Peter Fischer, Powder Diffraction and Superconductors

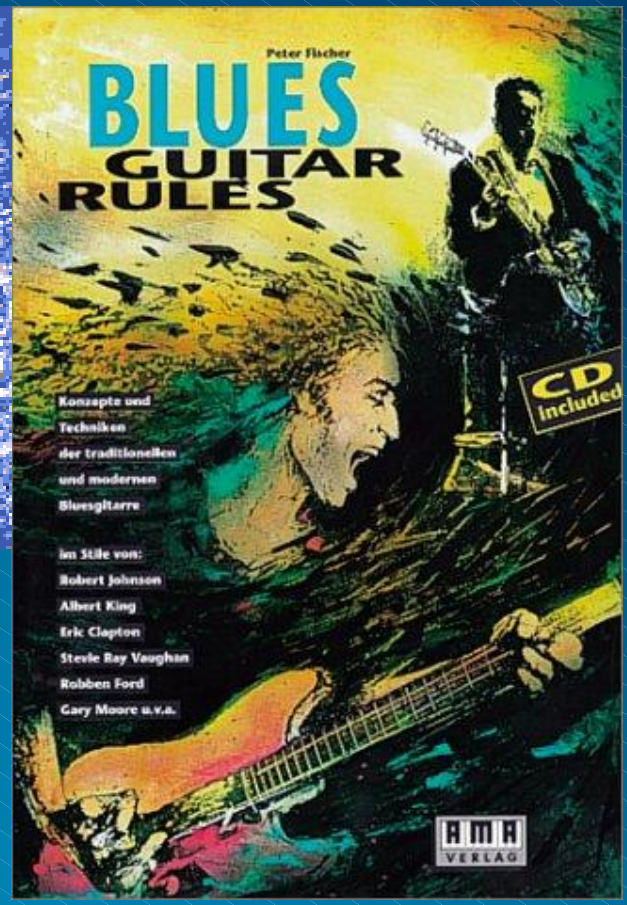
Festkolloquium aus Anlass der Pensionierung von Dr Peter Fischer

Alan Hewat, Diffraction Group, ILL Grenoble

Peter Fischer's many interests

Gardening

Music



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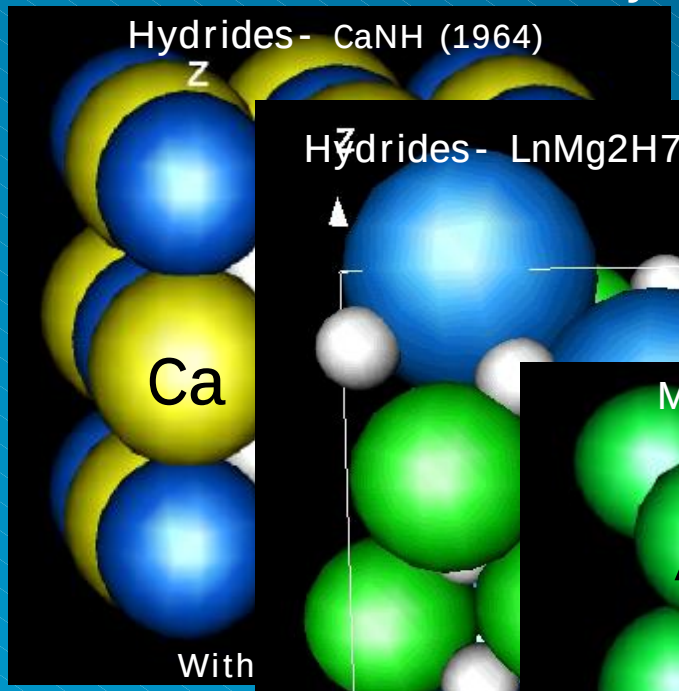
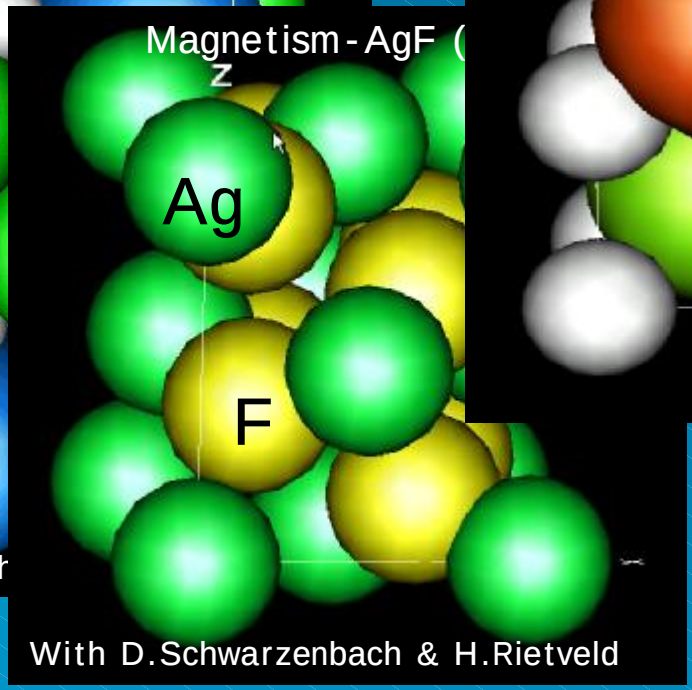
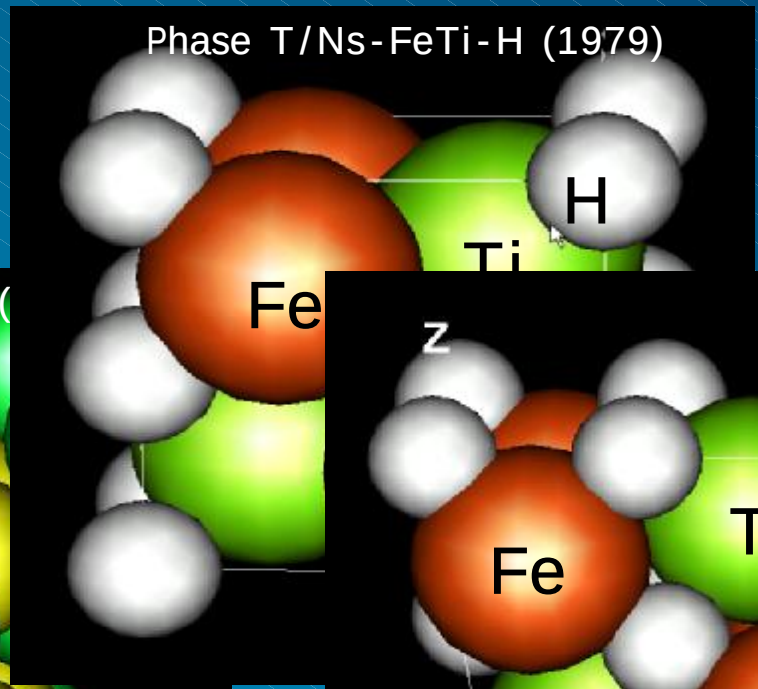
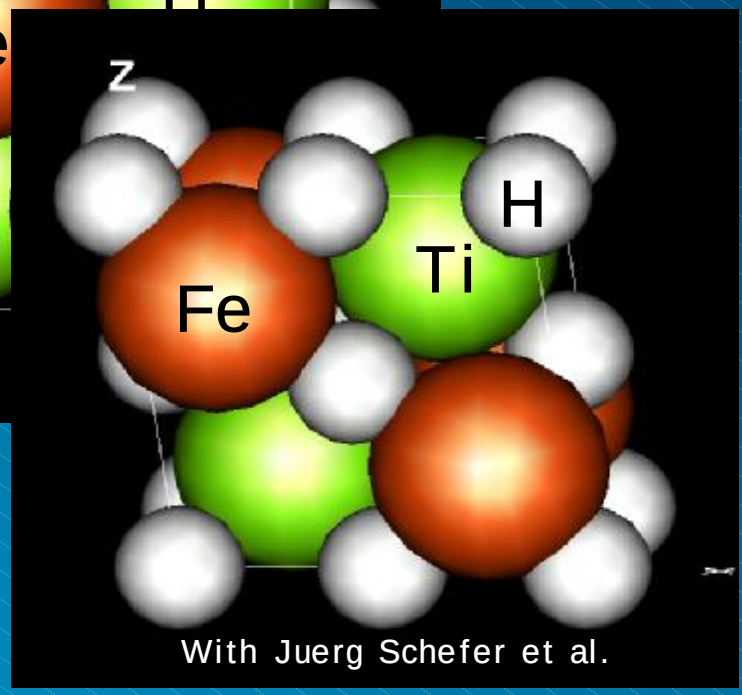
Peter Fischer's many interests

Hydrides, Magnetism, Phase T/Ns



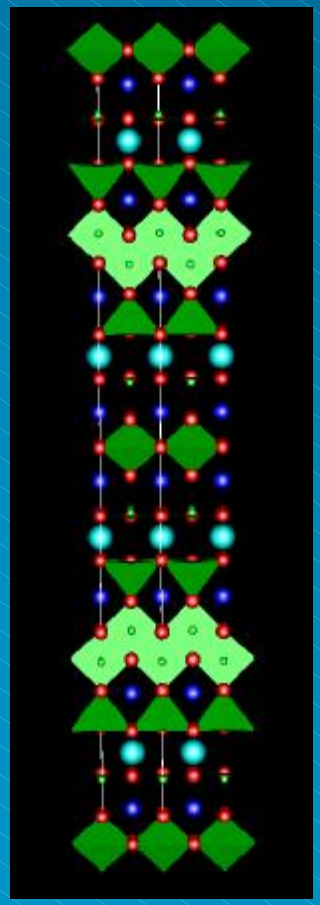


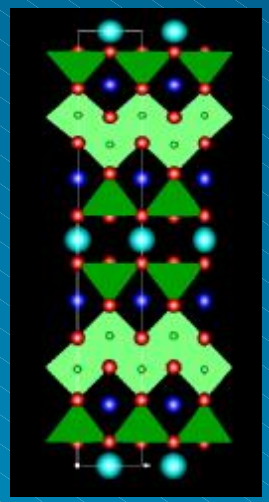


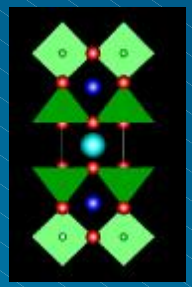


Peter Fischer's many interests

High Tc Superconductors







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Some of Peter Fischer's many contributions to high-Tc

Francois,M. Yvon,K. Fischer,P. Decroux,M. (1987) Solid State Commun. **63** 35-40
Structural phase transition at 150K in the high-temperature superconductor $La_{1.85}Sr_{.15}CuO_4$

Francois,M. Walker,E. Jorda,JL. Yvon,K. Fischer,P. (1987) Solid State Commun. **63** 1149-1153
Structure of the high-temperature superconductor $Ba_2YCu_3O_7$ by X-ray and neutron powder diffraction.

Rupp,B. Fischer,P. Poerschke,E. Arons,RR. Meuffels,P. (1988) Physica C: Superconductivity **156** 559-565
Neutron diffraction study of highly oxygen deficient superconducting $YBa_2Cu_3O_{6.39}$

Francois,M. Junod,A. Yvon,K. Hewat,AW. Capponi,JJ. Strobel,P. Marezio,M. Fischer,P. (1988) Solid State Comm. **66** 1117
A study of Cu-O chains in the high Tc superconductor $YBa_2Cu_3O_7$ by high resolution neutron powder diffraction

Karpinski,J. Kaldis,E. Rusiecki,S. Jilek,E. Fischer,P. Bordet,P. Chaillout,C. Chenavas,J. Hodeau,JL. Marezio,M. (1989) J.Less-Common Met. **150** 129-137
Two New Bulk Superconducting Phases in the Y-Ba-Cu-O System: $YBa_2Cu_{3.5}O_{7+x}$ (Tc 40K) and $YBa_2Cu_4O_{8+x}$ (Tc 80K)

Trounov,VA. Kaganovich,TY. Kurbakov,AI. Matveev,AV. Balagurov,AM. Hewat,AW. Fischer,P. Antson,O. Maayouf,RMA. (1992) Physica C: Superconductivity **197** 123-130
Neutron diffraction studies of isotope-substituted tetragonal superconductors $RBa_2Cu_{2.76}Fe_{.24}O_{7+delta}$ (R= Sm, Y)

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Neutron diffraction investigation of structures of 'RE-124' (RE = Dy, Ho, Er) and 'Nd-247' superconductors; 2D antiferromagnetism in 'Dy1'

Hewat,AW. Fischer,P. Kaldis,E. Karpinski,J. Rusiecki,S. Jilek,E. (1990) Physica C: **167** 579-590
High resolution neutron powder diffraction investigation of temperature and pressure effects on the structure of the high-Tc superconductor $Y_2Ba_4Cu_7O_{15}$

Guillaume,M. Allenspach,P. Mesot,J. Roessli,B. Staub,U. Fischer,P. Furrer,A. (1993) Z.Phys.B:Condensed Matter **90** 13-17
A systematic neutron diffraction study of $RBa_2Cu_3O_7$ (R=yttrium and rare earths) high-Tc superconductors

Fischer,P. Kaldis,E. Karpinski,J. Rusiecki,S. Jilek,E. Trounov,V. Hewat,AW. (1993) Physica C: **205** 259-265
Neutron diffraction analysis of ^{44}Ca and Ca substituted superconductors $YBa_2Cu_4O_8$ with Tc = 90K

Trounov,VA. Kaganovich,TYu. Fischer,P. Kaldis,E. Karpinski,J. Jilek,E. (1994) Physica C: **227** 285-290
High-resolution RFTOF neutron diffraction study of the temperature dependence of the structure of the Tc=87K superconductor $Y_{0.944}Ca_{0.1}Ba_2Cu_4O_8$

Boettger,G. Mangelschots,I. Kaldis,E. Fischer,P. Krueger,Ch. Fauth,F. (1996) J.Physics: Condensed Matter **8** 8889-8905
The influence of Ca doping on the crystal structure and superconductivity of orthorhombic $YBa_2Cu_3O_{7-d}$

Hellebrand,B. Wang,XZ. Baeuerle,D. Guillaume,M. Fischer,P. Vybornov,M. Rogl,P. (1996) Physica C: **261** 97-104
Structural analysis of superconducting $NdBa_{1.5}Sr_{0.5}Cu_3O_{7-d}$

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High Tc Superconductors

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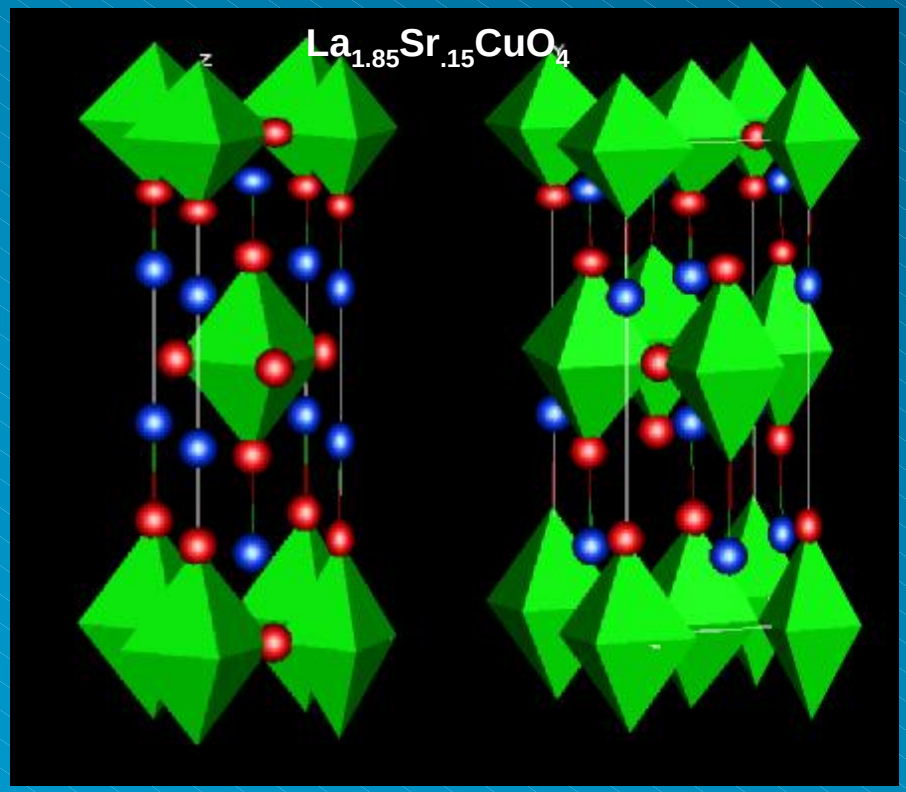

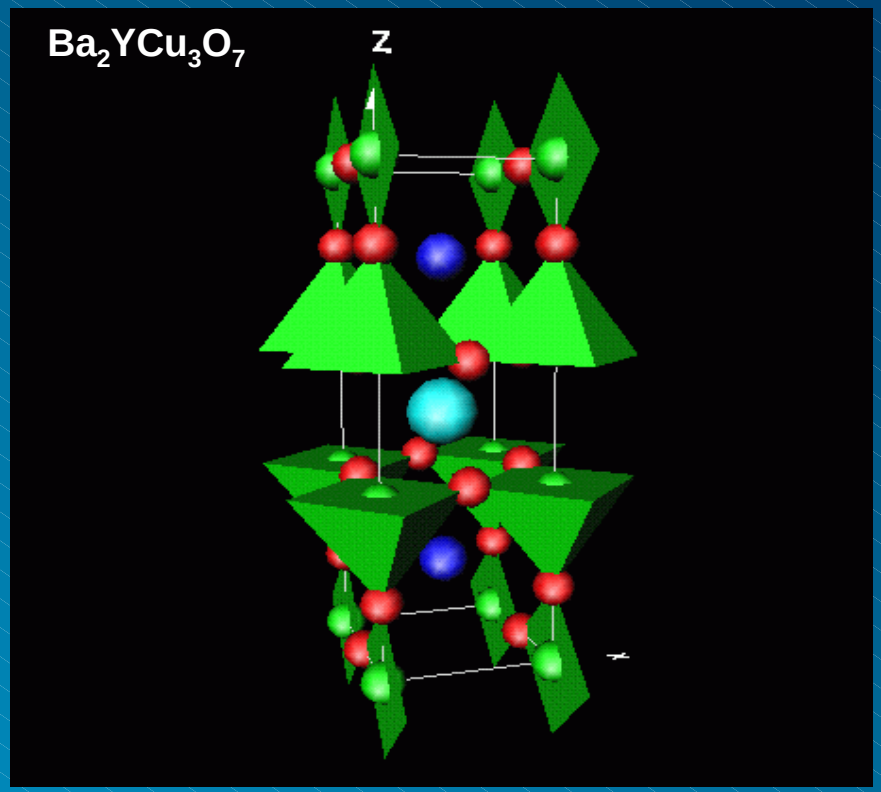

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High Tc Superconductors

- Bednorz & Muller idea of coupling between electrons & polarons
- Search for structural changes associated with superconductivity
- Structural transitions in $La_{1.85}Sr_{0.15}CuO_4$ (PSI-Geneva group 1987)
- Buckling of CuO chains in Y123 (PSI-Geneva-Grenoble group 1988)
- Buckling of CuO planes in Y123 (Argonne group 1990)

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High Tc Superconductors

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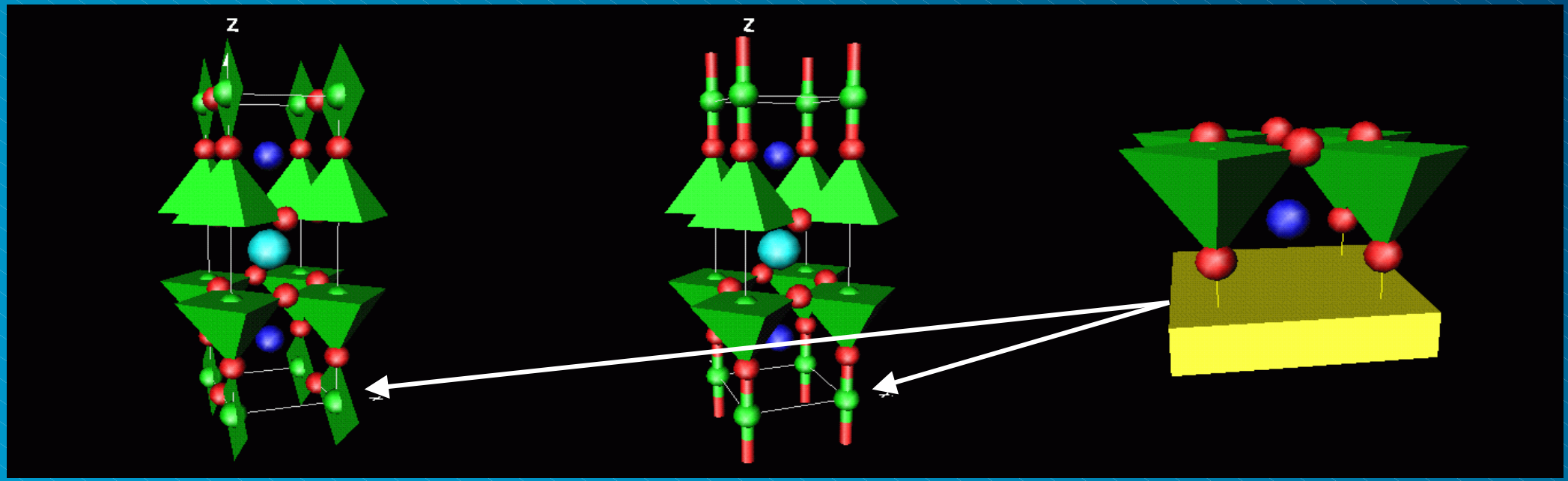
Neutron diffraction study of highly oxygen deficient superconducting $YBa_2Cu_3O_{6.39}$

Superc. $YBa_2Cu_3O_7$ Non-superc.$YBa_2Cu_3O_6$ CuO chain Charge Reservoir



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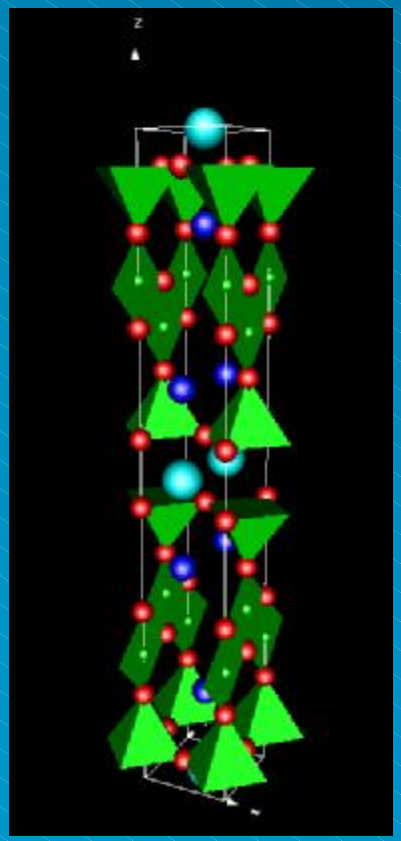
High Tc Superconductors

- Effect of doping with divalent ions eg Ca^{++} cf oxidation-reduction
- Ca^{++} replacing Y^{+++} changes electron hole density, like charge transfer



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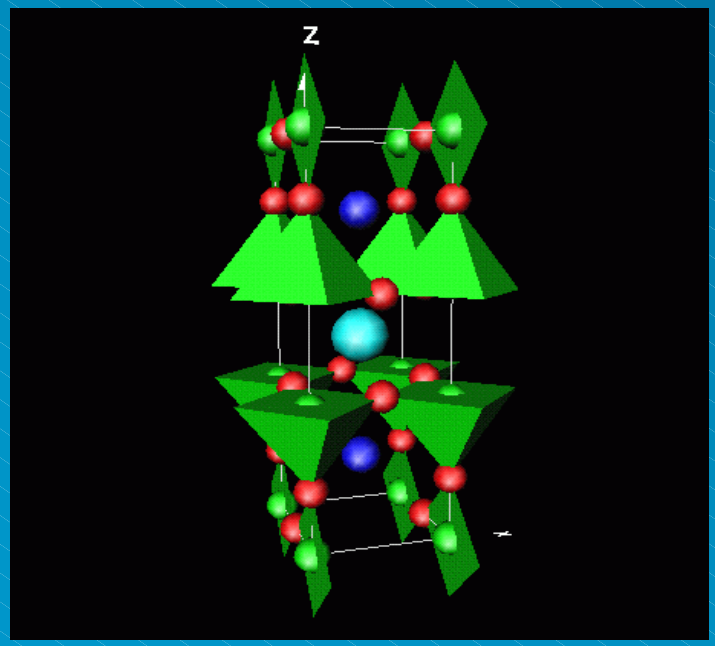
High Tc Superconductors

- Exchanging Cu++ with trivalent ions eg Fe^{+++} supresses superconductivity
- Use of isotopes to determine sites of substituting ions

$YBa_2(Cu,Fe)_3O_{7+delta}$



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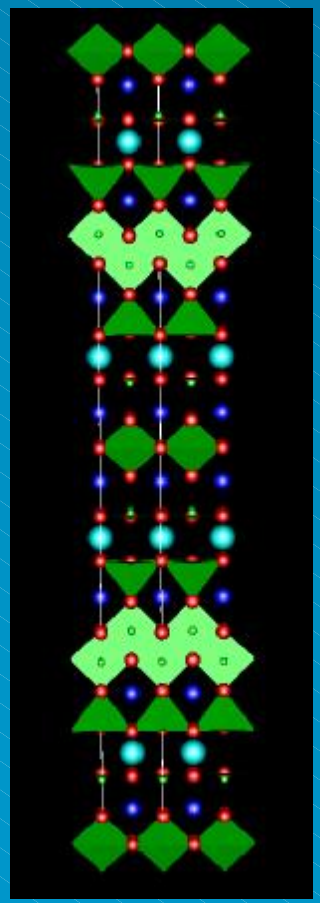
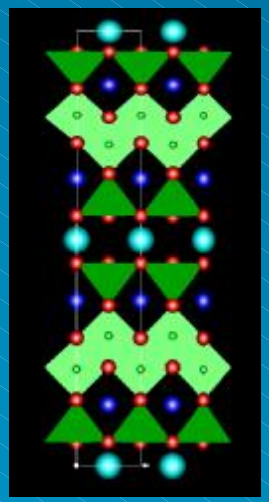
High Tc Superconductors

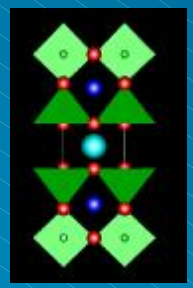
- New kinds of charge reservoir layers – intergrowth of layers



$YBa_2Cu_{3.5}O_{7+x}$



$YBa_2Cu_4O_{8+x}$



$YBa_2Cu_3O_7$

Karpinski,J. Kaldis,E. Rusiecki,S. Jilek,E. Fischer,P. Bordet,P. Chaillout,C. Chenavas,J. Hodeau,JL. Marezio,M. (1989) J.Less-Common Met. **150** 129-137

Two New Bulk Superconducting Phases in the Y-Ba-Cu-O System: $YBa_2Cu_{3.5}O_{7+x}$ (Tc 40K) & $YBa_2Cu_4O_{8+x}$ (Tc 80K)

Berastegui,P. Fischer,P. Bryntse,I. Johansson,L-G. Hewat,AW. (1996) J.Solid State Chem. 127 31-39

Influence of stacking faults and temperature on the structure of $Y_2Ba_4Cu_7O_{15}$, investigated by high-resolution neutron diffraction and electron microscopy

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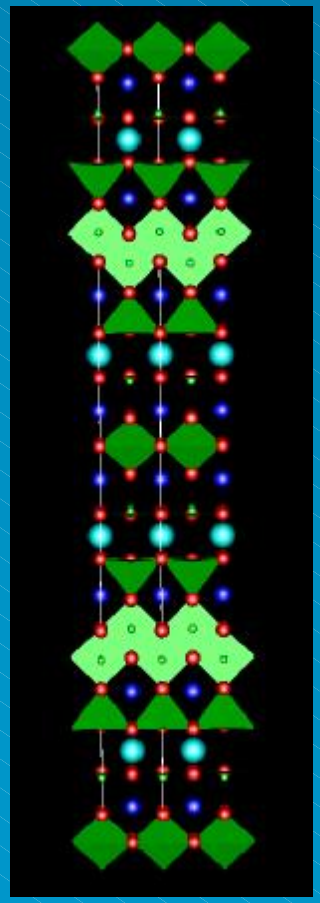
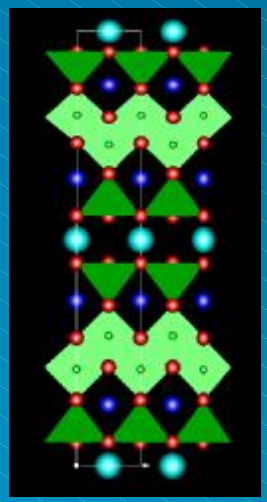
High Tc Superconductors

- Effect of pressure on Tc and structure – different layer compressibility



$YBa_2Cu_{3.5}O_{7+x}$



$YBa_2Cu_4O_{8+x}$

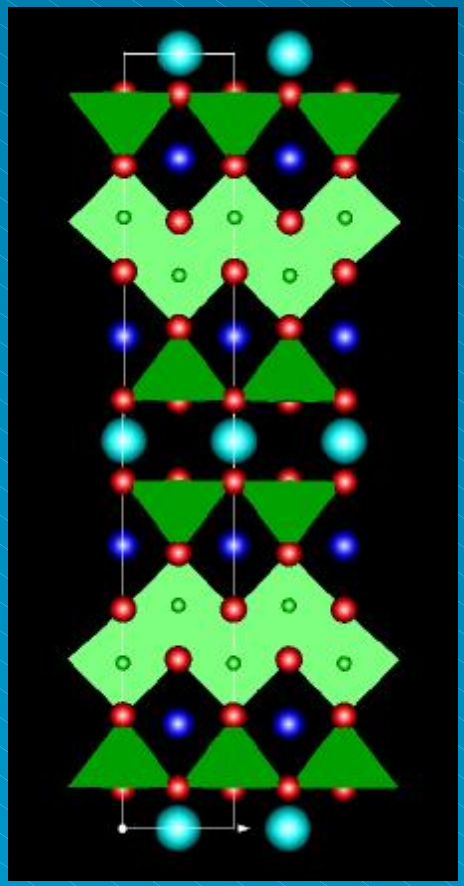
Hewat,AW. Fischer,P. Kaldis,E. Karpinski,J. Rusiecki,S. Jilek,E. (1990) Physica C: Superconductivity 167 579-590

High resolution neutron powder diffraction investigation of temperature and pressure effects on the structure of the high-Tc superconductor $Y_2Ba_4Cu_7O_{15}$

- Increase of Tc in Y124 and Y247 with Pressure
- Try to relate change in Tc to charge transfer
- Charge transfer due to relative compressibilty of charge reservoir and superconducting layers

High Tc Superconductors

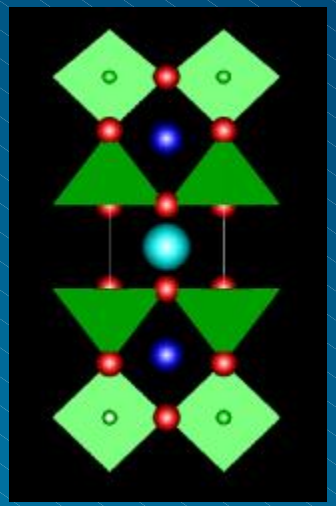
- Effect of magnetic ordering of RE cation on superconductivity



$YBa_2Cu_4O_{8+x}$

Roessli,B. Allenspach,P. Fischer,P. Mesot,J. Staub,U. Maletta,H. Brueesch,P. Ritter,C. Hewat,AW.
(1992) Physica B: Condensed Matter 180 396-398

Crystal structures and long-range antiferromagnetic ordering n in $REBa_2Cu_3O_{7-delta}$ (RE = Yb, Nd)



$YBa_2Cu_3O_7$

Fischer,P. Roessli,B. Mesot,J. Allenspach,P. Staub,U. Kaldis,E. Bucher,B. Karpinski,J. Rusiecki,S. Jilek,E. Hewat,AW.
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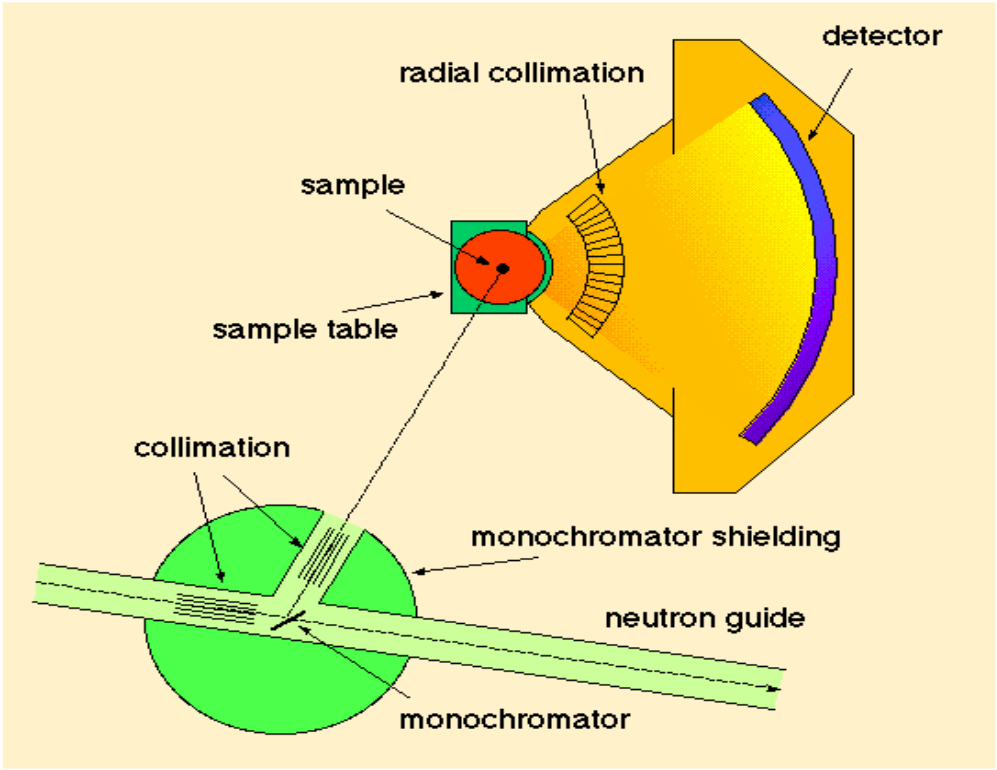
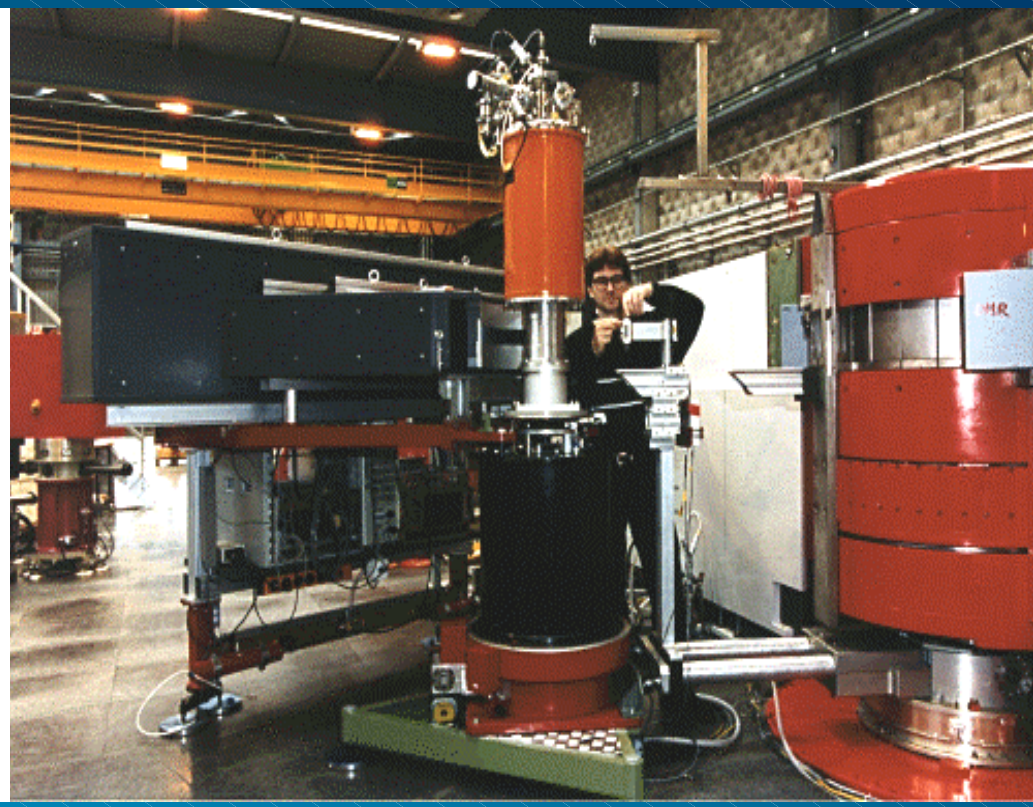
DMC high efficiency PSD powder diffractometer at PSI





- Position sensitive BF3 detector (400 cells, angular separation of 0.2°)
- Oscillating radial collimator suppresses peaks from sample environment
- Simultaneous measurements within a scattering angle of 80°
- Wavelength range of 2.3Å to 6.5Å with maximum 2θ=145°

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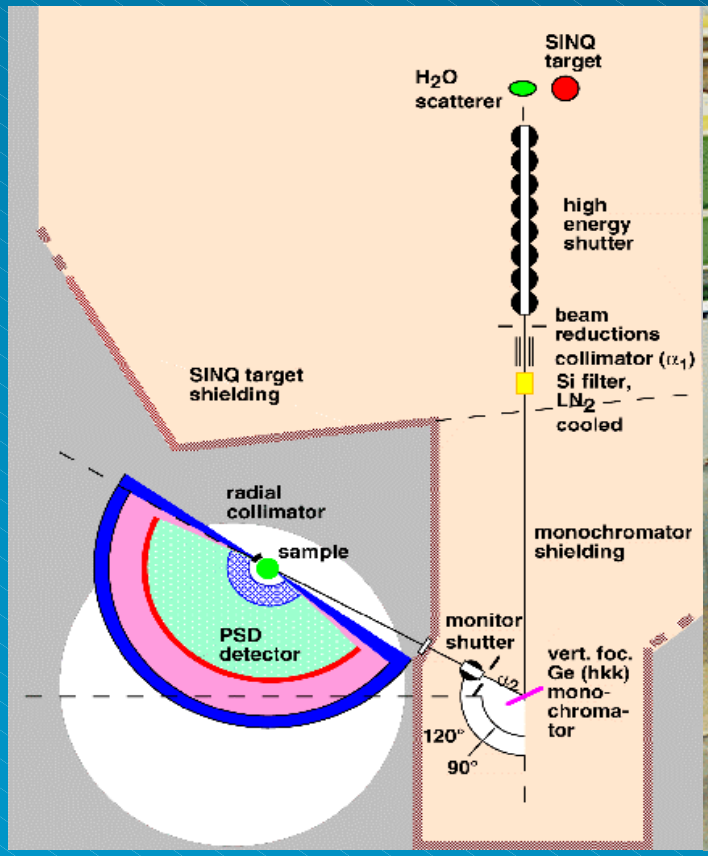
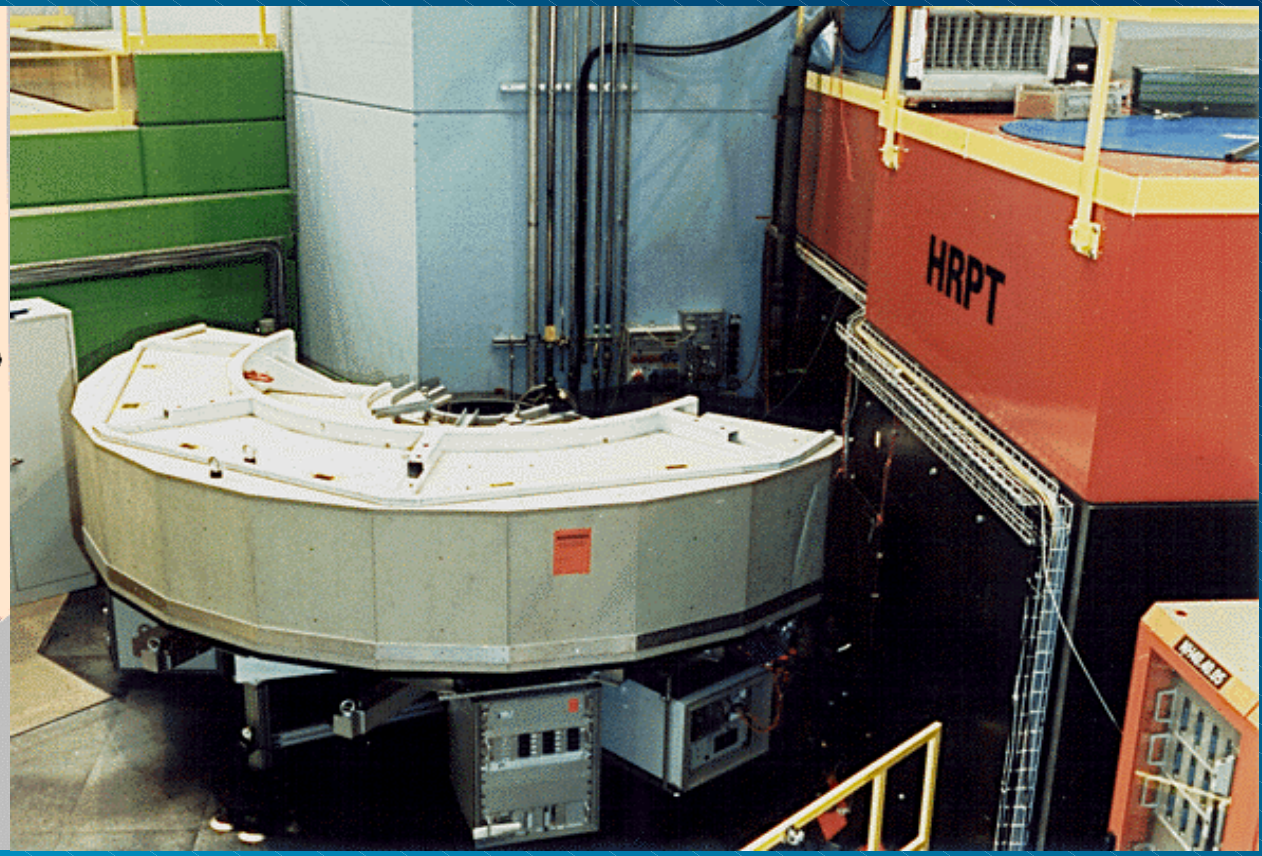
HRPT 1600 cell high resolution PSD powder diffractometer at PSI





- Position sensitive 3He detector (1600 cells, angular separation of 0.1°)
- Oscillating radial collimator suppresses peaks from sample environment
- Simultaneous measurements within a scattering angle of 160°

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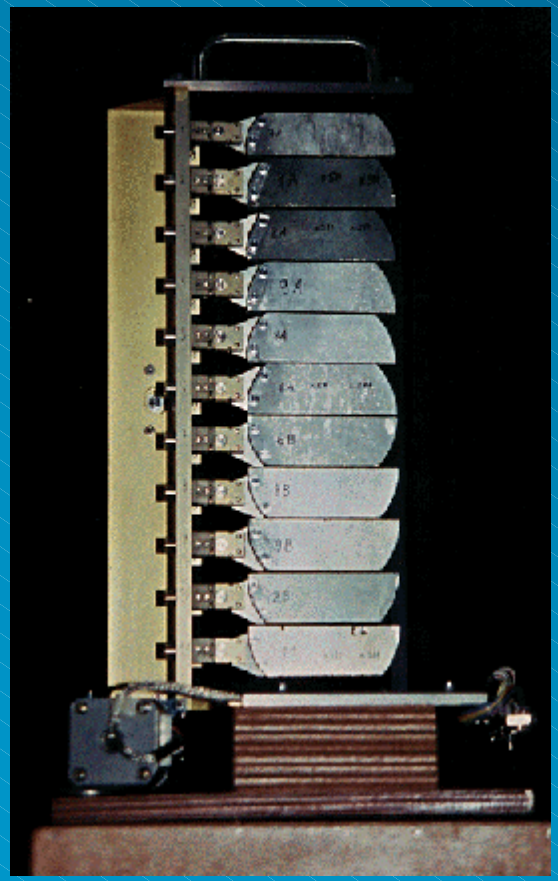
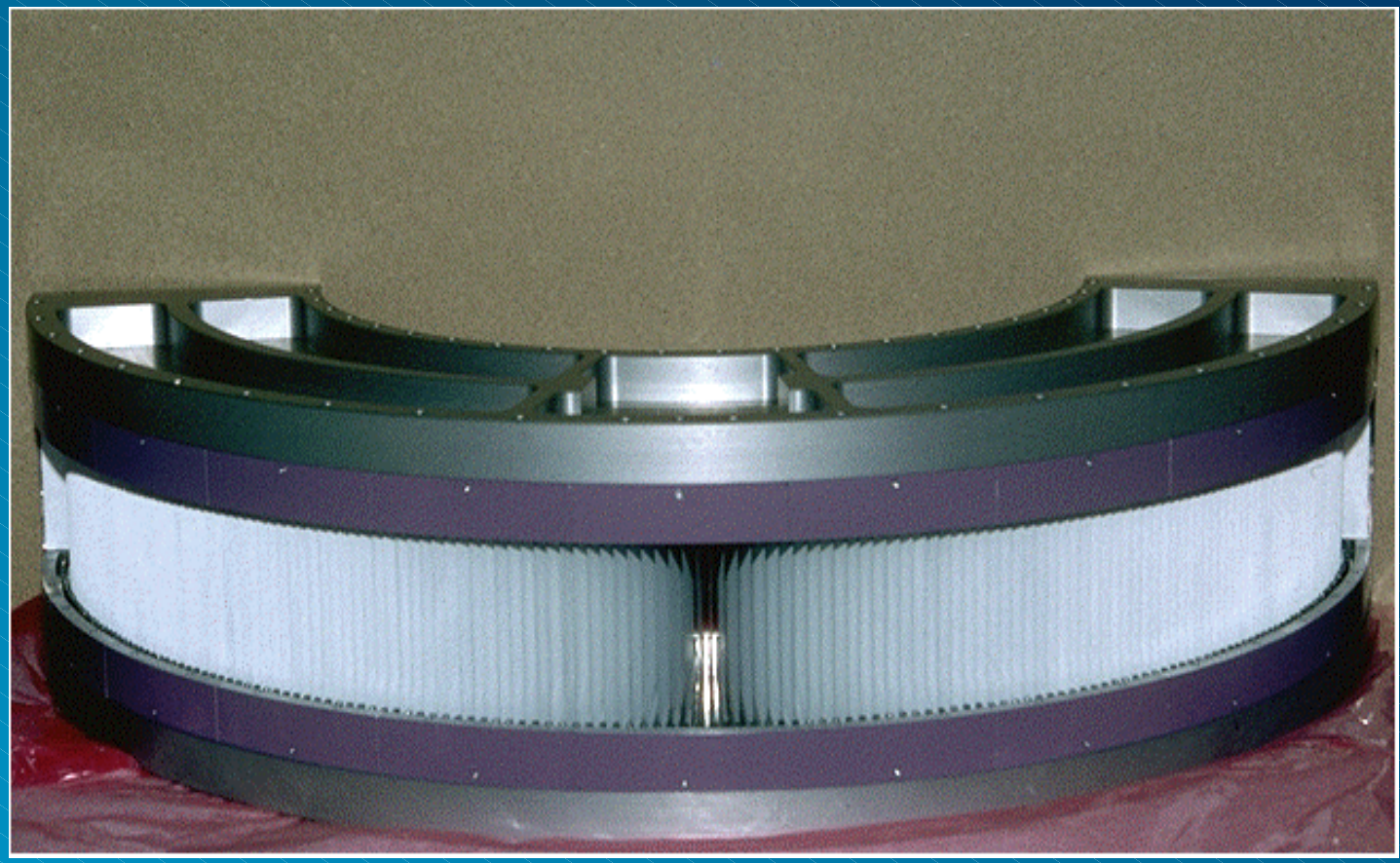
HRPT 1600 cell high resolution PSD powder diffractometer at PSI





- Ge-wafer monochromator [511] at $2\theta_M$=90° or 120° gives 1.5Å or 1.9Å
- Other [hhk] reflections available for wavelengths from 1.1Å to 2.4Å
- Oscillating radial collimator suppresses peaks from sample environment

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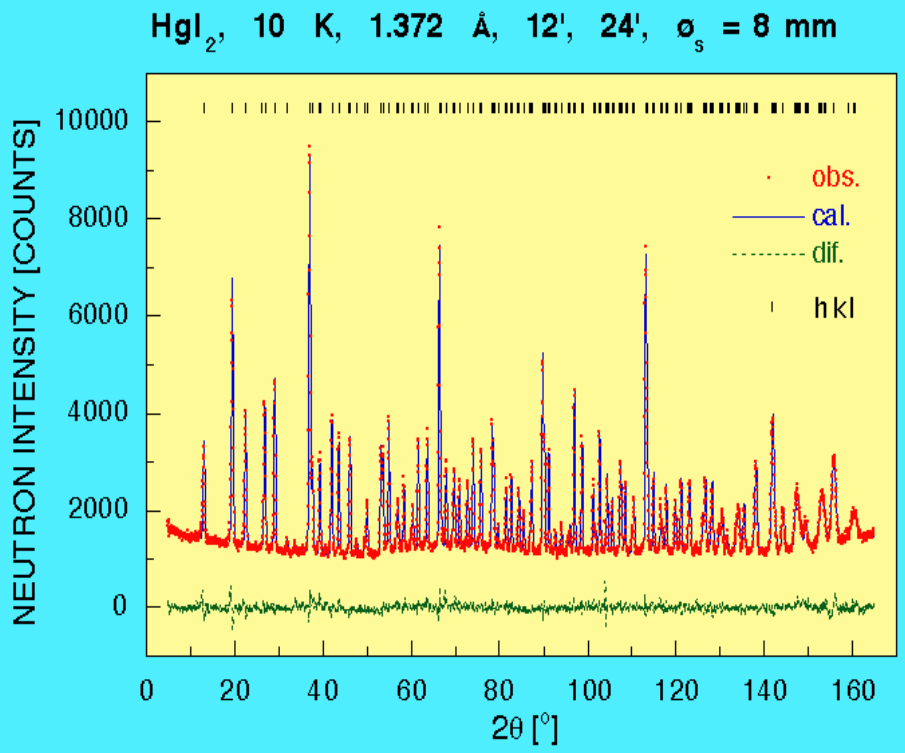
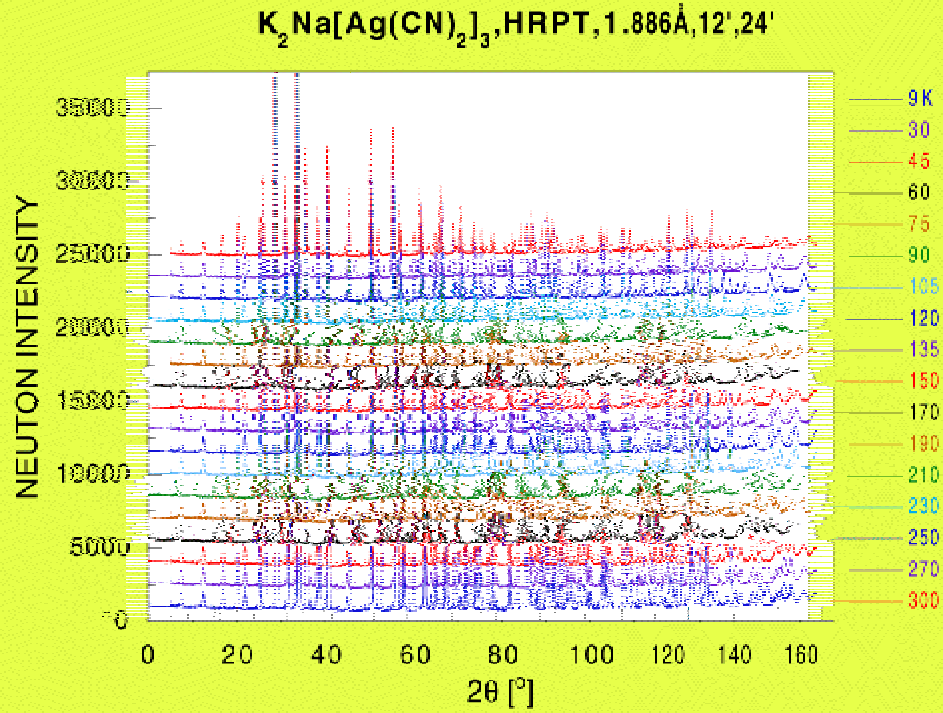
HRPT 1600 cell high resolution PSD powder diffractometer at PSI





a) High resolution pattern from Hg_2I on HRPT – difficult with X-rays

b) High flux of HRPT allowed study of $K_2Na[Ag(CN)_2]_3$ at many temperatures

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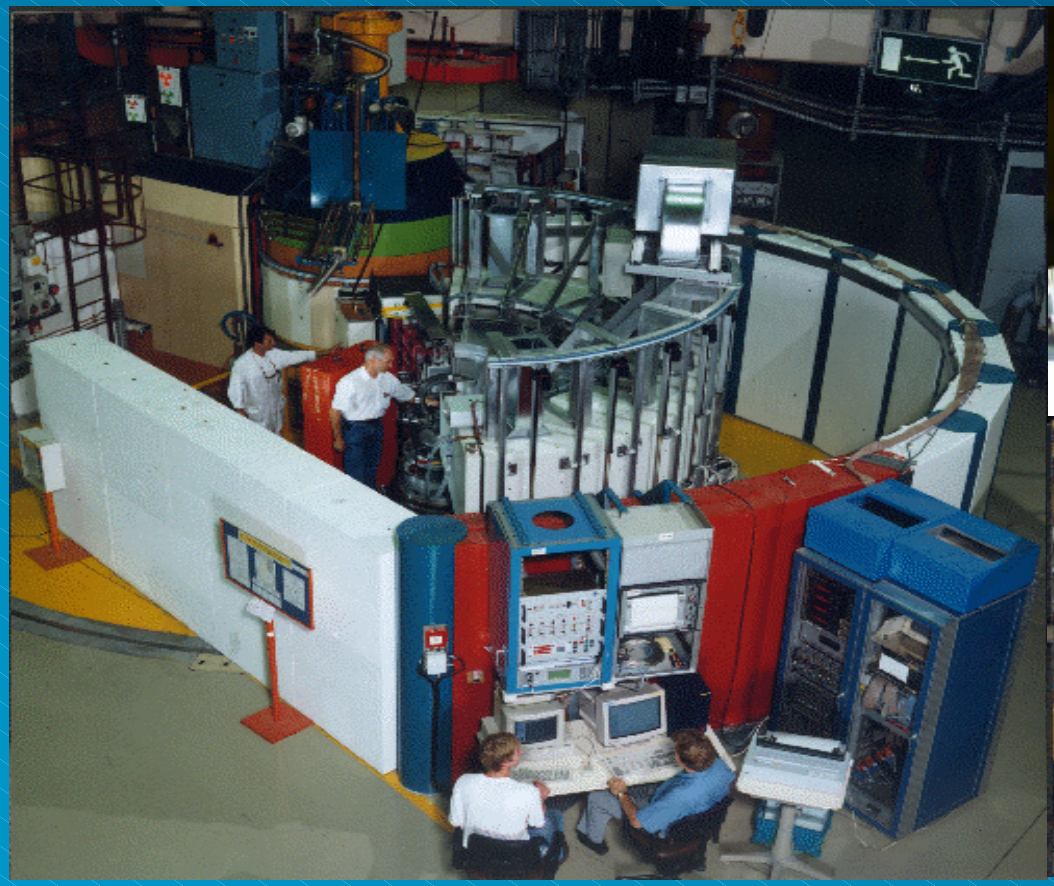
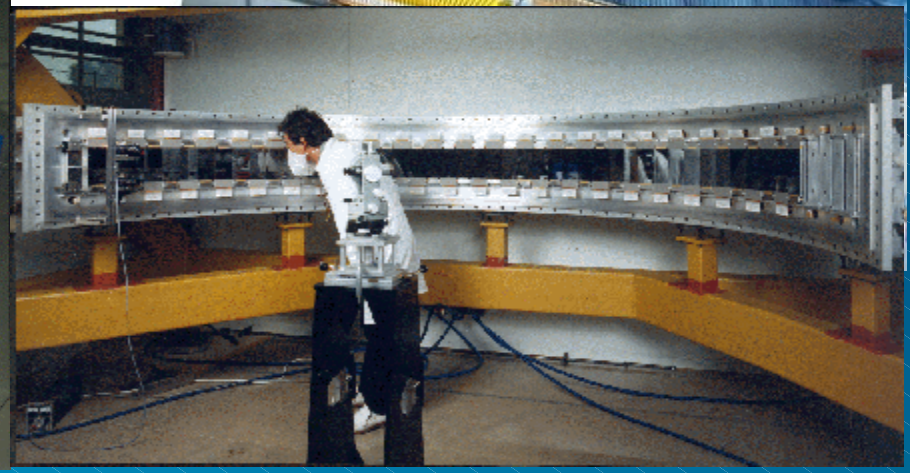
D20 microstrip detector –ILL equivalent of HRPT (Convert, Hansen et al)





- Microstrip detector works well, but we will use wires for new detectors
- Extremely fast (300 msec real time expts) but lower resolution than HRPT

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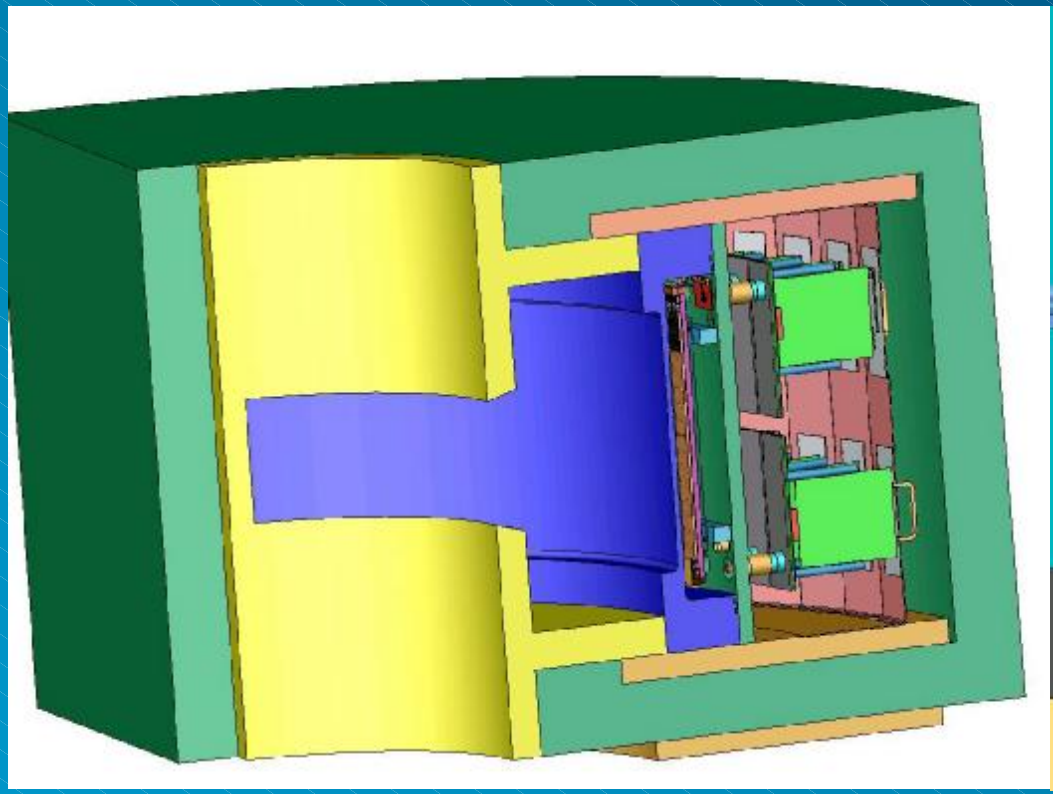
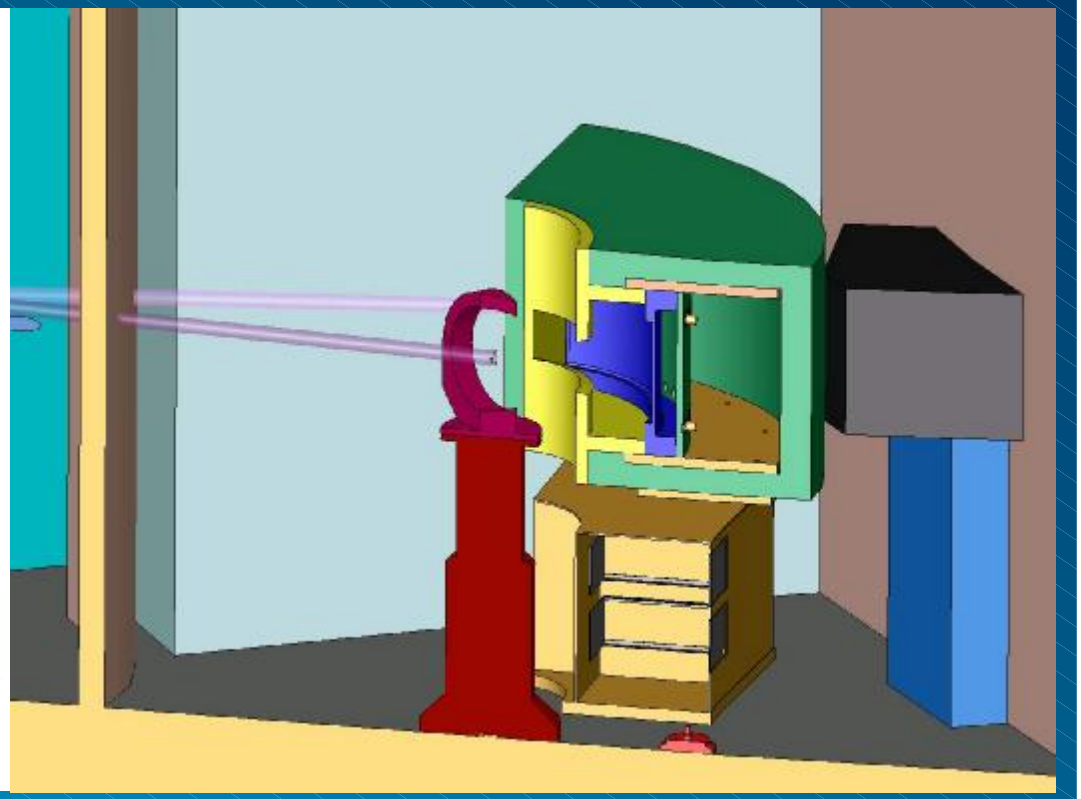
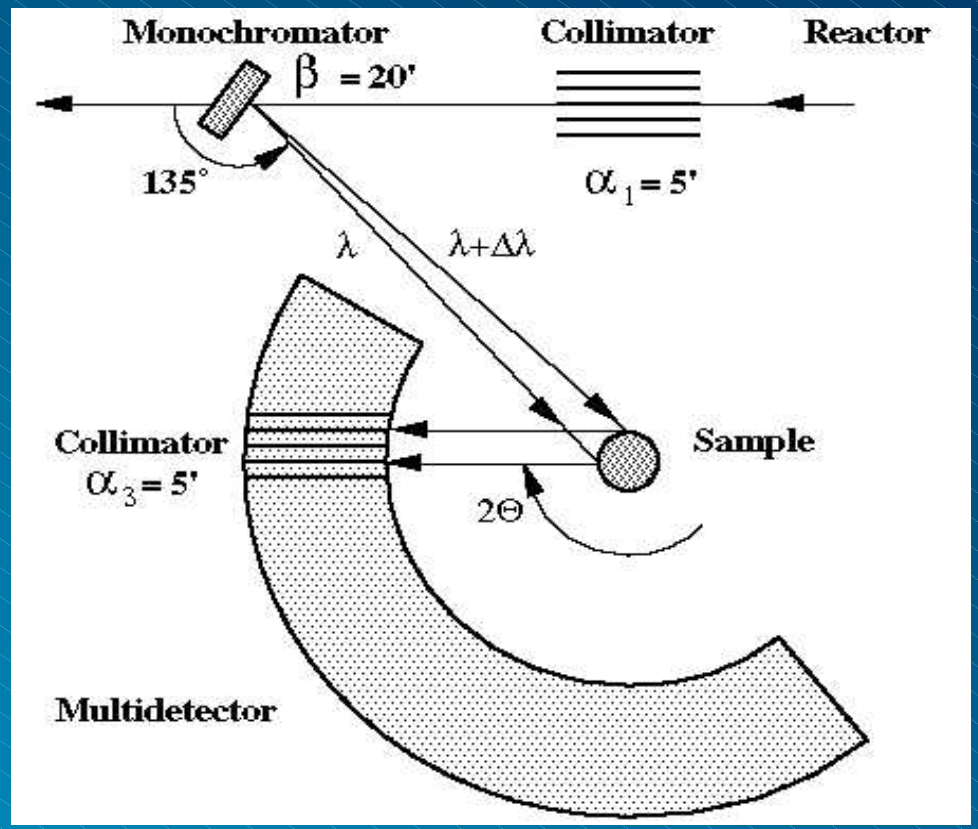
New 2D resitive wire detector for D19, & eventually for a new powder machine





- 400 mm high resitive wires, very large solid angle – 30° x 120°
- Medium resolution, 0.2° in both horizontal and vertical directions
- Order of magnitude faster than D20 i.e. ~50 msec time resolution

D2B multi-collimator detector –ILL equivalent of HRPT (Suard, Hewat)



- Large focusing Ge-335 monochromator
- Large array of high resolution collimaters
- V. high resolution, but slower than HRPT

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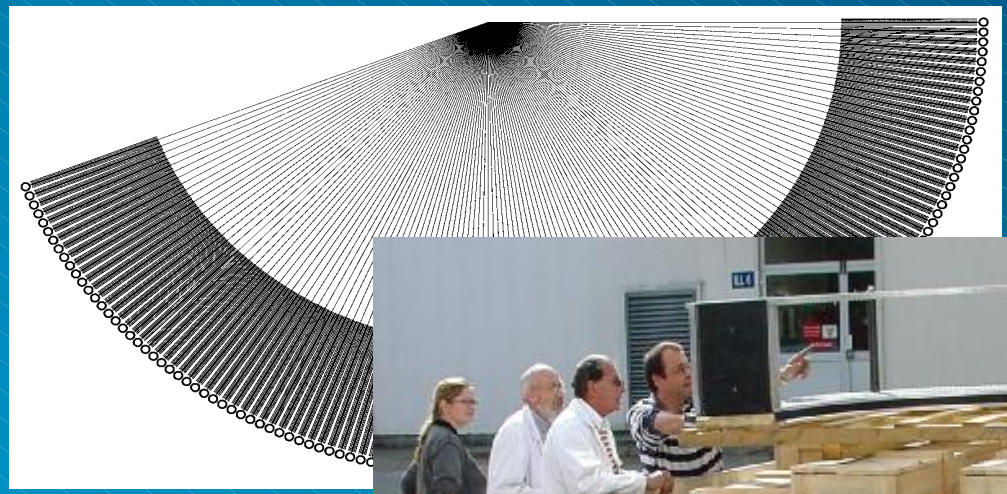
Alan Hewat, Diffraction Group, ILL Grenoble

Super-D2B multi-collimator detector – x 6 increase in intensity at high res.



- 128 x 400 mm high resitive wire detectors, high resolution collimators
- New detector delivered to ILL last week, to be installed in January

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Very best wishes to Peter and Hedi…
And their cats !