DRAC or DRACULA
A Small Sample, High Pressure Diffractometer

D19 Millennium - A Revolution in large 2D Gas Detectors

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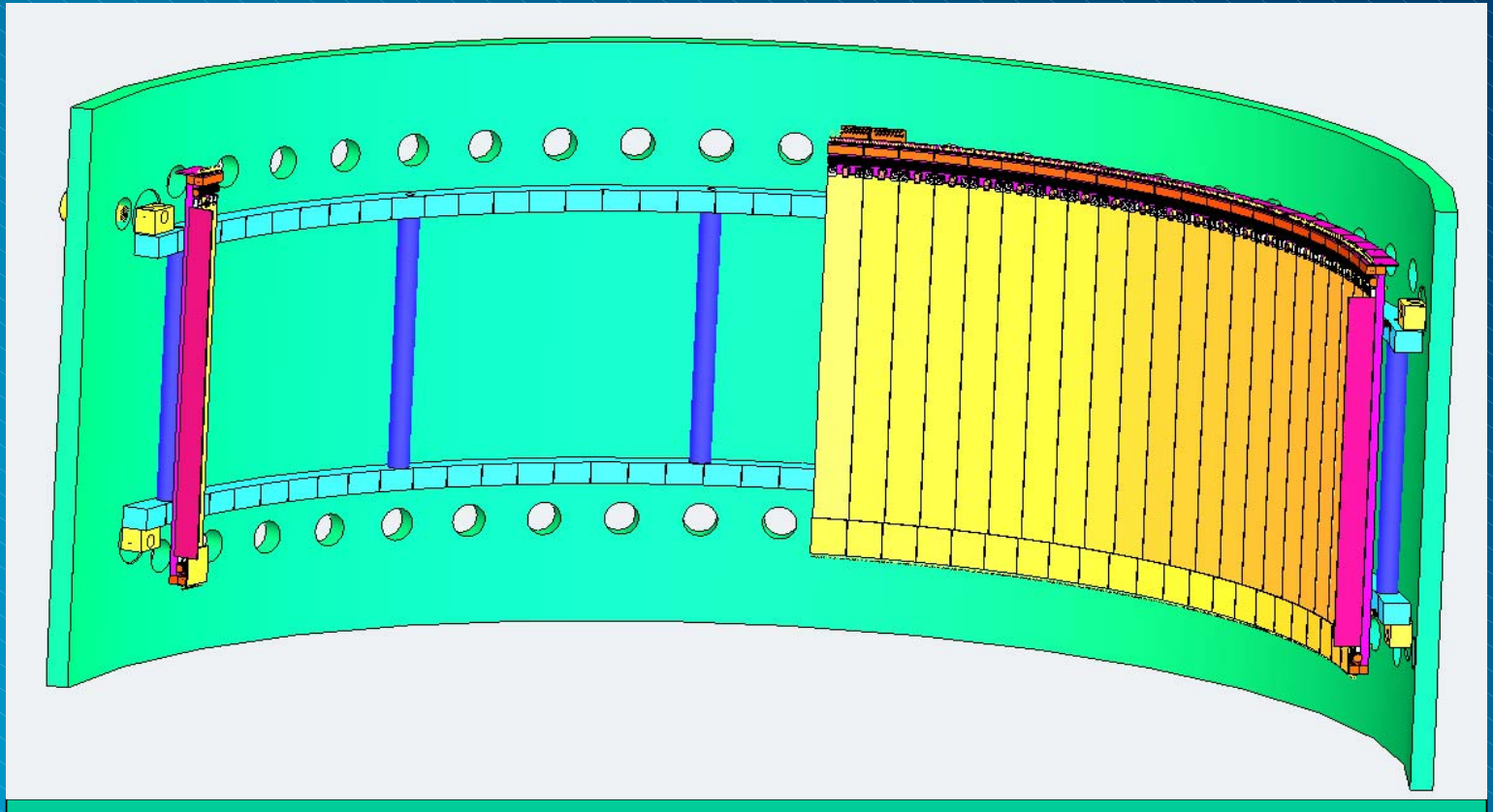
D19 Millennium - A Revolution in large 2D Gas Detectors



2D with Solid Angle > 1 steradian c.f. 0.27 on D20

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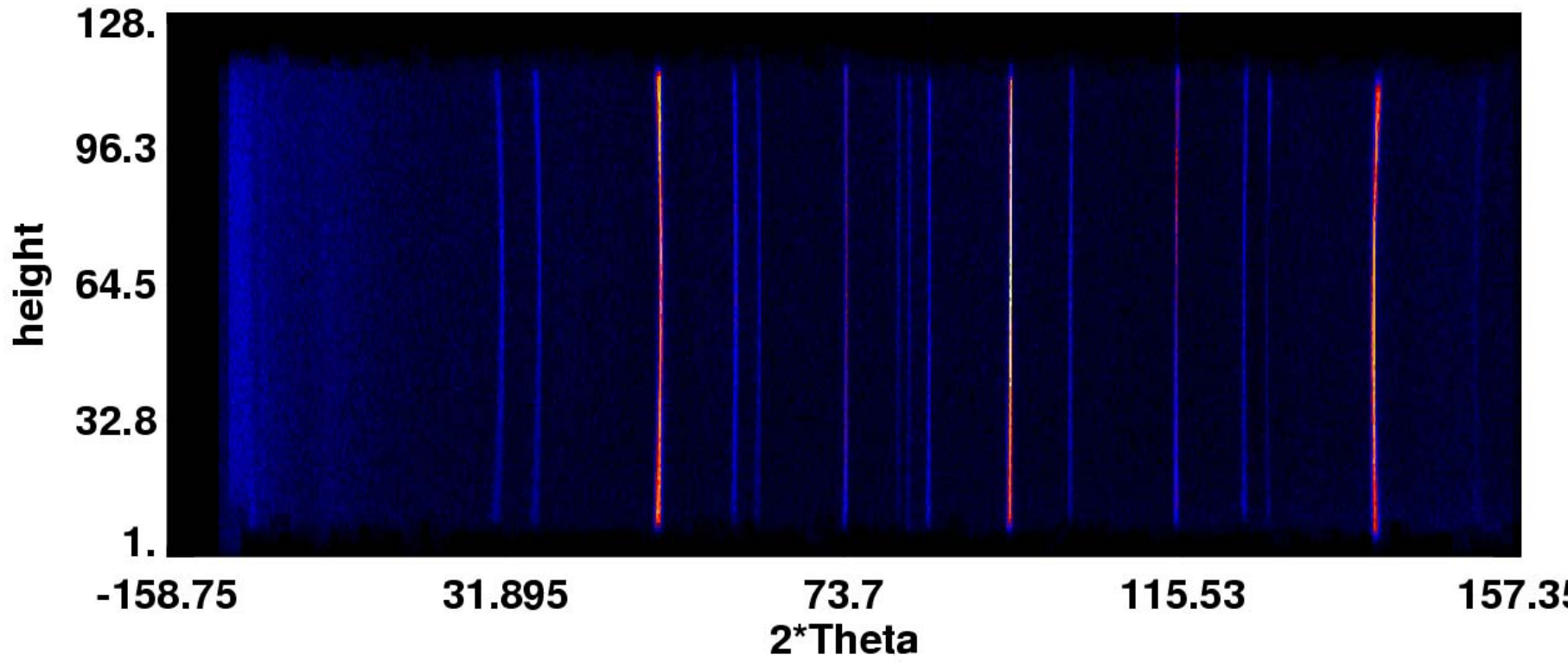
Use of a 2D Detector for Powder Diffraction (D2B, SPODI…)



First results with new super-D2B 2D detector (May 2003)

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Diffractometer for

RApid

Collection over

Ultra

Large

Areas

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Comparison of TOF & CW Diffractometers

Jorgensen, J.D., Cox, D.E., Hewat, A.W., Yelon, W.B.

"Scientific opportunities with advanced facilities for neutron scattering"
Shelter Island Workshop, 1984
Nuclear Instruments and Methods in Physics Research B12 (1985) 525-561

Efficiency for a given resolution = time averaged flux on the sample
* sample volume
* detector solid angle

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Comparison of TOF & CW Diffractometers

	D20	GEM	DRACULA	SNS
time averaged sample flux	5×10^{7}	$\sim2\times10^{6}$	$\sim10^{8}$	$\sim2.5\times10^{7}$
detector solid angle	0.27 sr	4.0 sr	1.5 sr*	3.0 sr
efficiency	1.7	1	18	9

* Based on new D19 detector: R=760 mm, h=400 mm, 800 linear resistive wires covering $30^{o}\times160^{o}$

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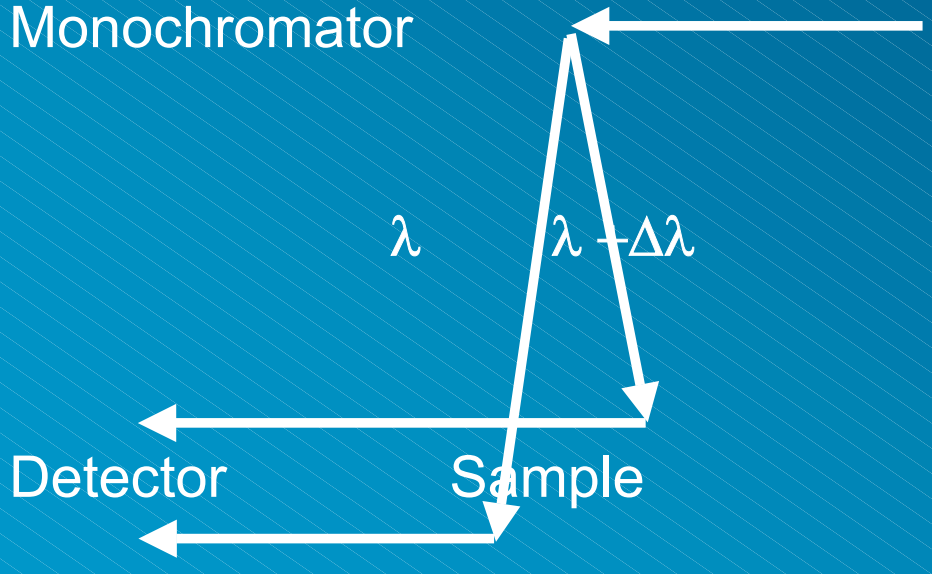
Q: Why is the sample flux so high from a reactor

A: A relatively wide band of wavelengths is used (1% for 0.1% resolution)

Large Focussing Monochromators



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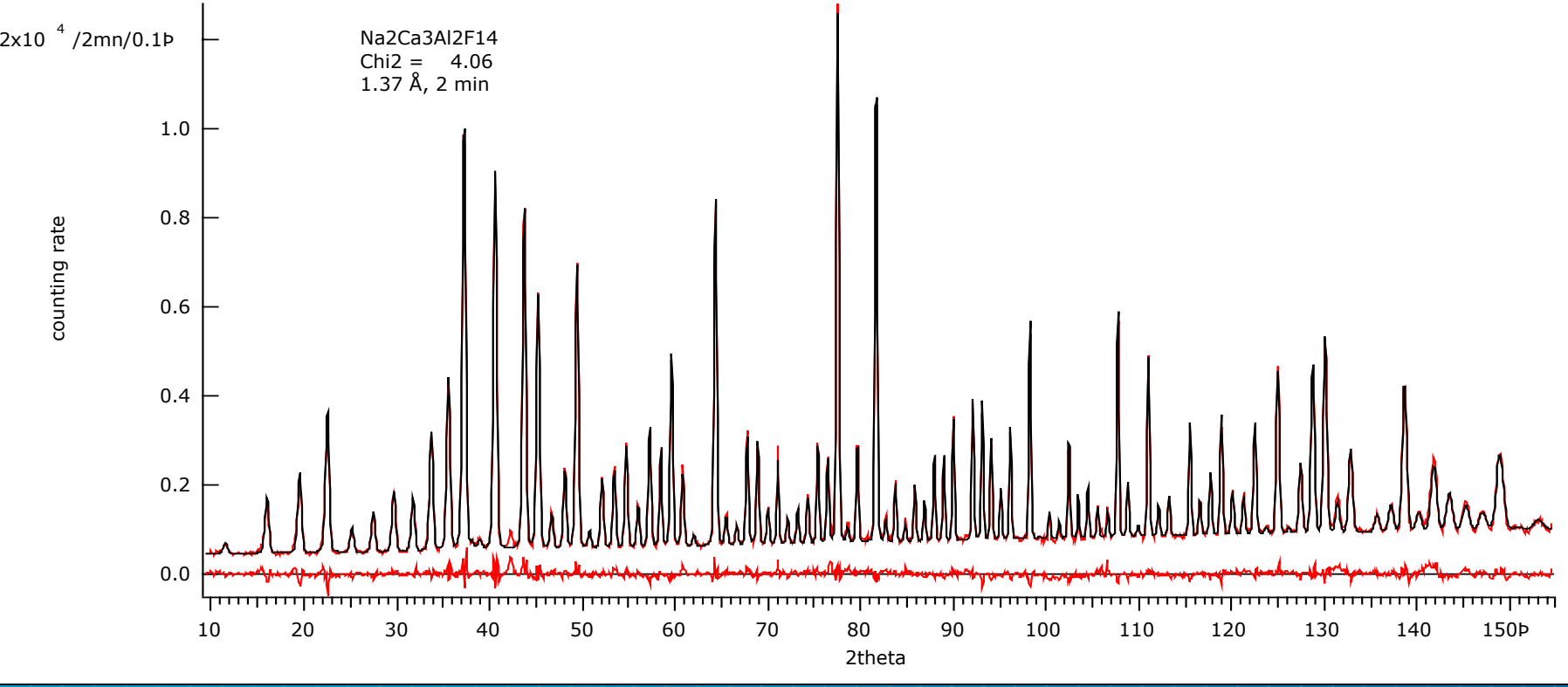
D20 is very fast (chemical kinetics)

Thomas Hansen (2003) ILL News, June 2003

2 minute D20 data for a ~700 mm³ sample of $Na_2Ca_3Al_2F_{14}$



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GEM can measure very small samples

Radaelli, Hammon & Chapon (2003) Neutroni e Luce di Sincrotrone

~700 minute GEM data for a 2mm^3 sample of $Y_3Al_5O_{12}$

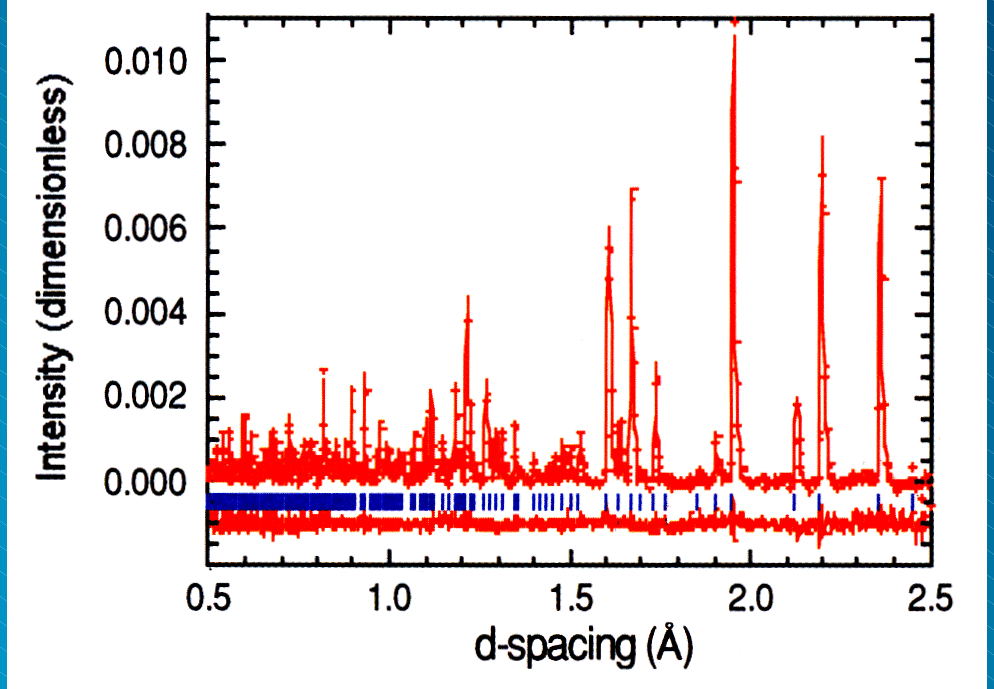

Fig. 7. Rietveld Refinement plot for a 2 mm^2 sample of Yttrium Iron Garnet (YAG), after an overnight data collection.

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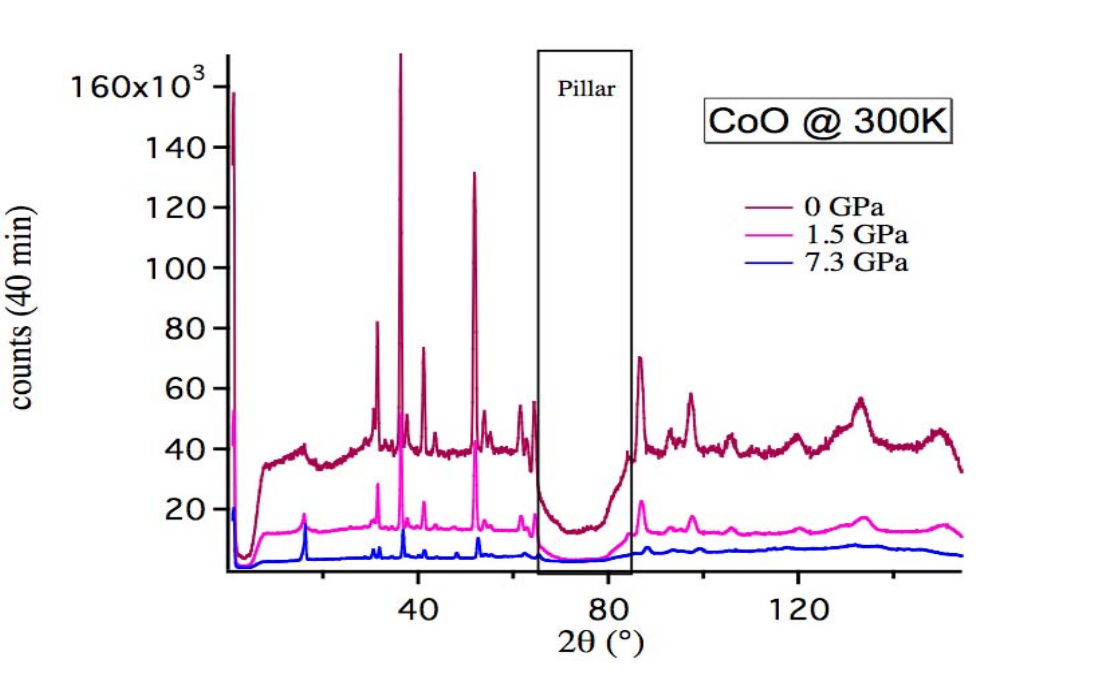
D20 with "large" Paris-Edinburgh Pressure Cell (50 Kg)

Kernavanois et al. (2003) Advanced Millennium Pressure Project

40 minute D20 data for a 100 mm³ sample of CO at 7.3 GPa



BUT low temperatures -> smaller cells -> 1-10 mm³ samples

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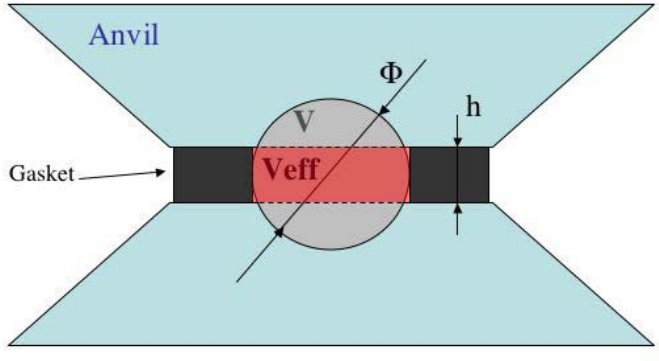
Very High Pressure with Small Samples at Low Temperature

LLB Kurtchatov saphire/diamond cell 10+ GPa
50mm diameter cell, Sample << 1mm^3

ILL Compact Paris-Edinburgh cell 10 GPa
120mm diameter cell. Sample < 2mm^3

Powder sample



V = Total sample volume

Veff = Effective sample volume

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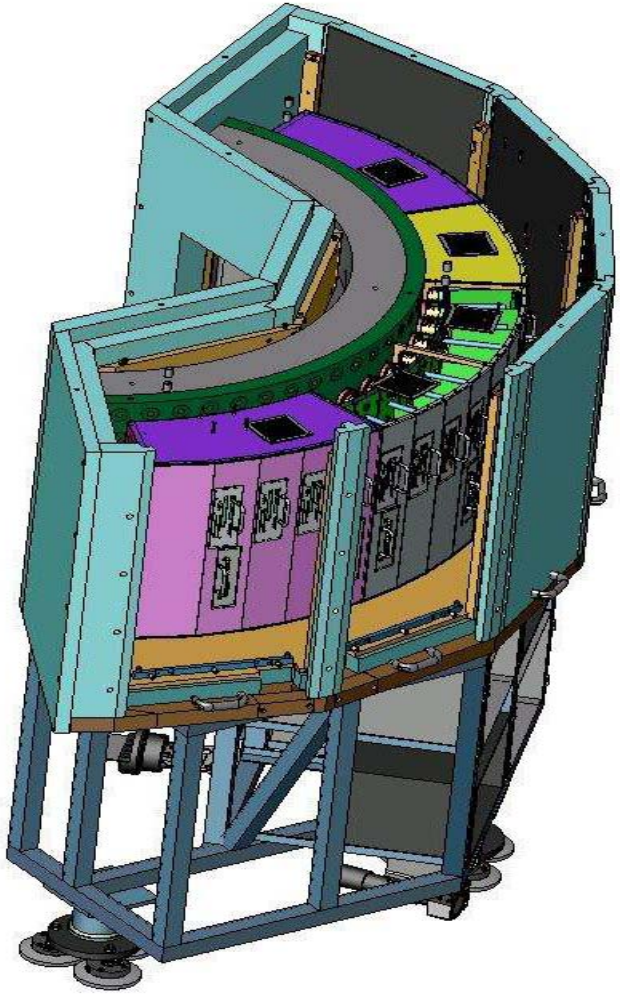
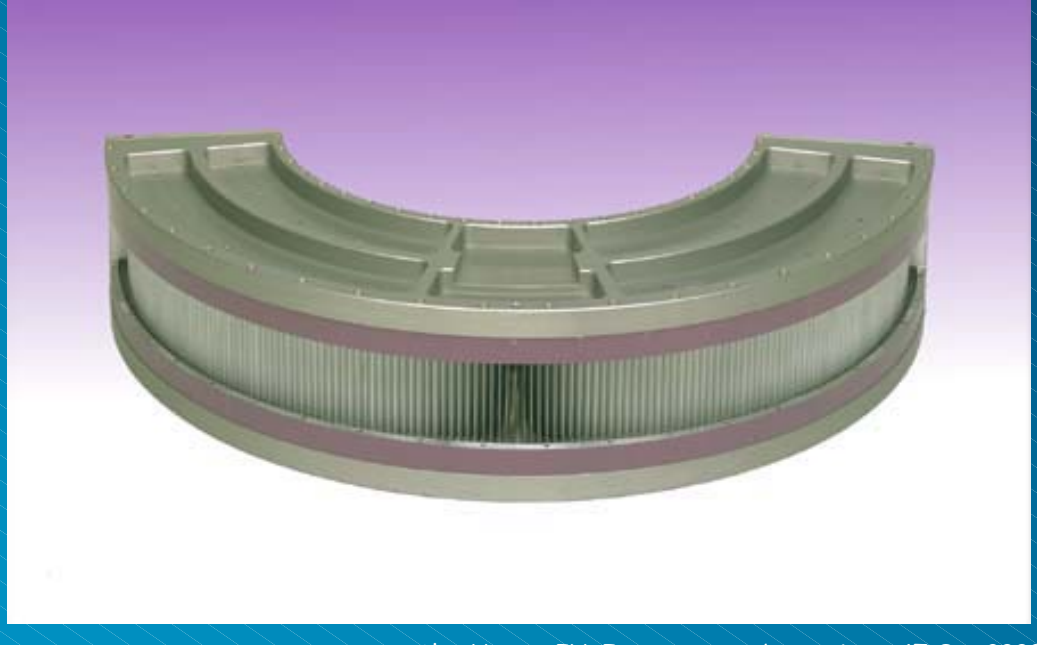


What do we want to do ?

- Order of magnitude smaller samples than D20
- Low background (pressure cell)
- Large, compact 2D area detector (D19 model)
- Radial collimator



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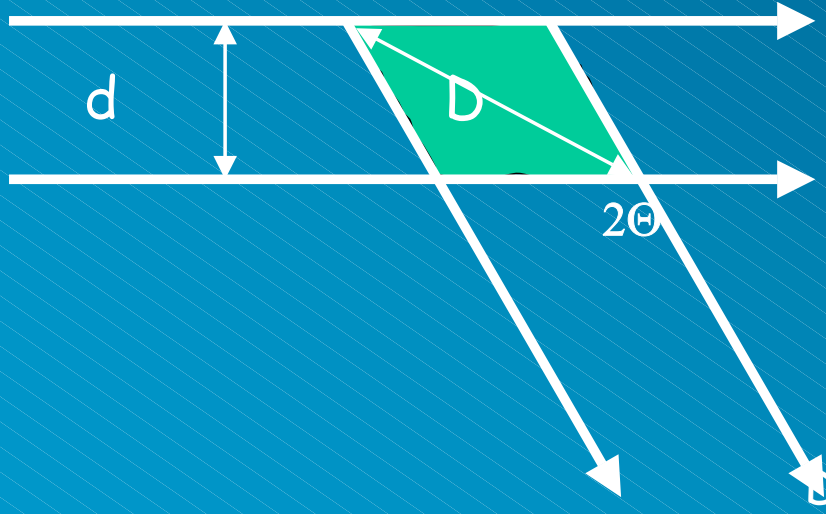
Large detector on a reactor near 90 degree scattering

±15° vertical as for the new D19 detector cf ±7° for new Paris-Edinburgh cell
±30° horizontal ie $2\Theta = 60° - 120°$ (maximum range of scattering angles)



d = diameter of the incident beam
D = diameter of scattering volume
= d/sinΘ
= d√2 minimum at $2\Theta = 90°$
= 2d maximum at $2\Theta = 60°$ & $120°$

D = 5mm – 7mm for $2\Theta = 60° - 120°$

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Can we obtain all d-spacings with a 2Θ range of 60°-120° ?

Use a large focusing Ge monochromator near 90° take-off to obtain several λ

[115] -> 1.54Å;		d= 0.889Å - 1.54Å
[113] -> 2.44Å;	(graphite filter)	d= 1.39Å - 2.44Å
[111] -> 4.61Å;	(beryllium filter)	d= 2.66Å - 4.61Å

DRAC or DRACULA
Need for a High Flux Thermal Beam Tube

Convert D20 to DRACULA ?

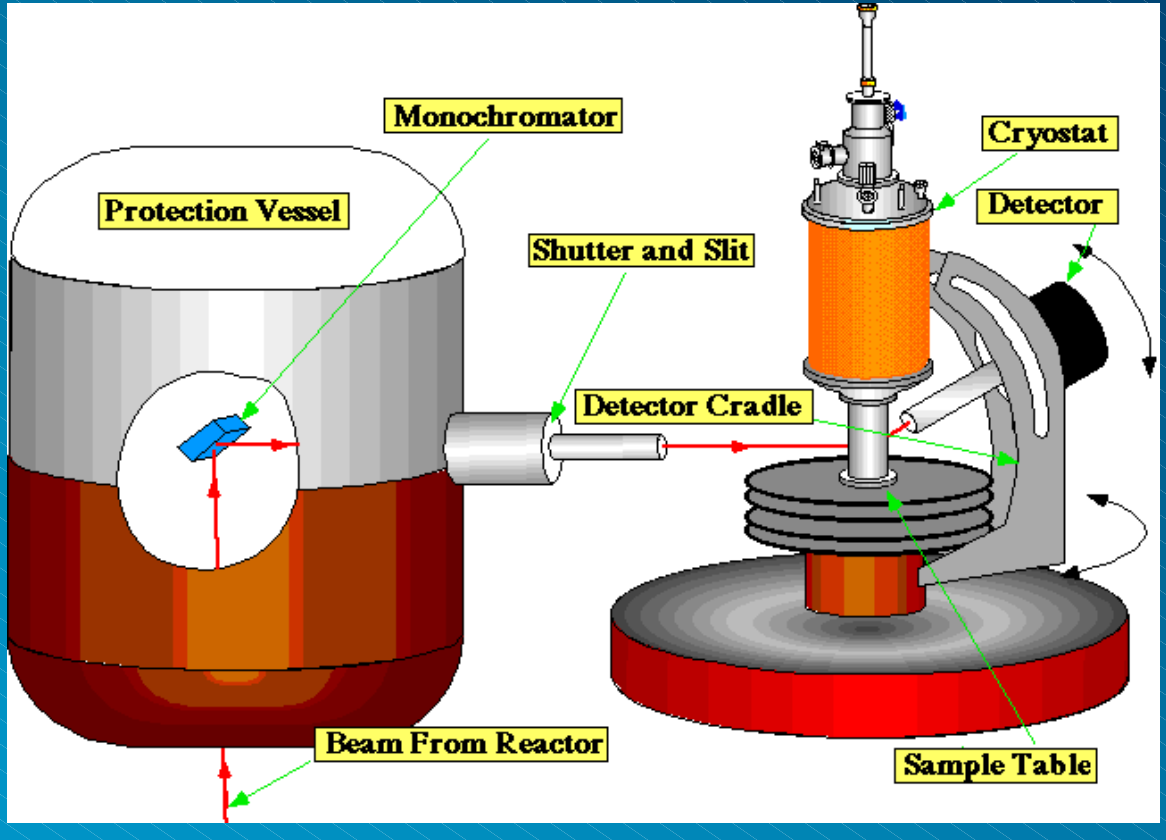
D20 has only recently been finished & is now working well

D20 is the ILL's most requested machine (57 proposals)

Only 2 modern powder machines for 22% of all proposals

DRAC or DRACULA
Need for a High Flux Thermal Beam Tube

Convert CRG-D15 (inclined thermal beam) to DRACULA ?



Problem: Inclined beam, low flux on sample $< 10^6$ n.cm^{-2}.sec^{-1}

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Need for a High Flux Thermal Beam Tube

Convert H3 (D9) to "Big H3" (cf H9 Radiography) ?

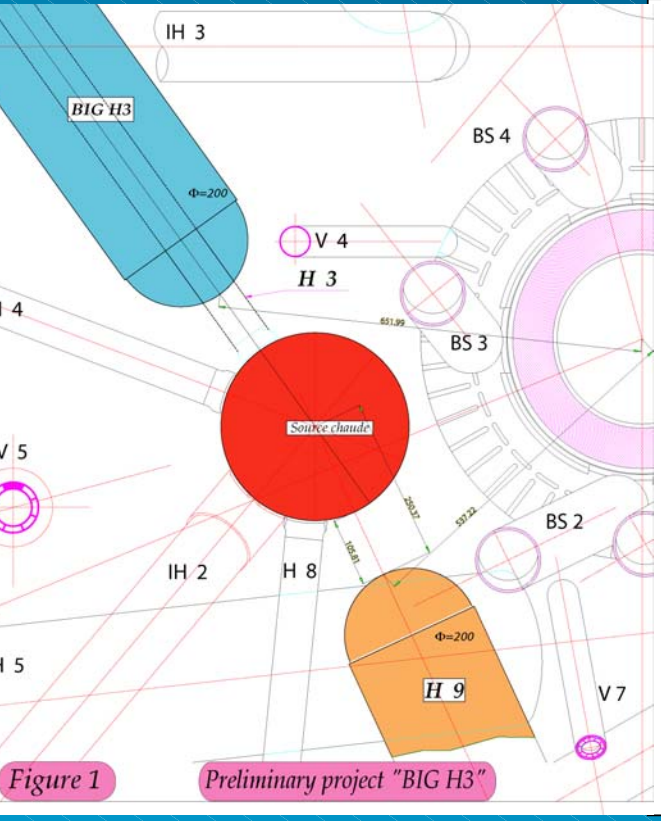


Figure 1 Preliminary project "BIG H3"

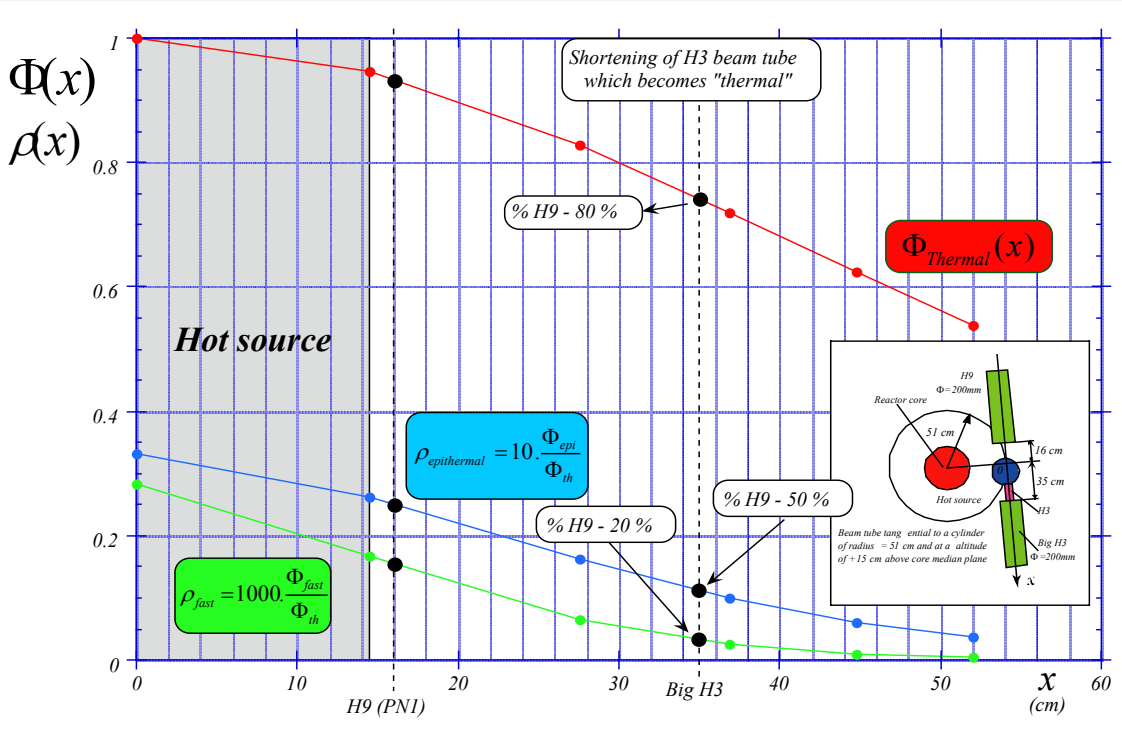
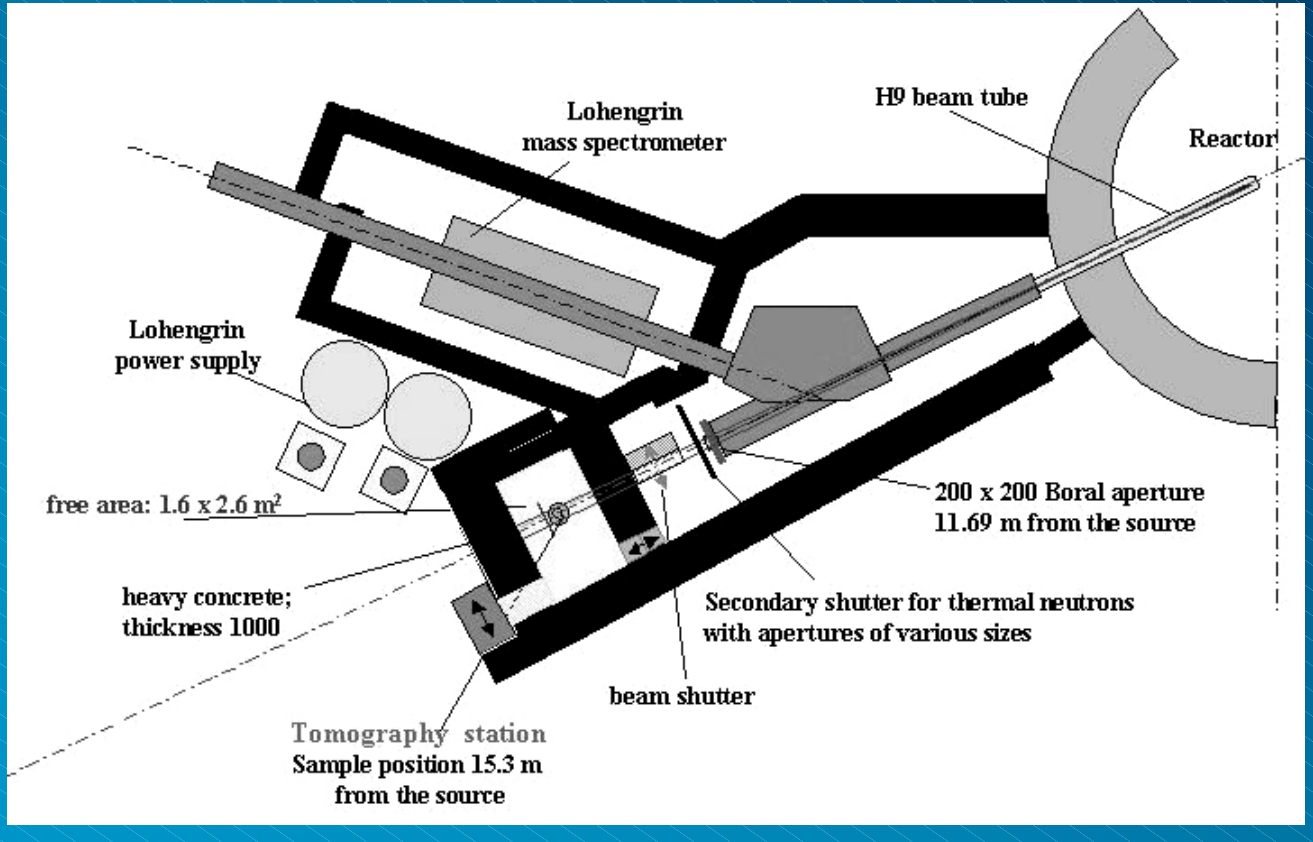


Figure 2 *Thermal neutron flux (Arbitrary unit) and "Background" in the reator core versus location x (R_0 = 51 cm and H= +15 cm) (Non-perturbated flux calculated without beam tube)*

Problem: Hot source instrument D9 is unique at ILL

DRAC or DRACULA
Need for a High Flux Thermal Beam Tube

Convert H9 Radiography (most intense ILL beam) to DRACULA ?



Transfer radiography to super-mirror guide (resolution) ?

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Can we compete with the Americans while waiting for ESS ?

(Free Advice)

- Use our natural advantage – time average flux on sample
- Use big detectors, as on pulsed neutron sources
- Do not assume that the SNS will be a long time coming
- Do not wait until the SNS is operational before reacting