

2.4 Safety and regulatory standards

In accordance with the following directives:

- **2**006/95/EC
  The Low Voltage Directive
- 2004/108/EC
  The Electromagnetic Compatibility Directive

The MiD complies with the following safety standards:

- IEC 61010-1: 2010 (3rd Edition)
  Safety requirements for electrical equipment for measurement, control, and laboratory use.
- UL 61010-1: May 2012
  Electrical Equipment for Measurement, Control, and Laboratory Use; Part 1: General Requirements.
- CSA C22.2 61010-1 (3rd Edition - 2011)
  Safety Requirements for Electrical Equipment.

The MiD conforms to the following standards for EMC conformity:

- **IEC**/EN 61326:2006
  Electrical equipment for measurement, control and laboratory use EMC requirements.
- EN 61000-3-2:2006 + A1:2009 + A2:2009
  Electromagnetic compatibility (EMC).
  Limits for harmonic current emissions
  (equipment input current < 16 A per phase).
- EN 61000-3-3:2008
  Electromagnetic compatibility (EMC).
  Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.
- ICES-003:2004
  Spectrum Management and Telecommunications Policy.
  Interference-Causing Equipment Standard.
  Digital Apparatus.

In accordance with all of the essential requirements of all applicable European product directives; the declaration of conformity document is available upon request.

FCC CFR47:Part 15:B:2008

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their expense.

Modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment under FCC rules.

Subject to the Waste Electrical and Electronic Equipment (WEEE) Directive; see WEEE compliance statement.

WEEE Compliance Statement

This statement is valid only for customers in EU member countries. The European Union (EU) directive for product recycling (The Waste Electrical and Electronic Equipment - WEEE Directive) will shortly be incorporated into the national laws of each EU member state. Products falling under the scope of the WEEE Directive are identified with a crossed over "wheelie" bin symbol on the product label. An authorized waste disposal service must be used to dispose of the product for recycling or disposal, or alternatively return the product to KNAUER.

WARNING The manufacturer's declaration becomes invalid if the user modifies the original product or installs additional components.

AVERTISSEMENT La déclaration du fabricant est annulée si l'utilisateur modifie l'origine du produit ou installe des composants supplémentaires.

2.4.1 Electromagnetic compatibility

The manufacturer has tested and evaluated the MiD to ensure it fully complies with EMC and safety standards as outlined in IEC 61010-1: 2010.

2.4.2 Precautions

The following safety precautions concerning the operation of the MiD and the site in which it is used must be observed at all times in order to prevent injury and damage to the system and associated instruments.

WARNING At least two people are required to lift or move the MiD.

AVERTISSEMENT Au moins deux personnes sont nécessaires pour soulever ou déplacer le MiD.

WARNING To prevent injury and damage to equipment please ensure the blanking plug is removed from the exhaust port before activating the pumps.

AVERTISSEMENT Pour éviter blessures et dommages matériels, veuillez vous assurer que le bouchon de fermeture soit retiré de l'orifice d'échappement avant d'activer les pompes.

	**WARNING** **DO NOT** use the instrument if there are signs of visible damage. **DO NOT** operate if site conditions are not within specifications. **DO NOT** override any safety interlock. **AVERTISSEMENT** **NE PAS** faire fonctionner l'appareil s'il présente des signes de dommages visibles. **NE PAS** faire fonctionner si les conditions du site ne sont pas conformes aux spécifications. **NE PAS** altérer un verrouillage de sécurité.
	**WARNING** **DO NOT** attempt to operate the instrument with the covers removed. High voltages are present when the instrument is in operation. **DO NOT** attempt to adjust or replace components other than those that have been described in these Instructions. **AVERTISSEMENT** **NE PAS** essayer de faire fonctionner l'appareil avec les couvercles enlevés. Des hautes tensions sont présentes lorsque l'appareil est en fonctionnement. **NE PAS** tenter de régler ou remplacer des composants autres que ceux qui ont été décrits dans ce Guide de l'utilisateur.
	**WARNING** The instrument is not designed to be operated in a potentially explosive atmosphere. It is the responsibility of the customer to verify the operating environment meets the requirements of a "non-hazardous area" with regards to potentially explosive atmosphere. **AVERTISSEMENT** L'instrument n'est pas conçu pour être utilisé dans une atmosphère explosible. Il est de la responsabilité du client de vérifier que l'environnement de fonctionnement répond aux exigences d'un secteur non-dangereux quant à l'atmosphère explosible.

3. Product information

Note: Only use the device for applications that fall within the range of the intended use. Otherwise, the protective and safety equipment of the device could fail.

The 4000 MiD® is a compact mass detector system that employs micro-engineering technology to identify the chemical contents of solutions.

The MiD incorporates technologies patented by Microsaic Systems plc including; spraychip®, vac-chip™, and ionchip®.

A chemical sample, dissolved in suitable solvents, is introduced into the spraychip, typically from an HPLC or syringe pump. Gas phase ions are formed and are introduced into the vacuum chamber through the vac-chip.

The ions introduced through the vac-chip are then focused using a series of electrostatic ion optics. The ionchip filters the ions according to their mass-to-charge (m/z) ratios and directs them to the detection system.

The spraychip ion source

The spraychip is a micro-electrospray ion source. Compared to conventional electrospray ion sources, microspray provides the following advantages:

- Increased ionisation efficiency
- Lower flow rates, which means analysis of very small sample volumes (for example, nanolitres) over long periods of time.
- Very low solvent consumption and minimum waste, when coupled to a nano-LC.
- Lower voltages are required to provide efficient electrospray.
- The spraychip can be coupled to nano-flow systems (without a flow split) or to traditional LC systems (using a flow splitter).

The vac-chip and ion optics

The vac-chip interface allows the MiD to achieve the operating pressures required for analysis and it aids transportation of ions from the microspray source into the vacuum system of the MiD.

Behind the vac-chip, there is a series of ion optics: a tube lens, an exit lens, an ion guide and an inter-quadrupole lens. Ions generated from the spraychip enter the vac-chip and are focused into the ionchip using the ion optics.

The ionchip

The ionchip is a micro-engineered quadrupole mass analyser. It functions like a conventional quadrupole mass analyser, acting as a mass filter, separating ions in order of their mass-to-charge (**m/z**) ratios. However, it is about one hundredth the volume of a conventional quadrupole mass analyser.

Vacuum system

The vacuum system consists of a vacuum chamber coupled to two turbo-molecular pumps, which are backed by a small diaphragm pump. All vacuum pumps are integrated within the MiD. Unlike conventional mass spectrometers there are no external, floor-standing rotary pumps. This

significantly reduces the equipment noise, footprint, and size. This also eliminates complications associated with rotary pumps, such as back-stream of pump oil and the added expense of purchasing an oil trap.

The vacuum system comprises three sections:

- The vac-chip interface
- The ion guide chamber
- The analytical chamber

The pressures in the chambers are monitored using Pirani gauges which also act as high-voltage interlocks. These gauges turn off any high voltages if the pressure readings in the chambers are above a set safety value.

3.1 Theory of microspray

Microspray is a soft ionisation technique. A voltage, generally between 0.7 and 1.5 kV, is applied to an analyte dissolved in a suitable solvent; generally a mixture of water and an organic solvent. The solvent passes through an emitter or capillary tip at a flow rate of 300-1000 nL/min. The voltages and flow rates used in microspray are lower than for conventional electrospray ionisation. This means that lower volumes of sample and solvent are consumed by the MiD. When coupled with a nano-flow LC, solvent consumption is reduced by several orders of magnitude when compared to traditional HPLC systems.

Under the correct conditions, a plume of charged aerosol droplets forms from a Taylor cone. Gas-phase analyte ions are subsequently formed from these aerosol droplets. Ions produced by this method can have single or multiple charges. Generally, high molecular weight compounds, for example, proteins, produce a series of multiply-charged ions.

3.2 Views

3.2.1 The front panel

Fig. 1 shows the connections and ports on the front panel of the MiD. Refer to the labels listed in the table below during operation.

Connection	Description
K	USB Port
L	On/Off Power switch
M	LED Status Indicators
N	Spraychip assembly high voltage connection

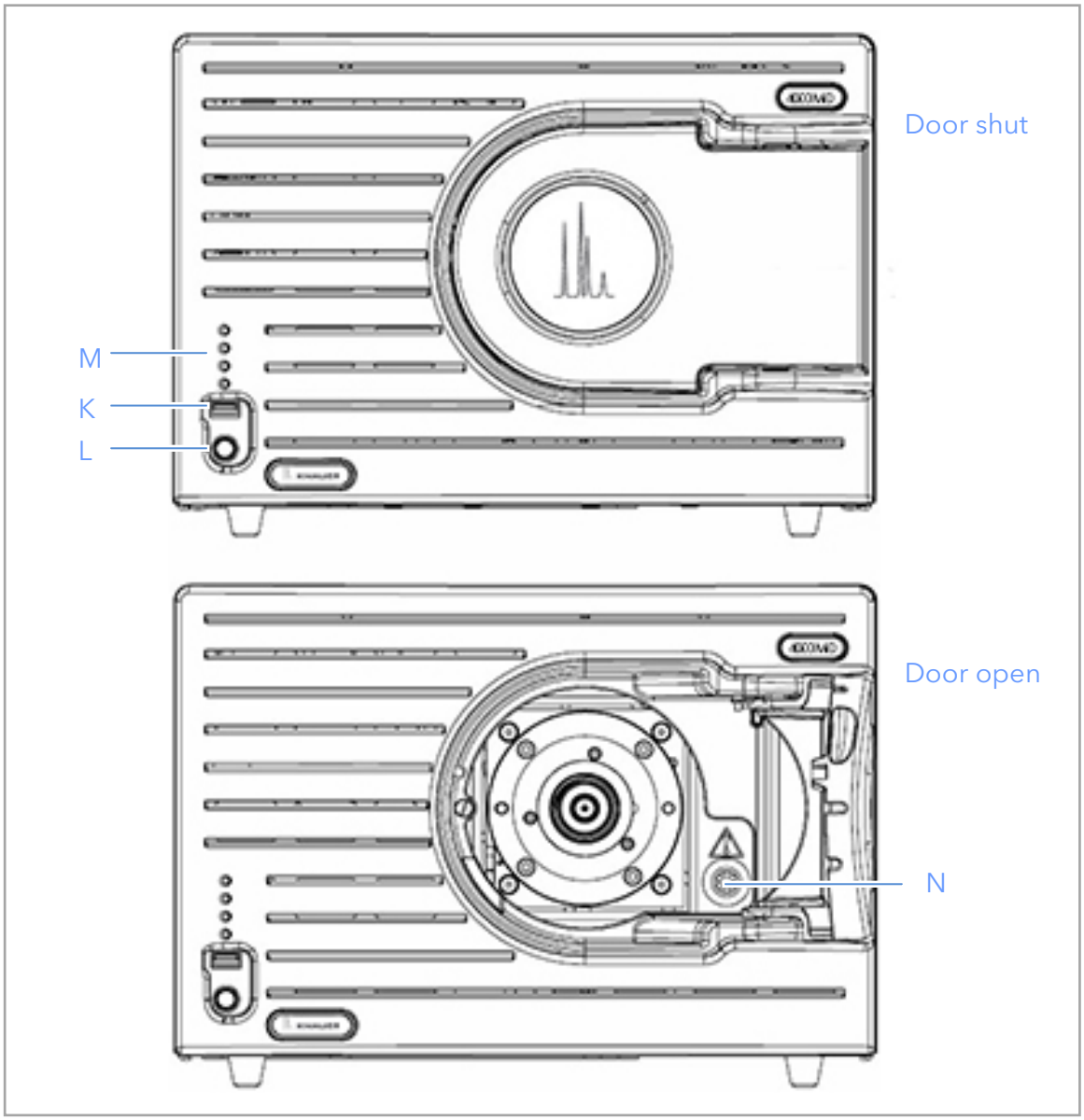

Fig. 1 Front panel connections

3.2.2 LED status indicators

There are four LED status indicators on the front panel of the MiD (see M - Fig. 1). They are used to indicate the current operational status of the instrument; the LEDs are shown in detail in Fig. 2.

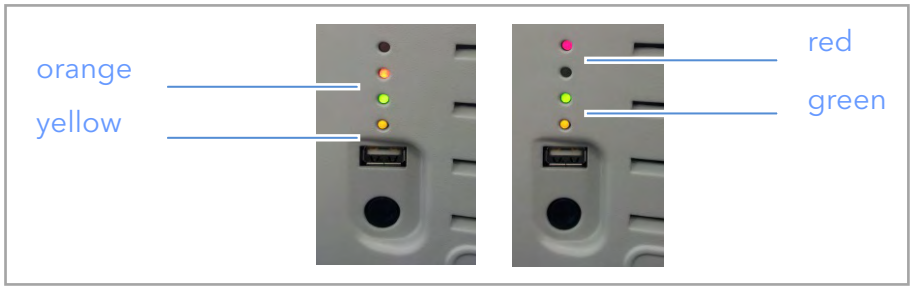

Fig. 2 LED status indicators

The LEDs indicate the following statuses:

Red: Indicates that a serious error has occurred. User intervention will be required to rectify the fault. Fault details will be displayed on via error

dialog in the software. The LED will not be reset until the application is restarted, which is also required to confirm the fault has been remedied.

Orange: Indicates that the MiD is acquiring data (mass scanning). The LED will not be lit unless the MiD is scanning, for example it will not be lit when a start or stop time is in effect.

Green: The hardware interlock is engaged when the LED is lit and vice versa, see „5.8.4 Operating the front cover safety interlock“ on page 26 for more details.

Yellow: Indicates that the MiD is in operate mode, when unlit the MiD is in standby.

3.2.3 The rear panel

Fig. 3 shows the connections and ports on the rear panel of the MiD. These ports include terminals and connectors for the gas supply, vacuum exhaust system and computer peripherals.

Refer to the labels listed in the table below when connecting the MiD and any associated instruments.

WARNING The 4000 MiD provides double/reinforced insulation to mains circuits. Any external equipment that is connected to the 4000 MiD through the rear panel must itself also provide double/ reinforced insulation to the mains supply.

AVERTISSEMENT Le 4000 MiD offre une double isolation renforcée pour l'alimentation secteur. Tout équipement externe connecté aux 4000 MiD par le panneau arrière doit lui aussi fournir une double isolation renforcée à l'alimentation secteur.

Connection	Description
A	Nebuliser Gas Port
B	Aux I/O Port
C	VGA Monitor Port
D	RS232 Port
E	4x USB Ports
F	2x Ethernet Ports
G	Pump exhaust
H	Main power
I	PS/2 Ports
J	eSATA Port
K	HDMI Port

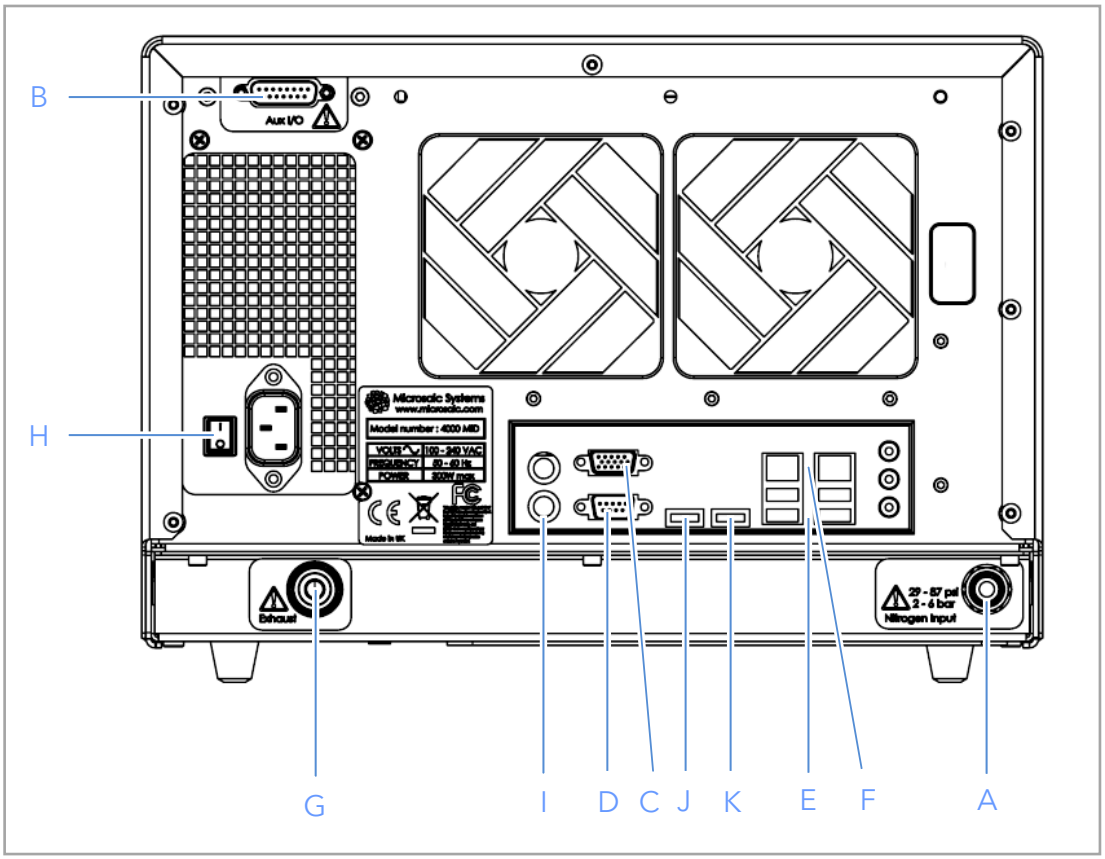

Fig. 3 Diagram of rear panel

4. Scope of delivery

Note: Only use original parts and accessories made by KNAUER or a company authorized by KNAUER.

- 4000 MiD
- MiDas
- Starter kit:
  - Mains leads (2 in total)
  - PTFE tubing (form Nitrogen input)
  - Exhaust Silencer
  - Split flow interface
- Tool kit

Valid documents:

- Instructions (English)
- Declaration of conformity

5. Unpacking and setup

5.1 Site requirements and storage conditions

The chapter „9. Troubleshooting“ on page 47 describes the site requirements and storage conditions necessary for the MiD. Make sure all the requirements are met before installation and use of the system.

5.2 Power supply

The power supply in the MiD accepts any line voltage in the range 100–240 V. There is no voltage selector at the rear of the MiD and there are no externally accessible fuses.

CAUTION When operating MiD it must be possible to disconnect the instrument from mains supply at any time. In the event of an emergency the power connector of the instrument must be easily accessible and removable.

ATTENTION Lors de l’utilisation MiD il doit être possible de déconnecter l’appareil de l’alimentation secteur à tout moment. En cas d’urgence, le connecteur d’alimentation de l’instrument doit être facilement accessible et débranchable.

CAUTION When installing or operating the instrument you must ensure that there is sufficient space behind the instrument to unplug the power cord.

ATTENTION Lors de l’installation ou l’utilisation de l’instrument vous devez vous assurer qu’il ya suffisamment d’espace derrière l’appareil pour débrancher le cordon d’alimentation.

5.3 Power cords

Power cords are available for the MiD depending on the country/region of operation. The female end of all supplied power cords are identical and plug into the rear of the instrument (see Fig. 3). The male end of the cord will fit the wall outlet of the appropriate country/region.

WARNING The MiD must never be operated from a power outlet that has no ground connection. The absence of a ground connection can lead to electric shock or short circuit.

AVERTISSEMENT Le MID ne doit jamais être utilisé à partir d’une prise de courant qui n’a pas de connexion à la terre. L’absence de mise à la terre peut provoquer un choc électrique ou un court-circuit.

WARNING Never use a power cord other than that supplied by the manufacturer. The use of an inadequately rated power cord can lead to electric shock or short circuit.

AVERTISSEMENT N’utilisez jamais un cordon d’alimentation autre que celui fourni par le fabricant. L’utilisation d’un cordon d’alimentation non-adéquat peut provoquer un choc électrique ou un court-circuit.

WARNING Never use any cabling not supplied or recommended the manufacturer. Use of unspecified cabling may lead to improper operation or failure to comply with safety or EMC regulations.

AVERTISSEMENT Ne jamais utiliser des câbles non fournis ou recommandés par le fabricant. L'utilisation de câbles non spécifié peut entraîner un mauvais fonctionnement ou du non-respect de la sécurité ou de la compatibilité électromagnétique.

5.4 The MiD and associated parts

The following tables list the parts that are available with the MiD and their part numbers. These numbers can also be used to order any replacement items that are required.

Note: Part numbers and kit contents are subject to change.

CAUTION All items listed must only be supplied by the manufacturer or an agent thereof. Use of alternative parts may lead to improper operation of the MiD or failure to comply with safety or EMC regulations.

ATTENTION Tous les articles énumérés ne doit être fourni que par le fabricant ou un agent de celle-ci. L'utilisation de pièces alternatives peut conduire à un mauvais fonctionnement du MID ou un manquement à la sécurité ou de la compatibilité électromagnétique.

Calibration kit

Part number	Description of part
A66916	Calibration kit - containing
	Plug $^{1}/_{32}$" fingertight
	Tubing sleeve, $^{1}/_{16}$" OD
	Syringe adapter fitting, $^{1}/_{16}$" OD
	PEEK tubing – $^{1}/_{32}$" OD x 0.007" ID
	Syringe adapter
	Syringe pump power supply
	New Era (NE-1000) syringe pump
	250 µL luer lock syringe
	Syringe pump communication cable

Optional accessories

Part number	Description of part
A66907	vac-chip O-ring kit
A66908	vac-chip screw kit
A66919	SFI/DFI tubing & ferrule kit

Tool kit

Part number	Description of part
A66915	Tool kit – containing
	0.8 x 4.5 x 125 mm flat screwdriver
	2.5 mm allen key – 'T' Handle
	4 mm allen key – 'T' Handle
	Size PH1 Phillips screwdriver
	Delrin tweezers – flat, round
	SFD cover plate and dust cap

5.5 Setting up the MiD

Fig. 4 shows a typical configuration of the 4000 MiD.

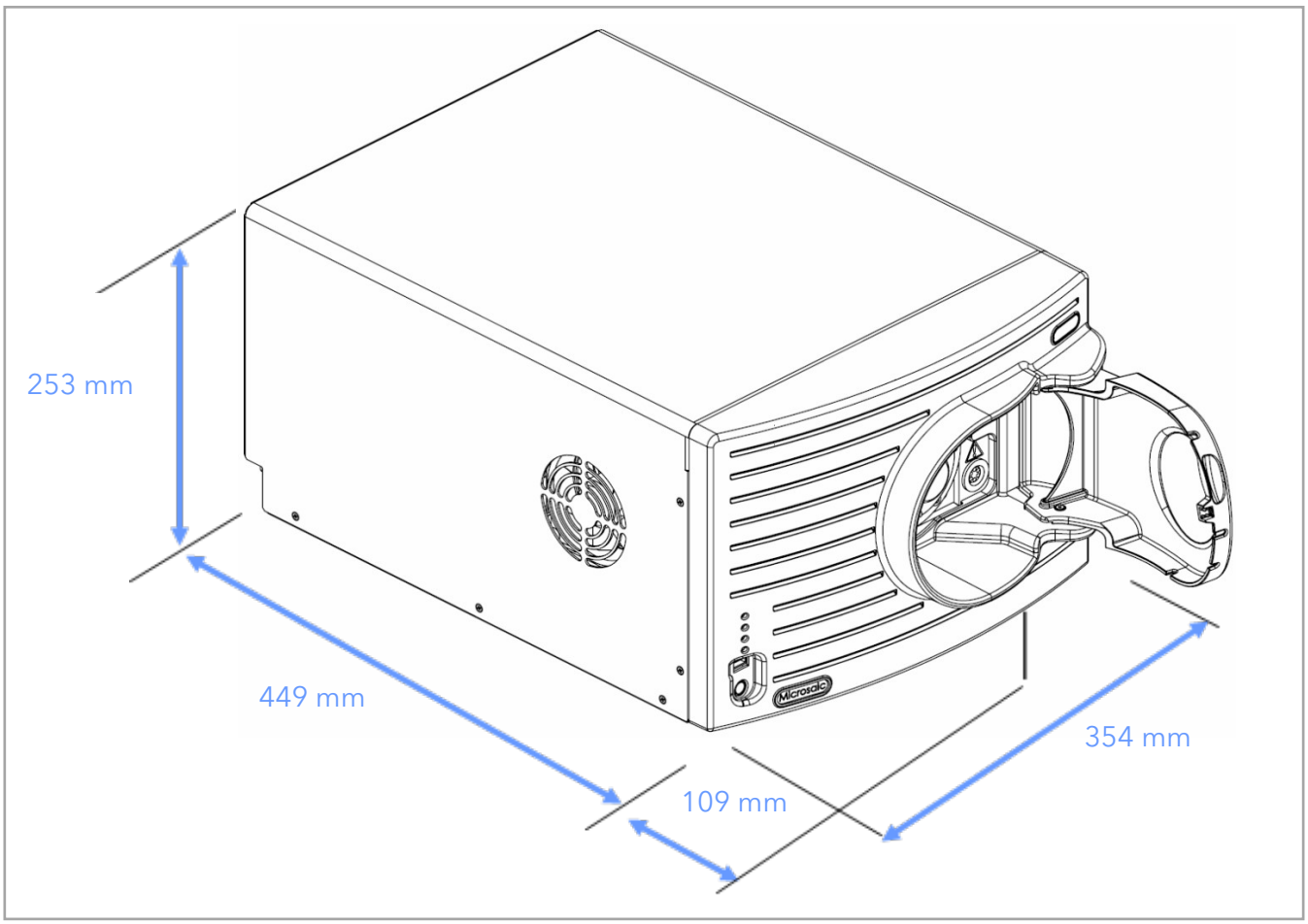

Fig. 4 The 4000 MiD

CAUTION Allow sufficient spacing around the MiD for proper cooling and for the connection of mains plug, gas inlets, syringe pump, HPLC etc.

ATTENTION Laissez un espace suffisant autour du MiD pour un refroidissement correct et pour le raccordement de la prise de courant, des entrées de gaz, de la pompe à seringue, HPLC, etc.

5.5.1 Operational configuration

The MiD can only be installed/operated in one configuration as illustrated in Fig. 1. Other analytical equipment can be placed on top of the instruh ment, such as an HPLC stack.

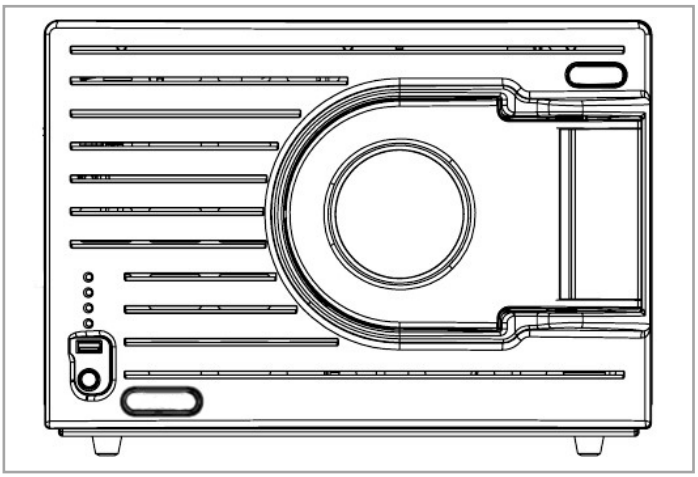

Fig. 5 Operational MiD configuration

Caution	**CAUTION** The MiD is too heavy to be lifted or moved by one person safely. To avoid personal injury and for general safety, if moving or lifting the MiD, always get another person to assist you. Always follow local health and safety regulations. **ATTENTION** Le MID est trop lourd pour être soulevé ou déplacé par une seule personne en toute sécurité. Pour éviter les blessures et pour la sécurité générale, si vous déplacez ou soulevez le MiD, demandez l'aide d'une autre personne. Suivez toujours les règles de santé et les règles de sécurité du pays.
Caution	**CAUTION** The maximum weight that can be supported by the MiD is 60 kg. **ATTENTION** Le poids maximum qui peut être pris en charge par le MiD est de 60 kg.

5.5.2 The rear panel

Fig. 3 shows the connections and ports on the rear panel of the MiD. These ports include terminals and connectors for the gas supply, vacuum exhaust system and computer peripherals.

Refer to the labels listed in the table below when connecting the MiD and any associated instruments.

Warning	**WARNING** The 4000 MiD provides double/reinforced insulation to mains circuits. Any external equipment that is connected to the 4000 MiD through the rear panel must itself also provide double/ reinforced insulation to the mains supply. **AVERTISSEMENT** Le 4000 MiD offre une double isolation renforcée pour l'alimentation secteur. Tout équipement externe connecté aux 4000 MiD par le panneau arrière doit lui aussi fournir une double isolation renforcée à l'alimentation secteur.

WARNING The 4000 MiD is used to analyse liquid samples, liquid contact with external equipment may lead to the risk of electric shock or short circuit. The user must ensure that fluidic connections are not close to ancillary equipment and are checked for leaks prior to use. In the event of a leak, any ancillary equipment not designed for use with liquids must be turned off until the liquid is removed.

AVERTISSEMENT Le 4000 MiD est utilisé pour analyser des échantillons liquides, le contact du liquide avec un équipement externe peut entraîner un risque de choc électrique ou de court-circuit. L'utilisateur doit s'assurer que les connexions fluidiques ne sont pas près de l'équipement auxiliaire et sont vérifiées pour les fuites avant de les utiliser. Dans le cas d'une fuite, les équipements auxiliaires non conçu pour être utilisé avec des liquides doivent être éteint jusqu'à ce que le liquide soit éliminé.

When connecting items to the rear panel for operation of the MiD use the following procedure.

Procedure

1. Connect a suitable length of clean PTFE tubing from the gas supply to the Nebuliser Gas Port A. 6 mm tubing can be used.

Note: If replacing or refitting the gas supply tubing it is recommended that the end of the line is freshly cut before connection to gas port A.

2. If necessary connect a suitable length of 8 mm tubing from the pump exhaust port G to the laboratory's exhaust system. Alternatively if operating the MiD in a fume hood the user can fit the optional silencer (A66906).
3. Connect the supplied power cable to the MiD's mains socket H.
4. If required connect an ethernet cable into one of the ports F.

CAUTION Use only clean PTFE tubing and stainless steel fittings for the nitrogen gas line to avoid contamination.

ATTENTION Utilisez uniquement des tubes en PTFE propre et des raccords en acier inoxydable pour la conduite de gaz d'azote pour éviter la contamination.

5.5.3 Switching on the system

Procedure

1. When all the electrical and gas connections have been completed, connect the MiD to the mains supply.
2. Set the power switch at the rear of the unit to 'on' (see H in Fig. 3).
3. Switch the MiD on by pressing the power button on the front panel (see L in Fig. 4). The on-board computer runs through its start-up sequence.
4. The system will start automatically.

5.5.4 The source, filter, detector (SFD) assembly

Fig. 6 illustrates the SFD assembly. The assembly consists of the following components:

- The vac-chip flange
- The ion guide
- The ionchip
- Detector assembly

The main SFD assembly and associated parts are not user changeable parts and Fig. 6 is provided as a reference only. The SFD can only be assembled and fitted to the MiD by trained personnel. When fitted, the SFD assembly creates two chambers: the analytical chamber (housing the ionchip and detector) and the ion guide chamber (housing the ion guide).

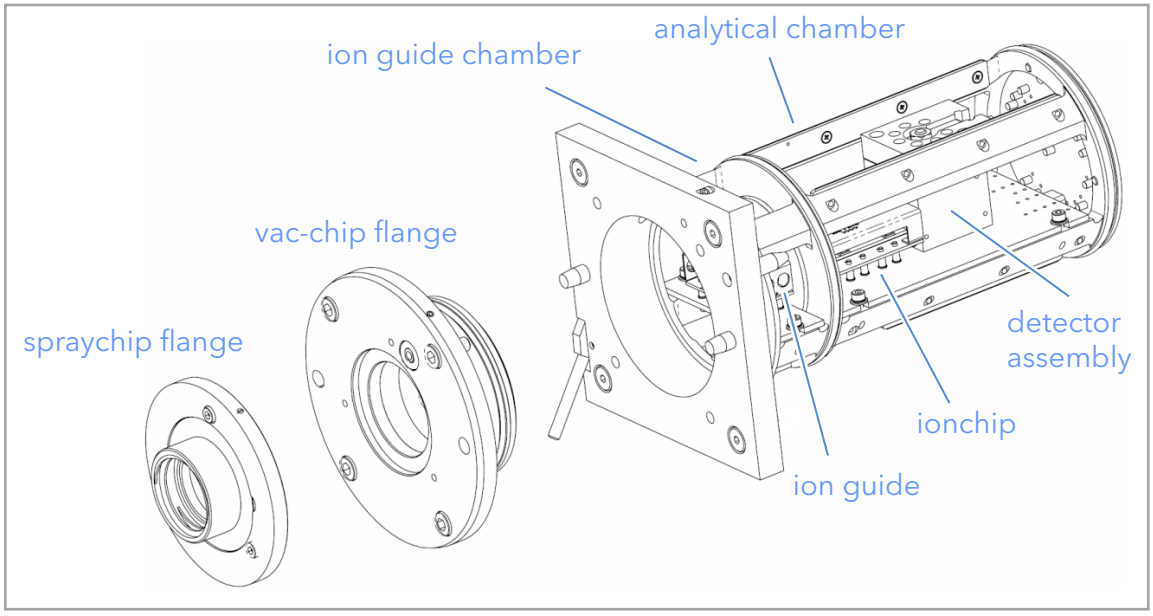

Fig. 6 The SFD assembly

5.6 The spraychip flange

The spraychip flange is used to connect the MiD's microspray source to the SFD and provides the nebuliser gas connection. The spraychip and vac-chip flanges, once assembled together, generally remain so unless extensive cleaning is required. To fit the spraychip and vac-chip flanges together follow the steps below.

Procedure

1. Ensure the O-ring is present and then lower the spraychip flange down onto the front face of the vac-chip flange. Align the three mounting holes with the threaded sections on the vac-chip flange, as shown in Fig. 7.

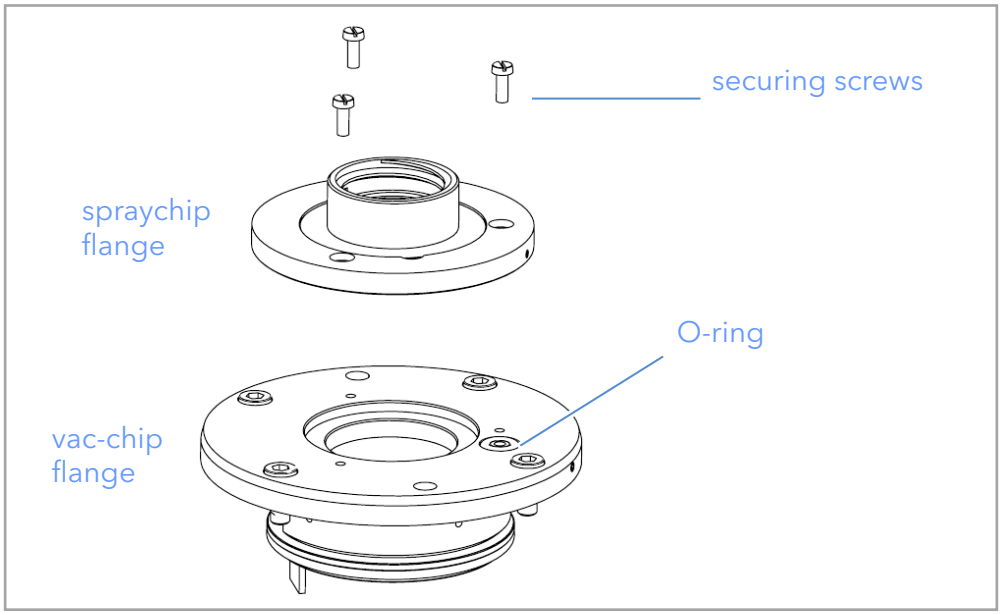

Fig. 7 Assembling spraychip flange to the vac-chip flange

2. Using the 2.5 mm 'T' allen key, screw the spraychip flange to the vac-chip flange.

   Note: There is a single orientation where the holes and threaded sections will align.

3. Removal of the flange is the reverse of fitting.

The two flanges assembled together will be referred to as the vac-chip assembly throughout the rest of these instructions.

5.7 The vac-chip assembly

The vac-chip assembly houses the vac-chip and the tube lens assembly (Fig. 7). The vac-chip assembly will be fitted and removed from the MiD as part of routine customer maintenance procedures whenever the vac-chip needs to be cleaned or replaced (see „8.7 Removing and replacing the vac-chip" on page 42 for further details).

To fit or remove the vac-chip assembly follow the subsequent steps. The vac-chip assembly is designed to be fitted or removed with the door of the MiD open.

Caution

CAUTION Always wear powder-free gloves when handling all components of the vac-chip assembly. Fingerprint residues can cause problems with the operation of these devices.

ATTENTION Toujours porter des gants non poudrés lors de la manipulation de tous les composants de l'assemblage du vac-chip. Les résidus digitales peuvent causer des problèmes de fonctionnement de ces dispositifs.

Procedure

1. The MiD without the vac-chip assembly should look like in Fig. 8.

   Note: When no vac-chip assembly is fitted an SFD cover plate (not shown) must be fitted.

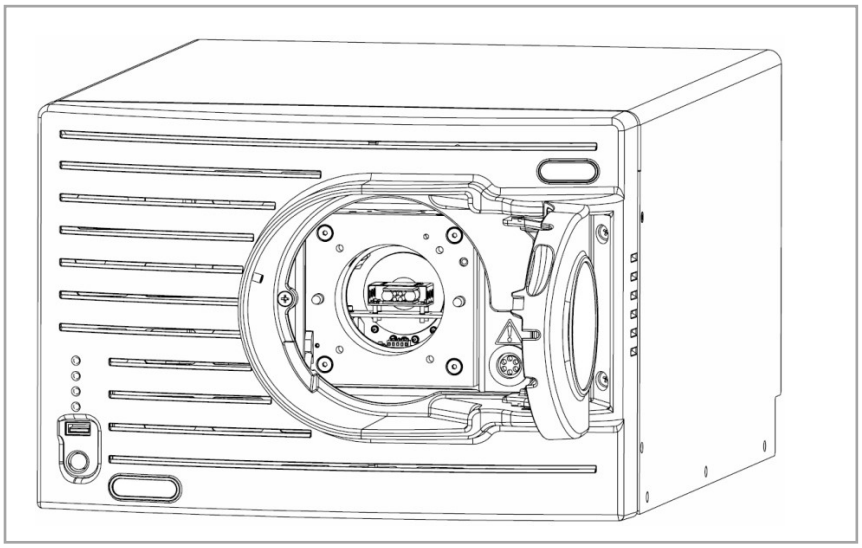

Fig. 8 MiD without the vac-chip assembly fitted

2. Locate the vac-chip flange on the SFD using the dowels as shown in Fig. 9. Gently push the vac-chip flange into place, do not force the flange into position.

Note: There is a single orientation where the holes and threaded sections will align.

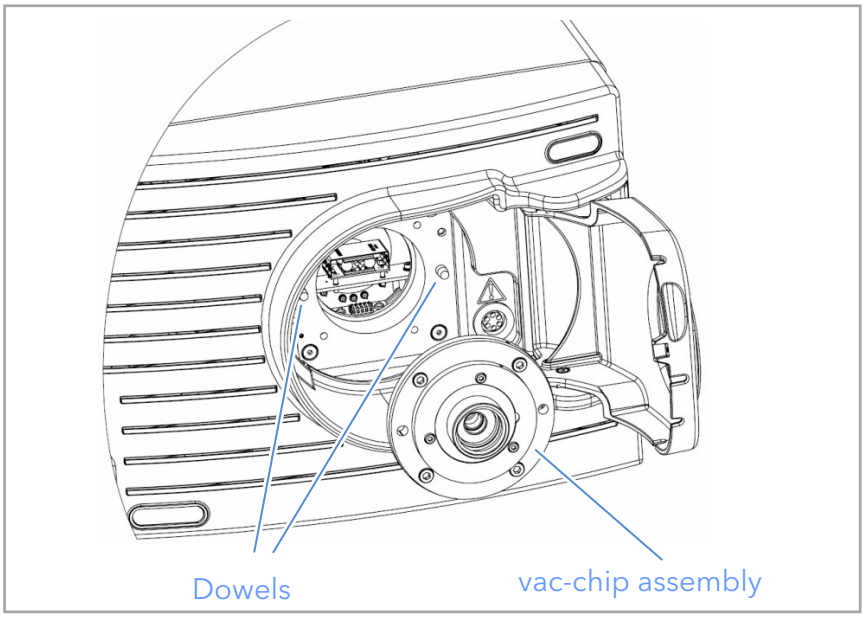

Fig. 9 The vac-chip assembly being installed on the MiD

3. If excessive resistance is felt when fitting the assembly to the SFD stop immediately, remove the assembly, and retry step 2.
4. Once positioned on the SFD fit the four M4 screws provided.
5. Use the 4 mm “T” Allen key and tighten the four M4 screws in an alternating criss-cross pattern until the screws are tight.
6. If excessive force is required stop immediately and repeat steps 2-5.
7. Once the vac-chip assembly is fitted the MiD should look as shown in Fig. 10.

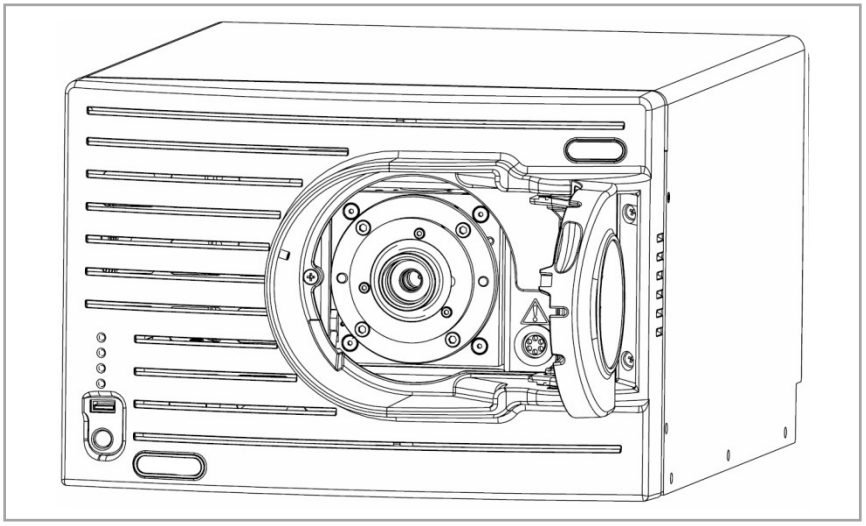

Fig. 10 vac-chip assembly fully installed on the MiD

8. To remove the vac-chip assembly from the MiD the user must first ensure the system has been vented.
9. Use the 4 mm “T” Allen key and loosen the four M4 screws in an alternating criss-cross pattern until the screws are loose.
10. Remove the four M4 screws.
11. Gently pull the vac-chip assembly away from the SFD using the dowels as guides.
12. Once the vac-chip assembly is removed, the SFD cover plate must be fitted.

Once the vac-chip assembly has been fitted the only remaining component required to complete the MiD is the microspray source which is contained within the spraychip assembly.

5.8 The spraychip assembly

The spraychip® assembly consists of the spraychip and a mounting interface, there are three available components

- The spraychip 200
- Split Flow Interface (SFI)
- Direct Flow Interface (DFI) – optional

WARNING High voltages are present in the spraychip assembly when it is in operation. Incorrect installation of the assembly could make it electrically unsafe. To prevent any risk of injury, please carefully follow the instructions provided to install the spraychip assembly.

AVERTISSEMENT Des tensions élevées sont présentes dans l’assemblage spraychip quand il est en opération. Une mauvaise installation de l’assemblage pourrait le rendre électriquement dangereux. Pour éviter tout risque de blessure, s’il vous plaît suivez attentivement les instructions fournies pour installer l’assemblage spraychip.

5.8.1 The Split Flow Interface (SFI)

The SFI incorporates a built in splitter that enables you to connect a high flow system, such as an HPLC or MiDas™ compact interface module, to the MiD. KNAUER recommends to use a flow rate range of 10 µL – 2 mL/min. The SFI is also used for calibrating the MiD (see „7.1 Calibrating the MiD“ on page 30).

The SFI is designed to use 1/32“ OD PEEK tubing for the input and waste lines. Various split ratios can be achieved by connecting a suitable length of PEEK tubing to the waste (high flow) port.

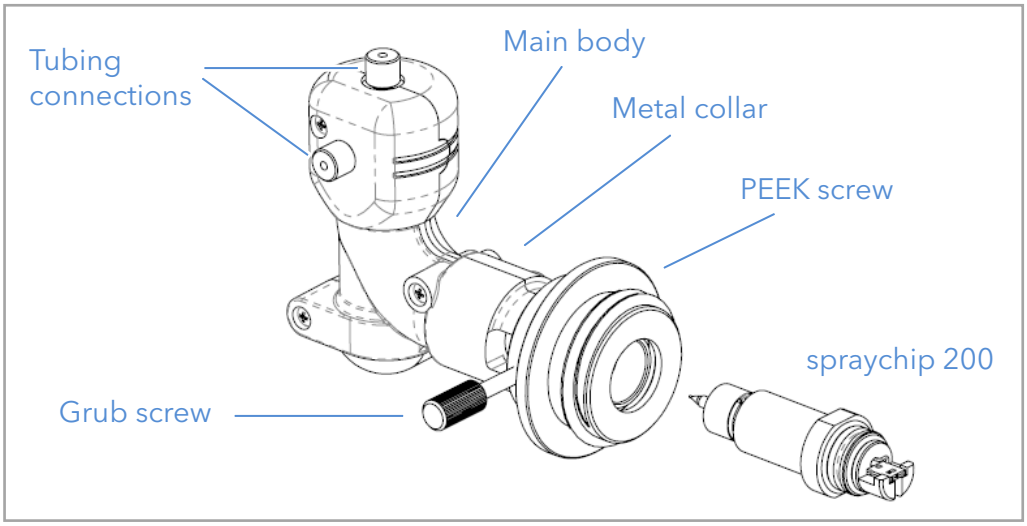

Fig. 11 The Split Flow Interface (SFI)

To assemble the spraychip to the main body of the SFI use the following procedure.

Procedure

1. Place the PEEK screw over the metal collar as shown in Fig. 11.
2. Unscrew the grub screw so that the spraychip 200 body will fit easily through the PEEK screw and metal collar.

   Note: Do not completely remove/unscrew the grub screw from the metal collar.

3. Carefully insert the spraychip 200 into the SFI and screw the body into the conductive union until finger tight.

   Note: Do not use a tool and do not overtighten the spraychip 200.

4. Fasten the spraychip into the SFI using the grub screw. The assembled SFI will look as shown in Fig. 12.

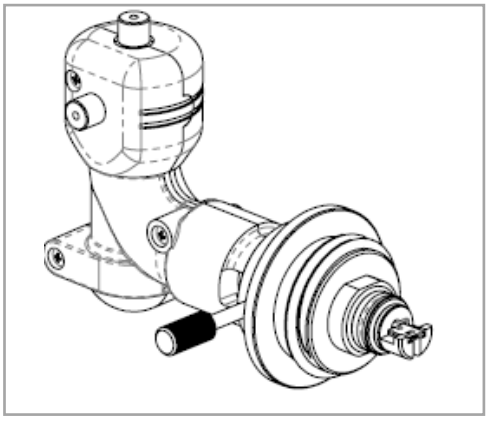

Fig. 12 Assembled SFI

Note: The orientation of the spraychip 200 will vary when fitted.

5. For removing the spraychip from the SFI reverse steps 1-5.

The SFI can be fitted to the MiD in two orientations, shown in Fig. 13. The functions of the two tubing connections on the main body are not interchangeable. They are used as the input line and as the waste line of the split.

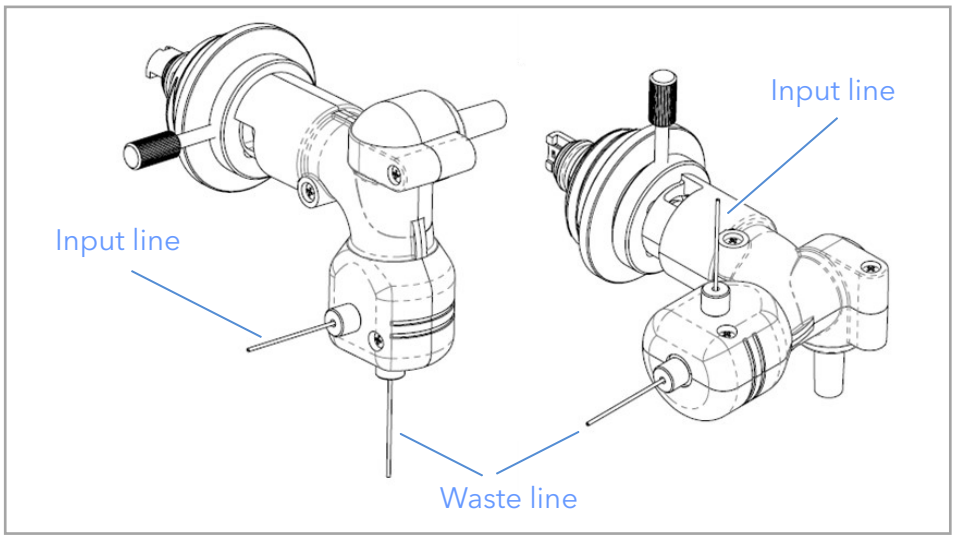

Fig. 13 SFI orientations

When creating a split with the SFI, it is important to note the following:

- KNAUER recommends a flow rate of 0.3 - 2 µL/min to the spraychip 200.
- The split ratio can be changed by changing both the inner diameter and the length of the waste line (high flow tube).
- The split ratio varies with the input flow rate and liquid composition (changes during a gradient).
- Flow rates can be measured using the flow meter assembly, see section „8.4 Liquid flow rate measurement“ on page 35.
- For a fixed length decreasing the diameter of the waste line increases the spraychip flow rate.
- For a fixed diameter increasing the length of the waste line increases the spraychip flow rate.
- Changing the diameter of the waste line has a greater effect on the split ratio than changing the length.

To reduce the delay time between the liquid system and any associated signal (for example a UV cell) the length of the fluidic connections between the liquid system and the SFI should be kept to a minimum.

You can create your own split by connecting an appropriate waste line to the SFI. Appendix A: Flow Splitting details how to calculate the theoretical flow rates from a ratio of tube lengths and diameters.

5.8.2 The Direct Flow Interface (DFI) – optional

The DFI can be used to directly infuse samples from a syringe pump and couple the MiD to a nano-flow LC system. KNAUER recommends a flow rate range of 200 – 2000 nL/min to the spraychip 200.

The DFI consists of two conductive unions connected by a 50 mm length of 25 µm ID PEEK tubing. The DFI is designed to accept 1/32" OD PEEK tubing as the input line.

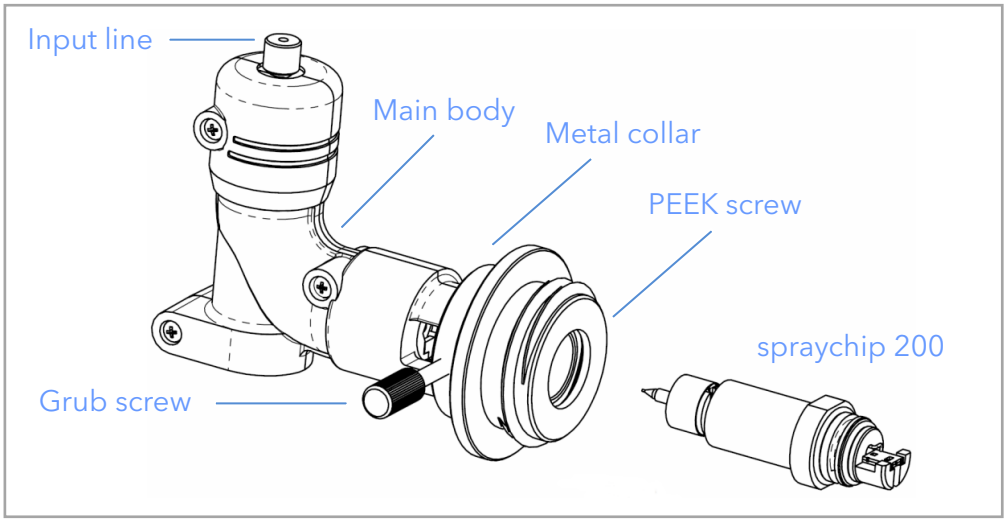

Fig. 14 The Direct Flow Interface (DFI)

To assemble the spraychip to the main body of the DFI use the same procedure as detailed for the SFI (see section 5.8.1 on page 23).

5.8.3 Installing spraychip assemblies

The DFI and SFI assemblies can both be fitted to the MiD using the procedure which is detailed below.

Procedure

1. Ensure the door is open at 90°.
2. Before fitting a spraychip assembly to the MiD a nitrogen flush of the interface must be initialised. Open the software and click the nitrogen flush button, after a few seconds a flow of nitrogen gas should be audible.
3. Align the DFI/SFI and spraychip 200 with the opening in the vac-chip assembly.
4. Gently slide the DFI/SFI into the assembly until the PEEK screw reaches the threaded section of the vac-chip assembly. Take care during insertion that the spraychip 200 does not collide with the metalwork.
5. Screw the PEEK collar into the assembly until finger tight.

Note: If there is any excessive resistance when tightening the screw, stop and repeat steps 3-5.

6. Connect the high-voltage connector from the DFI/SFI to the high-voltage output located at the front of the MID, see Fig. 15.
7. Close the door of the front cover.

Note: Ensure the PEEK tubing lines from the DFI/SFI are fed through the cut-outs in the door, see Fig. 15.

8. Removal of the DFI/SFI is the reverse of fitting. Removal of the assembly must not be performed without the nitrogen flush active. Once removed a dust cap should be fitted to the vac-chip assembly.

Note: The dust cap is available as part of the SFD cover kit.

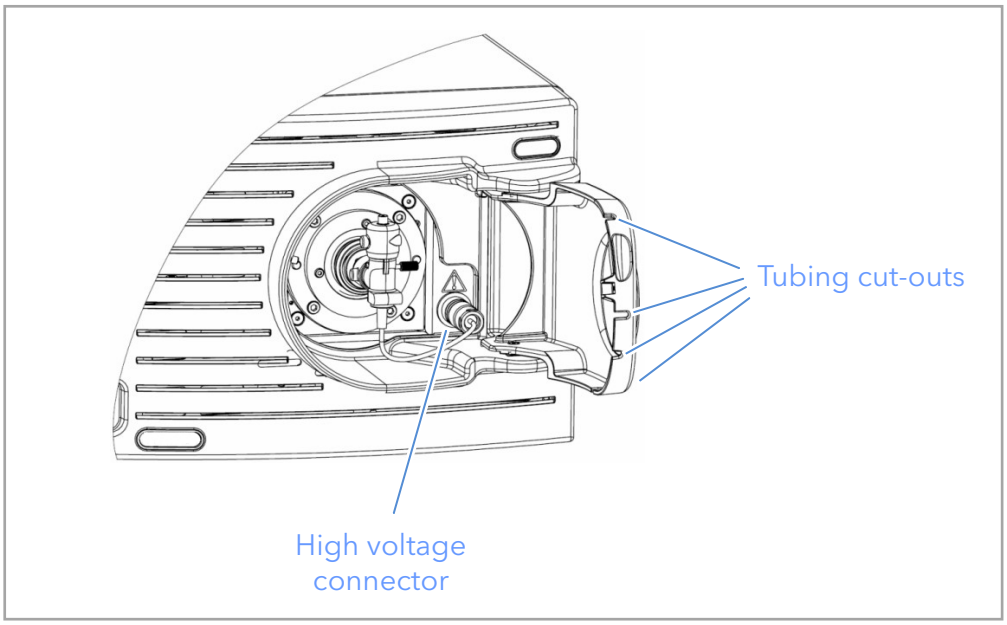

Fig. 15 The spraychip assembly installed on the MiD

5.8.4 Operating the front cover safety interlock

The MiD has a safety interlock system to protect users from high voltages. This system is operated by the door in the front cover. The door has two positions as shown in Fig. 16.

When the door is shut, the safety interlock is off and high voltages can be applied, his is indicated in the Status bar. When the door is fully closed it should be pushed gently forward until the catch engages with the front cover. The catch is designed to prevent accidental activation of the safety interlock.

When the door is opened, the safety interlock is engaged and high voltages are disabled, again indicated in the Status bar. The door will click into position when the door reaches 90° and will remain fixed in this orientation until pushed shut.

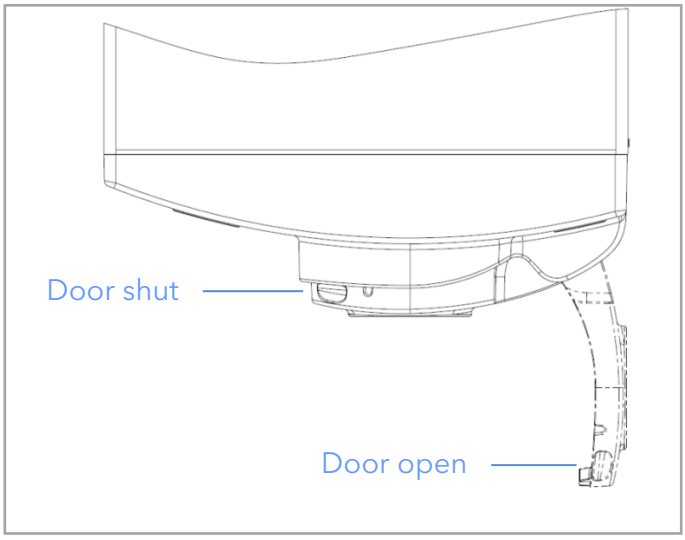

Fig. 16 Front cover door positions

5.8.5 Installing a syringe pump

You must install a syringe pump in order to calibrate the instrument or to analyse samples directly infused via syringe.

You can use any stand-alone syringe pump to deliver liquid to the spray-chip. Please follow the instructions, including all safety references, listed in the manuals supplied with your syringe pump.

Note: You must have a syringe, fittings, and tubing for connecting the syringe pump to the MiD before installation.

	**CAUTION** If the MiD is installed as a constituent part of another system, the safety of the assembled system is the responsibility of the person responsible for that systems assembly. **ATTENTION** Si le MiD est installé en tant que partie intégrante d'un autre système, la sécurité du système assemblé est de la responsabilité de la personne responsable de cette assemblage.
	**CAUTION** When installed, during normal operation, this product has a sound pressure emission (at the operator position and 1m from the rear of the instrument) of <70dB. **ATTENTION** Une fois installé et en fonctionnement normal, ce produit a une émission de pression acoustique (à la position de l'opérateur et de 1 m de l'arrière de l'instrument) de <70dB.
	**CAUTION** To ensure the stated sound level is met the pump exhaust port must either be connected a laboratory exhaust system (see the section „5.5.2 The rear panel" on page 17) or have a silencer fitted (available from KNAUER). **ATTENTION** Pour garantir le niveau sonore indiqué soit atteint, l'orifice d'échappement de la pompe doit être connectée soit un système d'échappement en laboratoire (voir la section sur le panneau arrière, page 17) ou alors d'êtres équipé d'un silencieux (disponible auprès d'KNAUER).
	**WARNING** Removal of the top cover of the 4000 MiD can lead to the risk of personal injury and exposure to hazardous voltages. Never remove the cover of the 4000 MiD, only certified persons are authorised to carry out repairs internally. **AVERTISSEMENT** Le retrait du couvercle du 4000 MiD peut conduire à un risque de blessures et d'exposition à des tensions dangereuses. Ne retirez jamais le couvercle du 4000 MiD, seules les personnes certifiées sont autorisées à effectuer des réparations internes.

6. Operation

6.1 Preparing to analyse

This section describes the steps you need to follow in order to prepare the MiD for analysing chemical samples.

Note: Follow each subsection in order.

6.1.1 MiD system pump-down

The MiD has to be pumped down before it can be used for analysis. To pump the system down the user should follow the steps detailed below.

Procedure

1. Click the"pump down" button in the software. This will initiate the pump down cycle. Nitrogen gas purges the interface before the vacuum pumps are activated.
2. Allow 30 minutes to ensure pump down is complete and all electronics are warmed-up and functioning within their correct environmental parameters.

   The base pressures in the ion guide (IG) chamber and analytical (AQ) chamber must be below ~2.0 E-3 Torr and 5.0 E-4 Torr, respectively. Pressure readouts for these chambers are displayed in the software. Check these pressures are achieved before proceeding further.

   To vent the system, click the vent button in the software. This will initiate the vent cycle. The user will be prompted to confirm before the vent cycle starts.

6.2 Shutting down the MiD

The following section details the basic procedures for putting the MiD into 'standby', venting the system, and powering down the system.

6.2.1 Entering 'Standby' mode

Procedure

1. If using an LC system, flush the system using a mobile phase solution containing 95% of the organic solvent. Follow the procedure described in the corresponding software instructions.
2. Monitor the spray current in the software. The spray current value turns grey when the microspray has stopped.
3. Click the Operate/Standby button to set the instrument to standby mode. All high voltages and the nebuliser gas are switched off.

6.2.2 Venting the MiD

The MiD can be left in standby mode. If, however, you need to vent the MiD to atmosphere, to change the vac-chip for example, please follow the instructions below.

Procedure

1. Click the vent button in the software.
2. A dialog appears to confirm that you wish to vent the instrument. Click <Yes>. The MiD vents to atmosphere, and the pressures in the analytical and ion guide chambers increase to 9.0E2 Torr.

6.2.3 Shutting down the MiD

At times, the MiD has to be powered down, for example, when service or maintenance work has to be performed. Follow the procedure in the corresponding software instructions.

7. Functional tests

Note: Standard processes regarding IQ and OQ in single devices may be handeled differently in individual cases.

7.1 Installation Qualification (IQ)

The customer may request the Installation Qualification, which is free of charge. In case of a request, the Technical Support of KNAUER or from a provider authorized by KNAUER performs this functionality test during the installation.

The Installation Qualification is a standardized document that includes the following:

- confirmation of flawless condition at delivery
- check if the delivery is complete
- certification on the functionality of the device

7.2 Operation Qualification (OQ)

The Operation Qualification includes an extensive functionality test according to KNAUER standard OQ documents. The Operation Qualification is a standardized document and free of charge. It is not part of the delivery, please contact the Technical Support in case of request.

The Operation Qualification includes the following:

- definition of customer requirements and acceptance terms
- documentation on device specifications
- device functionality check at installation site

Test intervals To make sure that the device operates within the specified range, you should test the device regularly. The test intervals are dependent on the usage of the device.

Execution The test can be carried out either by the Technical Support of KNAUER or from a provider authorized by KNAUER (for a fee).

8. Calibration

The MiD has to be calibrated before any sample analyses can be performed. Sodium Formate (NaOOCH) is used to calibrate the 4000 MiD. The required solution is 1 mg/mL in 1:1 2-propanol:water. It is recommended that the MiD is recalibrated if known m/z or resolution values have shifted, an ion guide or ionchip is replaced or the MiD is moved to a new environment.

Note: It is essential that the solution used for calibration is free of particulates as they can affect the microspray. If filters are used during sample preparation it is recommended that non-cellulose based filters are used, for example nylon based 0.22 µm filters.

8.1 Installing the calibration kit

The peaks calibration is performed via SFI by using the KNAUER calibration kit (A66916) and infusing the appropriate calibration solution directly from a syringe pump.

Procedure

1. If the MiD is turned off, switch it on and pump the instrument down, as described in the section MiD system pump-down.
2. Fill the luer lock syringe (A66918) with the calibration solution ensuring there are no air bubbles in the syringe.
3. Fit the syringe to the syringe pump ensuring the syringe piston is tightly gripped to the pump barrel.
4. Disconnect the PEEK tubing from SFI input and waste line ports.
5. Install the plug (A66917) into the waste line port of the SFI and complete all fluidic connections between the SFI and the syringe (see Fig. 17).

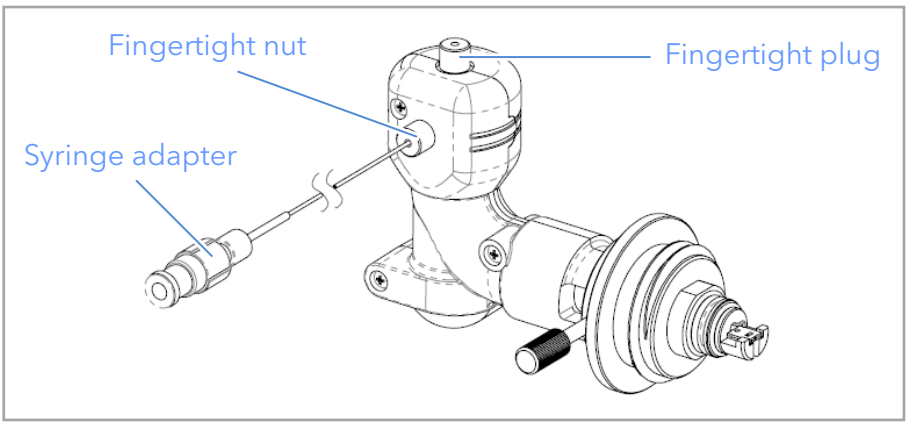

Fig. 17 Calibration kit set up

Note: Make sure the connection line is flushed with calibration solution before connecting the line to the SFI.

8.2 Calibration routine

The calibration of the MiD can be performed via the control software. For detailed information on the procedure please refere to the corresponding software instructions.

8.3 Flushing the system after calibrating

After the calibration routine is completed, the calibration kit, SFI and spraychip should be flushed to remove any trace of the calibration solution.

Procedure

1. Disconnect the SFI plug and infusion line from the SFI.
2. Manually flush the syringe and the infusion line with 50:50 (v/v) mixture of HPLC grade methanol and water with no additives.
3. Connect the PEEK tubing to the SFI input and waste line ports.
4. Attach the SFI to your LC system and infuse 50:50 (v/v) mixture of HPLC grade methanol and water with no additives at 1 mL/min for 5 minutes.
5. The system is now clean and ready for use.

9. Maintenance

9.1 General maintenance

There are no user serviceable parts in the 4000 MiD. The maintenance procedures described in this chapter must be carried out with the MiD in its installed location.

To perform any of the maintenance procedures the door has to be opened with the safety interlock engaged. If in any doubt, power down the instrument (see the section „6.2.3 Shutting down the MiD“ on page 28) and perform the maintenance with the instrument disconnected from the mains.

The external surfaces of the 4000 MiD can be cleaned by wiping the surfaces down with 10% aqueous isopropyl alcohol.

It is recommended to perform periodic inspections and maintenance of the 4000 MiD components to ensure its operational performance. The recommended inspection and maintenance periods are listed in the table below and presented as guidance only. The frequency of the maintenance will vary depending on the system usage and type of sample analysed.

It is recommended to flush the system daily with Methanol and Water for 10 minutes to remove the sample from the microfluidic lines and minimise system carryover.

Recommended inspection and maintenance periods for the 4000 MiD components:

Components	Daily	Weekly	Monthly	Page
System flush	X			31
Spraychip		X		34
Vac-chip		X		45
SFI			X	36
DFI			X	36
Vac-chip flange			X	46

WARNING The 4000 MiD must be disconnected from the mains supply if the exterior surfaces are being cleaned to avoid risk of electric shock

AVERTISSEMENT Le 4000 MiD doit être débranché de la prise du secteur si les surfaces extérieures sont en cours de nettoyage pour éviter tout risque de choc électrique.

WARNING The manufacturer is not responsible for any damage caused by improper use of the MiD, improper maintenance, unauthorized modifications or failure to comply with the procedures detailed in the manufacturers documentation.

AVERTISSEMENT Le fabricant plc n'est pas responsable de tout dommage causé à la suite d'une mauvaise utilisation du MID, d'un mauvais entretien, de modifications non autorisées ou du non-respect des procédures décrites dans la documentation du fabricant.

The items used with the 4000 MiD that can be maintained by the user are the spraychip 200®, vac-chip™, DFI and SFI. All items can be cleaned and/or replaced by the user. The recommended procedures for replacing/cleaning the items are detailed in the following sections.

The following warning notices apply to all cleaning procedures detailed in this chapter.

WARNING Handling, toxic, flammable and hazardous chemicals can lead to health and safety risks.

AVERTISSEMENT La manipulation de produits chimiques toxiques, inflammables et dangereux peut conduire à des risques de santé et de sécurité.

WARNING Local safety regulations must be followed and suitable PPE must be worn. The chemicals should only be handled in accordance with manufacturers MSDS (Material Safety Data Sheet).

AVERTISSEMENT Les règles de sécurité locales doivent être respectées et des EPI adaptés doivent être portés. Les produits chimiques ne doivent être manipulés que conformément aux directives des fabricants MSDS (Material Safety Data Sheet).

WARNING Appropriate safety measures should be observed when using the ultra-sonic bath (please refer to the manufacturer's notes).

AVERTISSEMENT Des mesures de sécurité appropriées doivent être observées lors de l'utilisation du bain à ultra-sons (s'il vous plaît se référer aux notes du fabricant).

CAUTION Always wear powder-free gloves when handling all components of the vac-chip assembly. Fingerprints can cause problems with the operation of these devices.

ATTENTION Toujours porter des gants non poudrés lors de la manipulation de tous les composants de l'assemblage du vac-chip. Les empreintes digitales peuvent causer des problèmes de fonctionnement de ces dispositifs.

9.2 Removing and replacing the spraychip

Replace the spraychip® 200 when sensitivity decreases to unacceptable levels. Please follow the procedure below in the event that the spraychip has to be replaced or removed.

Procedure

1. Put the MiD into standby mode, if necessary, by clicking the Operate/ Standby button.
2. Activate the N2 flush, after a few seconds a flow of nitrogen gas should be audible.
3. Ensure the door is fully open at 90˚.
4. Disconnect the flow interface (DFI or SFI) high-voltage connector from the high-voltage output located at the front of the MiD (see Fig. 15).
5. Unscrew the spraychip assembly from the MiD. Once removed, a dust cap should be fitted to the vac-chip assembly.
6. Unscrew the grub screw to unfasten the spraychip from the assembly (see Fig. 32 for reference).

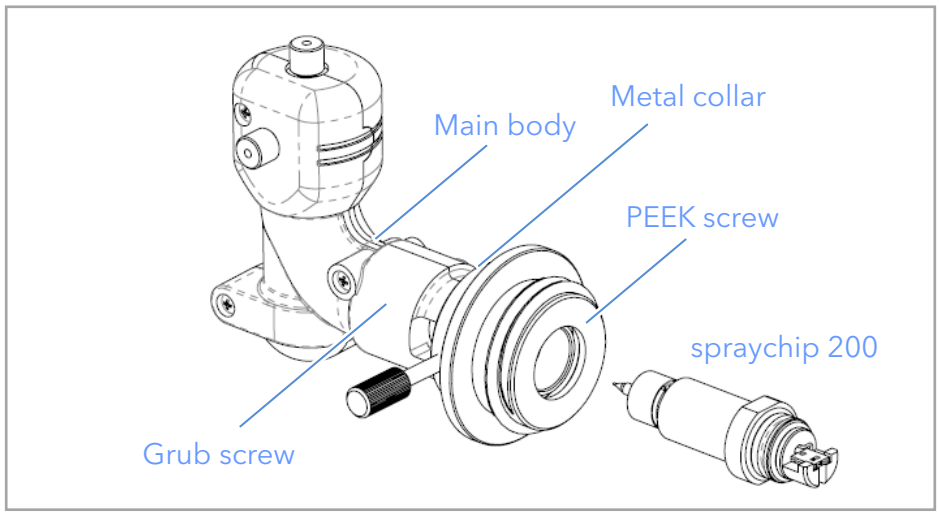

Fig. 18 The Split Flow Interface (SFI)

7. Carefully unscrew and remove the spraychip from the DFI/SFI.
8. Carefully screw a new (or cleaned) spraychip into the assembly.

   Note: Do not use a tool and do not overtighten the spray-chip.

9. Tighten the grub screw. This fastens the spraychip into position.
10. Align the DFI/SFI and spraychip with the opening in the vac-chip assembly
11. Gently slide the DFI/SFI into the assembly until the PEEK screw reaches the threaded section of the vac-chip assembly. Take care during insertion that the spraychip does not collide with the metalwork.
12. Screw the PEEK collar into the assembly until finger tight.

    Note: If there is any excessive resistance when tightening the screw, stop and repeat steps 6–12.

13. Connect the high-voltage connector from the DFI/SFI to the high-voltage output located at the front of the MID (see Fig. 15).
14. Close the door.

9.3 Cleaning the spraychip

This is the recommended cleaning procedure for the spraychip. The calibration kit will be required to follow the procedure in this section. The spraychip can be cleaned by using either the DFI or SFI.

9.3.1 Cleaning the Spraychip with DFI

Procedure

1. Fill a syringe with a 50:50 (v/v) mixture of HPLC grade methanol and water with no additives and mount in a syringe pump.
2. Attach the DFI to the syringe using the adaptor and tubing provided for calibration.
3. Screw the spraychip to be cleaned into the DFI and place it on a lint free tissue on a flat surface.

CAUTION Do not mount the DFI to the MiD during this process

ATTENTION Ne montez pas le DFI á la MiD au cours de ce processus

4. Infuse at least 150 µL of the water/methanol using a flow rate of 10 µL/min. The solution will flood the spraychip during this process.
5. Unscrew the spraychip from the DFI and gently blow dry with compressed air/nitrogen to remove any excess liquid.
6. Leave the spraychip for a few hours to dry completely
7. The spraychip is now clean and ready for use.

Note: If an increased delay is observed on the split flow interface (SFI) when using the cleaned spraychip then attempt to clean again. In the event that this delay continues to be unacceptable then the spraychip must be replaced.

If the spraychip looks visually degraded or you have any queries please contact KNAUER before using the device.

9.3.2 Cleaning the Spraychip with SFI

Procedure

1. Fill a syringe with a 50:50 (v/v) mixture of HPLC grade methanol and water with no additives and mount in a syringe pump.
2. Disconnect the PEEK tubing from the SFI (input and waste line).
3. Install the SFI plug into the waste line port and complete all fluidic connections between the SFI and the syringe.
4. Screw the spraychip to be cleaned into the SFI and place it on a lint free tissue on a flat surface.

CAUTION Do not mount the SFI to the MiD during this process

ATTENTION Ne montez pas le SFI á la MiD au cours de ce processus

5. Infuse at least 150 µL of the water/methanol using a flow rate of 10 µL/min. The solution will flood the spraychip during this process.
6. Unscrew the spraychip from the SFI and gently blow dry with compressed air/nitrogen to remove any excess liquid.
7. Leave the spraychip for a few hours to dry completely
8. The spraychip is now clean and ready for use.

Note: If an increased delay is observed on the split flow interface (SFI) when using the cleaned spraychip then attempt to clean again. In the event that this delay continues to be unacceptable then the spraychip must be replaced.

If the spraychip looks visually degraded or you have any queries please contact KNAUER before using the device.

9.4 Liquid flow rate measurement

In the case that sensitivity or spray stability remains poor after cleaning or replacement of the spraychip 200. It is recommended the liquid flow rate through the spraychip assembly is measured. This can be performed on both the DFI and SFI. To measure the liquid flow rate, the flow meter assembly (Fig. 33) will be required.

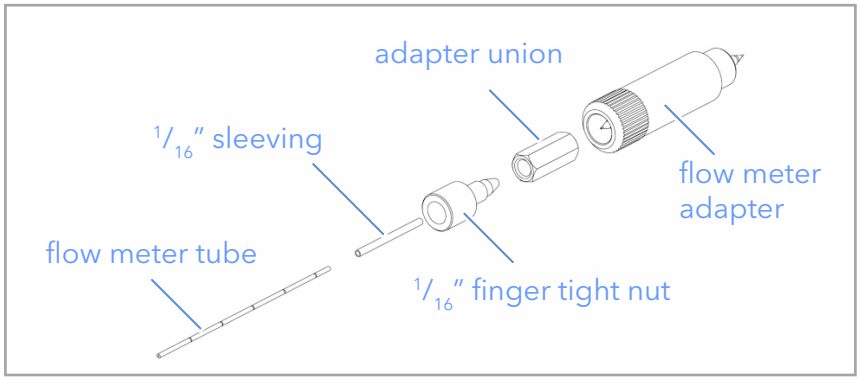

Fig. 19 Flow meter assembly

Procedure

1. Remove the spraychip from the DFI/SFI (see „8.2 Removing and replacing the spraychip“ on page 33).
2. Fit the flow meter assembly to the DFI or SFI as required, using the same procedure as when fitting a spraychip. An SFI complete with the flow meter assembly is shown in Fig. 34.

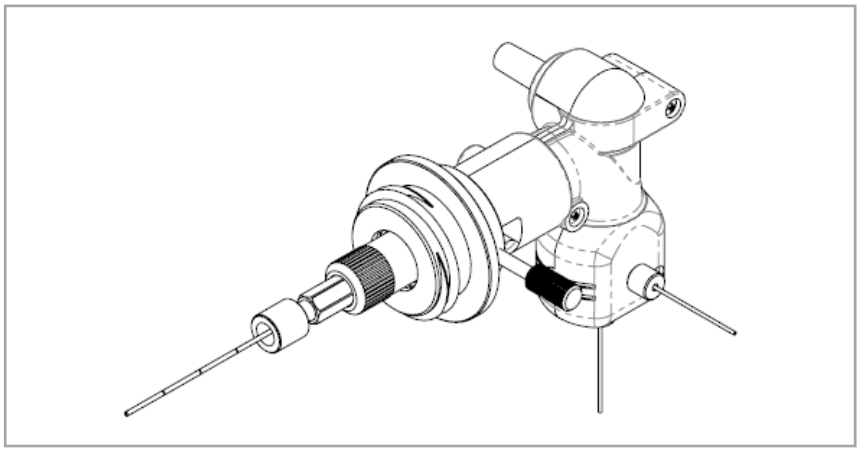

Fig. 20 SFI with flow meter assembly

3. Set the desired input flow rate for the liquid/solvent supply e.g. LC or syringe pump.
4. Turn on the pump.

Note: Flow rates should only be measured with the flow meter tube in a horizontal position.

5. Start a timer when the liquid meniscus reaches the first visible graduation on the flow meter tube.
6. Measure the time taken for the liquid meniscus to travel over a number of graduations.
7. Stop the timer when the mobile phase reaches the desired graduation on the flow meter tube.
8. The output flow rate can now be calculated using the following equation:

$$\text{Flow rate (µL/min)} = \frac{\text{Number of divisions}}{\text{Time/min}}$$

Note: The measured flow rate should be slightly higher (~20%) than the desired flow rate defined from the spit ratio

9. If the flow rate is not as expected, repeat the measurement using steps 3-8.
10. If the measured flow rate is still incorrect, the next step is to clean the DFI/SFI see section 8.5 below.

The same procedure can be used to measure the output flow when a custom split ratio is created for an SFI (see„5.8.1 The Split Flow Interface (SFI)“ on page 23). If the measured flow is incorrect the user can simply change the length or diameter of the waste line and re-measure the flow rate.

9.5 Spraychip assembly cleaning

The DFI and SFI can both be flushed and cleaned. The flow meter assembly will be required to follow the procedures in this section.

9.5.1 Cleaning the Direct Flow Interface

The following procedure should be used to clean the DFI.

Procedure

1. Fill a syringe with a 50:50 (v/v) mixture of HPLC grade methanol and water with no additives and mount in a syringe pump.
2. If fitted remove the spraychip from the DFI (see „8.2 Removing and replacing the spraychip“ on page 33).
3. Screw the flow meter adaptor into the DFI (Fig. 35) using the same procedure as when fitting a spraychip (see „8.2 Removing and replacing the spraychip“ on page 33).

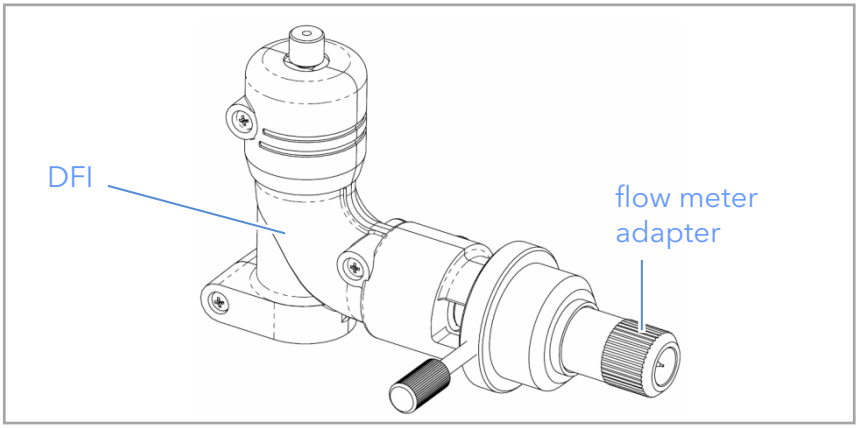

Fig. 21 DFI with flow meter adapter

4. Attach the DFI to the syringe using the input line provided with the calibration kit.

CAUTION Do not mount the DFI to the MiD during this process

ATTENTION Ne montez pas le DFI á la MiD au cours de ce processus

5. Attach the input line to the syringe.
6. Using the syringe pump, infuse at least 100 µL of the methanol/water solution through the DFI at a flow rate of 10 µL/min. The solution will flow through the DFI and will drip from the end of the flow meter adaptor.
7. When the desired amount of solvent has been infused stop the syringe pump.
8. Remove the flow meter adaptor from the DFI using the same procedure as when removing a spraychip.
9. The DFI is now clean and ready for use.

In the event the DFI appears blocked and/or the measured flow rate is incorrect, then replace the low flow tubing located inside the DFI (see „8.6 Spraychip assembly maintenance“ on page 38).

9.5.2 Cleaning the Split Flow Interface

The following procedure should be used to clean the SFI.

Procedure

1. Fill a syringe with a 50:50 (v/v) mixture of HPLC grade methanol and water with no additives and mount in a syringe pump.
2. If fitted, remove the SFI from the MiD (see „5.8.3 Installing spraychip assemblies“ on page 25) and remove the spraychip (see „8.2 Removing and replacing the spraychip“ on page 33).
3. Fit the following components of the flow meter assembly to the SFI; flow meter adapter and adaptor union.
4. Attach the SFI to the syringe using the adaptor union and the provided infusion line and fitting (Fig. 36).

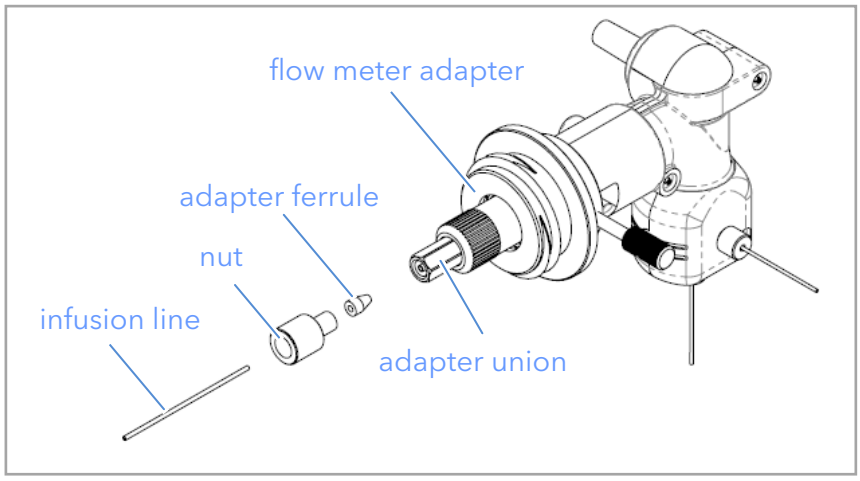

Fig. 22 SFI and flow meter adapter fittings

5. Using the syringe pump flush the SFI.
6. Infuse at least 200 µL of the methanol/water solution through the SFI. The solution will drip from the end of the waste and input lines of the SFI.

7. Disconnect the infusion line and the adaptor fitting from the SFI.
8. The SFI is now clean and ready for use.
9. To check the SFI is working as expected measure the output flow rate (see „8.4 Liquid flow rate measurement“ on page 35).

Note: The measured flow rate should be slightly higher (~20%) than the desired flow rate defined from the spit ratio

In the event the SFI appears blocked and/or the measured flow rate is incorrect, then replace the low flow tubing located inside the SFI (see „8.6 Spraychip assembly maintenance“ on page 38). If the problem persists and/or you have any queries please contact KNAUER before using the SFI.

9.6 Spraychip assembly maintenance

When the spraychip assemblies appear blocked and/or the measured flow rates are incorrect, then the low flow tubing should be replaced. The following sections detail the procedures for replacing the tubing in both the DFI and SFI assemblies. The SFI/DFI tubing kit (A66919) will be required for the following sections.

9.6.1 Replacing the Direct Flow Interface tubing

The following procedure should be used to replace the tubing inside the DFI.

Procedure

1. Place the DFI onto a clean surface.
2. If fitted, remove the spraychip from the DFI (see „8.2 Removing and replacing the spraychip“ on page 33).
3. Unscrew the grub screw until the metal collar will rotate when twisted.

Note: Do not completely remove the grub screw from the metal collar.

4. Rotate the collar until the grub screw is in the ‘11 o’clock’ position, gently remove/pull the metal collar from the body of the DFI (Fig. 37).

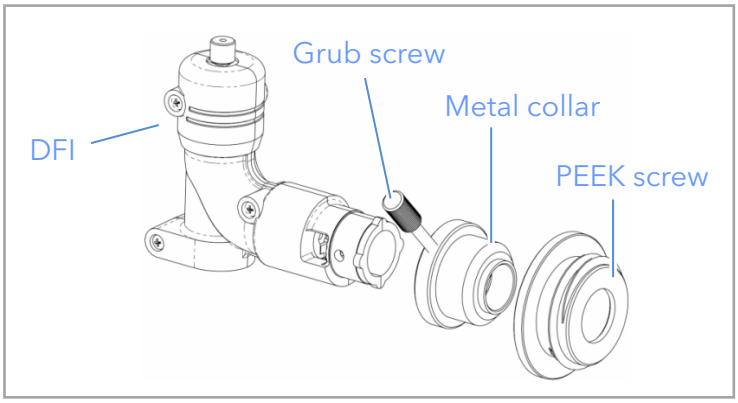

Fig. 23 DFI with PEEK screw and metal collar

5. Using the PH1 Phillips screwdriver, loosen the three screws in the main body of the DFI. Once the screws are loose remove the top cover of the DFI (Fig. 38).

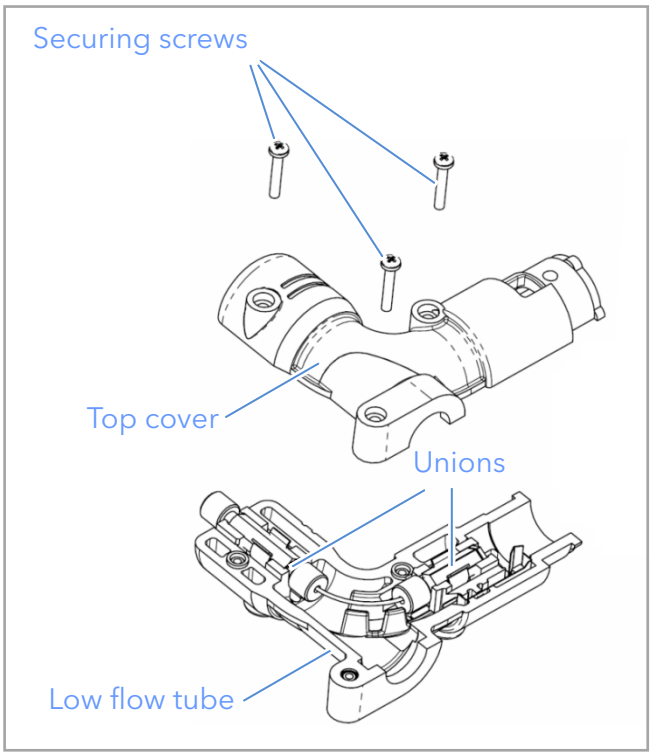

Fig. 24 DFI with cover opened

Note: It is not necessary to remove the three screws from the top cover of the DFI.

6. Remove the unions and tubing from the DFI base using the plastic tweezers (Fig. 39).

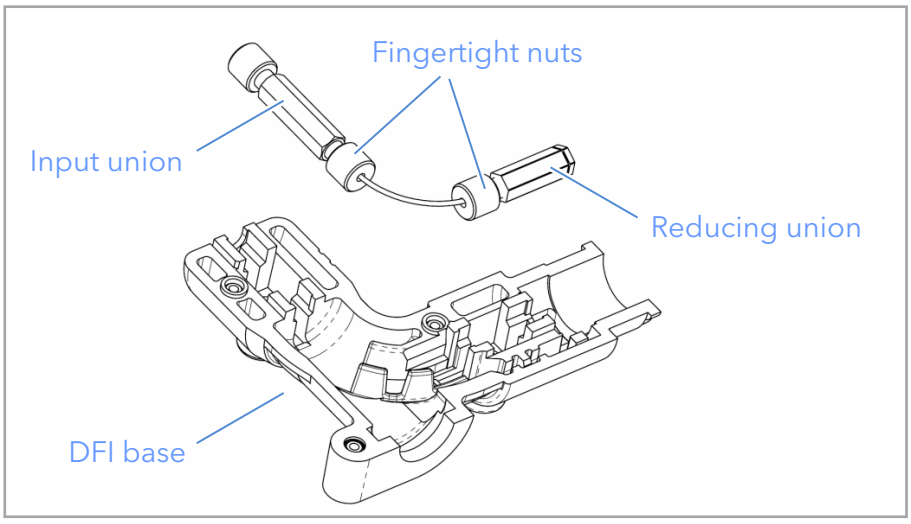

Fig. 25 DFI with unions and low flow tube removed

7. Unscrew the fingertight nuts from the input and reducing unions and remove the low flow tube.
8. To fit a new low flow tube, first slide the tube through one of the fingertight nuts.
9. Fit the nut to the input union, the larger of the two; push the tube into the union whilst tightening the nut.
10. Slide the opposite end of the low flow tube into the second finger-tight nut.

11. Use the weight of the input union to maintain pressure on the tube whilst tightening the nut into the reducing union.
12. Press the unions and tube back into position within the DFI. The unions will click into the metal clips and the moulding of the DFI base. Ensure the unions are fitted as shown in Fig. 38.

    Note: The unions will only fit into the DFI base in one configuration. Do not force the unions to fit.

13. Refit the DFI cover and tighten the 3 securing screws using the PH1 Phillips screwdriver.
14. Refit the metal collar and PEEK screw by reversing steps 3-5.

The DFI low flow tube has been successfully changed. Fit either a spraychip 200 or measure the flow rate (Liquid flow rate measurement). If the initial problem persists and/or you have any queries please contact KNAUER.

9.6.2 Replacing the Split Flow Interface tubing

The following procedure should be used to replace the tubing inside the SFI.

Procedure

1. Place the SFI onto a clean surface.
2. If fitted remove the spraychip from the SFI (see „8.2 Removing and replacing the spraychip“ on page 33).
3. Unscrew the grub screw until the metal collar will rotate when twisted.

   Note: Do not completely remove the grub screw from the metal collar.

4. Rotate the collar until the grub screw is in the ‘11 o’clock’ position, gently remove/pull the metal collar from the body of the SFI (Fig. 40).

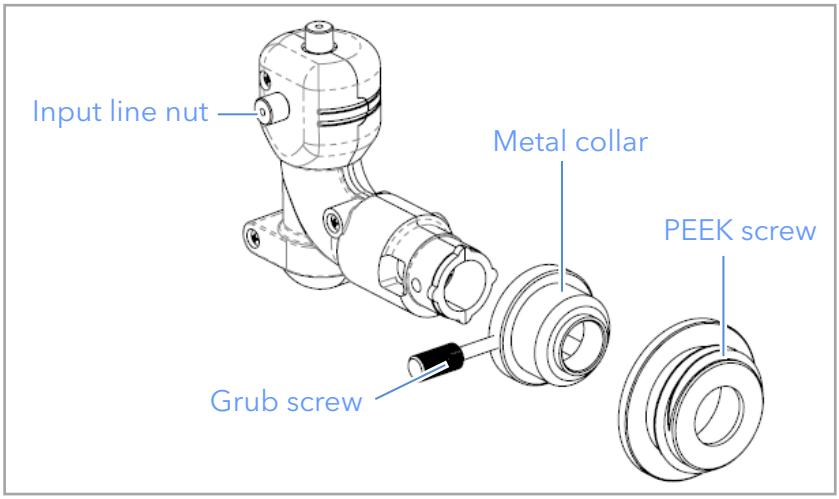

Fig. 26 SFI with PEEK screw and metal collar

5. Unscrew the input line nut (Fig. 40 and Fig. 41) and associated tubing.
6. Using the PH1 Phillips screwdriver, loosen the three screws in the main body of the SFI. Once the screws are loose remove the top cover of the SFI (Fig. 41).

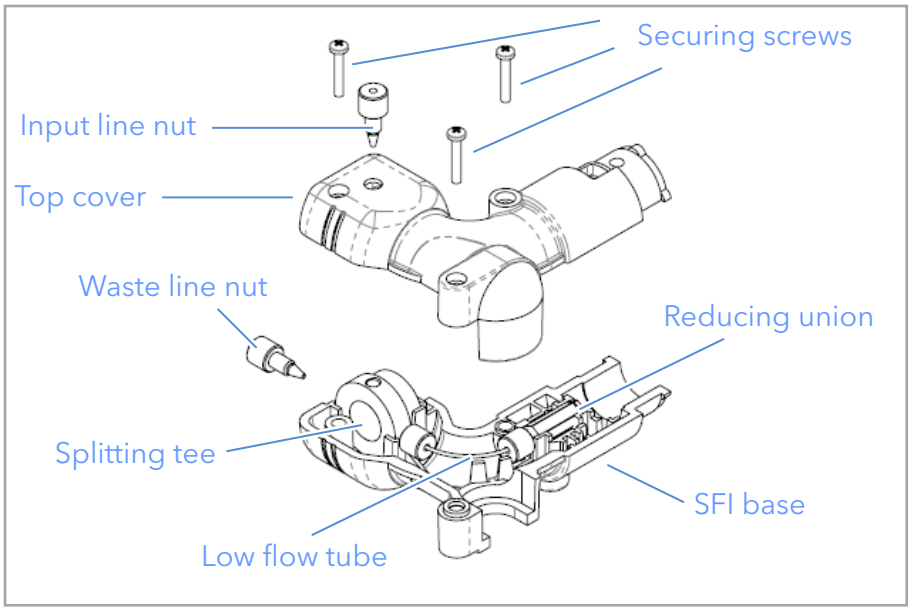

Fig. 27 SFI with cover opened

Note: It is not necessary to remove the three screws from the top cover of the SFI.

7. Once the cover is removed, use the PH1 Phillips screwdriver to remove the screw retaining the tee (Fig. 42).

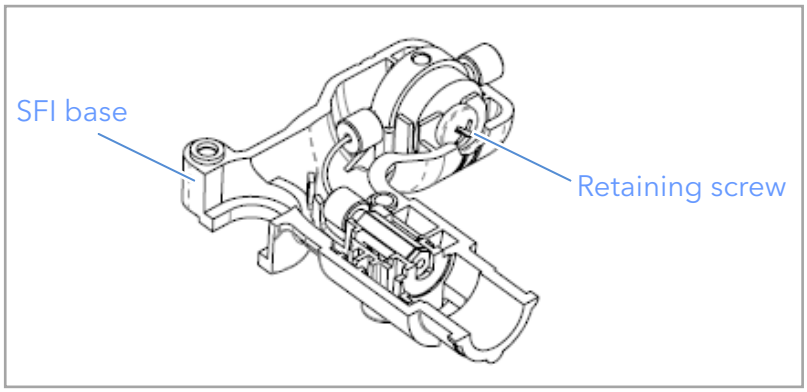

Fig. 28 SFI splitting tee and retaining screw

8. Remove the tee, reducing union and tubing from the SFI using the plastic tweezers (A66911) (Fig. 43).

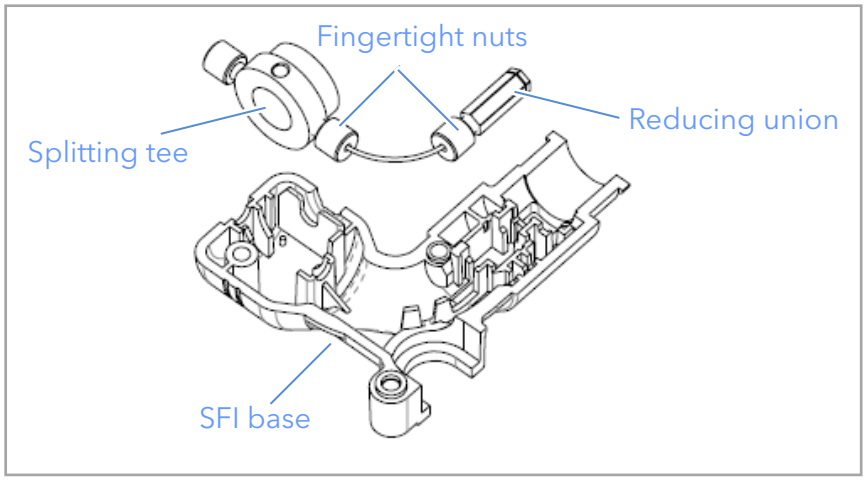

Fig. 29 SFI with splitting tee and reducing union removed

9. Unscrew the fingertight nuts from the tee and reducing union and remove the low flow tube.
10. To fit a new low flow tube, first slide the tube through one of the fingertight nuts.
11. Fit the nut to the splitting tee; gently push the tube into the tee whilst tightening the nut.
12. Slide the opposite end of the low flow tube into the second fingertight nut.
13. Using the weight of the reducing union to maintain pressure on the tube, tighten the second fingertight nut into the splitting tee.
14. Press the tee, union and tube back into position within the SFI. Ensure the electrical connection for the tee is aligned with the retaining screw aperture. The fittings will click into the metal clip and the moulding of the SFI base. Ensure the unions are fitted as shown in Fig. 57.

    Note: The tee and union will only fit into the SFI base in one configuration. Do not force the unions to fit.
15. Using the PH1 Phillips screwdriver fit the retaining screw to the splitting tee (Fig. 42).
16. Refit the SFI cover and tighten the 3 securing screws using the PH1 screwdriver.
17. Refit the input line nut and tubing (Fig. 40 and Fig. 41).
18. Refit the metal collar and PEEK screw by reversing steps 3-6.

The SFI low flow tube has been successfully changed. Fit either a spraychip 200 or measure the flow rate (Liquid flow rate measurement). If the initial problem persists and/or you have any queries please contact KNAUER.

9.7 Removing and replacing the vac-chip

Please follow the procedure below in the event that the vac-chip has to be replaced or removed. Please refer to Fig. 44 when following this procedure.

CAUTION Turn off any fume hoods or ventilation directly surrounding the MiD when replacing the vac-chip, if safe to do so.

ATTENTION Lors du remplacement du vac-chip, éteignez les hottes de ventilation entourant directement le MiD, si le niveau de sécurité le permet.

Procedure

1. If the MiD is under vacuum, make sure that the instrument is not scanning. Turn off any sample/mobile phase pumps to ensure that fluid is not flowing to the spraychip.
2. Place the MiD into standby mode, if necessary, by clicking the Operate/Standby button.
3. To remove the vac-chip assembly from the MiD first vent the system.
4. Open the door until at 90˚.
5. Remove the DFI/SFI from the MiD (see „5.8.3 Installing spraychip assemblies“ on page 25 for details).
6. Use the 4mm “T” Allen key loosen the four M4 screws securing the vac-chip assembly in an alternating criss-cross pattern until the screws are loose.

7. Remove the four M4 screws.
8. Gently pull the vac-chip assembly away from the SFD using the dowels as guides.
9. Once the vac-chip assembly is removed, the SFD cover plate must be fitted to the MiD.
10. Lay the assembly face down on a clean lint free surface (Fig. 59).
11. The tube lens assembly is attached to the vac-chip flange with five vacuum screws. The vac-chip is located under this assembly.

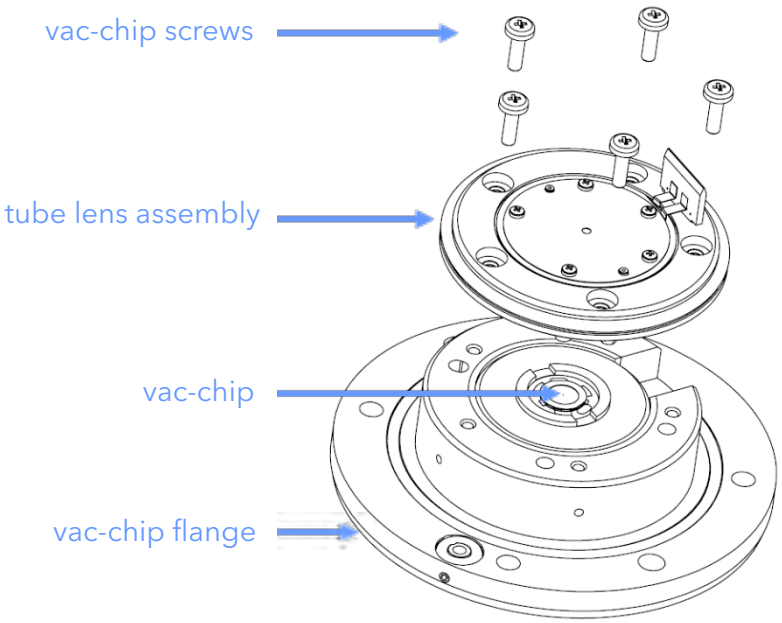

Fig. 30 The vac-chip and tube lens assembly

12. Using the Phillips head screwdriver partially unscrew the five vacuum screws in the following pattern 1, 4, 2, 5, 3 (refer to Fig. 60), repeat until the screws are loose.

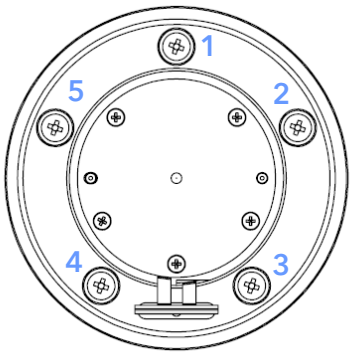

Fig. 31 Tube lens assembly and vacuum screws

13. Gently lift the tube lens assembly away from the vac-chip flange.
14. Using a pair of tweezers, remove the vac-chip from the flange (Fig. 46).

Note: The vac-chip can become stuck on the tube lens assembly. Check that it is not before resting the assembly to one side.

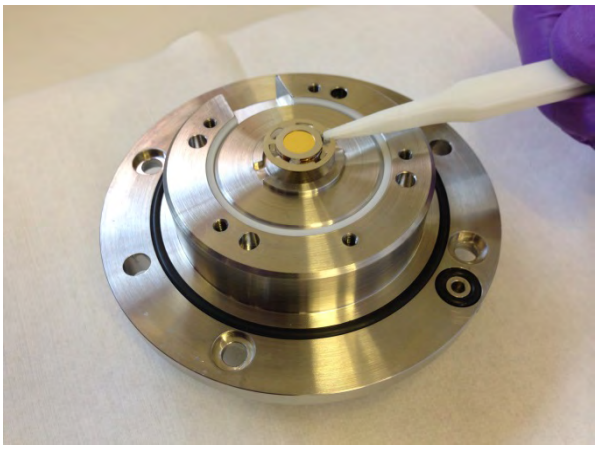

Fig. 32 How to handle the vac-chip

15. Place the new vac-chip in the vac-chip flange ensuring that the larger face of the chip is facing downwards (Fig. 46).

    Note: The user MUST ensure that the small O-rings (A66907) are present on the vac-chip flange (under the vac-chip) and the underside of the tube lens assembly. Also ensure that both O-rings are properly seated.

16. Lower the tube lens assembly onto the vac-chip flange, it will locate with two dowels. Ensure the assembly is lying parallel to the vac-chip flange.

17. Using the supplied flat head screwdriver, sequentially tighten the five vacuum screws in the following pattern 1, 4, 2, 5, 3 (Fig. 45), repeat until the screws are tight.

    Note: Do not over tighten the vacuum screws and do not continue to tighten screws if any resistance is felt, in this case remove the assembly and retry.

Caution

CAUTION The vacuum screws have been specially made for the MiD. Do not substitute these screws unless they have been provided by the manufacturer.

ATTENTION Les vis à vide ont été spécialement conçues pour le MiD. Ne pas remplacer ces vis, sauf qu'ils ont été fournis par le fabricant.

18. Locate the vac-chip flange on the SFD using the dowels as shown in „Fig. 9 The vac-chip assembly being installed on the MiD“ on page 21. Gently push the vac-chip flange into place, do not force the flange into position.

    Note: There is a single orientation where the holes and threaded sections will align.

19. If excessive resistance is felt when fitting the assembly to the SFD, stop immediately, remove the assembly and retry step 18.

20. Once positioned on the SFD fit the four M4 screws provided.

21. Use the 4mm “T” Allen key and tighten the four M4 screws in an alternating criss-cross pattern until the screws are tight.

22. If excessive force is required stop immediately and repeat steps 18-21.
23. Fit the DFI/SFI (Installing spraychip assemblies).
24. Close the door.

9.8 Cleaning the vac-chip

The following procedure is the recommended cleaning procedure for your vac-chip.

Procedure

1. Remove the vac-chip as described in the Removing and replacing the vac-chip.
2. Prepare a small ultrasonic bath in a fume hood/suitable extracted area. Fill the bath with room temperature water.
3. Prepare a clean test-tube (20mm OD). This tube dimension ensures that when you place the vac-chip inside, the face of the vac-chip will not touch any surfaces.

WARNING To avoid damaging the vac-chip do not use different sized test-tubes or other glassware for cleaning.

AVERTISSEMENT Pour éviter d'endommager le vac-chip, ne pas utiliser des tubes à essai de tailles différentes ou autres objets en verre pour le nettoyage.

4. Tilt the test tube close to horizontal and carefully place the vac-chip just inside in the mouth of the tube.
5. Slowly turn the test tube until vertical allowing the vac-chip to slide slowly to the bottom of the tube.
6. Pour enough HPLC grade water into the test-tube to cover the vac-chip.
7. Place the test tube in a suitable rack in the ultrasonic bath and sonicate for 10 minutes.

WARNING Do not heat the ultrasonic bath as this can damage the vac-chip.

AVERTISSEMENT Ne pas chauffer le bain à ultrasons car cela peut endommager le vac-chip.

8. Remove the test tube from the bath and carefully pour most of the water away without removing the vac-chip.
9. Refill the tube with HPLC grade acetonitrile such that the vac-chip is submerged as before and sonicate for 10 minutes.
10. Repeat steps 7-8 using HPLC grade methanol.
11. Carefully pour off the methanol and then gently tip the vac-chip out into a shallow petri dish or on to lint free tissue such that the vac-chip can be easily picked up with tweezers.
12. Using flat tweezers carefully hold the vac-chip by pinching either side of the larger metal ring (Fig. 61).
13. Gently blow dry the vac-chip with compressed air/nitrogen. Remove as much excess liquid as possible.
14. Place the vac-chip in an oven at 75 °C for 30 min to completely dry it.

Note: If an oven is not available, place the vac-chip on a lint free tissue and leave for few hours to dry completely

15. The vac-chip is now clean and ready for use.

If the device looks visually degraded or you have any queries please contact KNAUER before using the device.

9.9 Cleaning the vac-chip flange

The following procedure is the recommended cleaning procedure for your vac-chip flange.

Caution

CAUTION The vacuum screws have been specially made for the MID. Do not substitute these screws unless they have been provided by the manufacturer.

ATTENTION Les vis à vide ont été spécialement faite pour le MID. Ne pas remplacer ces vis, sauf qu'elles ont été fournies par le fabricant.

CAUTION The vac-chip is fragile. Always handle it with extreme caution.

ATTENTION Le vac-chip est fragile. Toujours manipuler avec une extrême prudence.

Procedure

1. Clean the vac-chip flange, especially the cone region (Fig. 47) using HPLC grade water followed by HPLC grade Acetonitrile & HPLC grade Methanol.
2. It is recommend that a lint free cloth or cotton bud is used to clean the cone region with each solvent, rather than immersing the whole flange.

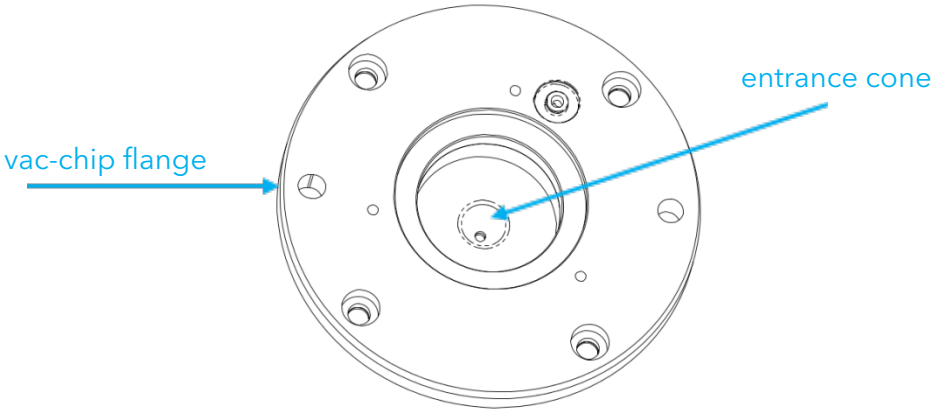

Fig. 33 Vac-chip flange and cone region

3. Repeat until the cone region is clean
4. Place the vac-chip flange in an oven at 40°C for 30 minutes to completely dry it.
5. Once dry, remove the flange from the oven and flush with clean, dry Nitrogen

Note: If no oven is available, the flushing with Nitrogen and leaving covered in tissue should be sufficient.

10. Troubleshooting

This chapter provides information on what to do in the unlikely event that you experience difficulty with the MiD. This list is not exhaustive if in any doubt please contact KNAUER for assistance.

WARNING In the event that these troubleshooting guides have to be used, please ensure that the MiD is switched off, unless otherwise stated.

AVERTISSEMENT Dans le cas où ce guide de dépannage doit être utilisés, s'il vous plaît s'assurer que le MID est éteint, sauf indication contraire.

CAUTION Always wear eye protection and use suitable tools when handling capillaries.

ATTENTION Toujours porter une protection oculaire et utiliser des outils appropriés lors de la manipulation des capillaires.

The following table details some basic symptoms, possible causes and potential solutions for some basic issues with the 4000 MiD.

Symptom	Possible Cause	Remedy
Cannot apply any voltages to the spraychip® assembly.	Interlock is engaged.	Make sure the front door is fully closed. Check the interlock status symbol on the Status bar.
There is a drop in ion signal intensity; a reduction in the value of the spray current.	Nebuliser gas flow rate has decreased.	Check all connections are fitted tightly.
		Check the main gas supply.
		Check the O-rings located in the spraychip assembly for cracks. Replace the O-rings if there are any cracks.
	Capillary tip may be clogged.	Change the spraychip 200 (see chapter 8.2 on page 33).
	Obstruction in ion tunnel.	Clean or change the spraychip 200 (see chapter 8.3 on page 34).
There is a drop in ion signal intensity; a reduction in spray current	Air bubbles in sample line.	Flow sample through the system, and allow time for air bubbles to dissipate.

Symptom	Possible Cause	Remedy
No signal; spray current established and unchanged.	Ion optics have the wrong voltages.	With the MiD on, load one of the four default tune files (see chapter 7 on page 30).
	Detector is switched off.	With the MiD switched on and pumped down, check that the detector is switched on and has the correct voltage applied to the Horn (see chapter 7 on page 30).
	Pressures are not at the operating values.	With the MiD switched on and pumped down, check the pressures in the ion guide and the analytical chambers are at operating values.
	The vac-chip is clogged.	Replace the vac-chip (see chapter 8.2 on page 33).
No signal; no spray current.	No sample flow	Check liquid connections and sample flow from the syringe pump/LC to the spraychip assembly.
	Capillary tip may be clogged.	Change the spraychip 200 (see chapter 8.2 on page 33).
	A voltage cannot be applied to the spraychip assembly because the interlock is engaged.	Make sure the front door is fully closed. Check the interlock status symbol.
Drop in ion signal to zero counts; capillary current increases.	A droplet has formed inside the spraychip assembly	Ensure that no sample is flowing through the system. Increase the flow rate of the nebuliser gas to 5 L/min. Enable the high-voltage supply and increase the capillary voltage. Run the system under these conditions for 15 minutes. Use a higher nebuliser flow rate if the problem persists.
		Replace the spraychip 200 (see chapter 8.2 on page 33).
Severe drop in TIC background accompanied with no signal for late eluting peaks in an HPLC reverse gradient chromatograph.	The vac-chip is clogged.	Replace the vac-chip (see chapter 8.2 on page 33)..

Symptom	Possible Cause	Remedy
Severe fluctuations in the spray current, especially when spraying a solution with a high aqueous content.	There is an electrical short within the spray-chip 200.	Reduce the spraychip tip voltage
		Stop the sample flow and increase the nebuliser gas flow for five minutes. Restart sample flow.
		Change the spraychip 200 (see chapter 8.2 on page 33).
Spray current fluctuations increase under fixed conditions.	Capillary tip may be dull or clogged.	Replace the spraychip 200 (see chapter 8.2 on page 33).
	A leak in the tubing	Check all fluidic connections.
Ions are in the wrong m/z position.	System is not calibrated, or has lost its calibration.	Follow the procedure to calibrate the MiD (see chapter 7.1 on page 30).
Base pressure is too high, or there is insufficient vacuum in the Ion Guide and Analytical chambers	O-rings may be leaking	Contact KNAUER.
	Vacuum pump exhaust tubing is restricted or blocked.	Ensure that the tubing is free from any restrictions.
	Vacuum pumps may require replacement.	Contact KNAUER.

11. Technical data

Requirement	Description	
Indoor use	The 4000 MiD can only be used in an indoor environment	
Bench space	Required:	56cm x 35.5cm x 25.5cm (L x W x H)
	MiD weight:	32 kg
Power requirements	Line voltage:	100–240V AC ±10 %
	Line Frequency:	50/60 Hz
	Power:	300W (peak)
	Overvoltage Category II:	For transient overvoltages typically present on the mains supply For temporary overvoltages on the mains supply
Altitude	Operation:	Up to 2000 m
Temperature	Operation:	15–30°C
	Storage:	-10–50°C
Relative humidity	Operation:	40–80 %
	Pollution Degree 2:	Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected
	Storage:	10–90 %, non-condensing
Nitrogen gas	Pressure:	2–6 bar (29–87 psi)
	Purity:	≥ 99.5 %
	Tubing:	Site must use either stainless steel or PTFE tubing
	Fitting:	Stainless Steel ∅ 6 mm push lock fitting
Pump exhaust	Tubing:	∅ 8 mm push lock fitting

12. Reorder

Part	Article no.
Spraychip 200	A66901
All metal vac-chip	A66902
Split flow interface (SFI)	A66913
Re-built kit for split flow interface	A66914
Calibration kit for split flow interface	A66916

Appendices

Appendix A: Flow Splitting

In its simplest form, a flow splitter is composed of a union or tee with tubing of various inner diameters attached as shown in Fig. 48.

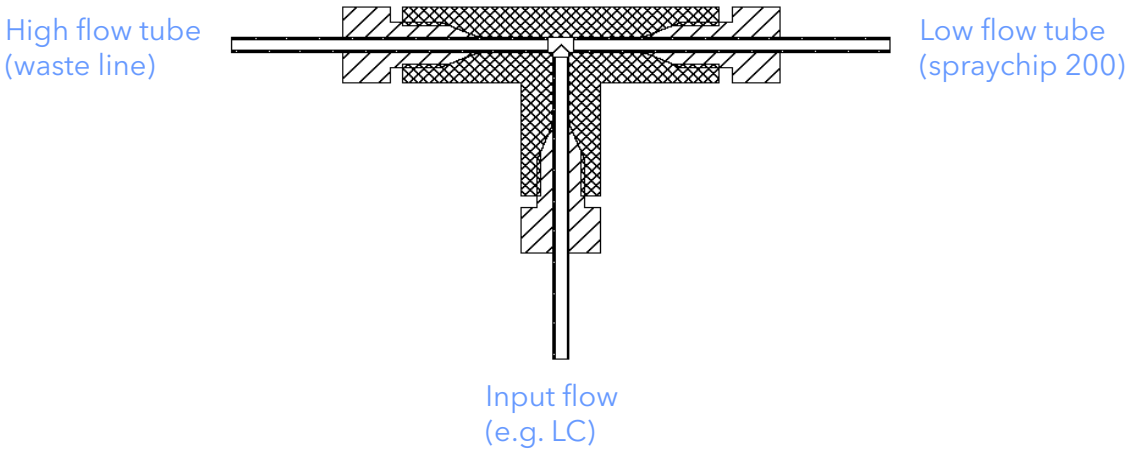

Fig. 34 Basic flow split

- The split ratio can be changed by changing both the inner diameter and the length of the waste line (high flow tube).
- The split ratio varies with the input flow rate and liquid composition (changes during a gradient).
- Flow rates can be measured using the flow meter assembly, see chapter „8.4 Liquid flow rate measurement“ on page 35.
- For a fixed length decreasing the diameter of the waste line increases the spraychip flow rate.
- For a fixed diameter increasing the length of the waste line increases the spraychip flow rate.
- Changing the diameter of the waste line has a greater effect on the split ratio than changing the length.

The split ratio (R) is the ratio of the flow rates exiting the high flow tube and the low flow tube. This is dependent on a number of factors including the properties of the fluid, for example, viscosity. However, the following equations can be used to calculate the split ratio for the MiD.

Equation 1

$$R = \frac{D_{HF}^4 \times L_{LF}}{D_{LF}^4 \times L_{HF}}$$

Where

DHF – Inner diameter of the high flow tube in microns
LHF – Length of the high flow tube in centimetres

DLF – Inner diameter of the low flow tube in microns
LLF – Length of the low flow tube in centimetres

Equation 2

$$R = \frac{High\ Flow\ Rate}{Low\ Flow\ Rate} = \frac{(Input\ Flow\ Rate - Low\ Flow\ Rate)}{Low\ Flow\ Rate}$$

Flow rates in units of µL/min

Equation 2 can be rearranged to give Equation 3.

Equation 3

$$Low\ Flow\ Rate = \frac{Input\ Flow\ Rate}{1 + R}$$

Equation 1 can be used to estimate the length of the high-flow tube that is required. For example, if an HPLC method uses a flow of 1.0 mL/min, using Equation 2 to achieve a flow rate of 1 µL/min in the spraychip 200 (low flow tube).

$$R = \frac{(Input\ Flow\ Rate - Low\ Flow\ Rate)}{Low\ Flow\ Rate}$$

$$\therefore R = \frac{(1000 \times 1) - 1}{1} = 999$$

For the SFI the following is constant.

$$R = \frac{L_{LF}}{D_{LF}^4} = 1.61 \times 10^{-5}$$

Using Equation 1.

$$999 = \frac{D_{HF}^4}{L_{HF}} \times 1.61 \times 10^{-5}$$

If the inner diameter of your desired waste tube is 254 µm then,

$$L_{HF} = \frac{(254)^4}{999} \times 1.61 \times 10^{-5} = 67.1cm$$

Note: It is always better to start with a longer piece of tubing (at least 10 cm longer) so that if the low flow rate is too high, the length of the waste tube can be cut to provide a suitable flow rate.

SFI split ratios for different waste tubing lengths and diameters

Waste tubing length/cm	Split ratio for tubing ID 0.005" (127 µm)	Split ratio for tubing ID 0.007" (178 µm)	Split ratio for tubing ID 0.01" (254 µm)
25	167.8	647.6	2685.2
50	83.9	323.8	1342.6
75	55.9	215.9	895.1
100	42.0	161.9	671.3
150	28.0	107.9	447.5
200	21.0	81.0	335.6
250	16.8	64.8	268.5

Note: It is important to note that actual ratios may differ due to various factors, such as, liquid composition. Adjustments to tubing lengths may be required.

Calculate an appropriate split ratio and attach the required length of PEEK tubing to the waste port of the splitting tee. Attach the nut, finger tighten. The other end can either be directed to waste or to another analytical instrument, for example, a UV detector.

Note: The split ratios can change if the PEEK tubing from the waste port is attached to another analytical instrument. The theoretical calculations provided in this manual cannot be used for such systems.

Once established, measure the flow rates of different gradient compositions to establish any variations in flow. KNAUER recommends that the flow rate throughout the gradient should be 0.3–2 µL/min.

Appendix B: Auxiliary I/O

The auxiliary I/O port (Aux I/O) is located at the rear of the 4000 MiD (see Fig. 3 on page 13). The port can be used to supply and receive analog voltages and also to send/receive triggers. The port is a 15-way D-type male socket and is shown in more detail in Fig. 49.

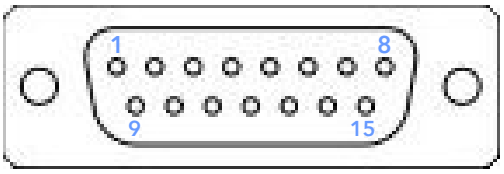

Fig. 35 Auxiliary I/O port

The port contains two optically isolated digital inputs and two optically isolated digital outputs. The digital inputs require 10 mA to activate, this can be supplied via the 5 V reference also available at the connector (see table below). The 5 V output is protected by a resettable fuse which trips at 100 mA. The digital outputs are open collector, and are rated at 50 mA.

There port also houses four optically isolated analog inputs and four optically isolated analog outputs. The inputs have an impedance of 100K, and the outputs can source or sink 10 mA. Both the inputs and outputs have ranges of 0 to +1 V full scale.

Caution

CAUTION Any external instrument sending/receiving triggers and/or analog voltages to the 4000 MiD should not exceed the input/output values stated here. The manufacturer is not responsible for any damage to external instrumentation from improper connections made to the 4000 MiD.

ATTENTION Tout instrument externe envoyant / recevant des déclencheurs et / ou des tensions analogiques du 4000 MiD ne doit pas dépasser les valeurs d'entrée / sortie indiqués ici. Le fabricant n'est pas responsable de tout dommage à l'instrumentation externe de connexions incorrectes sur le 4000 MiD.

WARNING Connecting terminals are separated from mains circuits by reinforced insulation. The terminals must only be connected to external circuits that are themselves separated from mains voltages by at least double/reinforced insulation.

AVERTISSEMENT Les bornes de raccordement sont séparées du circuits d'alimentation secteur par une isolation renforcée. Les bornes ne doivent être raccordés à des circuits extérieurs qui sont eux-mêmes sont séparés des tensions d'alimentation par au moins une isolation double / renforcée.

Both the analog and digital parts share a common ground and all the inputs and outputs are isolated from the main system ground with components rated to at least 1000 V. This is a protection measure only, and operation with different ground voltages is not recommended.

The table below lists the auxiliary port pin numbers and associated signals, along with a description. This table should be referred to if you have been supplied with an open ended cable for development purposes. Wires will either be coloured or numbered as appropriate identifiers.

Auxiliary I/O port pin assignments

Pin Number	Signal Name	Description	Comments
1	+5 V	Isolated 5 V supply	-
2	Digital Out 1	Output trigger	Designated as second output trigger
3	Digital In 0	Input trigger	Designated as first input trigger
4	Analog Out 1	Analog output voltage	Designated as Analog output channel 2
5	Analog Out 3	Analog output voltage	Designated as Analog output channel 4
6	Analog In 1	Analog input voltage	Designated as Analog input channel 2
7	Analog In 3	Analog input voltage	Designated as Analog input channel 4
8	Ground	Isolated Ground	Isolated from main system ground
9	Digital Out 0	Output trigger	Designated as first output trigger
10	Digital In 1	Input trigger	Designated as second input trigger
11	Analog Out 0	Analog output voltage	Designated as Analog output channel 1
12	Analog Out 2	Analog output voltage	Designated as Analog output channel 3
13	Analog In 0	Analog input voltage	Designated as Analog input channel 1
14	Analog In 2	Analog input voltage	Designated as Analog input channel 3
15	Ground	Isolated Ground	Isolated from main system ground

WARNING Never use any cabling not supplied or recommended by the manufacturer. Use of unspecified cabling may lead to improper operation or failure to comply with safety or EMC regulations.

AVERTISSEMENT Ne jamais utiliser de câbles non fournis ou recommandés par le fabricant. L'utilisation de câbles non spécifiée peut entraîner un mauvais fonctionnement ou du non-respect de la sécurité ou de la compatibilité électromagnétique.

WARNING Use of any cabling not supplied or recommended by the manufacturer may lead to the risk of electric shock or short circuit.

AVERTISSEMENT L'utilisation d'un câblage non fourni ou recommandé par le fabricant peut entraîner un risque de choc électrique ou de court-circuit.

The following tables give example trigger wiring connections for use if you have been supplied with an open ended cable, examples include triggering from active and passive sources. All terminations not made to the MiD should be made in accordance with the relevant manufacturer's instructions.

CAUTION The manufacturer is not responsible for any damage to external instrumentation from improper cable terminations.

ATTENTION Le fabricant n'est pas responsable de tous dommage aux instrumentations externes due à des terminaisons de câbles inappropriés.

Triggering from an active source

From External Instrument	Comments	Connect to MiD Aux I/O Pin Number	Signal Name
Ground/trigger return	External instrument ground/trigger return	15	Isolated Ground
Start trigger	Typically TTL level	3	First input trigger
Stop trigger	Typically TTL level	10	Second Input Trigger

Triggering from a passive source

To & From External Instrument	Comments	Connect to MiD Aux I/O Pin Number	Signal Name
Volt-free contact	First side of volt-free contact	1	Isolated 5V supply
Volt-free contact	Second side of volt-free contact	3	First input trigger

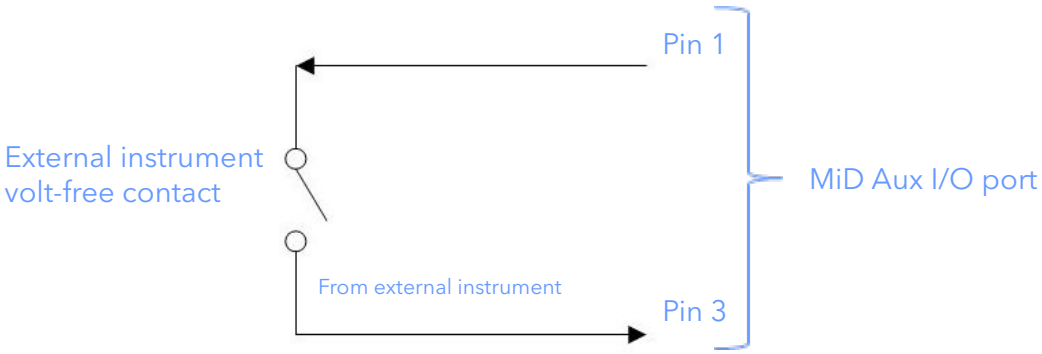

Fig. 36 Volt-free contact wiring diagram

CAUTION If attaching the MiD to a passive trigger source the user must ensure the external instrument is rated for the output from the MiD. The manufacturer is not responsible for any damage to external instrumentation.

ATTENTION Lors de la fixation du MiD à la source de déclenchement passif, l'utilisateur doit s'assurer que l'instrument externe est évalué pour la sortie à partir du MiD. Le fabricant n'est pas responsable de tout dommage à l'instrumentation externe.

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