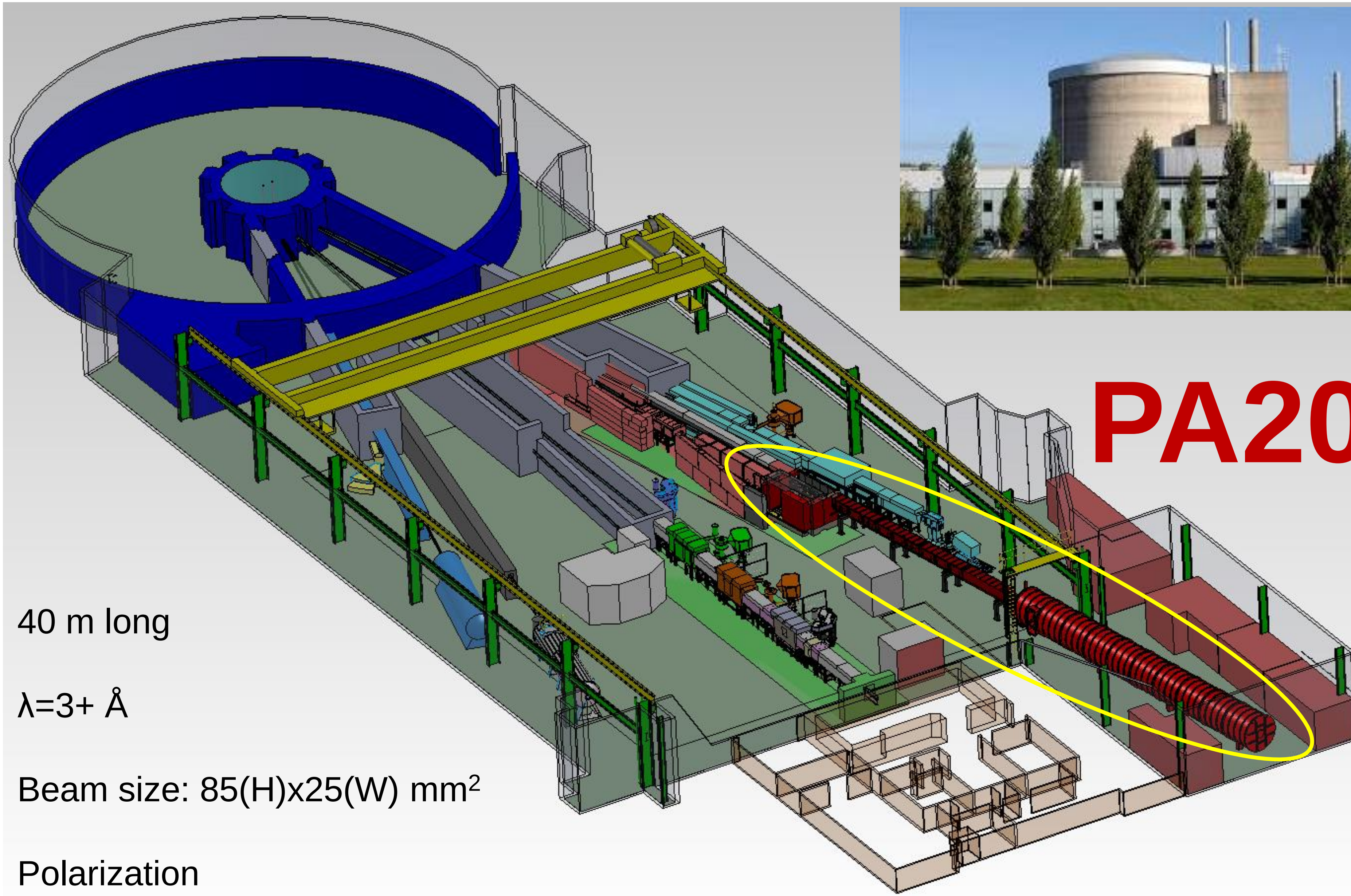
DE LA RECHERCHE À L'INDUSTRIE

ENGINEERING AND SAMPLE ENVIRONMENT OF SANS

Cremlin 2018 Petergof | Sylvain Désert

MAY 15TH 2018

PA20 $10^{-3} < Q_{MIN} < 1$ Å^{-1}



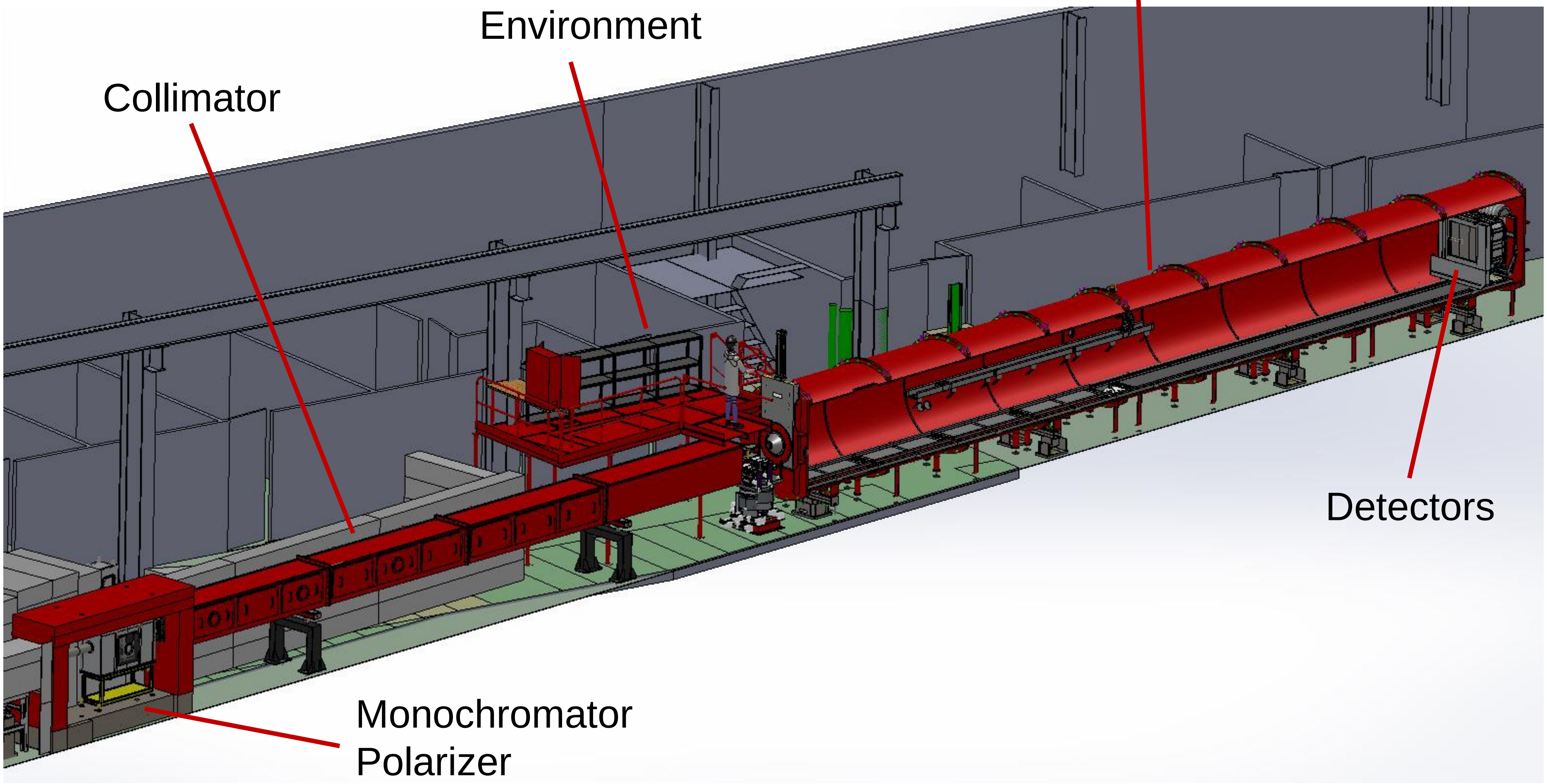
40 m long

λ=3+ Å

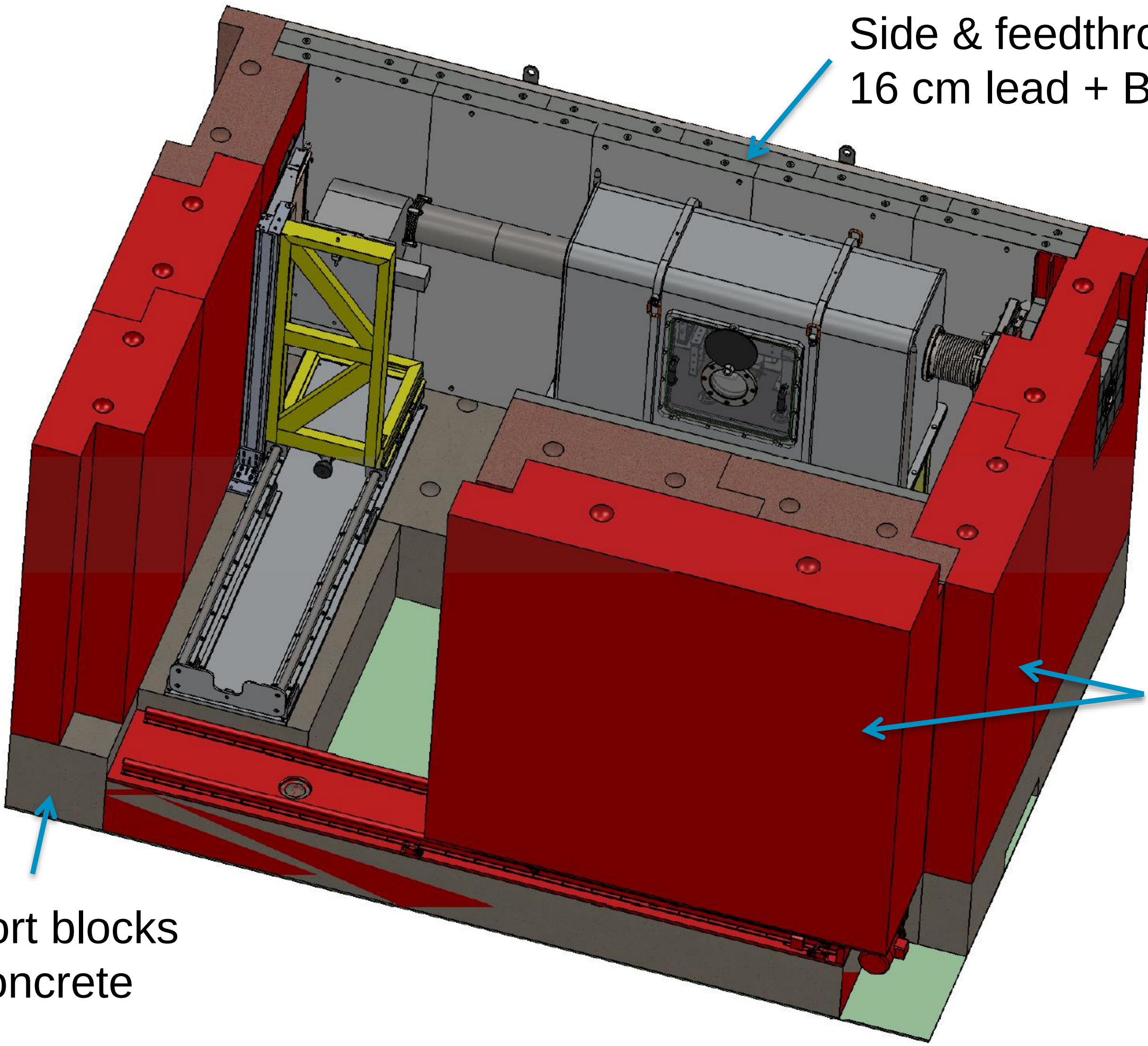
Beam size: 85(H)x25(W) mm^2

Polarization

PA20 - OVERVIEW



MONOCHROMATOR AND POLARIZATION CASEMATE



Side & feedthrough
16 cm lead + B_4C

Roof
Std concrete

Side walls & Door (5T)
Concrete d=3.9
40 cm

Support blocks
Std concrete
40 cm

50 Tons

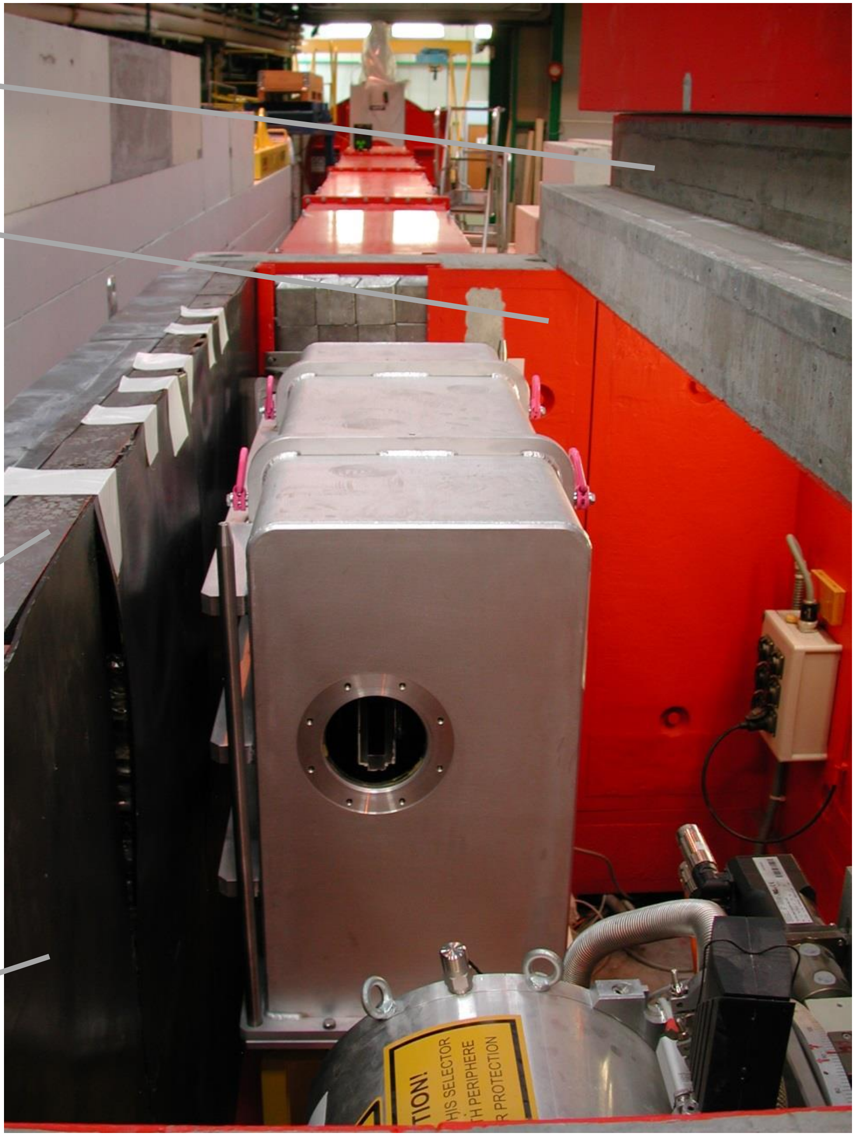
CASEMATE

Concrete d=2.3

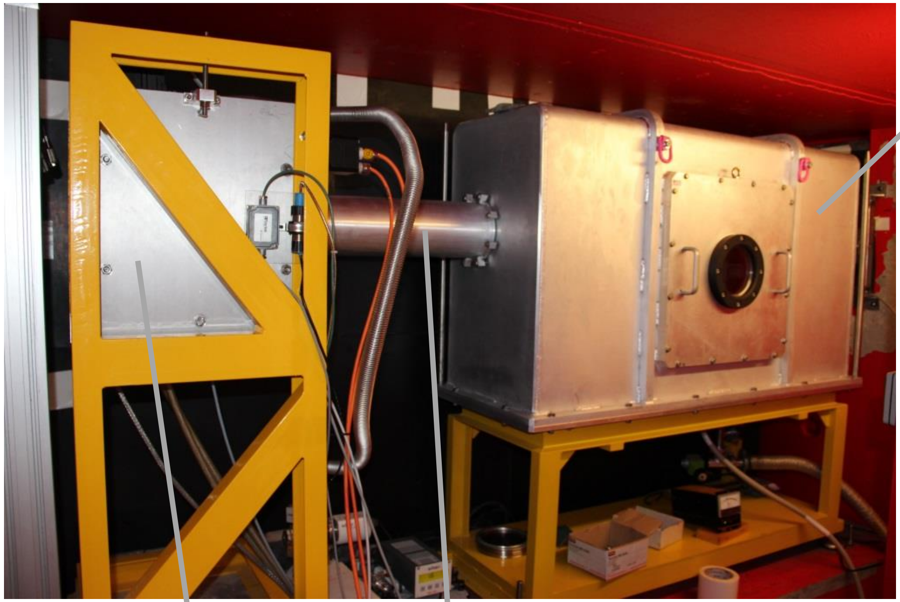
Concrete d=3.9

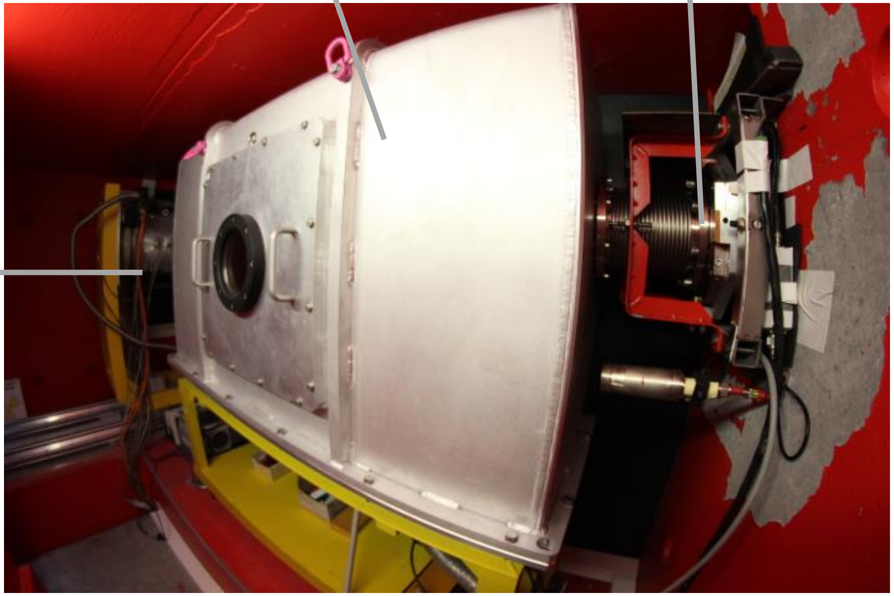
Lead 16 cm

B_4C



CASEMATE – INSIDE VIEW





Polarizer tank – 1.5 m

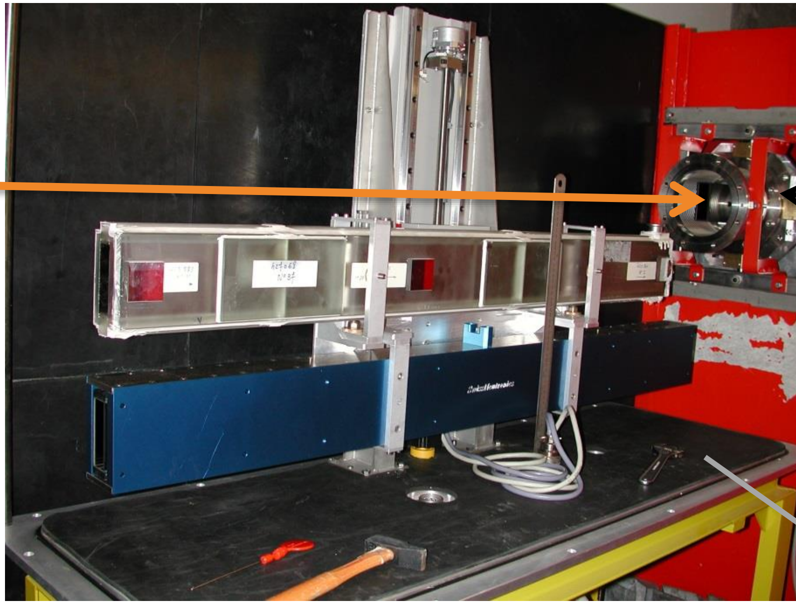
Spin Flipper – 50 cm

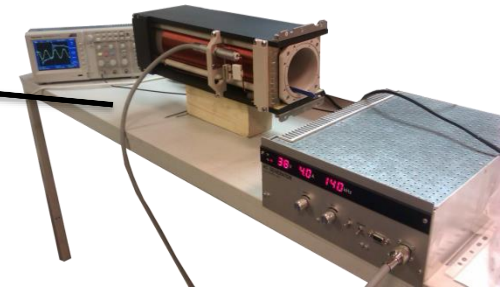
80 cm gap
ToF foreseen

Velocity
selector

POLARIZER

n





Spin Flipper
(Mirrotron)

Reference plate

- Free position
- Guide
- Polarizer (double V-cavity) with P ~ 99%@4Å
  (Swiss Neutronics)

COLLIMATOR

16 m overall length

4 elements of 3.75 m in Al

2 supports

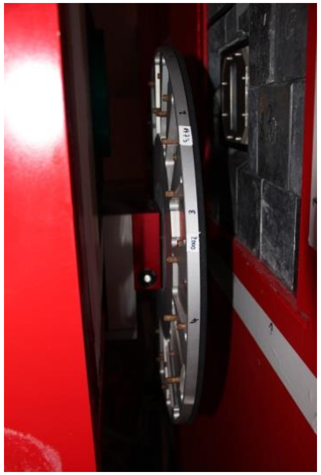
Vacuum 0.1 mbar

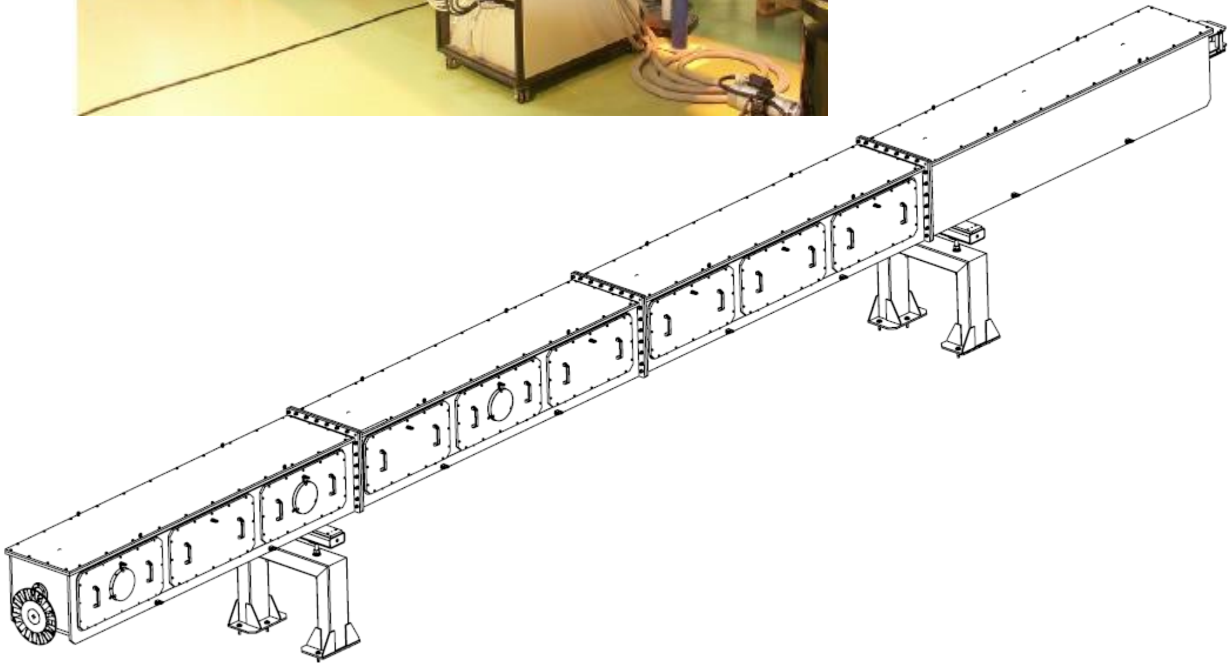
Attenuator wheel at entrance

Telescopic nose at exit

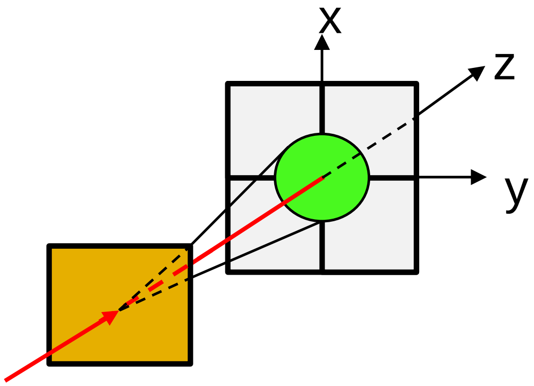
Inspection hatches

(Thales)





SANS MODE



Rectangular apertures with slits

Up to 85(H) x 25(W) mm^2

6 collimation lengths : 19, 16, 12, 8, 4, 2 m

16 positions attenuator wheel in front of the collimator

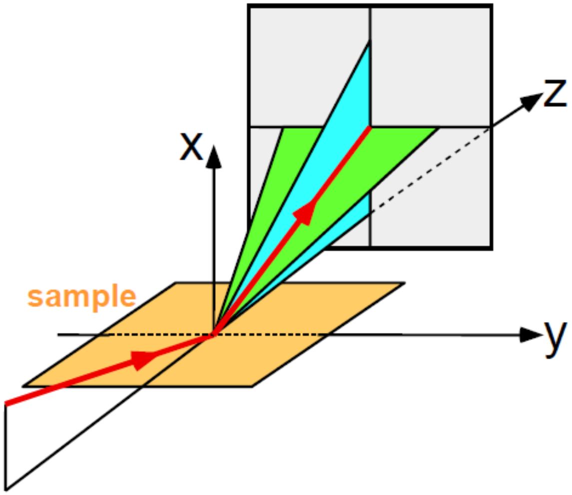
“standard” collimation : 25x25 mm^2 entrance and 12.5x12.5 mm^2 exit

i.e. full use of beam width

GISANS MODE

For surface studies

1) Incident angle on the sample with a thin rectangular beam
either vertical or horizontally (for liquids)



2) Beam axis centered and sample rotated (not for liquids)

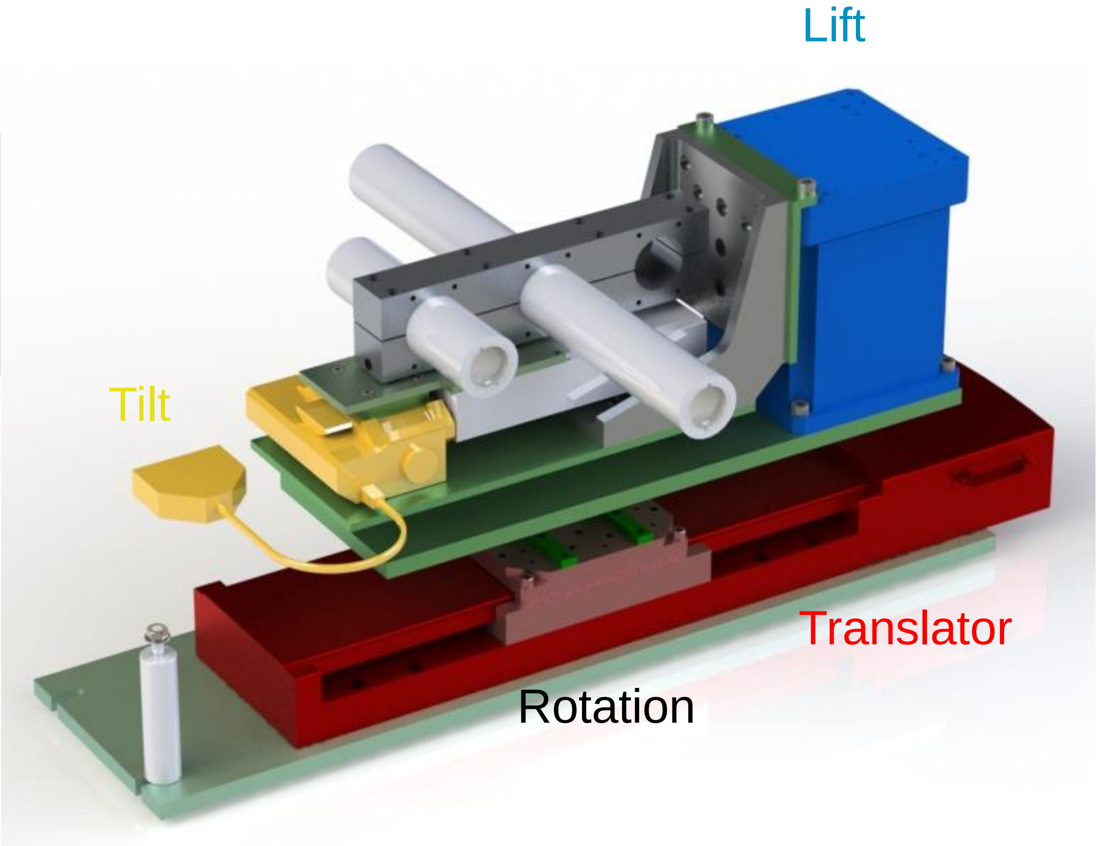
VSANS MODE

Two sets of lenses inserted in the rear part of the collimator in front of the sample

Qmin (1/Å)	I (Å)	L (m)	Lens number
4E-04	9.2	19	19
6E-04	9.2	19	19
8E-04	6.5	19	37
1E-03	8.4	12	37

Target : $Q_{min} = 4.10^{-4}$ Å^{-1}

4 DoF for alignment



BEAM POLARIZATION

Polarization of the beam before the collimator

must be kept up to the sample for 4+ Å neutrons

⇒ Use of a guide field

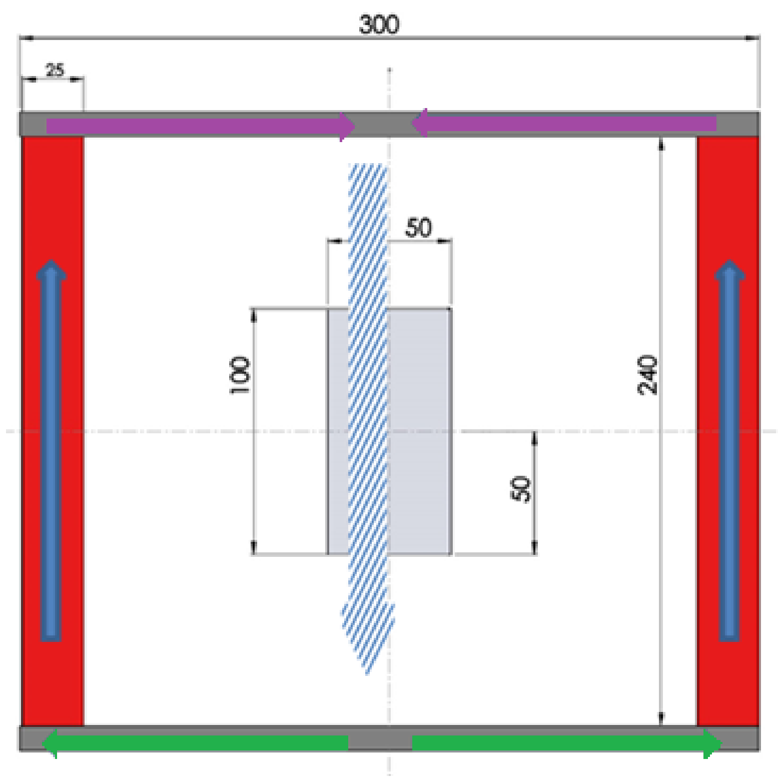
With constraints:

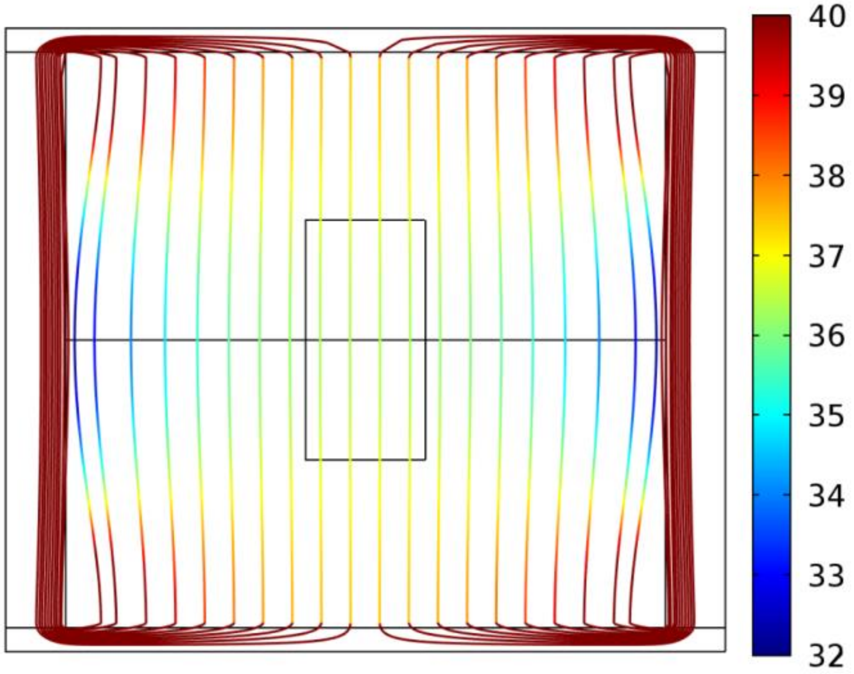
- Distance between bottom and upper plate = 239 mm (to fit the guides)
- No magnetic parts inside the magnetic field
- No long space without magnetic guide field
- Removable telescopic plates (+300/-0 mm) to guide until the sample

GUIDE FIELD - PRINCIPLE

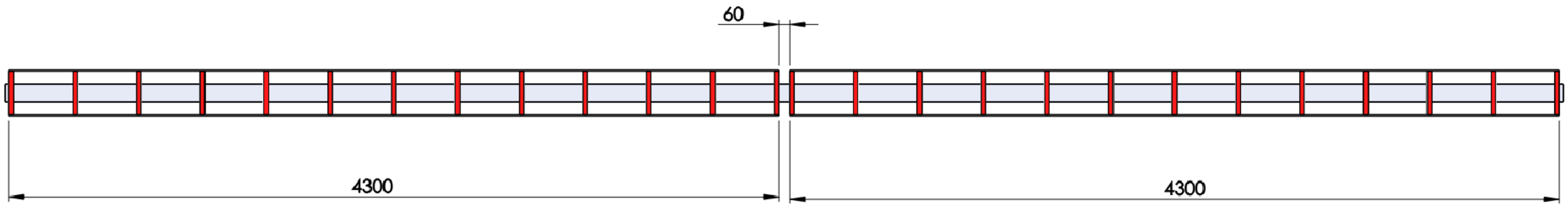
All the magnets are set along the same direction

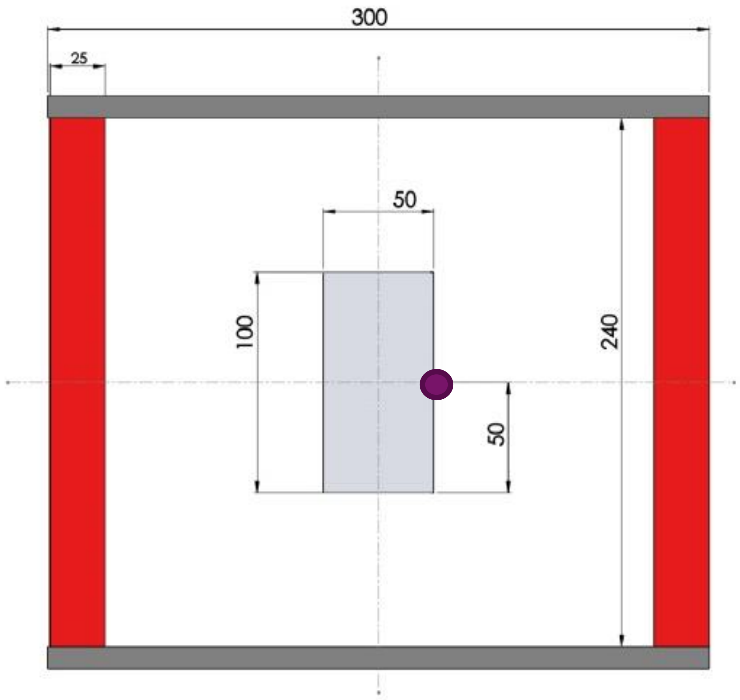
Magnetic field is guided by the iron plates and loops homogeneously over the beam

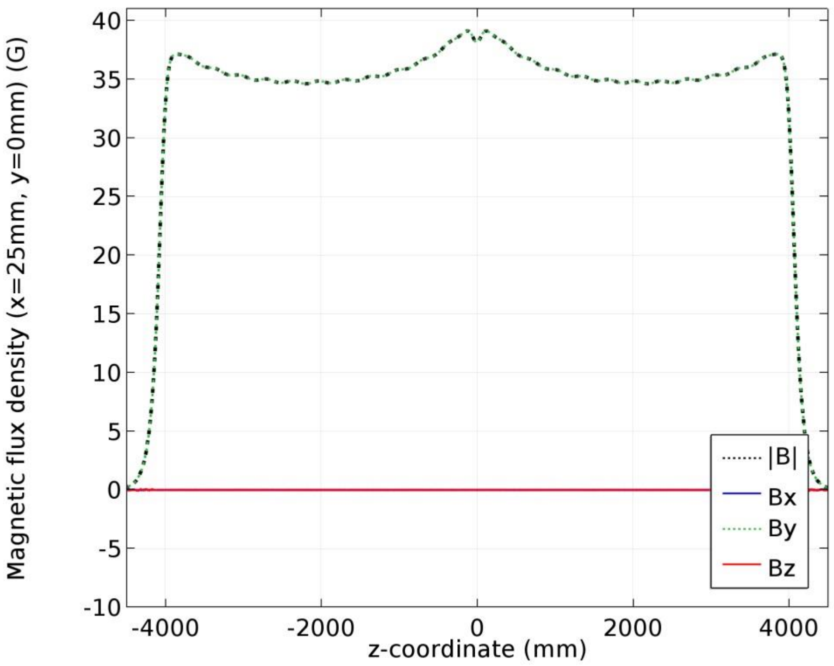




GUIDE FIELD - SIMULATIONS

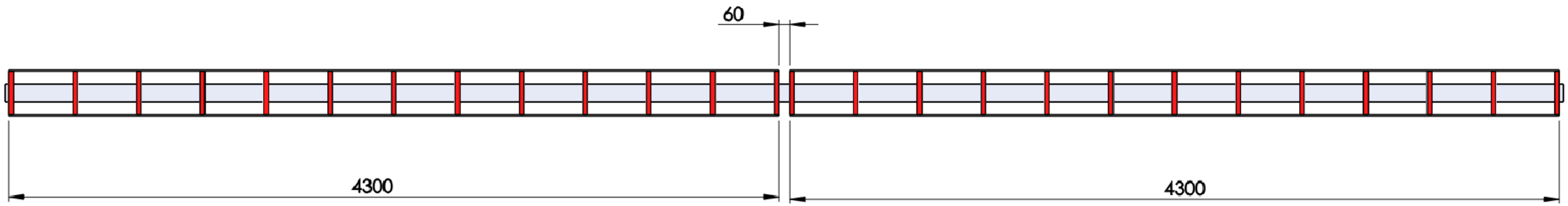


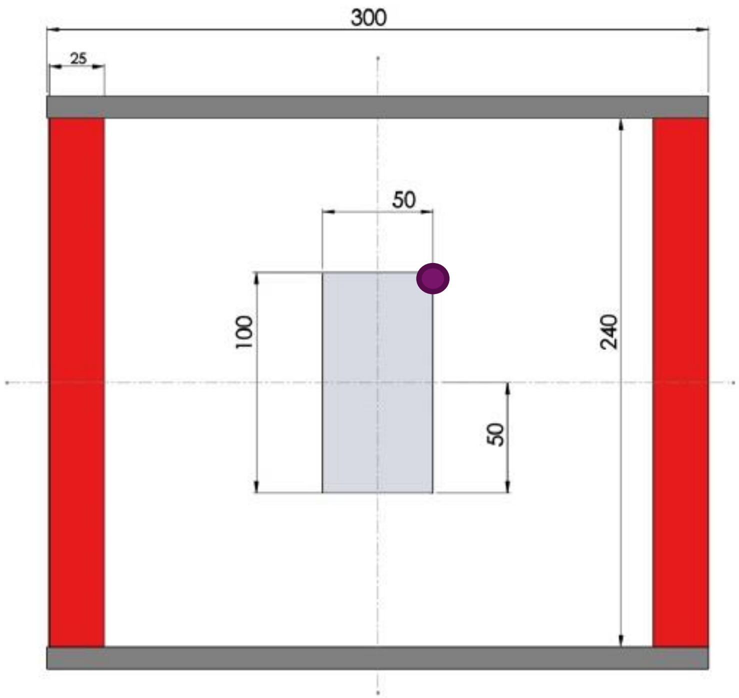


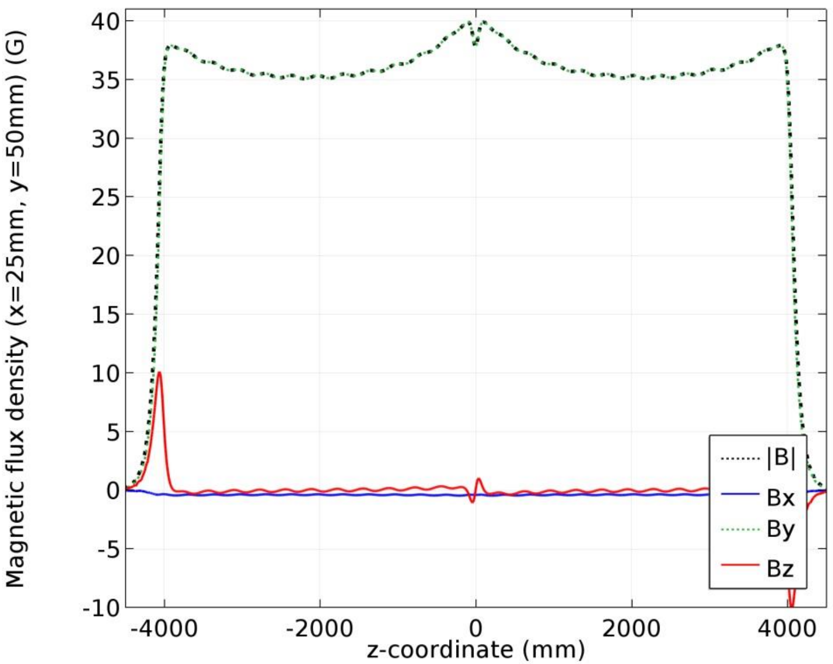


Only component is 35 G vertical (By)

GUIDE FIELD - SIMULATIONS

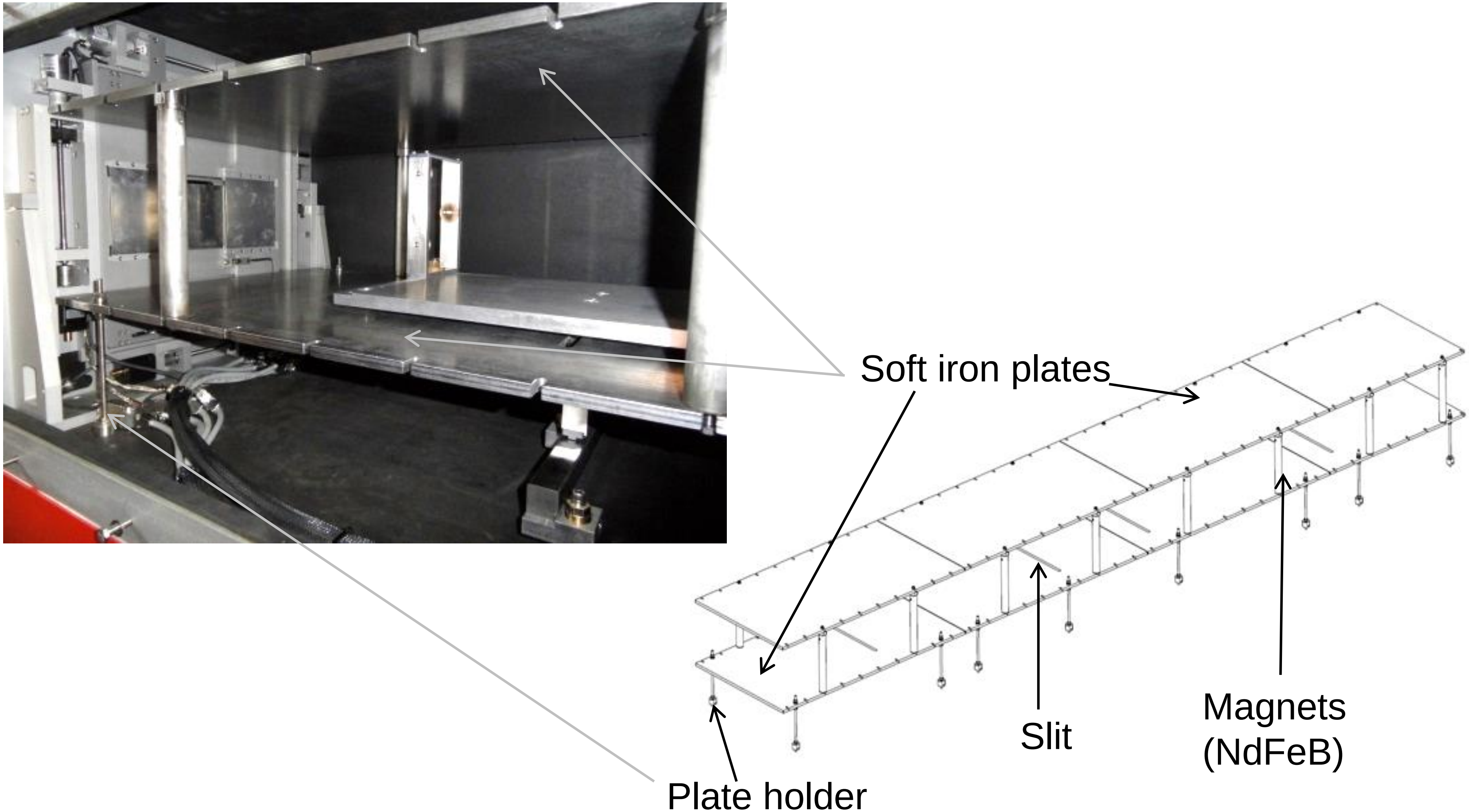






35 G vertical (By) and 2 G longitudinal (Bz)

GUIDE FIELD



- Dedicated tool required for plate handling

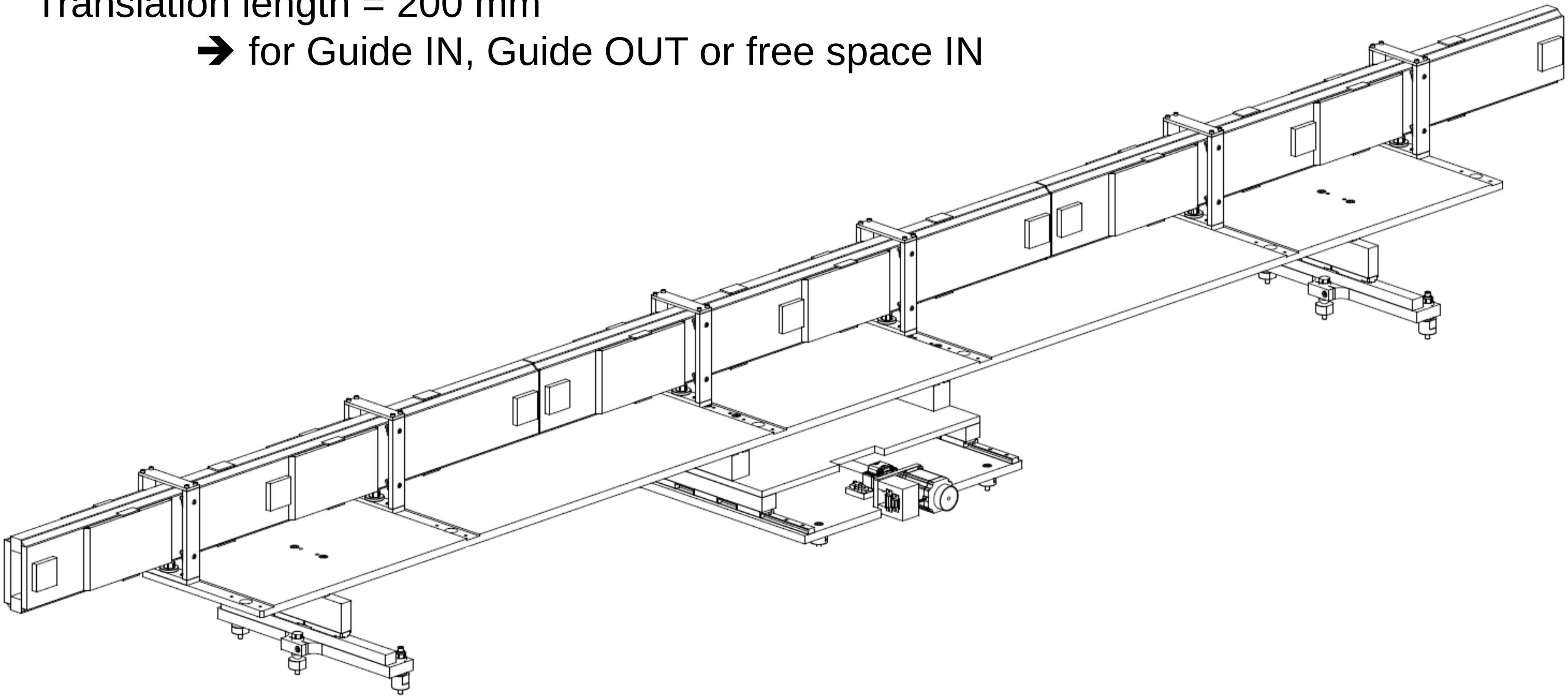
GUIDE TRANSLATION

Guide element Length =1250 mm, m=1

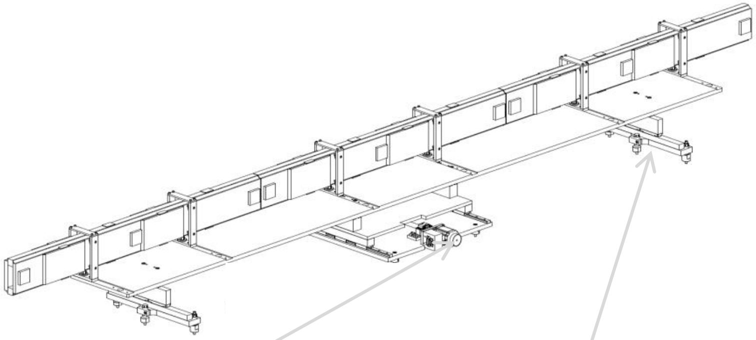
3 elements : 3750 mm, ~60 kg and 2 elements of 1250 mm

Translation length = 200 mm

➔ for Guide IN, Guide OUT or free space IN



GUIDE TRANSLATION



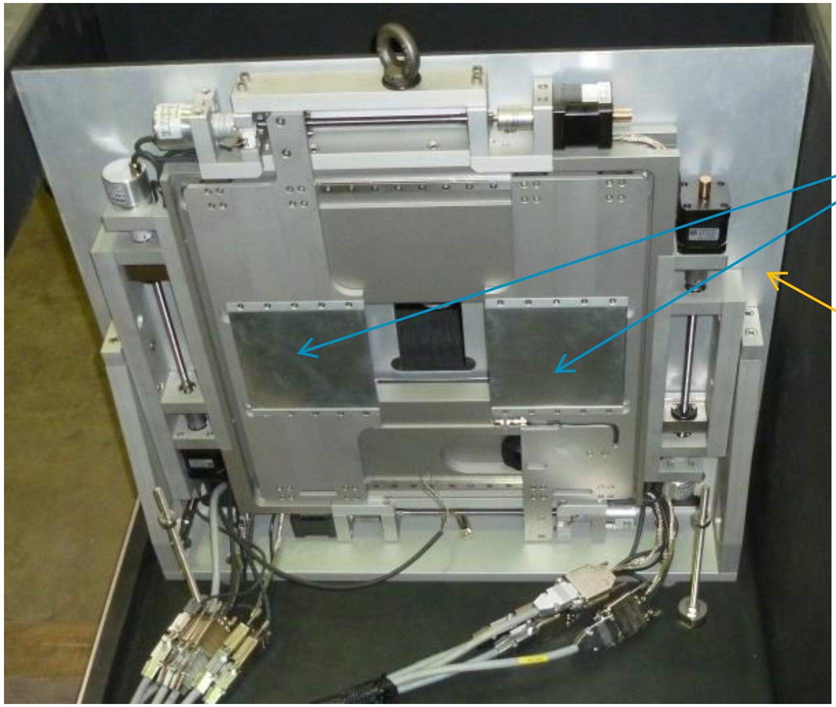
Motorization

Side rollers

Unconstrained move: one motor, side rollers

Rail, motors and encoders located under the Fe plates

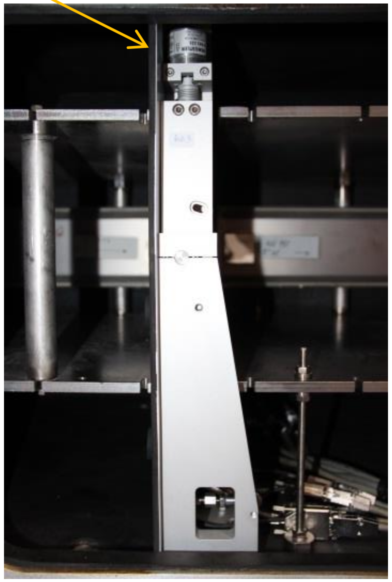
BLINDS



Max opening 100 mm vertical and horizontal

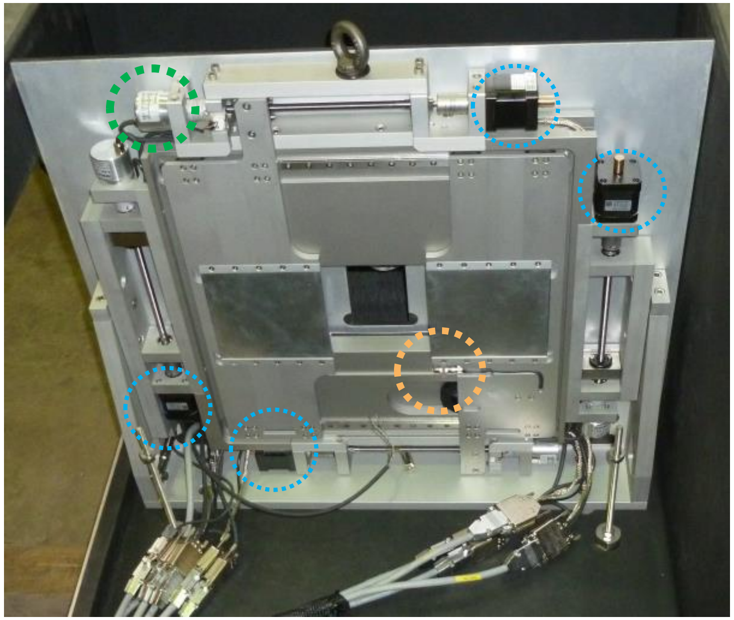
4 independent blinds
to cover any part of the incoming guide and shift the beam axis for GISANS

B4C frame covering whole guide section but the beam (to isolate noise)



Slim (50 mm) for insertion/removal without impact on the plates

BLINDS - MOTORIZATION



4 motors : one by plate

End switch and anti-collision sensors

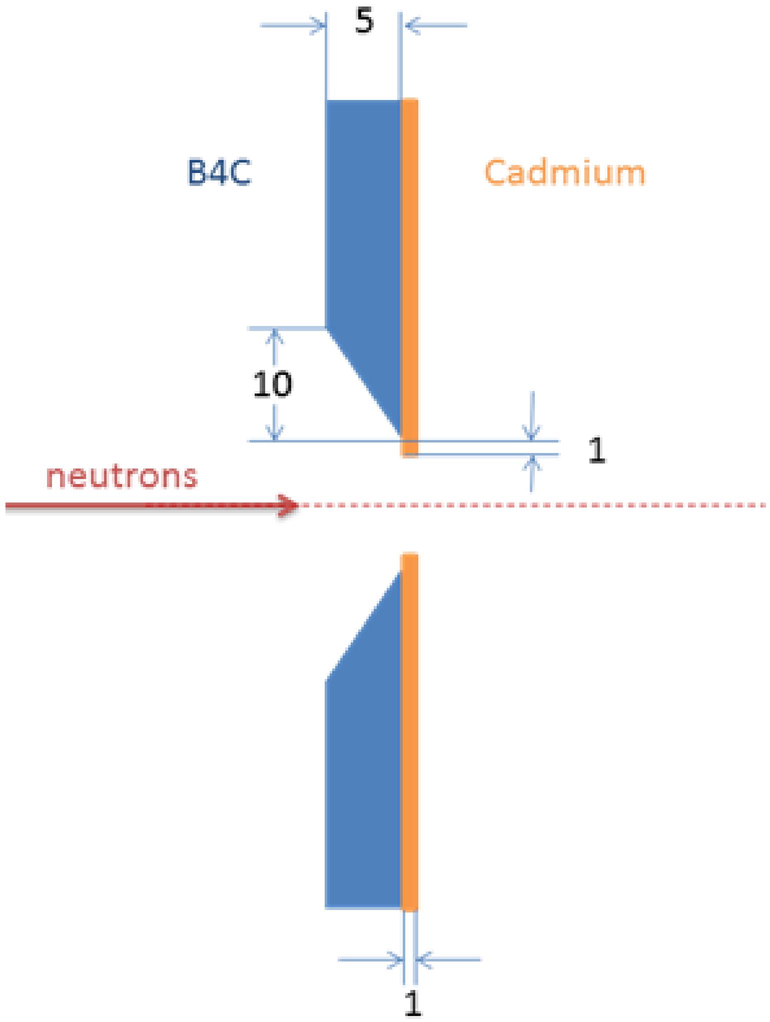
Slim absolute encoder (*Hengstler*, ϕ 40 mm)
➔ 60 mm maximum gap between Fe plates

Motors and encoders outside the Fe plates
➔ No interaction with guide field

BLINDS - ABSORBERS

Composite assembly:

- 5 mm B4C :
  - stop most of incoming neutrons
  - low γ radiation
  - slope to avoid reflection
- 1 mm Cd :
  - sharp machining
  - high neutron capture



TELESCOPIC NOSE

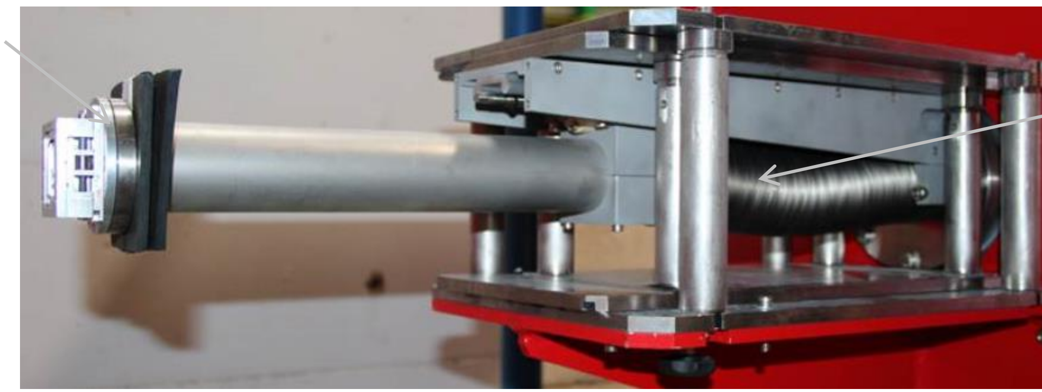
Telescopic nose and independent telescopic guide field

500 mm -0 /+300 mm

Diaphragm holder at the edge

Sapphire window

Stainless edge welded bellow

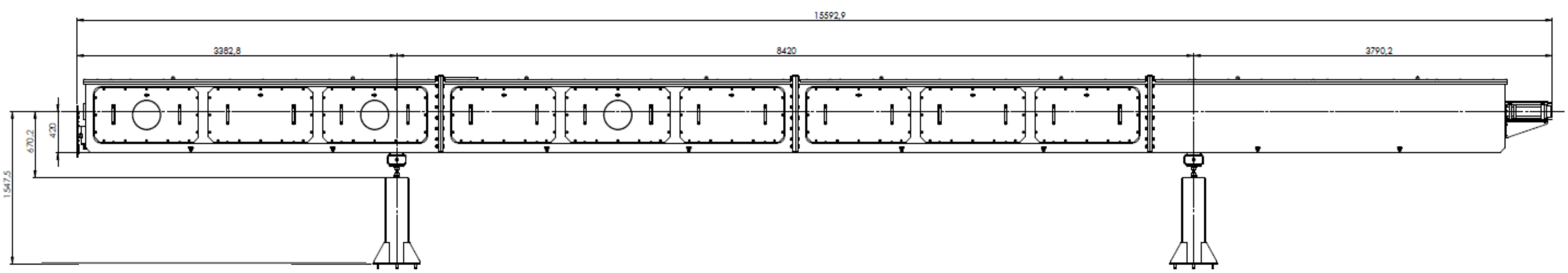


Threaded rod

COLLIMATOR SUPPORT

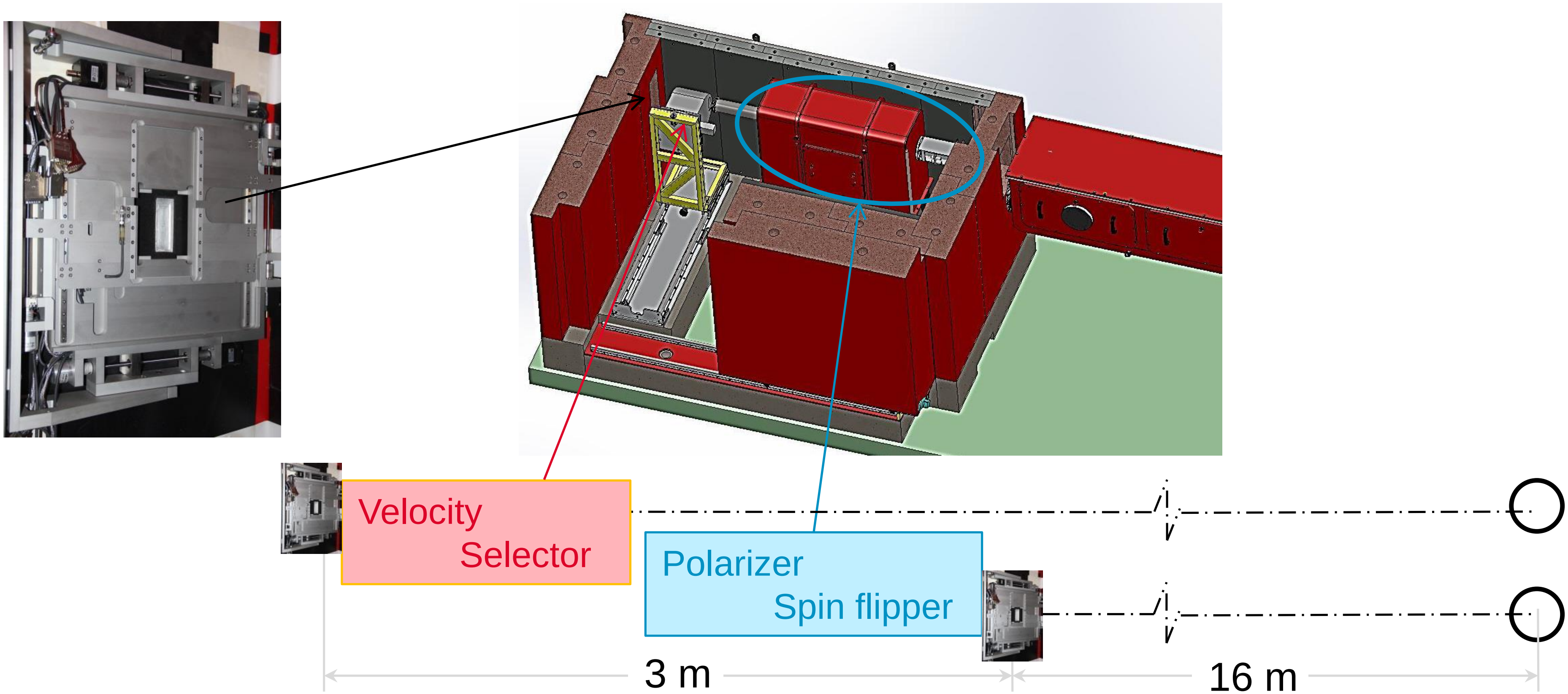
Only 2 supports
(2 temporary supports during assembly)

➔ Offers easy alignment



19 M COLLIMATION

Sample to detector distance = 19 m to get a 2x19 m instrument



➔ Incompatible with polarization mode

SAMPLE ENVIRONMENT ACCESS

Side access

Platform for top access
& storage

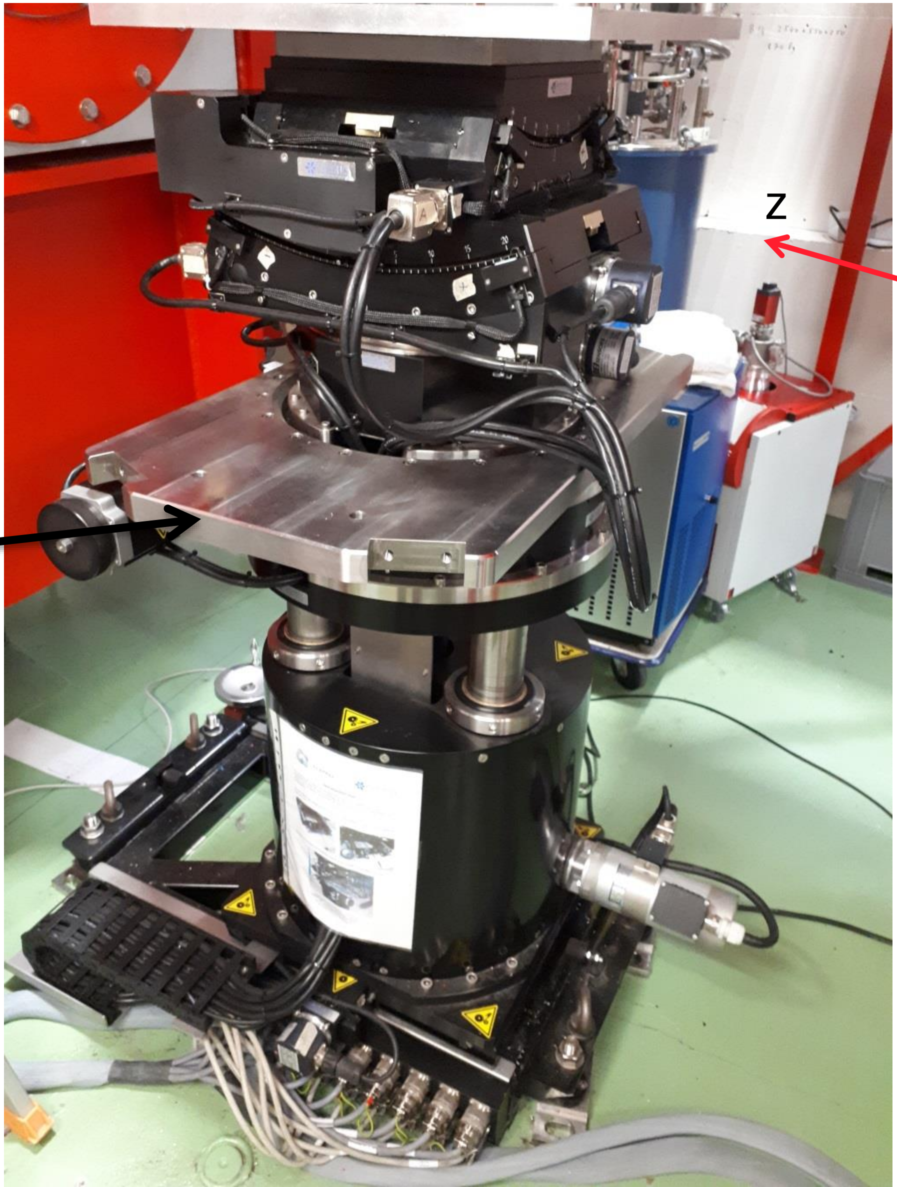
SAMPLE POSITIONING

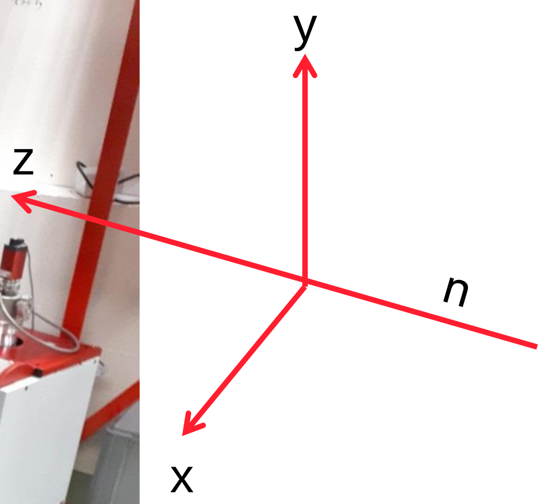
6 DoF:

X 50 mm
Y 300 mm
Z 300 mm (manual)
θ_X +/- 15°
θ_Y +/- 180°
θ_Z +/- 15°

θ_Y +/- 180° for EM (independant)

(Positechnics)





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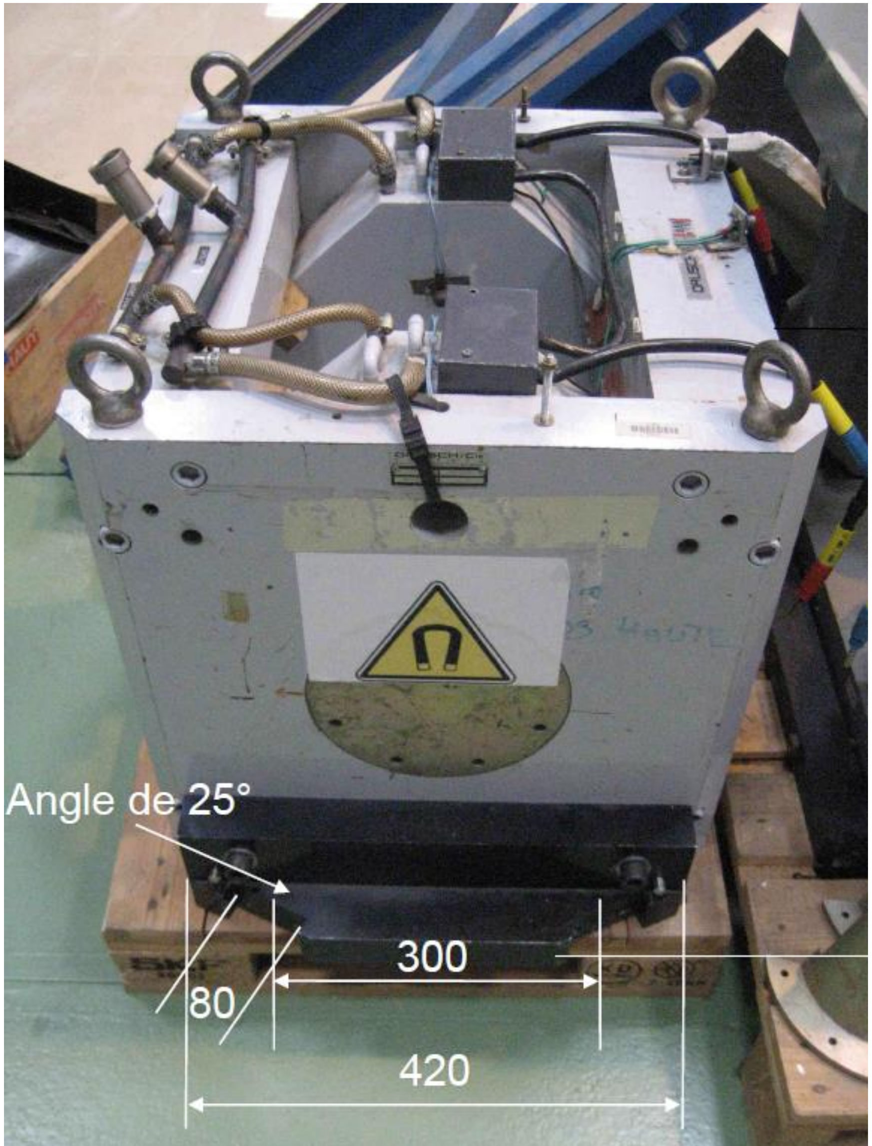
ELECTROMAGNET 2T



- 500 kg
- 60 A
- Perpendicular magnetic fields

ELECTROMAGNET

3470

1.8T @ 10 mm
5 A

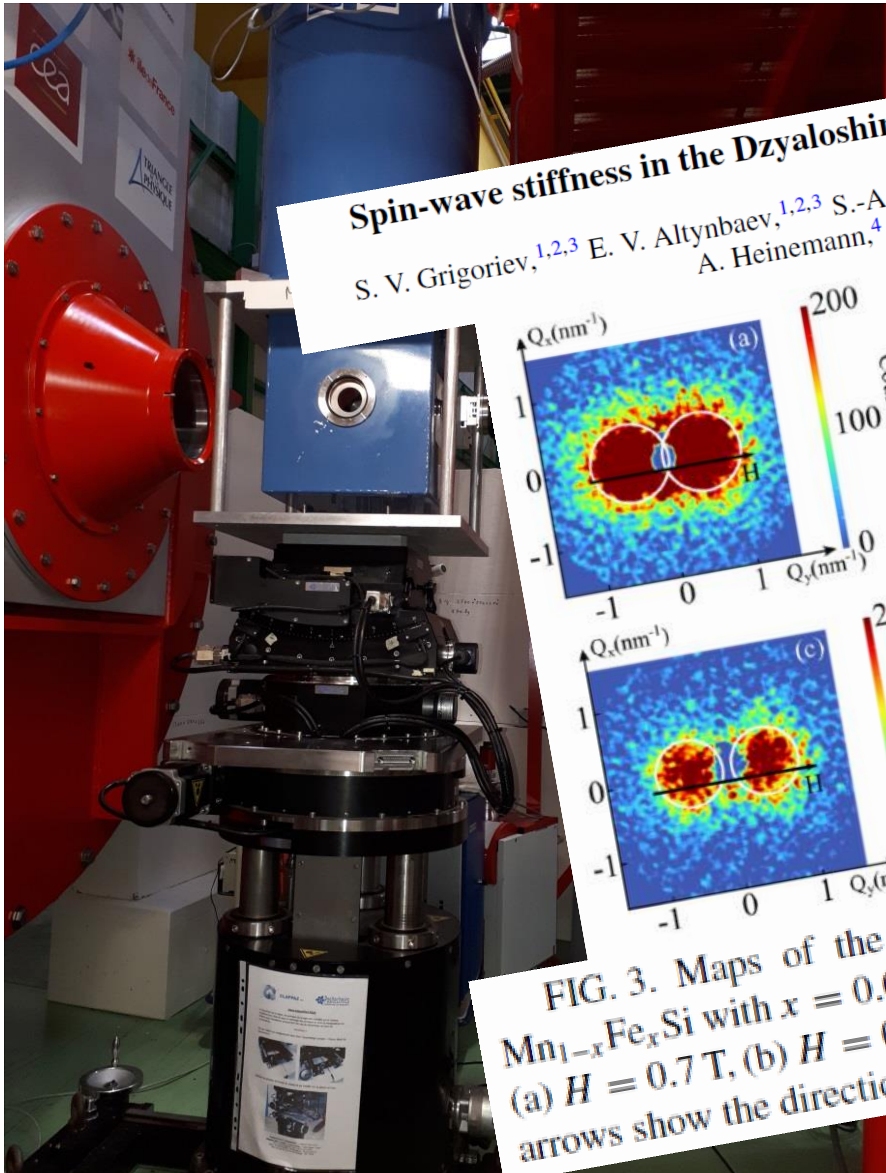
5403 FG

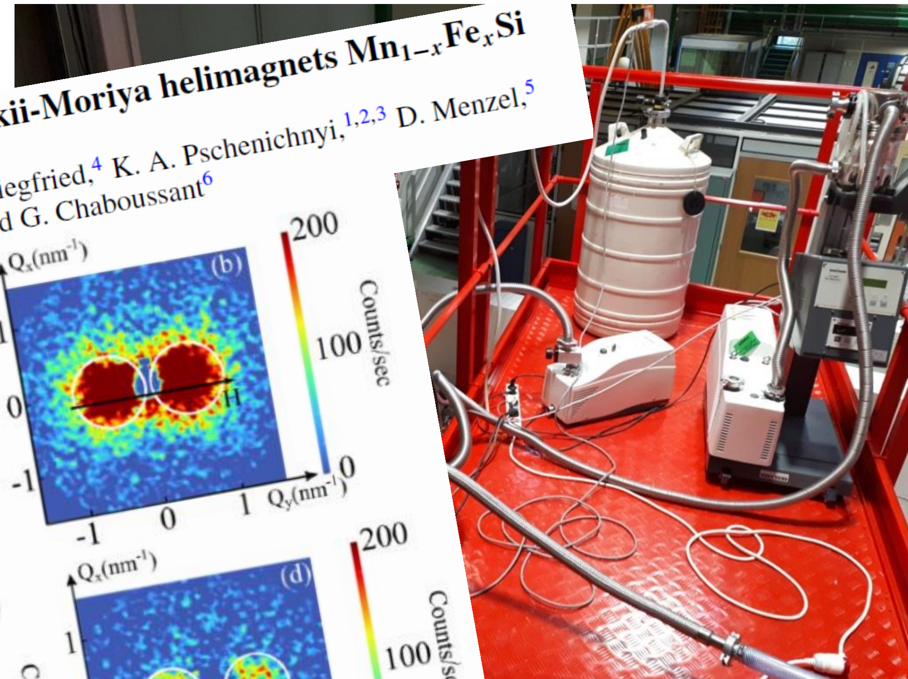
1.6T @ 10 mm
50 A

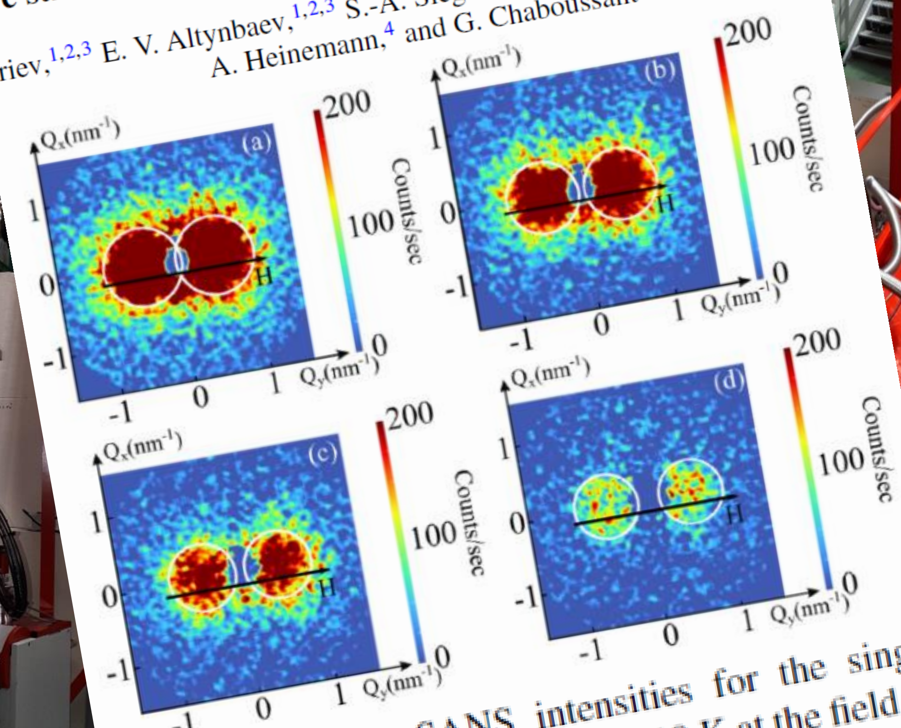
(GMW Associates)

- Perpendicular & Longitudinal magnetic fields
- Crycooler insertion possible (loss of B max)

SUPRA COIL 10T – 4K







Spin-wave stiffness in the Dzyaloshinskii-Moriya helimagnets $Mn_{1-x}Fe_xSi$

S. V. Grigoriev,[1,2,3] E. V. Altynbaev,[1,2,3] S.-A. Siegfried,[4] K. A. Pschenichnyi,[1,2,3] D. Menzel,[5] A. Heinemann,[4] and G. Chaboussant[6]

FIG. 3. Maps of the SANS intensities for the single crystal $Mn_{1-x}Fe_xSi$ with $x = 0.03$ taken at $T = 10$ K at the field above H_{C2} (a) $H = 0.7$ T, (b) $H = 0.9$ T, (c) $H = 1.1$ T, and (d) $H = 1.8$ T. The arrows show the direction of the field.

CRYOCOOLER

Easier to prepare than Cryostats:

- No filling
- No pre-cooling
- No required supply around
- Approx. 1 hour to get to 7K

(ARS Cryo : DE 204)

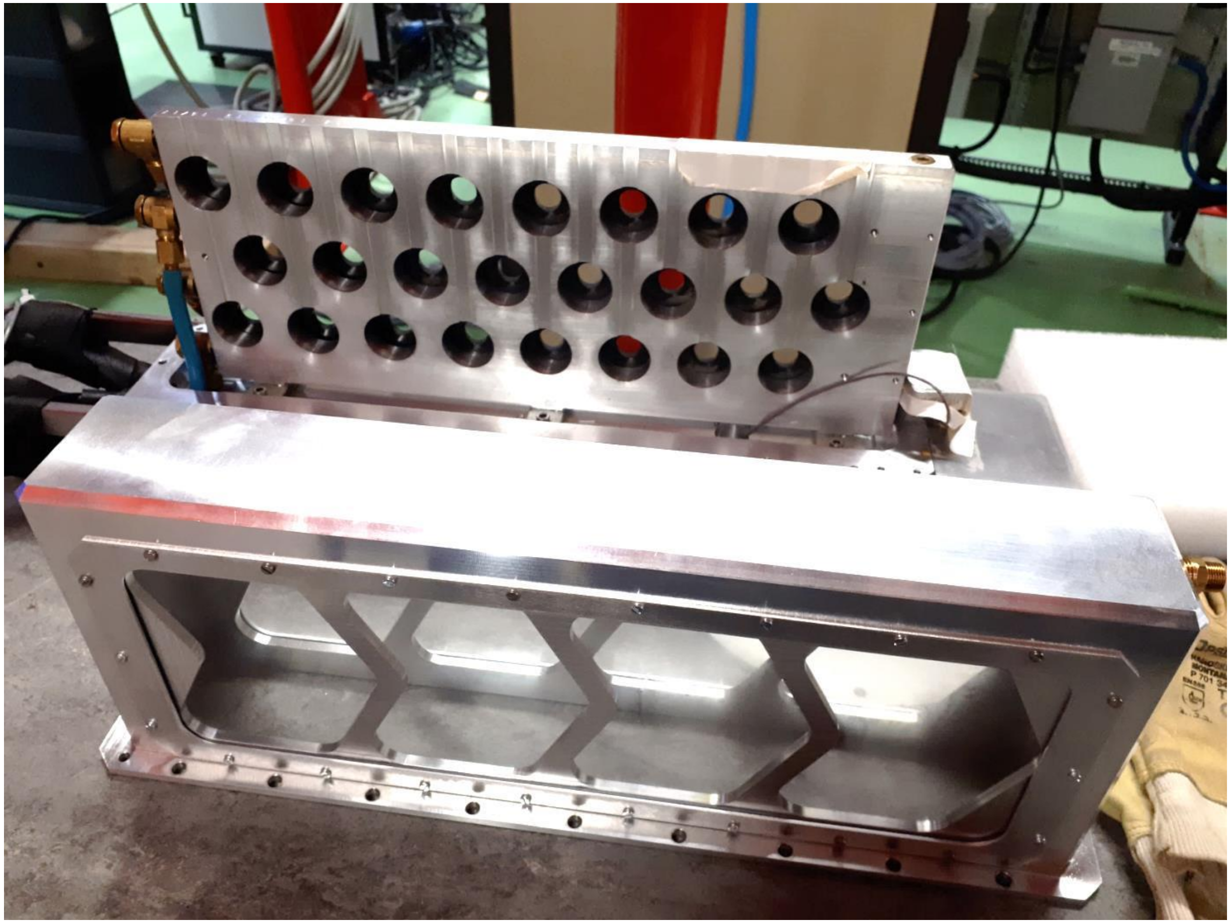
WATER COOLING

Standard:

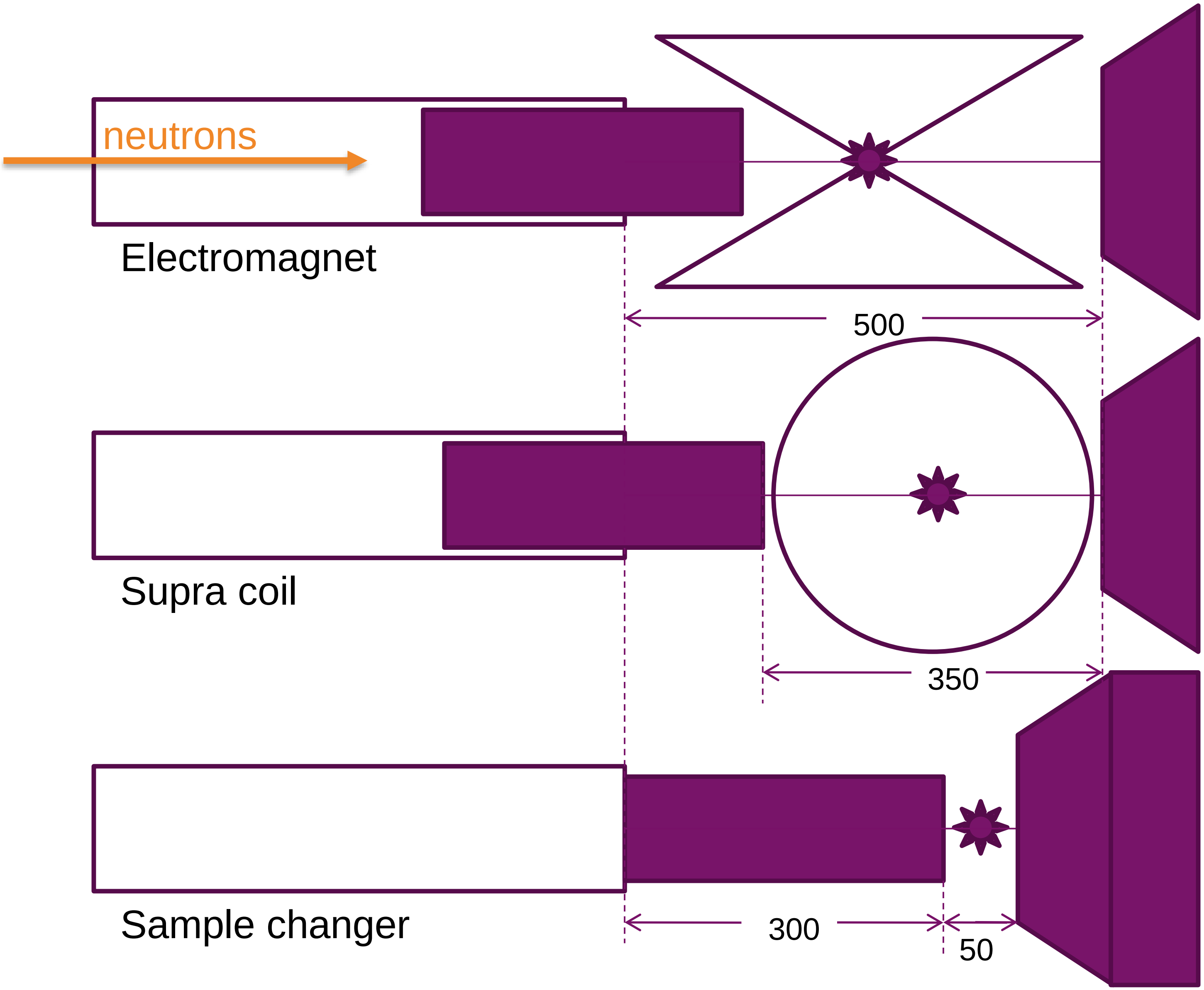
- -10 to 80°C
- Close-loop with probe
- Computer control & record

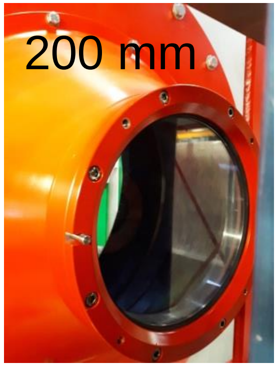
2D SAMPLE CHANGER

- 24 positions
- Temp controlled
- Optionnal vessel
  for He circulation



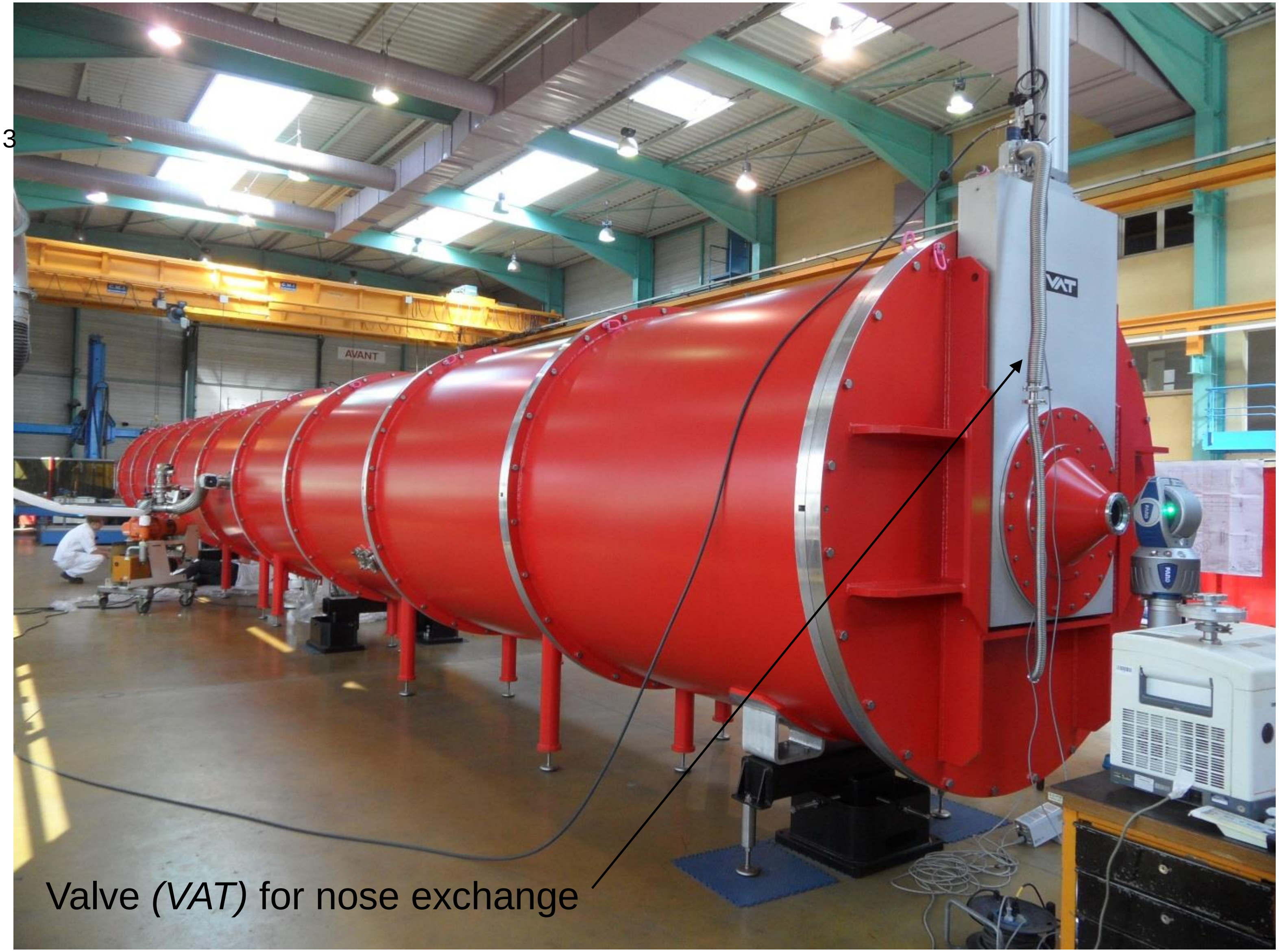
MINIMIZING AIR GAP





DETECTOR TANK

- $V = 63\ m^3$
- L=19 m
- Al 5754
- (SDMS)



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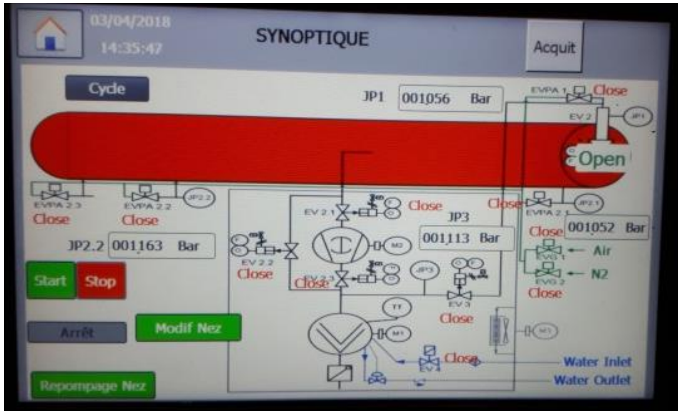
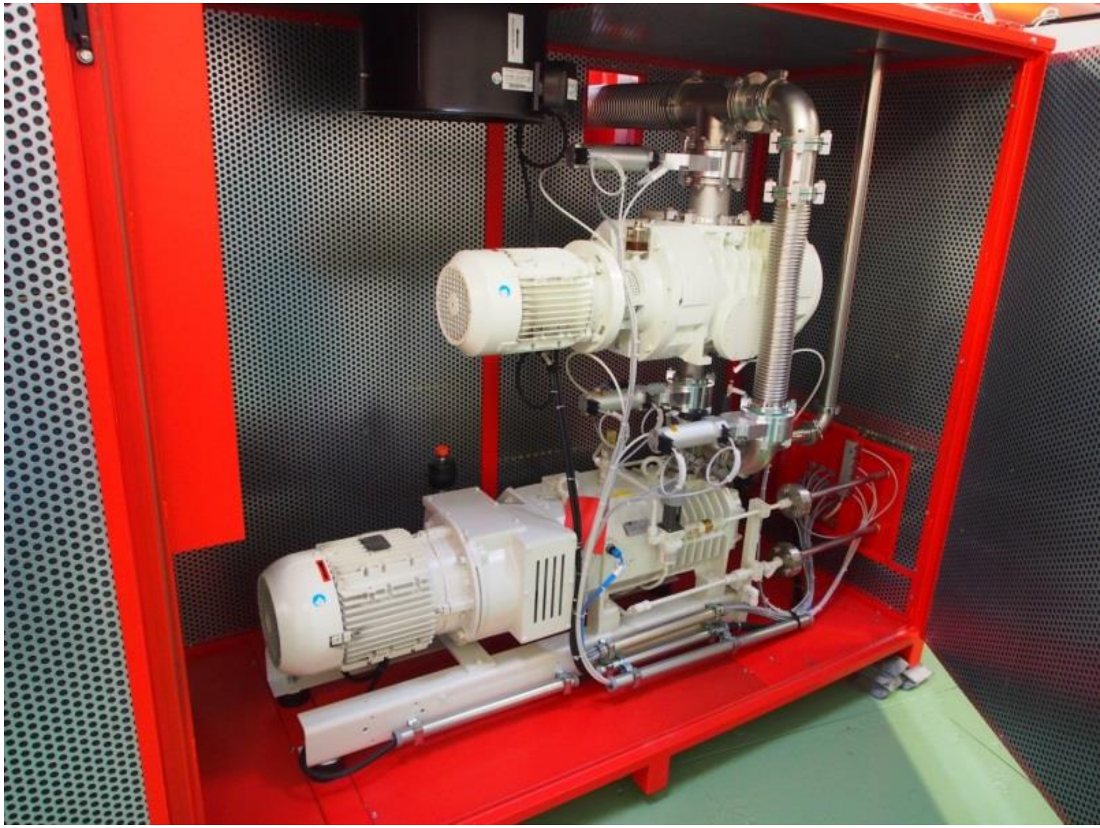
cea

VACUUM



Automat (survey & nose exchange)

Vacuum hoses

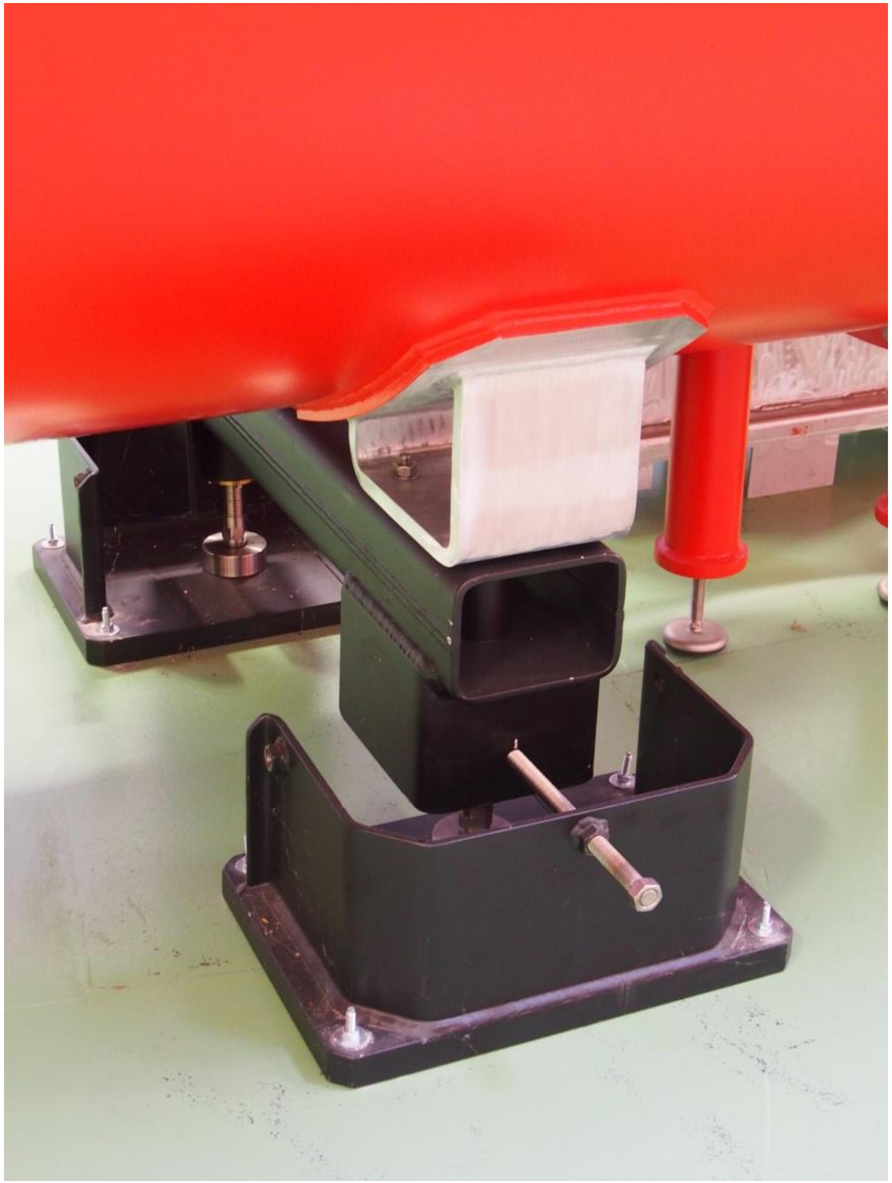


- 1 primary pump (1 bar to 100 mbar)
- 1 secondary pump (100 mbar to 1 mbar)

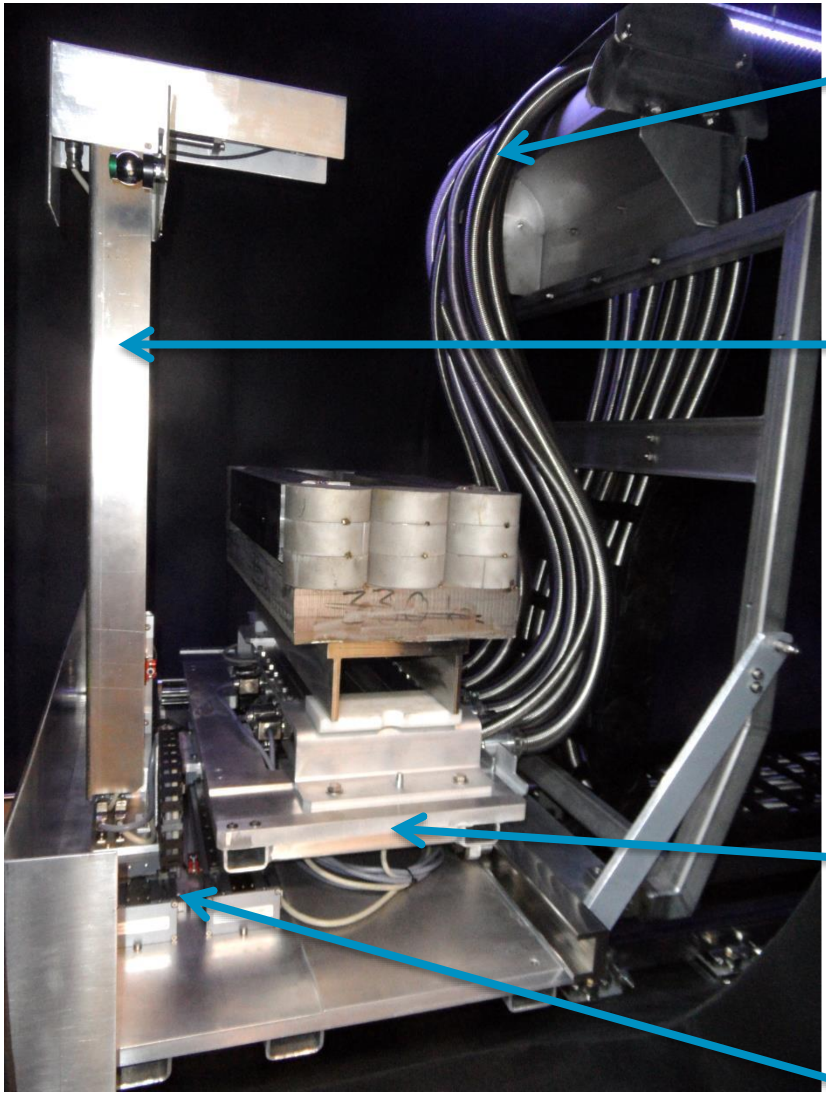
➔ 1 bar to 1 mbar in 2 hours

➔ 70 dB max

ALIGNMENT



REAR DETECTOR CARRIAGE



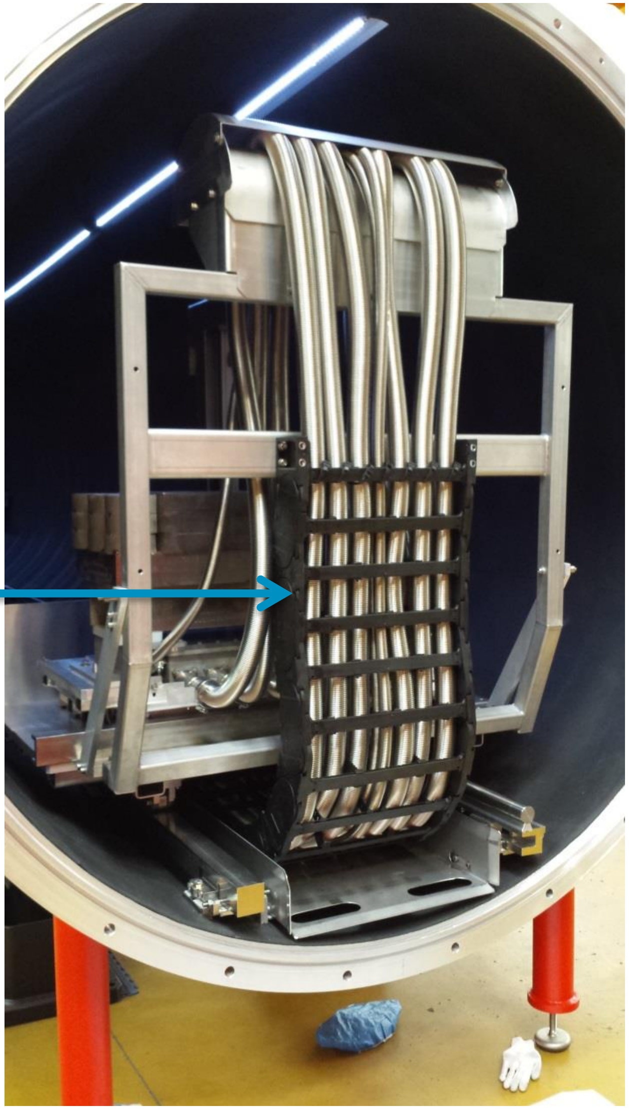
Loop hoses

Beamstop Y

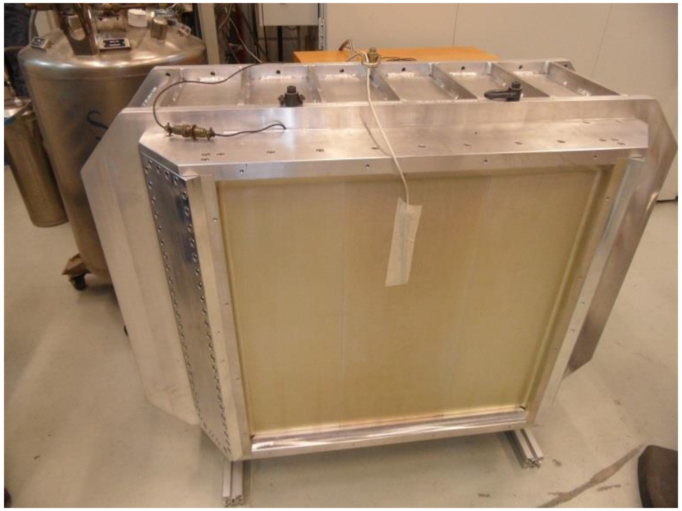
Cable chain

Lateral translator (300 mm)

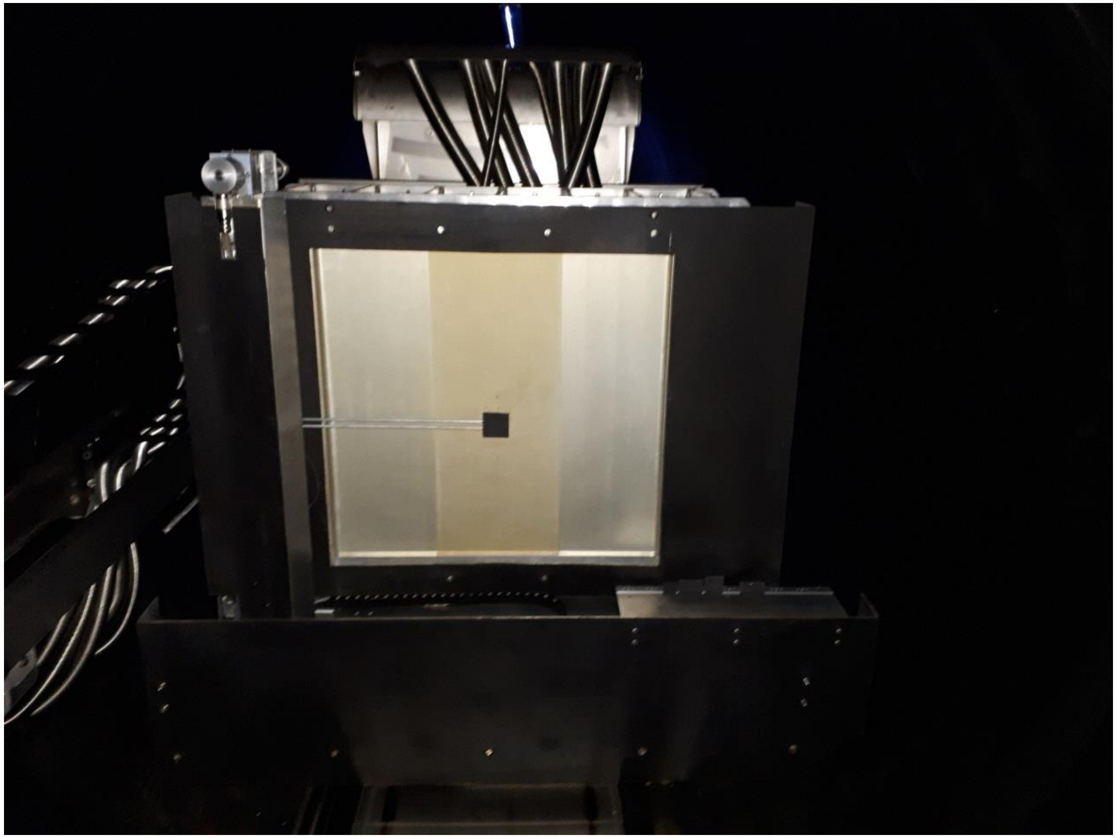
Beamstop X



REAR DETECTOR (1.4 – 19 M)



- Multi Anode ^{3}He *(ILL)*
- S = 64x64 cm^2
- 128 **rectangular** channels of 5 mm



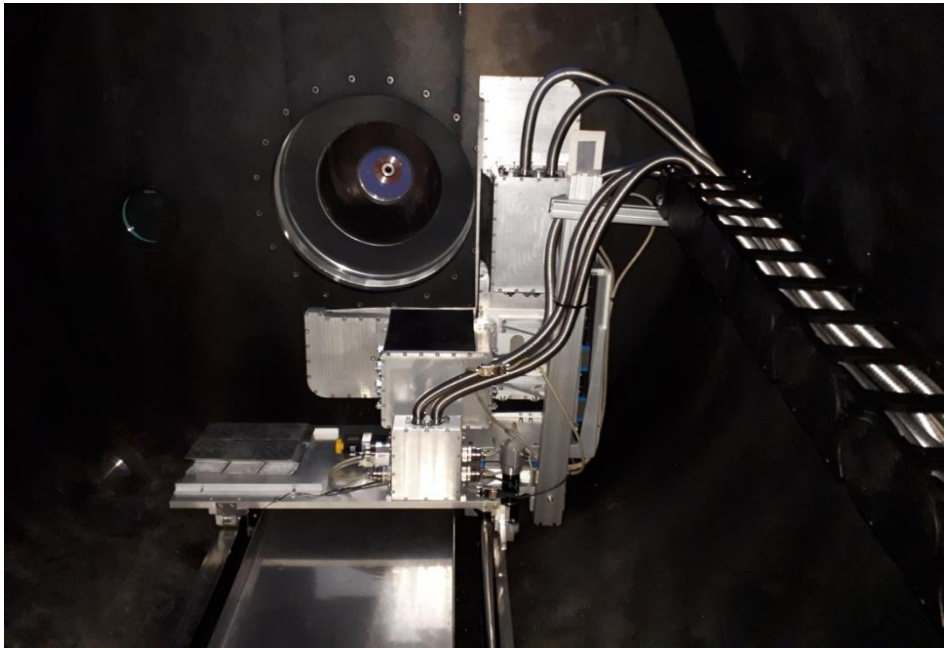
FRONT DETECTOR (1 – 9 M)

- 32 tubes (16 Hor. and 16 Ver.)
~ same plane (13 mm shift)

- Diam. 13 mm, 10 bars ^{3}He

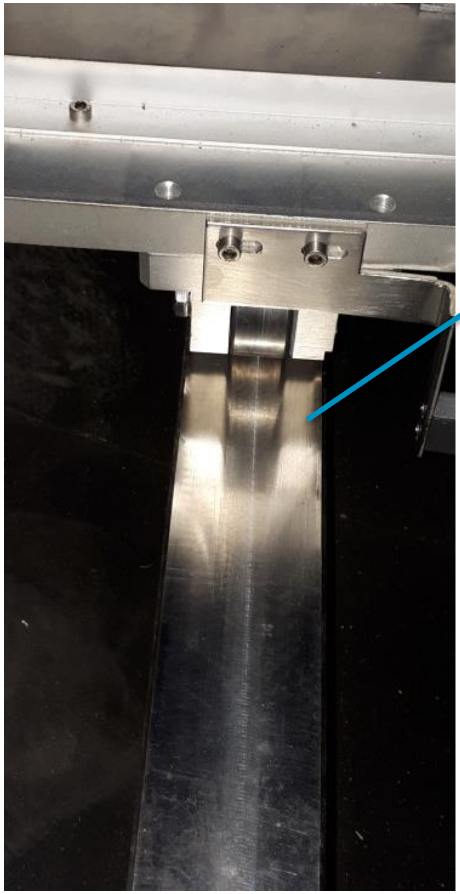
- S=64x20 cm^2

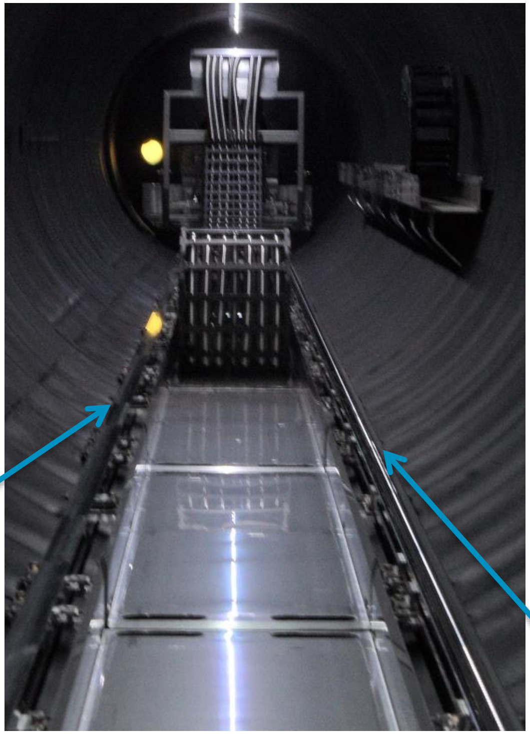
- Tx and Ty = 200 mm



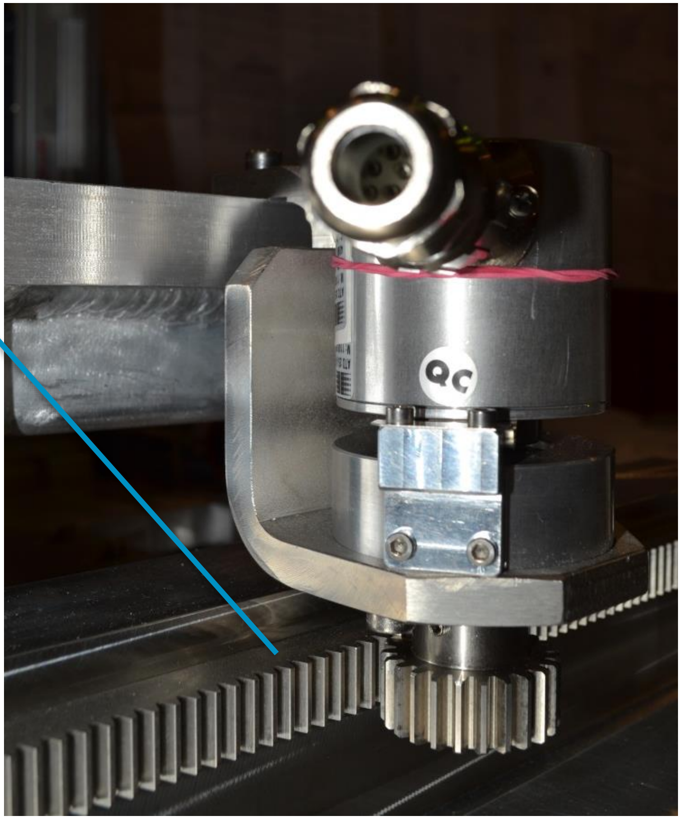
DETECTOR MOVE

Roller





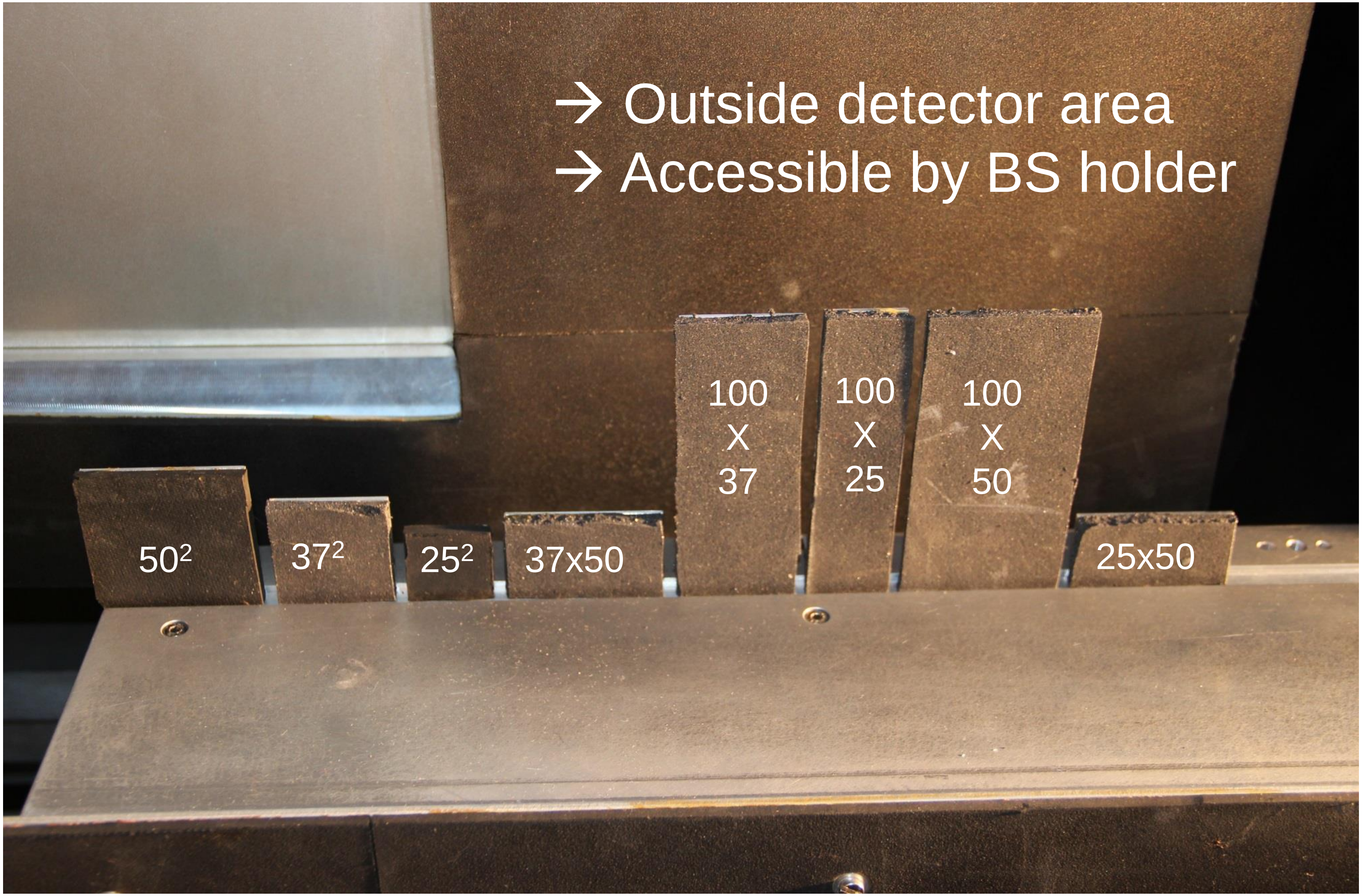
Rack & pinion



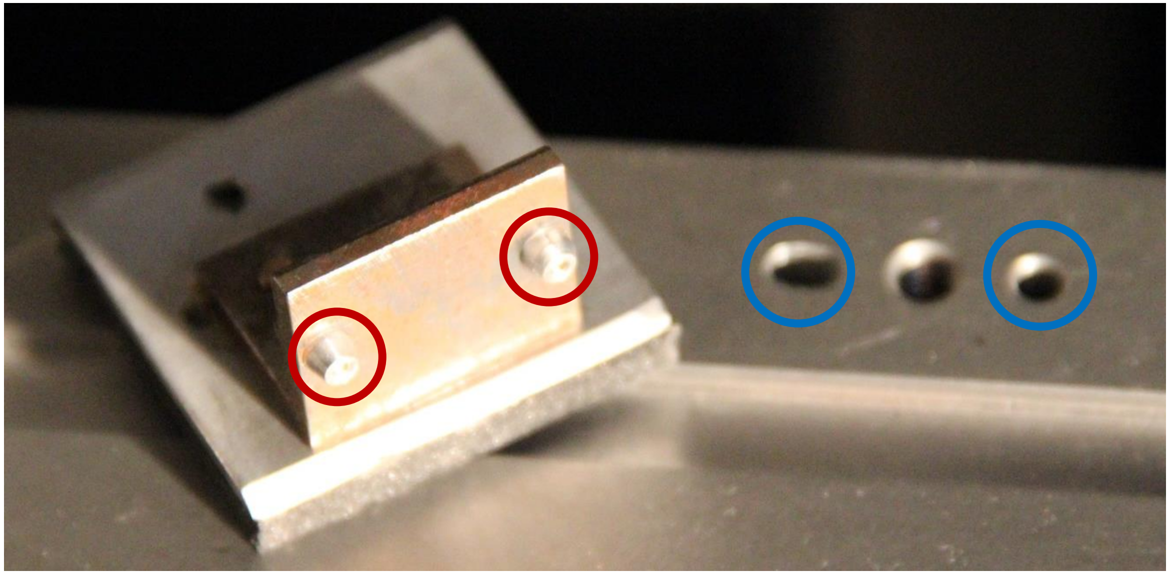
Detector, carriage : 400 kg
Cables : 100 kg

19 m in approx. 10 min

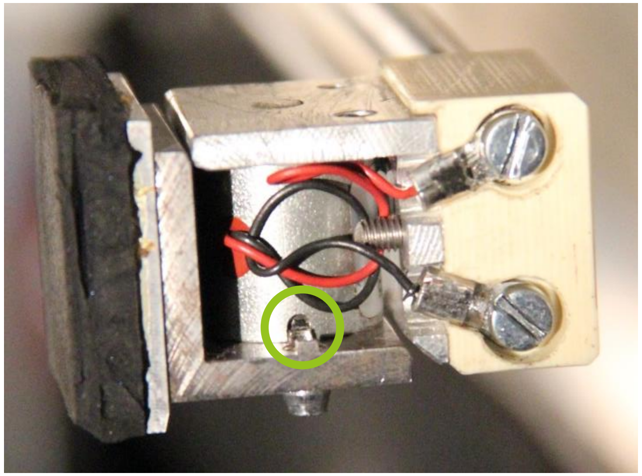
8 BEAM STOPS


→ Outside detector area
→ Accessible by BS holder
50²
37²
25²
37x50
100 X 37
100 X 25
100 X 50
25x50

RELIABLE POSITIONING

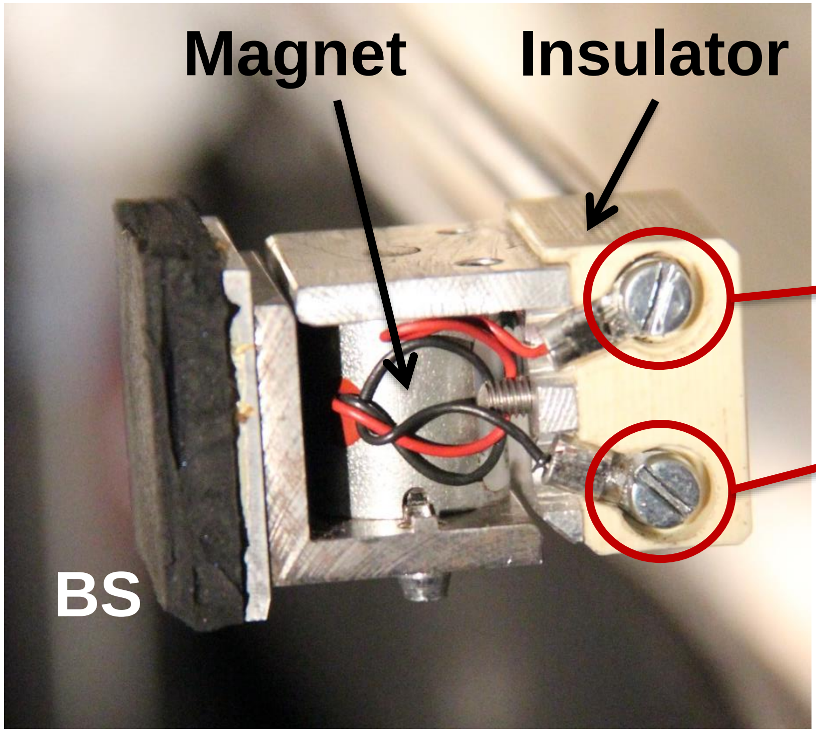


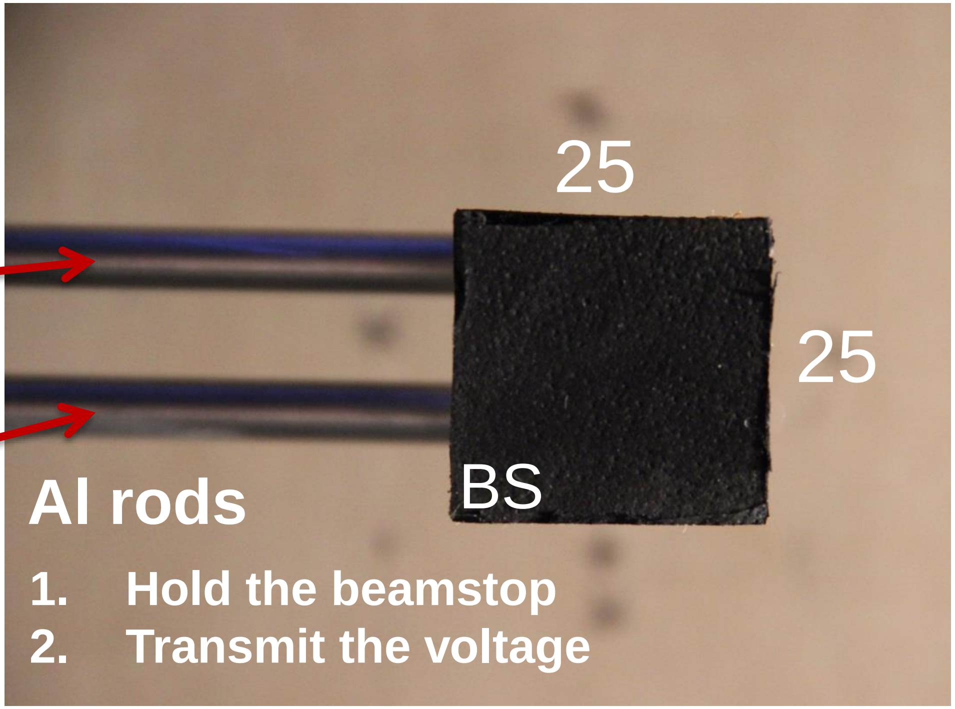
Conical shape
Circular/elongated holes
➔Reliable positioning on support



Side tabs
Indent machined on magnet
➔Reliable positioning on magnet

TRANSPARENT TO NEUTRONS

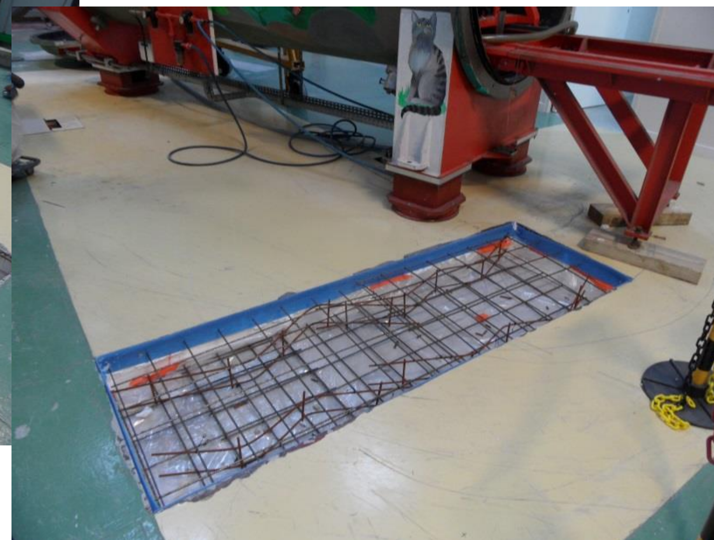




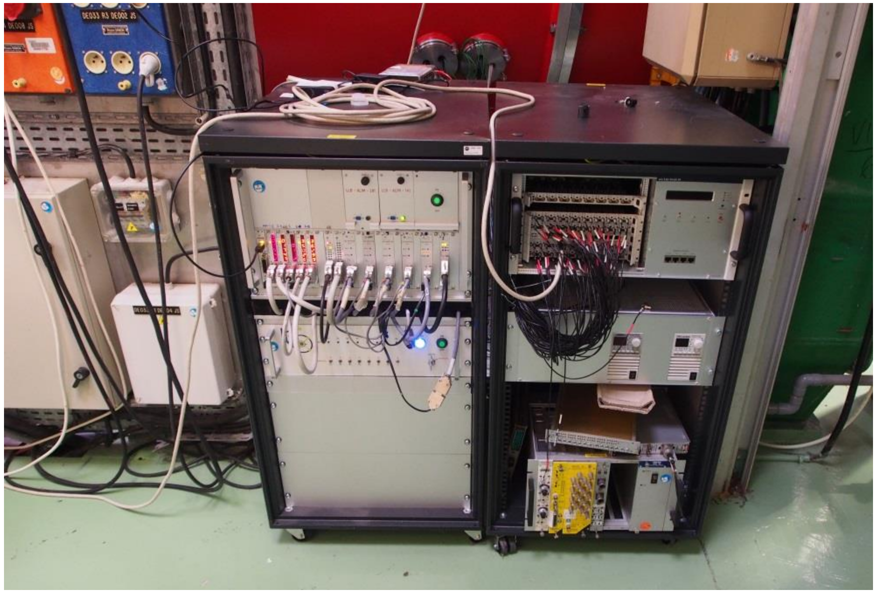
→ Whole device hidden behind a 25x25 mm^2 BS

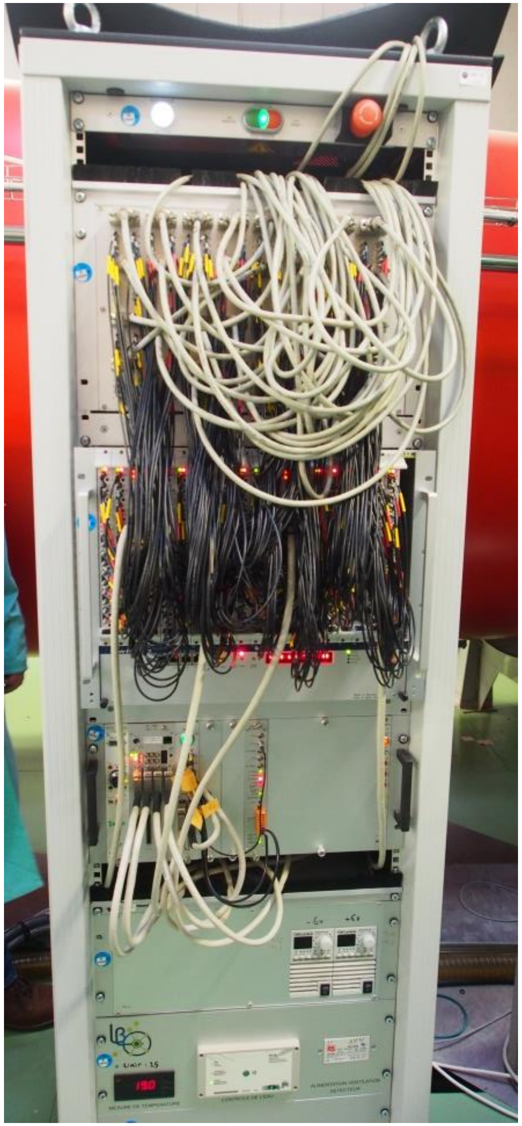
→ Hollow Al rods transparent to neutron

FLOOR LOAD (2T/M2)



ELECTRONICS

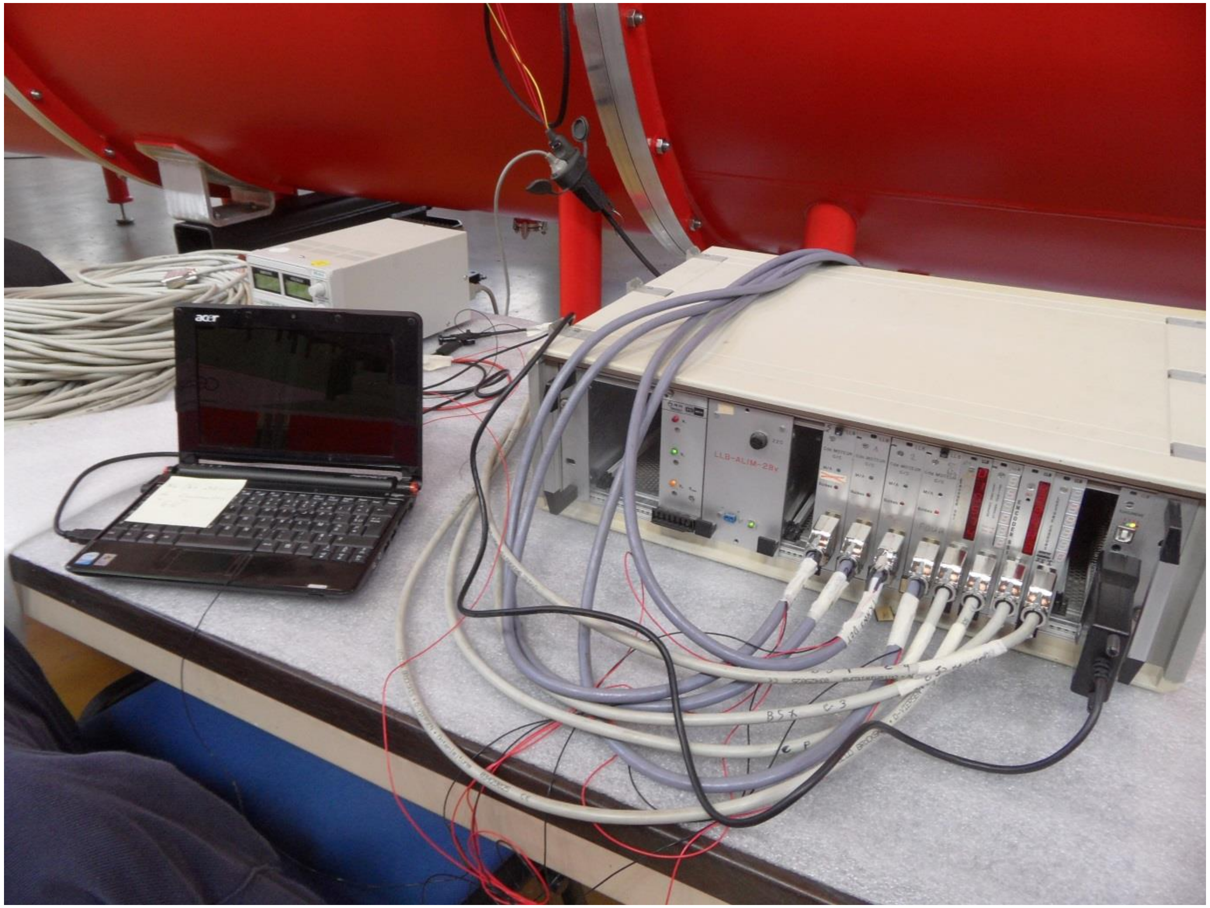




- Takes place
- Needs spare
- Needs to be well referenced
- Ethernet cards for long distances

CABLES !

FACTORY ACCEPTANCE TESTS



Portable electronic rack & dedicated computer

Electronicians test all the axes prior to FAT

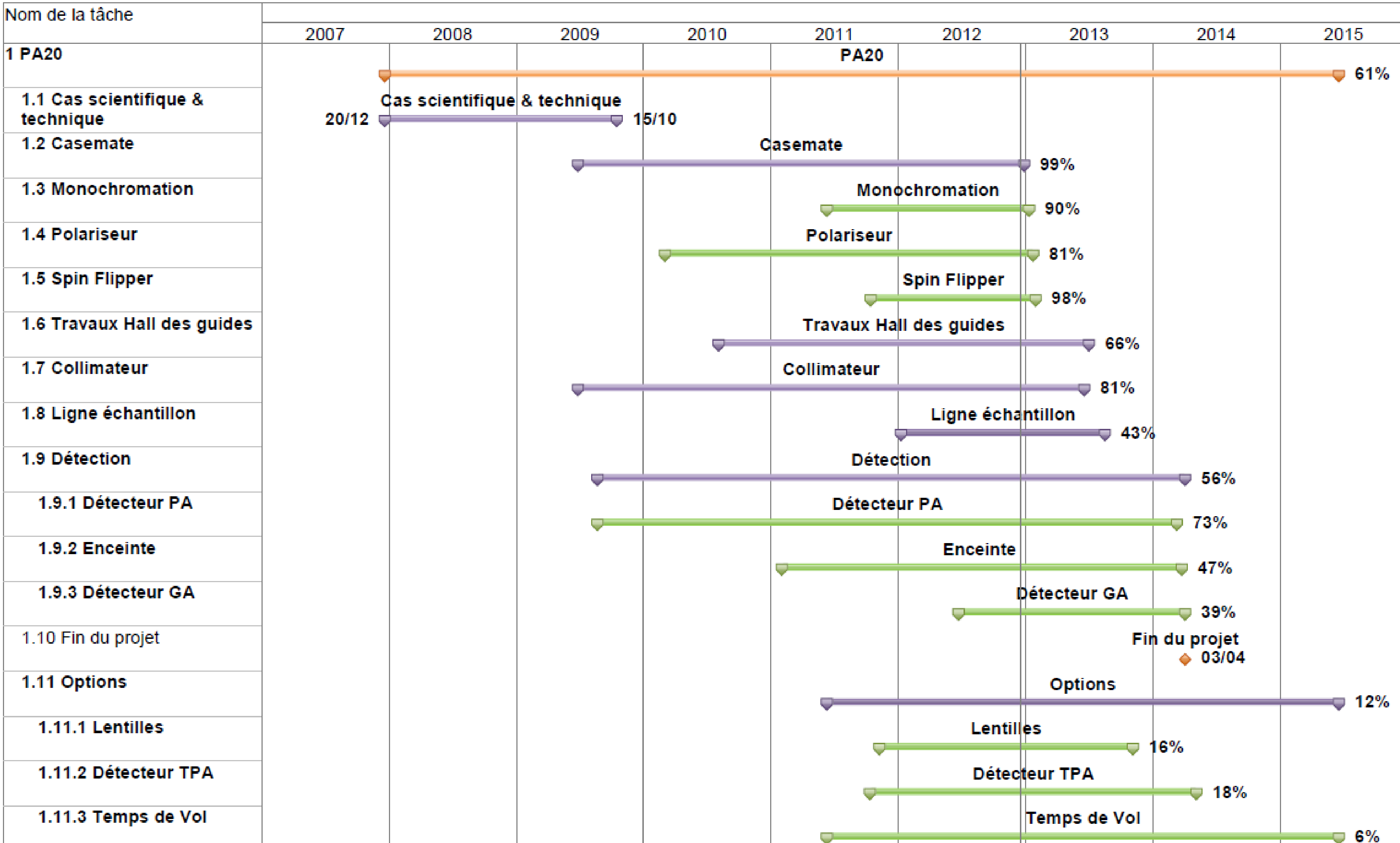
➔ All axes ready for FAT

➔ Plug'n Play when component is delivered

PROJECT MANAGEMENT

- Official team with steering comitee
- 1 lead Scientist + 1 lead Engineer
- Establish clear task allocation
- Compulsory periodic meeting
- Live planning

PLANNING


Nom de la tâche
2007
2008
2009
2010
2011
2012
2013
2014
2015
1 PA20
1.1 Cas scientifique & technique
1.2 Casemate
1.3 Monochromation
1.4 Polariseur
1.5 Spin Flipper
1.6 Travaux Hall des guides
1.7 Collimateur
1.8 Ligne échantillon
1.9 Détection
1.9.1 Détecteur PA
1.9.2 Enceinte
1.9.3 Détecteur GA
1.10 Fin du projet
1.11 Options
1.11.1 Lentilles
1.11.2 Détecteur TPA
1.11.3 Temps de Vol
PA20
61%
Cas scientifique & technique
20/12
15/10
Casemate
99%
Monochromation
90%
Polariseur
81%
Spin Flipper
98%
Travaux Hall des guides
66%
Collimateur
81%
Ligne échantillon
43%
Détection
56%
Détecteur PA
73%
Enceinte
47%
Détecteur GA
39%
Fin du projet
03/04
Options
12%
Lentilles
16%
Détecteur TPA
18%
Temps de Vol
6%

DE LA RECHERCHE À L'INDUSTRIE
cea

AKNOWLEDGEMENT

LLB Staff

Design office	P. Permingeat P. Lavie
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Motion control	F. Coneggo P. Lambert W. Josse G. Koskas
Call for tenders	S. Rodrigues
Technicians	M. Detrez S. Gautrot A. Helary
Scientists	G. Chaboussant J. Jestin A. Brûlet

TRIANGLE DE LA PHYSIQUE

NanoSciences ILE-DE-FRANCE

ISNIE

International

Society of

Neutron

Instrument

Engineers

You are welcome to join !

(sylvain.desert@cea.fr)

DENIM VII

7th Design and Engineering of Neutron Instruments Meeting 2018

DENIM 2018

16-19 September 2018 *Paul Scherrer Institut*
Europe/Zurich timezone

Overview

Programme Overview

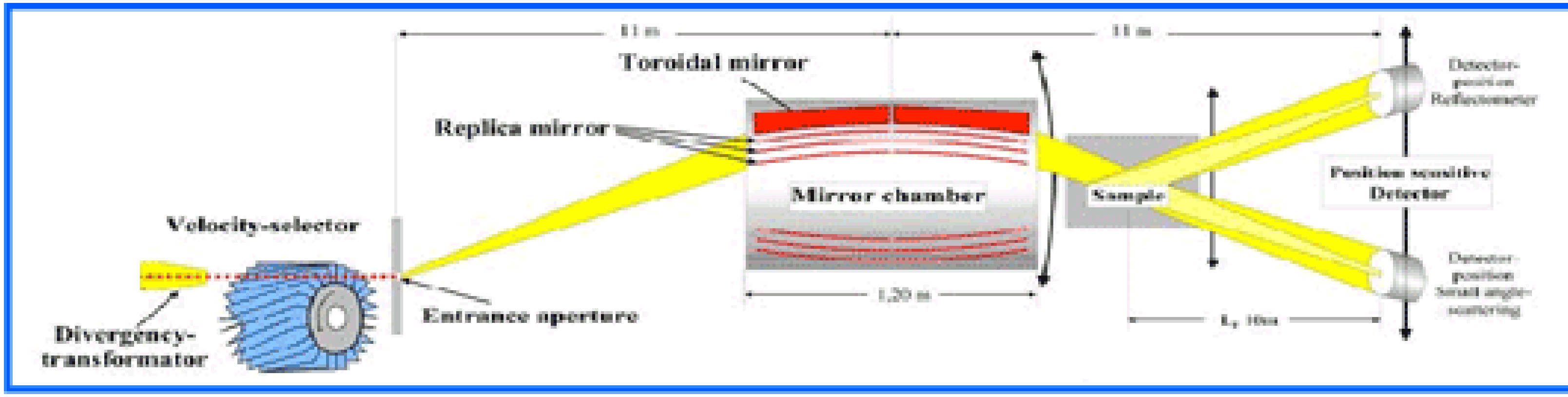
Timetable

We are pleased to announce that the 7th Design and Engineering of Neutron Instruments meeting will be held at PSI, Switzerland, from September 16 to 19, 2018. This will prove to be an essential conference for all engineers and technicians interested in the project management, design, specification, fabrication, acceptance testing, operation maintenance and upgrades of neutron scattering instruments. We look forward to seeing you in the heart of Europe next autumn.

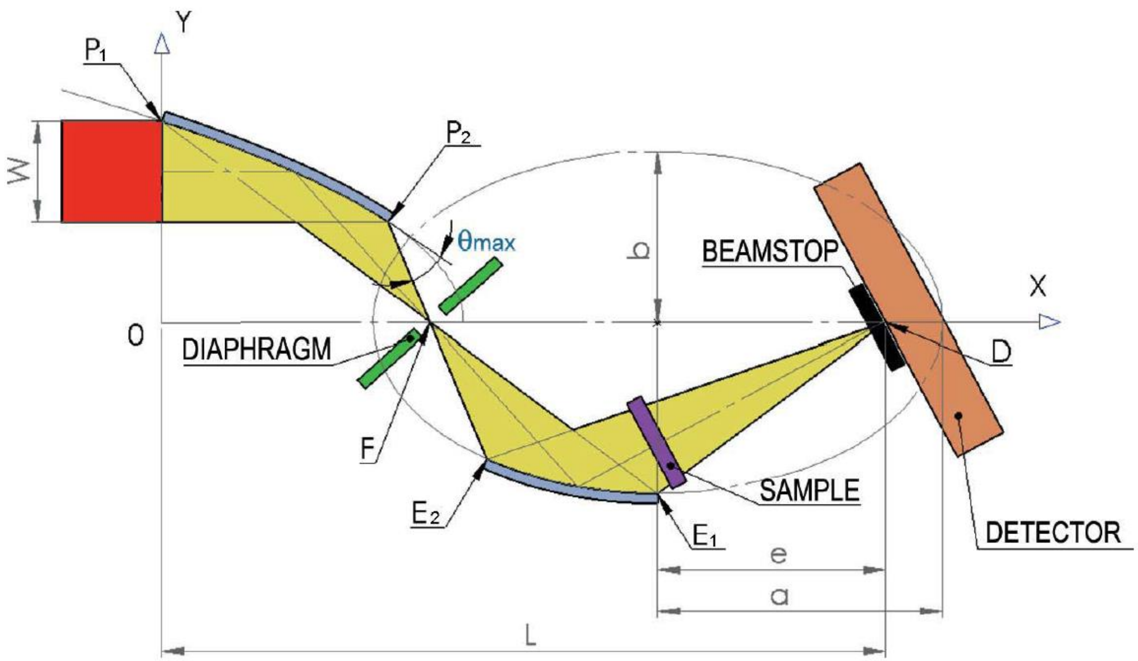
BACKUP SLIDES

MIRROR FOCUSING

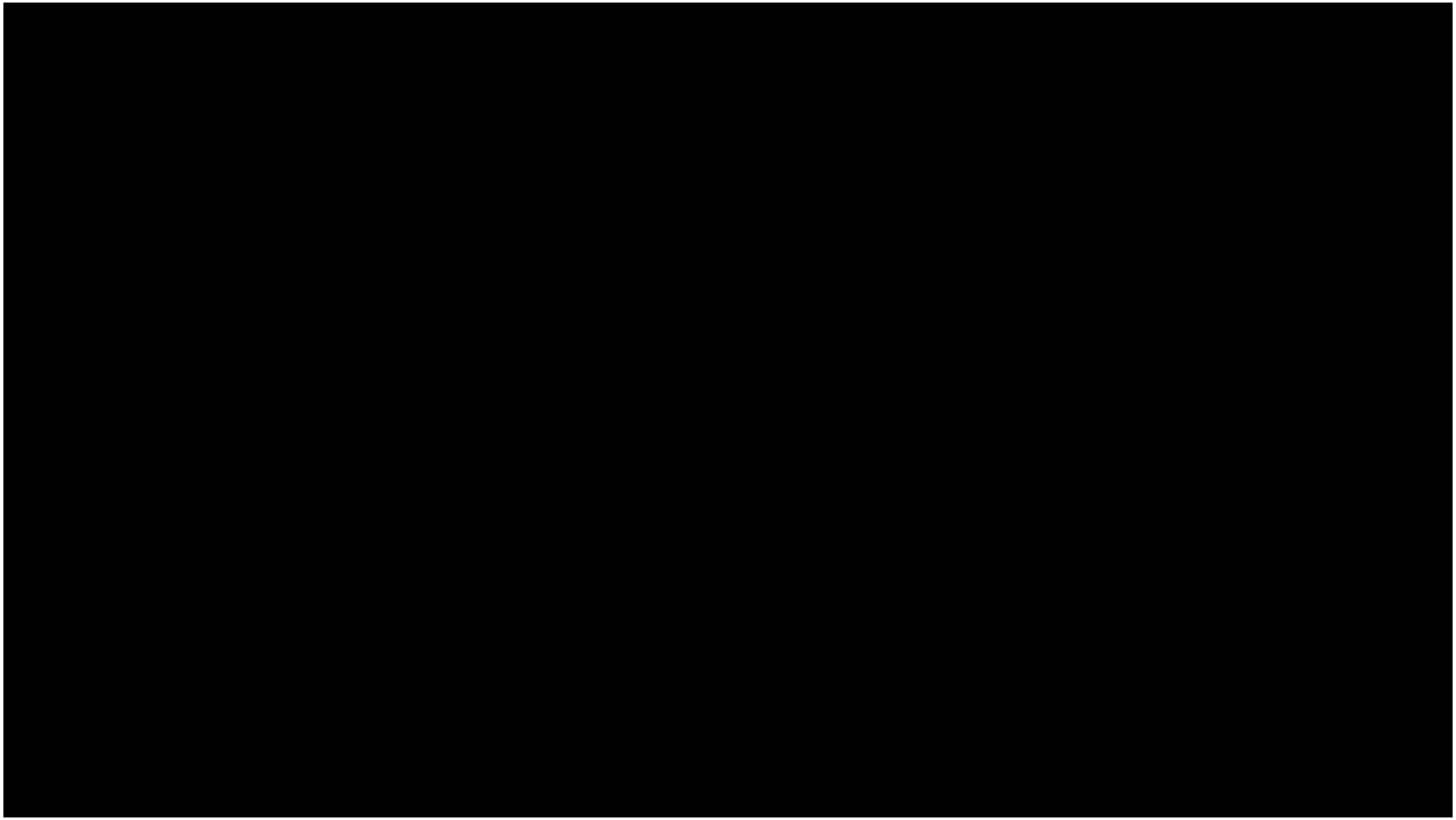
KWS3 @ FRM2



PARELLI concept



BEAMSTOP MOVIE

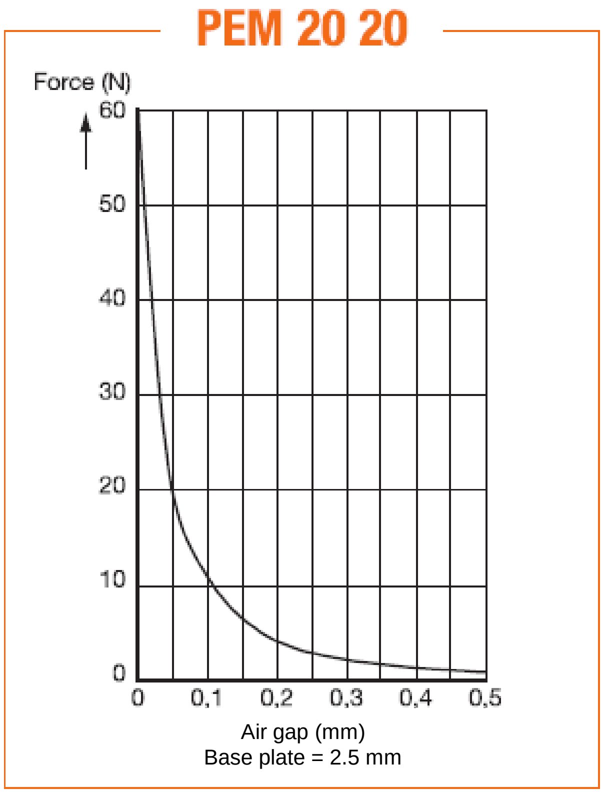


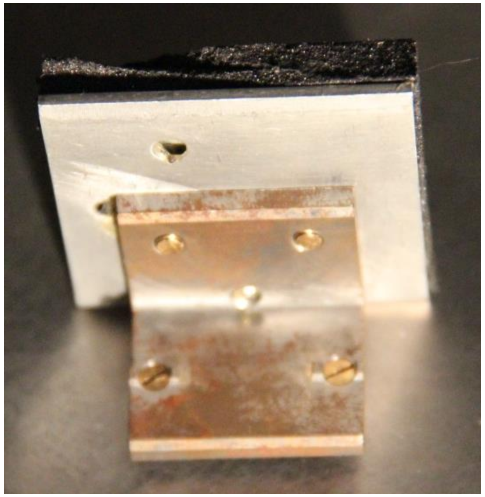
DETECTOR INSERTION

Electromagnet WITH permanent magnet

No current = magnetic field

Current = No magnetic field





B4C 5 mm
Al plate 2 mm
Steel mounting
BS weight 40-150 g

GUIDE FIELD - CALCULATION

Adiabatic rotation without loss of polarization:

$$\omega_L > 10.\omega_B$$

$\omega_L = \gamma * B$ Larmor precession frequency

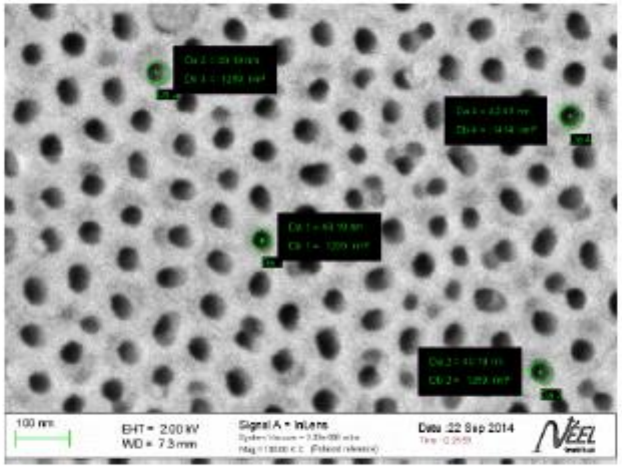
$\omega_B = v\frac{d\theta_B}{dy}$ Angular magnetic field rotation

$$\frac{d\theta_B}{dy} < 2.65B\lambda$$

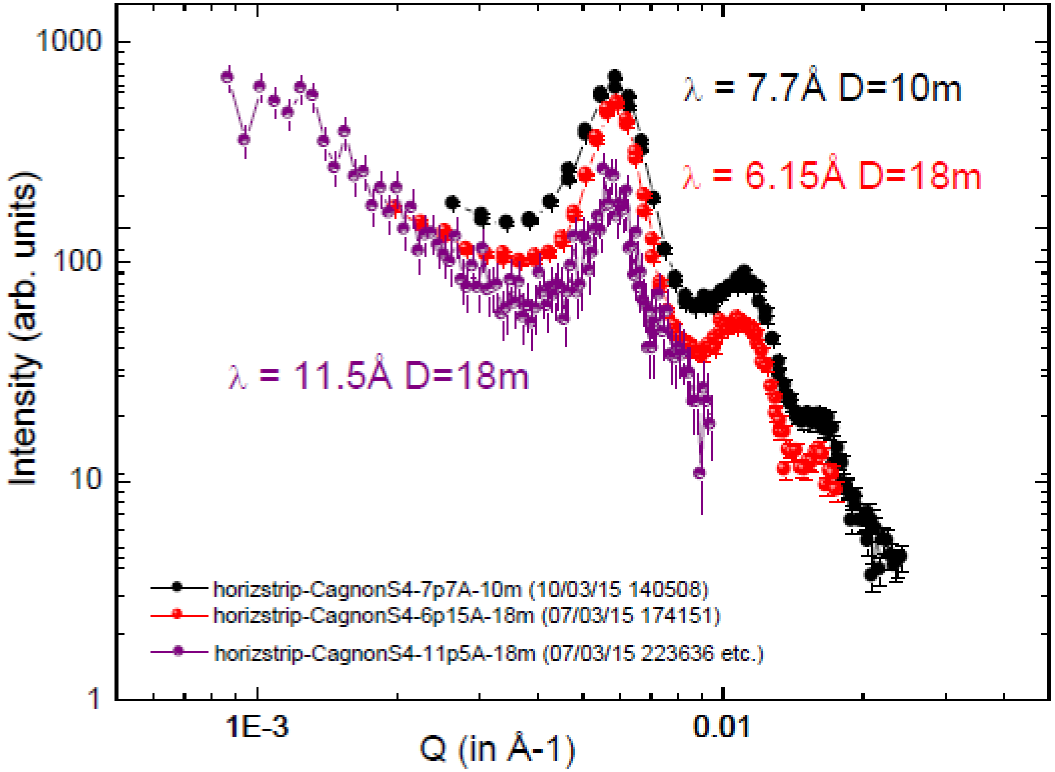
θ_B [°]
dy [cm]
B [mT]
λ [Å]

$\omega_L > 22.\omega_B$ @ λ = 4 Å

First Results / SANS

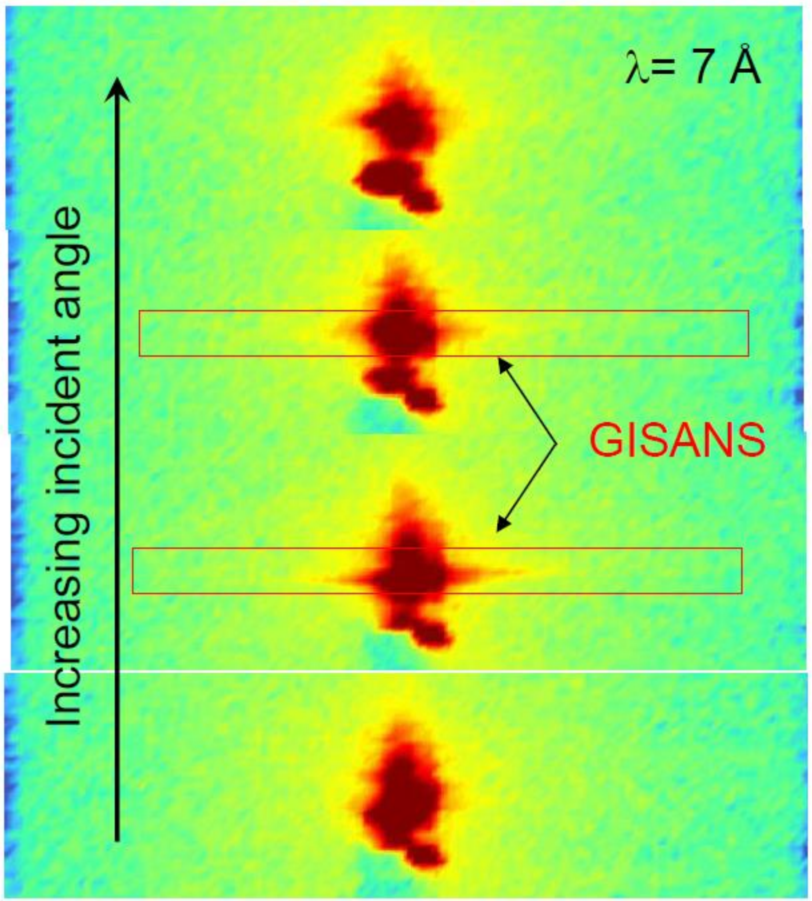


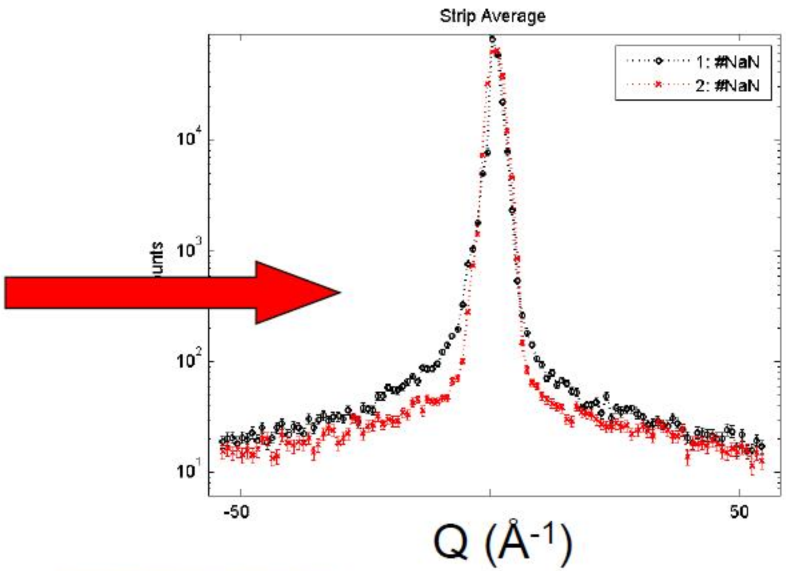
Spacing : 100 nm
Pore size : 40 nm

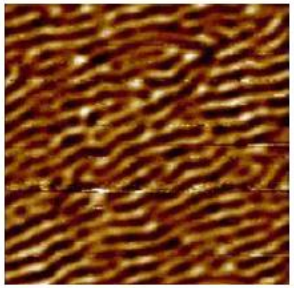


First Results / GISANS

GISANS on nanostructured $CoSiO_2$ / Si wafer

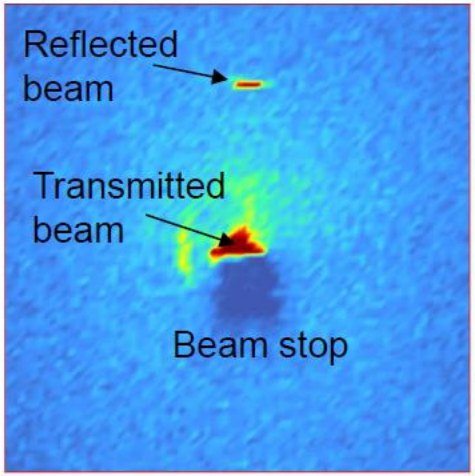


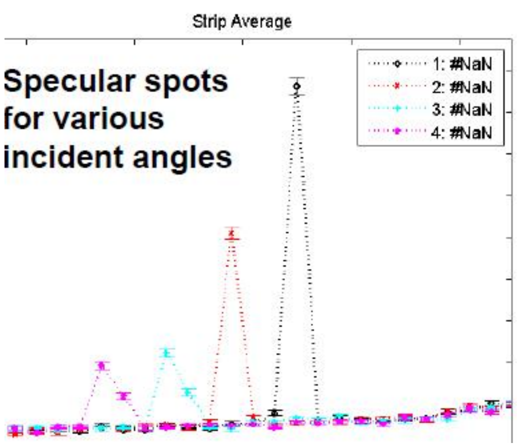




« domain » formation
length scale : 125 nm

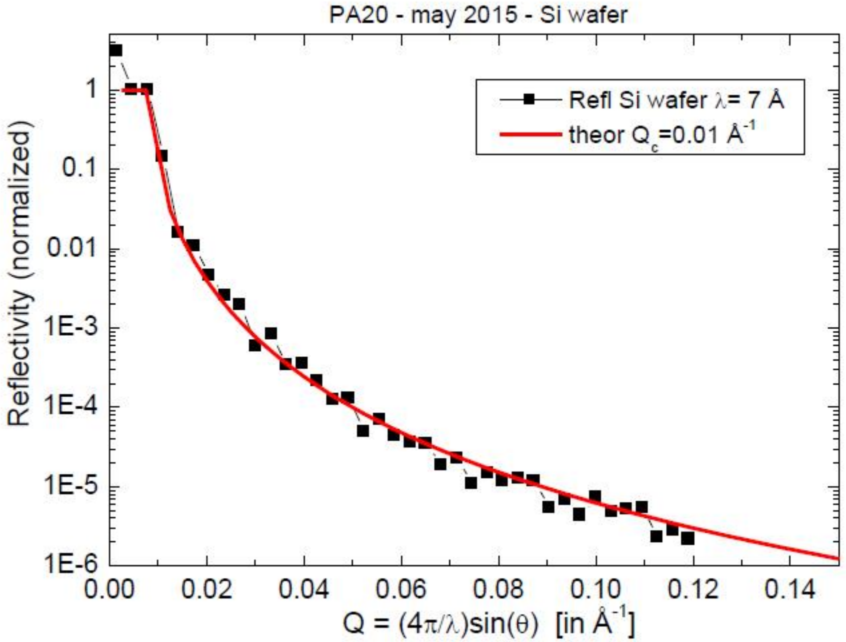
First Results / GISANS





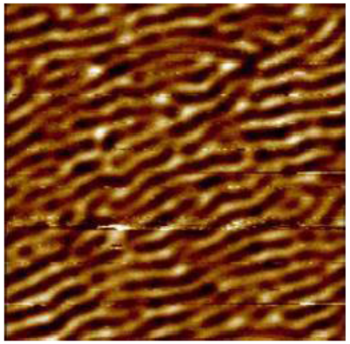
Reflectometry on a Si wafer

λ= 7 Å
Collimation : 2m
Diaphragmes : 1mm*25mm



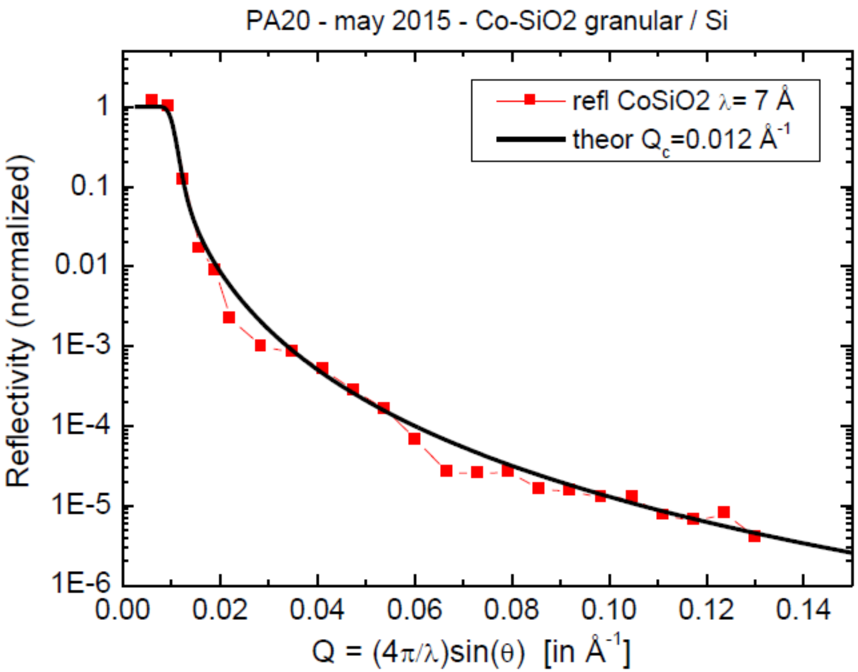
First Results / GISANS

Reflectometry on on nanostructured $CoSiO_2$ / Si wafer



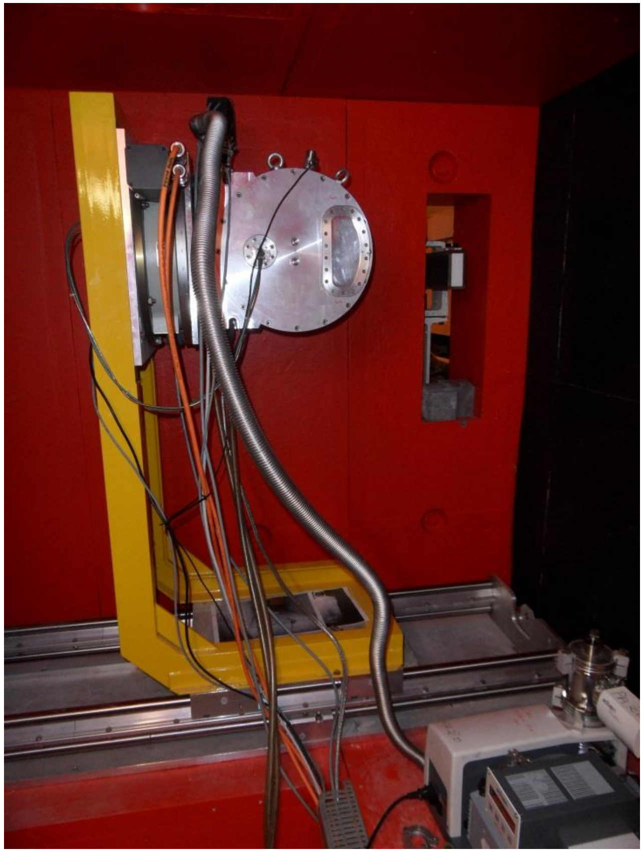
presence of weak stripe domains in the superferromagnetic phase

λ= 7 Å
Collimation : 2m
Diaphragmes : 1mm*25mm



VELOCITY SELECTOR

Telescopic support for maintenance

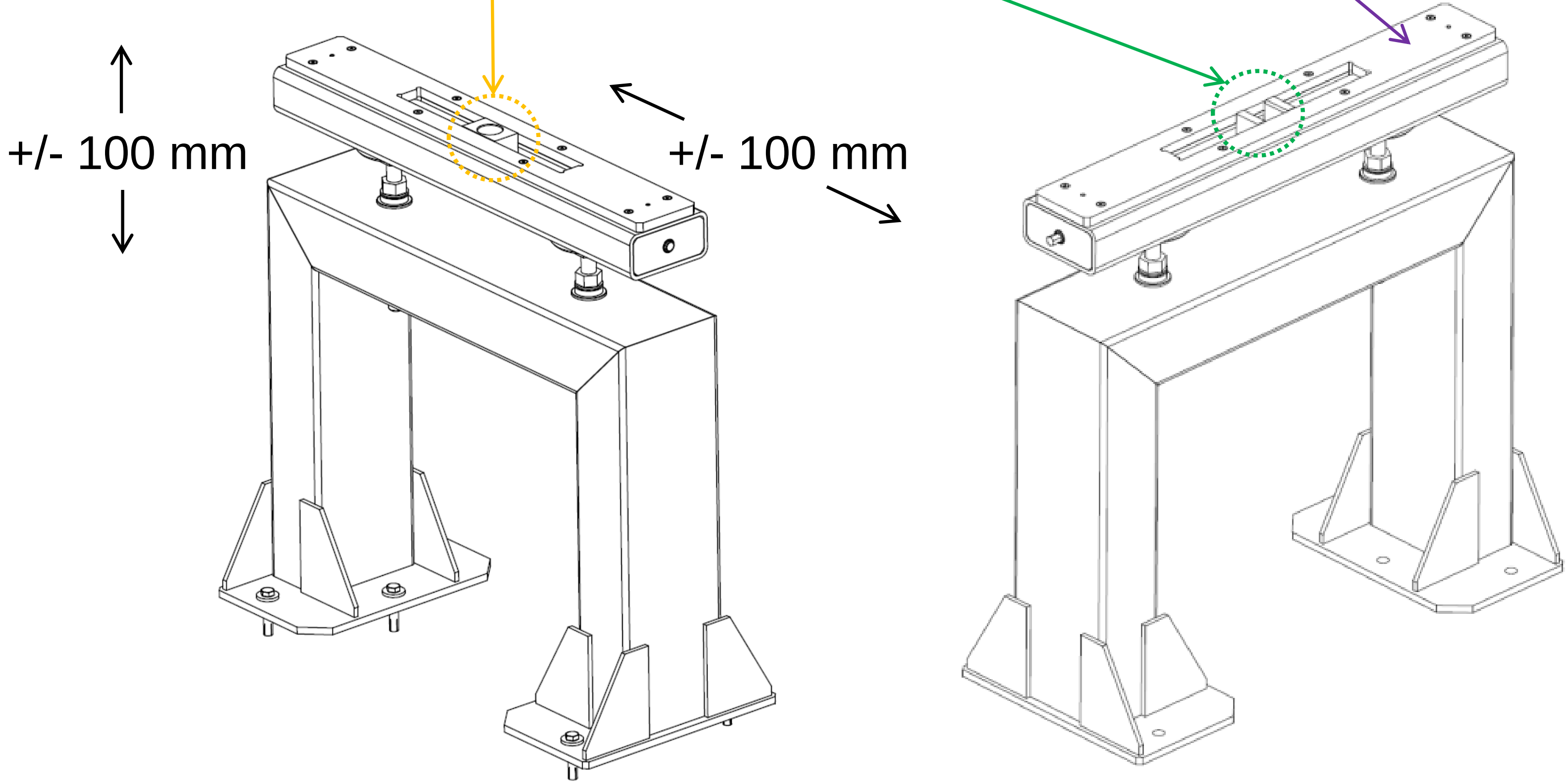


No vibration

SUPPORTS

Unconstrained move:

- Low friction coefficient with Teflon plate
- Cylindrical / Square index footprints



FAST NEUTRONS

- ✓ Upward guide removal => fast neutrons passed
- ✓ Rotation of 6m guide length (25 mm translation at casemate entry)