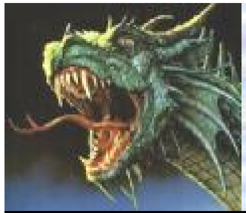
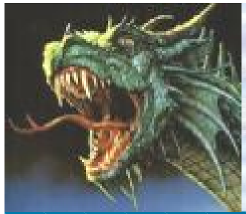


DRACULA and EXED

Alan Hewat, Diffraction Group, ILL Grenoble



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

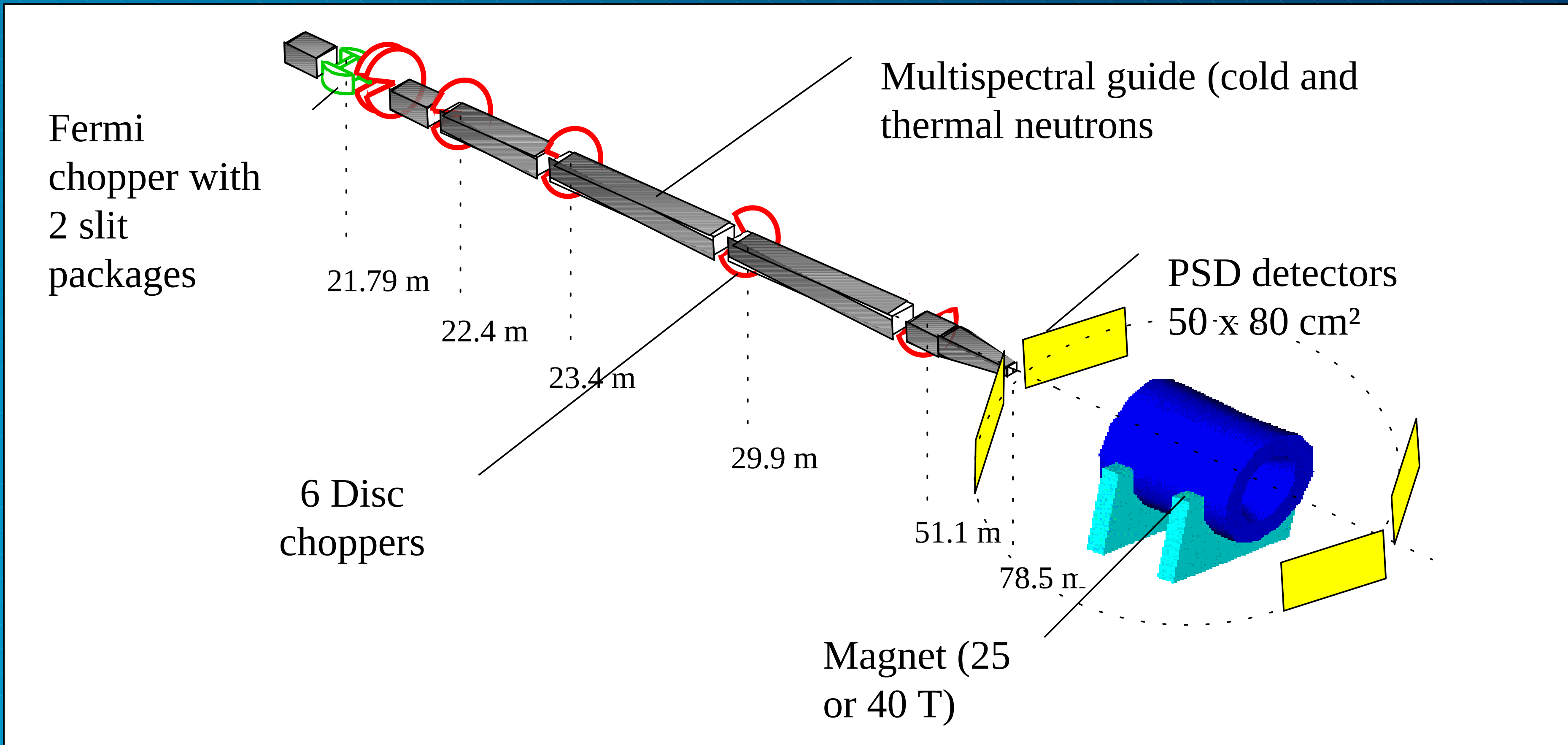
Nuclear Instruments and Methods in Physics Research B12 (1985) 525-561

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

Large detectors + high flux on the sample

Q: Why is the sample flux so high with TOF (EXED) ?

A: A relatively wide band of wavelengths is used with a converging guide

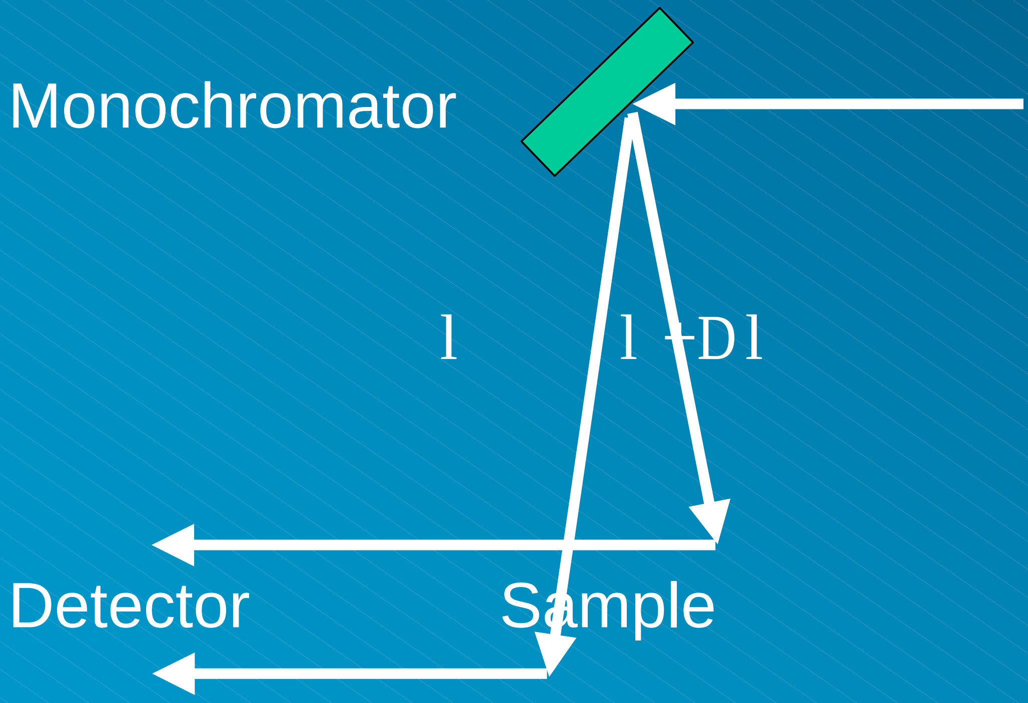


(Wavelength band 0.7 -> 1.8Å ultimately limited by frame overlap)

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)

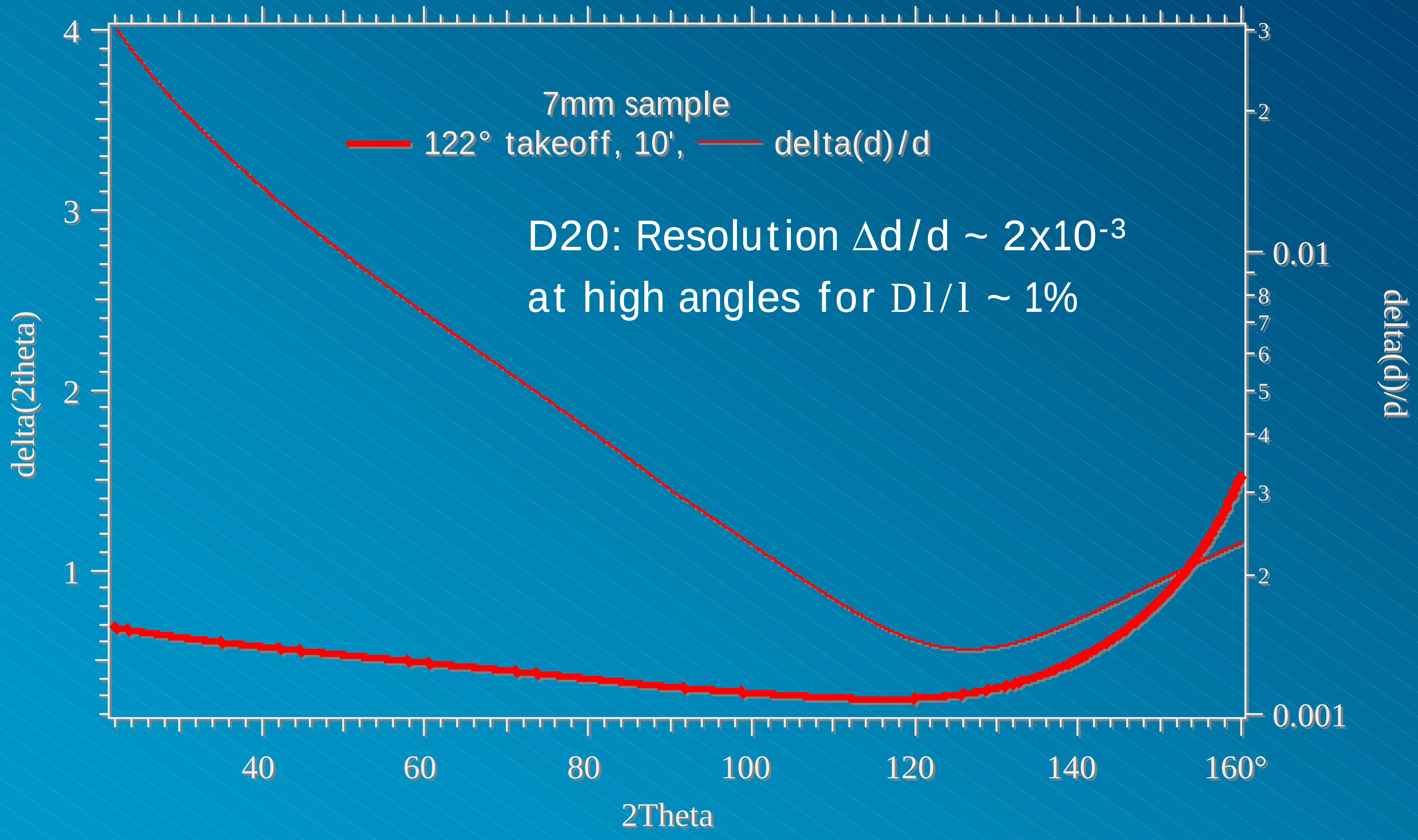
Large Focussing Monochromators



High Flux AND High Resolution

Q: Is High Resolution compatible with large Dl/l ?

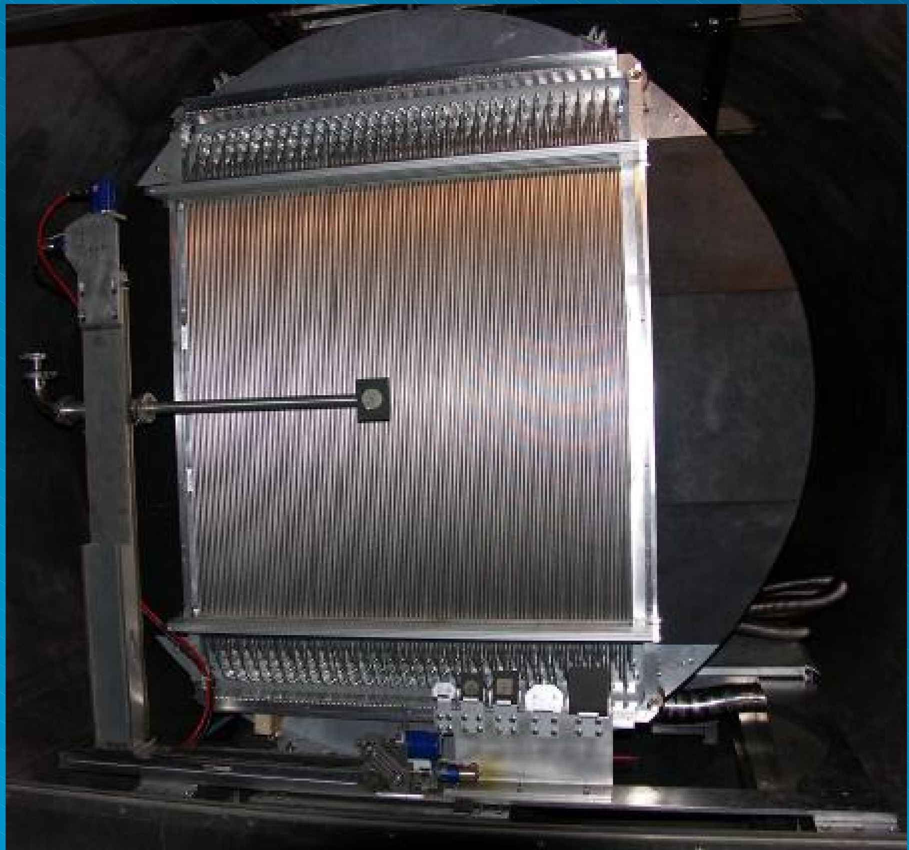
A: Yes. Resolution is INDEPENDENT of Dl/l at the focussing (take-off) angle.



Array of linear wire PSD detectors for EXED

Q: How do we build a very large detector for EXED ?

A: An array of linear wire detectors c.f. Super-D2B and D22 at ILL



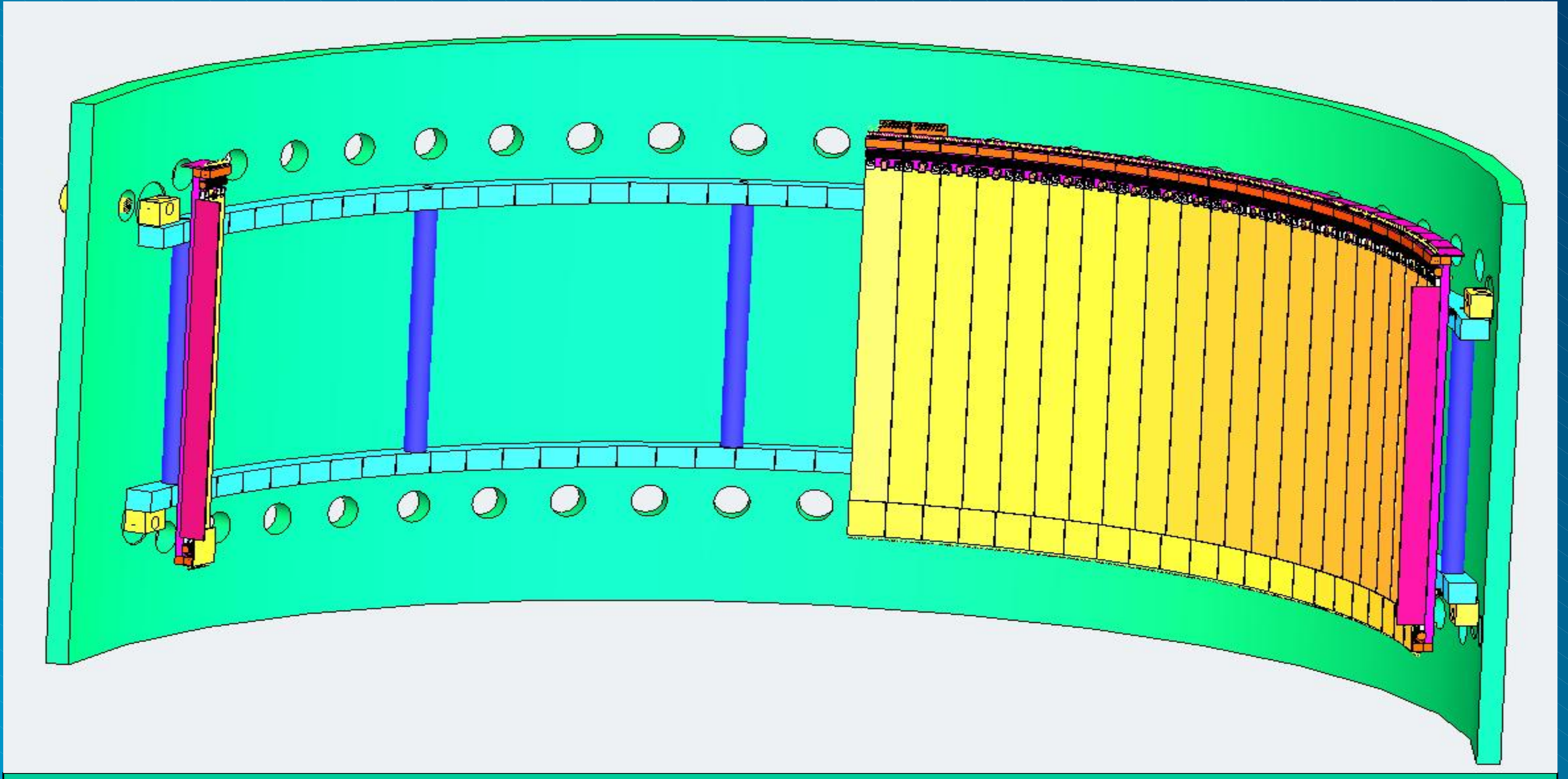
Array of 8mm x 1000mm linear wire detectors, D22

Array of linear wire PSD-tubes on Super-D2B at ILL

Linear-wire PSD detector for DRACULA

Q: How do we build a very large detector for Dracula ?

A: A new 2D linear wire He3-gas gas detectors developed at ILL & BNL



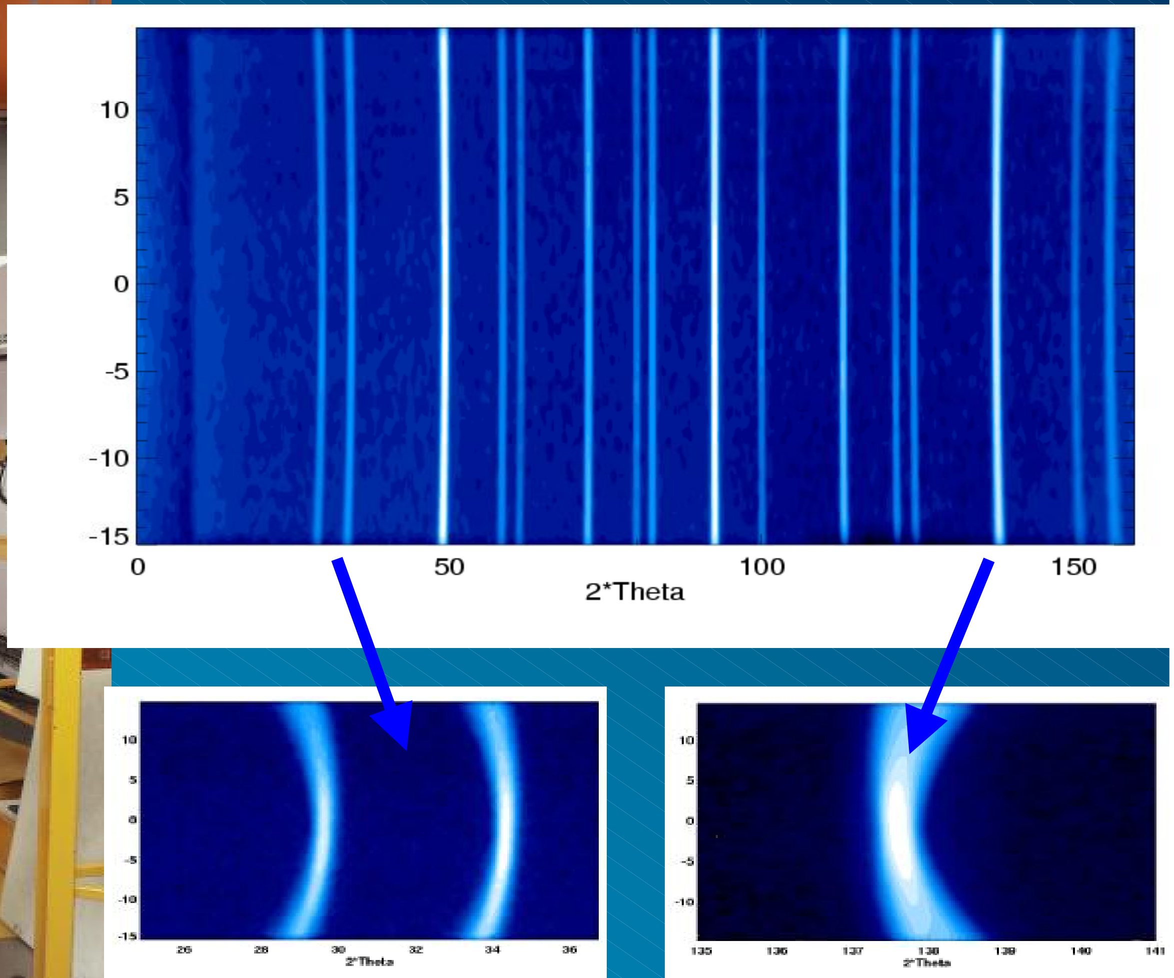
2D with Solid Angle > 1 steradian c.f. 0.27 on D20

D19 Millennium - A Revolution in large 2D Gas Detectors

2D detectors for Powder Diffraction

How do they work in practice ?

UK-EPSRC Super-D2B project at ILL



E.Suard, C.Ritter, A.Hewat, P.Attfield... (Edin.)

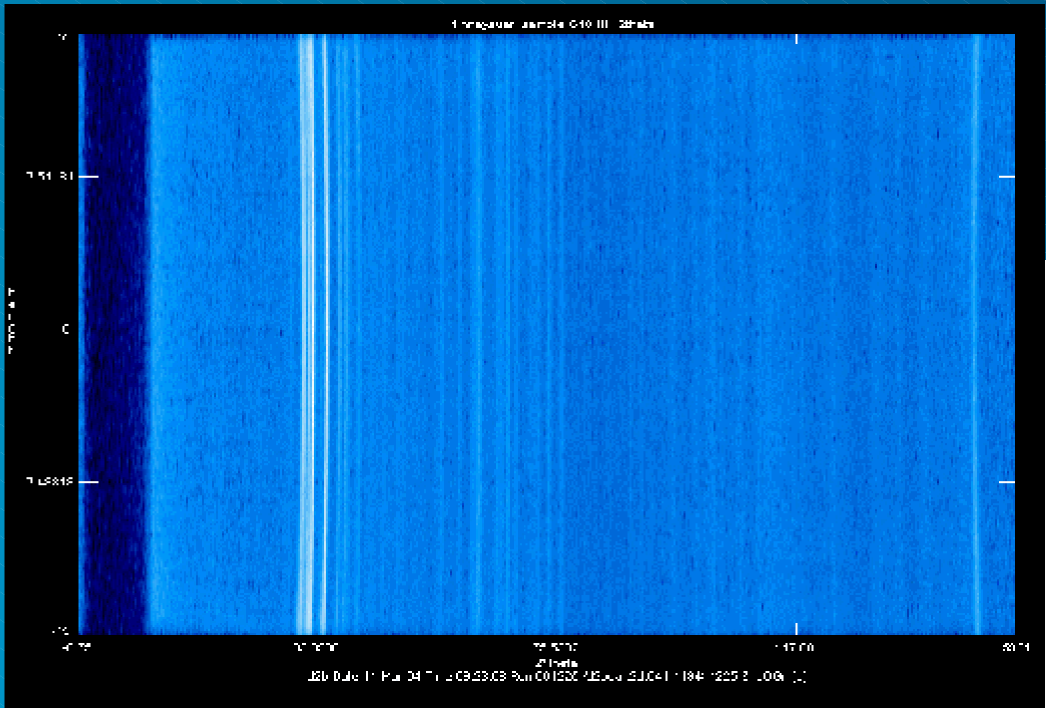
Super-D2B at ILL
Very high temperatures on small samples

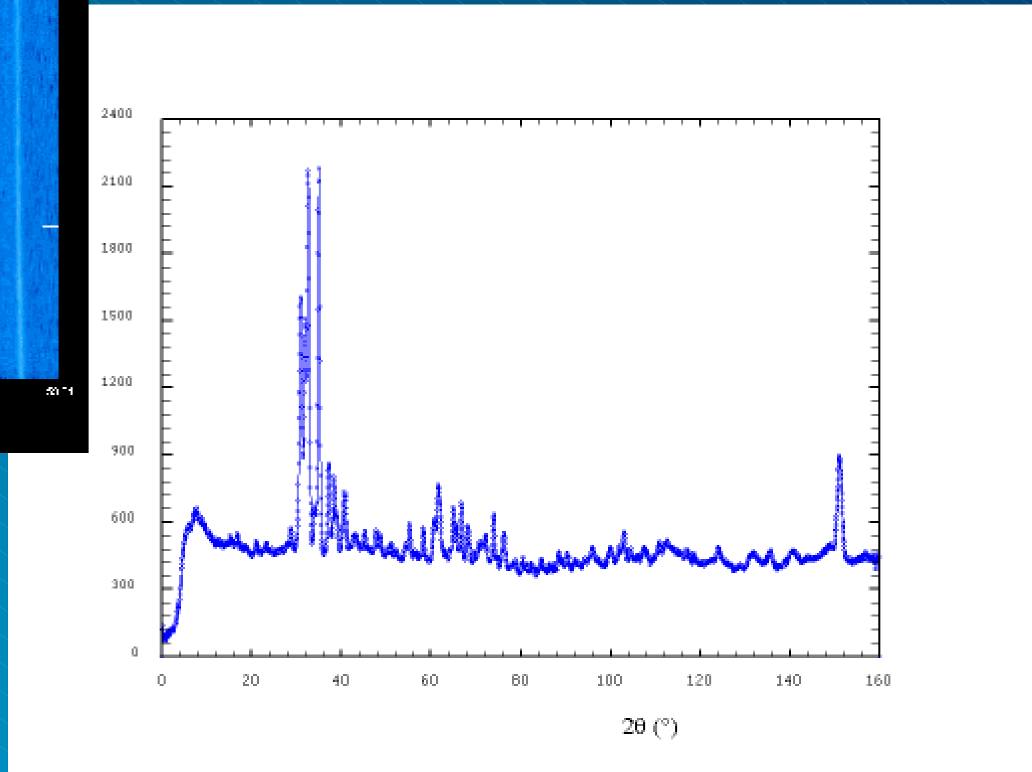
High T Microwave Furnace on D2B (Boysen et al.)

...with Carsten Korte from Giessen

Super D2B at ILL
Very small samples with very low B/G

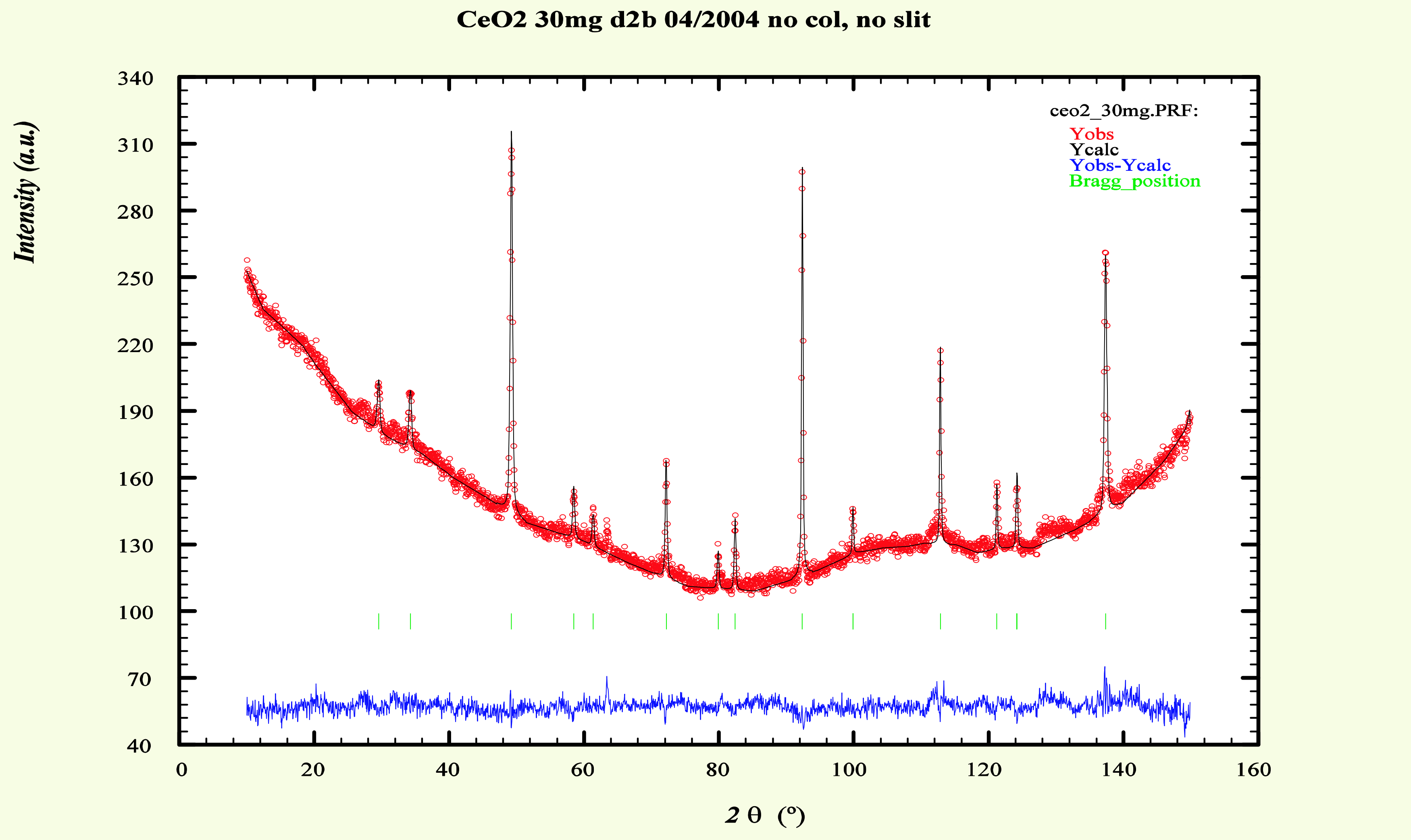
180 mg of HP Ice on Super D2B (J.Finney, E.Suard)



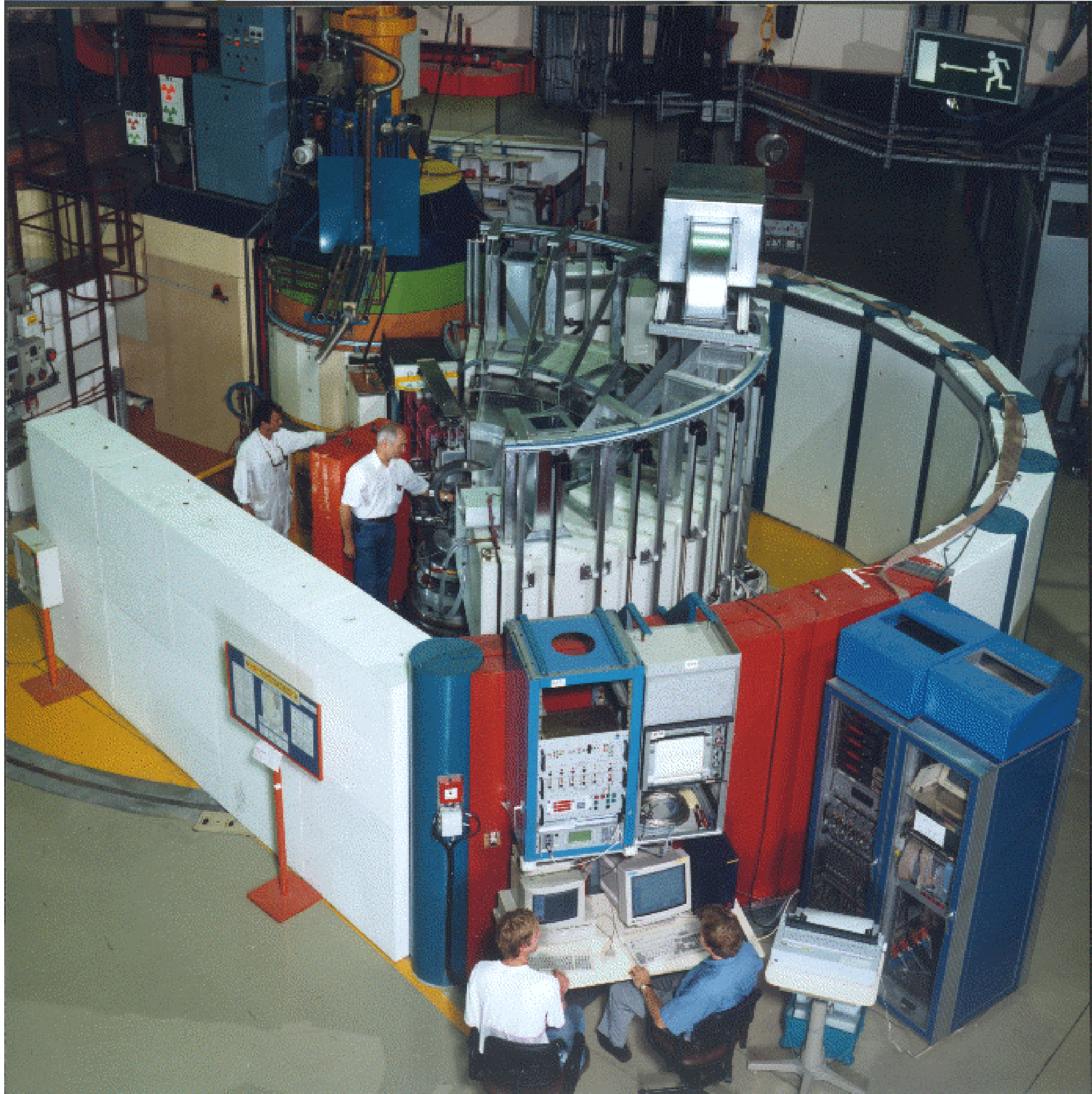


Super D2B at ILL
Very small samples with very low B/G

30 mg sample on Super D2B (E. Suard & C. Ritter, ILL)



D20 at ILL
Fast PSD Detector for very small samples



Large Microstrip Detector

A.Oed, P.Convert, T. Hansen, et al...

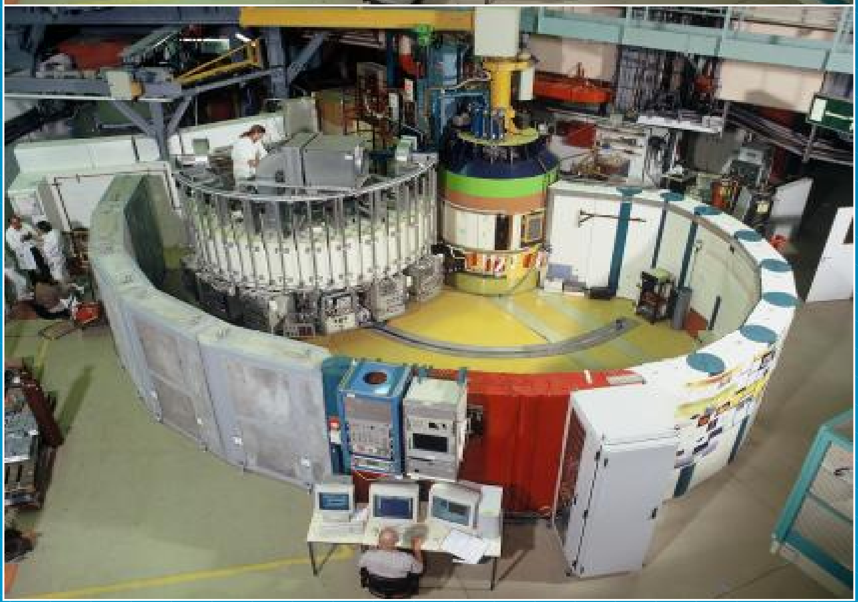
New ceramics to replace metals in engineering components

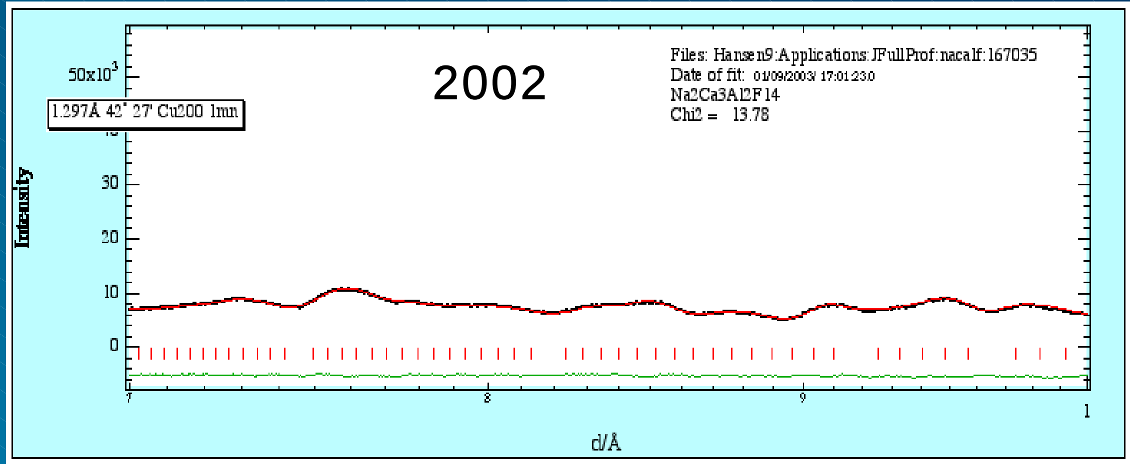
- The explosive SHS reaction was studied in real time with neutrons
- The reaction is exothermic, & heats the sample to 2200ºC in <1 sec
- The complete diffraction pattern (left) is collected at 300 ms intervals
  A World Record
- Knowledge of the SHS process allows us to prepare a pure Ti_3SiC_2 product

D.Riley, E.Kisi, T.Hansen, A.Hewat

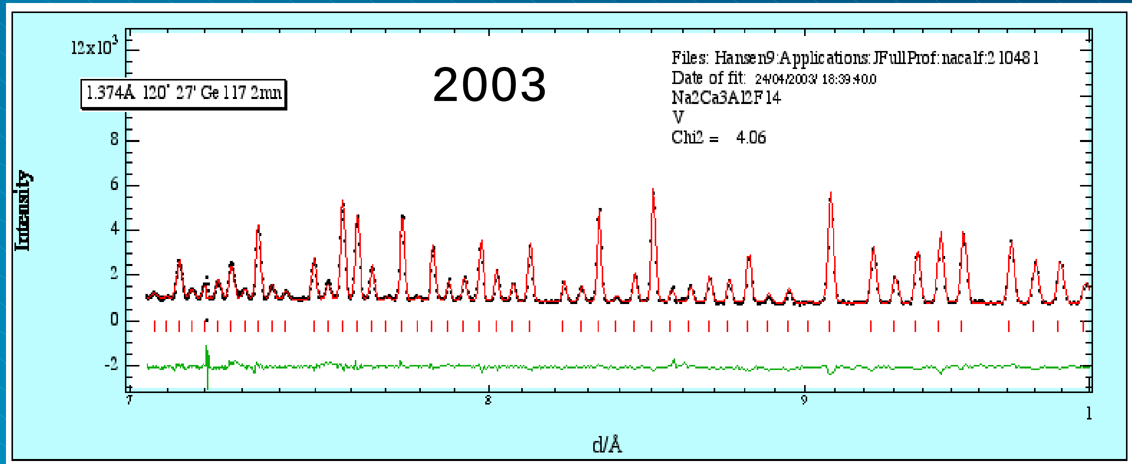
D20 – High Resolution but still very Fast

T.Hansen, P.Henry, P.Fischer





Before and After (data in 2 min.)



Higher D20 resolution since 2003

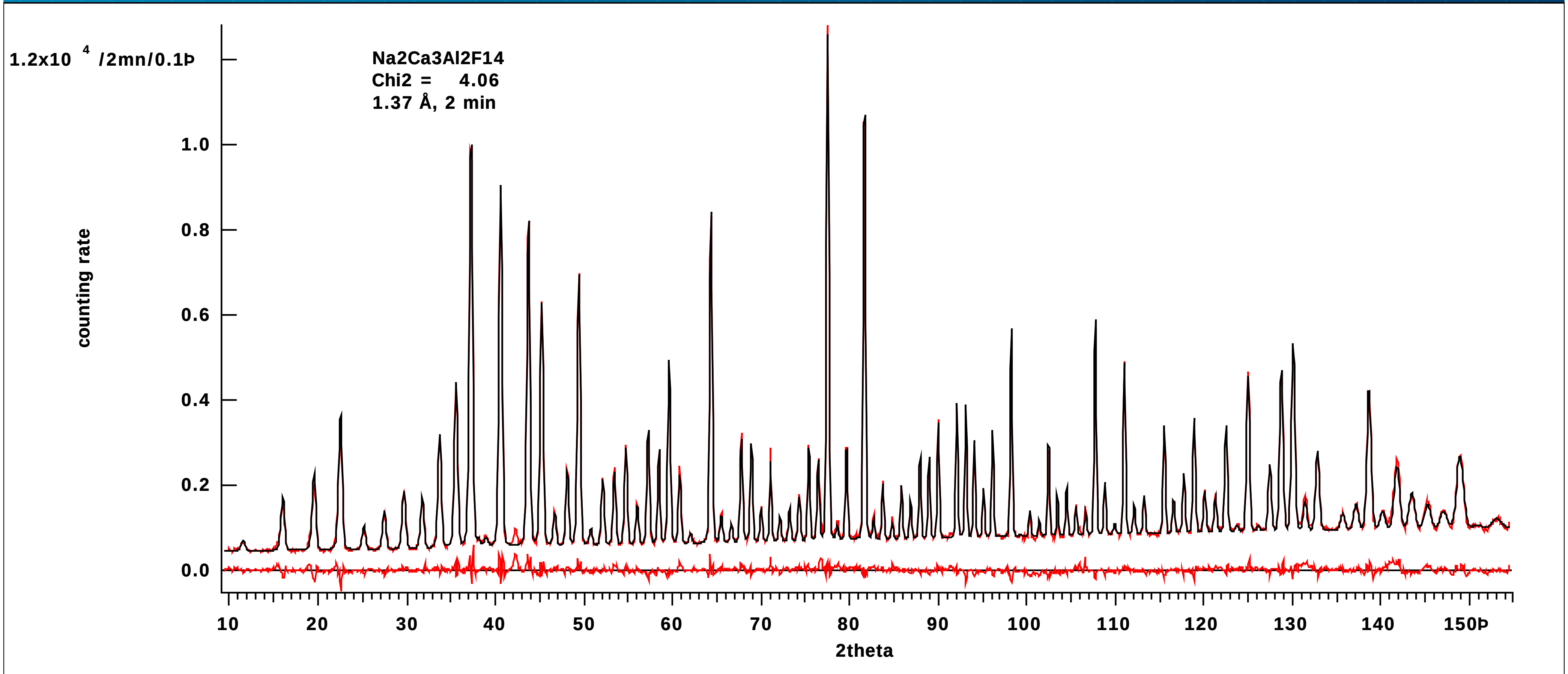
D20 – High Resolution but still very Fast

T.Hansen, P.Henry, P.Fischer

D20 is very fast (chemical kinetics)

Thomas Hansen (2003) ILL News, June 2003

2 minute D20 data for a ~700 mm^3 sample of $Na_2Ca_3Al_2F_{14}$



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 $Y_3Al_5O_{12}$

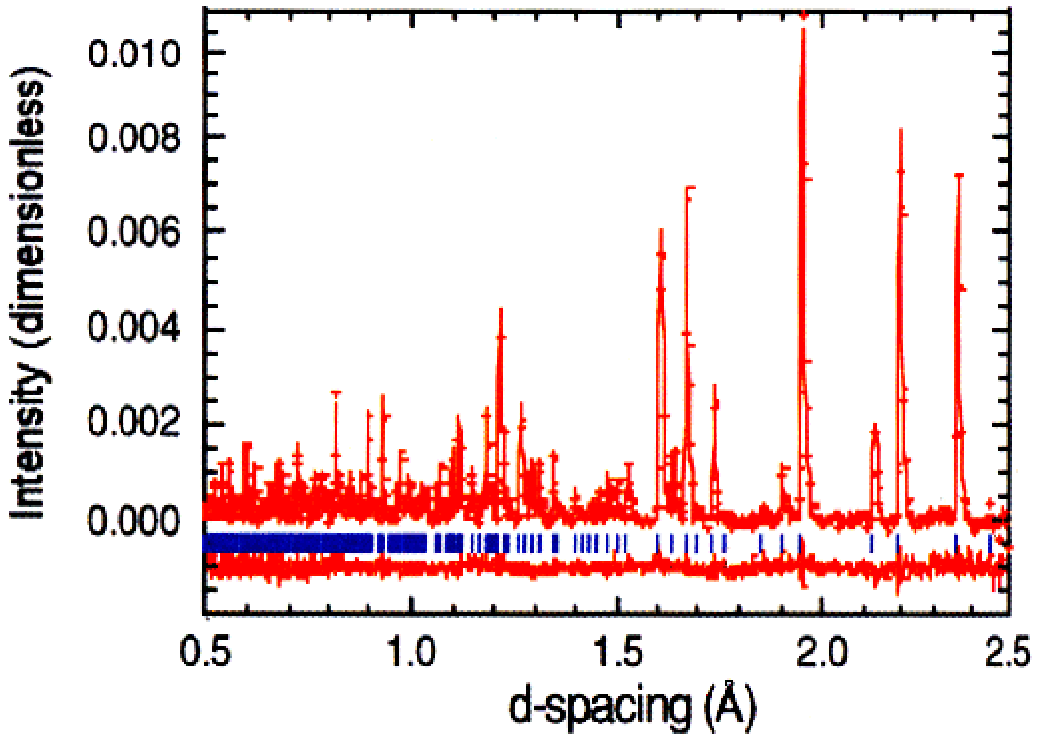


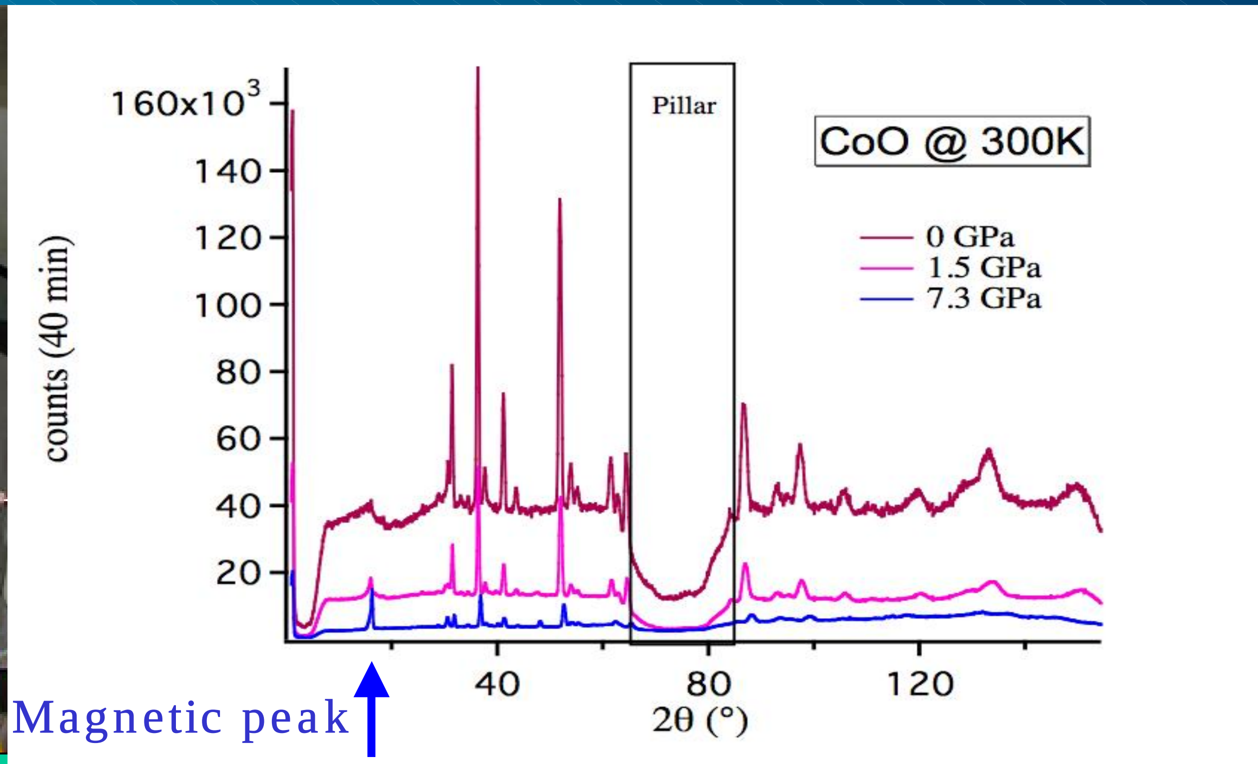
Fig. 7. Rietveld Refinement plot for a 2 mm^2 sample of Yttrium Iron Garnet (YAG), after an overnight data collection.

D20 – High Pressures, Small Samples

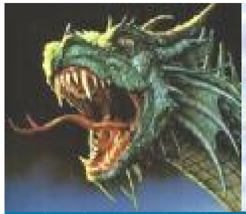
D20 with “large” Paris-Edinburgh Pressure Cell (50 Kg)

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



Comparison of TOF & CW Diffractometers

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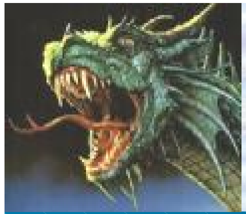
Efficiency for a given resolution = time averaged flux on the sample
* sample volume
* detector solid angle

Large detectors + high flux on the sample

Comparison of TOF & CW Diffractometers

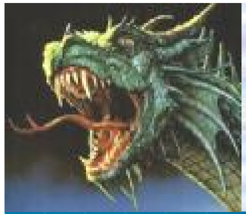
	D20	GEM
time averaged sample flux	$5x10^7$	$\sim 2x10^6$
detector solid angle	0.27 sr	4.0 sr
efficiency	1.7	1



Comparison of TOF & CW Diffractometers

	D20	GEM	DRACULA
time averaged sample flux	$5x10^{7}$	$\sim 2x10^{6}$	$\sim 10^{8}$
detector solid angle	0.27 sr	4.0 sr	1.5 sr*
efficiency	1.7	1	18

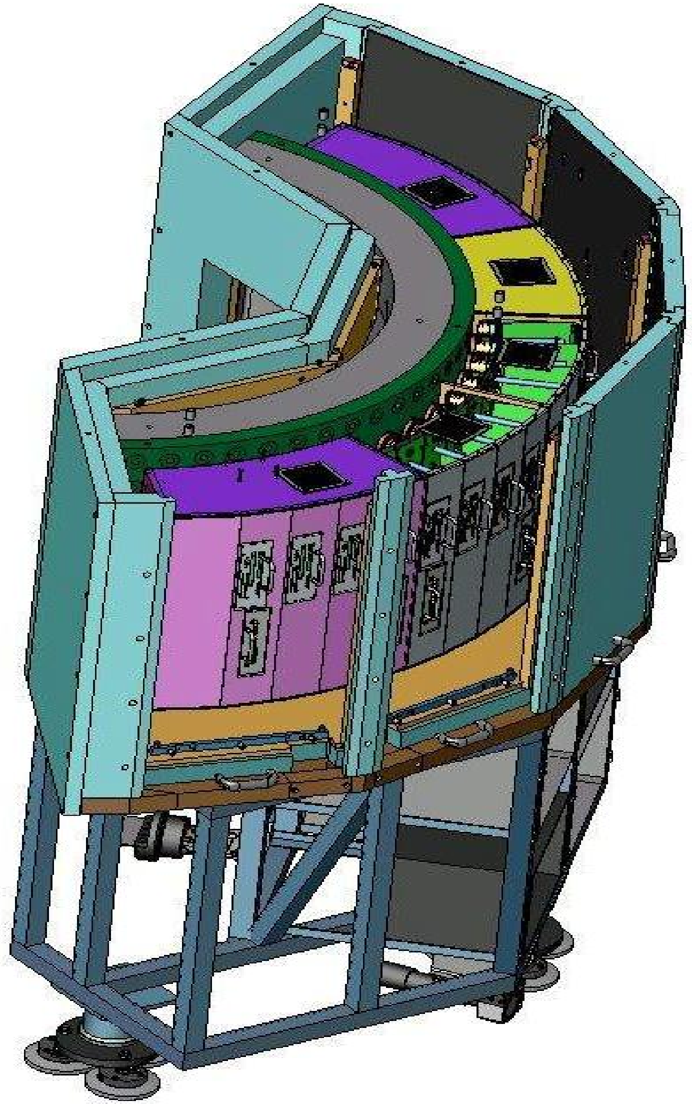
* Based on new D19 detector: R=760 mm, h=400 mm, 800 linear resistive wires covering 30ºx160º



Comparison of TOF & CW Diffractometers

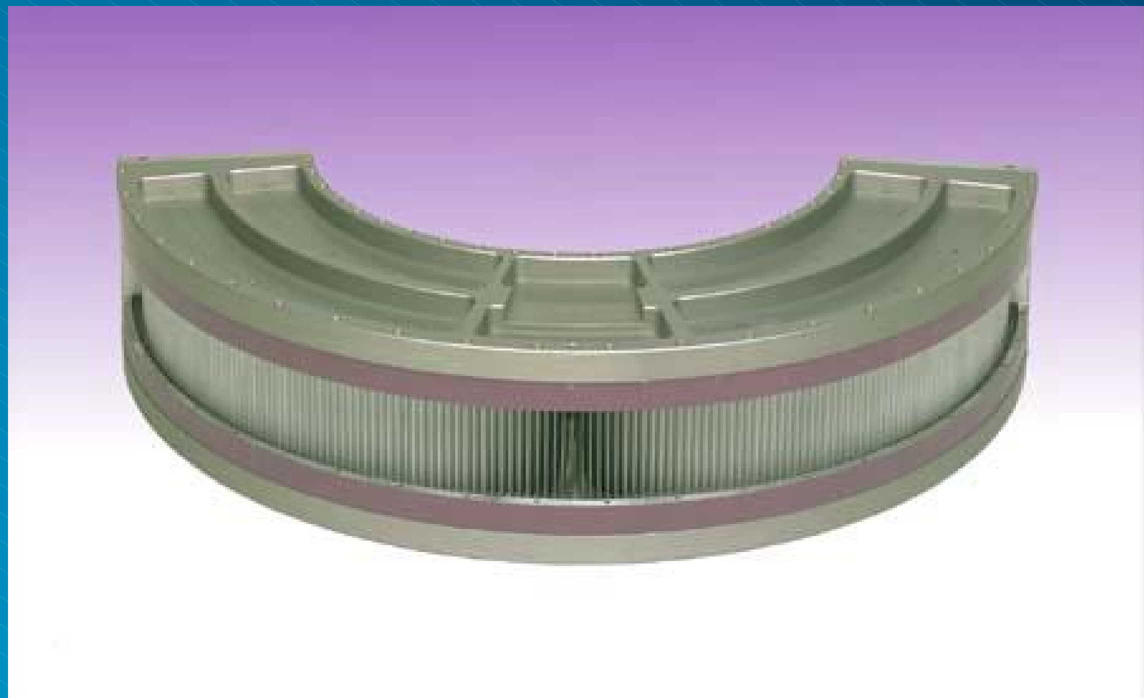
	D20	GEM	DRACULA	US-SNS
time averaged sample flux	$5x10^7$	$\sim 2x10^6$	$\sim 10^8$	$\sim 2.5x10^7$
detector solid angle	0.27 sr	4.0 sr	1.5 sr*	3.0 sr
efficiency	1.7	1	18	9

* Based on new D19 detector: R=760 mm, h=400 mm, 800 linear resistive wires covering 30ºx160º



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

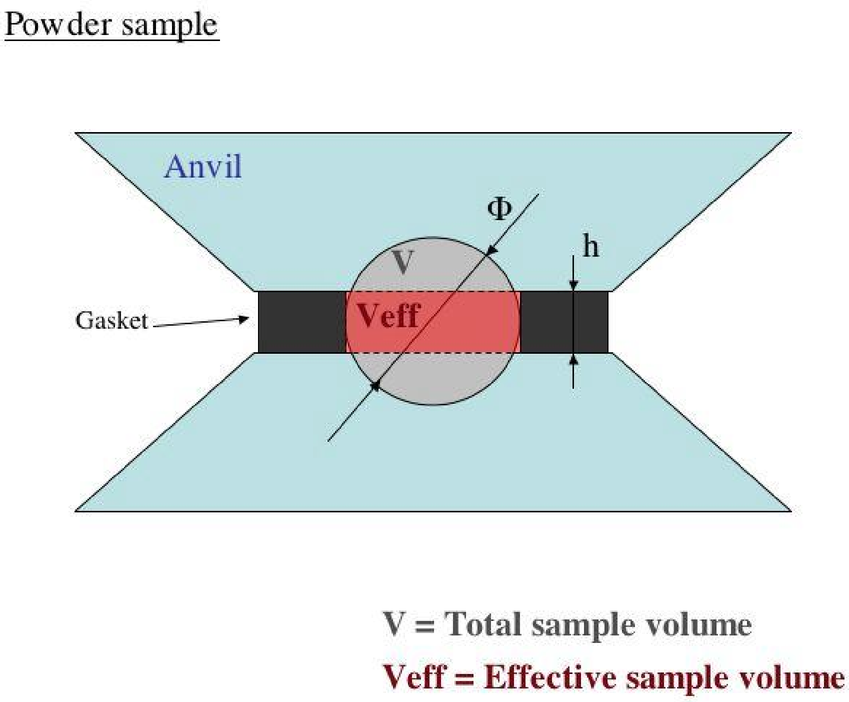


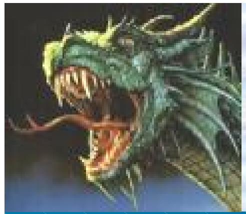
DRACULA
A Small Sample, High Pressure Diffractometer

Very High Pressure with Small Samples at Low Temperature

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

ILL Compact Paris-Edinburgh cell 10 GPa
180mm diameter cell. Useful sample ~4mm^3



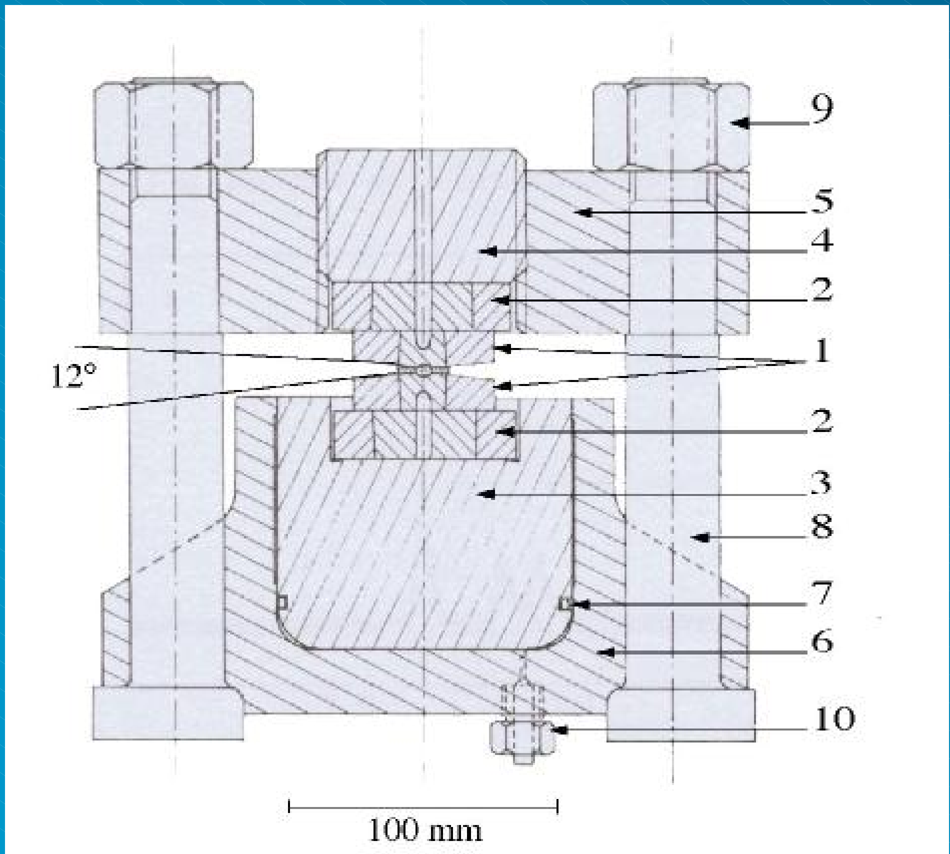


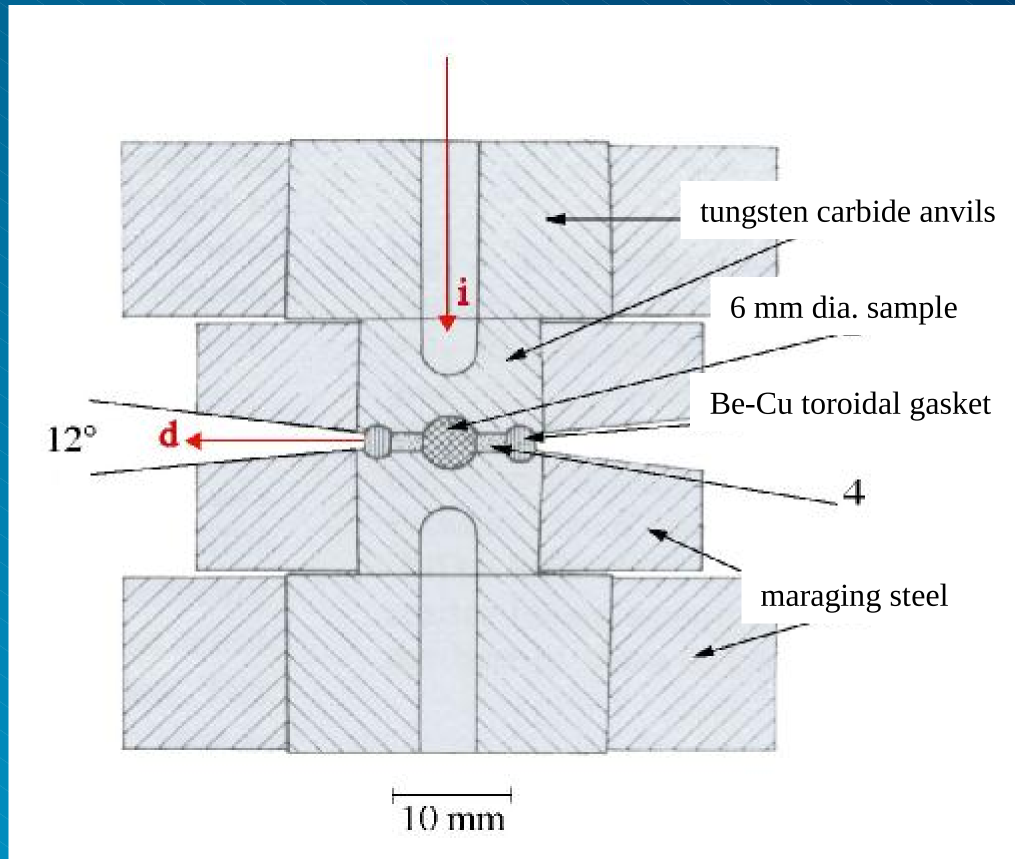
DRACULA

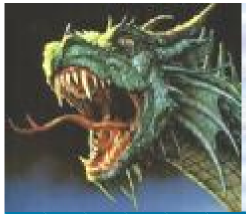
A Small Sample, High Pressure Diffractometer

Very High Pressure with Small Samples at Low Temperature

ILL Compact Paris-Edinburgh cell to 10 GPa. 180mm diameter cell. Useful sample ~4mm³



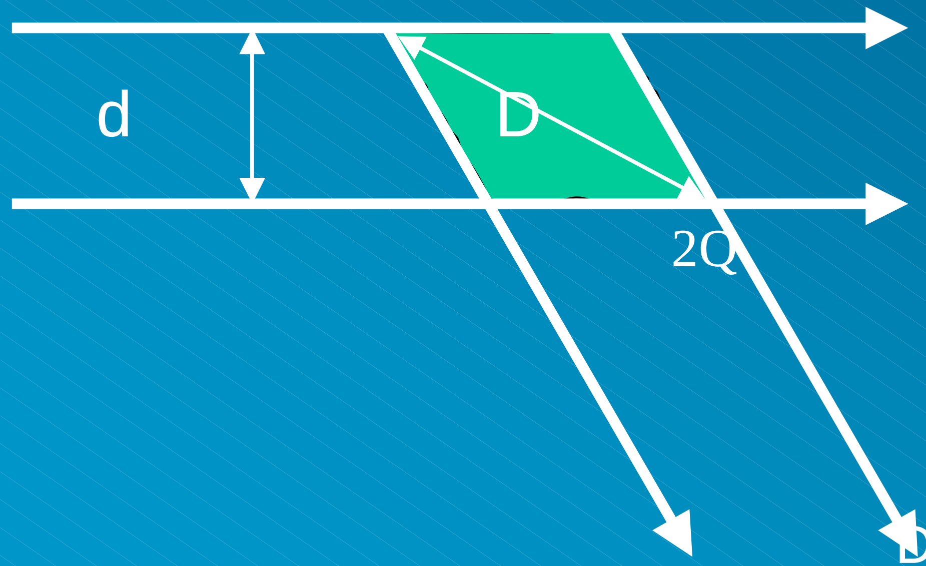




DRACULA
A Small Sample, High Pressure Diffractometer

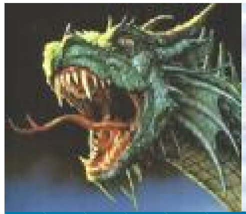
Large detector on a reactor near 90 degree scattering

±15º vertical as for the new D19 detector cf ±6º for new Paris-Edinburgh cell
±30º horizontal ie 2Q = 60º - 120º (maximum range of scattering angles)



d = diameter of the incident beam
D = diameter of scattering volume
= d/sinQ
= dÖ2 minimum at 2Q = 90º
= 2d maximum at 2Q = 60º & 120º

D = 5mm – 7mm for 2Q = 60º - 120º



DRACULA
A Small Sample, High Pressure Diffractometer

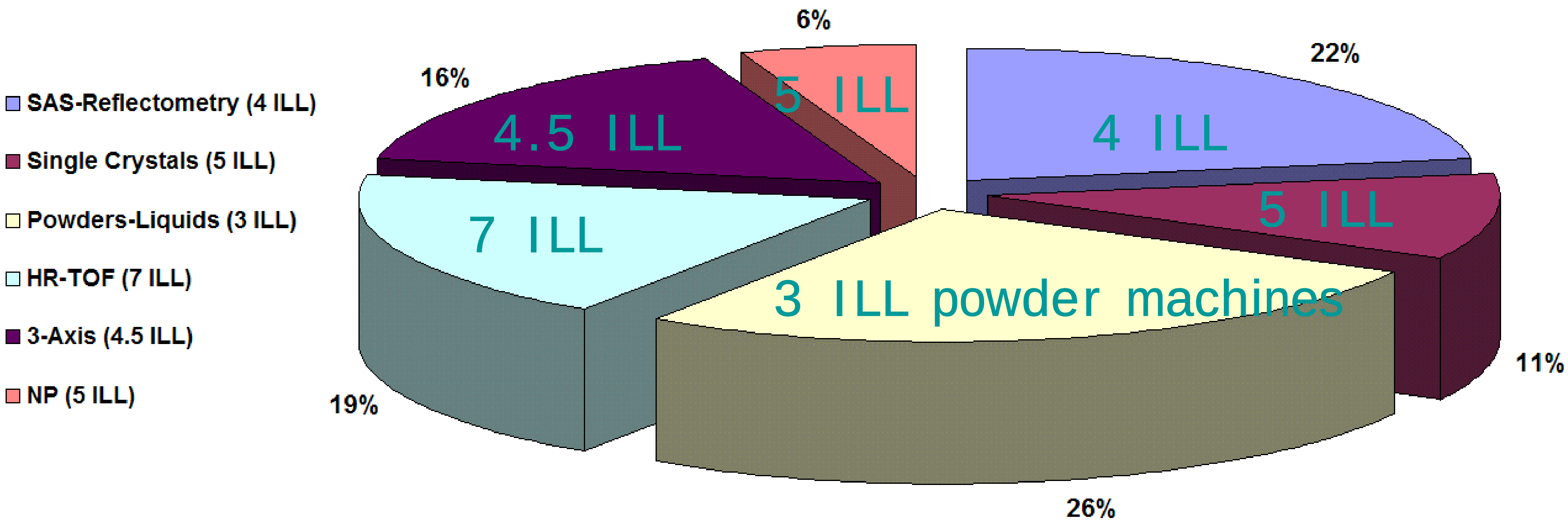
Can we obtain all d-spacings with a 2Q range of 60º-120º ?

Use a large focusing Ge monochromator near 90º take-off to obtain several l

[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

DRACULA
A Small Sample, High Pressure Diffractometer

At present only 3 ILL machines for more than ¼ of all proposals



DRACULA
A Small Sample, High Pressure Diffractometer

Can we compete with the Americans while waiting for ESS ?

Yes, but we must…

- 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