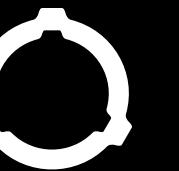




PRODUCT OVERVIEW

L-Type Rapid



L-TYPE RAPID

Fast & Simple Sample Loading

High-throughput sample characterization

The L-Type Rapid allows to cool samples from room temperature to 100 mK in less than 3 hours. After finishing the characterization, the sample can be removed automatically from the cold stage and the system is ready for the next sample within 10 minutes.

In this way, exceptionally high throughput can be realized with the entire time for installation, cooling and extraction per experiment totaling < 4 hours.

Simple Puck system

The L-Type Rapid works with an easy-to-use Puck system. This allows to set up an experiment or prepare a sample outside of the cryostat while a measurement is running. The use of multiple Pucks therefore allows the measurement system to be used with virtually no down time.

The Puck provides 40 DC electrical contacts and optionally up to 4 RF connections for sample contacting on the available standard sample holders. Customized sample holders can be easily integrated with the Puck.



L-TYPE RAPID

Fast & Simple Sample Loading

Compact size and ergonomic operation

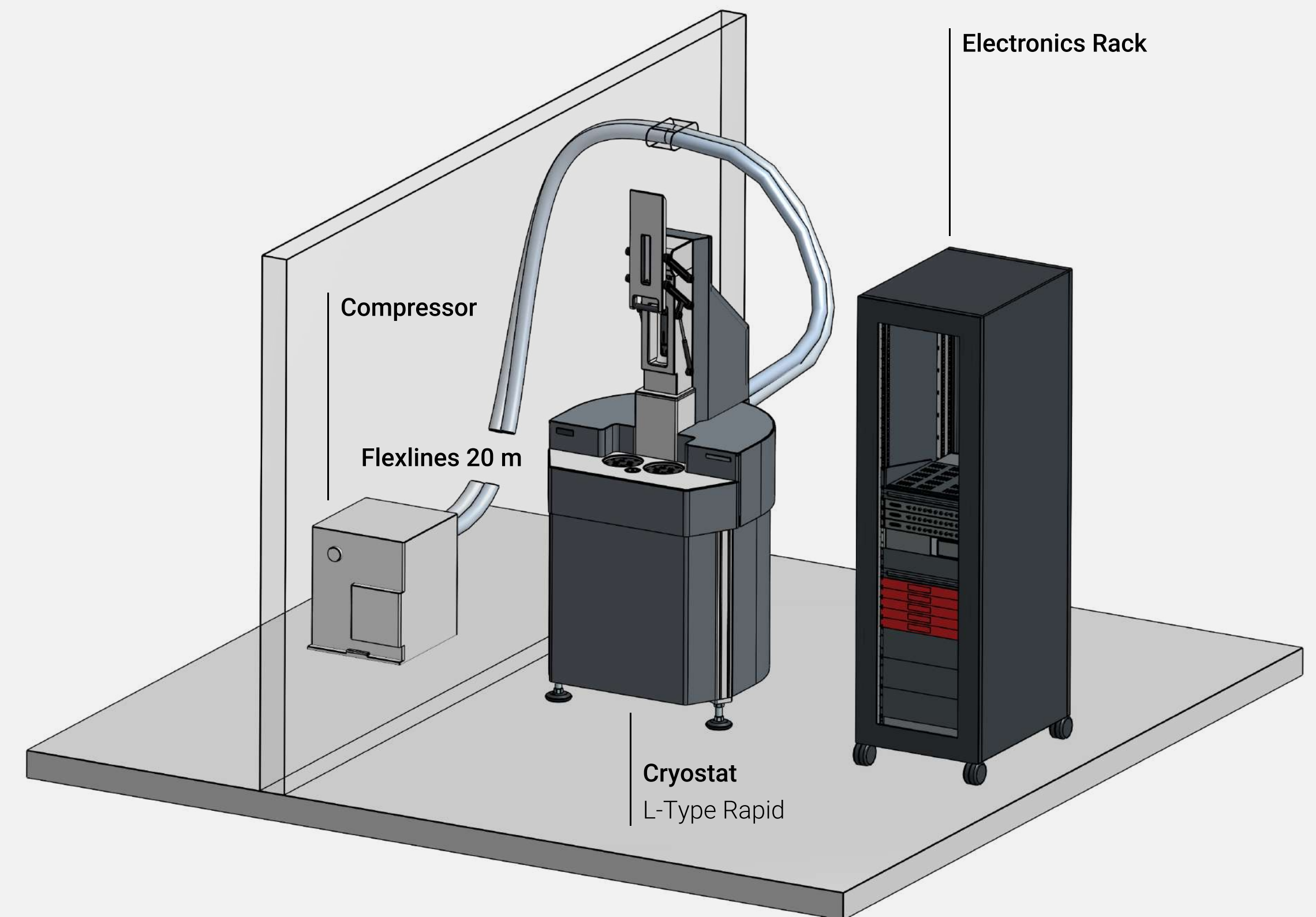
The L-Type Rapid is a compact cooling system that can be used in rooms with low ceiling height ($< 2.40\text{ m}$) on a very small footprint.

The combination of closed-cycle and magnetic cooling ensures particularly quiet and largely automated system operation, which does not require any special expertise. The required in-person interaction with the cryostat to change samples between measurements is limited to a few minutes.

One platform, many options

The capabilities of the L-Type Rapid can be extended to offer tailored solutions for a variety of low temperature applications.

A 5 Tesla sample magnet can be integrated, allowing to study magnetic properties such as magnetoresistance or Hall effect. The standard DC lines can be extended with 4 radio frequency lines equipped with multiple RF electronic components such as amplifiers, isolators, and low-pass filters used for characterization of quantum devices. Additionally we integrate QDevil products optimized for measurements of quantum electronic components.



L-Type Rapid: Typical System Layout

Sample Loading Workflow

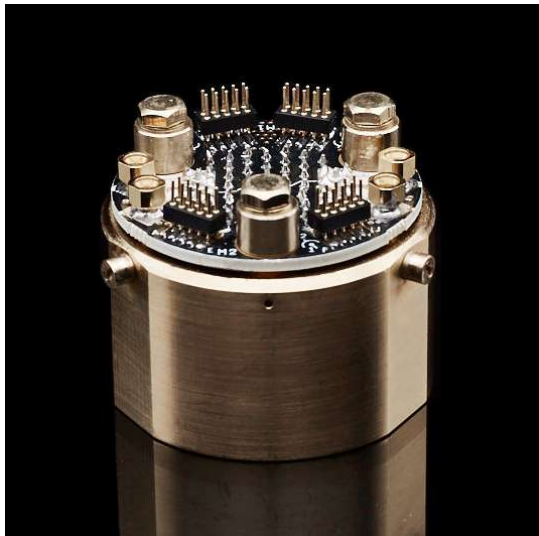
Simple sample preparation and automatic transfer

The L-Type Rapid works with an easy-to-use Puck system allowing for experiments to be prepared in advance while other measurements are running. A Sample Puck Station can be used to check the DC and RF connection at room temperature. To start a measurement, the Puck is placed into the airlock chamber of the automatic sample loader using the Puck transfer cage.

The sample loading and subsequent cooling is fully automated and controlled by the instrument software, reducing the physical interaction with the cryostat to a few minutes.



Puck Transfer Cage



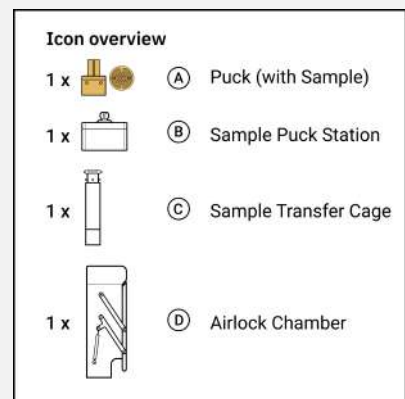
RF Puck 36



Sample Puck Station

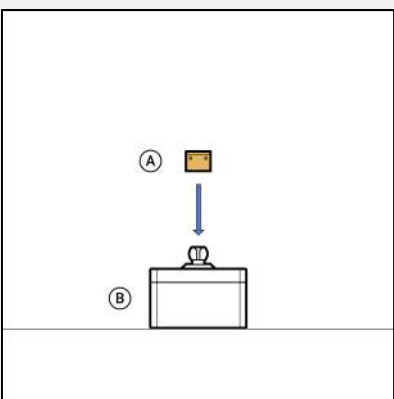
Sample transfer procedure

Components

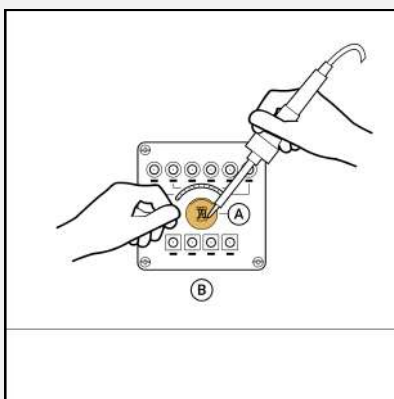


Signs and symbols

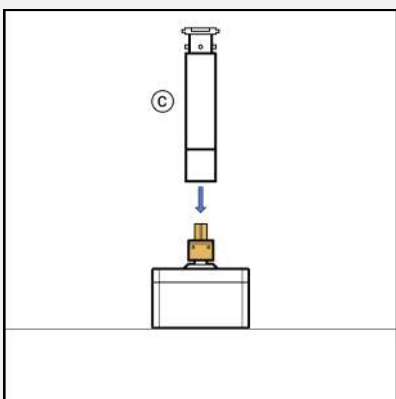
Prepare the sample on the Puck



Mount the Puck on the Sample Puck Station

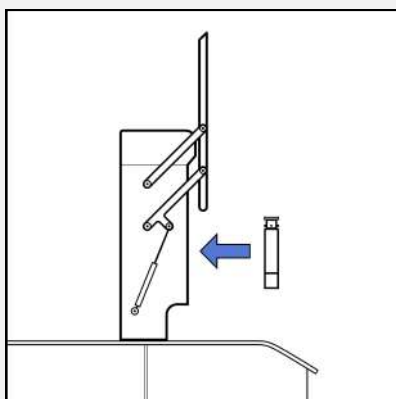


Make connections between the sample and the Puck



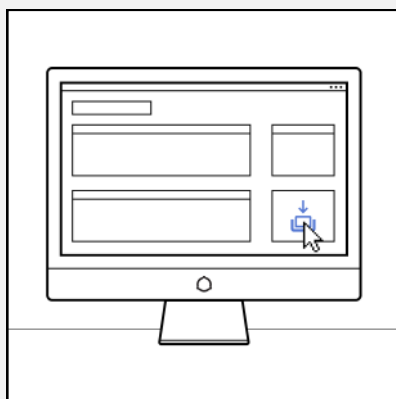
Grab the Puck with the Puck Transfer Cage.

Insert the Puck

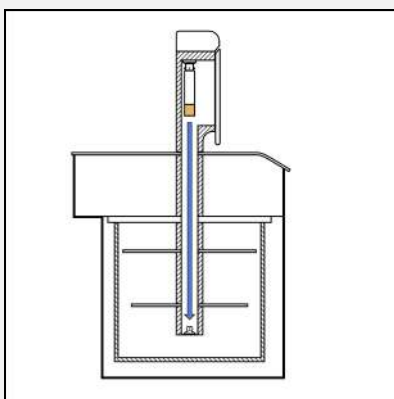


Place the Puck Transfer Cage with the Puck into the airlock chamber

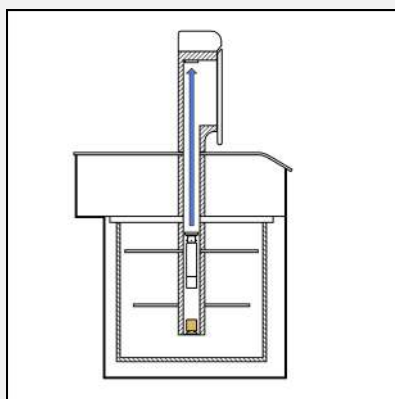
Software-controlled automatic sample transfer



Start the automatic sample transfer in the control software



Puck and sample are loaded into the cryostat ready to be cooled



The empty Transfer Cage moves back up into the airlock chamber

L-TYPE RAPID

Sample Interface

Puck connectivity and sample space

The DC Puck 36, with a diameter of 36 mm, offers 40 DC connections through pin connectors or bondable terminals. If RF wiring is integrated in the L-Type Rapid, the RF Puck 36 offers, additionally, 4 RF connections through SMPM connectors.

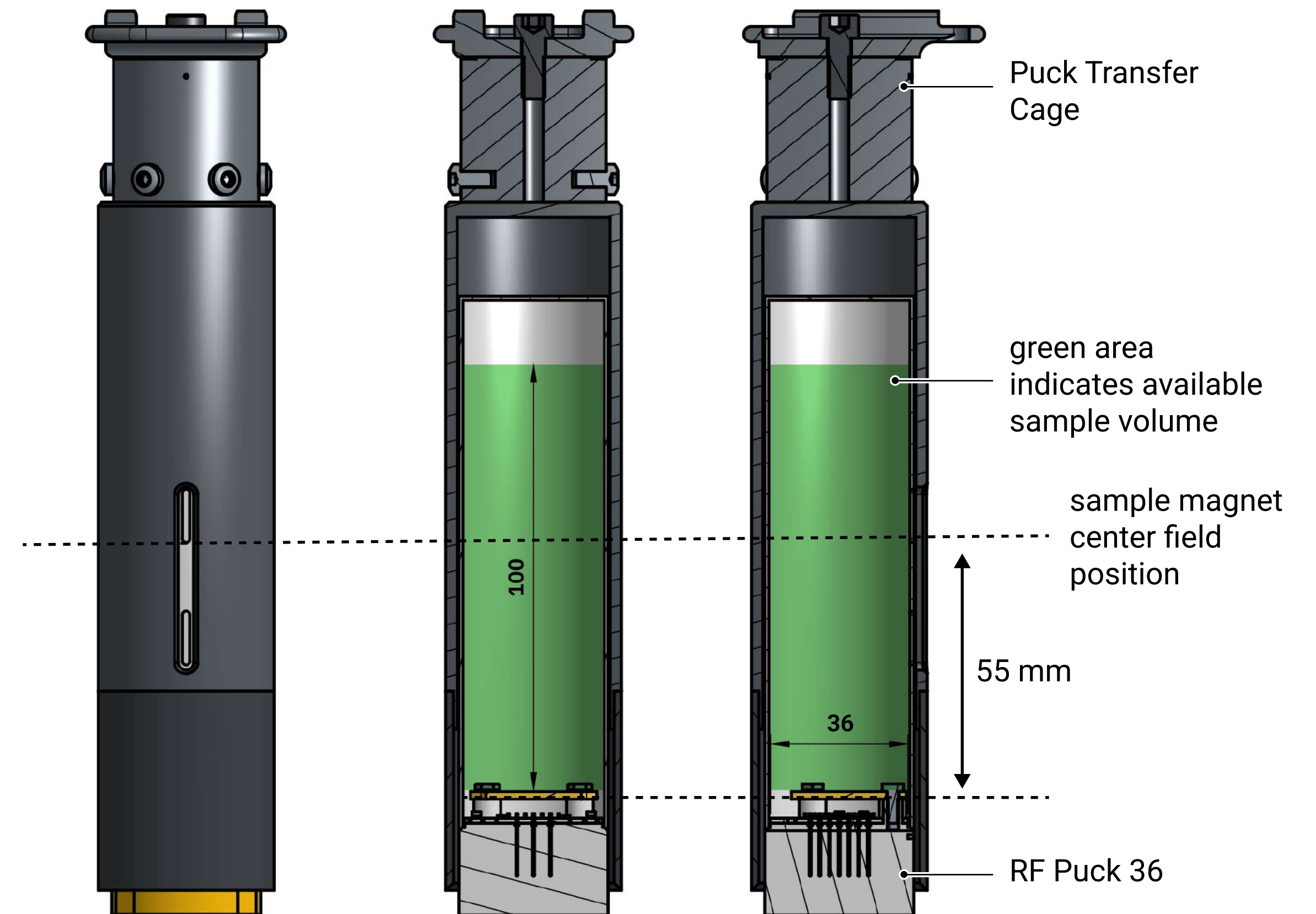
Samples and devices can be mounted on the Puck within a cylindrical volume of 36 mm in diameter and 100 mm in height.

4 x SMPM
Connectors
(with optional
RF wiring)



40 x DC pin
connectors

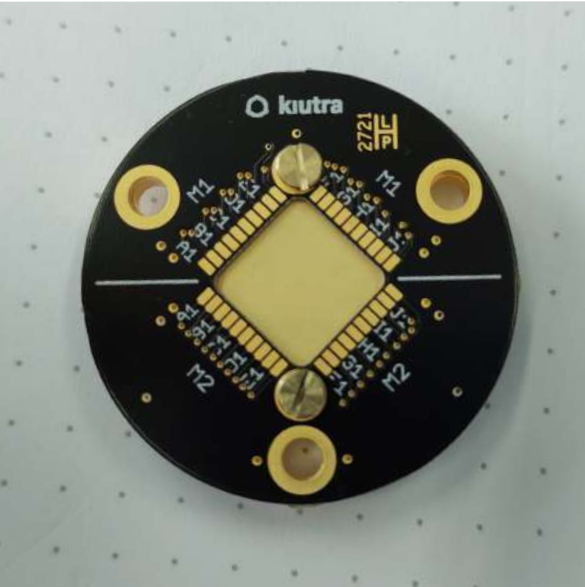
RF Puck 36



Sample Carrier Pads

Versatile sample holders

Kiutra offers Sample Carrier Pads with gold-plated bondable terminals, and a gold-plated copper platform for sample mounting and thermalization. Sample Carrier Pads can easily be mounted onto the Puck with matching DC connectors. If multiple pads are used, the operator can pre-bond samples on these carrier pads and store them ready to be loaded in the L-Type Rapid, minimizing the down time between measurements.



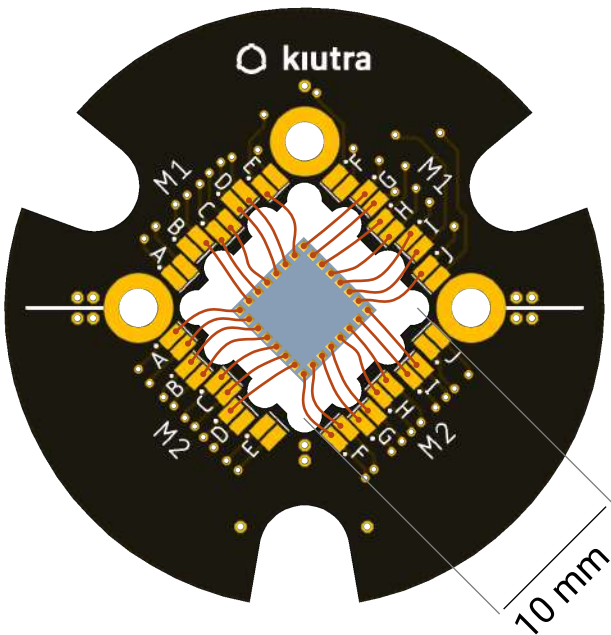
Sample Carrier Pad 40
top view



Sample Carrier Pad 40
bottom view

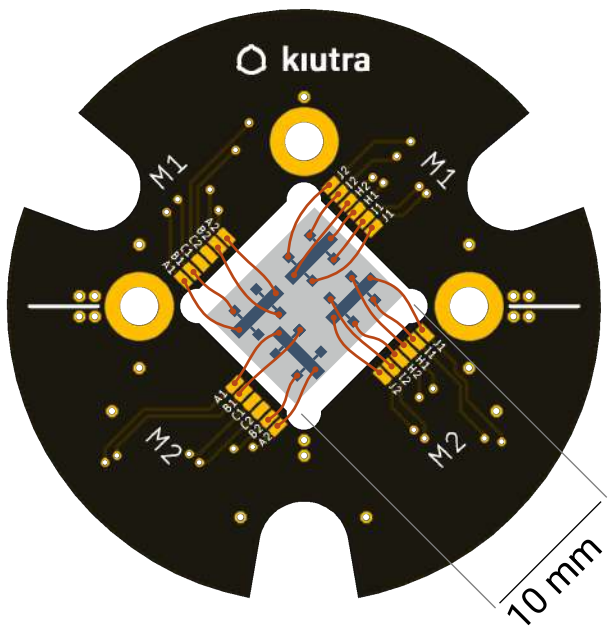


Sample Carrier Pad 40
mounted on **RF Puck 36**



Sample Carrier Pad 40

Provides access to all 40 DC wires through gold-plated pads in 4x10 arrays for maximum flexibility: multiple samples, devices with many contacts, etc.



Sample Carrier Pad 24

Provides access to 24 DC wires in a 4x6 pad array facilitating the use of twisted pairs for 6-point transport measurements, minimizing bond lengths.

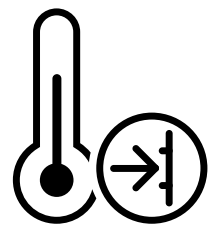
Flexible PCB-based designs

Kiutra's Sample Carriers have 2 standard PCB designs, Pad 40 and Pad 24, maximizing DC channels and ergonomics, respectively. We also support customers who want to design their own custom sample carriers PCBs.

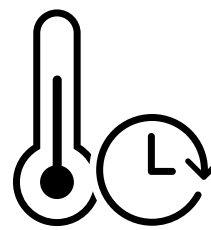


L-TYPE RAPID

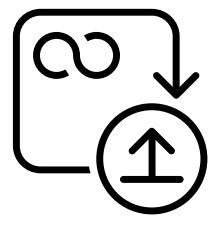
Cooling Performance



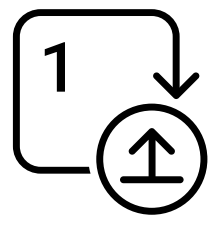
Temperature Range
100 mK - 300 K



Sample Cooldown Time
< 3 hours



Continuous Operation above
300 mK



One-shot Operation
3 hours @ 100 mK

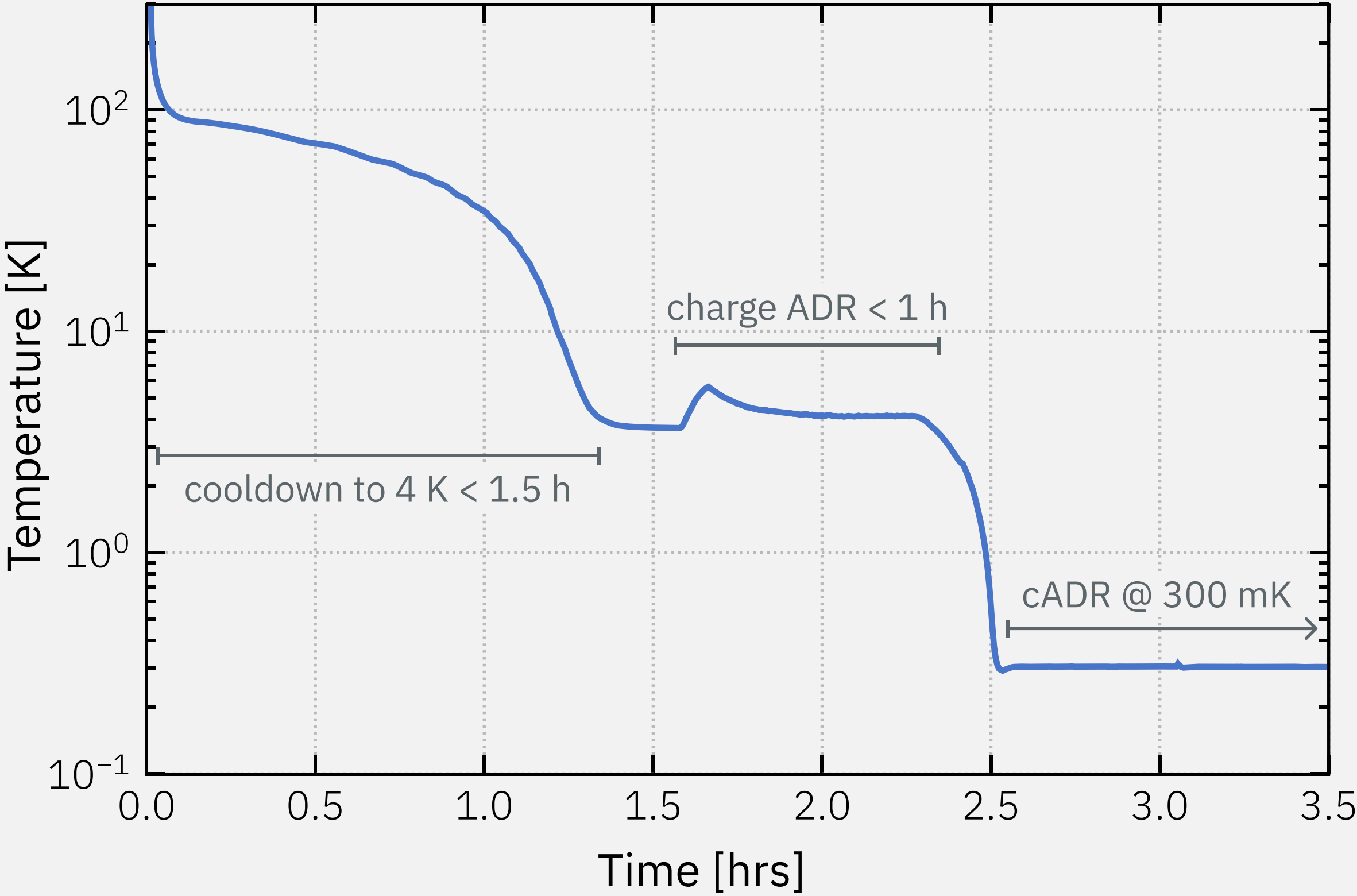


Figure: Cooling curve of a sample puck from room temperature to continuous adiabatic demagnetization refrigeration (cADR) operation at 300 mK in less than 3 hours.

L-TYPE RAPID

Temperature Control

Continuous and automatic cooling

The L-Type Rapid combines closed-cycle refrigeration with continuous adiabatic demagnetization refrigeration (cADR). Our intelligent temperature controller handles the cooling completely automatically, allowing the user to set the any temperature, or a continuous temperature ramp, from 100 mK to room temperature.

In the cADR mode, the temperature controller regularly recharges the assisting ADR unit to regenerate the cooling power of the whole system, while the temperature control of the sample stage is maintained.

Precise temperature control

Due to the solid-state nature of ADR, changes in the required cooling are relatively predictable, allowing for more precise temperature control. The L-Type Rapid provides a temperature stability better than 0.2 % (or 0.5 mK).

During cADR mode the assisting ADR unit is switched from the sample stage to the 4 K stage to be recharged. Switching stages disturbs the temperature control reducing the stability to 2% (or 5 mK) for a short period of time.

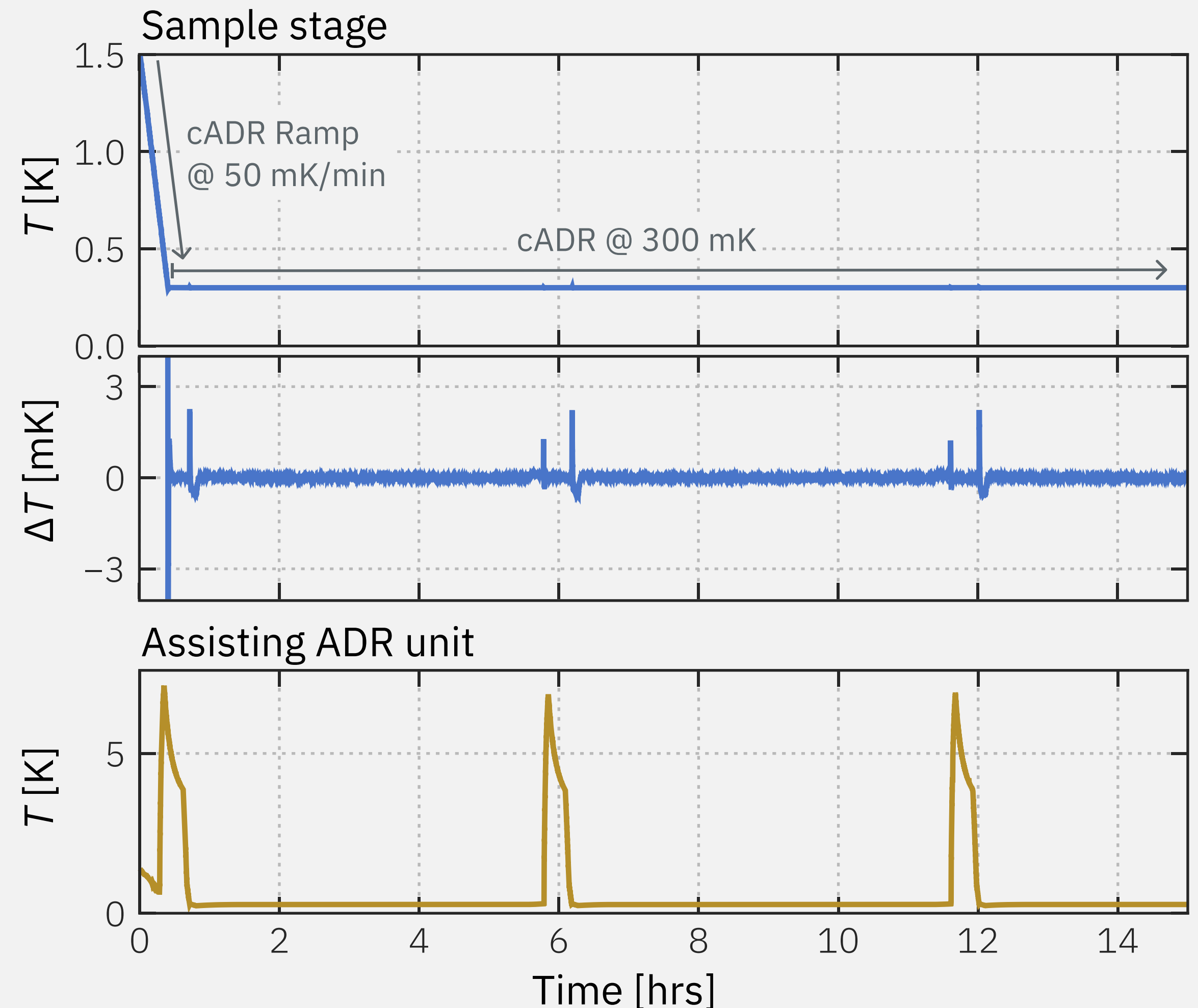


Figure: Accurate temperature control of the sample stage during continuous ADR cooling at 300 mK. The assisting ADR unit recharges automatically during operation.

Control Software

API access

The L-Type Rapid Modular Control Unit is provided with a well-documented Application Programming Interface. This allows users to integrate the L-Type Rapid seamlessly into existing software solutions or more complex measurement setups.

Graphical User Interface

Remote control and monitoring of the L-Type Rapid is provided through an easy-to-use Python-based Graphical User Interface with live data visualisation.

kiutra API

erations. The API is implemented as ne (like *controller_1*) in conjunction ad, set and procedures executed. presented as software instances as ements a set of remote procedures

(continued from previous page)

to avoid unintentional changes to

operations, simply call the *unlock* ss level.

ccess)

ply run the following piece of code:

ct, you can run the following com-

th information about the respective nething like this:

```
: 'execute'},
: str) -> bool>',
: hash: Passphrase hash using,
: min'\n\n'},
: 'execute'},

se level\n\n ',
in': 'read'},

ing.\n return:\n ',
'read'},

Devices\n\n Returns (list):,
'ead'},

ing with status information.\n\
isage)\n\n'}
```

kiutra

device_1

procedure_1

procedure_2

...

device_2

procedure_1

procedure_2

...

...

device_n

procedure_1

procedure_2

...

Jul 22, 2022

with the kiutra control software and API-accessible procedures.

e server.

s, like sweeps, can be implemented

emperature_control', '192.168.XX.

/0.5 K and a ramp of 0.15 K/min

(continues on next page)

API

1

2

API

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L-TYPE RAPID

Options Overview

Integration of RF electronics

- Low Noise Amplifiers
- Isolators/Circulators
- Low-Pass Filters
- IR Filters

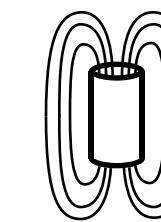
Integration of QDevil components

- QFilter DC low-pass filter
- QBoard modular sample holder
- QBox DC breakout



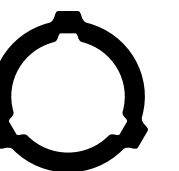
4 RF lines

up to 18 GHz



Sample Magnet

± 5 Tesla

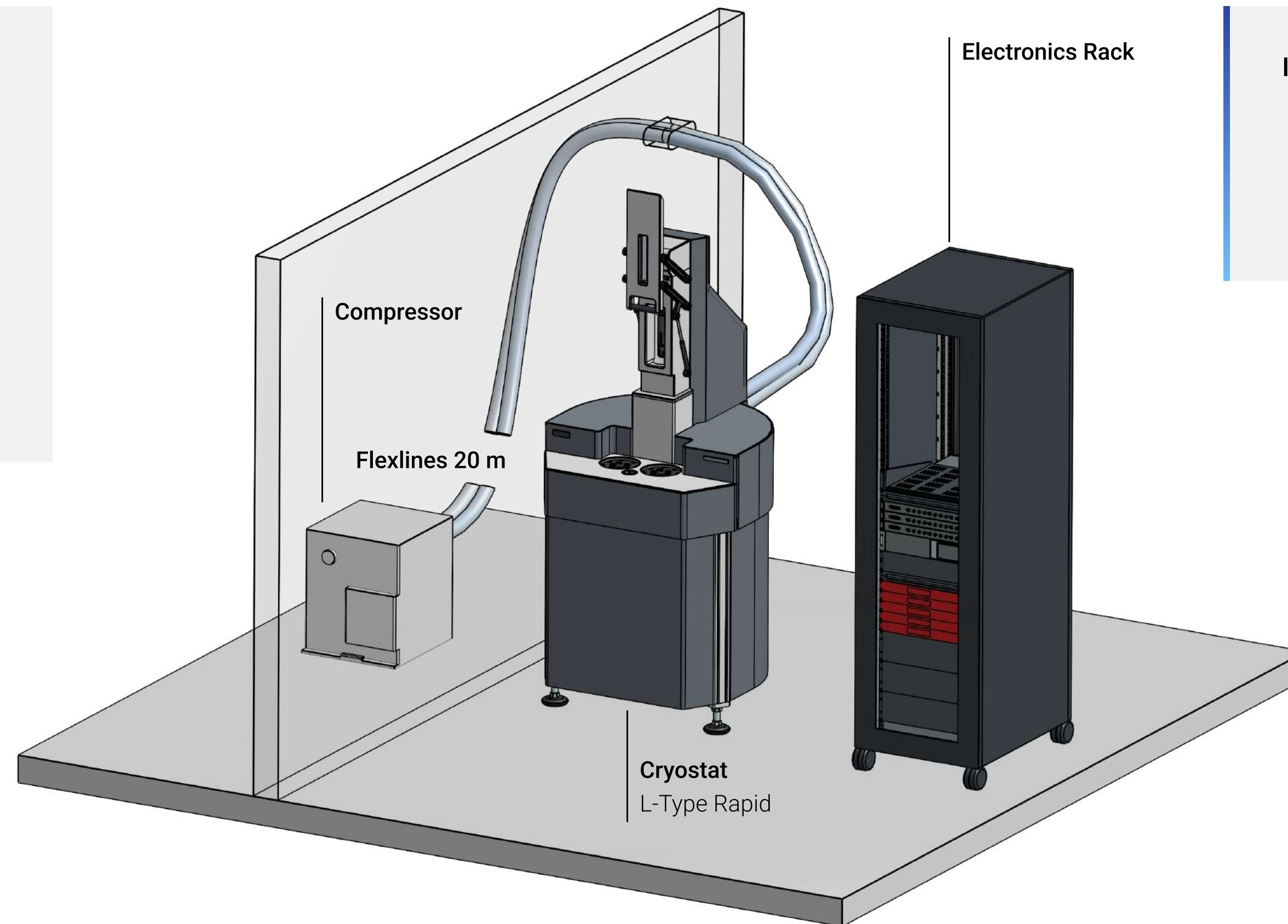


L-TYPE RAPID

Site Requirements

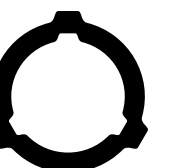
Compressor room

- Three-phase high current power supply
 - 380 - 415 V ($\pm 10\%$) V3~ @ 50 Hz
 - 480 V ($\pm 10\%$) V3~ @ 60 Hz
- Typical power rating:
 - 6.7 - 7.2 kW @ 50 Hz (max. 8.5 kW)
 - 8.0 - 8.5 kW @ 60 Hz (max. 9.8 kW)
- Cooling water (5 - 25 °C)



Installation site

- Standard power supply (100 - 240 V AC)
- Power rating: ~ 1000 W (max. 2000 W)
- Pressurized air (5 - 10 bar | Class 2)



L-TYPE RAPID

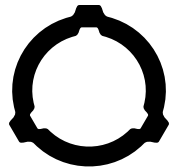
System Specifications

System size (cm) (w x l x h)	cryostat	94 x 94 x 232
	rack	60 x 80 x 168
	compressor	45 x 53 x 63
System weight (kg)	cryostat	< 600
	rack	< 250
	compressor	~100
Temperature range (K)		0.1 – 300
Continuous operation (K)		0.3 – 300
Stray field at sample position (mT) ^{*)}		< 0.05 (0.5 Gauss, 50 µT)
Available sample space (mm)	diameter	ø 36
	height	100

*) can be further reduced by an optional magnetic shielding. Expected stray-field below 0.5 µT/5mG

Cooldown time Cryostat (hours)		< 48
Cooldown time Sample (hours)	300 K – 100 mK	< 3
	(300 K – 4 K)	< 1.5
	(4 K – 100 mK)	< 1.5
Cooling power (µW)	@ 500 mK	50
	@ 1K	160
Operation time (hours)	@100 mK	3
Vibration (µm)		< 10
Temperature stability	typical	< 0.2 % (or 0.5 mK)
	while switching stages	< 2 % (or 5 mK)

Recharge time (minutes)	in one-shot operation	< 50
-------------------------	-----------------------	------



L-TYPE RAPID

Packlist

Cryostat

- Sumitomo RP-082B2 closed-cyle pulse tube cryocooler, 1W 4.2K, 40 W @ 45 K
- Sumitomo F-70H water-cooled indoor helium compressor, 20 m flexlines
- Two ADR units:
2 superconducting electromagnets, 2 heat switches, 2 cooling media
- Integrated passive quench protection
- Wide range pressure gauge
- User ports for custom integration of wiring and electronics: 2 x ISO-F 100, 1 x ISO-KF 25

Standard Wiring

- 40 DC lines user wiring to sample stage

Instrument Control

- Custom 19” electronics rack
- Kiutra Modular Control System (MCS):
Base Module, Power Module, Drive Module, 2x Load Module, Vacuum Control Module
- Kiutra Compressor Control Unit (CCU)
- Temperature monitor & controller
- Calibrated temperature sensor on sample stage
- Temperature sensors on cryocooler cold stages and first ADR unit
- Sample heater
- Computer with pre-configured instrument control software
- Two digital high frequency magnet power supplies
- User DC breakout through BNC connectors
- Filtered temperature sensor breakout

Automatic Vacuum Control System

- Pumping, purging and venting of cryostat and Sample Changer airlock chamber
- Oil-free roughing pump
- Turbomolecular pump

Automatic Sample Loader

- Airlock Chamber with motorized sample transfer
- Additional pressure gauge
- Puck for loading and unloading samples
- Puck Transfer Cage
- Sample Puck Station
- ISO-F 100 Gate Valve

