



Sample Environment in Neutron Instrumentation

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Services for Advanced Neutron Environment (SANE)
<http://www.ill.eu/sane>

Duties

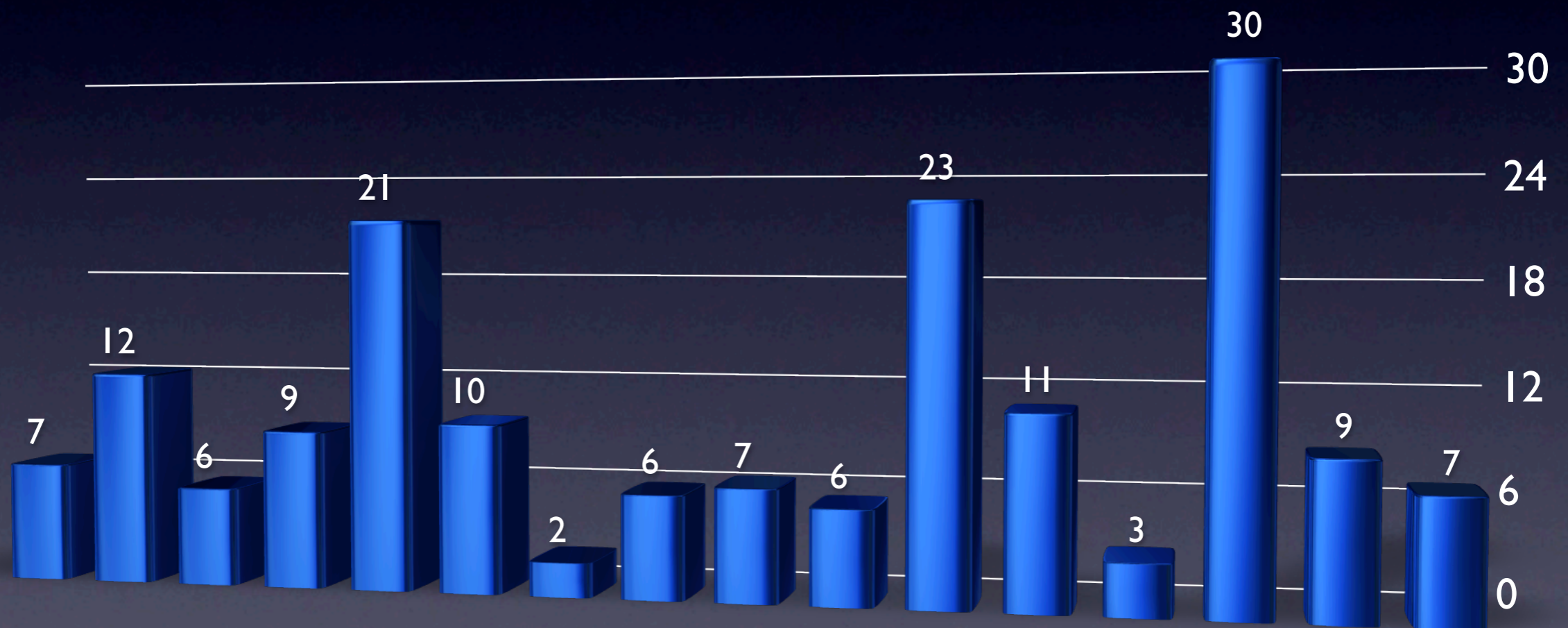
- provide sample environment equipments
- provide polarised neutron tools
- provide experimental support
- purchase/develop equipments optimised for neutron scattering

Team

- Gas Adsorption: 1 person
- High temperatures: 2 persons
- High pressures: 2 persons
- Low temperatures: 6 persons
- Polarimetry: 1 person
- Electronics: 1 person
- + engineer, secretary, ...

Statistics

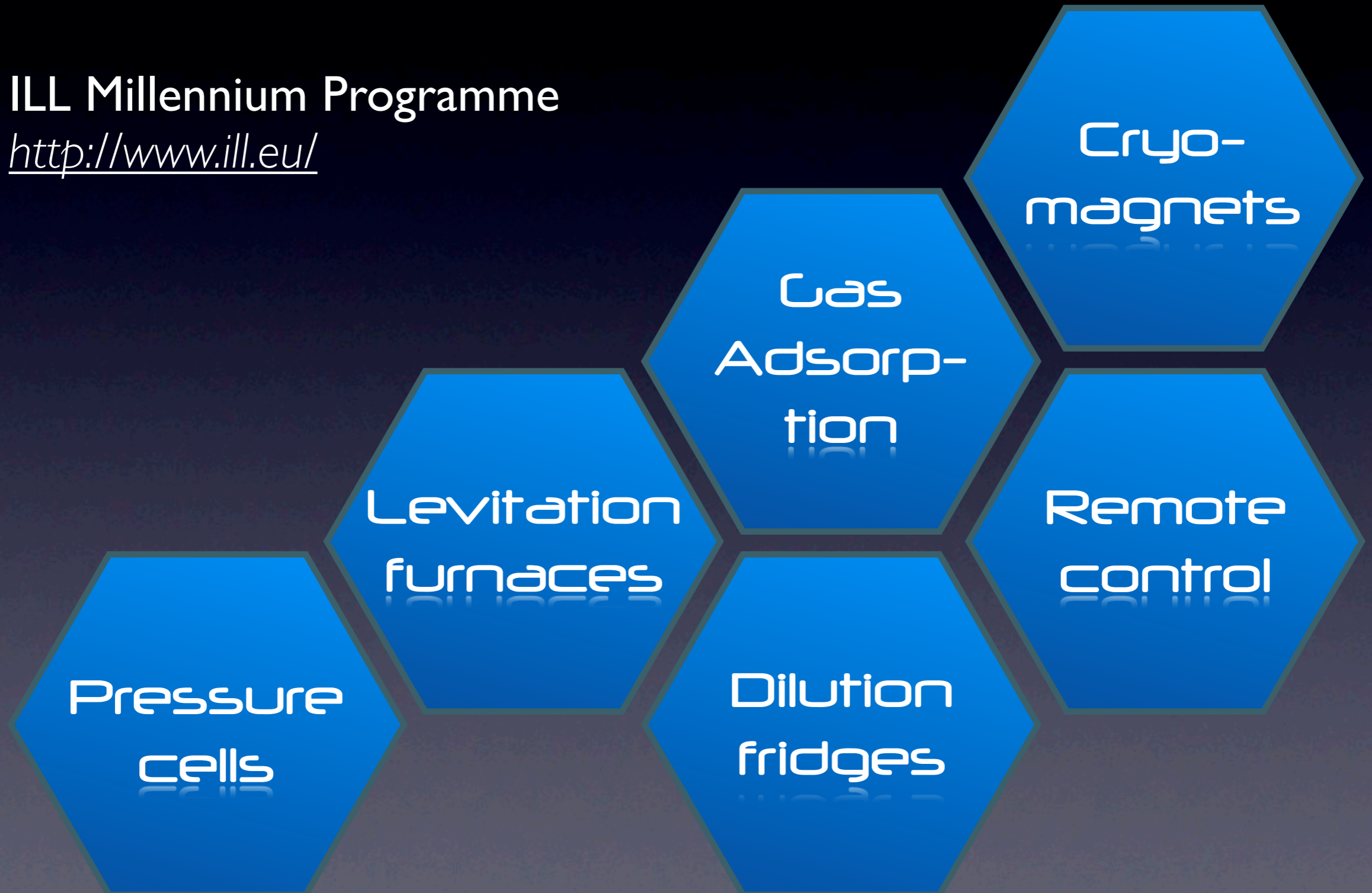
beam days lost per cycle (2003 to 2007)



over +1100 days allocated per cycle

Projects

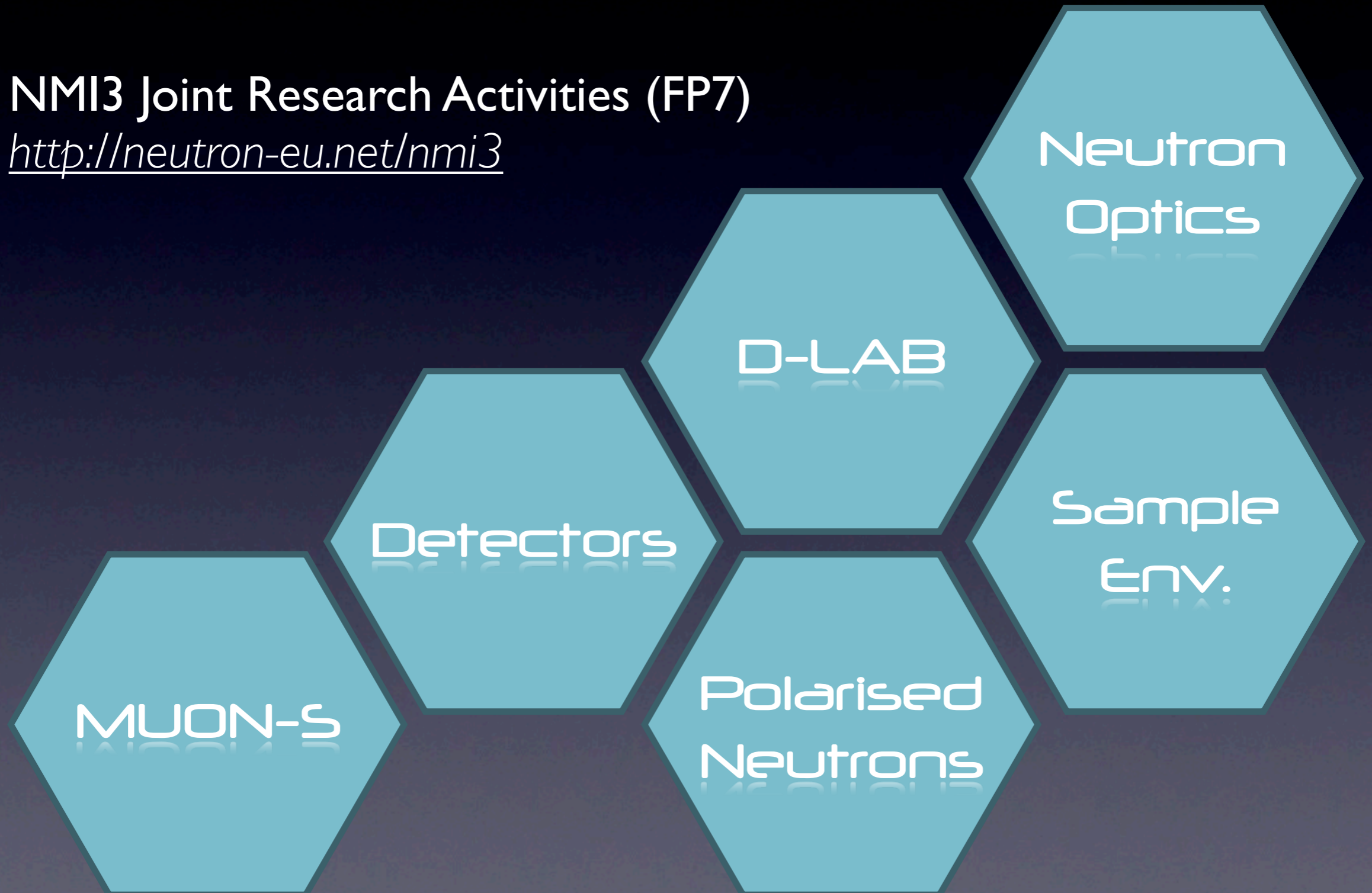
- ILL Millennium Programme
<http://www.ill.eu/>



Projects

- NMI3 Joint Research Activities (FP7)

<http://neutron-eu.net/nmi3>



Projects

- **NMI3 Joint Research Activities (FP7)**
<http://neutron-eu.net/nmi3>



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H₂ gas handling
& pressure cells

Gas Adsorption
Control Systems

ultra-high temperature
aerodynamic levitation furnace

Ultra-high temperature furnace using
electromagnetic/static levitation

Gas handling & pressure
cells for inert gases

Sample
Env.

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- NMI3 Joint Research Activities (FP7)

<http://neutron-eu.net/nmi3>

H₂ gas handling
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Gas handling & pressure
cells for inert gases

Sample
Env.

Cryogenics

- **68 cryostats / cryofurnaces**
1.5-320K / 1.5 - 550K
License contracted with
A.S. Scientific Corporation
<http://www.asscientific.co.uk>
- **9 dilution cryostats / inserts**
15 / 35mK - 320K
- **2 ^3He fridges**
350mK - 320K



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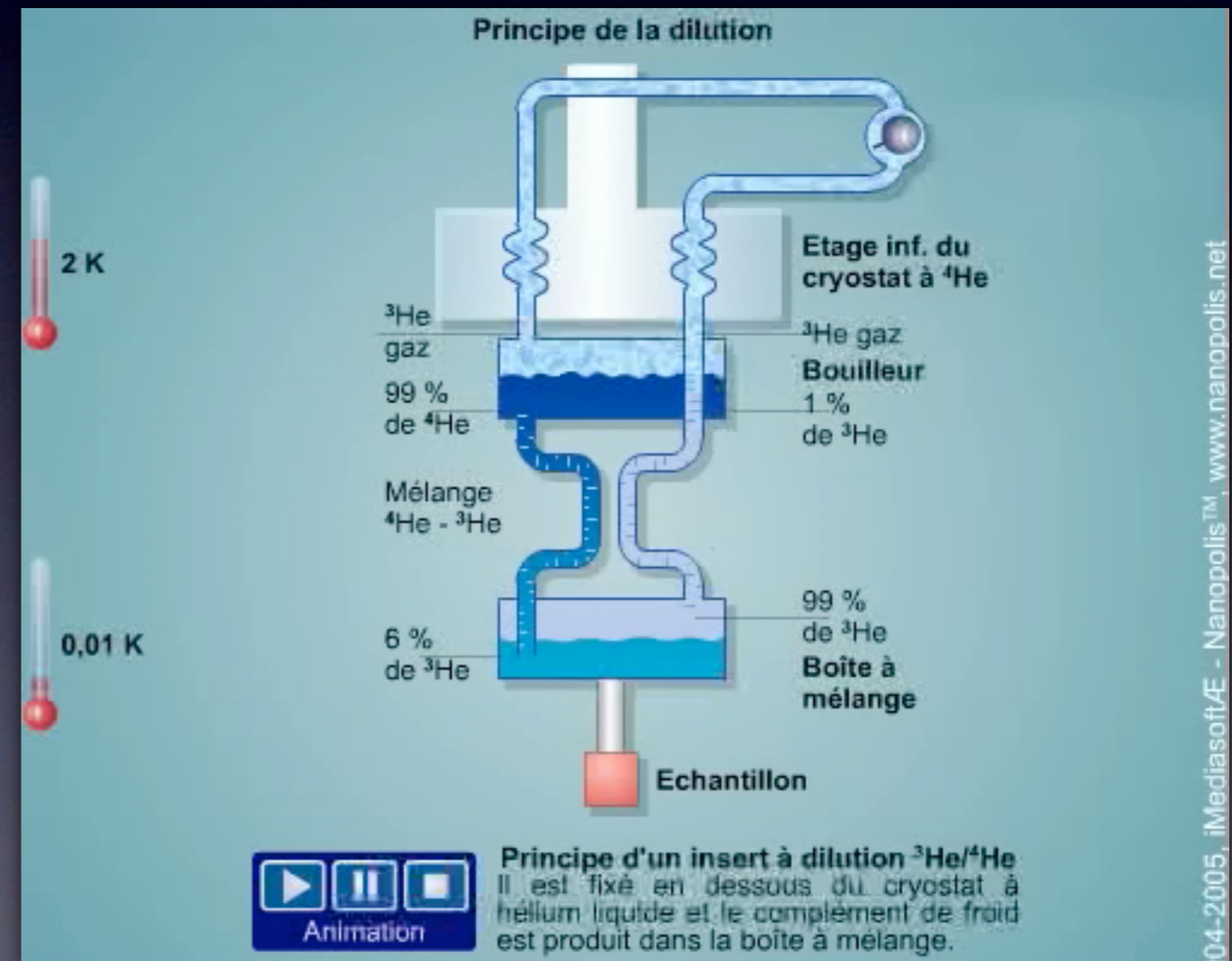
<http://www.asscientific.co.uk>

- 9 dilution fridges

15 / 35mK - 320K

- 2 ^3He fridges

350mK - 320K



Cryogenics

- **Thermometry**

cryogenic calibrator facility
covering 1.5 to 320K

batch of 20 sensors
calibrated at once

Cernox in cryostats,
RhFe in cryofurnaces

fully automatic



Cryogenics

- Cryogen-free top-loading cryostats

Ø70 sample chamber with temperature 2.6 to 320K

Ø50 sample chamber with temperature 2.6 to 650K

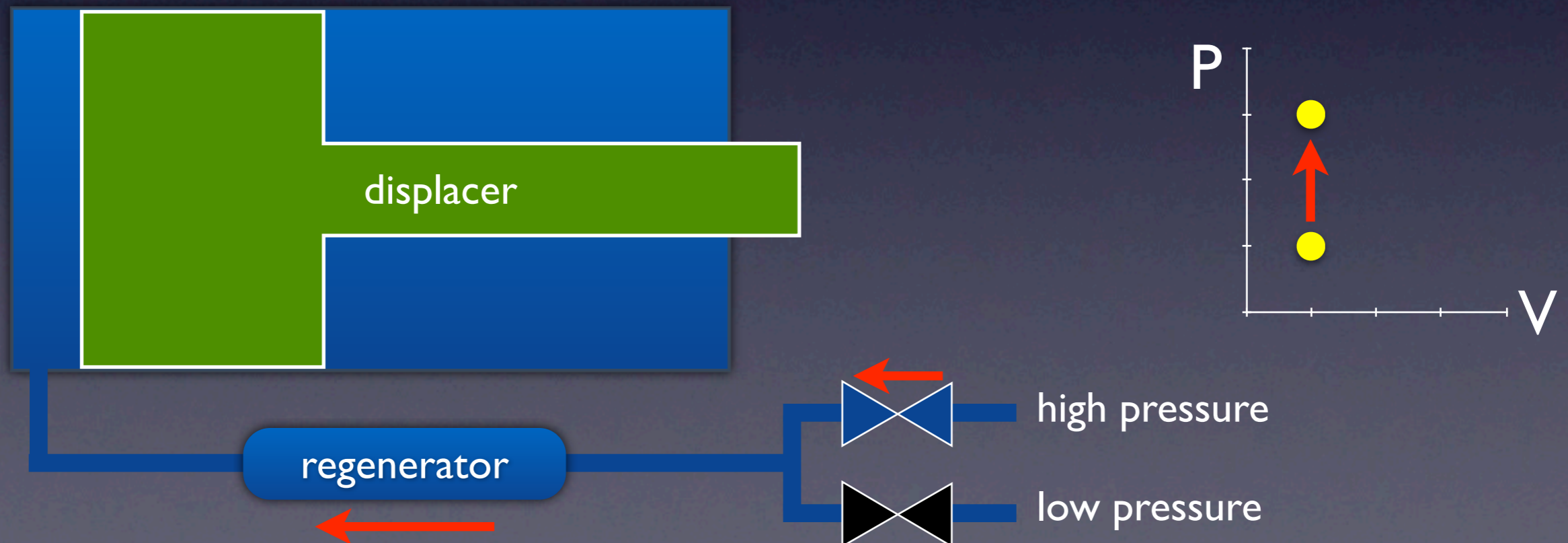
Sumitomo SRDK-408D2
1W @ 4.2K cold head



Cryogenics

- Gifford-McMahon cycle

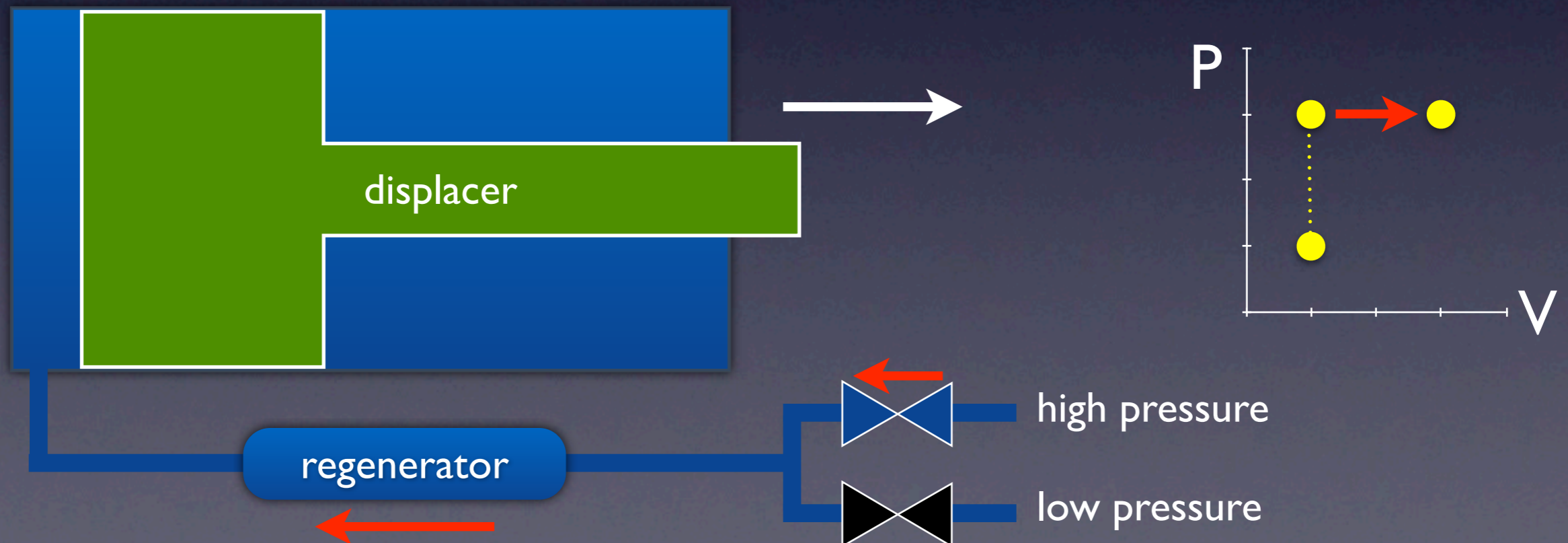
1 : pressurise expansion cylinder at minimum volume with regenerated pre-cooled gas



Cryogenics

- Gifford-McMahon cycle

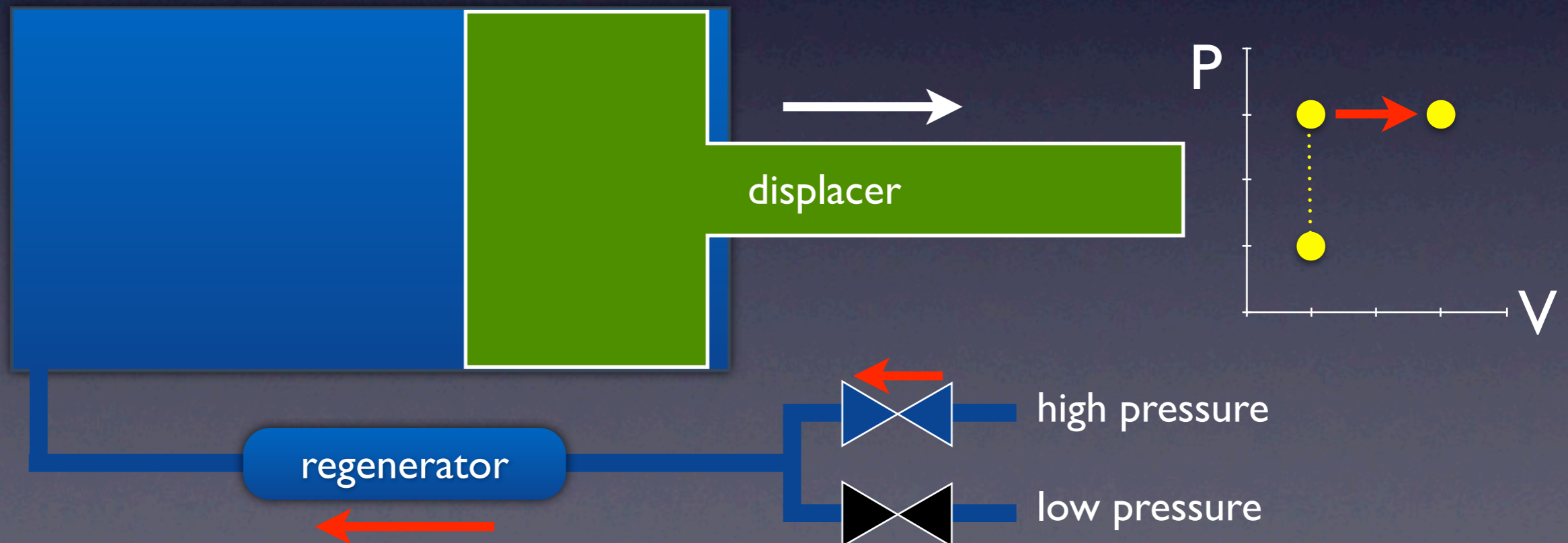
#2: maximise volume at high pressure by adding more pre-cooled gas



Cryogenics

- Gifford-McMahon cycle

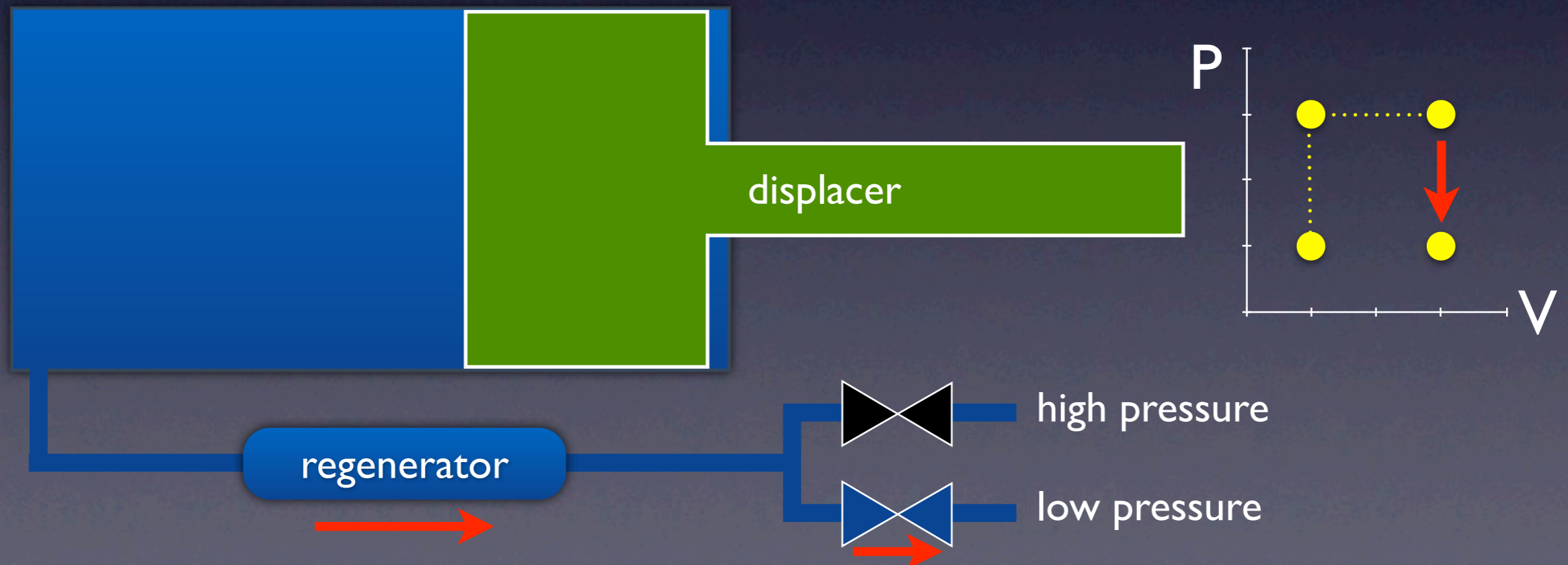
#2: maximise volume at high pressure by adding more pre-cooled gas



Cryogenics

- Gifford-McMahon cycle

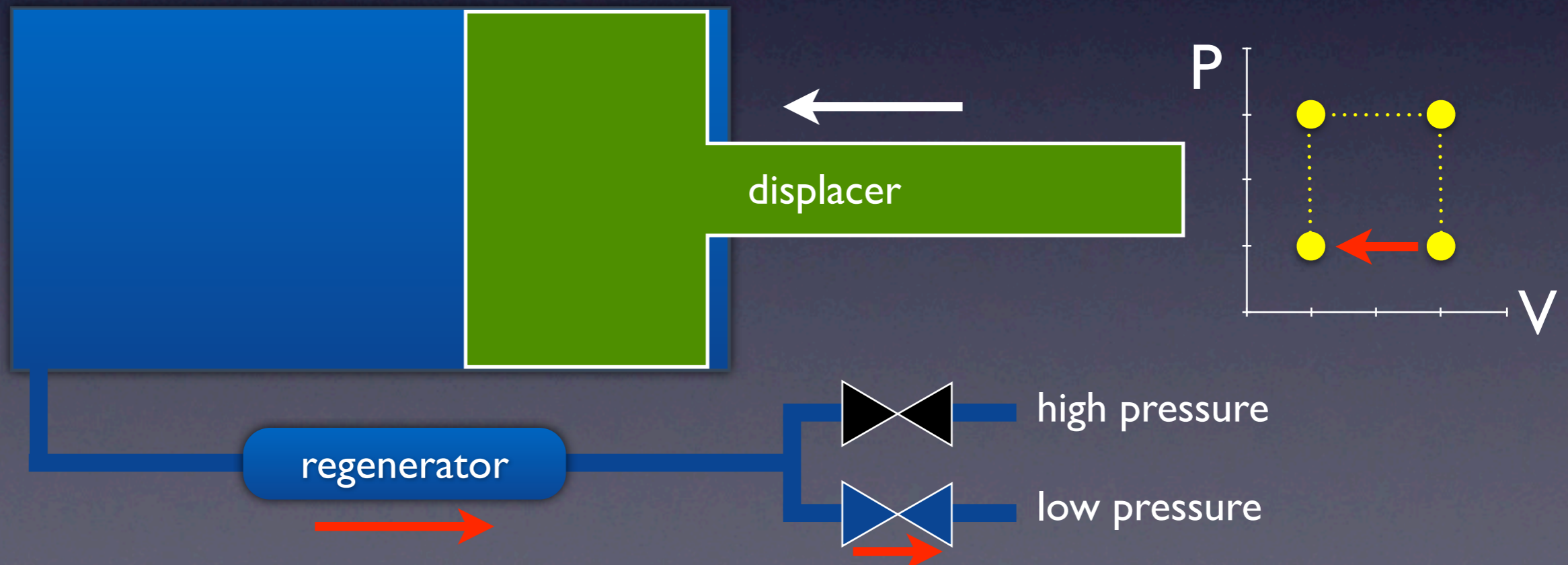
#3: de-pressurise and exhaust through the regenerator (cooling)



Cryogenics

- Gifford-McMahon cycle

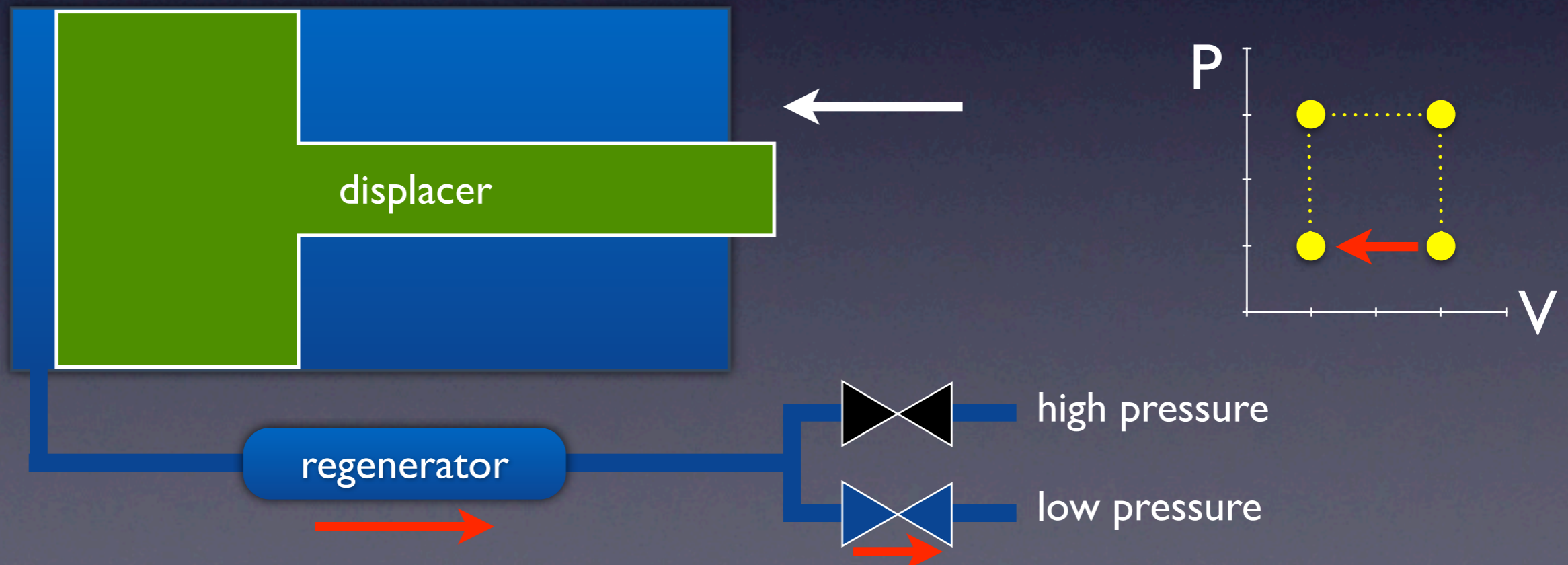
#4: minimise volume at minimum pressure by exhausting more gas (more regenerator cooling)



Cryogenics

- Gifford-McMahon cycle

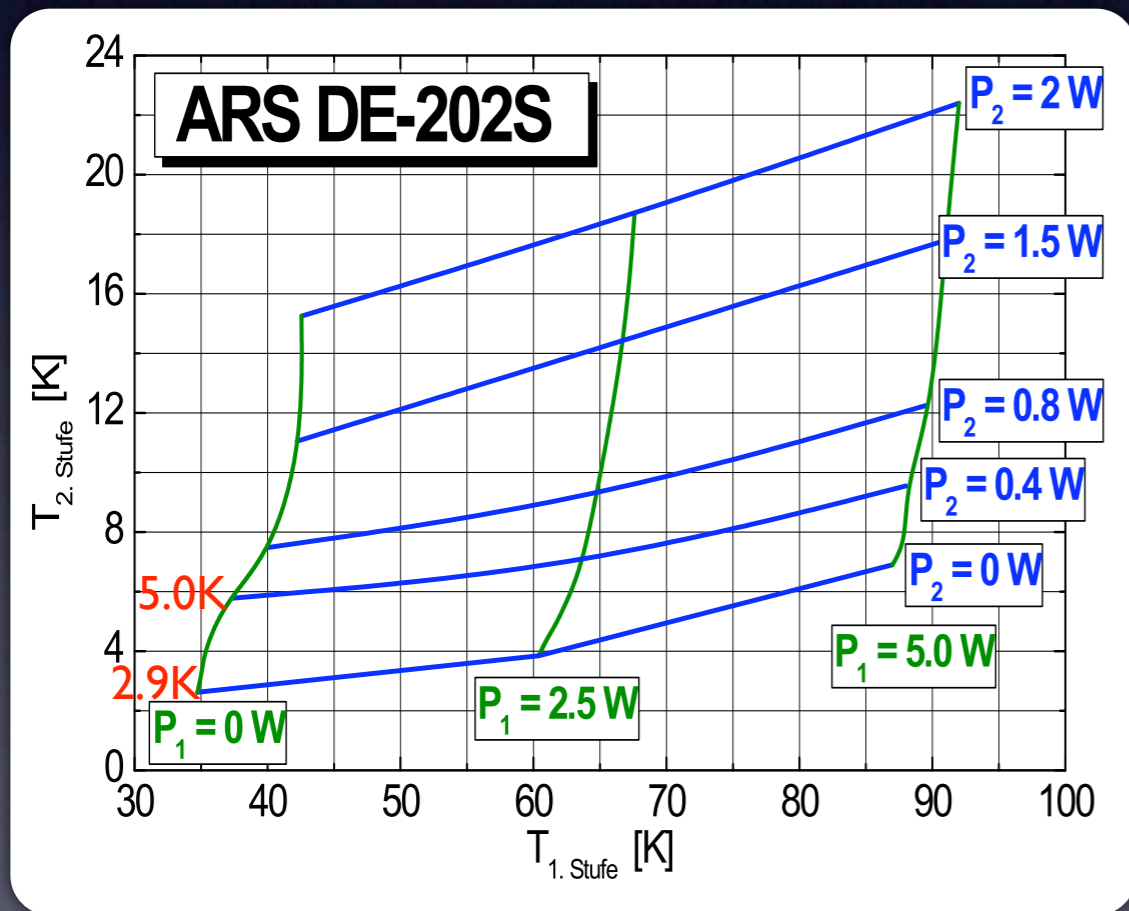
#4: minimise volume at minimum pressure by exhausting more gas (more regenerator cooling)



Cryogenics

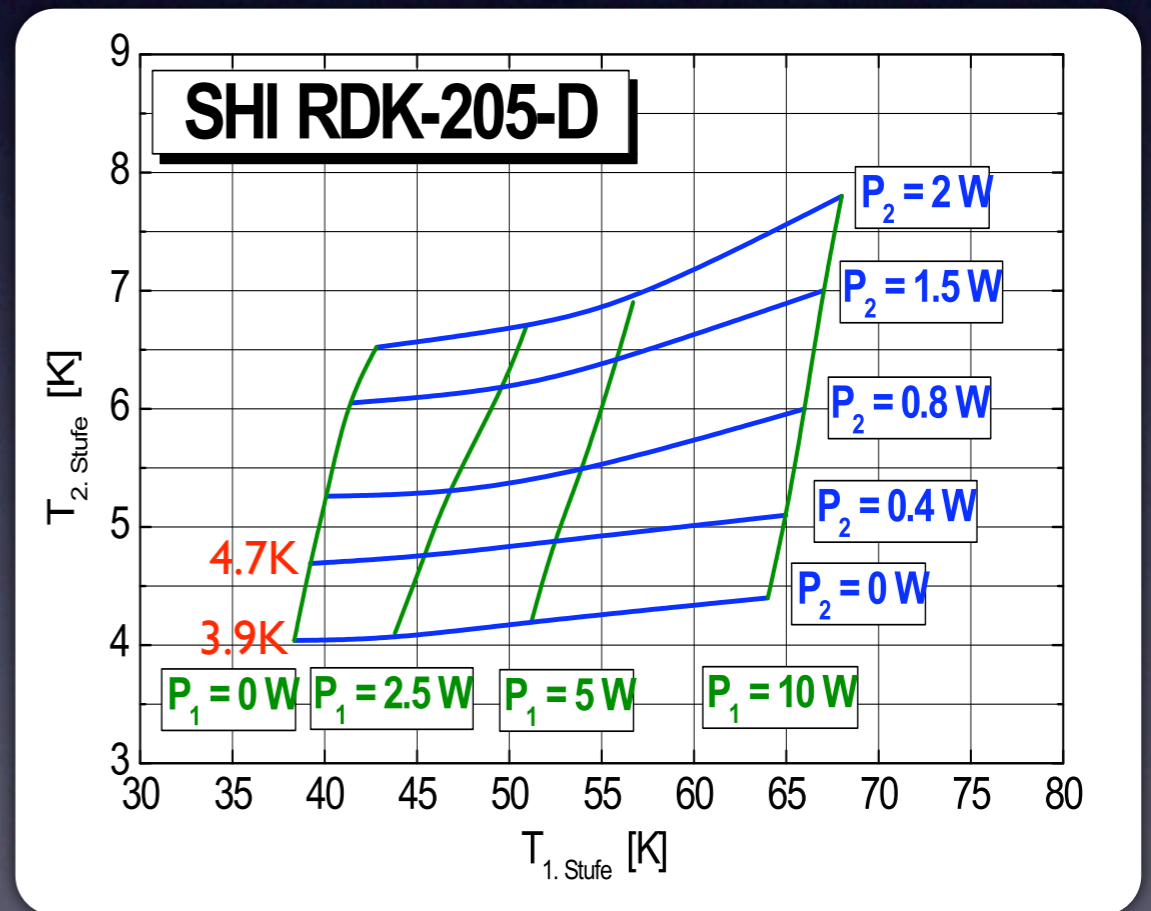
- Gifford-McMahon cycle

Advanced Research Systems



<http://www.arscryo.com>

Sumitomo Heavy Industries



<http://www.shicryogenics.com>

Cryogenics

- Compact 1.8 K cryogen-free cryostats

2h30 to T_{\min} from 300K

1h30 to heat to 300K

4 units at ILL, 1 at ESRF

License contracted with
Advanced Research Systems

<http://www.arscryo.com>



Cryogenics

- 100kbar @ 3K
cryogen-free cryostat

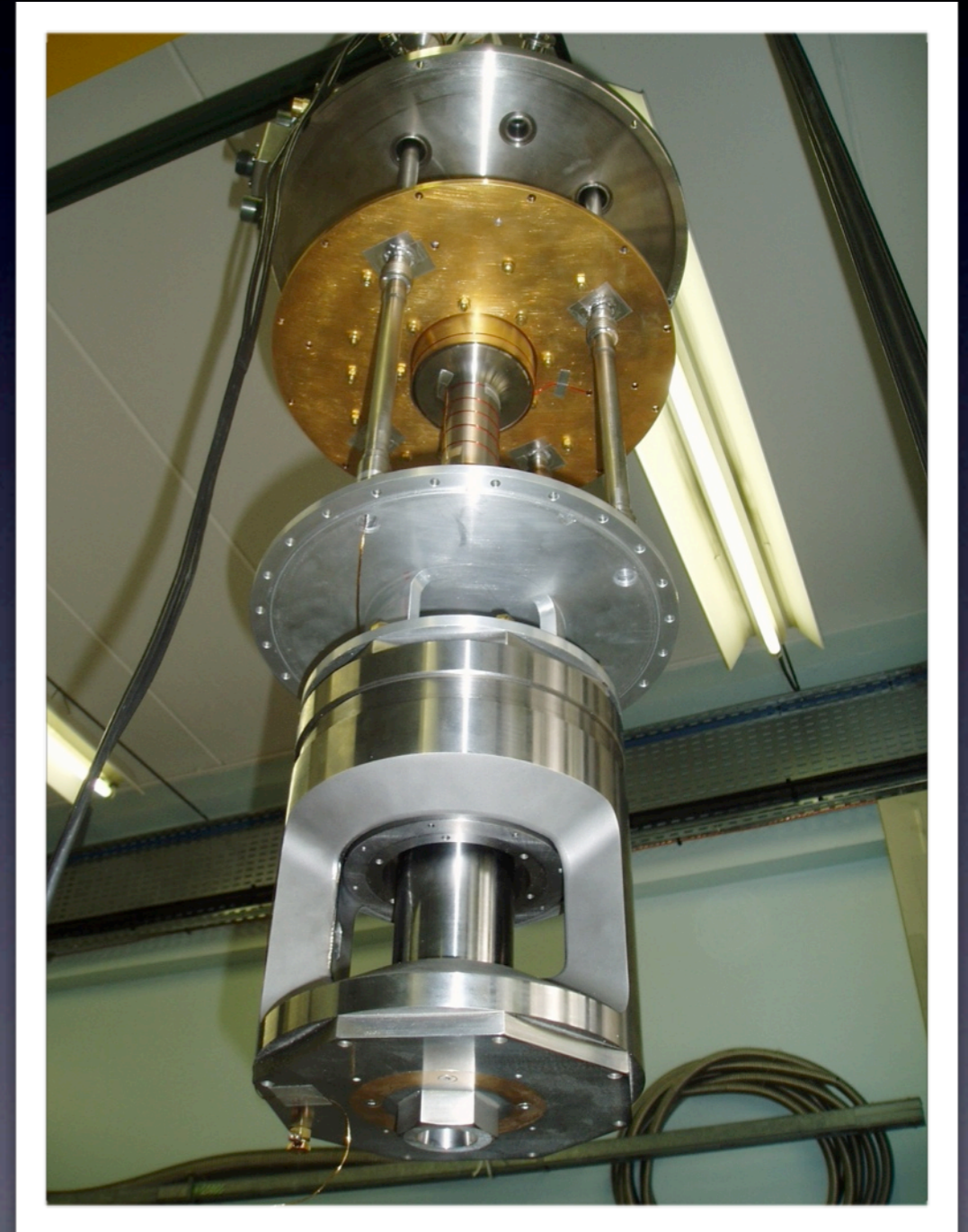
3h to 120K from 300K (LN₂)

3h to 3K from 120K

1 unit at ILL, 1 at PSI

Ø3x0.6mm @ 100kbar

Ø6x0.6mm @ 50kbar



Cryogenics

- Up to 15T @ 30mK

4 horizontal cryomagnets

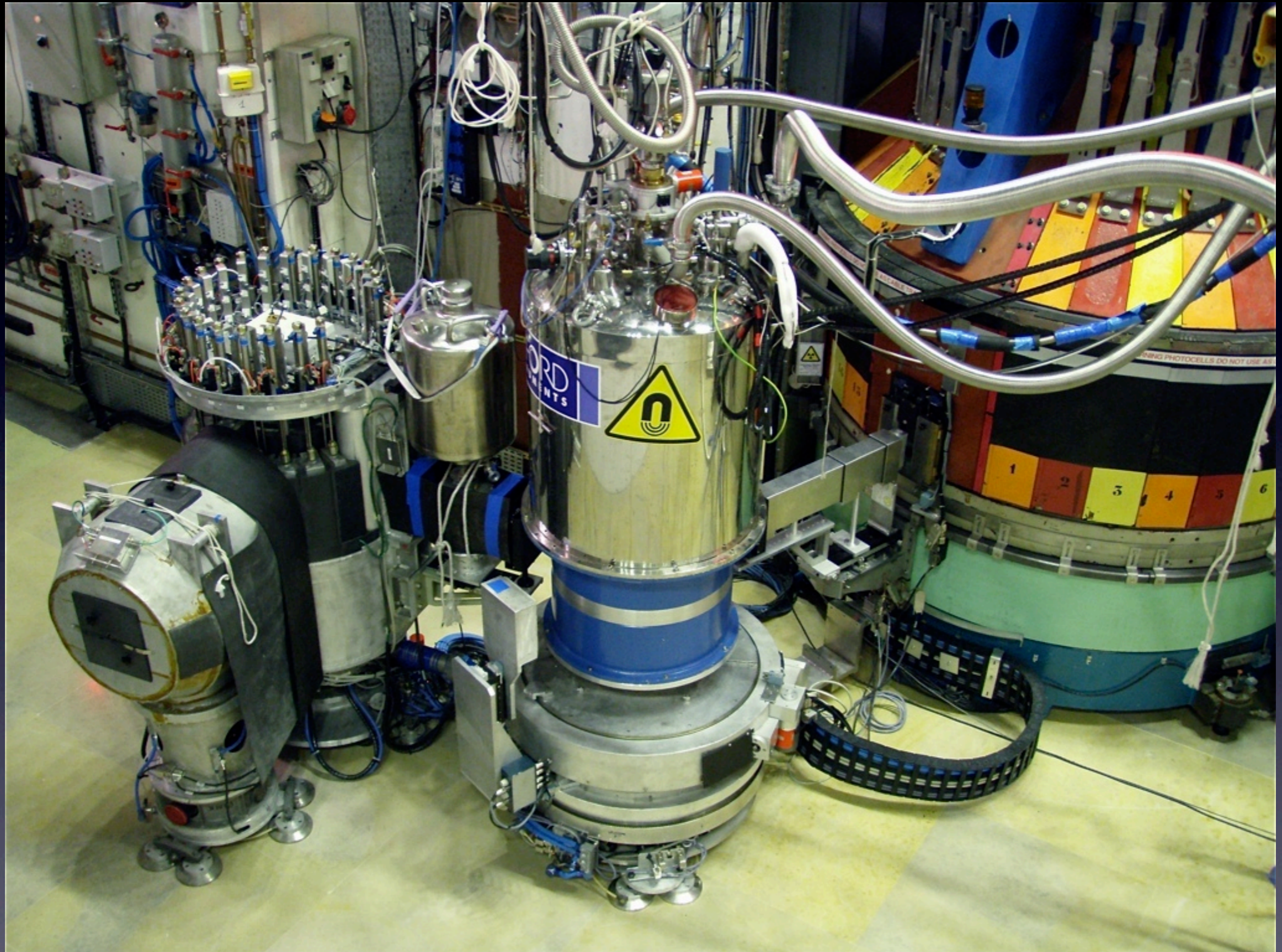
8 vertical cryomagnets

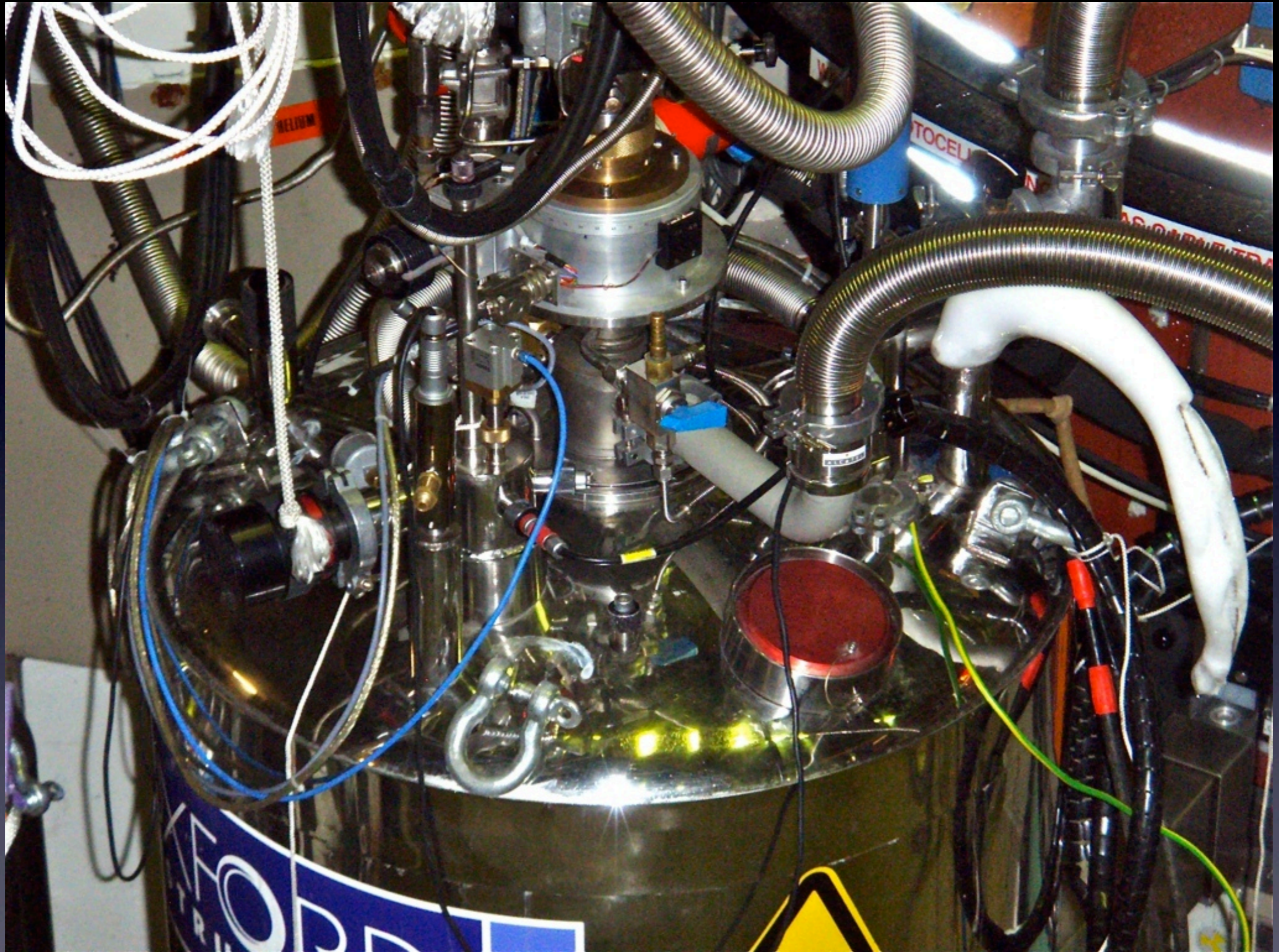
dilution inserts available

zero-boil-off option being developed in collaboration with Oxford Instruments (UK)

<http://www.oxford-instruments.com>

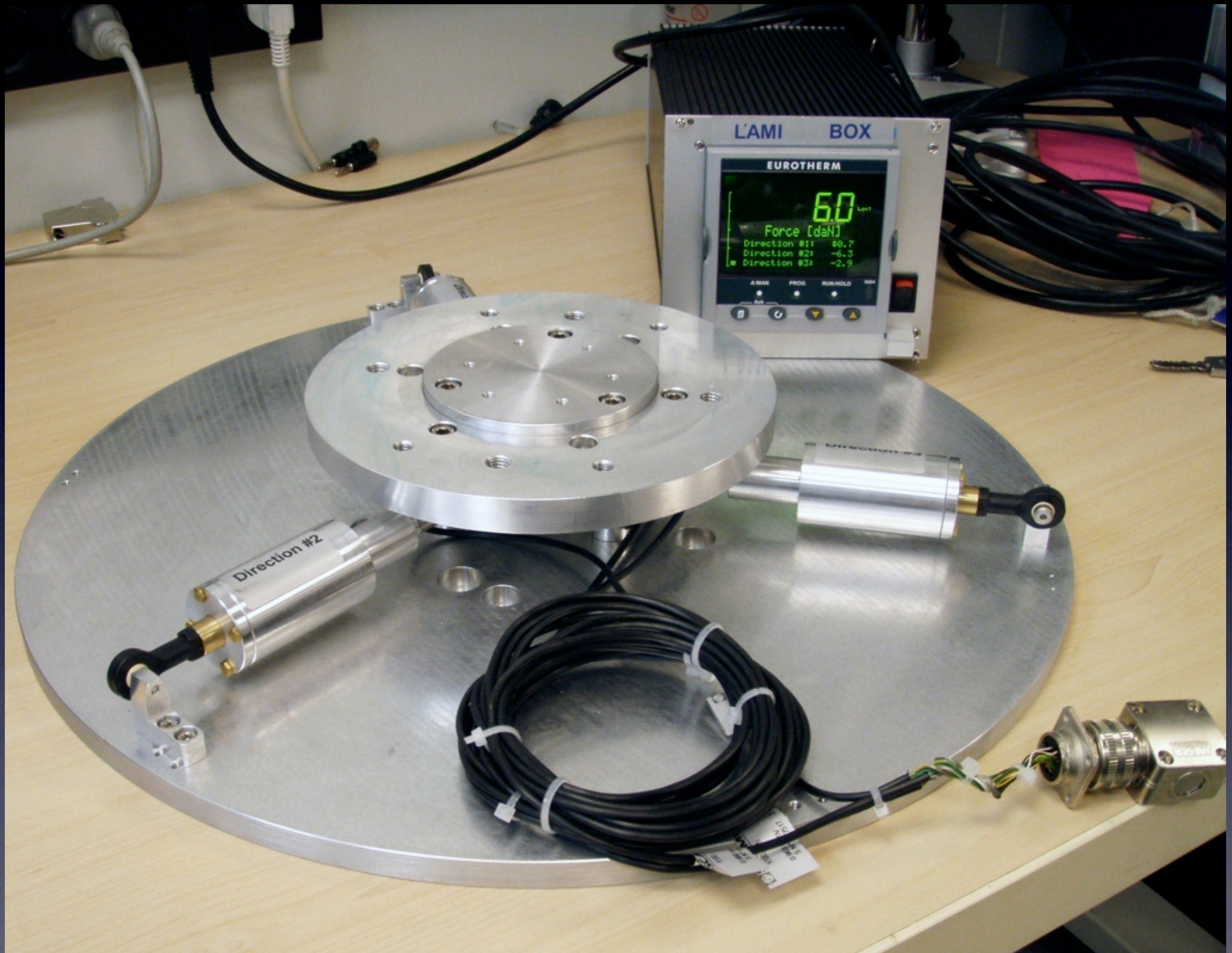






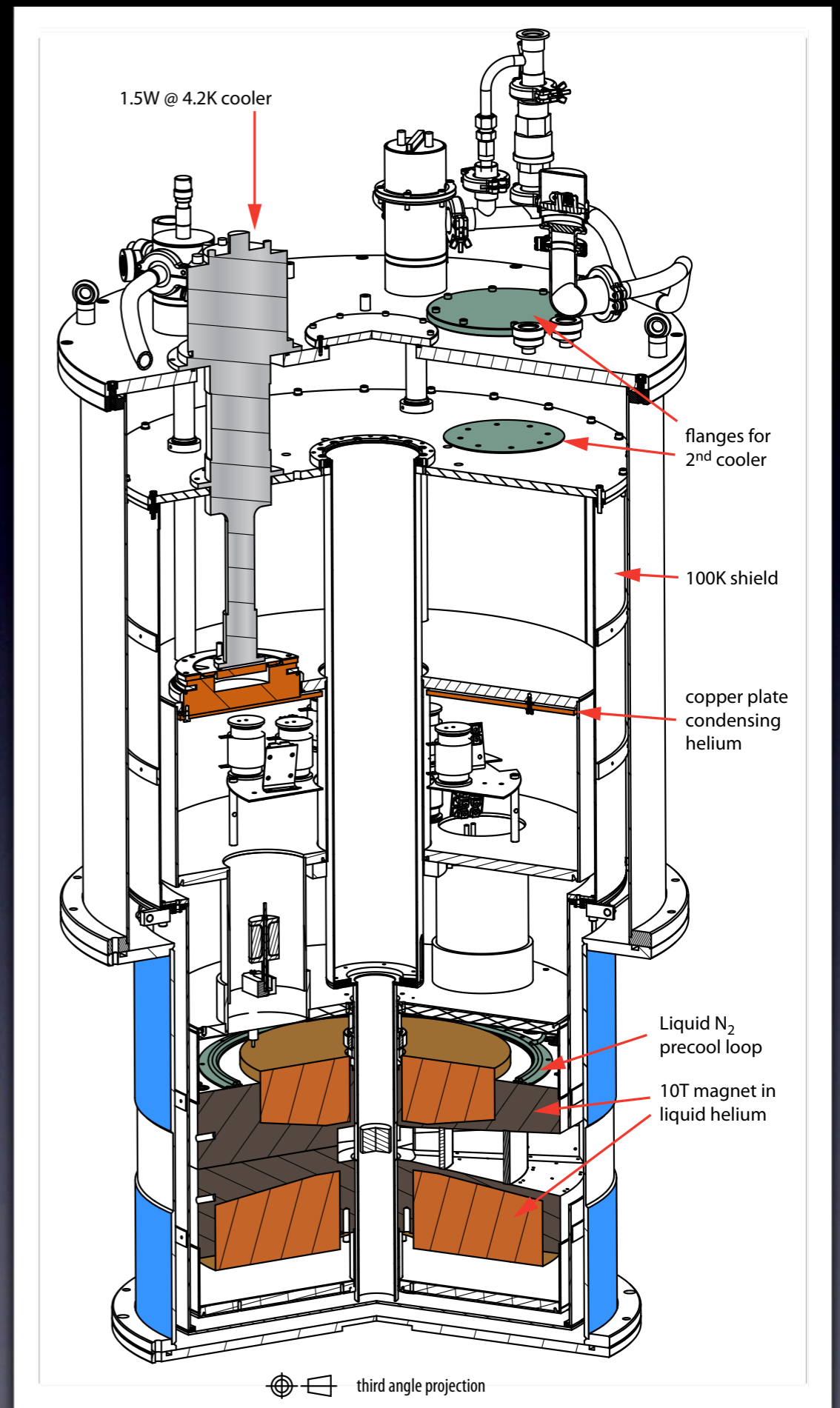
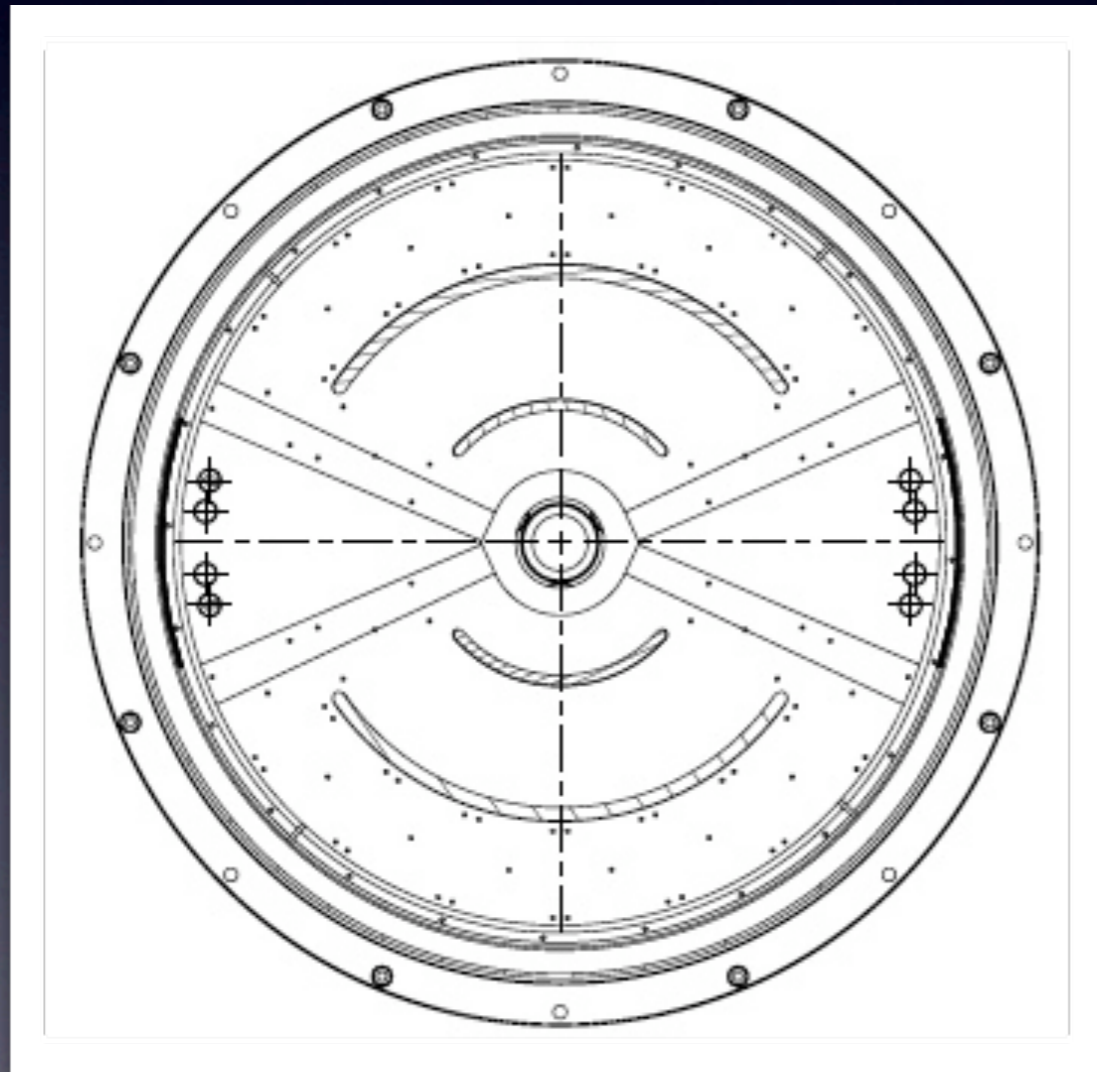
TOCELL





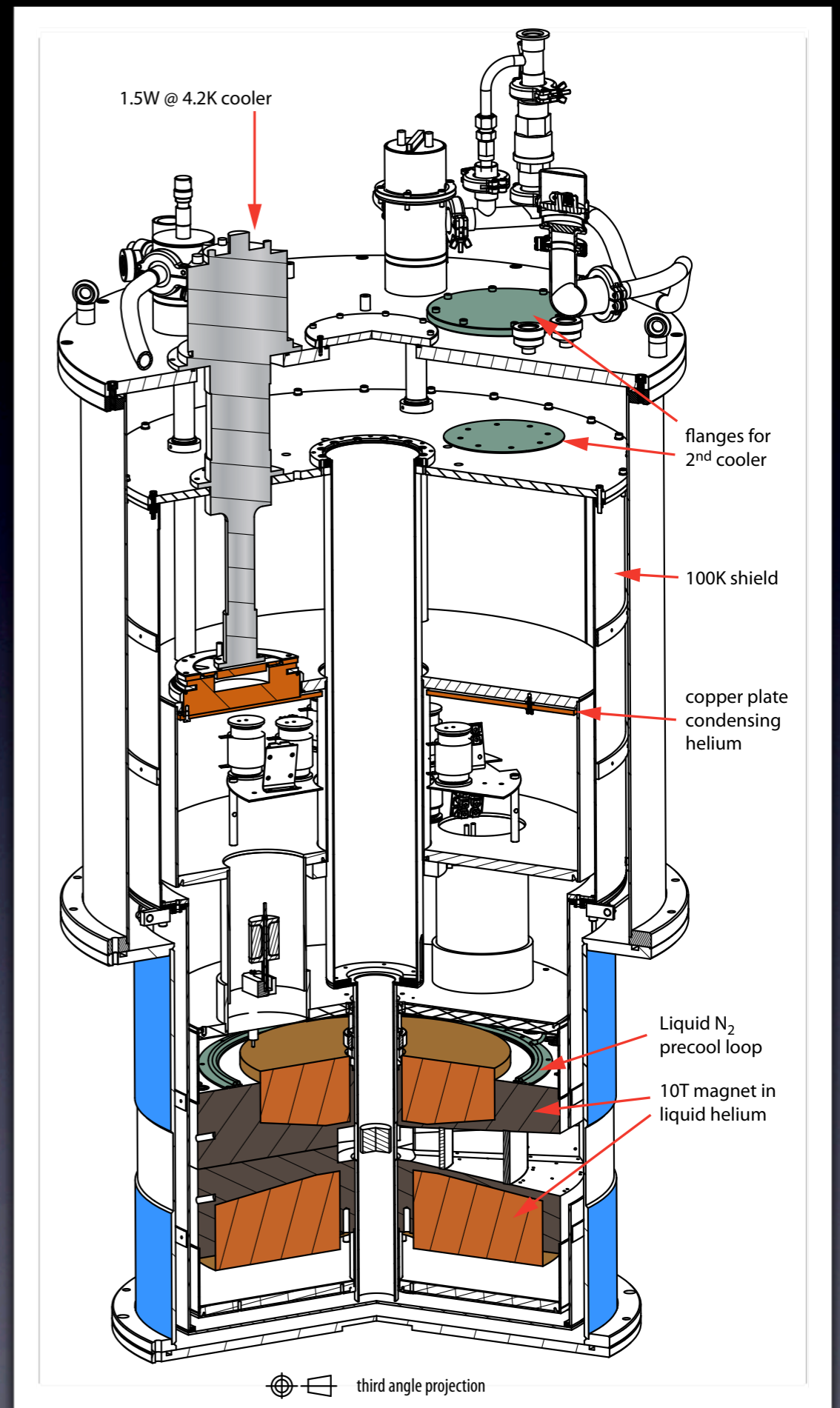
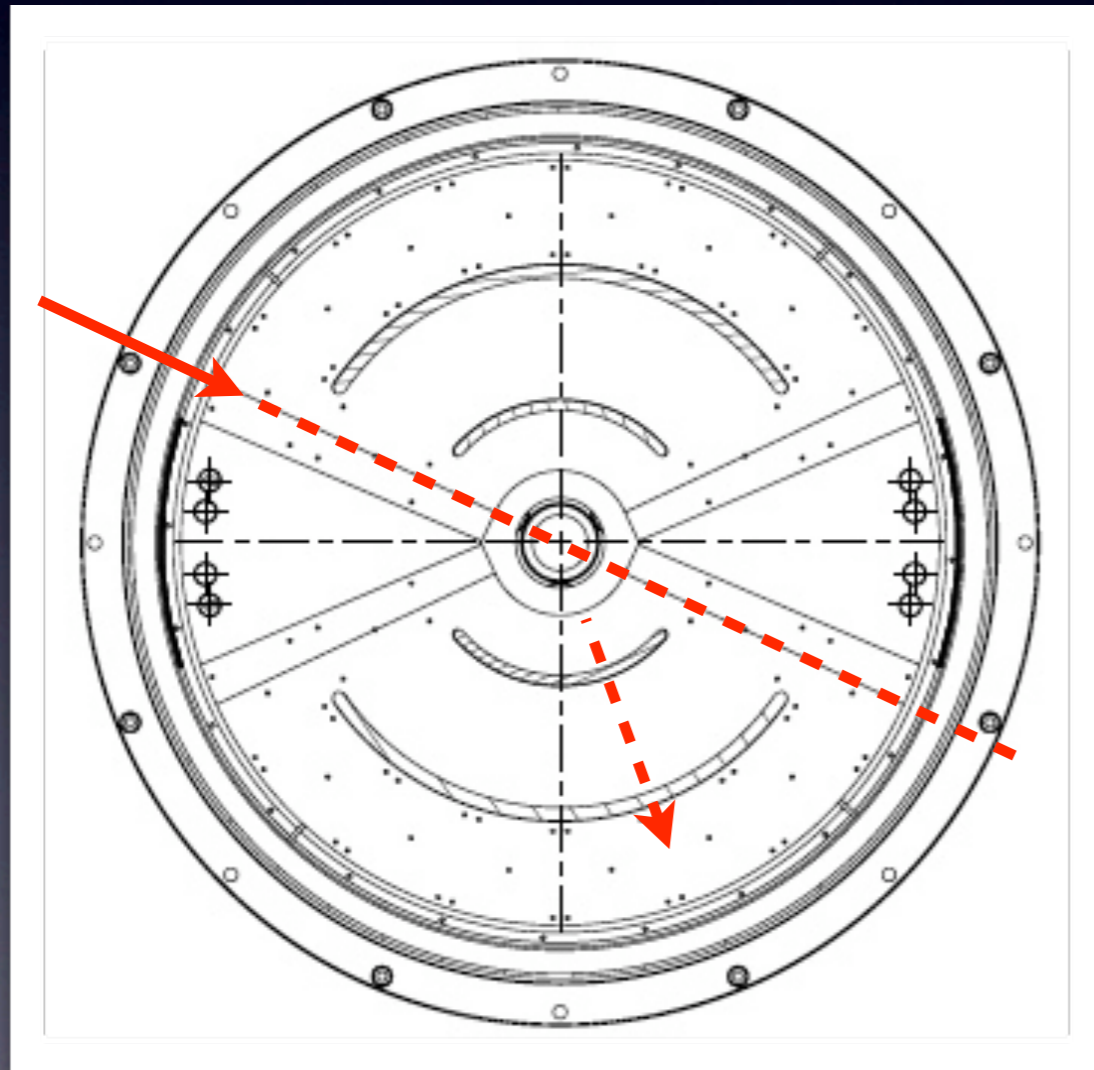
Cryogenics

- Zero-boil-off magnets



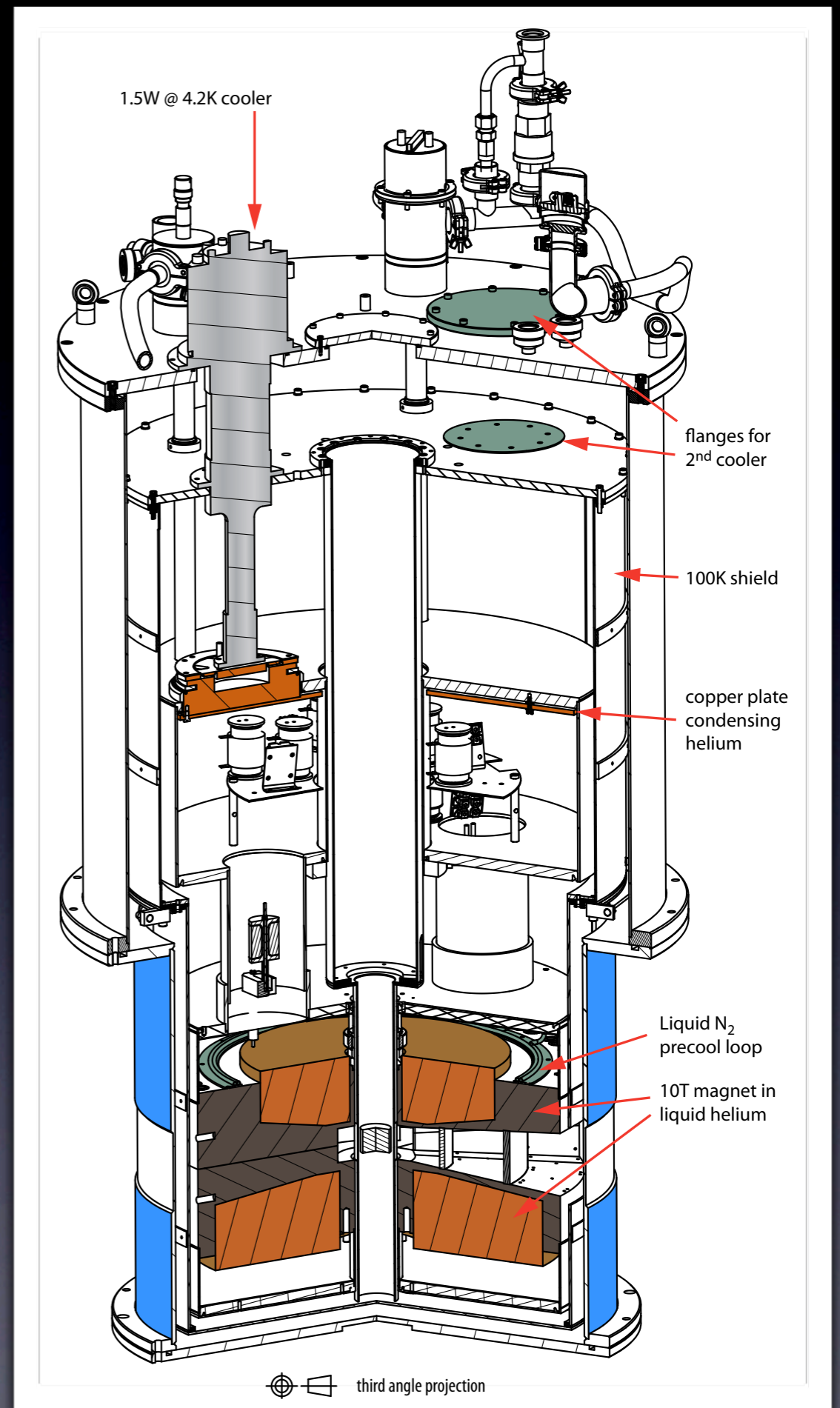
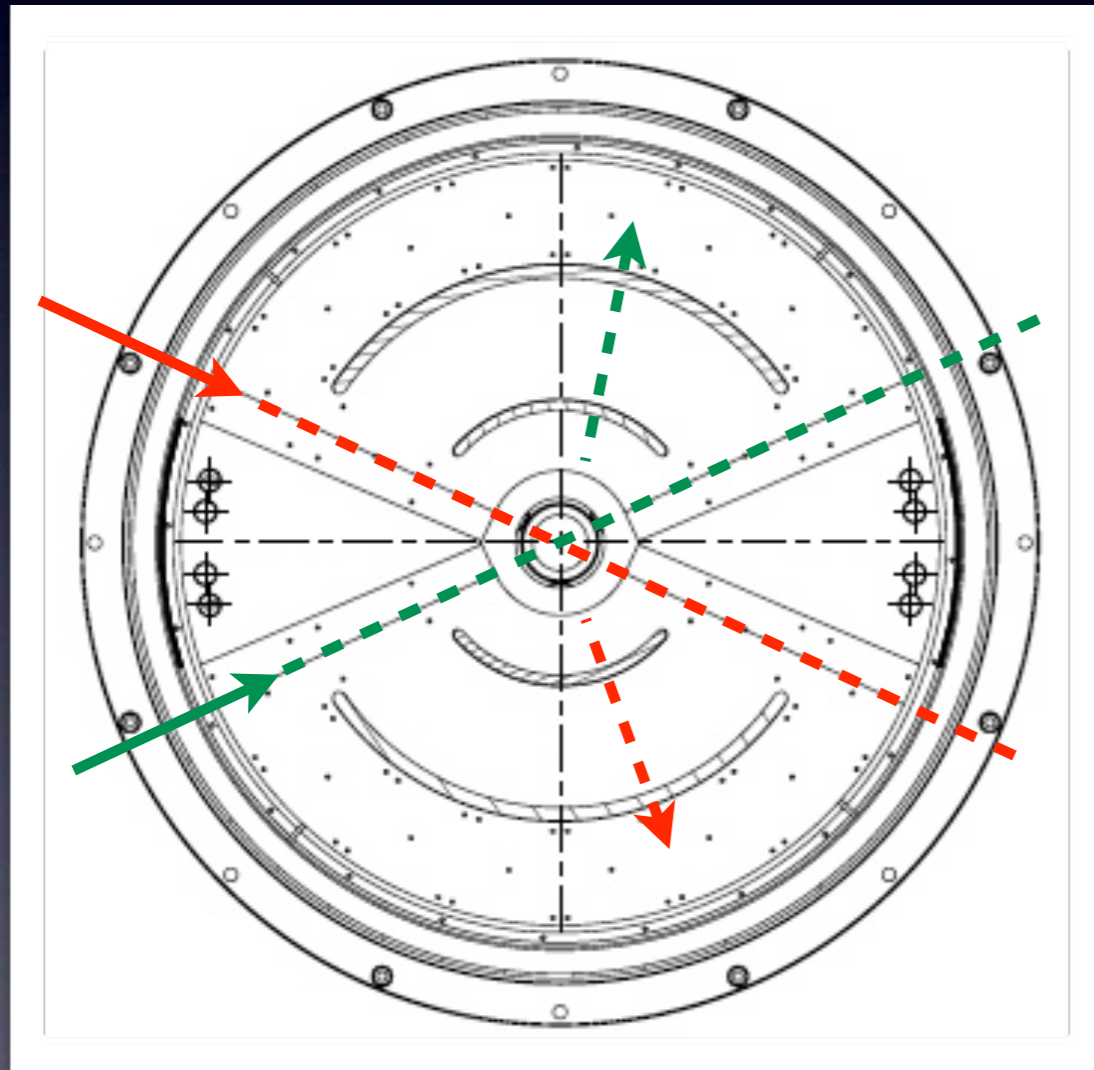
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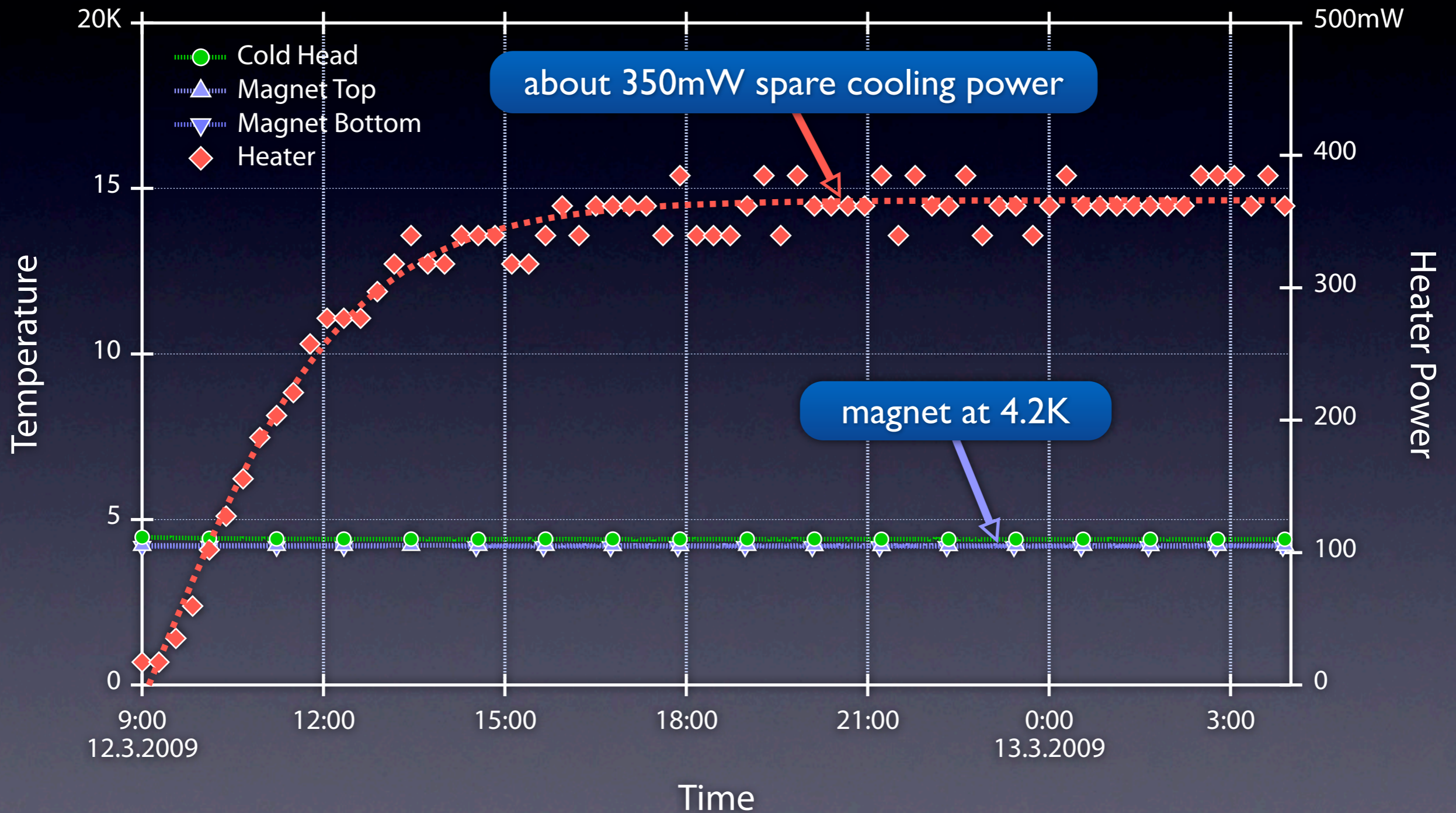


Cryogenics

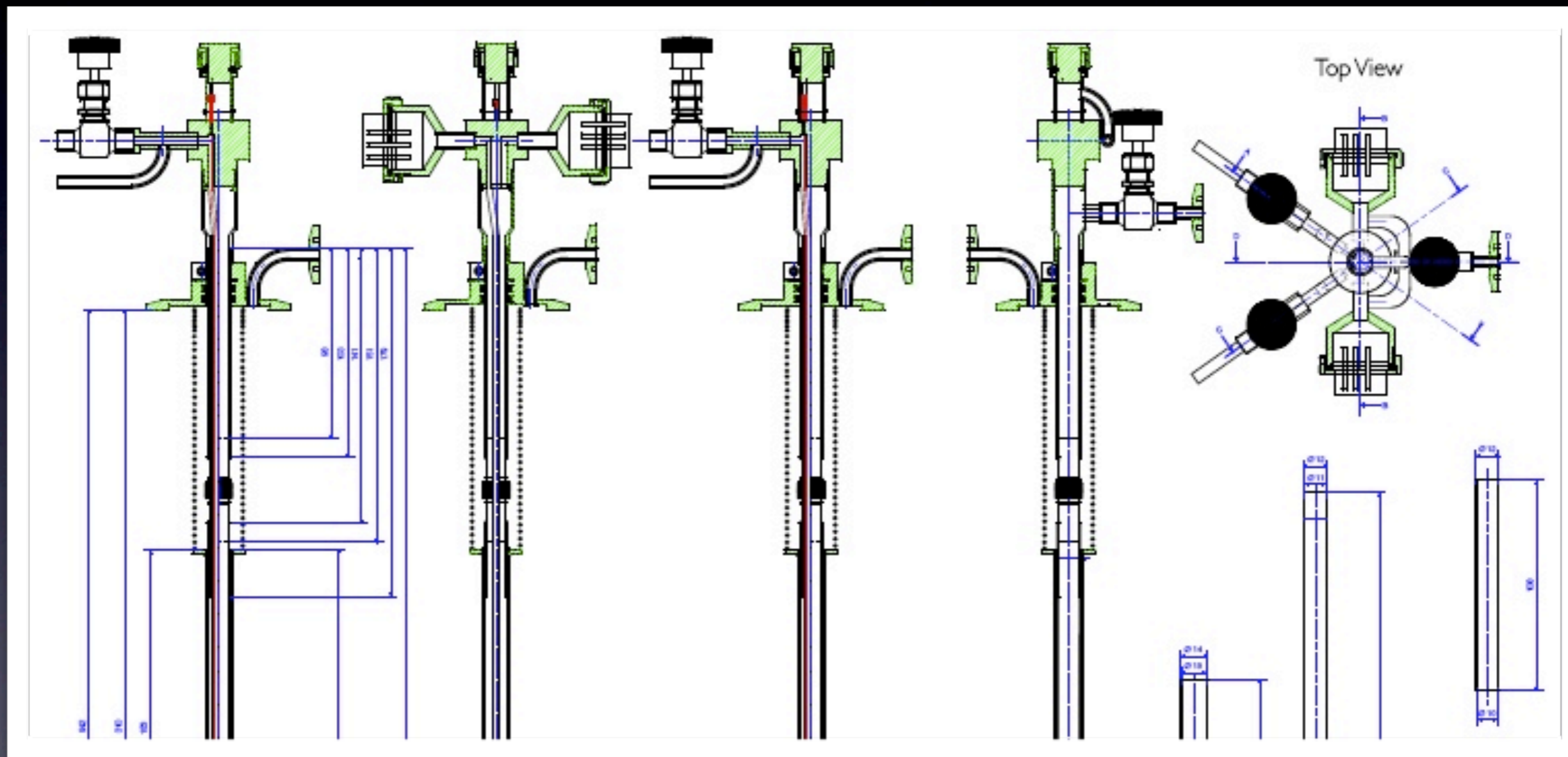
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Cryogenics



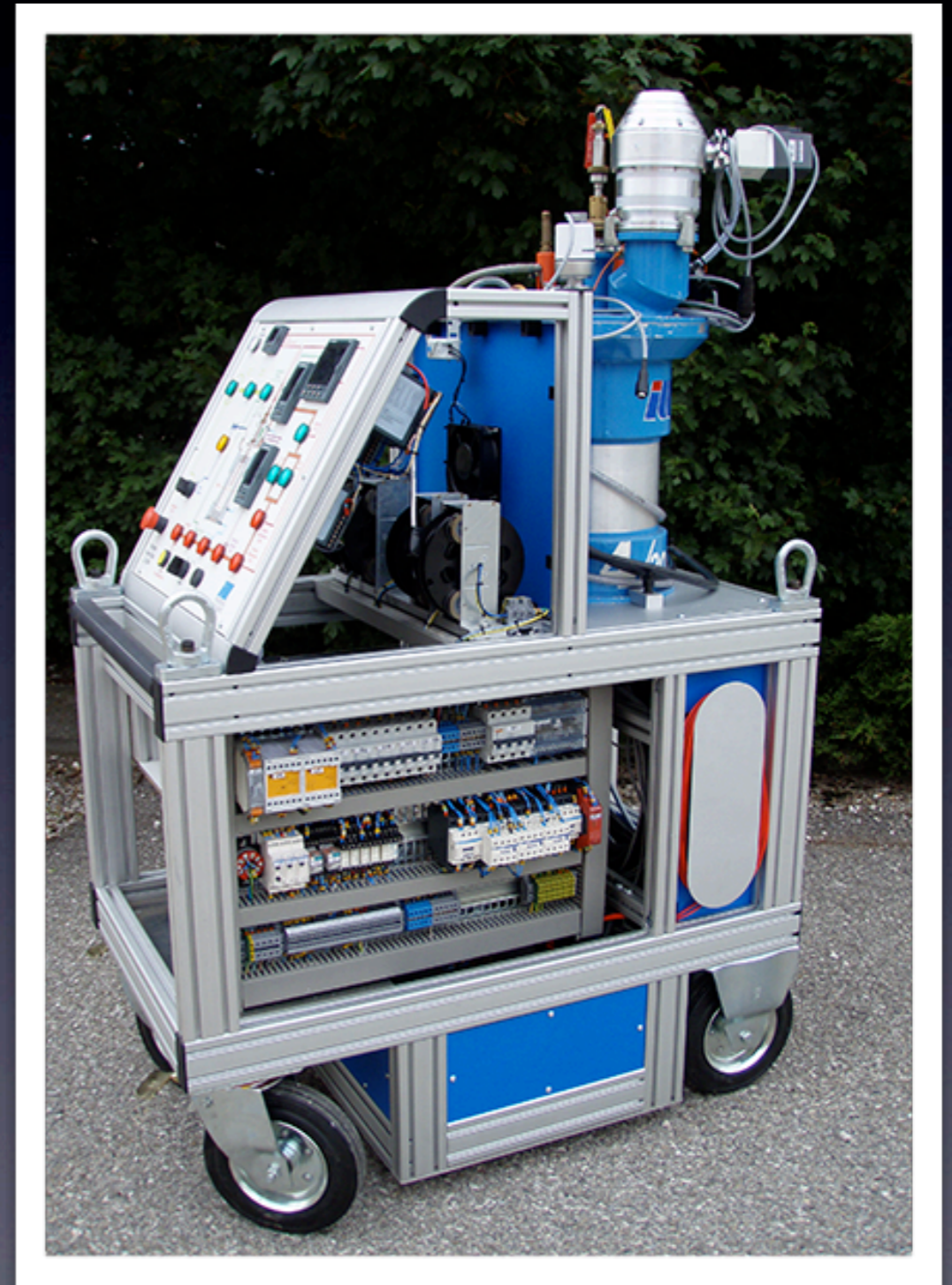
Gas Adsorption

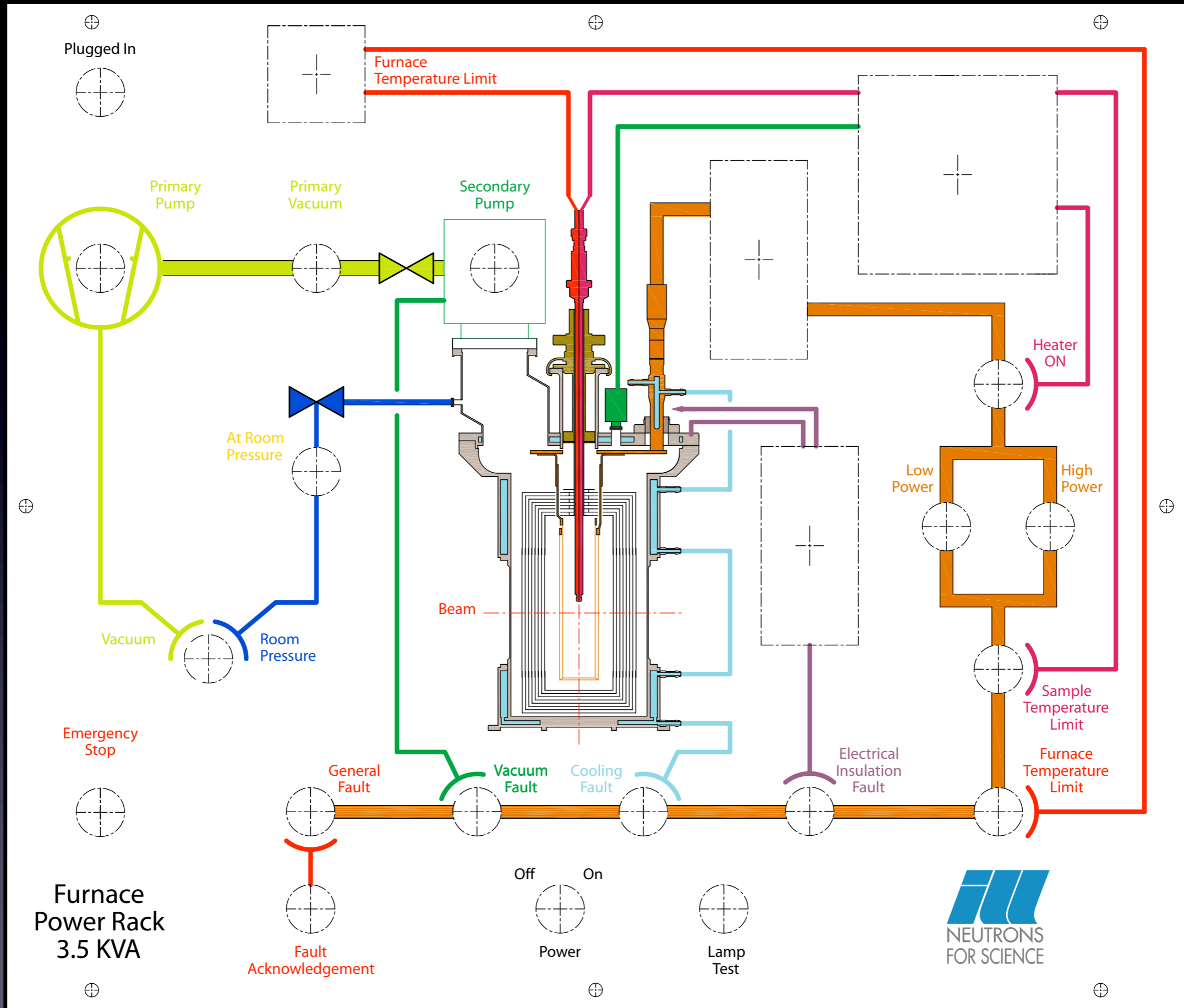


100 bar hydrogen injection sticks for cryostats

Furnaces

- 19 vanadium and niobium furnaces
up to 2000K
- 6 power racks
2 kVA or 3.5 kVA
automatic power and vacuum control
Ethernet port





Furnaces

- **Very compact furnaces for Eulerian cradles**

300K - 1100K

1h to reach 500K from RT

+30' to reach 1100K

30' to cool down to 650K

30' to replace the heater



Containerless Furnaces

Advantages

sample
purity

supercooled
states

possibility to
reach 3000K

Techniques

electromagnetic

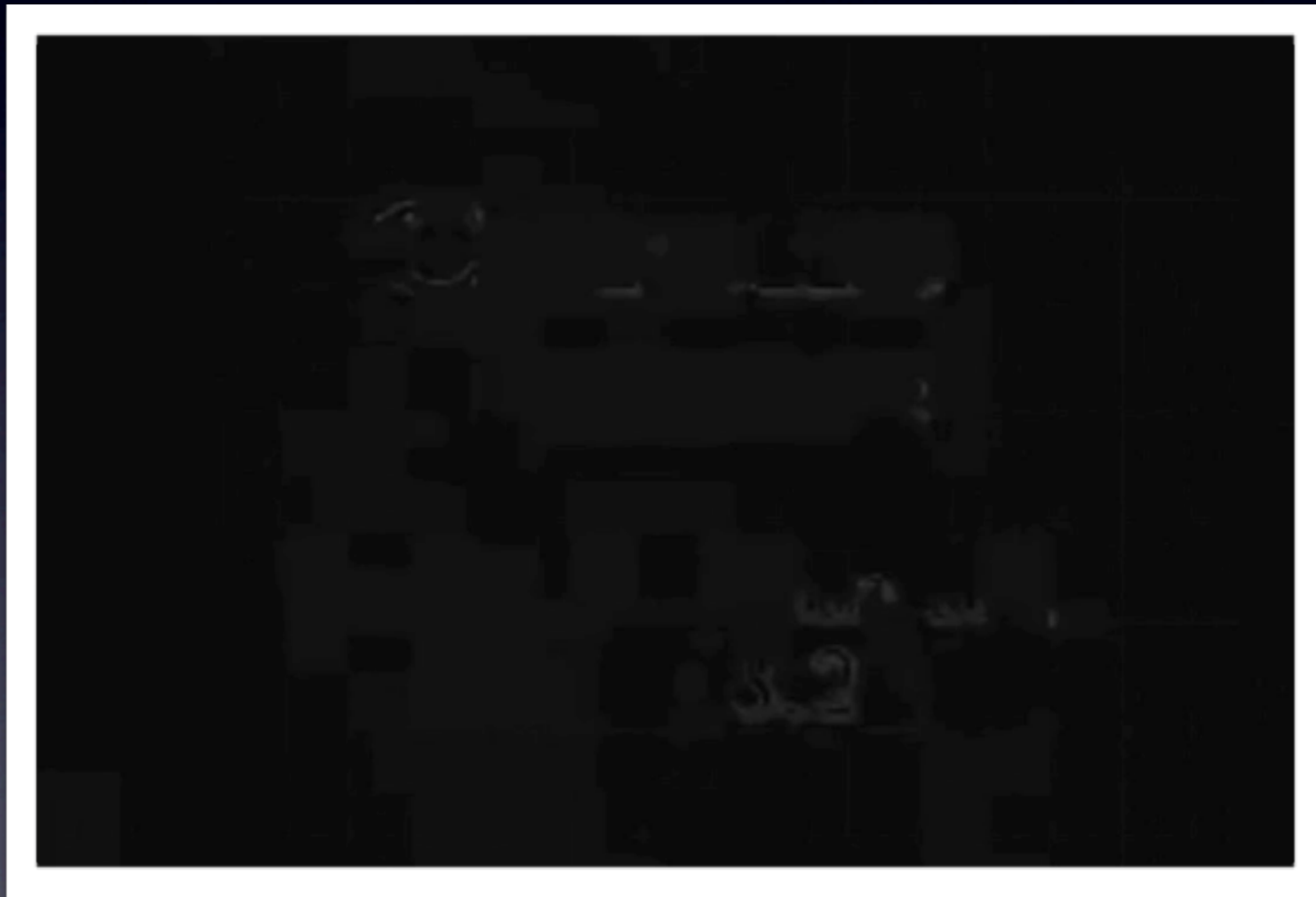
aerodynamic

acoustic

electrostatic

optic, etc...

Containerless Furnaces



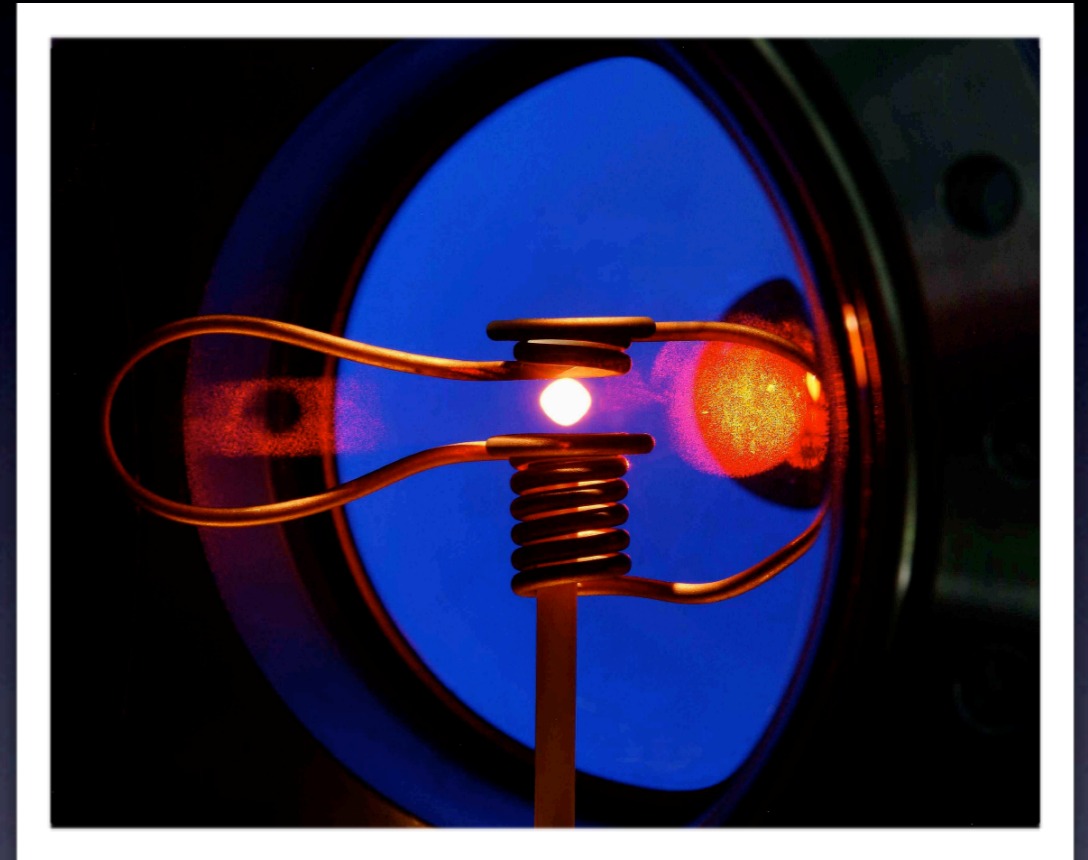
motivations

glass blowing
crystal growth
steel industry
foods processing
preservation of life
and more...

Containerless Furnaces

electromagnetic levitation

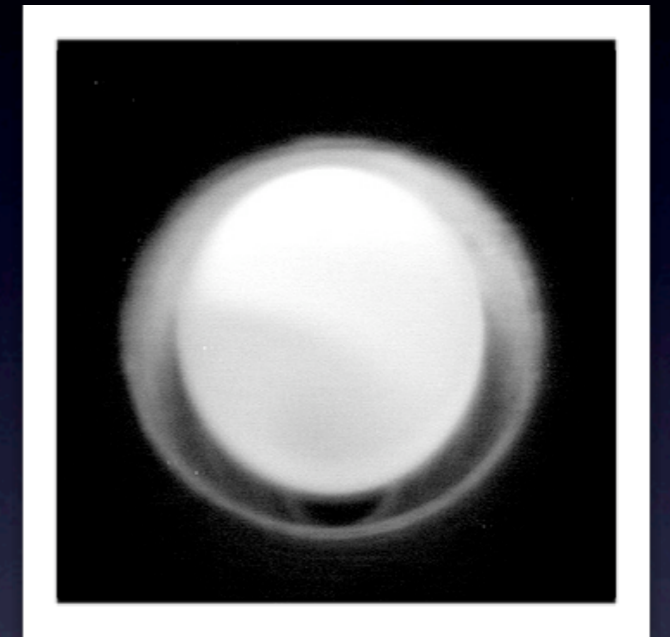
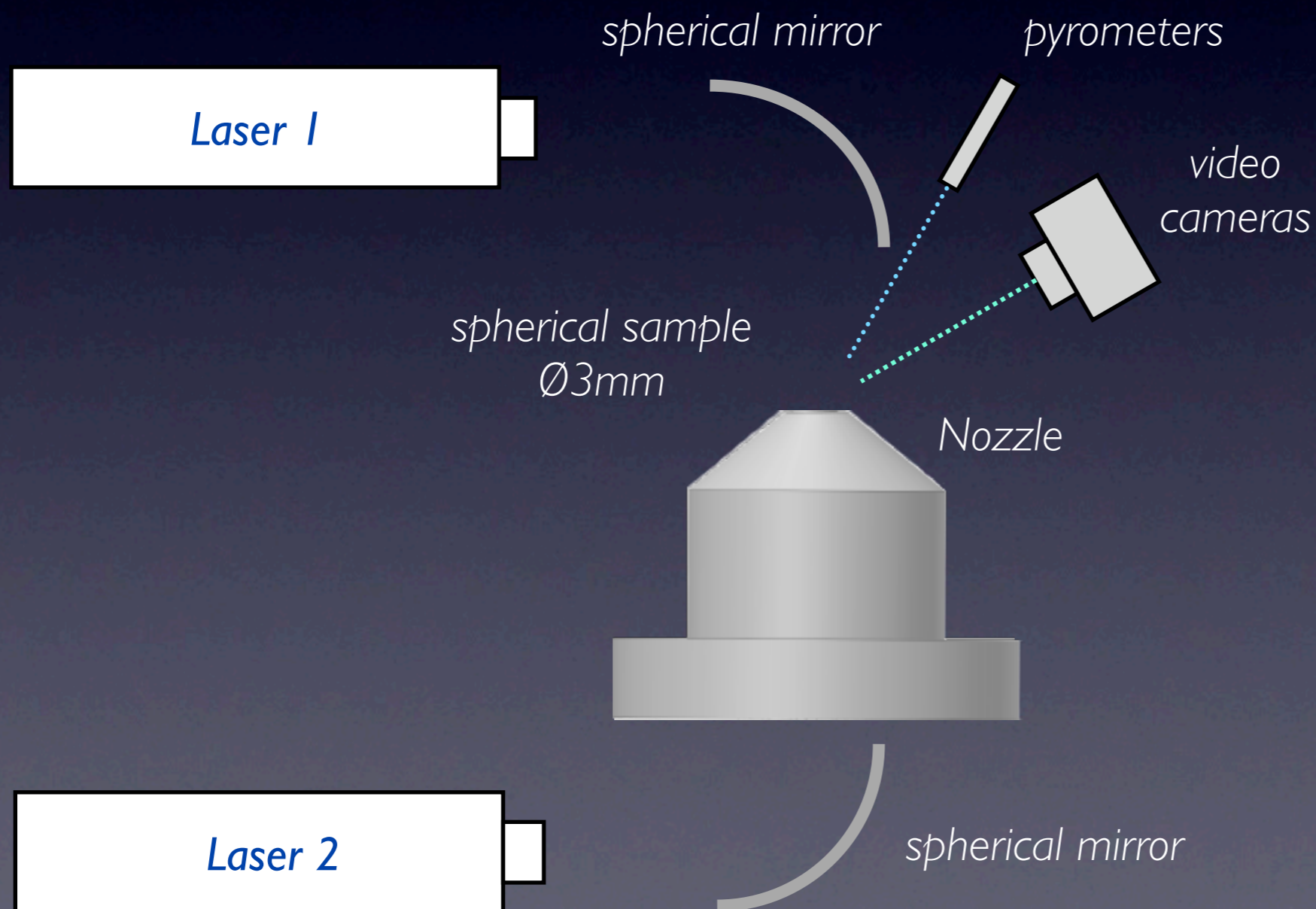
- eddy currents induce heat and counteract gravity (Lenz's law)
- Ø5-10 mm sample
- conducting sample
- may be combined with electrostatic technique



6kW - 260kHz generator
UHV chamber
water cooling
coils design

Containerless Furnaces

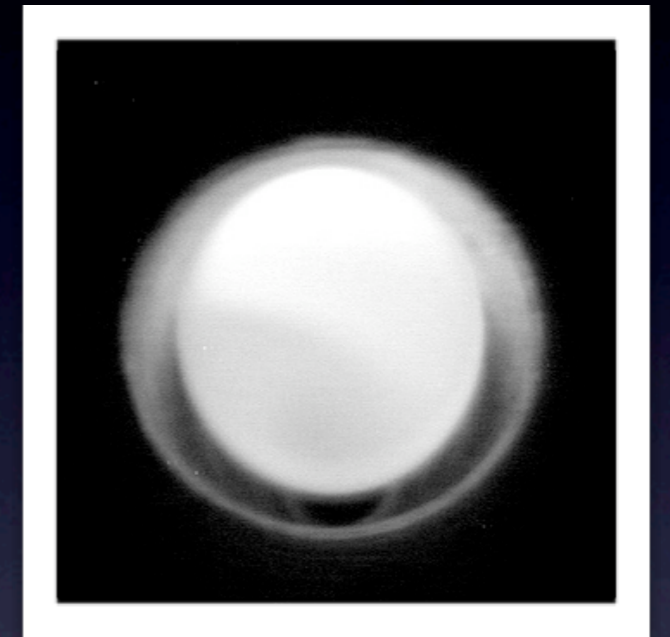
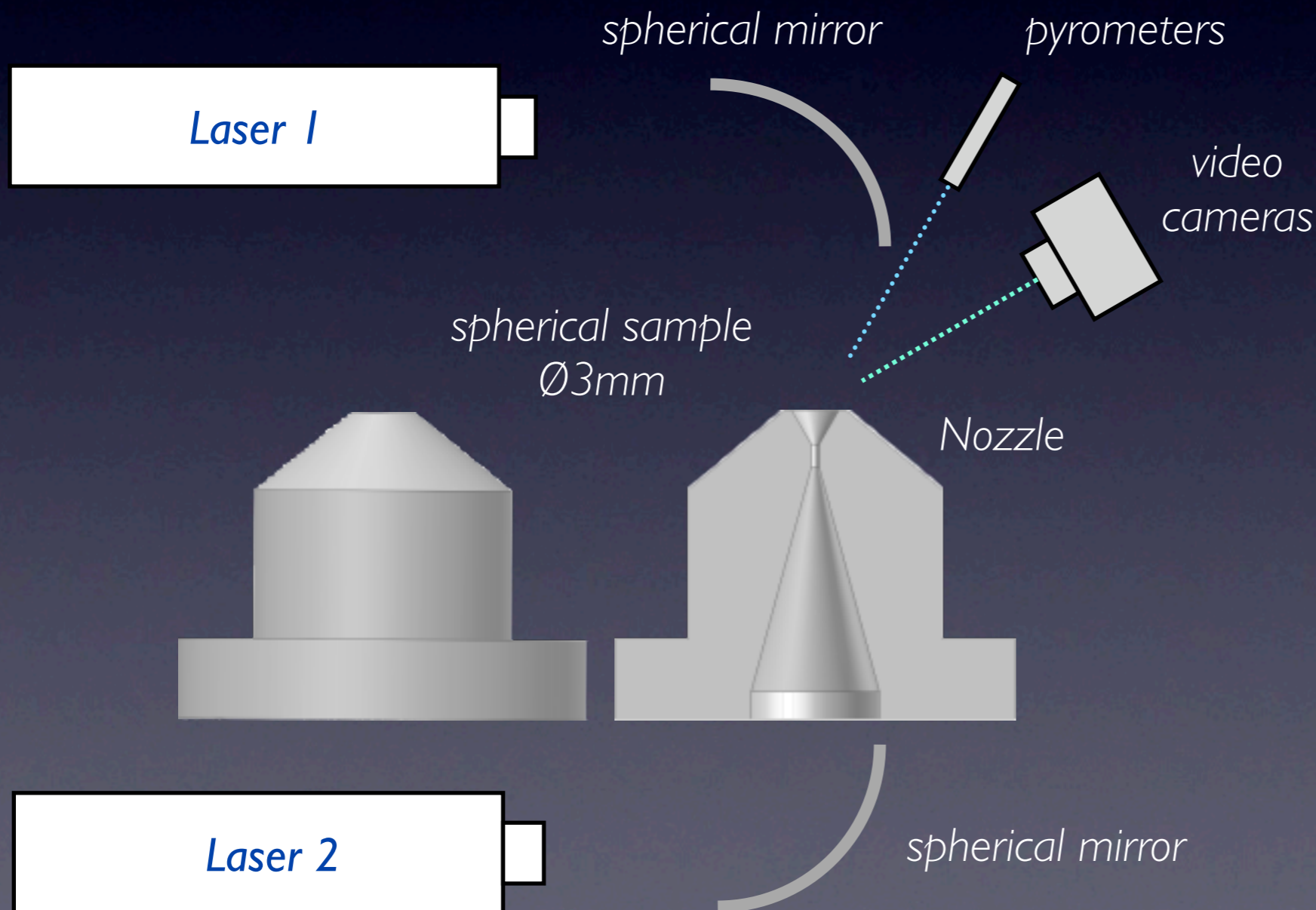
aerodynamic levitation



- 300 to 3000 K
- Ø3-5 mm sample
- $\frac{2}{3}$ sample in beam
- polarised neutrons

Containerless Furnaces

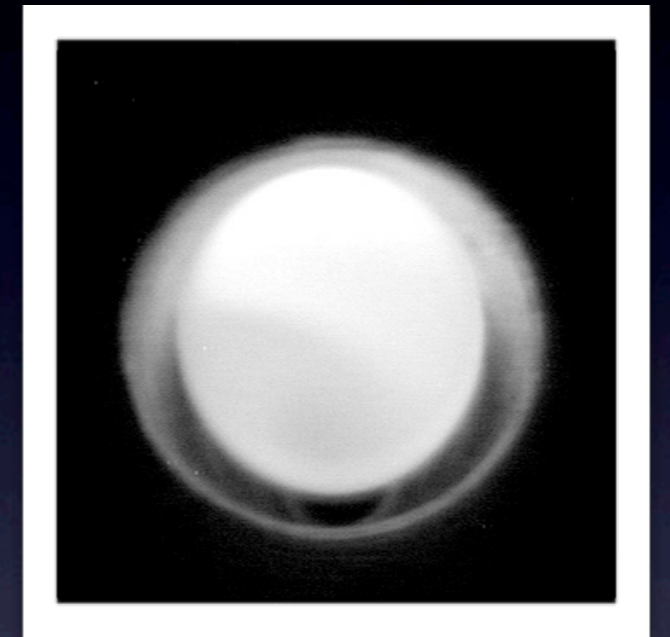
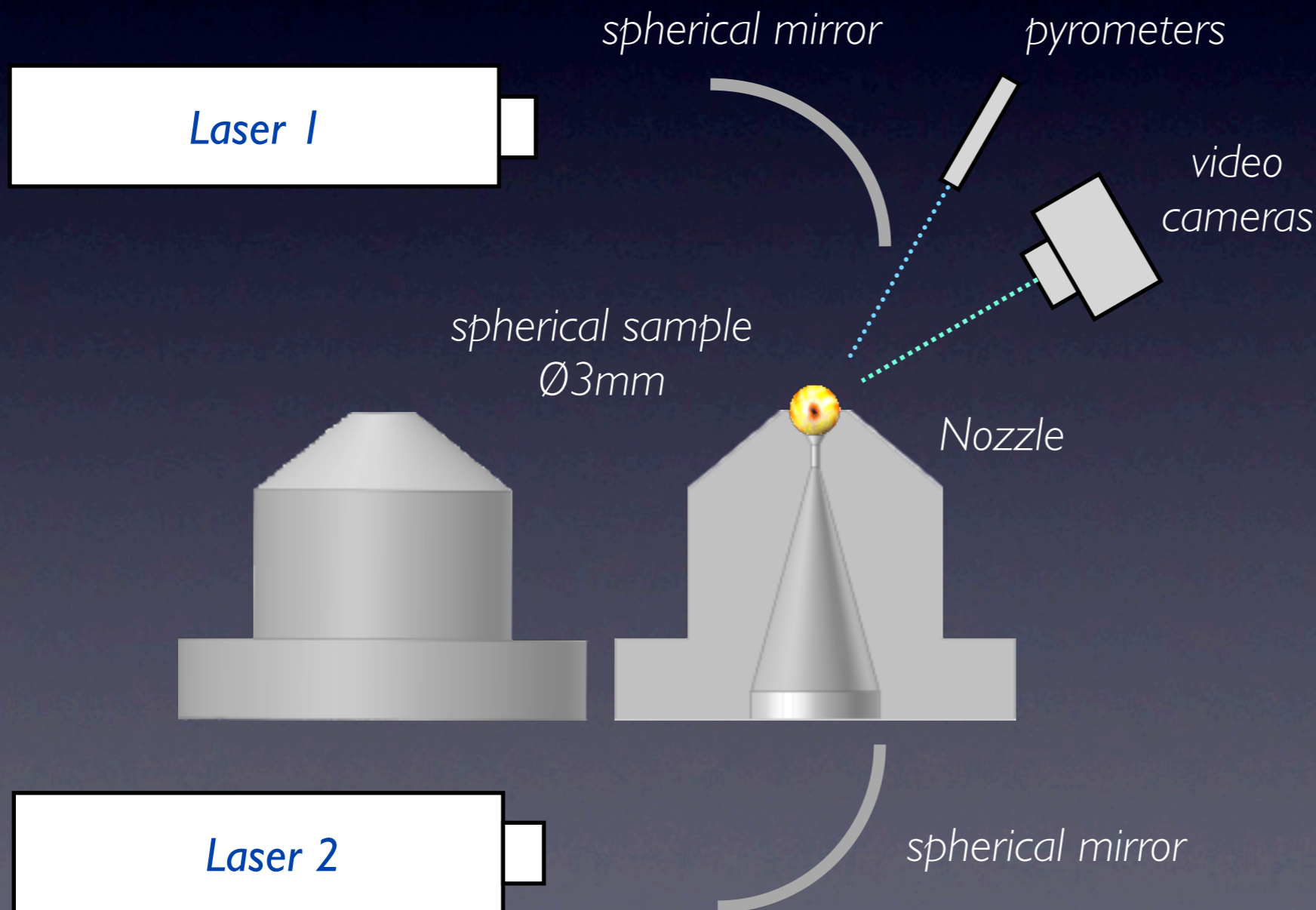
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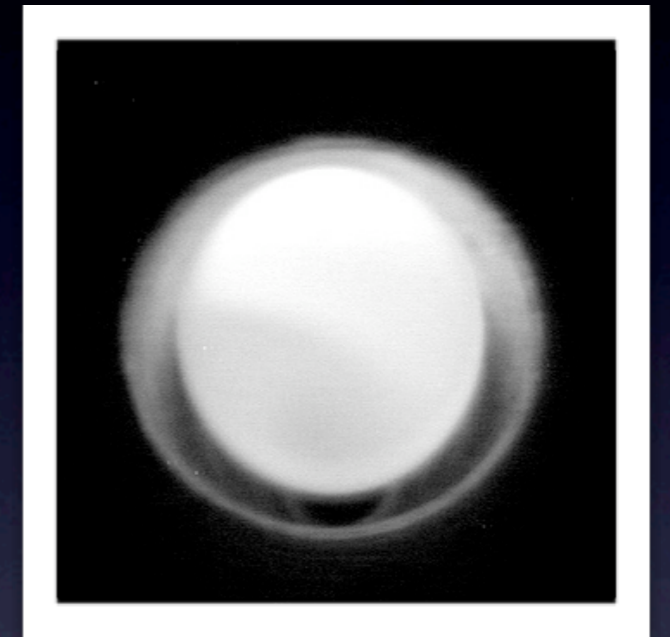
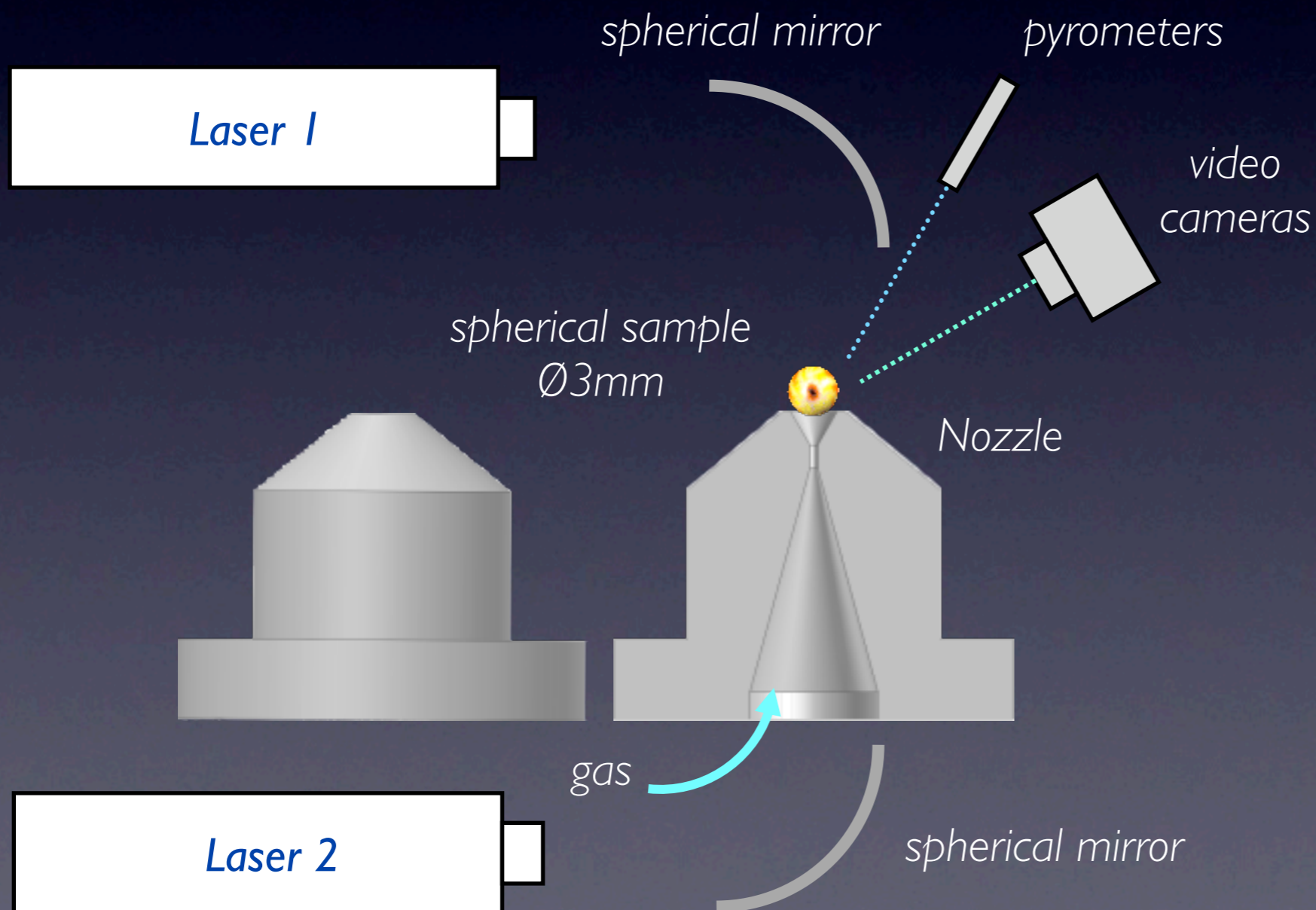
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Containerless Furnaces

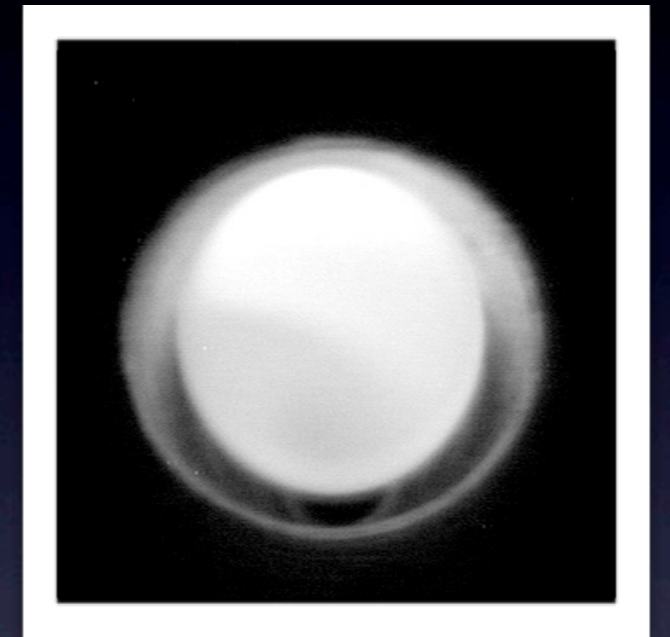
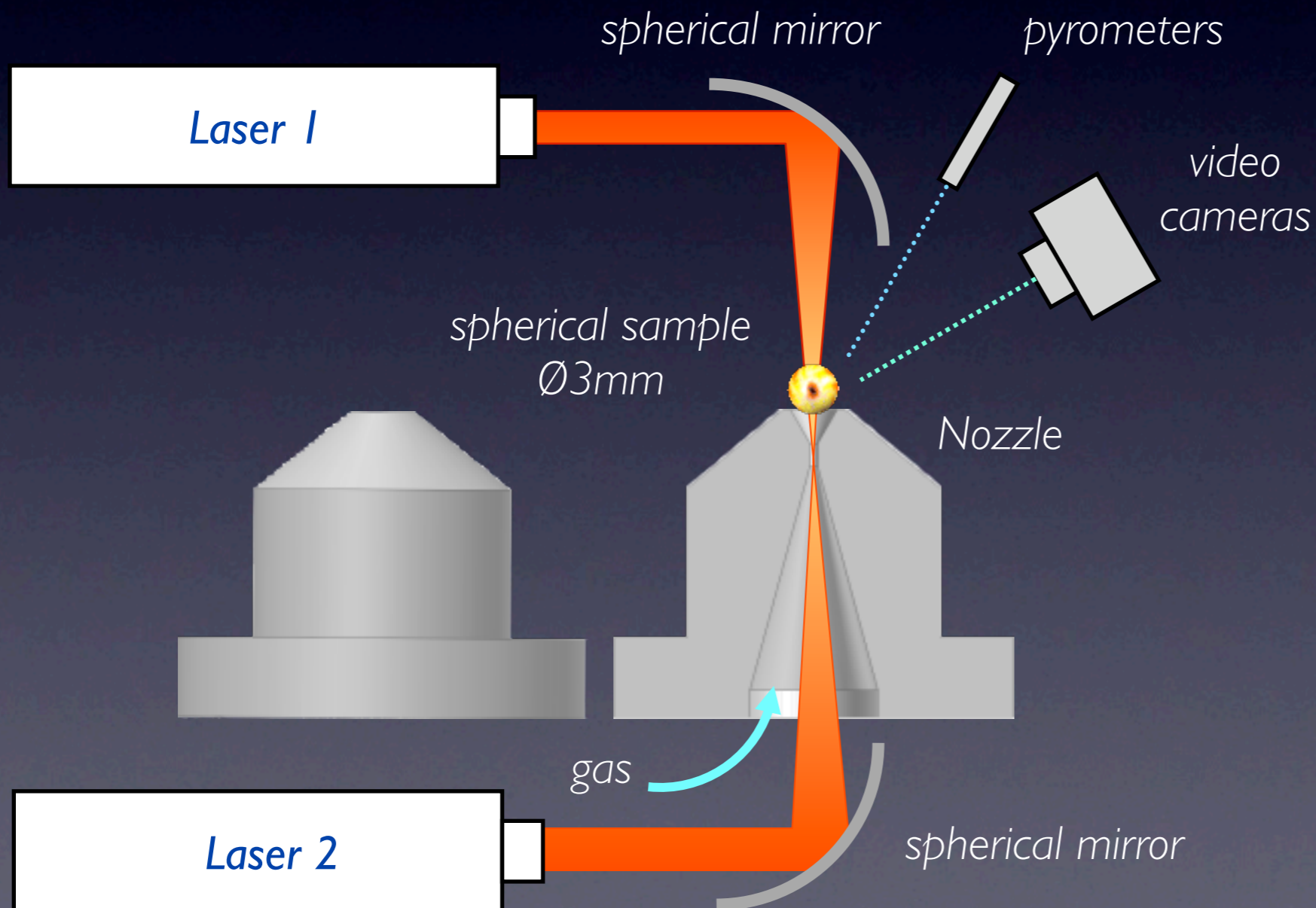
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Containerless Furnaces

aerodynamic levitation



- 300 to 3000 K
- $\text{\O}3\text{-}5$ mm sample
- $\frac{2}{3}$ sample in beam
- polarised neutrons

Pressure Cells

- **7 continuously loaded pressure cells (He)**
from 2.5 to 10 kbar
- **6 clamp cells**
from 10 to 30 kbar
fluorinert media
- **2 Paris-Edinburgh cells**
up to 100 kbar



Pressure Cells

- **High-precision control**

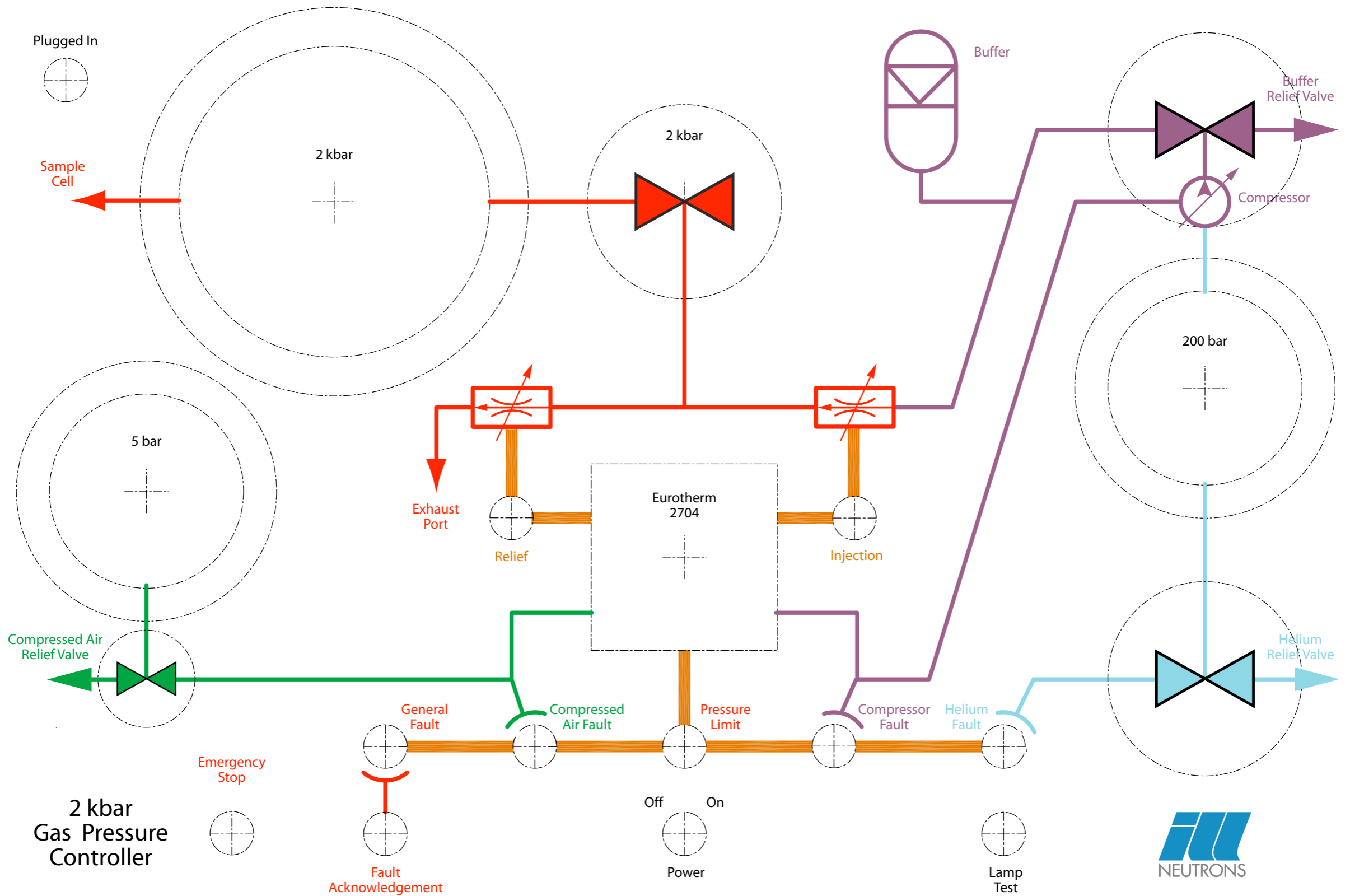
2 kbar regulation unit

loop #1 regulating the pressure in a 50 cm³ buffer handling rapid variations

loop #2 regulating the pressure in the cell

security loop with thresholds, max rates (50 bar/min), limits...





Polarimetry

Manipulation of the neutron polarisation vector

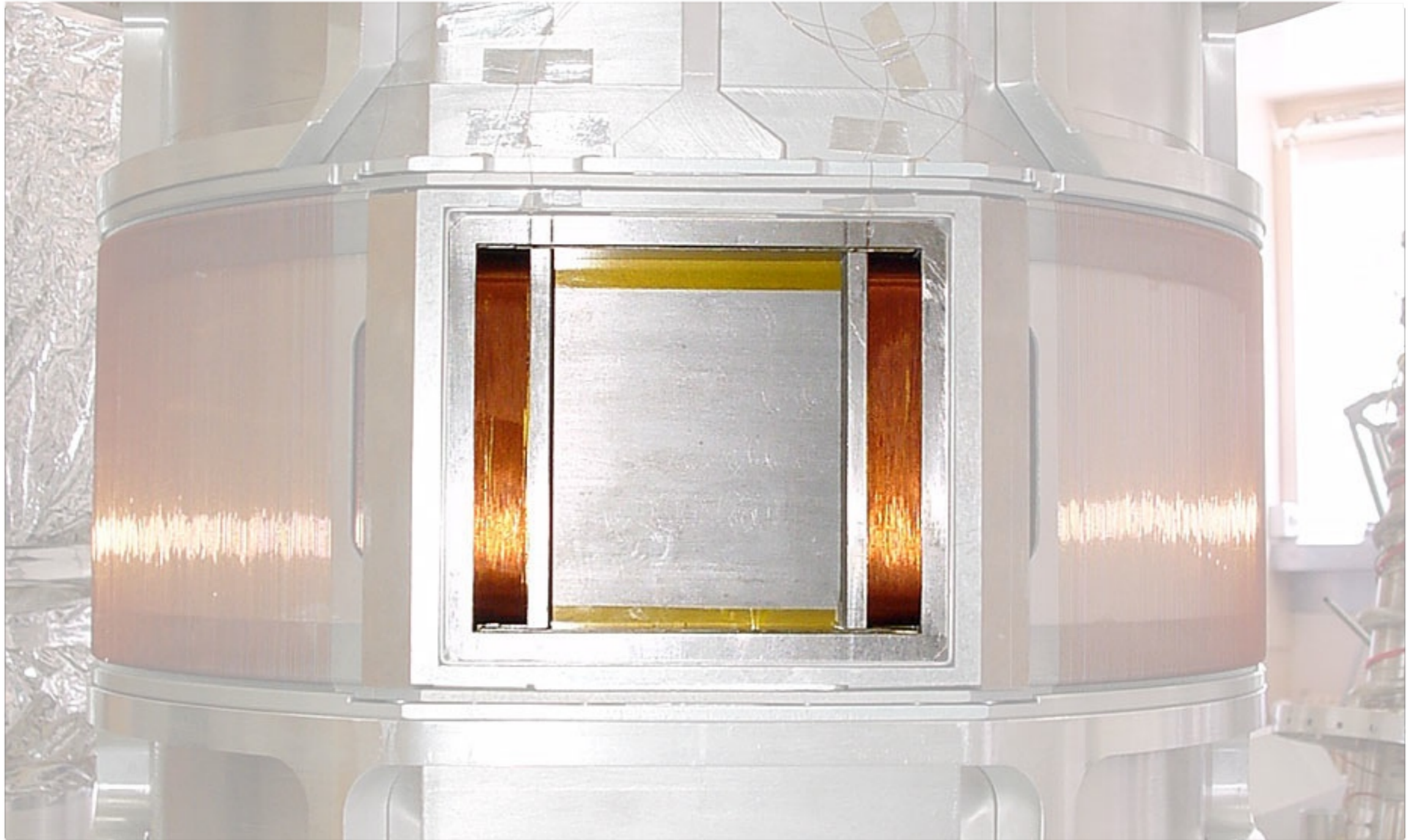
- neutron spin polarisers
- neutron spin flippers
- zero-field polarimeters

MoU signed with
JAEA, TU-Aachen, ...

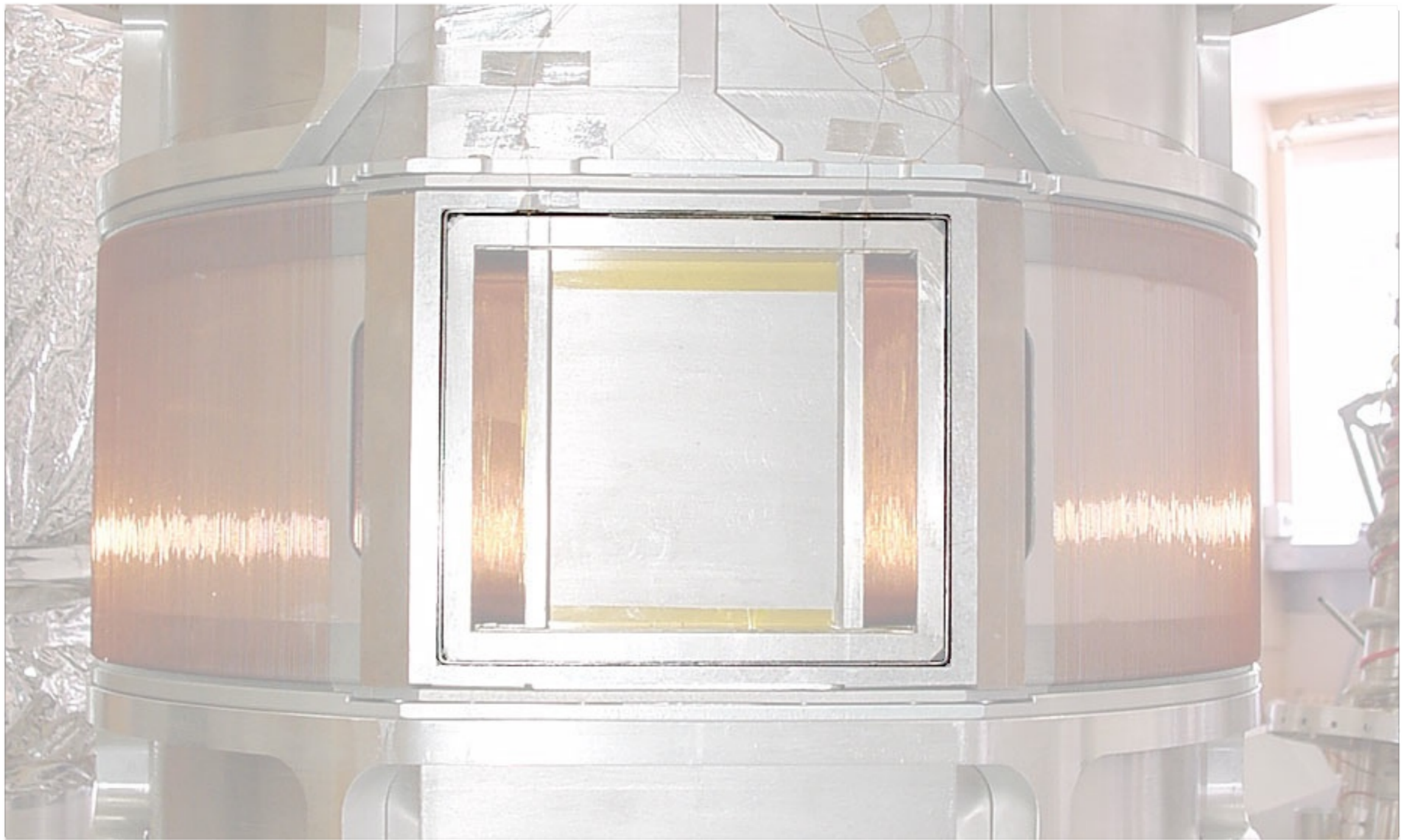
several copies built,
scientific collaborations



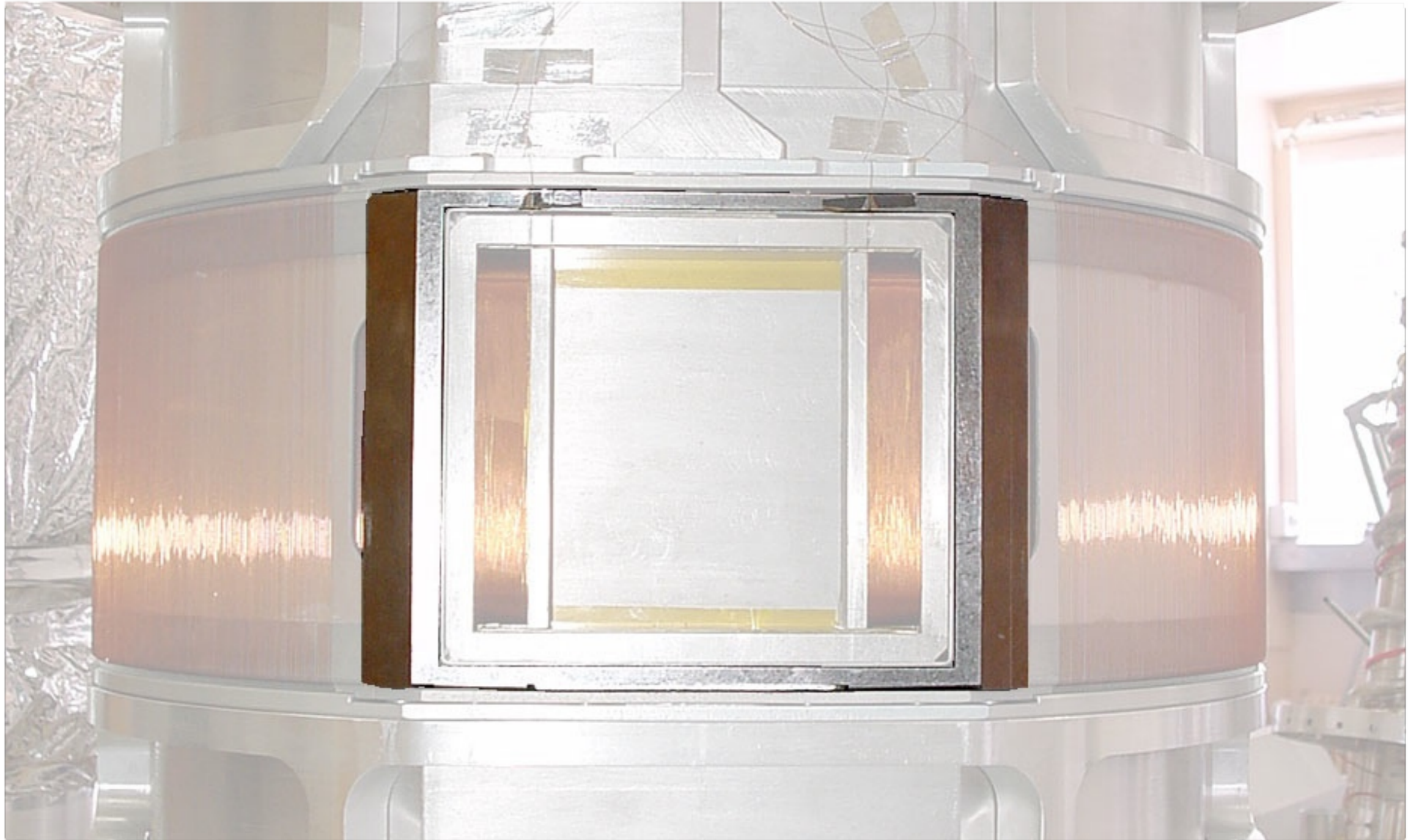
Polarimetry



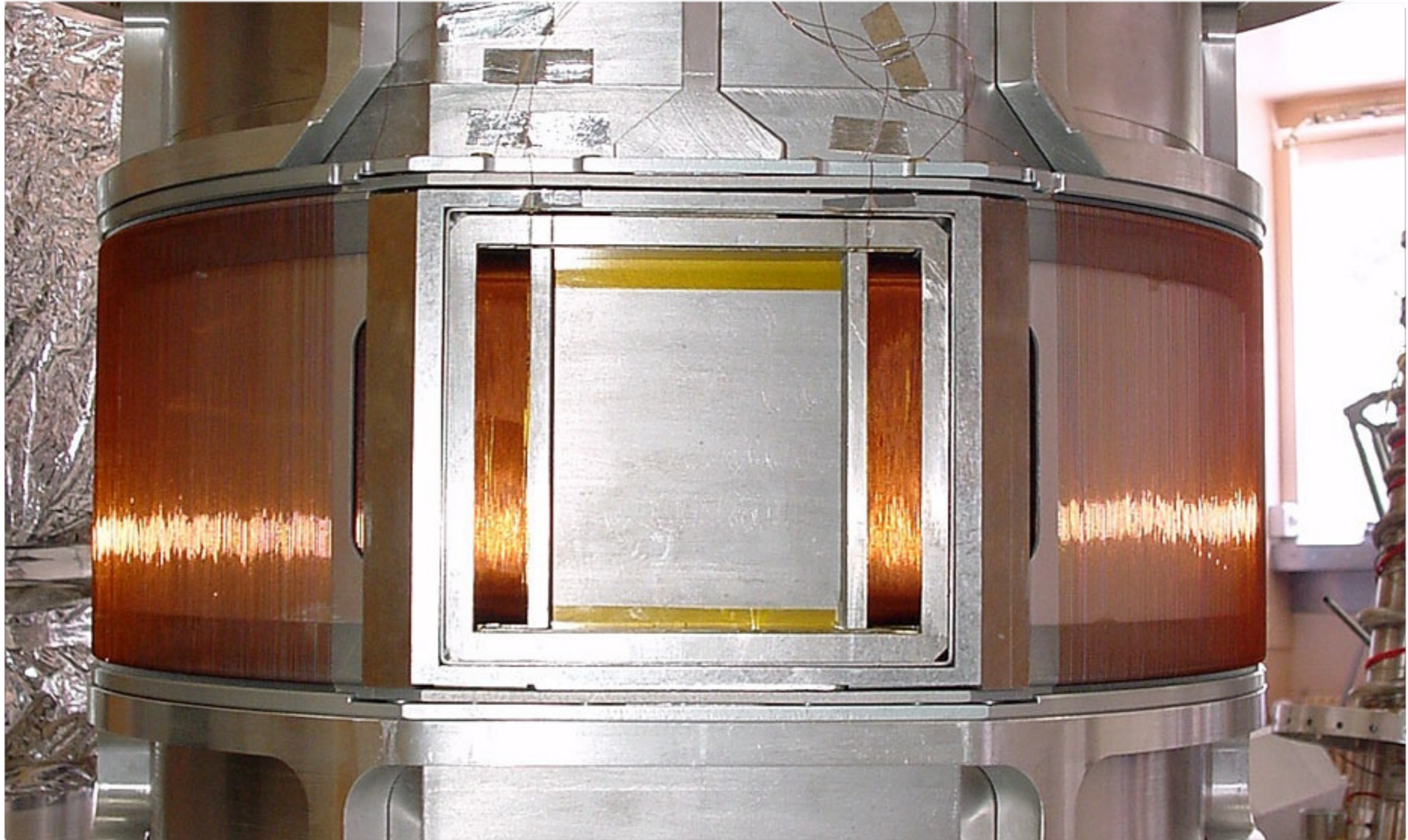
Polarimetry



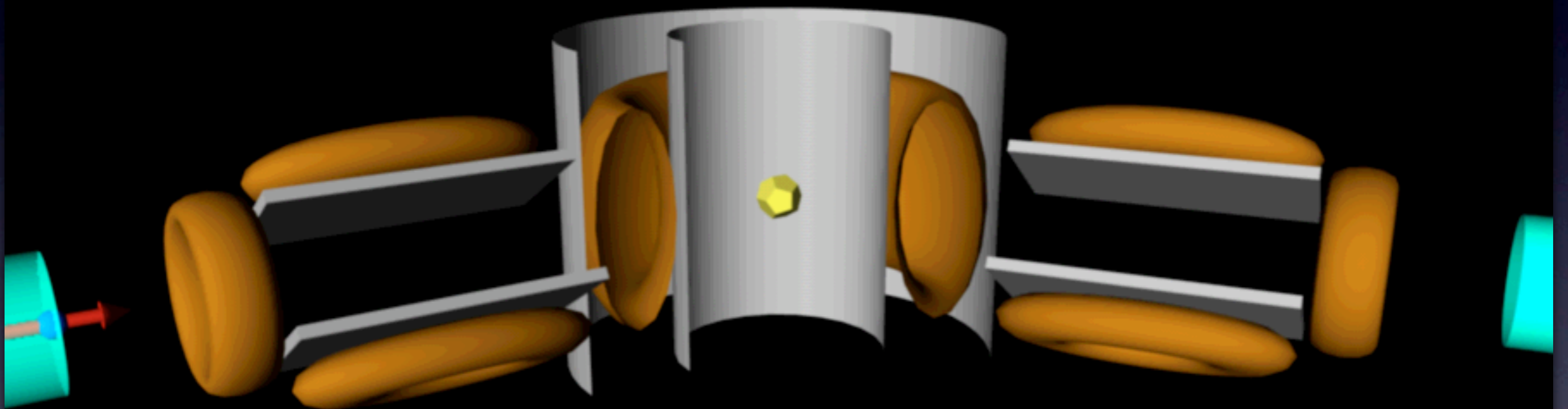
Polarimetry



Polarimetry

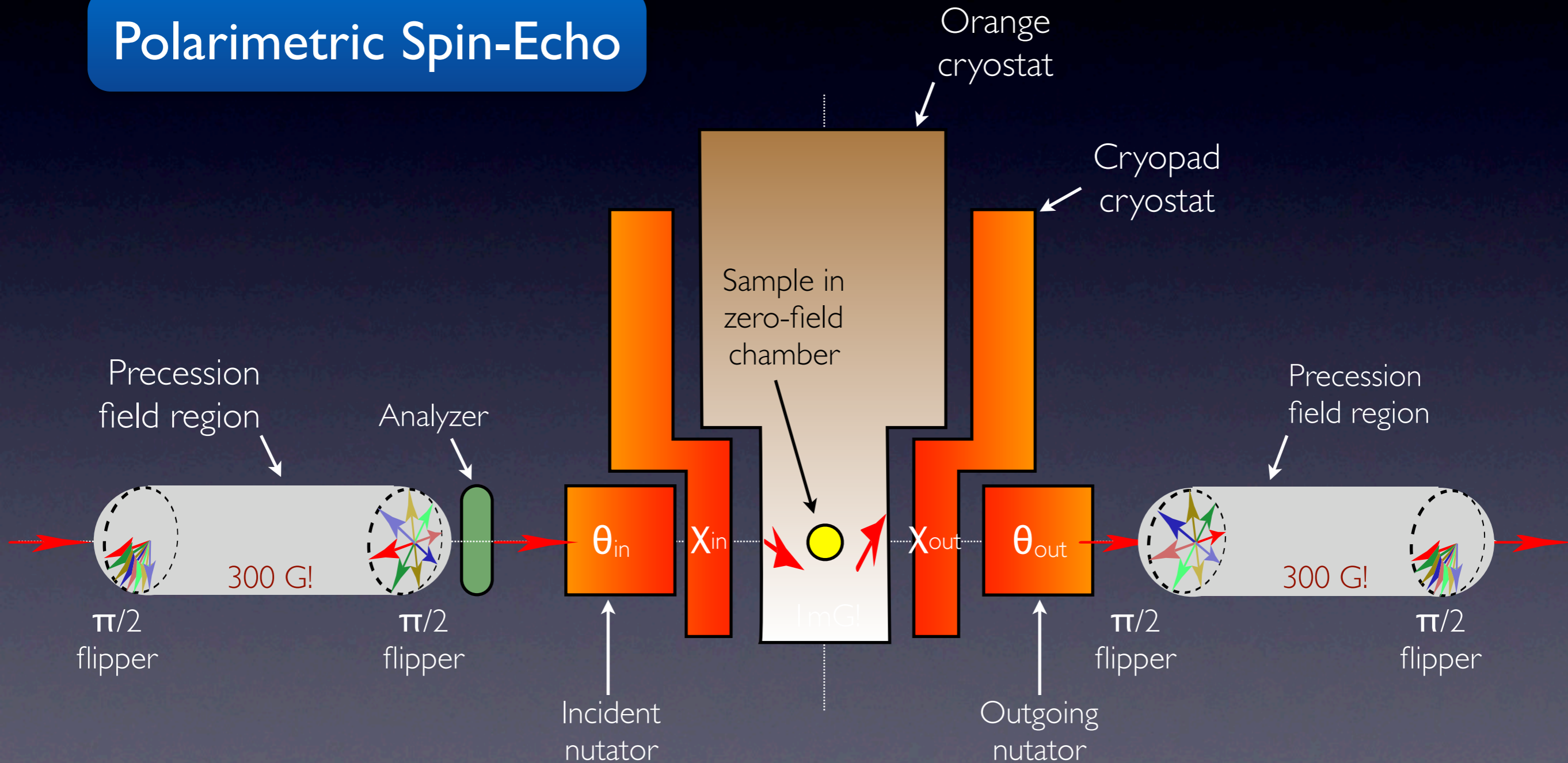


Polarimetry



Polarimetry

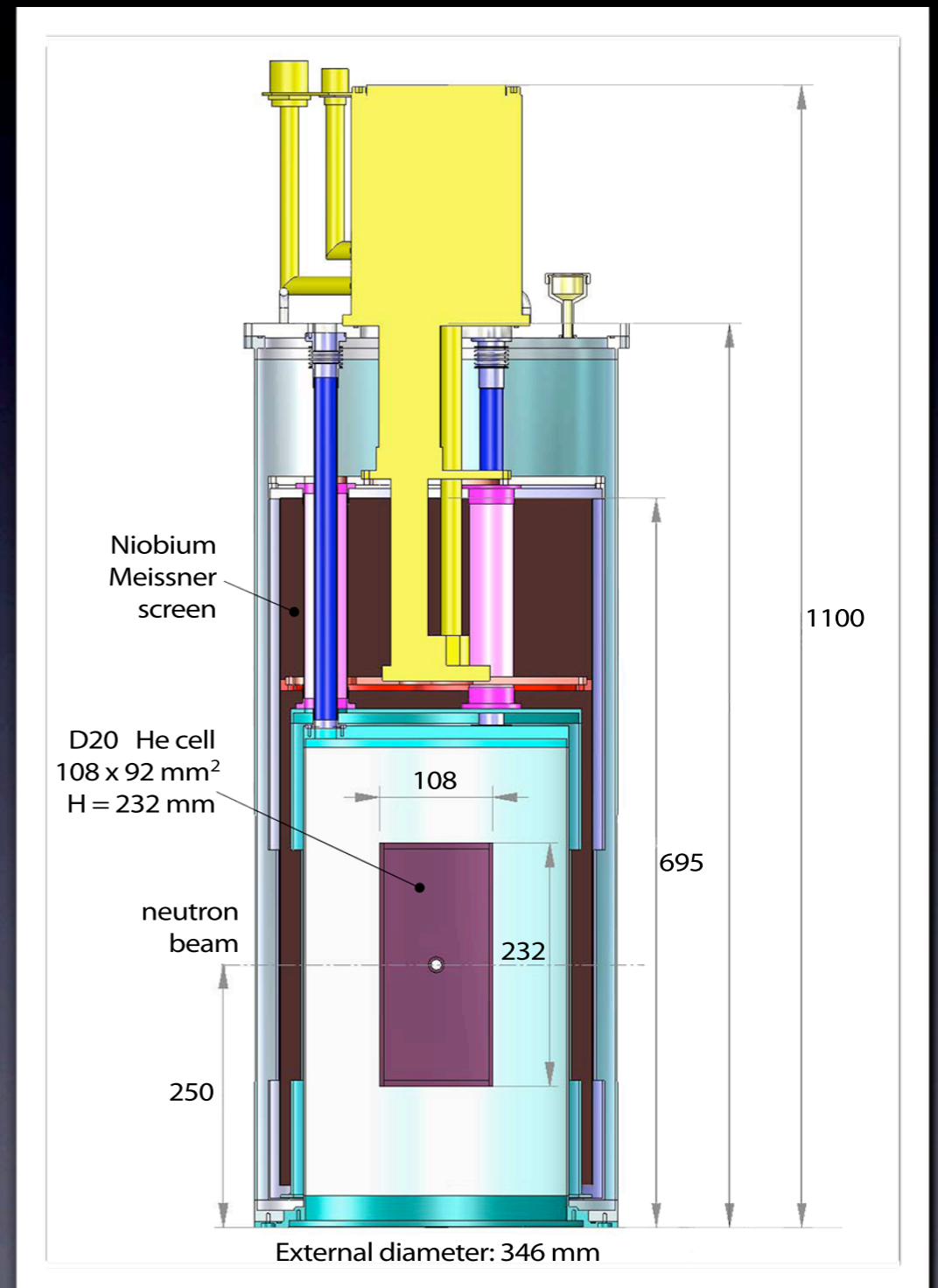
Polarimetric Spin-Echo



Polarimetry

^3He Spin Filter/Flipper

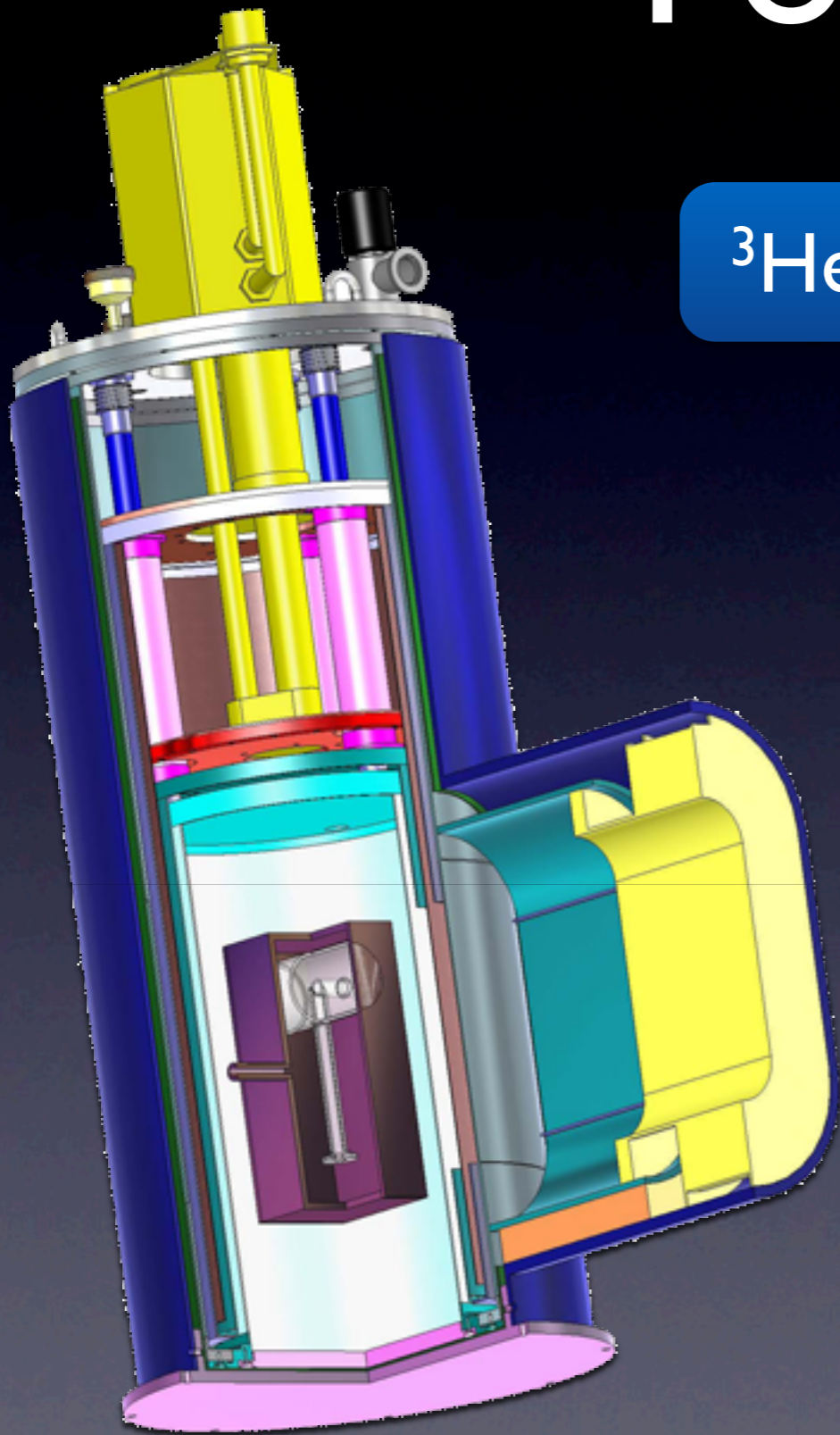
- homogeneous magnetic field trapped in a superconducting cylinder
- ^3He polariser
- perfect non-adiabatic flipper
- cryogen free technology
- neutron beam polarisation continuously monitored



Polarimetry

^3He Spin Filter/Flipper

99.9% efficient
flipper above
 0.3\AA in
400 gauss
stray field



Electronics

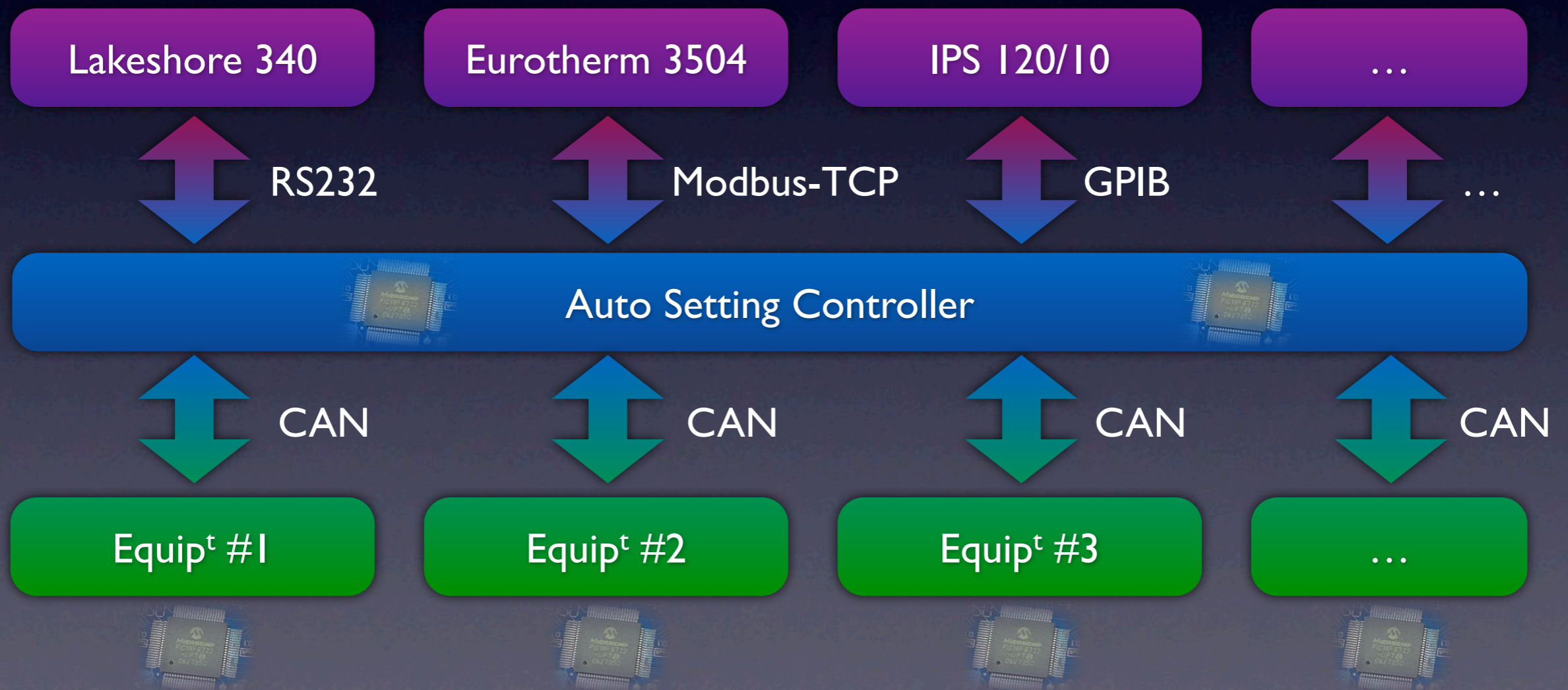
for cryostats, cryomagnets, cryofurnaces, furnaces...

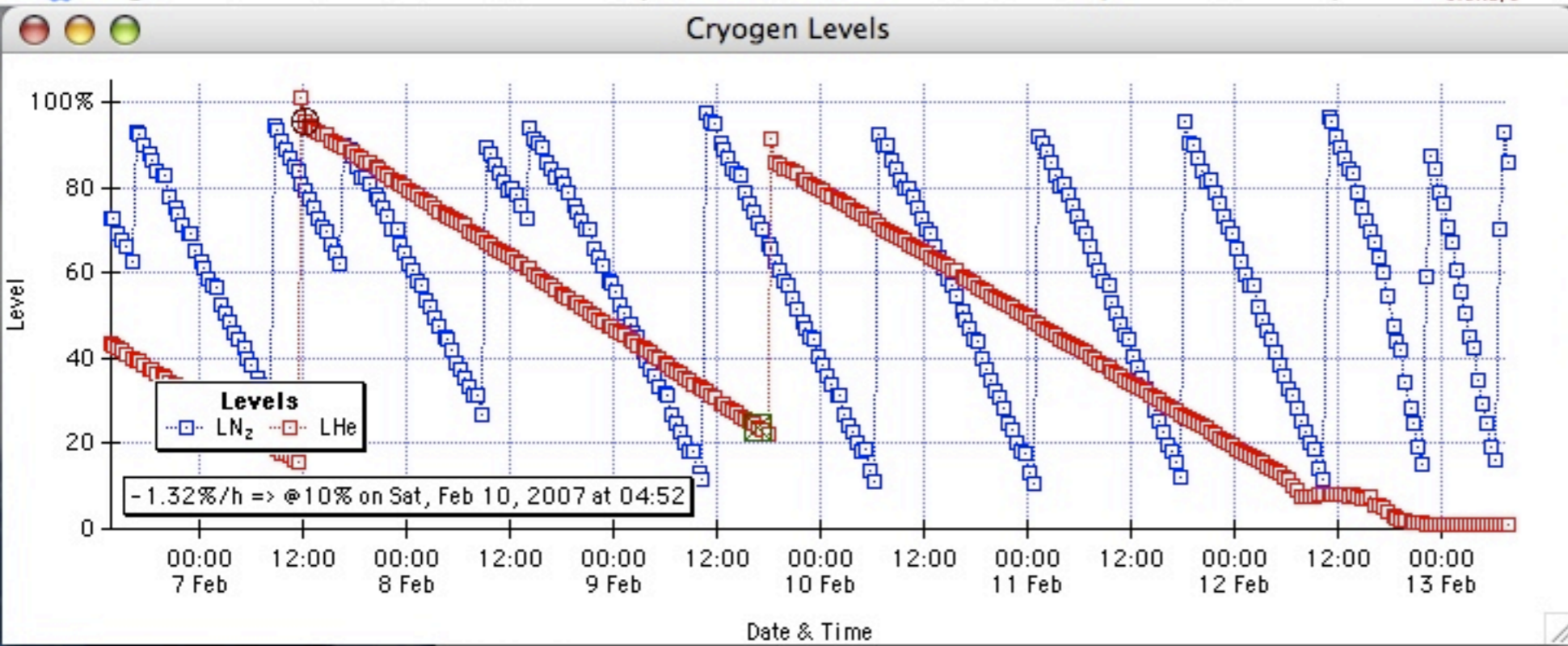


RS485 & ModBus TCP

Electronics

for cryostats, cryomagnets, cryofurnaces, furnaces...





Cryostat

Temperature Controller
 Setpoint: 325.000 K Regul. Temp.: <no value>
 Heating Power: <no value>

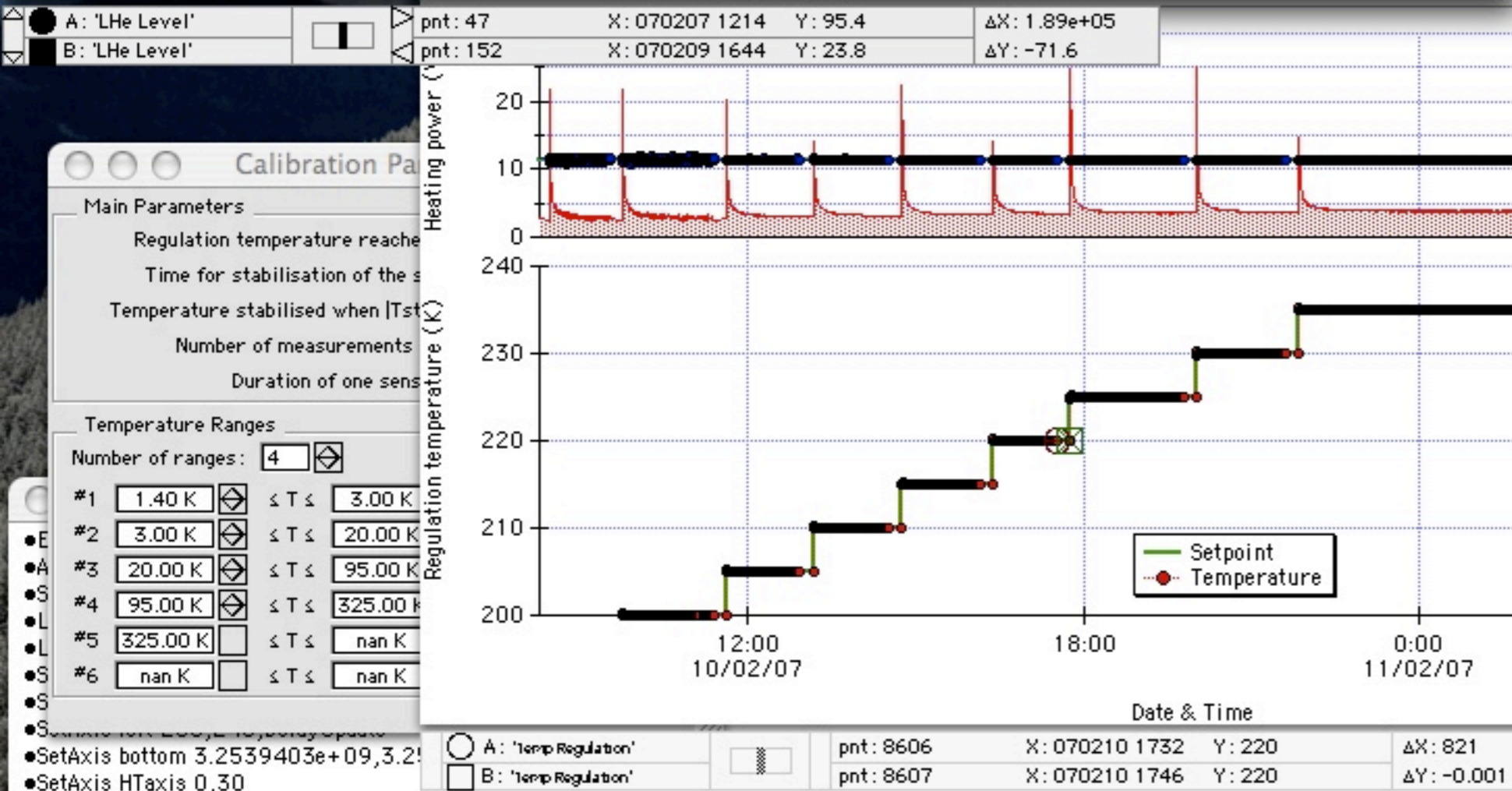
Cold Valve
 Mode: Auto Setpoint: 1.90 mbar
 Pressure: <no value> Output Power: <no value>

Levels
 Liquid He Level: <no value> Liquid N2 Level: <no value>

Sensors

Standard sensors

Top:	Pt103:	119.420 Ω	i.e.	322.815 K
	CX1030:	27.626 Ω	i.e.	322.538 K
Bottom:	Pt103:	119.222 Ω	i.e.	322.739 K
	CX1030:	32.577 Ω	i.e.	322.591 K



Calibration Parameters

Main Parameters

- Regulation temperature reached
- Time for stabilisation of the s
- Temperature stabilised when |Tst
- Number of measurements
- Duration of one sens

Temperature Ranges

Number of ranges: 4

#1	1.40 K	≤ T ≤	3.00 K
#2	3.00 K	≤ T ≤	20.00 K
#3	20.00 K	≤ T ≤	95.00 K
#4	95.00 K	≤ T ≤	325.00 K
#5	325.00 K	≤ T ≤	nan K
#6	nan K	≤ T ≤	nan K

Data Browser

root:

- Display
 - Waves
 - Variables
 - Strings
 - Info
 - Plot
- New Folder...
- Save Copy...
- Browse Expt...
- Delete...
- Preferences...
- Execute Cmd...

root

- V_Flag
- S_ASProc
- S_VDT
- Calibration
- LK 340 (0,1)
- LK 370 (0,4)
- LK 370 (0,5)
- LM-500 (0,3)
- Task List
- WEST 6100
- WinGlobals

A: 'temp Regulation' pnt: 8606 X: 070210 1732 Y: 220 ΔX: 821
 B: 'temp Regulation' pnt: 8607 X: 070210 1746 Y: 220 ΔY: -0.001

● SetAxis bottom 3.2539403e+09, 3.2
 ● SetAxis HTaxis 0, 30
 ● SetAxis CVaxis 0, 5
 ● ModifyGraph datelInfo (bottom) = {0, 1, -1}, dateFormat (bottom) = {Default, 2, 3, 1, 1, "", -6}
 ● ModifyGraph datelInfo (bottom) = {0, 1, -1}, dateFormat (bottom) = {Default, 2, 3, 1, 1, "DayOfMonth Month", -6}



Thank you for
your attention