Progress with DRACULA ?

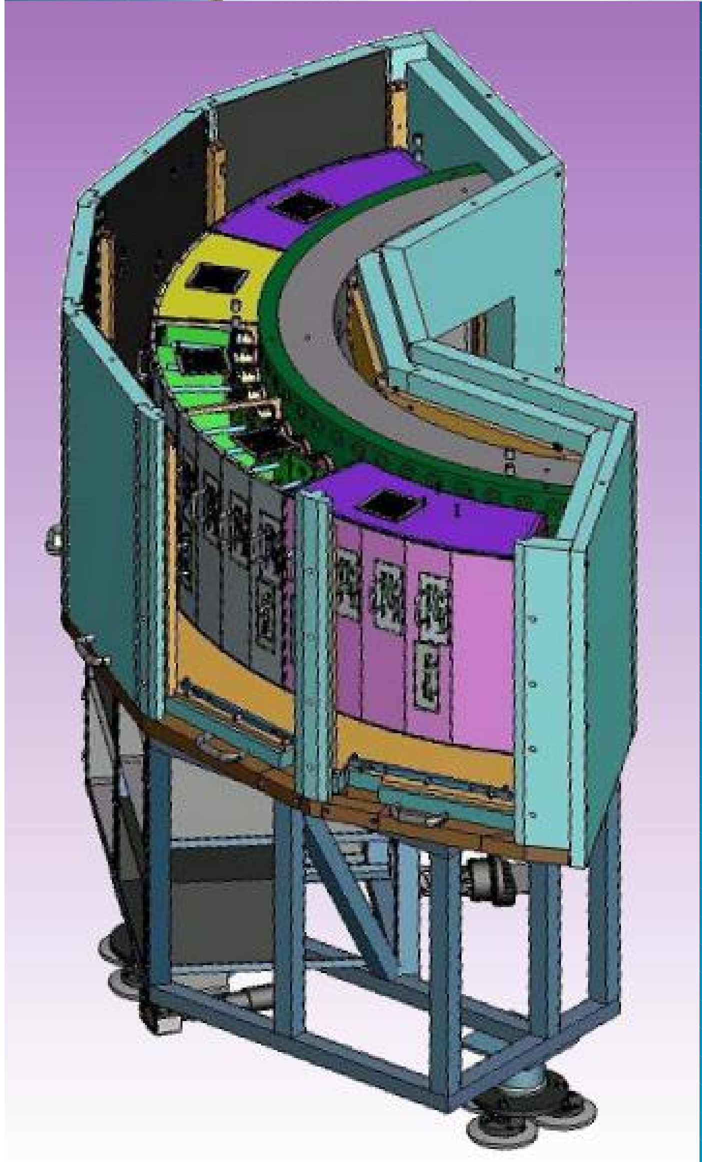
Diffractometer for
Rapid
ACquisition
Ultra
Large
Areas

DRAC, first presented at the ILL “Instrument Day” 26 Feb 2002

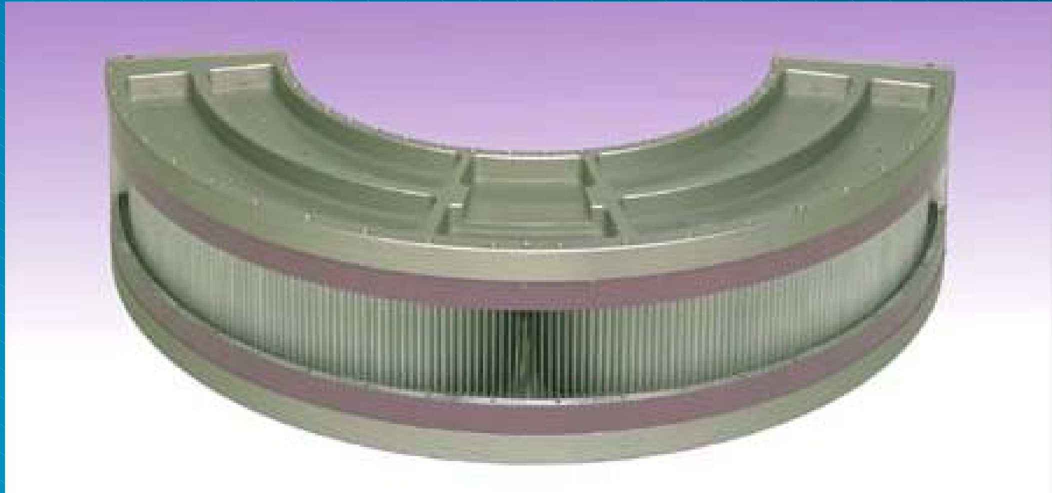
DRAC, highest priority for Instrument Committee 17 Oct 2003

Pilgrims Progress…

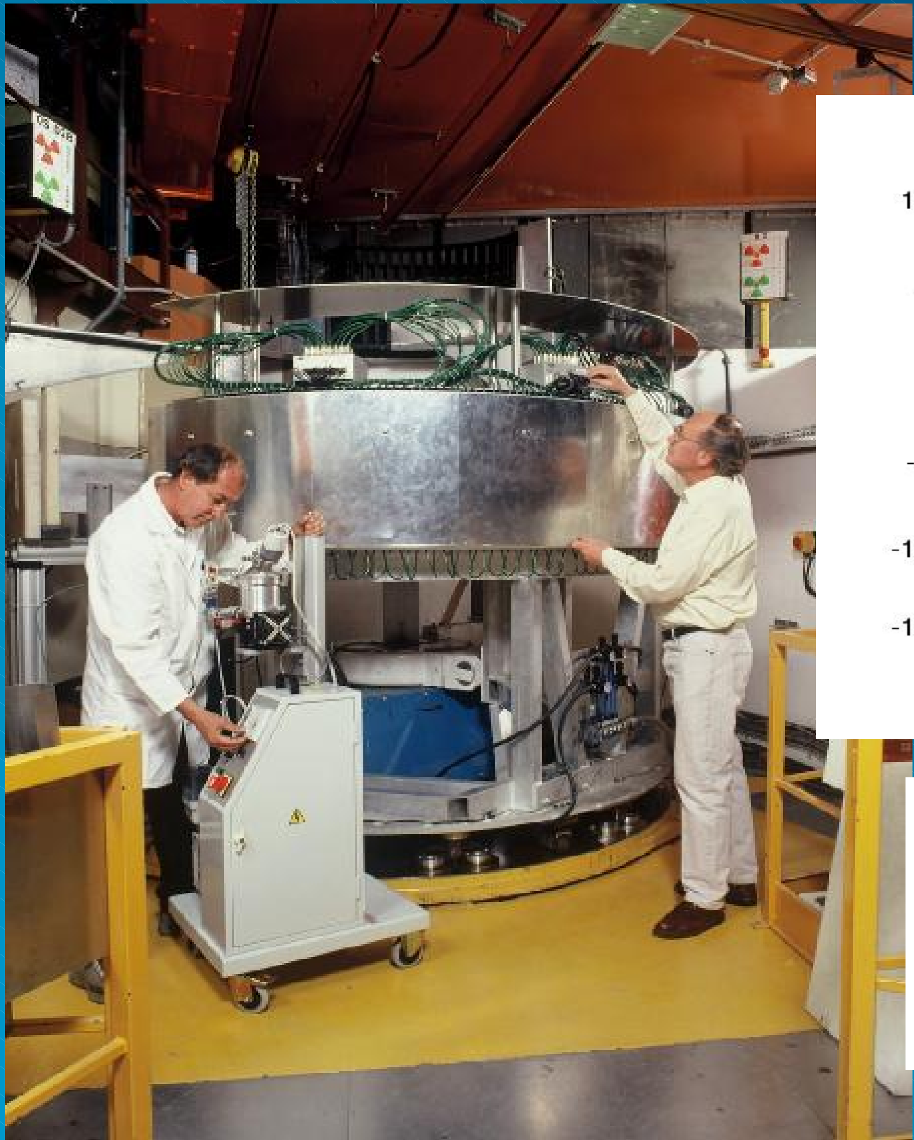
DRACULA - What do we want to do ?



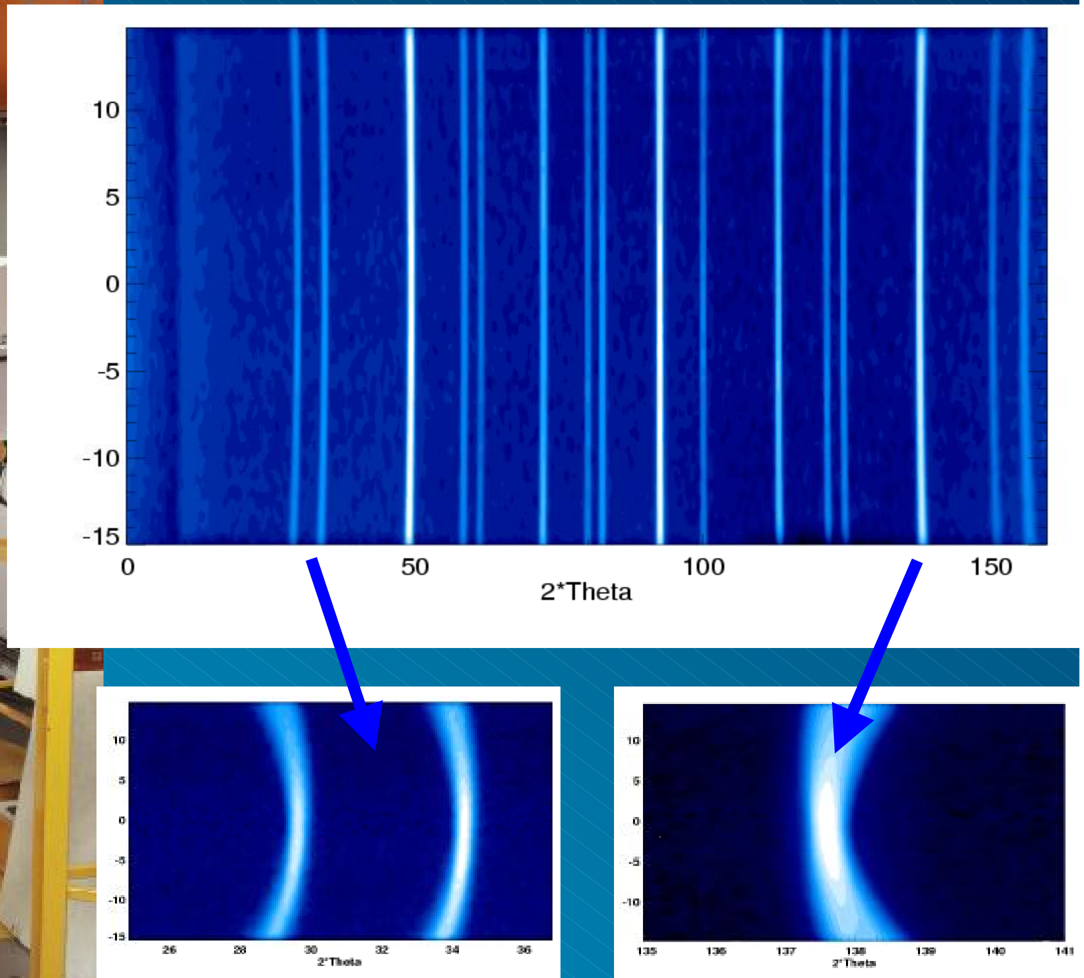
- Large, compact 2D area detector (cf D19)
- Order of magnitude faster than D20
- Competitive in speed to best SNS machine
- Moderate resolution over whole detector
- Special sample environments, v.small samples
- Radial collimator, Low background



2D detectors for CW Powder Diffraction
Super-D2B, SPODI at FRM2, ANSTO…

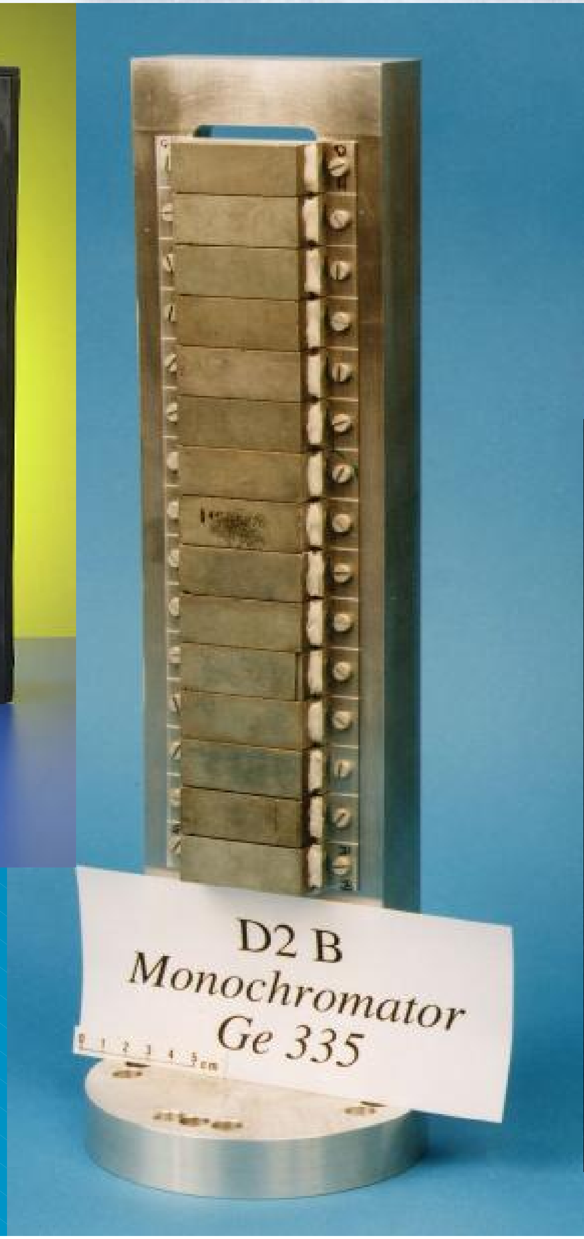


UK-EPSRC Super-D2B project at ILL



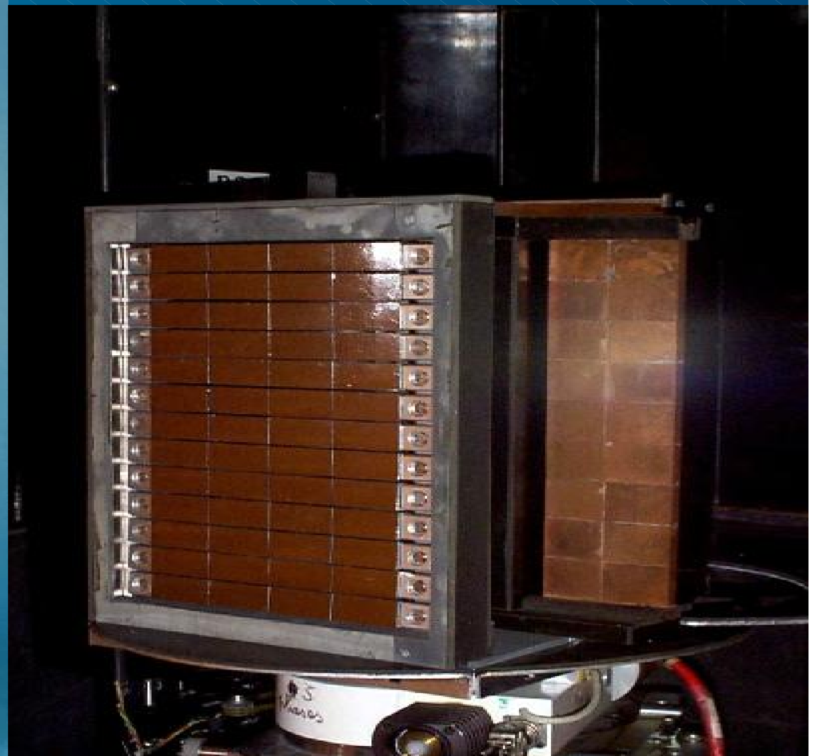
E.Suard, C.Ritter, A.Hewat, P.Attfield… (Edinburgh)

Big monochromators give very high flux
D2B, D20, IN8…

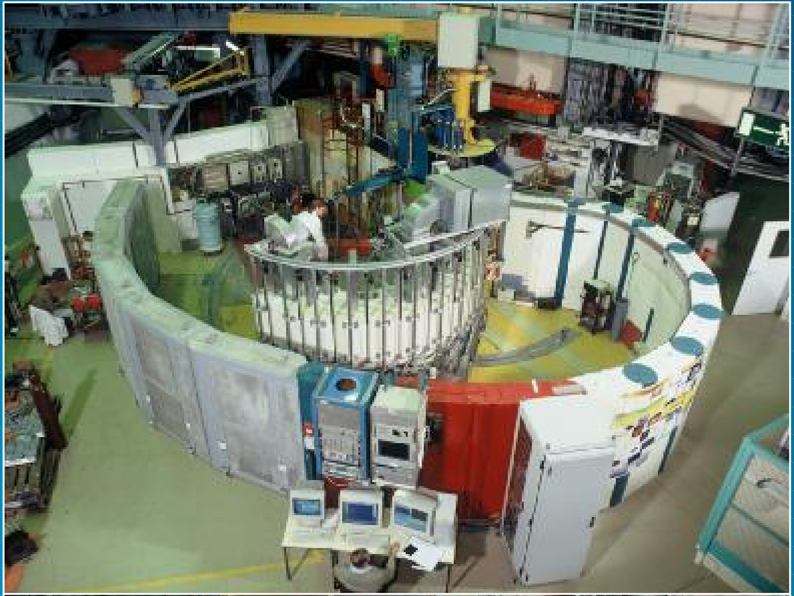


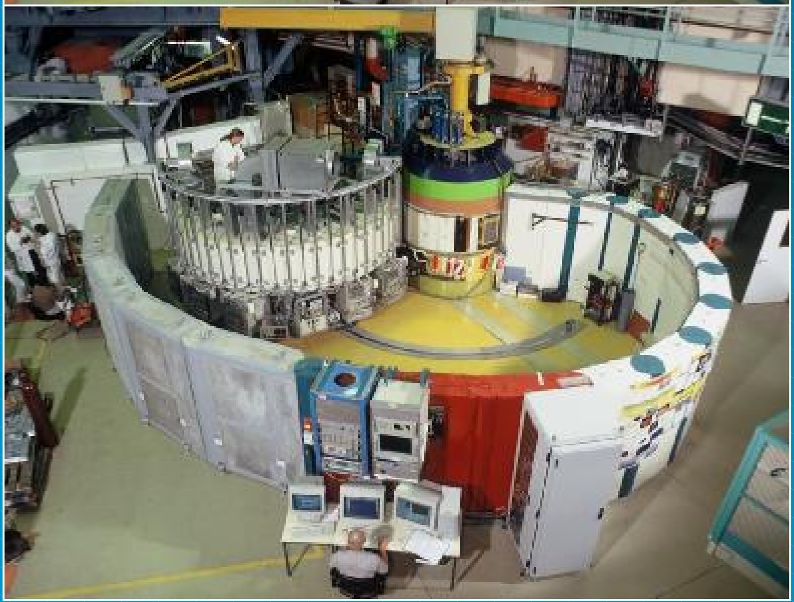
Very high flux on the sample

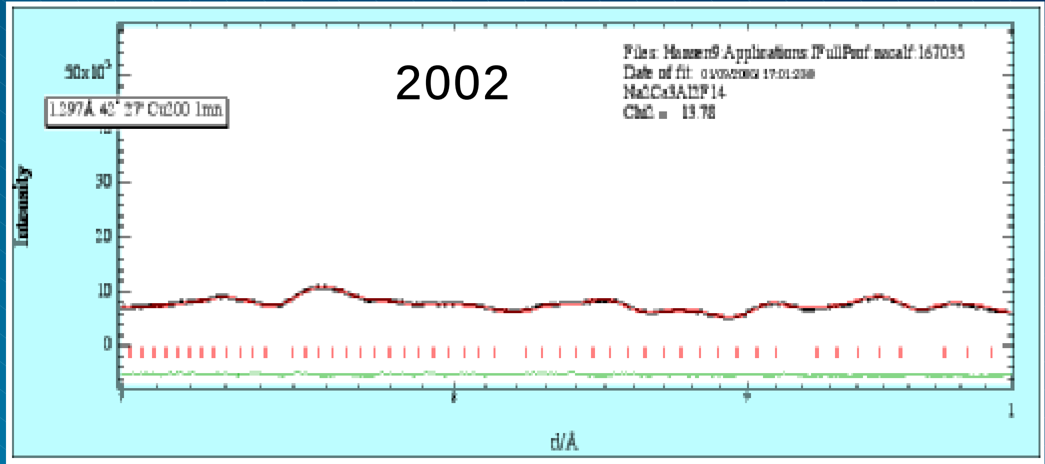
- D2B 1.0×10^{7} $n.cm^{-2}.sec^{-1}$
- D20 9.8×10^{7} $n.cm^{-2}.sec^{-1}$
- IN8 6.5×10^{8} $n.cm^{-2}.sec^{-1}$



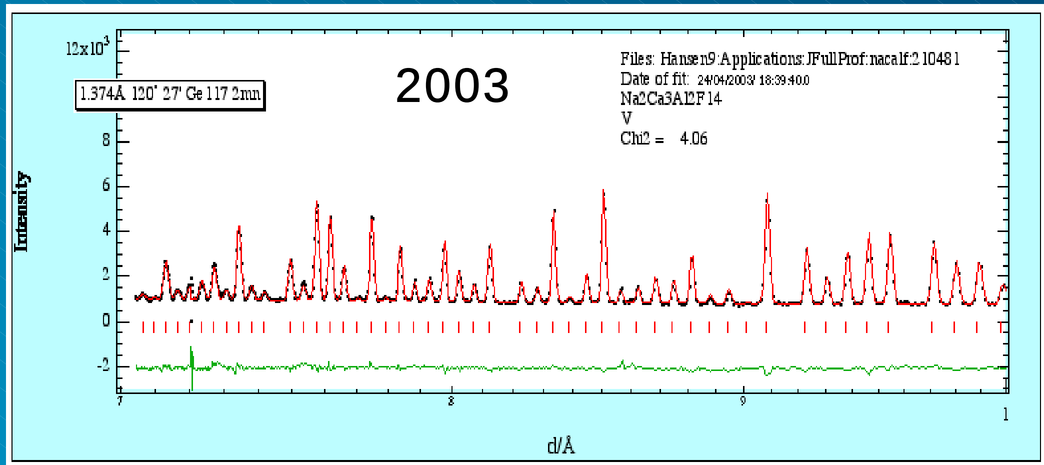
High flux compatible with good Resolution
High take-off option on D20





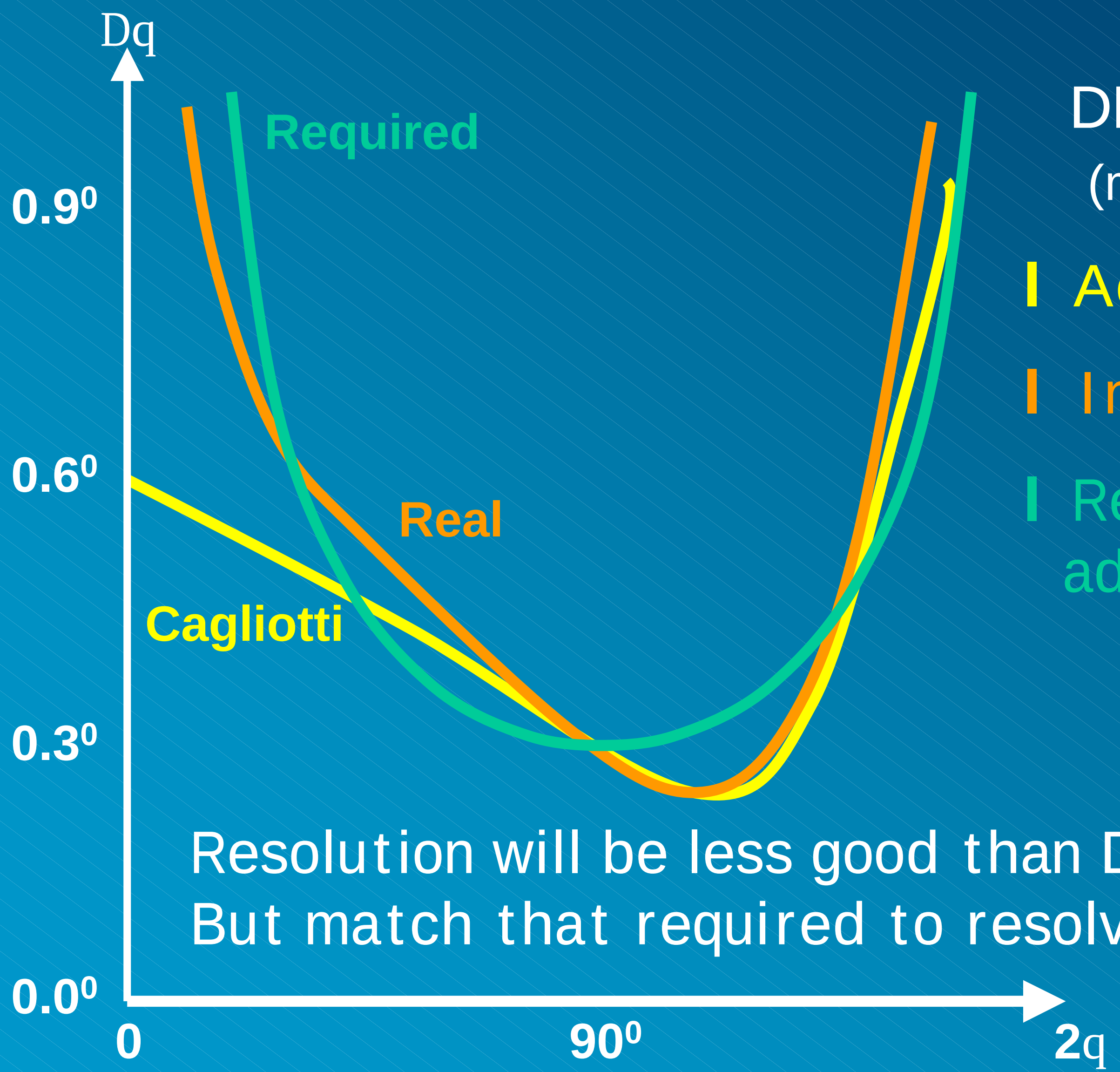


Before and After (data in 2 min.)



Higher D20 resolution since 2003

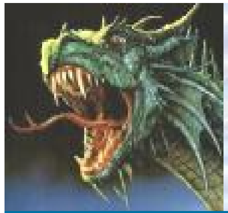
High flux compatible with good Resolution
DRACULA resolution matches peak density



DRACULA resolution
(minimum Dd/d~3*10^{-3})

- According to Caglioti
- Including vertical div.
- Required to resolve adjacent peaks

Resolution will be less good than D20 “hi-resolution”
But match that required to resolve adjacent peaks



Shoot the Dragon…

Pulsed Source are Best

I agree…

- Provided Europe has a high flux pulsed source (ESS)
- For very high resolution backscattering…
- But not for high intensity, moderate resolution
- We cannot compete with the American SNS if we only have ISIS, a medium flux pulsed source…

Comparison of TOF & CW Diffractometers

Jorgensen, J.D., Cox, D.E., Hewat, A.W., Yelon, W.B (1984)

"Scientific opportunities with advanced facilities for neutron scattering"

Shelter Island Workshop, 1984

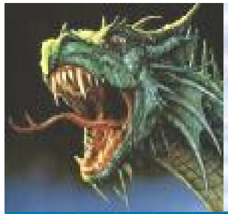
Nuclear Instruments and Methods in Physics Research B12 (1985) 525-561

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

P.G. Radaelli, S. Hull, H.J. Bleif & A. M. Balagurov (2001)

ESS Instrumentation Group Reports

"Powder Diffraction Instruments"



Comparison of TOF & CW Diffractometers

The time-averaged Flux*Detector criterium

With big detectors we can compete with the SNS

The time-average sample flux is higher on a CW source.

	D20	GEM	DRACULA	SNS
Flux average on sample	$5x10^7$	$\sim 2x10^6$	$\sim 10^8$	$\sim 2.5x10^7$
Detector solid angle	0.27 sr	4.0 sr	1.5 sr*	3.0 sr
Efficiency=Flux*Detector	1.7	1	18	9

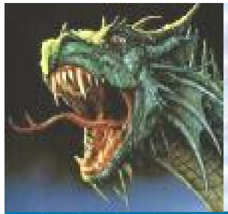
* Based on new D19 detector: R=760 mm, h=400 mm, 800 linear resistive wires 30^ox160^o

A High Resolution SNS Powder Diffractometer

B.E.F. Fender and A.W. Hewat, Jan. 78

The HRPD proposed for the Rutherford SNS[1] is essentially Steichele's original design[2,3,4], as developed on a pulsed source by Windsor and Sinclair[5], but with the following features. For comparison with a conventional HRPD see also Fender[6] and Hewat[7].

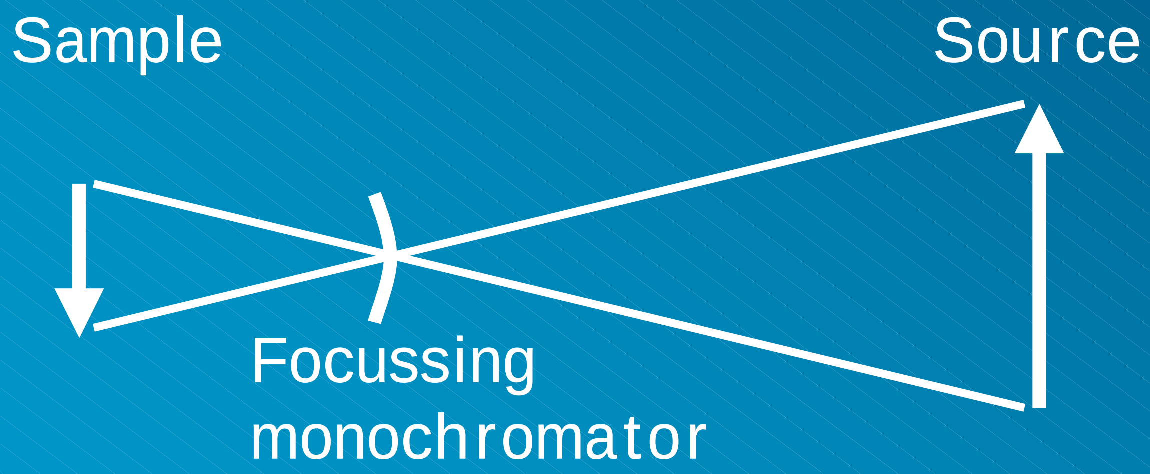
Constructed as HRPD at ISIS



Why is sample flux so high from a reactor?

A: Large vertically focusing monochromators ?

No ! Focusing in real space only
gives a factor of x2 or x3

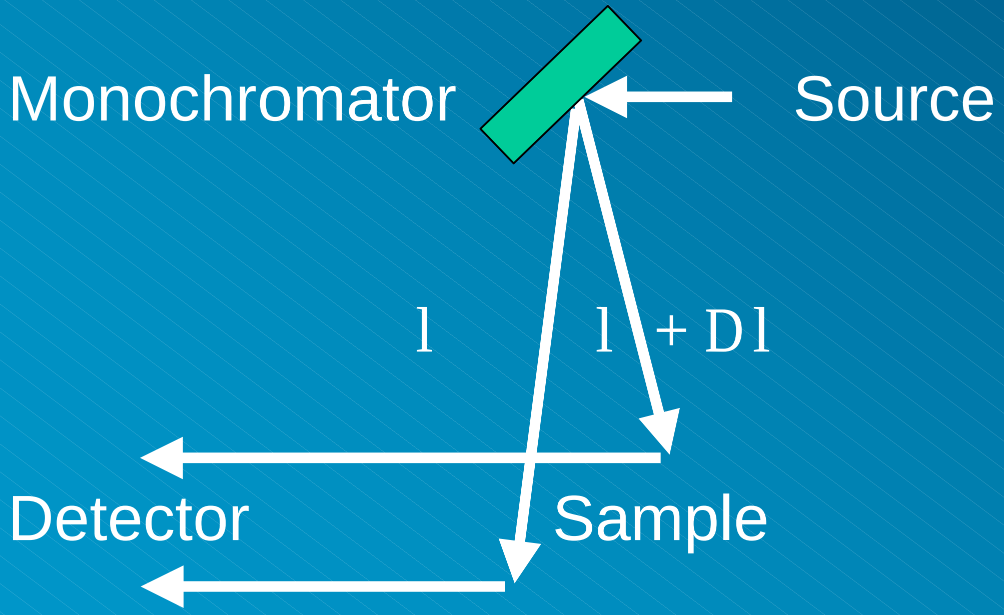


cf use of convergent guide with TOF

Why is sample flux so high from a reactor?

A: Large wavelength-band focusing monochromators ?

Yes ! Focusing in reciprocal space
can give a factor of x10

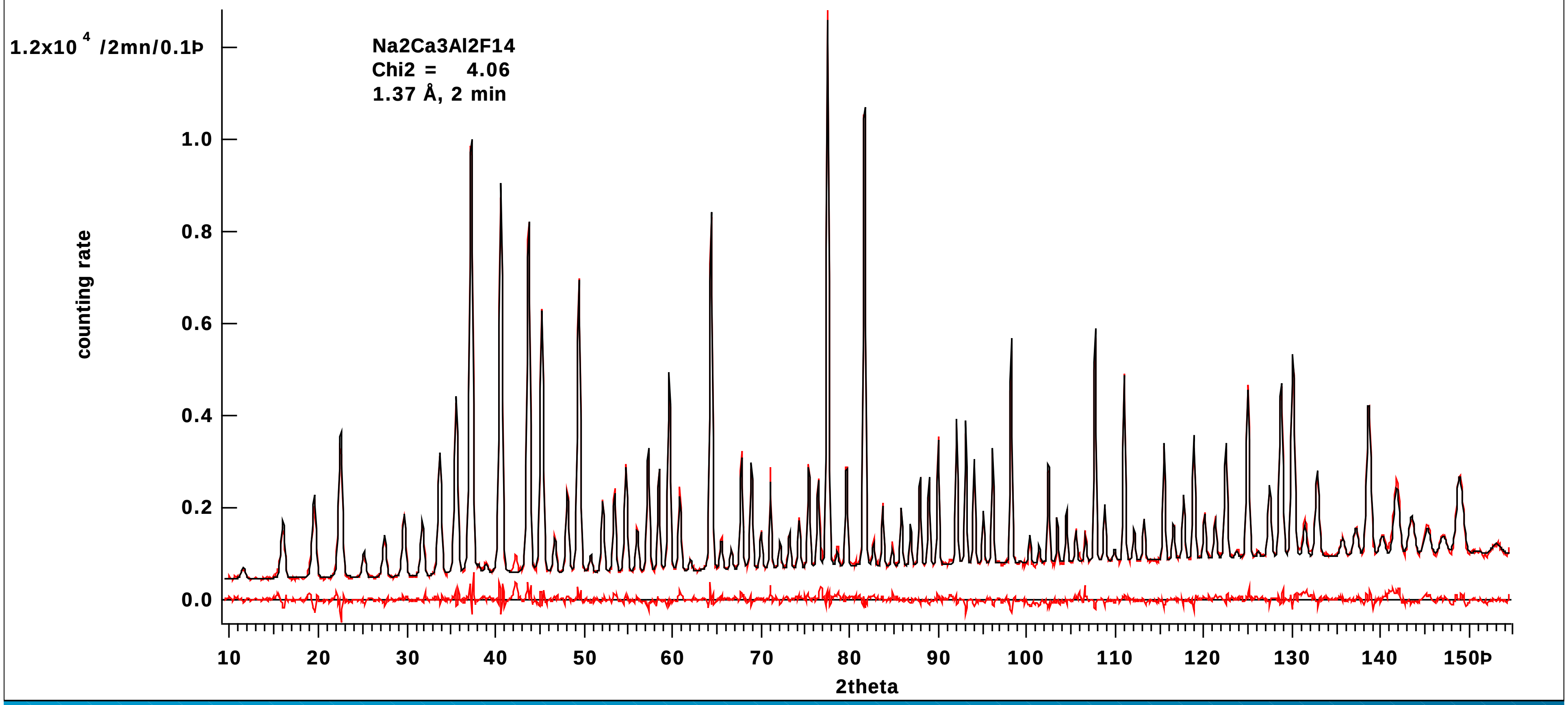


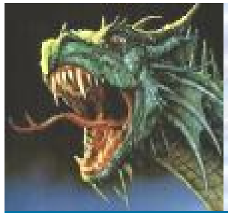
$\Delta d/d \sim 0.1\%$ for $\Delta\lambda/\lambda \sim 1\%$

D20 – Good Resolution but still very fast

Thomas Hansen (2003) ILL News, June 2003

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





Shoot the Dragon…

No Money/Manpower

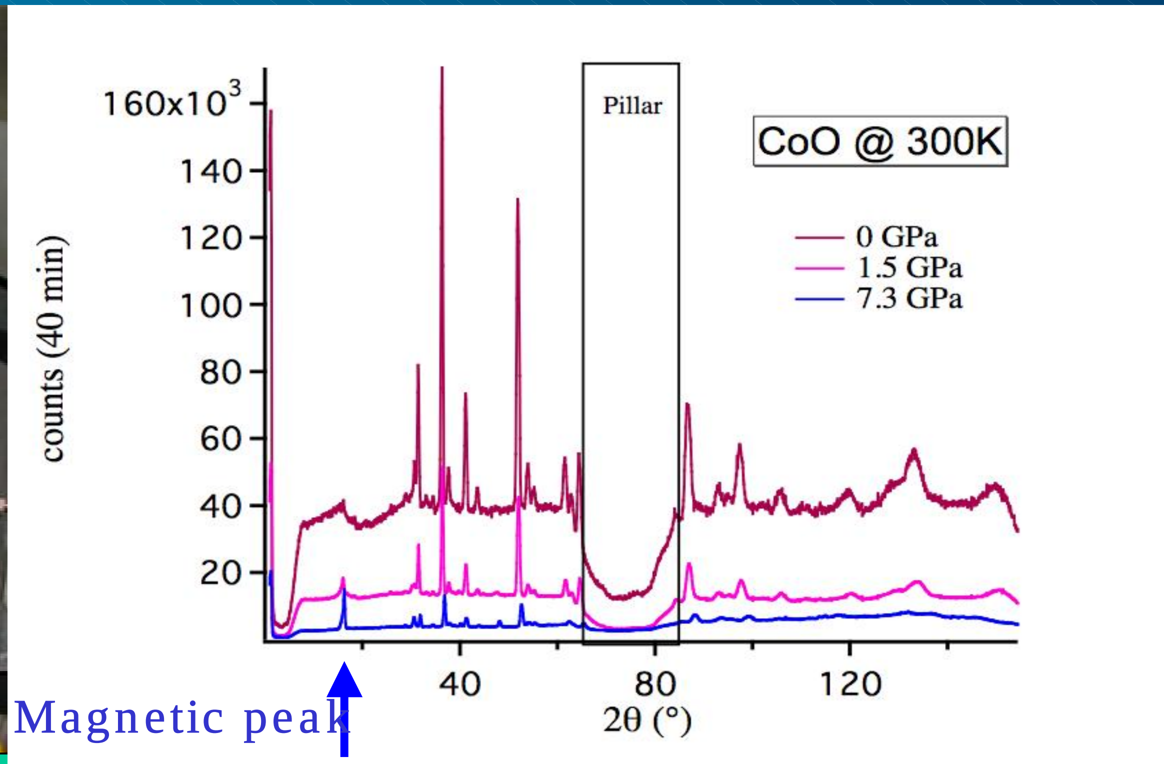
Don't believe it !

- We have EPSRC money unclaimed from the D2B project
- We have CCLRC money promised for new instruments…
- We propose using detectors already developed for D19
- The D19 detector is being built by ILL staff on CDD's
- CCLRC money is for the "full cost" materials+manpower

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

Kernavanois et al. (2003) Advanced Millennium Pressure Project

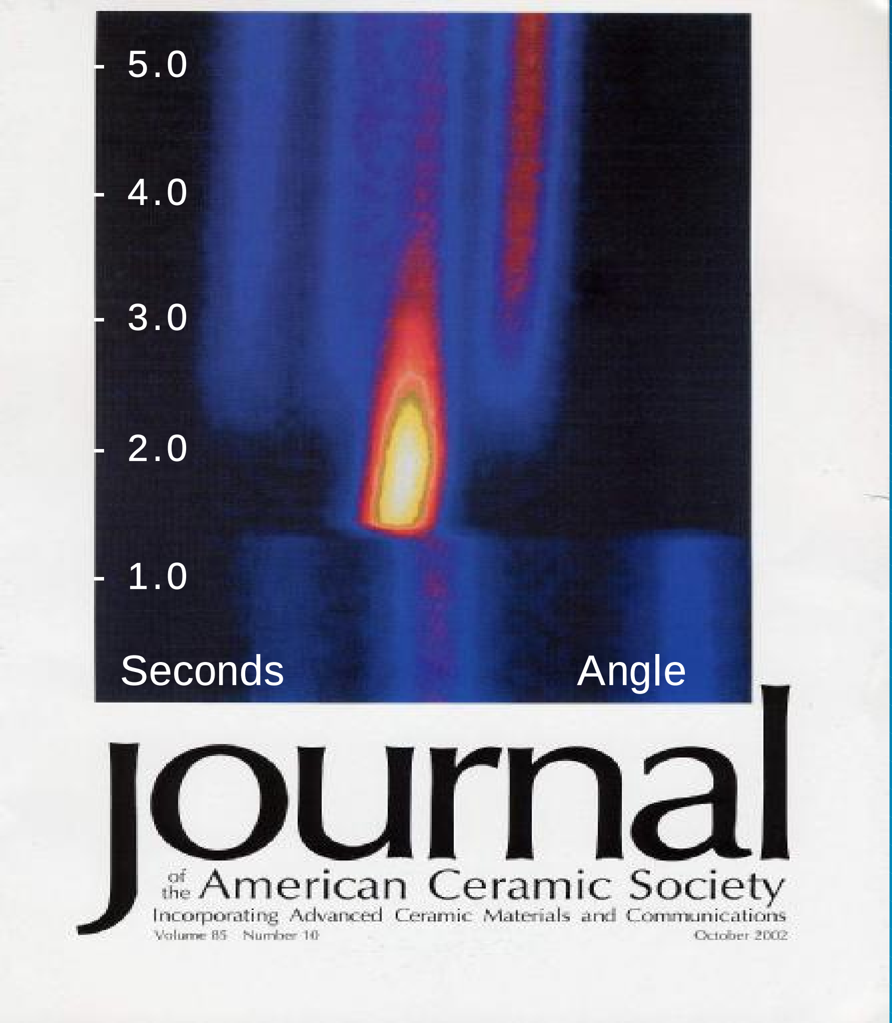
40 minute D20 data for a 100 mm^3 sample of CoO at 7.3 GPa



BUT low temperatures –> smaller cells -> 1-10 mm^3 samples

Applications –Small Samples, Fast Detectors

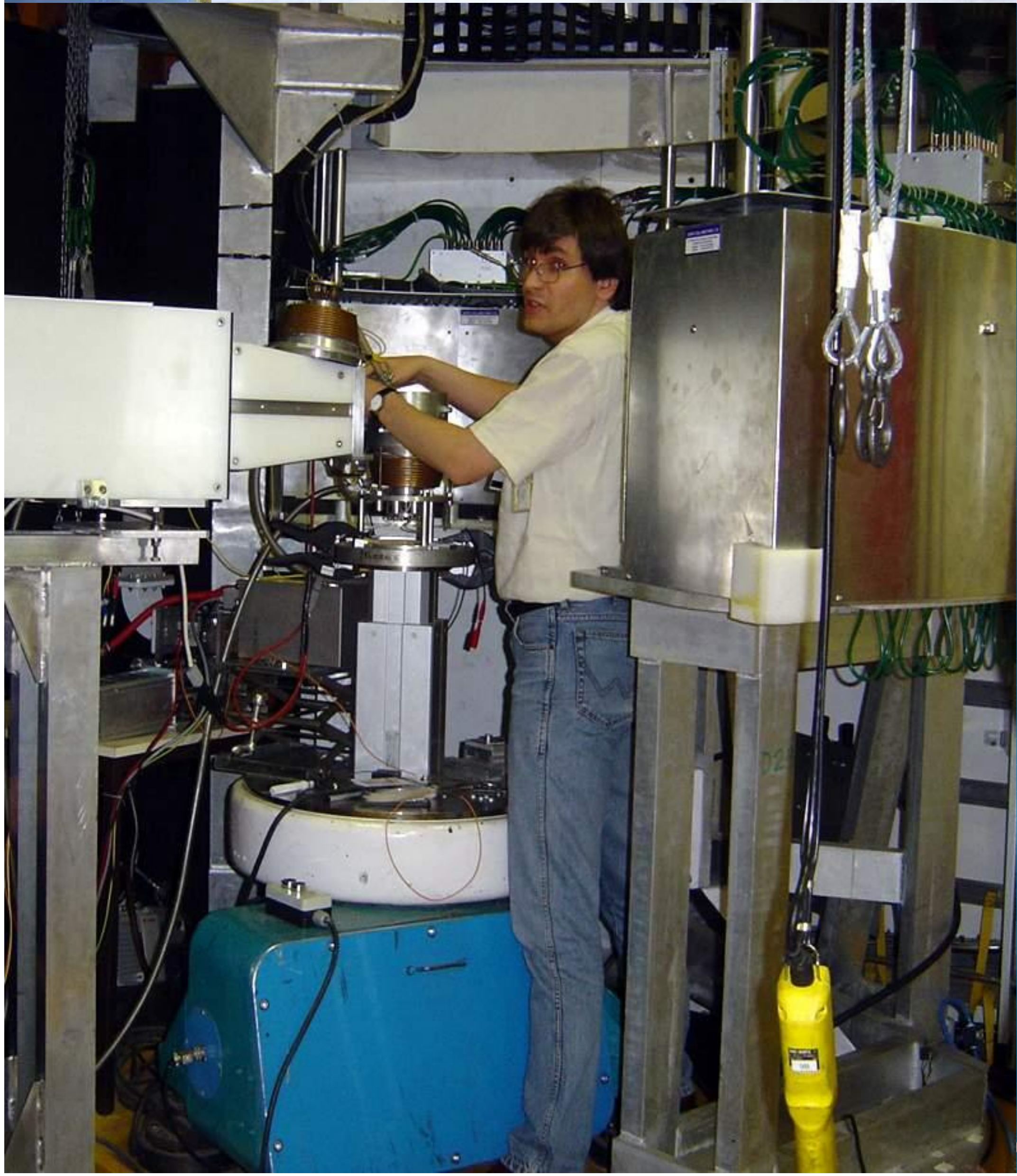
Very fast chemical and electrochemical kinetics



- 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

D.Riley, E.Kisi, T.Hansen, A.Hewat (2002)

Applications –Samples, Complex environments



High-T Microwave Furnace

Super-D2B (Boysen et al.)

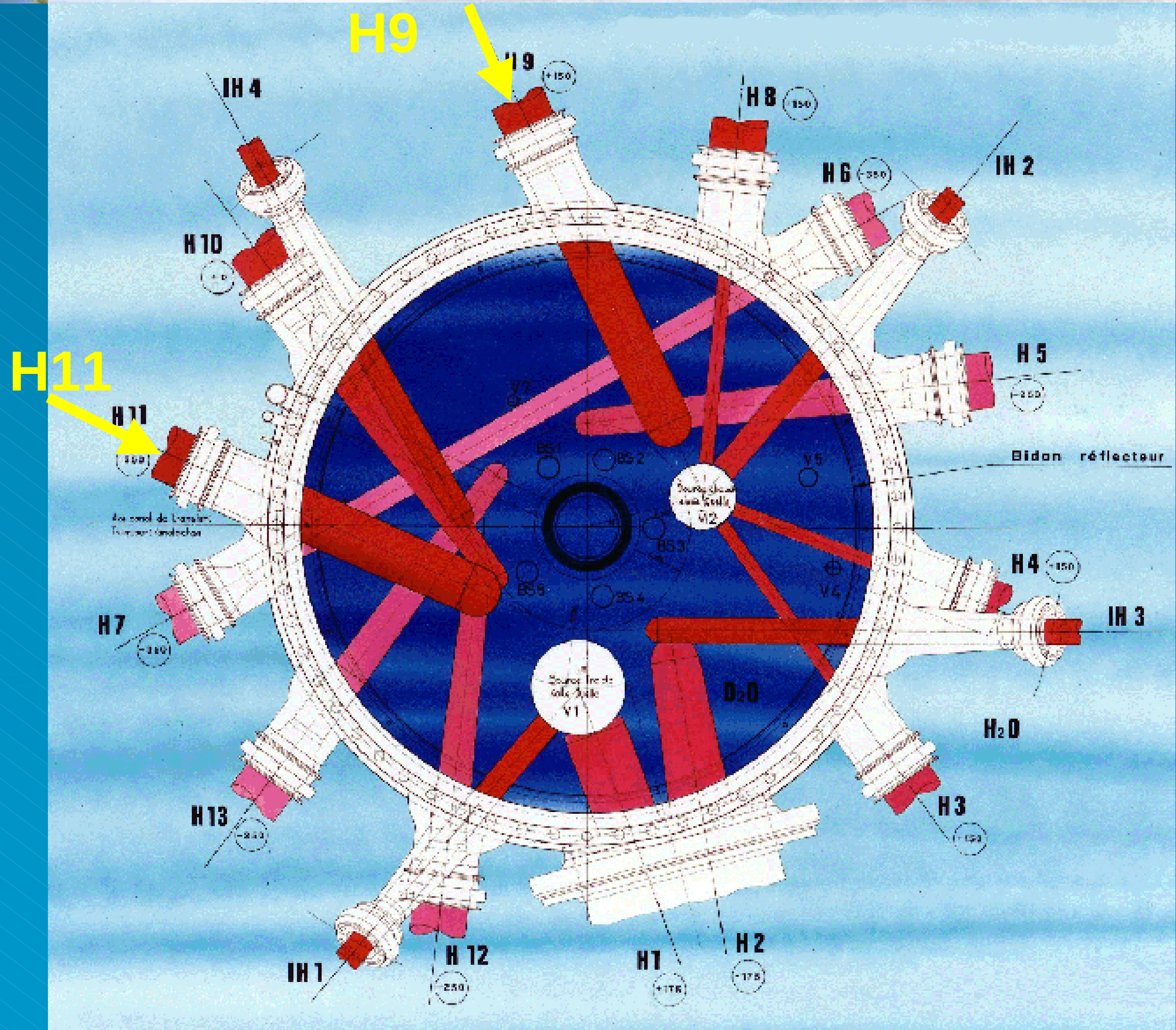
…with Carsten Korte from Giessen (2004)

Shoot the Dragon…

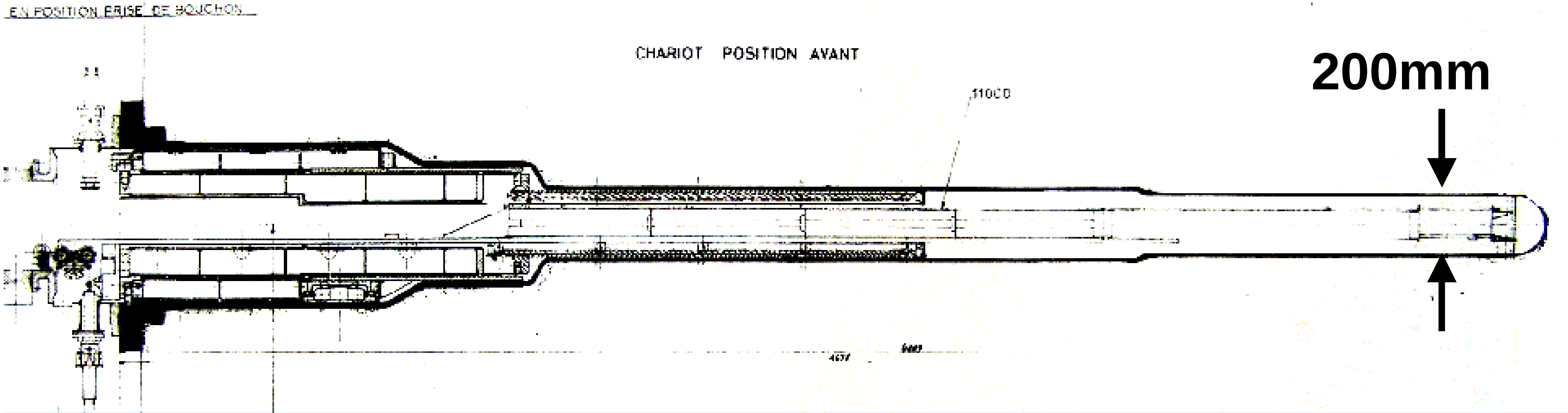
No Available Beam Tube

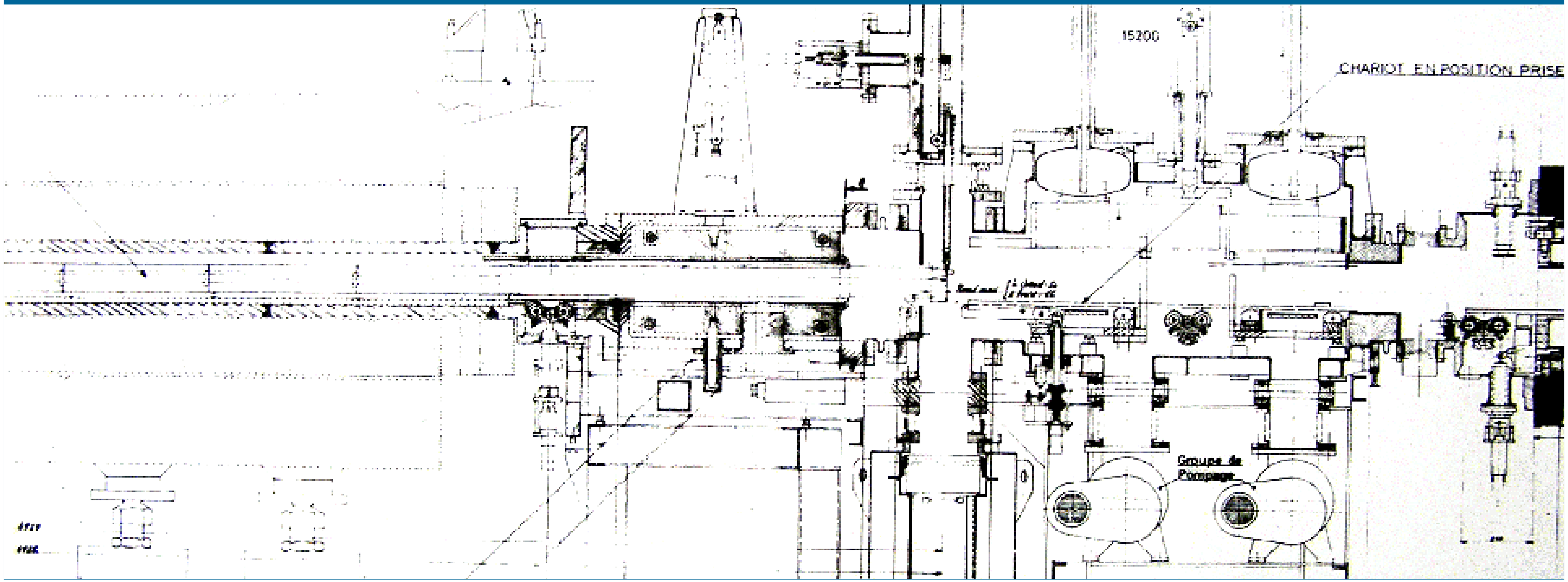
- DRACULA needs a high flux thermal beam tube
- The H9 beam tube has ILL’s highest flux
- Similar requirements for TOMOGRAPHY & DRACULA

High Flux ILL Thermal Beam-Tubes

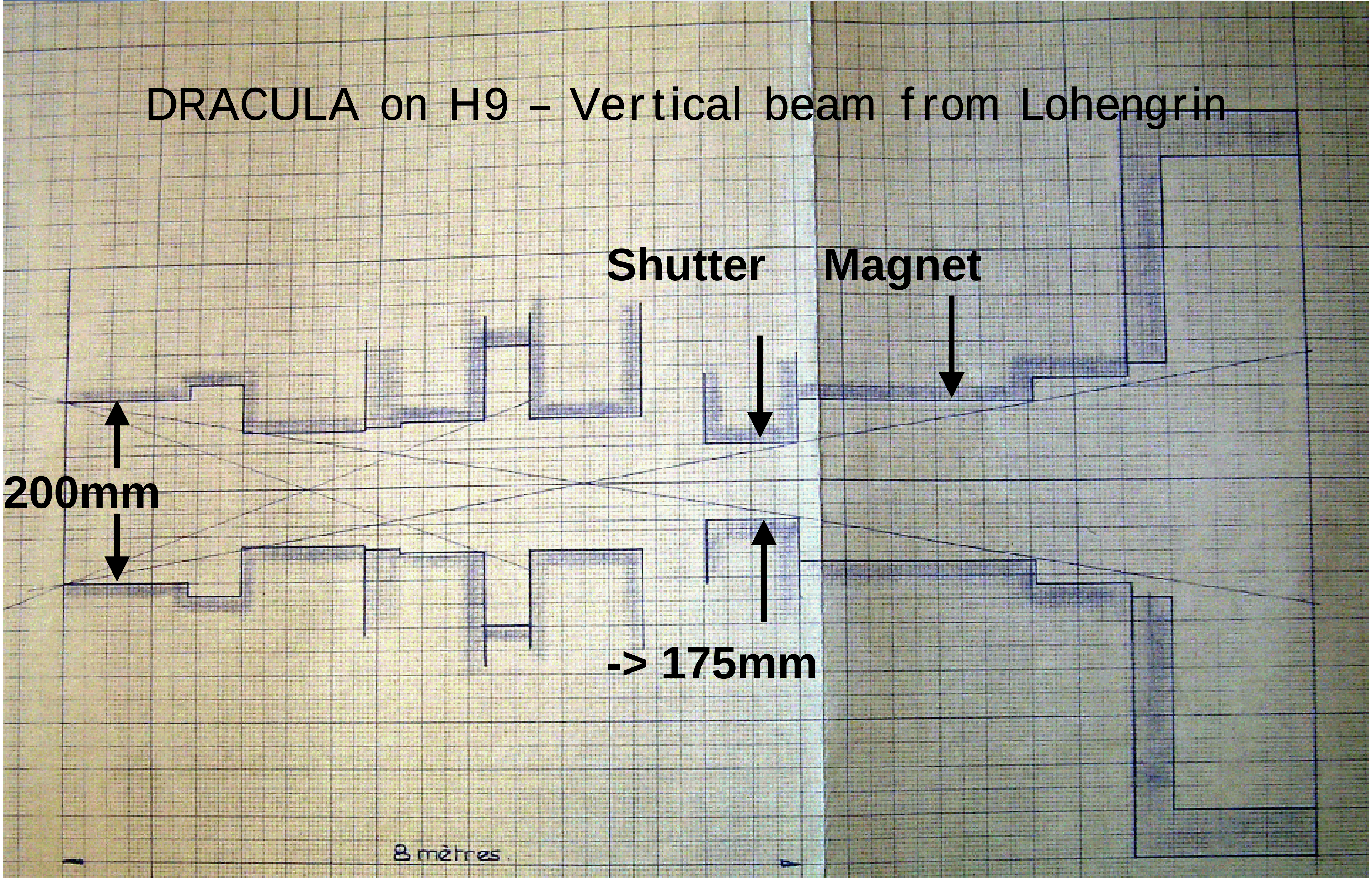


DRACULA on High Flux Beam Tube H9
H9 similar dimensions to H11 (D20)

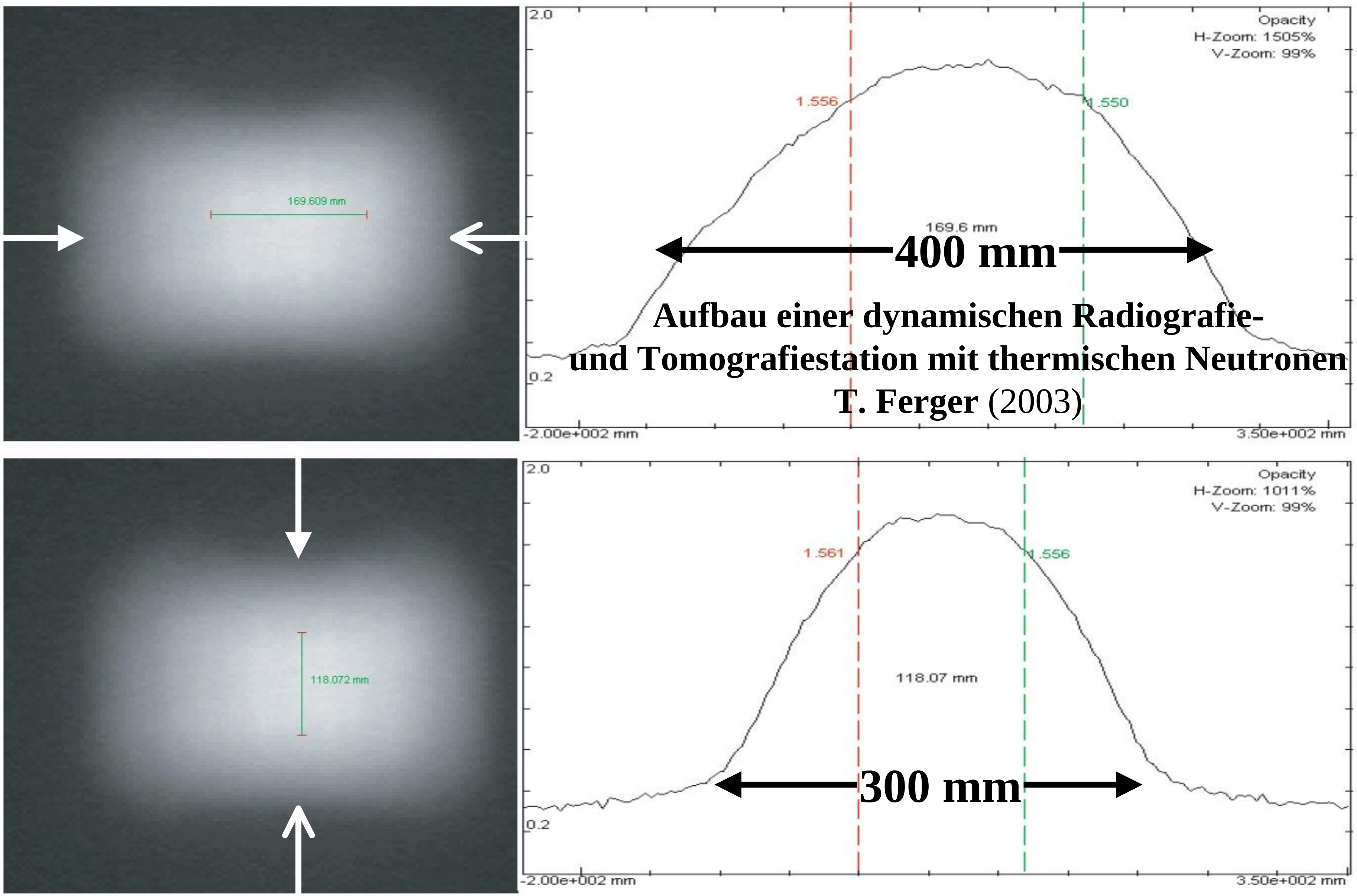




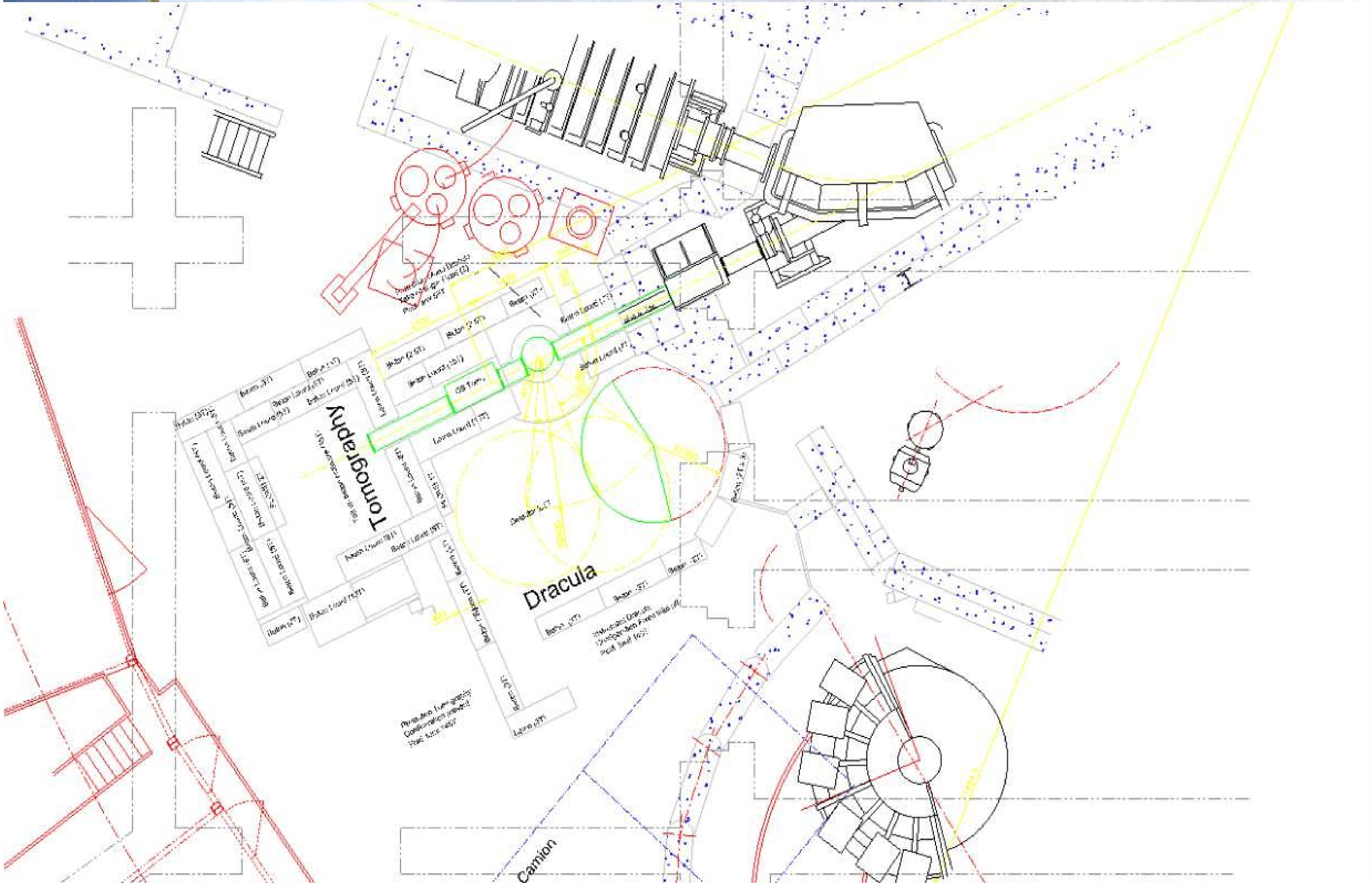
DRACULA on High Flux Beam Tube H9
H9 similar dimensions to H11 (D20)



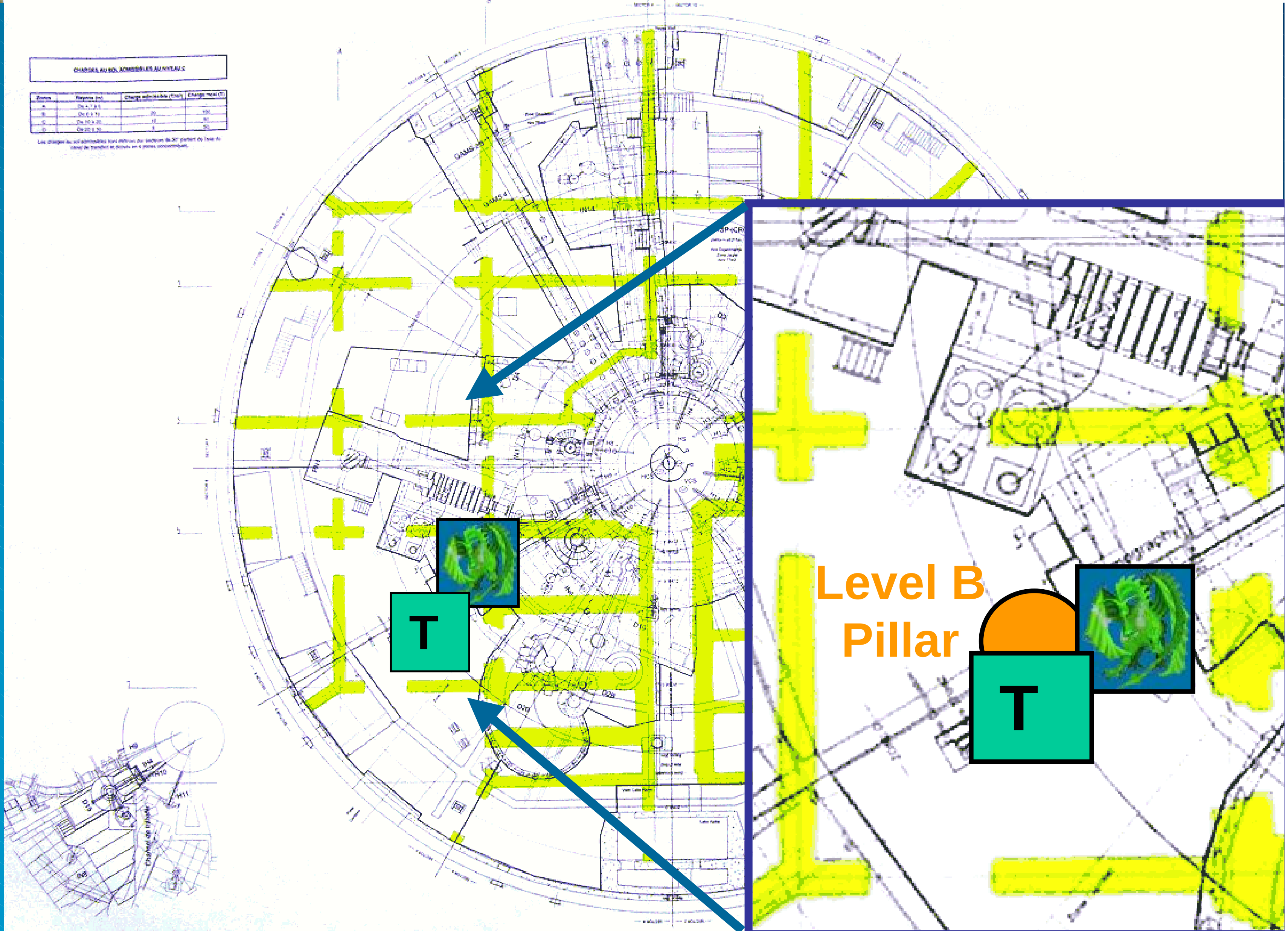
DRACULA on High Flux Beam Tube H9
H9 similar dimensions to H11 (D20)



DRACULA+TOMOGRAPH on Beam Tube H9
Level C Foor Plan

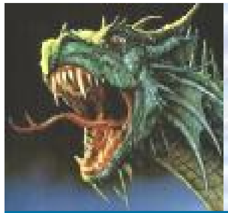


DRACULA+TOMOGRAPH on Beam Tube H9
Level B Support



DRACULA on H9 (co-existing with Tomography station)

- Tomography would be moved back ~4m
- Tomography could be supported using a pillar in level-B
- A detailed floor load calculation has been commissioned
- Tomography would benefit by having better resolution
- Tomography would benefit from a better, larger casemate
- Dracula monochromator would absorb ~15% of white beam

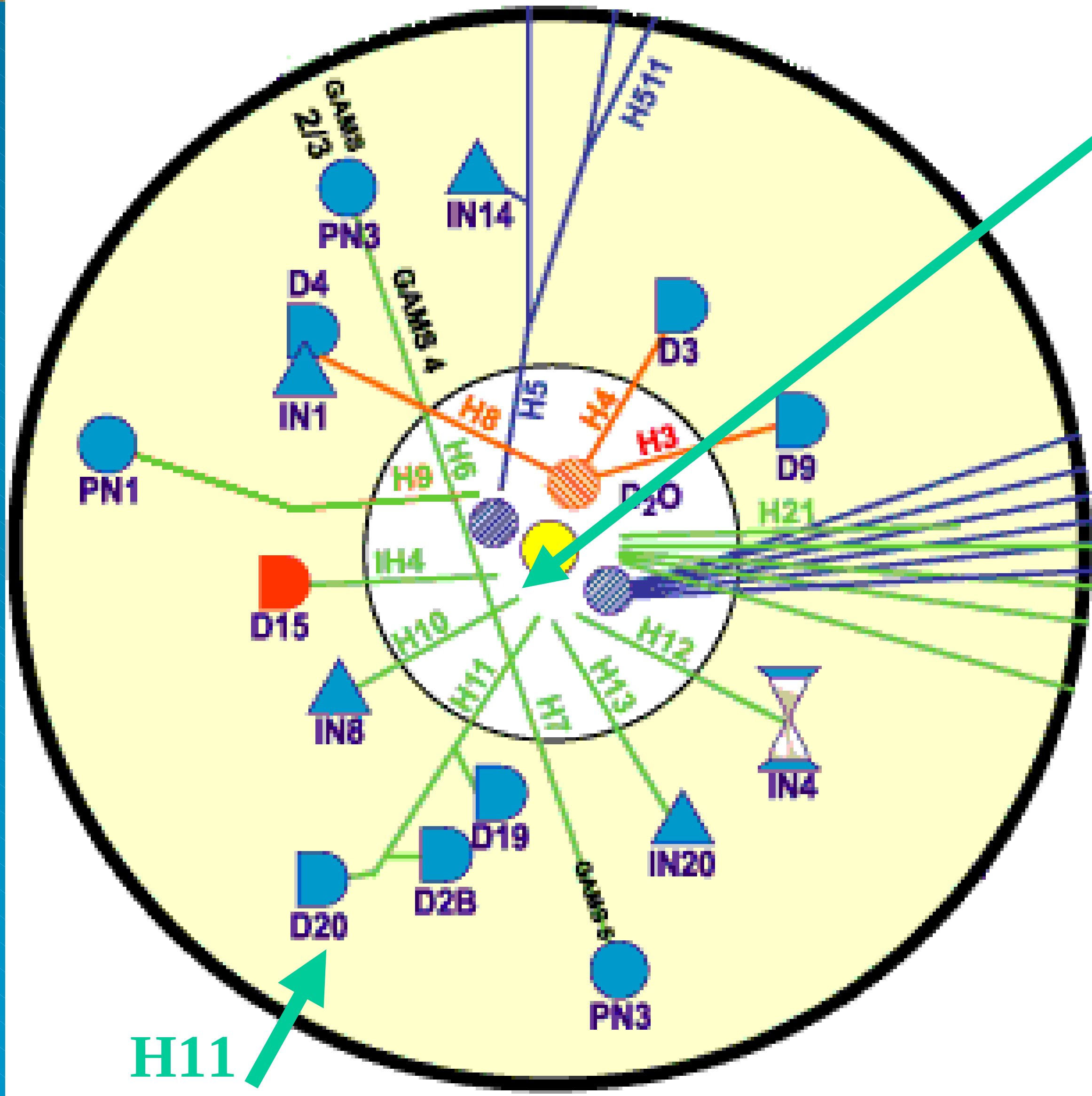


Convert D20 to DRACULA ?
Need for a High Flux Thermal Beam Tube

Too Many D’s,
upgrade D20?

- 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 ILL proposals

Publications on ILL Thermal Beam-Tubes from ILL WWW pages



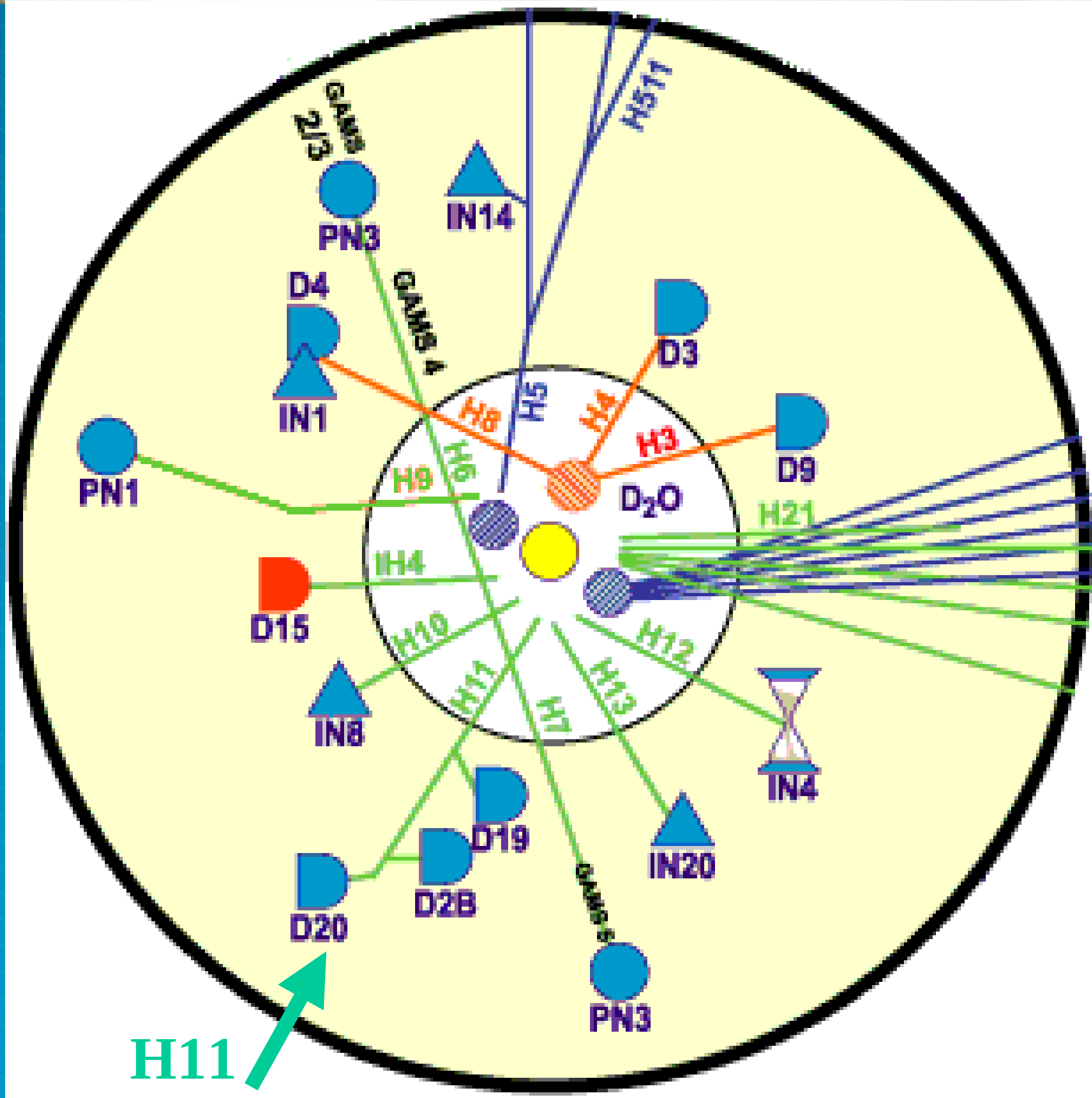
Most ILL Beam Tubes are Thermal

Number of Papers (1999-2004)

H6+7	(GAMS)	12
H9	(PN1)	14
H10	(IN8)	61
H12	(IN4)	22
H13	(IN20)	69
Total		178
H11	(D's)	458

Source: ILL library

Publications on ILL Thermal Beam-Tubes from ILL WWW pages

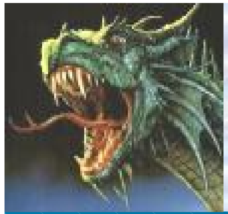


PRL, Phys.Rev., JACS, Nature, Science

Number of Papers (1999-2004)

H6+7	(GAMS)	5
H9	(PN1)	4
H10	(IN8)	20
H12	(IN4)	2
H13	(IN20)	14
Total		45
H11	(D's)	115

Source: ILL library

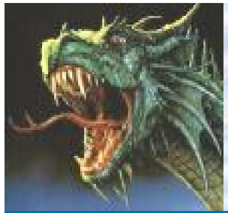


Highly cited ILL neutron diffraction papers

http://www.ill.fr/dif/citations/

Large number of citations for ILL neutron powder work

- **922 (D2B)** Hwang HY, Cheong SW, Radaelli PG, Marezio M, Batlogg B (1995) **Phy.Rev.Lett. 75**, 914.
  Lattice effects on the magnetoresistance in doped LaMnO3.
- **856 (D2B)** Cava RJ, Hewat AW, Hewat EA, Batlogg B, Marezio M, Rabe KM, Krajewski JJ, Peck WF, Rupp LW (1990) **Physica C. 165**, 419.
  Structural anomalies oxygen ordering and superconductivity in oxygen deficient Ba2YCu3Ox.
- **501 (D1A)** Capponi JJ, Tournier R, Chaillout C, Hewat AW, Lejay P, Marezio M, Nguyen N, Raveau B, Soubeyroux JL, Tholence JL (1987) **Europhysics Letters. 3,** 1301.
  Structure of the 100K superconductor Ba2YCu3O7 between 5-300K by neutron powder diffraction.
- **435 (IN8)** Rossat-Mignod, J. M., L. P. Regnault, et al. (1991) **Physica C 185-189**: 86-92.
  Neutron scattering study of the YBa2Cu3O6+x system.
- **367 (D16)** Deteresa JM, Ibarra MR, Algarabel PA, Ritter C, Marquina C, Blasco J, Garcia J, Delmoral A, Arnold Z (1997) **Nature 386,** 256-259
  Evidence for magnetic polarons in the Magnetoresistive materials
- **337 (D1A)** Fitch, A. N., H. Jobic, et al. (1986). **Journal of Physical Chemistry 90**, 1311-1318
  Localization of benzene in sodium-Y, zeolite by powder neutron diffraction.
- **335 (IN6)** Buchenau, U., M. Prager, et al. (1986). **Physical Review B 34**, 5665-5673.
  Low-Frequency modes in vitreous silica.
- **332 (IN13)** Doster, W., S. Cusack, et al. (1989) **Nature 337**: 754-756.
  Dynamical transition of myoglobin revealed by inelastic neutron scattering.
- **321 (D2B)** Radaelli PG, Cox DE, Marezio M, Cheong SW, Schiffer PE, Ramirez AP (1995) **Phys.Rev.Lett. 75,** 4488
  Simultaneous structural, magnetic, and electronic-transitions in La(1-x)Ca(x)MnO3 with x=0.25 and 0,5
- **319 (D2B)** Radaelli PG, Cox DE, Marezio M, Cheong, SW (1997) **Phys.Rev. B55,** 3015
  Charge, orbital, and magnetic ordering in La(0.5)Ca(0.5)MnO3



Shoot the Dragon…

Undermines ESS ?

If we want ESS we have to…

- Show we are making best use of what we already have

Shoot the Dragon…

No Pretty Pictures

Pretty Pictures: “C'est magnifique, mais ce n'est pas la guerre”

General Bosquet, watching the British Light Brigade charge Russian guns

If we want ESS we have instead to…

- Satisfy our users and earn their support
  ie Numbers of groups, proposals, publications, citations