Detector development in Europe

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The EU's Research Framework Programme (FP) is the EU's main instrument for research funding in Europe.

The TECHNI (Technology for Neutron Instrumentation) RTD project in FP5 (2000-2004) aims at developing new detectors and optical devices to improve the instrumentation of European neutron facilities.

A majority of the projects in TECHNI concern detectors.

Partners of TECHNI involved in detector development

HMI (Germany) : MSGC, Si-MSD
ILL (France) : MSGC, GEM, MWPC, PSPC, GSPC, Solid Scintillators, Image Plate
ISIS (UK) : Solid Scintillator, PSPC
Juelich (Germany): Image Plate
LIP (Portugal) : GSPC
Saclay (France) : Micromegas, MSGC
SOREQ (Israel) : Boron rich liquid scintillator
TU-Delft (Netherlands) : Scintillators, GEM, MSGC
Univ. Heidelberg (Germany) : Cascade
Univ. Milano (Italy) : Gamma detector for epithermal neutrons
INFM Perugia (Italy) : Si-MSD

MSGC: Micro Strip Gas Chamber ; Si-MSD : Silicon Micro Strip Detector ; GEM: Gas Electron Multiplier ; MWPC: Multi Wires proportional Chamber ; PSPC: Position Sensitive Proportional Counter ; GSPC: Gas Scintillating Proportional Chamber

More information about TECHNI → http://www.isis.rl.ac.uk/techni/

FP6 - Integrated Initiative Infrastructure (I3)

FP6 starting in 2005 = 16 260 M€

→ Integrated Initiative Infrastructure (I3) = 255 M€

I3 bring together transnational access, joint research projects, and cooperation networks for a common class of facilities (neutron scattering, lasers, …etc)

→ NMI3 (Neutron and muon Integrated Initiative Infrastructure) = 9.6 M€

Coordinator : Robert McGreevy

More information about FP6 → http://www.cordis.lu/fp6/infrastructures.htm
More information about NMI3 → http://www.isis.rl.ac.uk/nmi3/

Joint Research Projects in NMI3

~ 300 k€/Year/JRP
~ 6 partners/JRP
duration 4 years

Detectors
Optics
Polarisation
Fast Turning devices
Sample Environment
Software
Deuteration
Ultra Cold neutrons
Muons

SELECTION

- Existing working groups (for instance TECHNI for detectors and optics) have provided summaries of possible generic work
- All facilities have identified their priorities
- The approach taken to JRP is to concentrate on development of generic components of instruments. Development of generic parts of instruments offers a potential overall gain to a significant proportion of European instrument park.

Observers in NMI3

Observers will attend JRP meetings in order to learn about the results, and to contribute their expertise.

Observers are clearly future possible JRA partners.

There is a strong common interest and clear advantage in collaboration between Europe, USA and Japan.

Coordination is assured by American and Japanese representatives on the NMI3 General Assembly.

In order to protect IP rights all partners should clearly sign the same consortium agreement.

3 Detector projects in NMI3

	Detection features	Deliverable
DETNI Detectors for neutron instrumentation Partners: TU-Delft, Heidelberg, HMI, INFM, Juelich, UMM Observers: BNL , PSI	**Thin layer converter** with … a) Si-MSD and b) Low-pressure MSGC ; c) Multi-layer or gas converter with GEM Position resolution 100 μm (1 mm with GEM) Sensitive area 20 cm x 20 cm Detection efficiency > 50% Time resolution <1 μs count-rate 10^6/sec local, 10^8/sec global Gamma sensitivity < 10^{-7} for ^{60}Co energies (1.17; 1.33 MeV)	Full-size module of each one of the techniques a), b), and c) developed and tested. Front-end ASICs
MILAND Millimetre Resolution Large Area Neutron Detector Partners: FRM-II, GKSS, ILL, LIPC, LLB Observers: BNL, SNS, Univ. Tokyo	**3He converter** with a) counting mode charge readout (MWPC+Micro Strip cathode), … or b) integrating mode light readout (MSGC or GEM) Position resolution 1 mm Sensitive area 40 cm x 40 cm Detection efficiency > 50% Count-rate 10^5/sec local, 10^6/sec global @ 10% DTC Gamma sensitivity < 10^{-8} for ^{60}Co energies (1.17; 1.33 MeV)	Full-size module of either a) OR b) technique operational. Equiped with Front-end ASICs (charge readout) OR CCD camera (light readout). Transferable to the Industry.
LARGDET Large Detectors for condensed matter and biology Partners: BNC, DEMO, ILL, ISIS, LLB	**3He converter + MSGC, or Solid Scintillator + PM** Modularity without dead space Position resolution 2.5 mm Sensitive area 33 cm x 33 cm	Low cost module which can be assembled in all directions without dead space. Transferable to the Industry.

Examples of running instruments in Europe based on recent detector developments

Solid scintillator detectors
SXD, GEM, HRPD and ENGIN-X

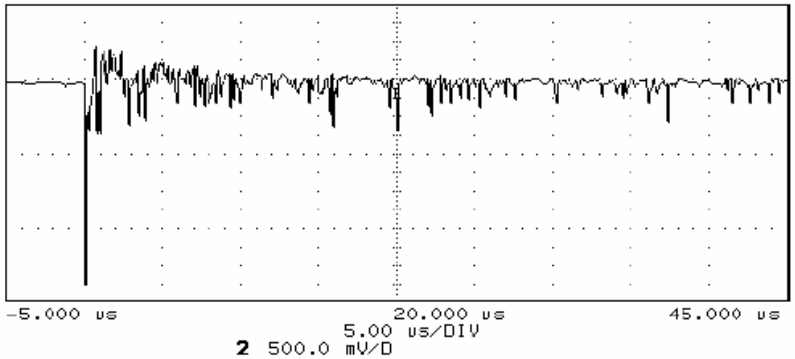
3He detectors D20, D19 and D4 : MSGC
D16 *and D19 (in 2004)* : MWPC
D22 (in 2004) : PSPC

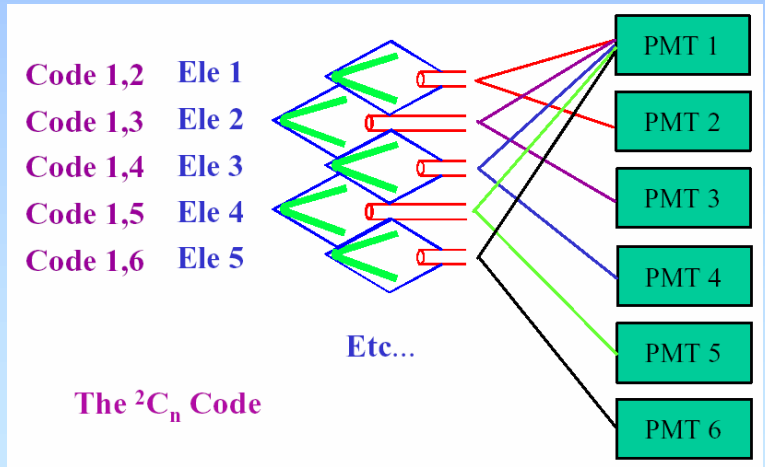
Integrating devices like Vivaldi (Image Plate) are also working very well

Electronics

Encoding : Coincident pairs of PMT outputs determine origin of a single neutron interaction
120 elements → ^2C_n coding to 16 PMT

Neutron discrimination : if the number of photoelectrons measured by the PM in Δt is > n, then the event is recorded.
→Better counting stability with T° (0.1%/°C)





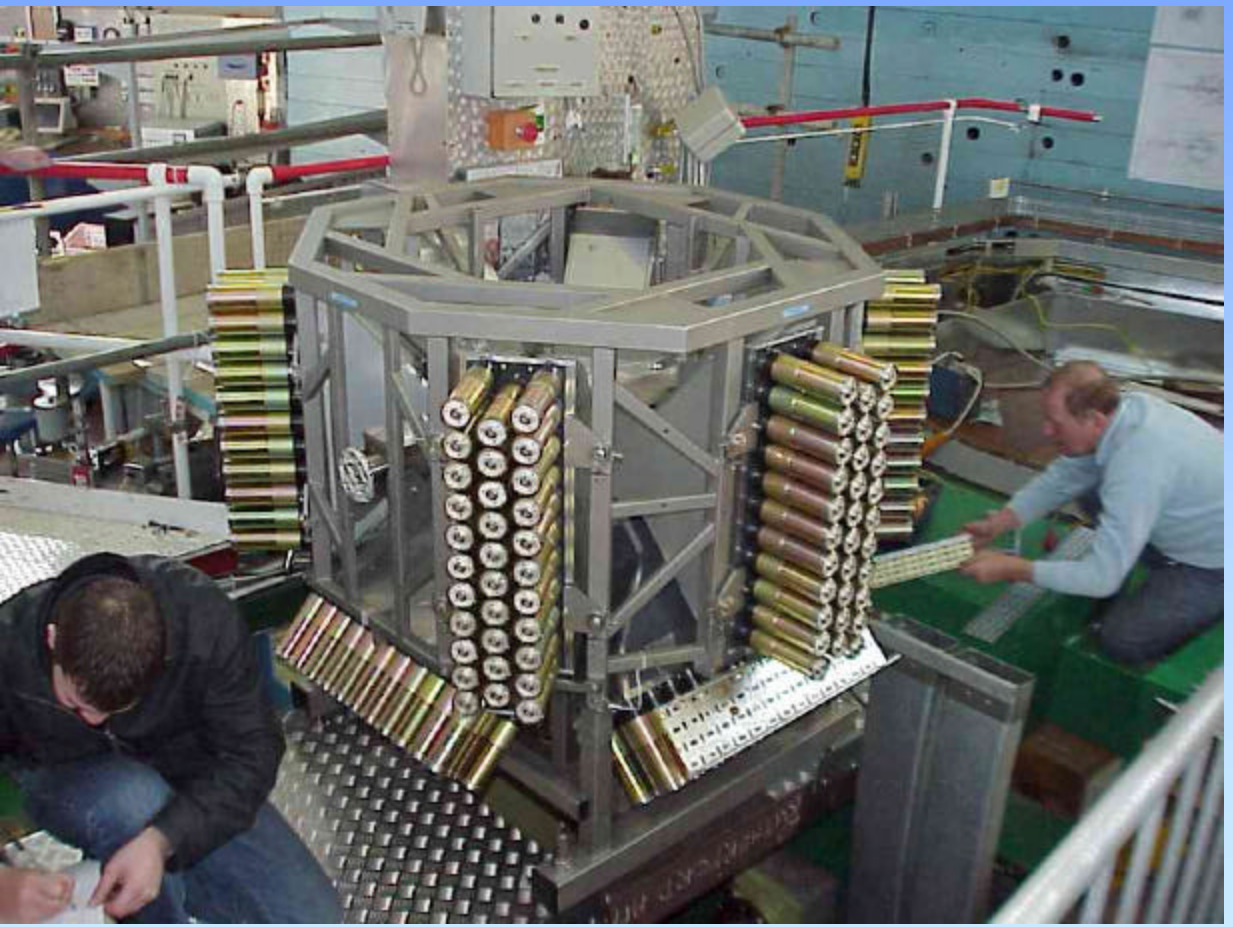
GEM

GEM can be used to perform high intensity, high resolution experiments to study the structure of disordered materials and crystalline powders

To meet both the scale and delivery time requirement, production of fibre optically encoded heads has been transferred to outside manufacturing companies

Angle range from 5° to 170°
Area 10 m2
5 mm position resolution
6550 detector elements in 75 modules.
660,000 individual optic fibres, whose total length is about 350 kilometres.

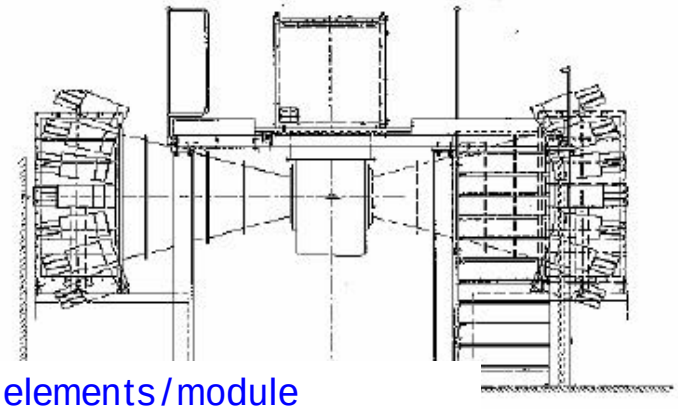
ISIS SXD



Incident wavelengths 0.2 - 10Å
11 Position-sensitive detectors with 192 × 192 mm2 active area and 3 × 3 mm2 resolution

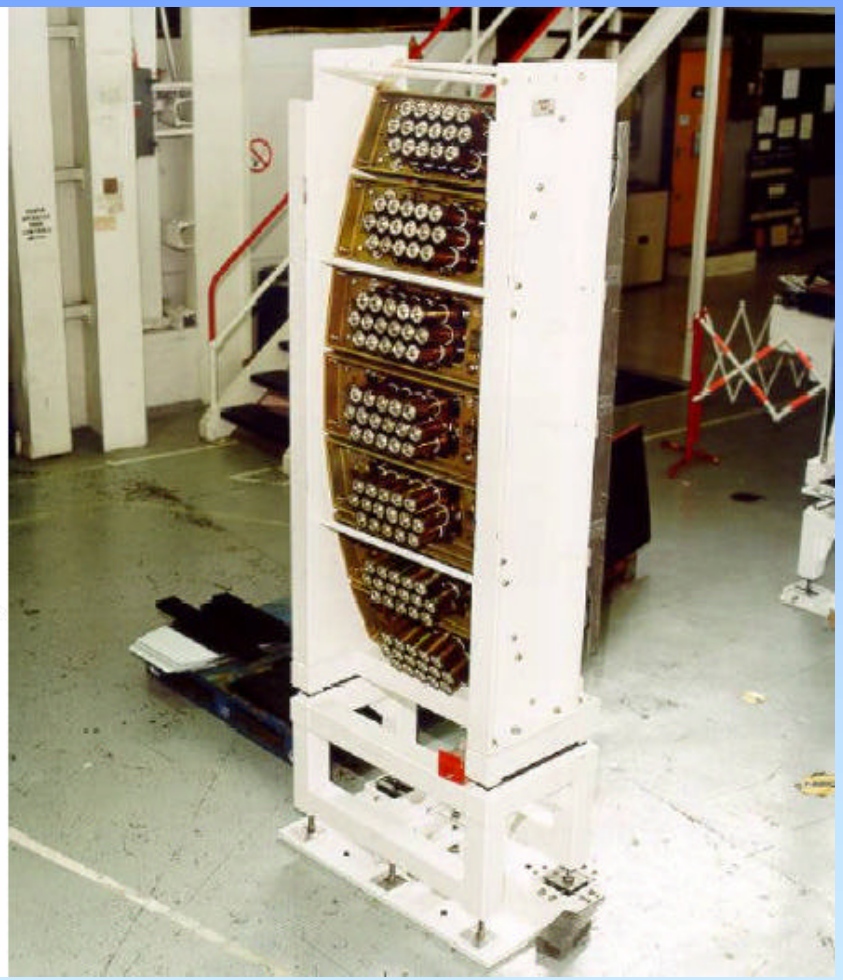
HRPD

Layout of the 14 HRPD 90° detector modules



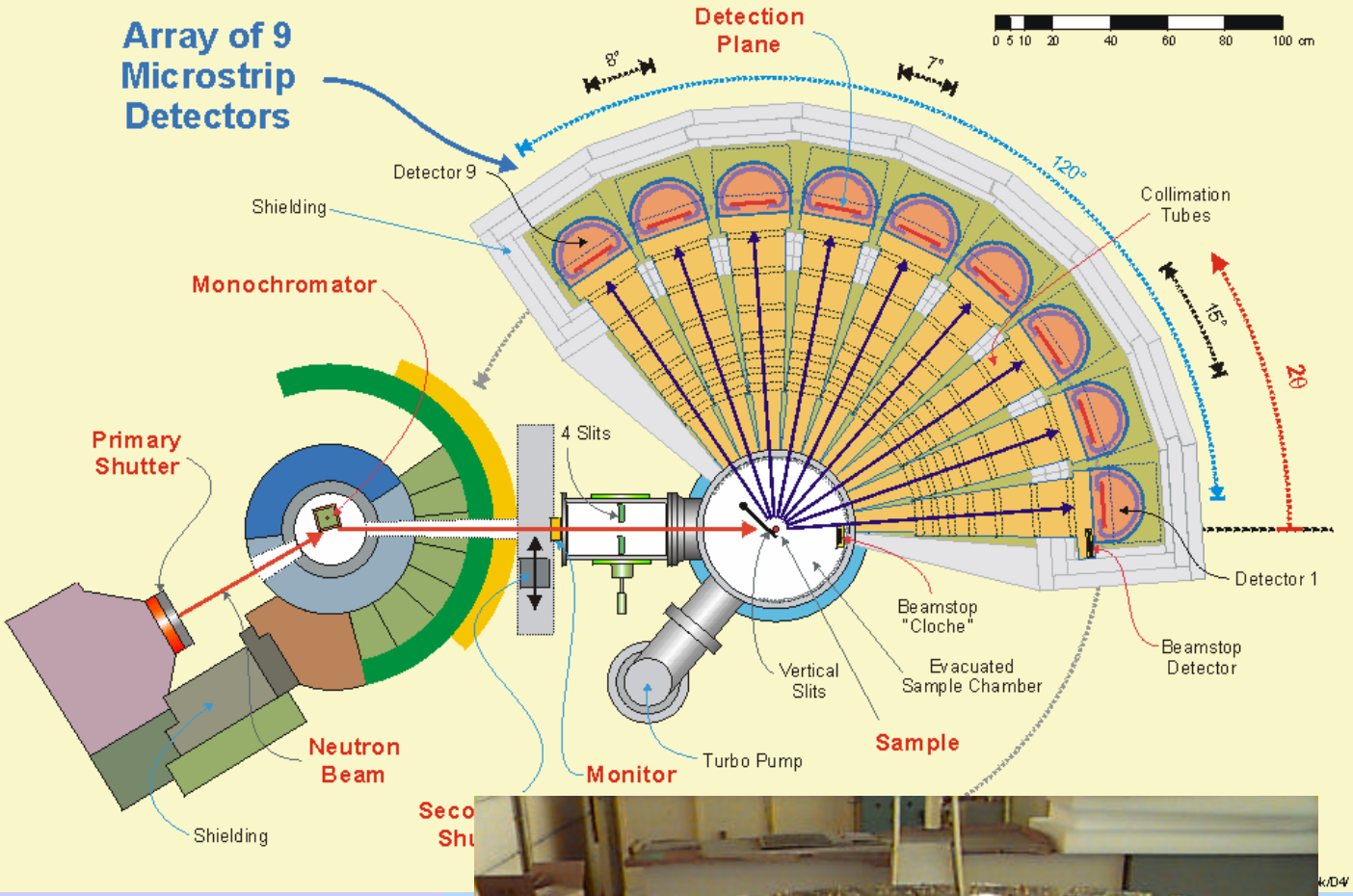
120 elements/module
One element = 5 mm x 200 mm
Total area = 1.68 m^2

The north bank ready for assembly



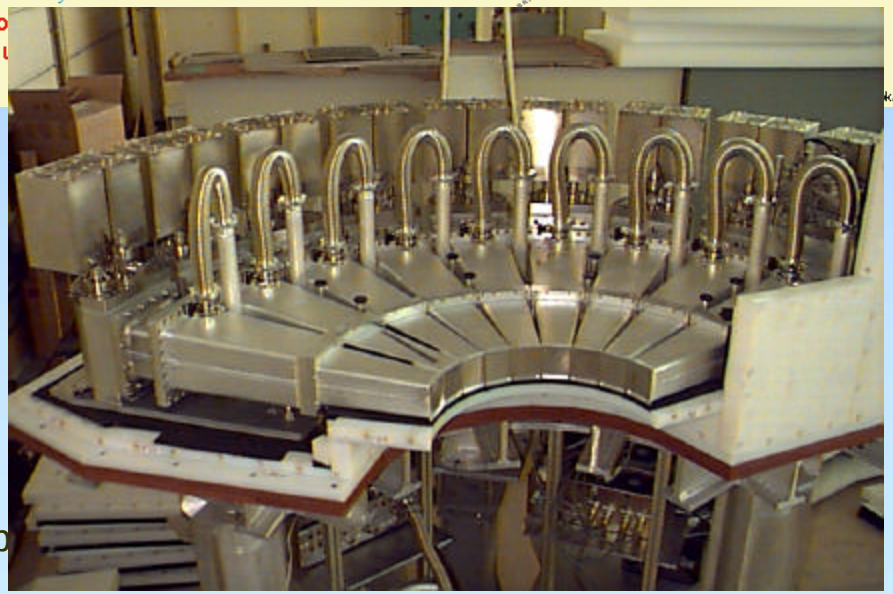

D20
Angular coverage : 160° x 5,8°
Angular resolution : 0,1°
working since July 2000

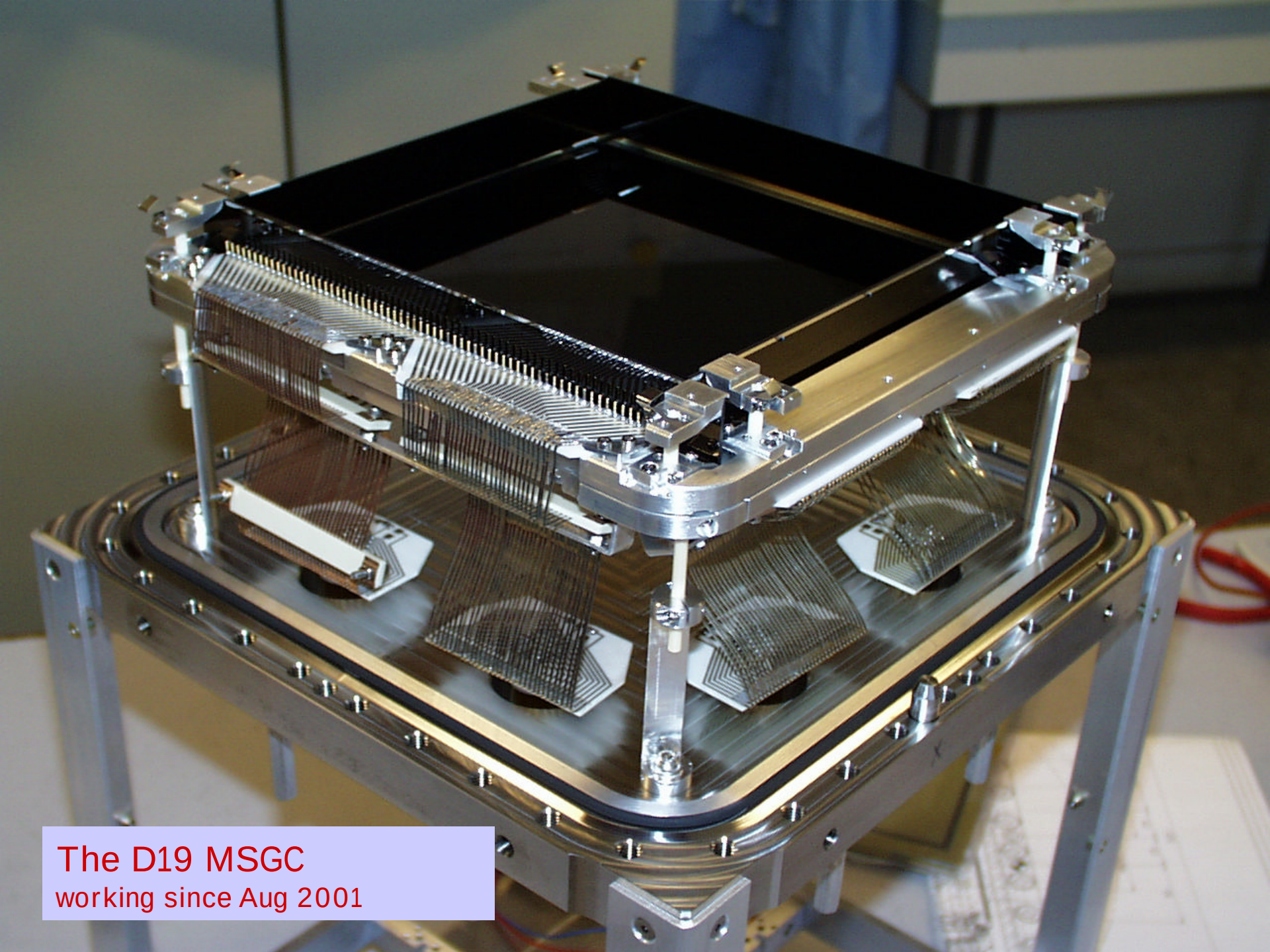
D4
Modularity & high efficiency

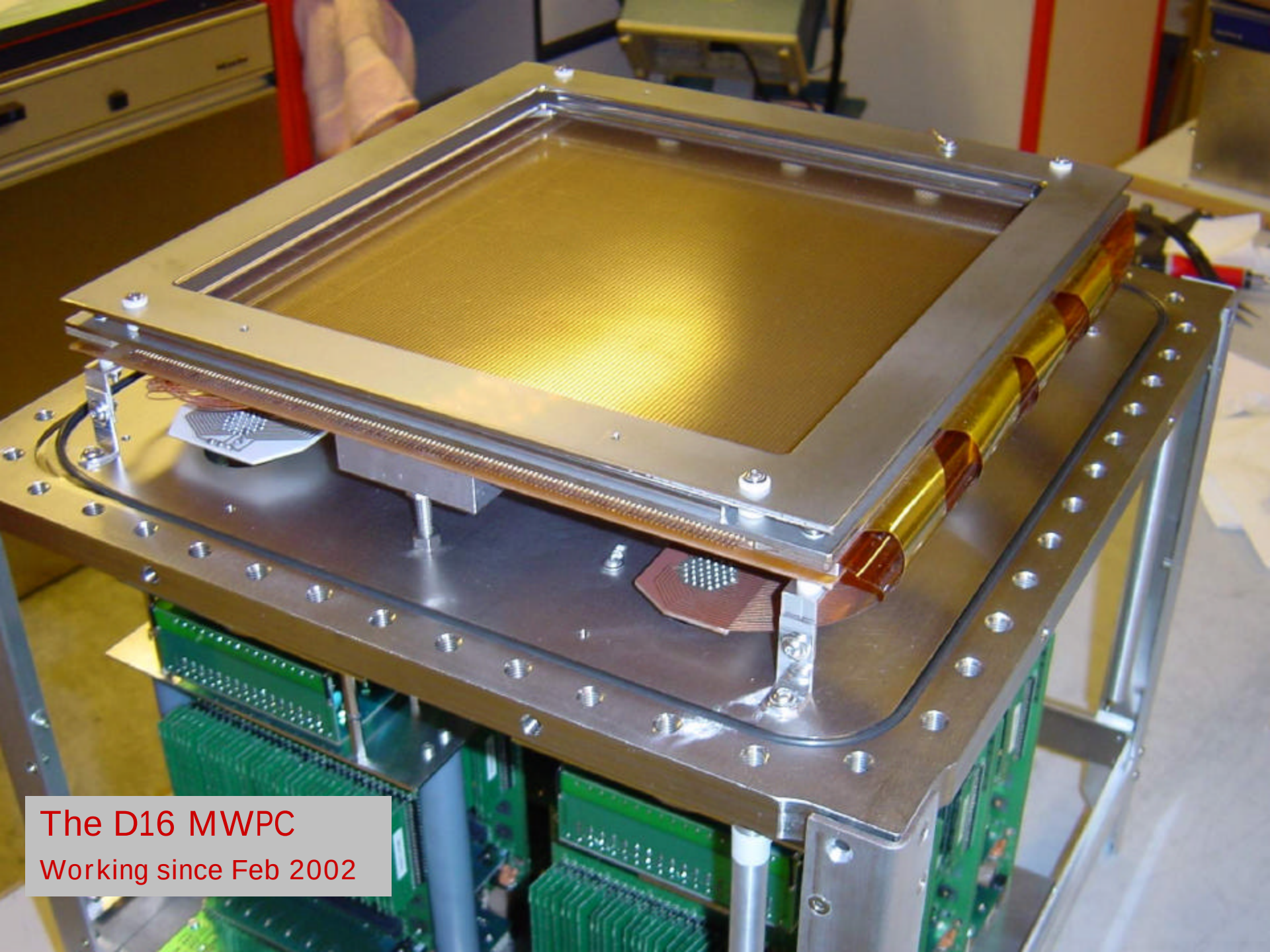


Aperture : 145° (2 scans) x 10 cm height
Position resolution : 2.5 mm
Absorption gap : 30 mm
Gas pressure : 15 bars 3He + 0.3 bar CF4
Detection efficiency : 90% (@ 0.7 angstroms)
Counting rate : 50 kHz/cell

working since September 2000

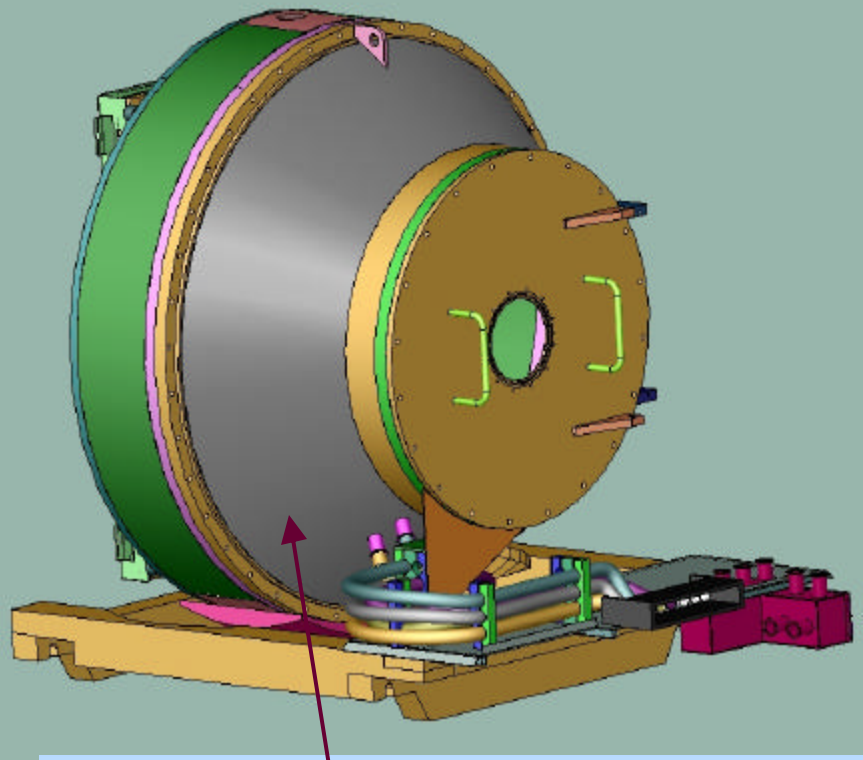



The D19 MSGC
working since Aug 2001

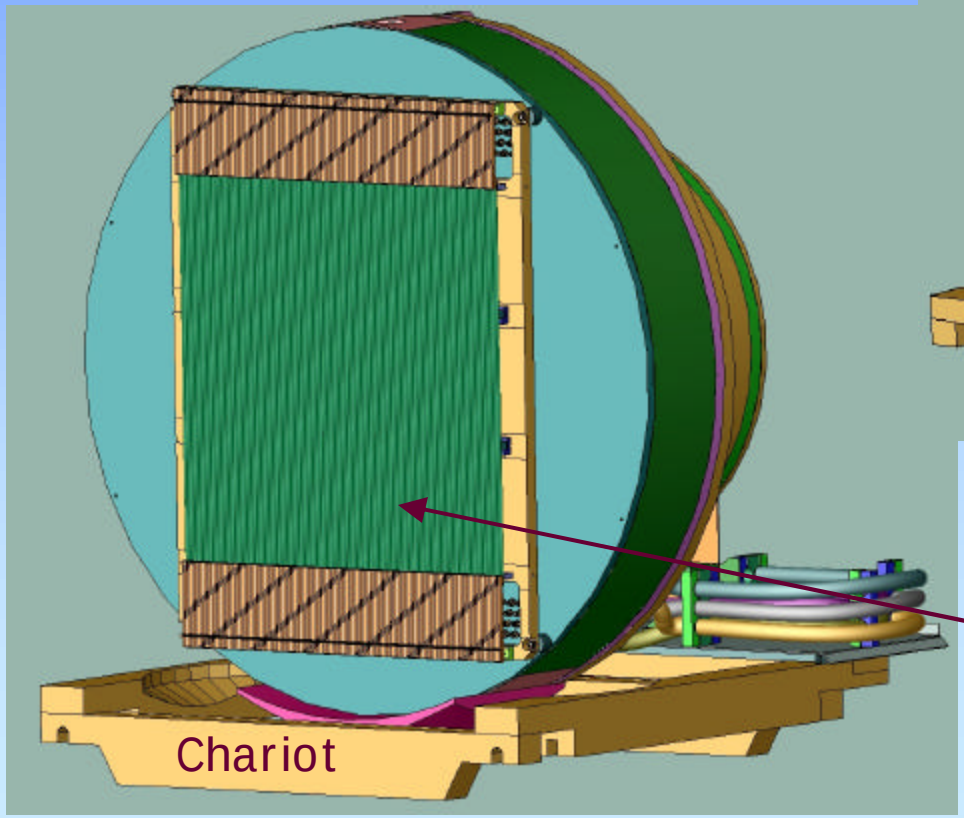

The D16 MWPC
Working since Feb 2002

Fast detectors for SANS : D22

Useful area = 102 cm x 102 cm
128 PSPC 7.95 mm diam,
104 cm detection length



Electronics vessel

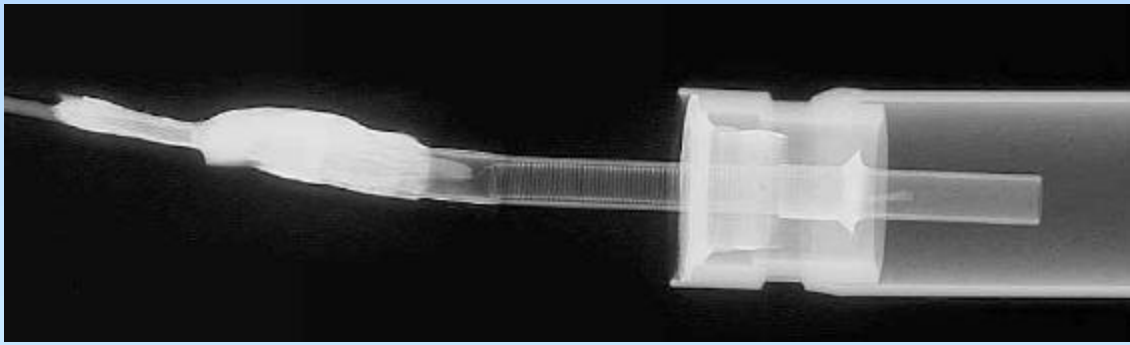


Reuter Stokes
detectors (in vaccum)

Prototype results

Spatial resolution (FWHM) :
6 mm at 10 kHz
9 mm at 100 kHz
Dead time = 1.4 µs
Count-rate = 70 kHz/tube @ 10% correction

8 of the 16 detectors were damaged due to unsuitable springs used to attach the anode wires.
All detectors will be radiographied.

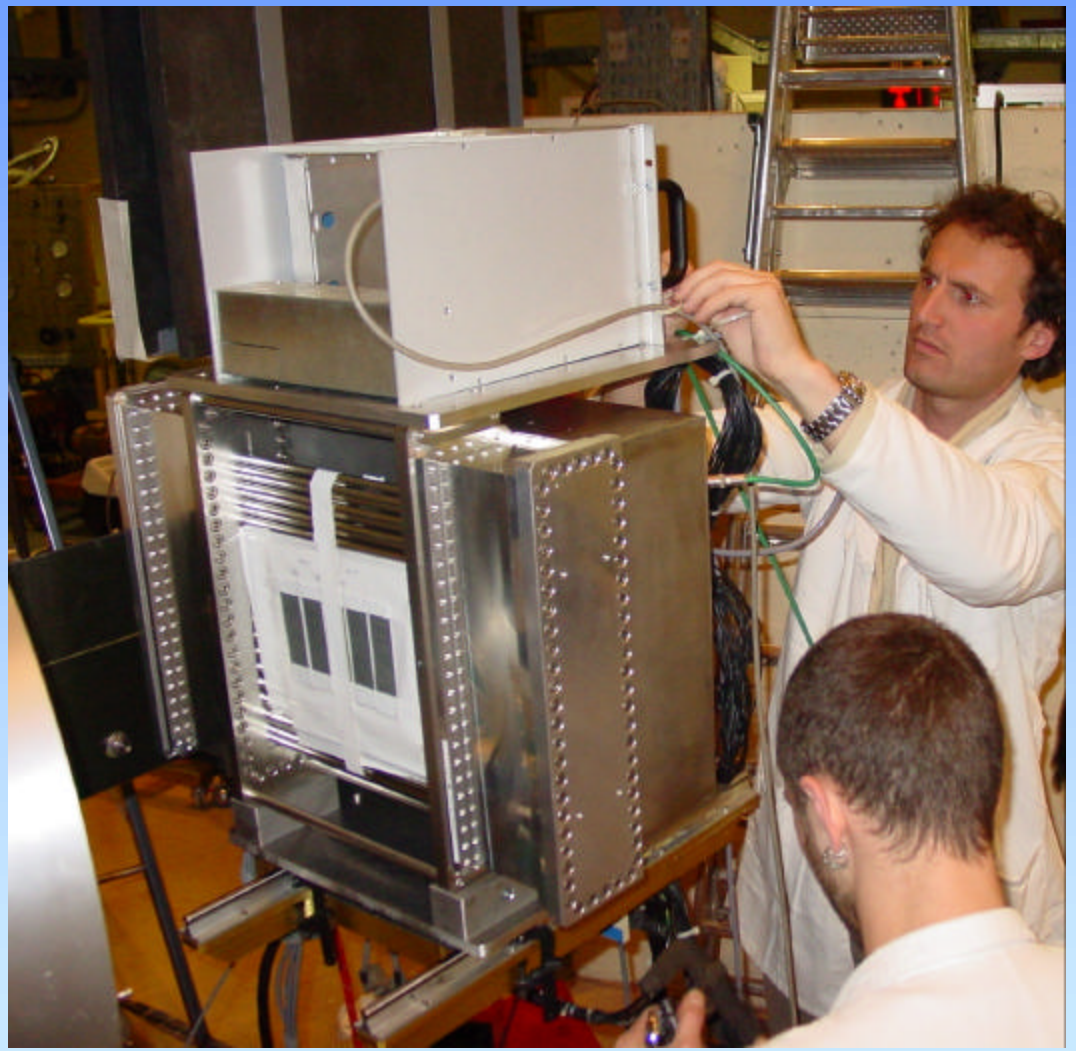


The MT32 Multitube

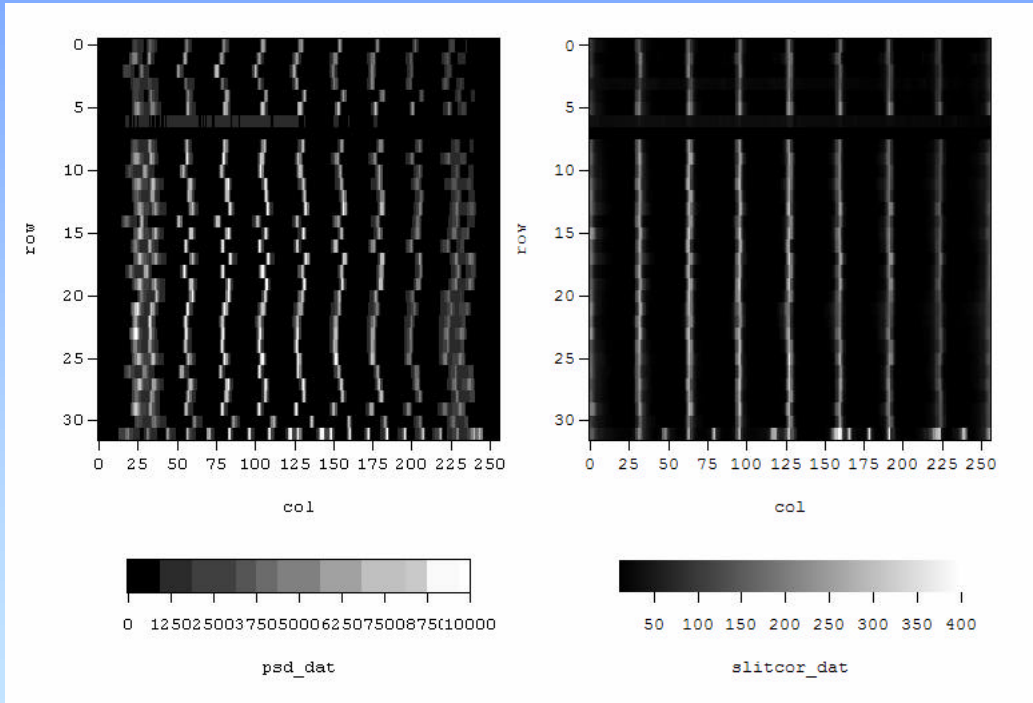
32 tubes 10 mm diam
+ 4 tubes 6.3 mm diam

25 cm long

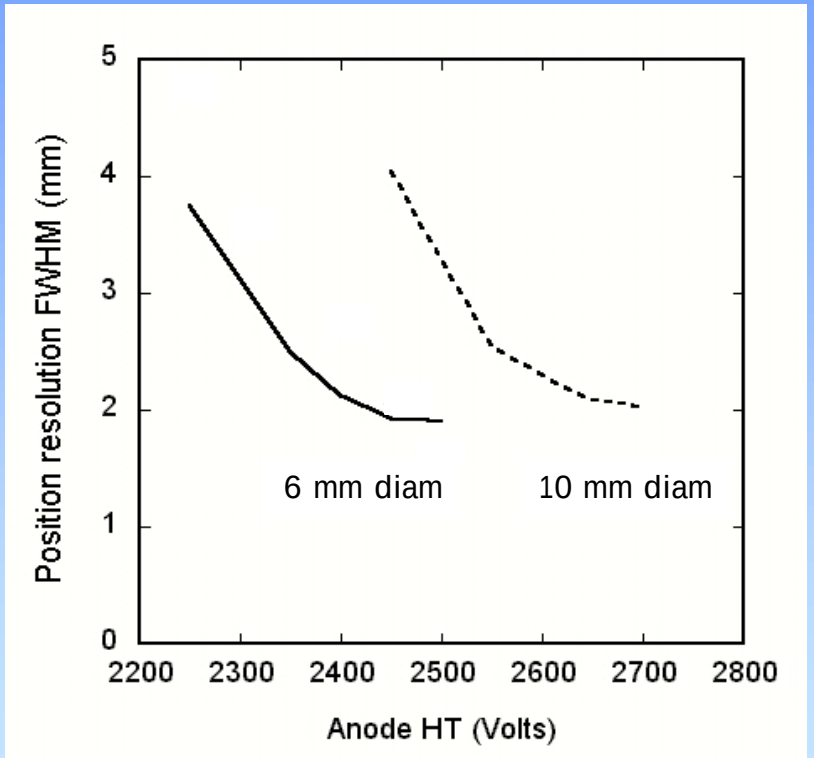
in zigzag every 9 mm



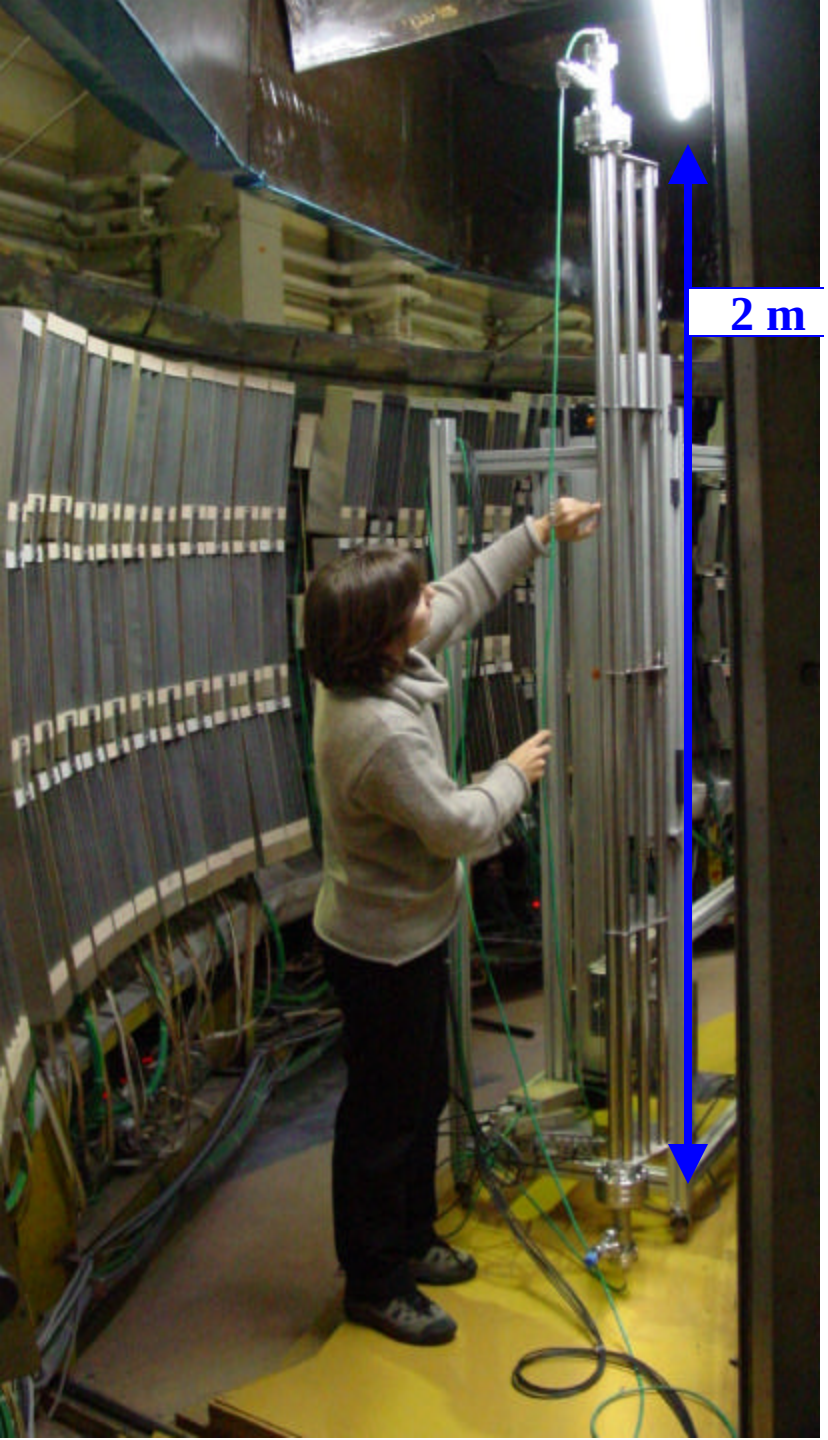
MT32 : results from Saclay

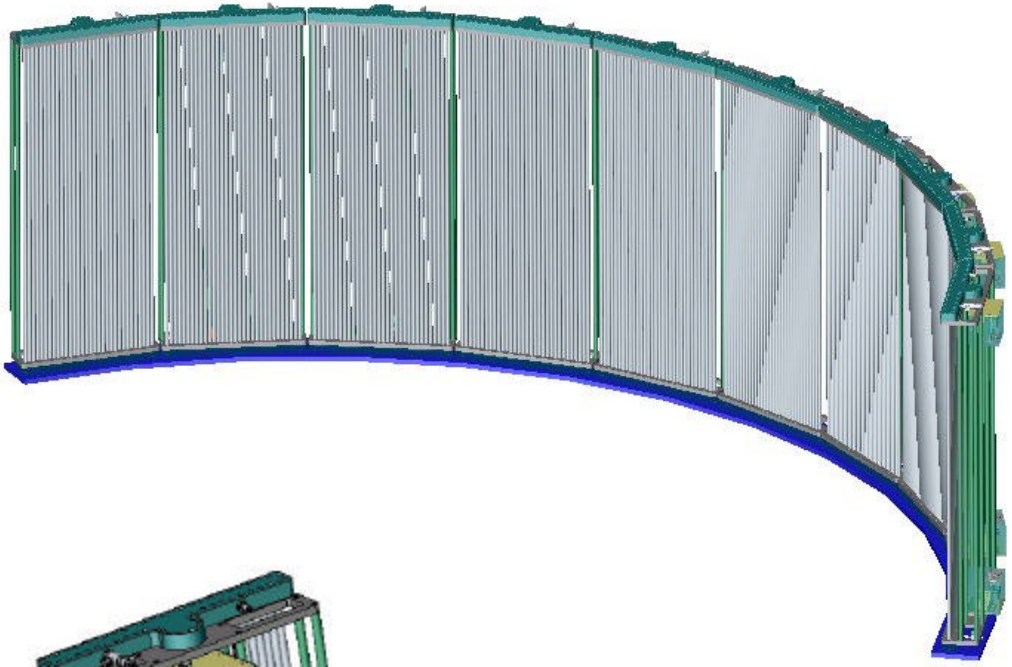


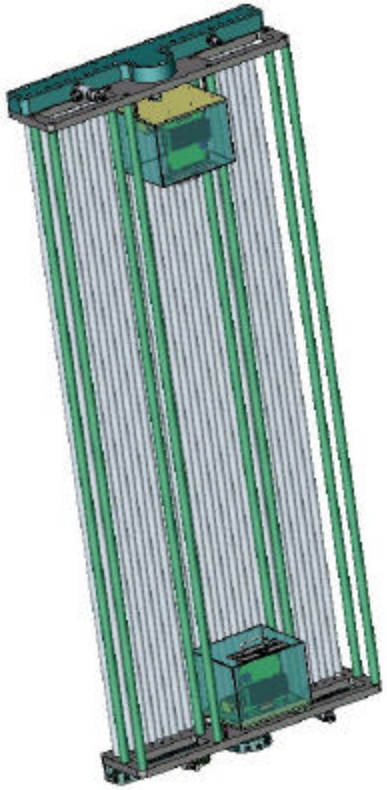
Position calibration



Position resolution



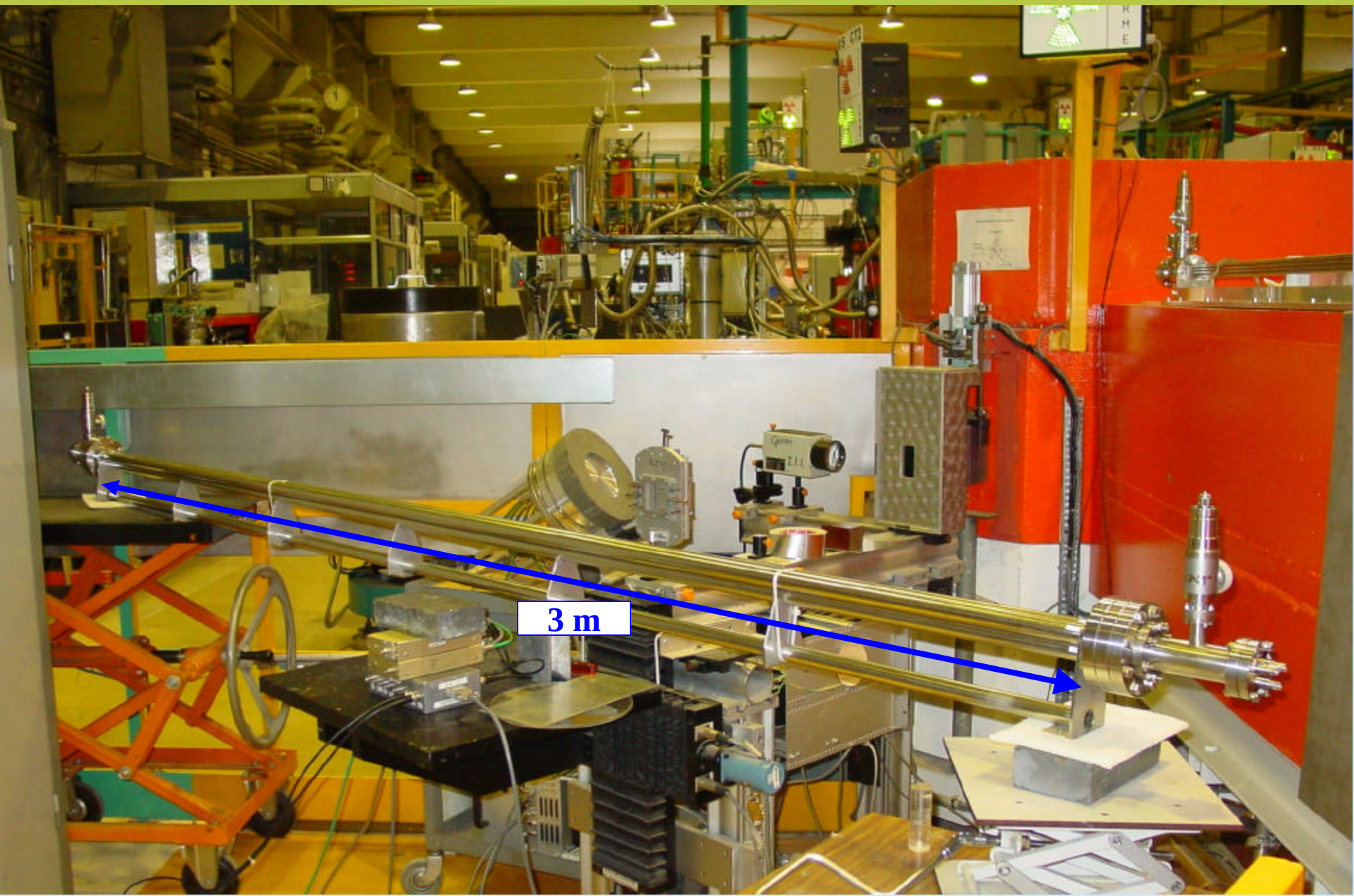




Multitube detector for the future IN5 TOF spectrometer

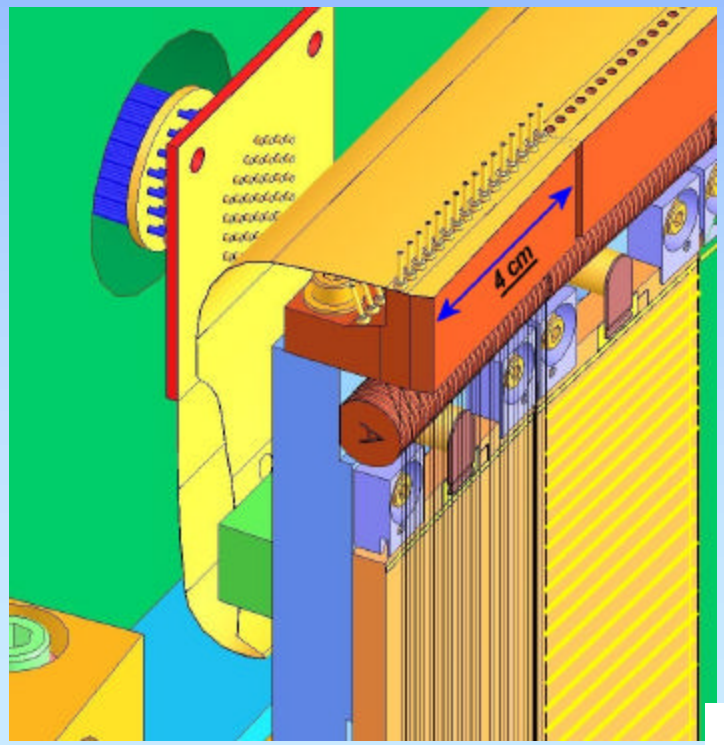
Assembly of 10 modules, 32 tubes each

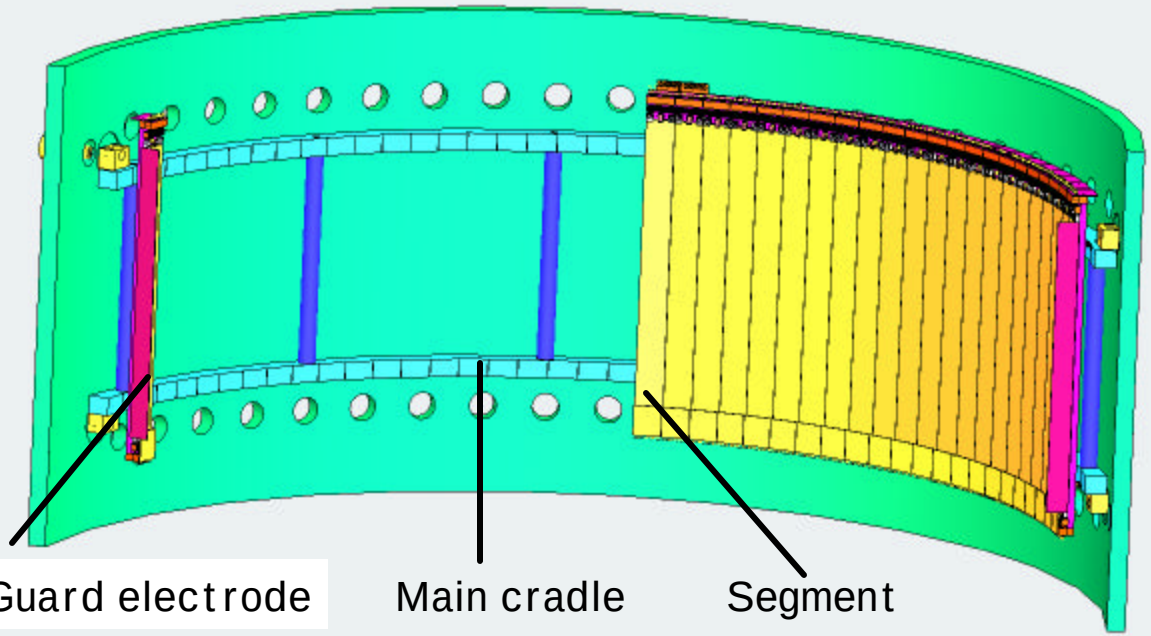
One tube is 1 inch diam., 2 m long

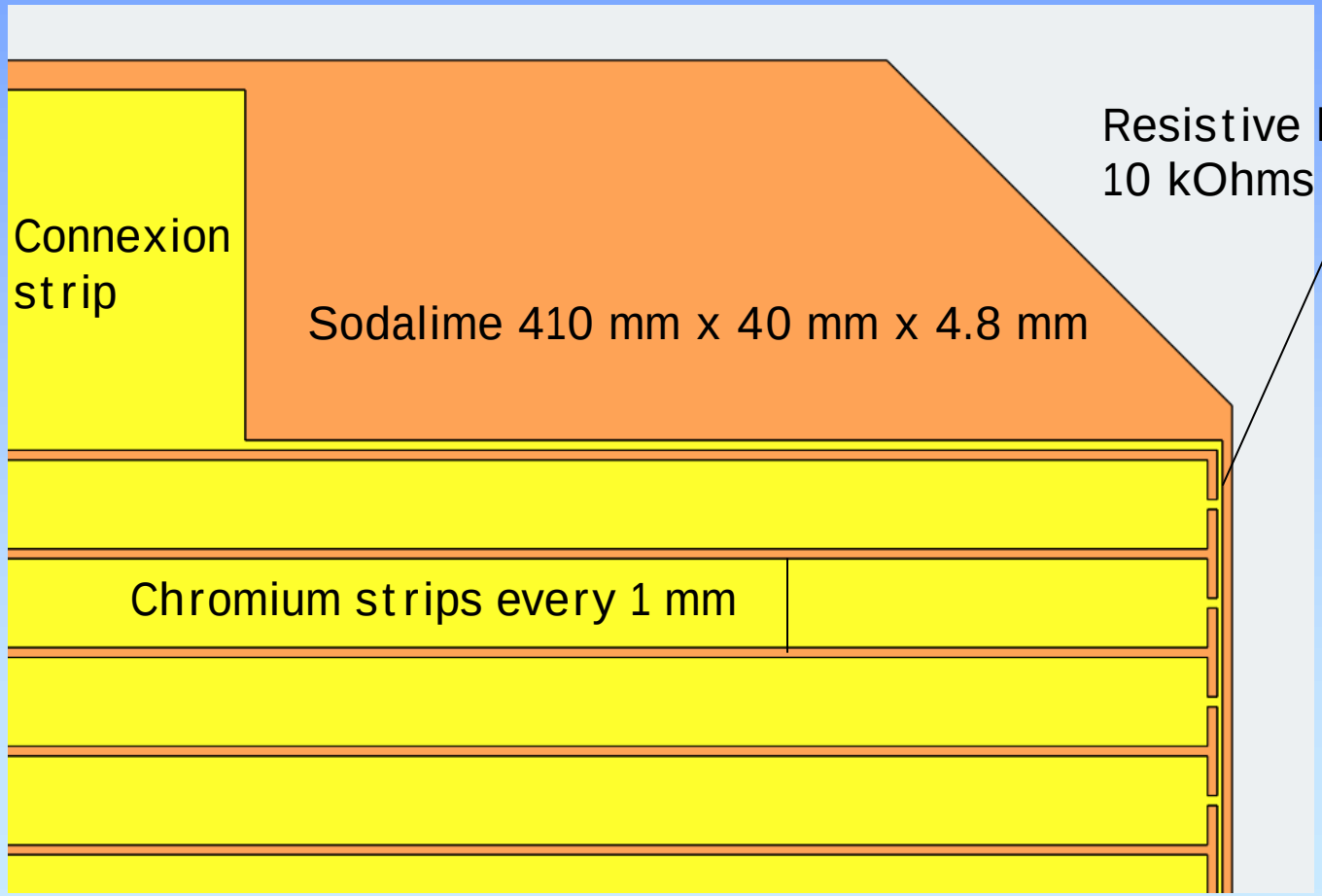

3 m

Large area curved detectors for Single Crystal Diffractometers : D19

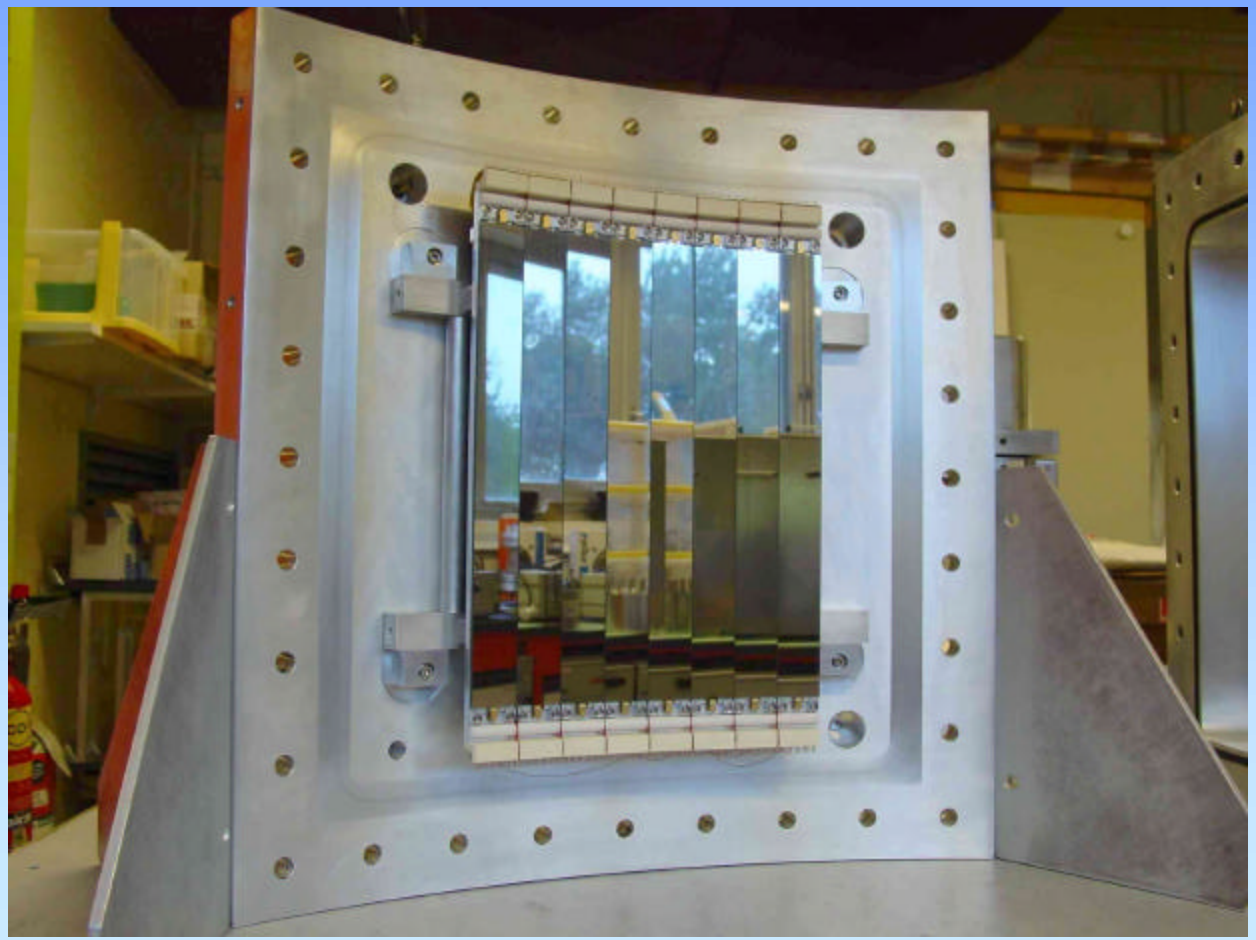
Radius of curvature : 76 cm
Active area : 160 cm X 40 cm (0.64 m^2)
Angular coverage : 30° x 120°
Spatial resolution : 2.5 mm x 2.5 mm
Detection efficiency : 60% @ 1 A
Count-rate : 50 kHz/anode wire
100 kHz/segment
2 MHz/détector

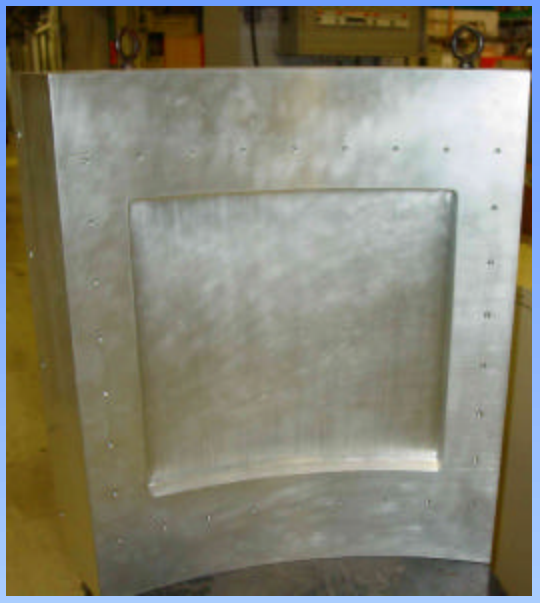


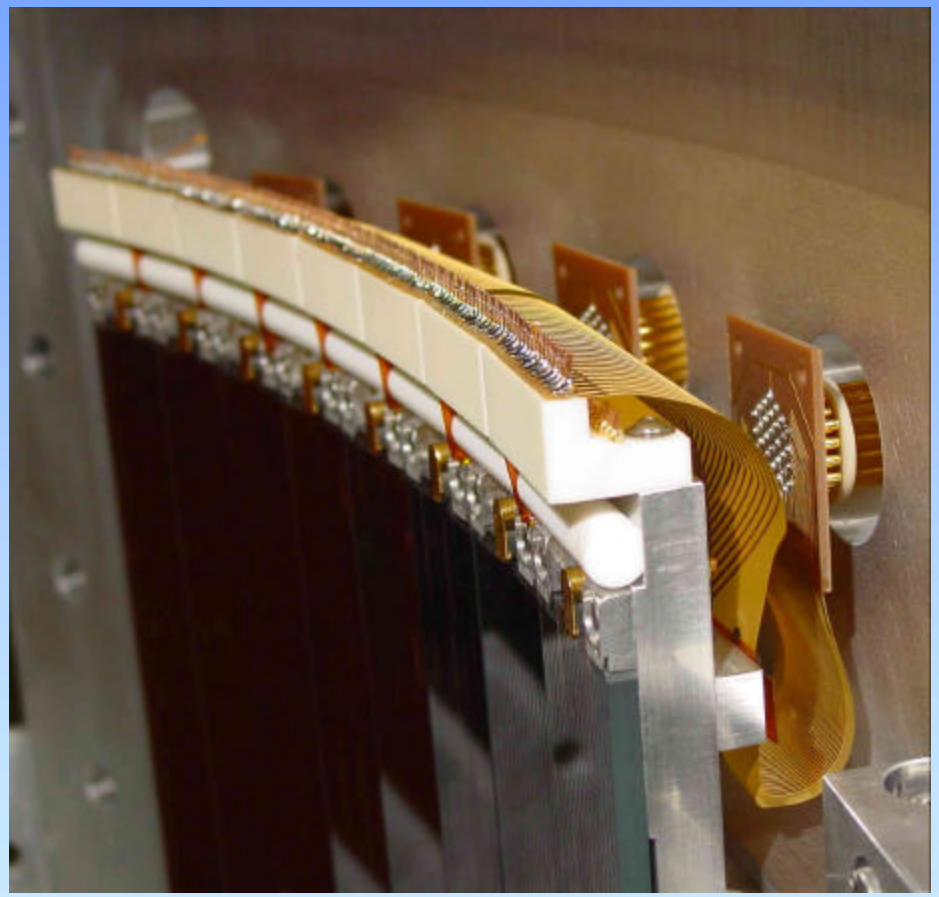


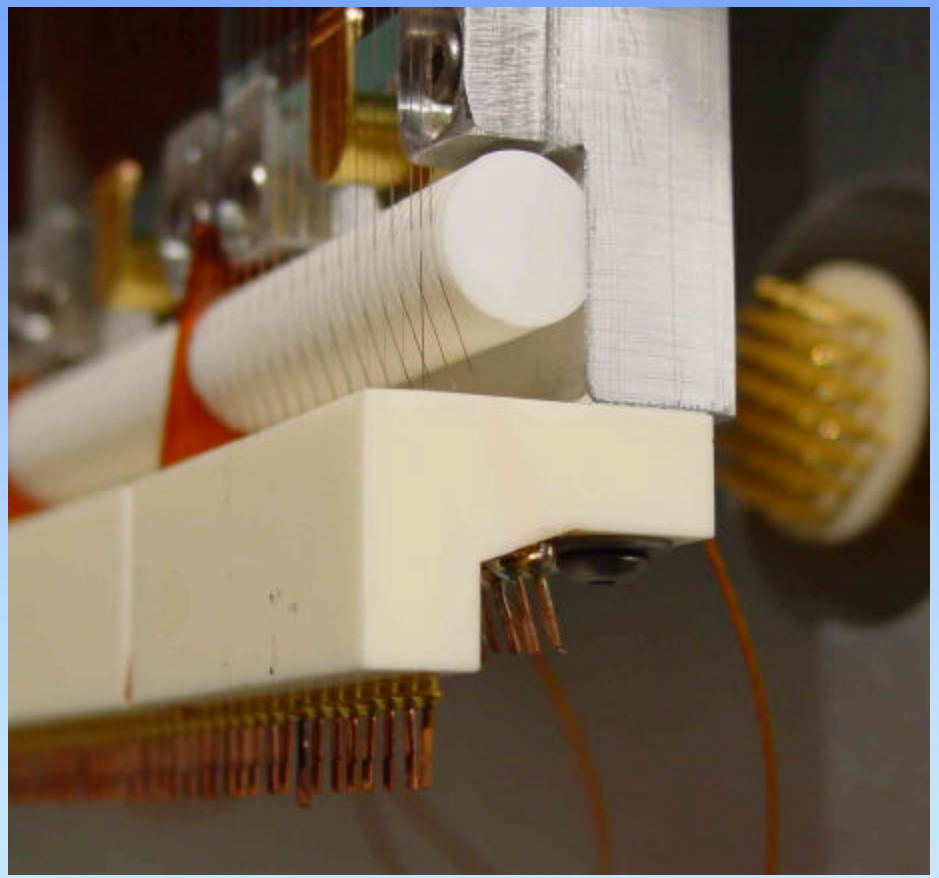

Connexion strip
Sodalime 410 mm x 40 mm x 4.8 mm
Resistive line 10 kOhms
Chromium strips every 1 mm

8-segments D19 Prototype

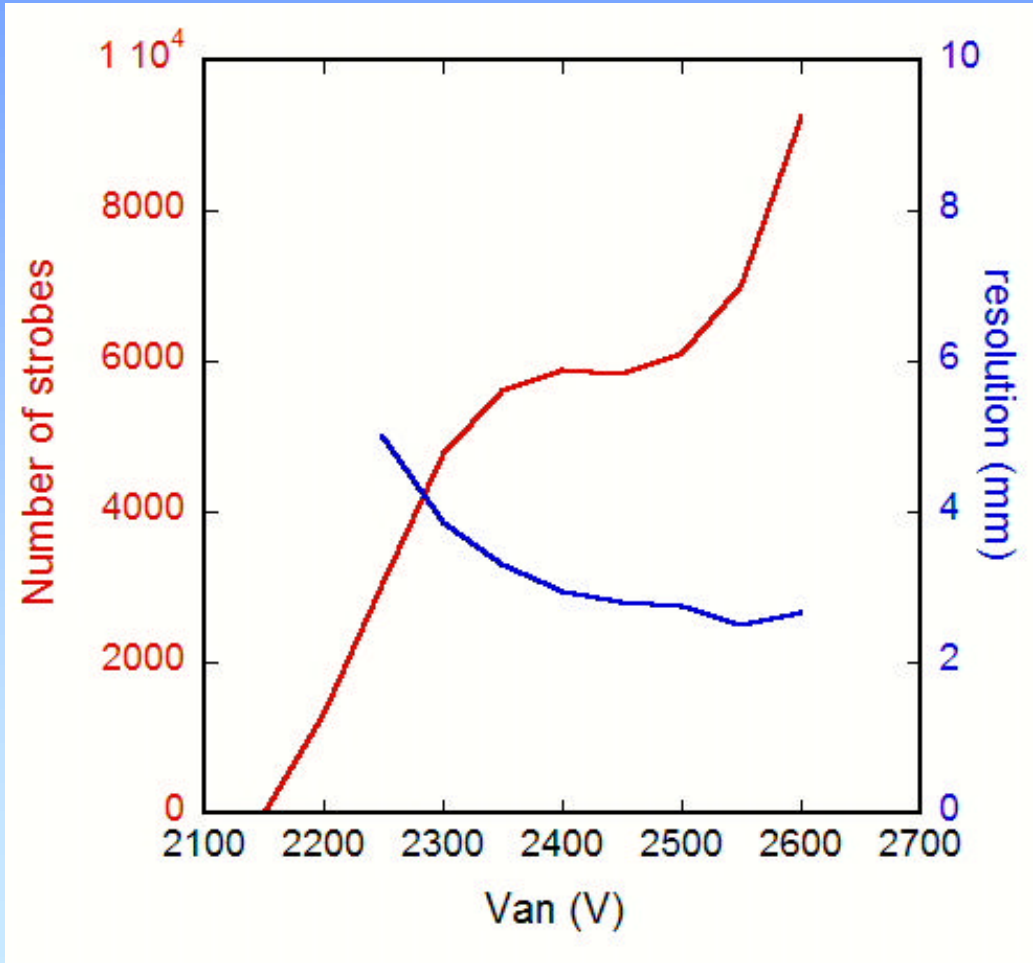








D19 Prototype : preliminary results (Mai 2003)



Conclusion

- Like in single crystal diffraction, with 6LiF/ZnS scintillators used for SXD-ISIS, and 3He MSGC for D19-ILL, different techniques may equally satisfy users of current instruments.

- For SNS and J-PARC, a precise choice of the technique used for each application will be useful, not only to optimize the instrument performances, but also to save development manpower.

- For each of the three NMI3 detector projects, protocols will be used to compare detection parameters of different techniques during a limited period of time.