“凝聚态物理-北京大学论坛” 2008-03

中子散射技术

的现况和前景展望

Introduction of
Neutron Scattering Project at
NSL-CARR

北京大学 2008年3月14日（星期五）下午 15:00 –16:40

中国原子能科学研究院
CHINA INSTITUTE OF ATOMIC ENERGY

报告内容

- 国际中子散射背景介绍
- 中子散射用中子源简介
- 我国中子散射建设情况

NSL CIAE

里程碑：中子科学的形成

- 1932年Chadwick发现中子
  1935年获诺贝尔奖
- 1934年Fermi发现中子核嬗变，
  1938年获诺贝尔奖
- 1938年Hahn和Strassmann
  发现中子诱发核裂变
  1944年获诺贝尔奖

里程碑：中子科学的应用

- 1942年：第一座原子核反应堆
- 1945年：第一颗原子弹
- 1952年：第一次氢弹
- 1954年：第一艘核潜艇
- 1954年：第一座示范核电站

NSL CIAE

核 武 器

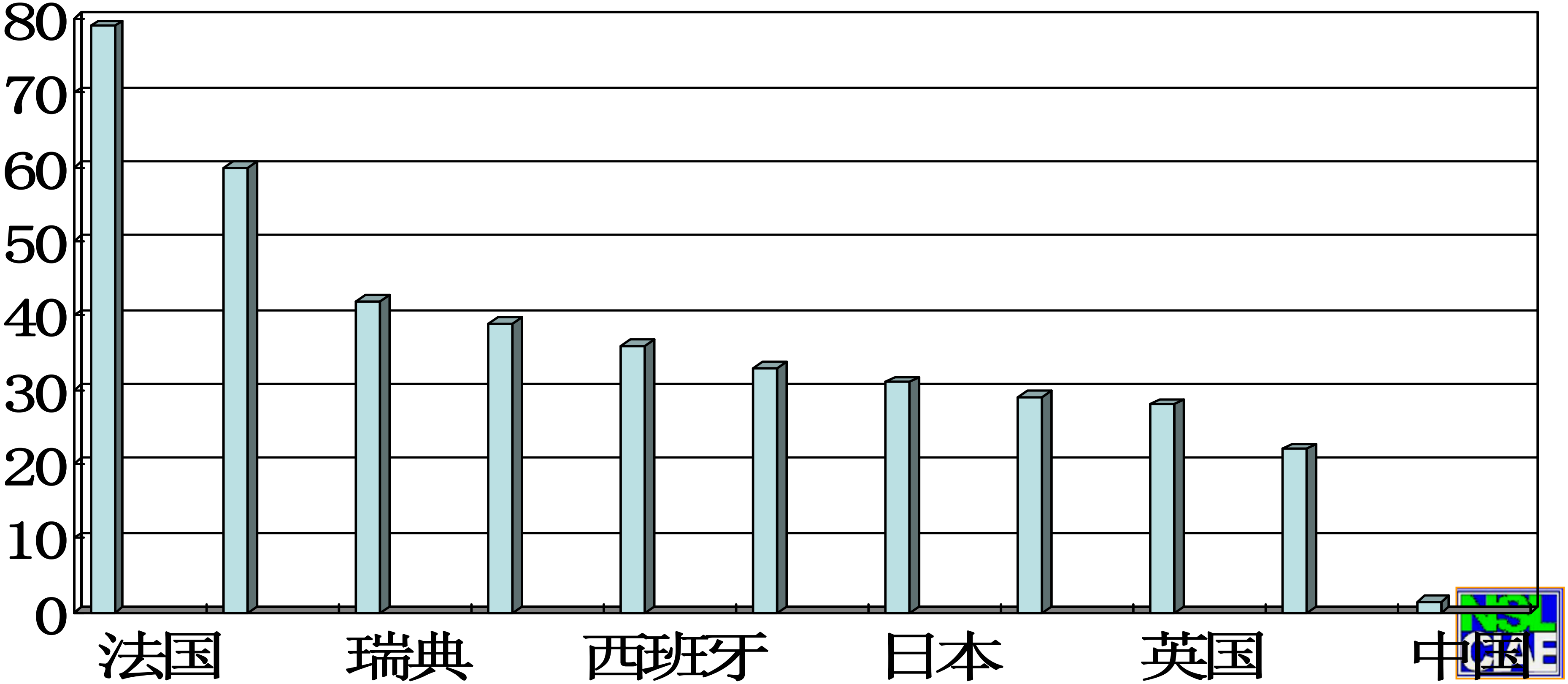
- 中子诱发核裂变的发现
  导致了核武器和核动力舰船
- 对人类历史和世界政治力量的格局
  产生了重大的深远影响

千秋功过也许要由后人来评说

NSL CIAE

能源：全球发电量的17%来自核电

正在运行的反应堆核电站	440 座
在建的反应堆核电站	107 座
总装机容量	351.2Gwe
反应堆运行史	8800 堆年



同位素与核医学

- 产值：每年几百亿美元
- 诊断和治疗的病人：
- 每年上亿人次
- 美国约50%的癌症患者接受放射治疗

帮助成千上万的癌症患者延长了寿命

其它应用

- 中子活化分析、中子掺杂生产半导体器件、中子辐照加工、中子辐照育种、中子测井等等

产生了不可估量的社会效益

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CHINA
Forward
WATER PURIFICATION

中 子 散 射

- 1946年Shull：

  用中子衍射研究磁性材料

  1955年Brockhouse：

  用中子散射研究晶格动力学
- 1994年他们因此获得诺贝尔奖
- 迟到的荣誉表明：

  经过几十年的实践中子散射的重要性已经得到国际学术界的公认

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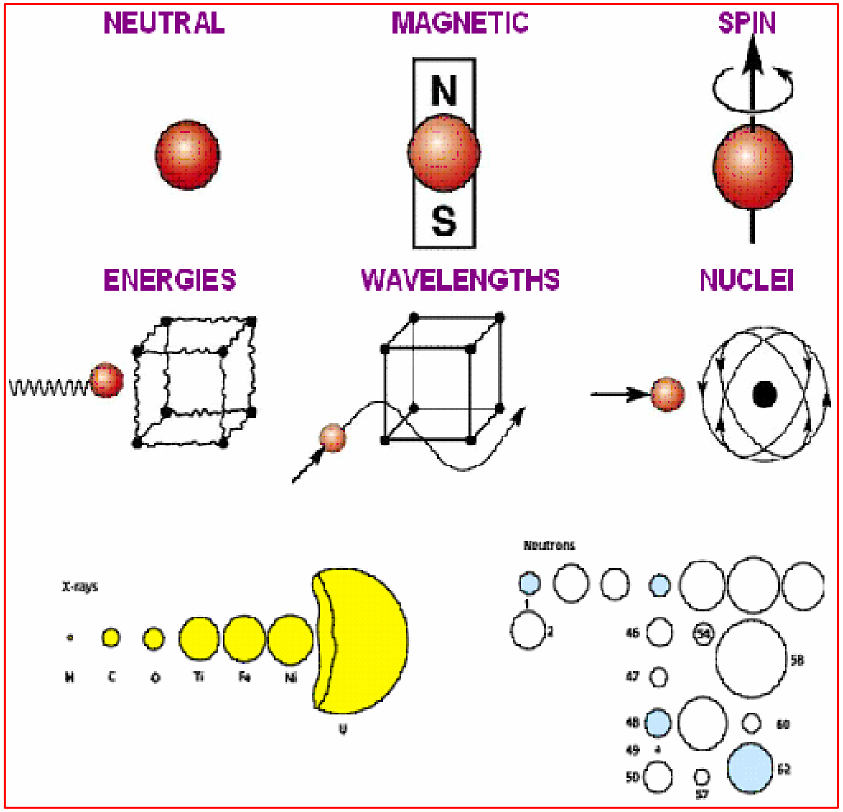
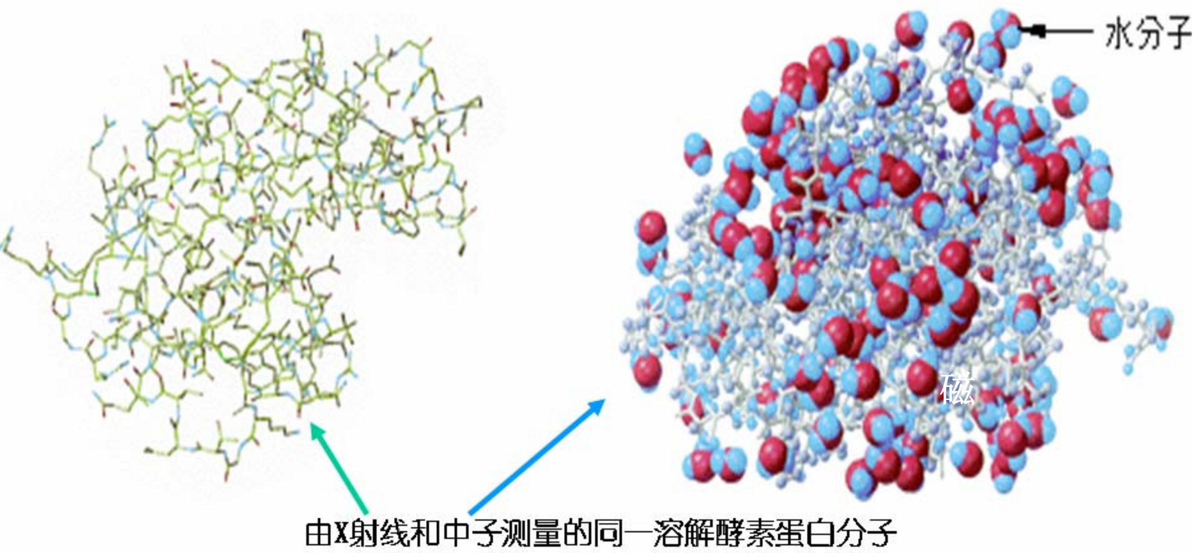
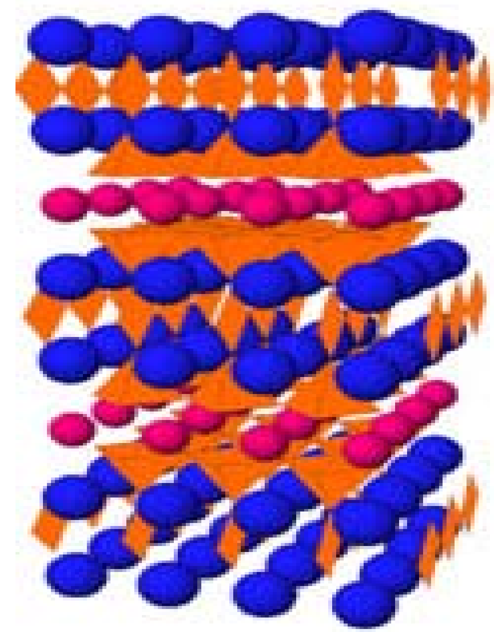
为什么用中子？独特的工具



- **穿透性**　工程应力和特殊样品环境的研究，对工业实际应用提供独特手段。
- **带磁矩**　直接研究磁性材料原子结构的独特工具，为研发新型磁性材料提供途径。
- **特异性**　鉴别轻元素和近邻元素，特别适用于高分子材料和医药生物方面等的研发。

科学意义和作用：中子能分辨出轻元素





溶解酵素蛋白分子

C-O-N ： 同步辐射；

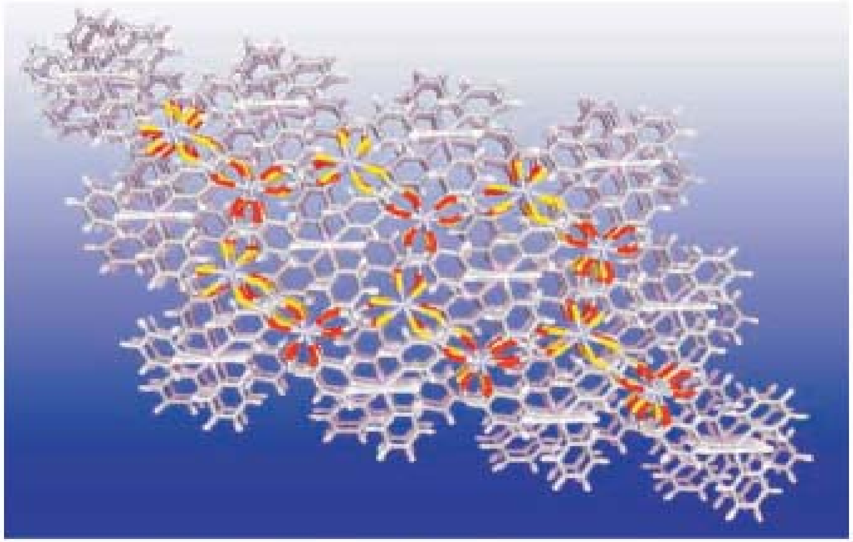
H： 中子衍射

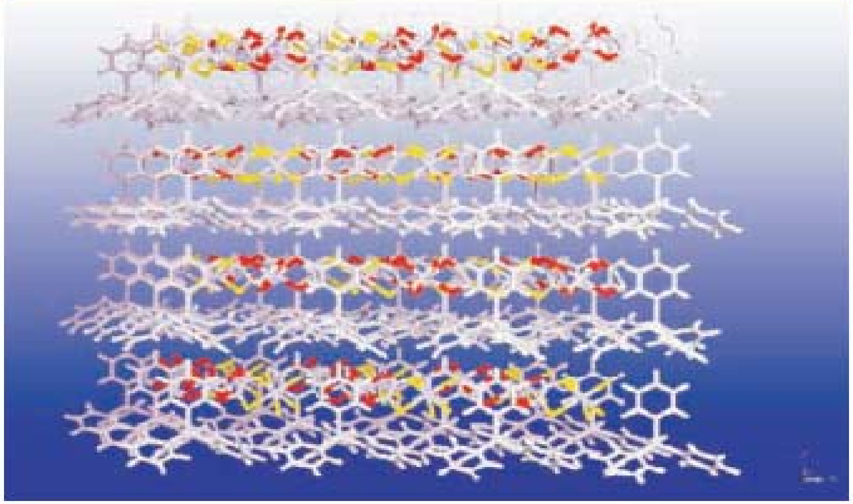
高温超导体YBCO

Y, Ba2, Cu3： 同步辐射；

O(6+δ)： 中子衍射

科学意义和作用：从（同步辐射）非磁到（中子）磁



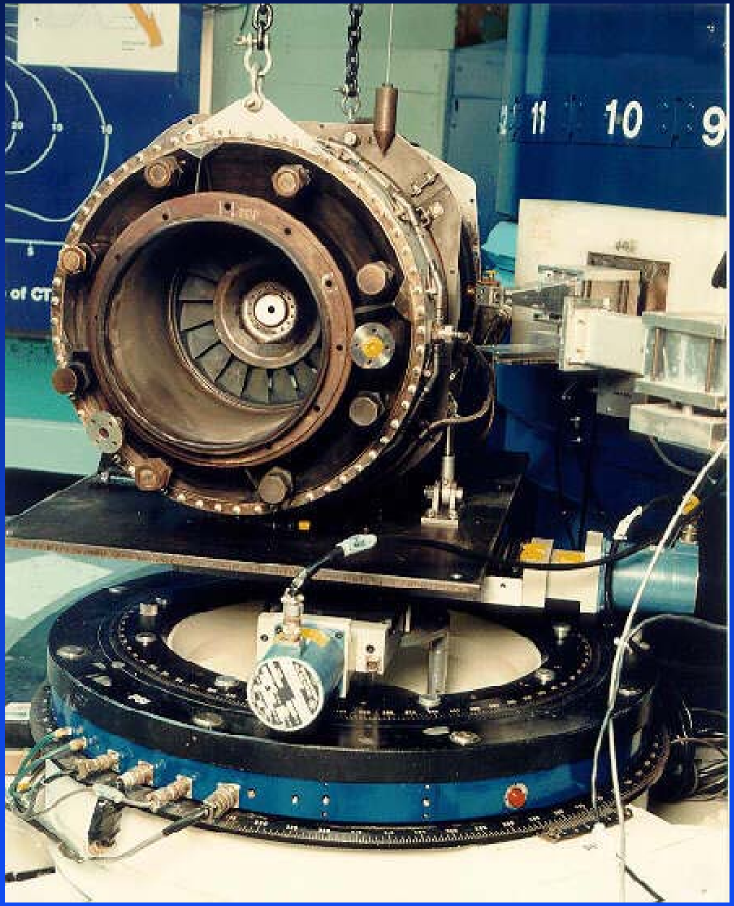


有机分子磁体(二硫代羧草酸盐)：

晶体结构（非磁）由同步辐射测定；

磁性结构由中子散射测定（红、黄部分）。

中子的高穿透能力使其在工业材料的研究中有着广泛的应用



Gas turbine aircraft engine

Natural gas cylinder

Courtesy of R. Rogge, Chalk River, Canada

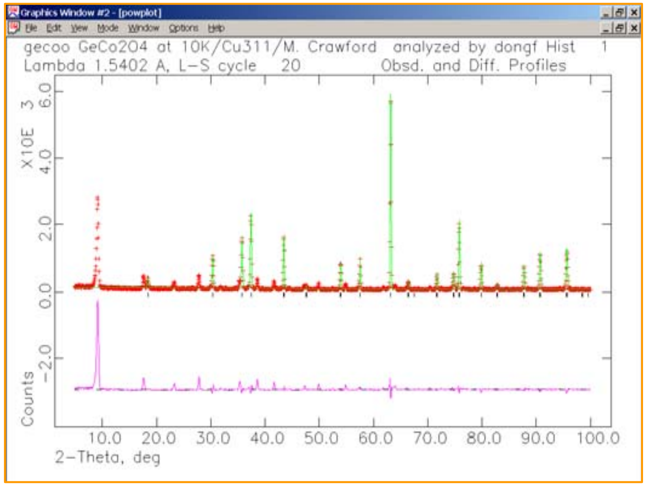
	研究课题	合作单位
1	1:12 应用型稀土永磁材料粉末中子衍射研究	北京大学
2	粉末中子衍射研究 2:17 等系列磁性材料的晶体结构和磁结构	中科院物理所
3	YSr2Fe3-xCox08 的晶体结构和磁结构研究	北京大学
4	高 Tc 超导 YBa2(Cu1-xCox)307 的结构研究	清华大学
5	纳米晶功能耐热陶瓷 SiC 和 Si3N4 的结构分析	上海硅酸盐所
6	新型结构材料 Fe3Al 金属间化合物的中子衍射研究	北京科技大学
7	LaNi5 型储氢电极材料的结构研究	南开大学
8	Pd-Dx 系统的动态结构研究	原子能院同位素所
9	单晶在外场作用下的中子衍射研究	中科院物理所
10	激光倍频材料 DLAP 和 MHBA 的中子衍射结构研究	山东大学
11	在大的单晶中次级消光的研究	原子能院物理所核理论室
12	NiTi 系列形状记忆合金相变机理的研究	上海钢铁研究院
13	铁基非晶态因瓦合金系列声子谱测量	东北大学
14	高温超导材料在不同温度下的声子谱研究	清华大学
15	储氢材料 LaNi5Hx 在不同含氢量下的声子谱测量	北京有色金属研究总院
16	LiTaO3 的相变和晶格动力学研究	山东大学
17	油岩孔隙大小分布及分维结构的测量	大庆油田
18	人血清白蛋白(HSA)分子在不同锌离子 Zn+2 浓度下的缔合效应研究	清华大学
19	小角中子散射测定 SiO2 超细粉的纳米粒度	原子能院化学所
20	YBa2Cu306+的非均匀反铁磁研究	中科院物理所
21	熔融织构高 Tc 超导材料辐照效应对提高临界电流密度 Jc 的影响研究	北京有色金属研究总院
22	NiCo 多层膜的结构中子反射研究	首都师范大学
23	R2Fe14B 永磁化合物间隙原子效应的中子衍射研究	北京大学
24	PVA 凝胶的中子小角散射研究	北京科技大学
25	纳米软磁材料的中子散射研究	钢铁研究总院
26	在外电场下激光倍频材料 KTP 晶体的中子衍射研究	山东大学
27	铀化锆和铀锆合金的中子衍射研究	原子能院堆工所
28	Hg-1223 相高 Tc 超导材料的中子衍射研究	南京大学
29	储氢 LaNi5 材料的中子衍射研究	中国工程物理研究院

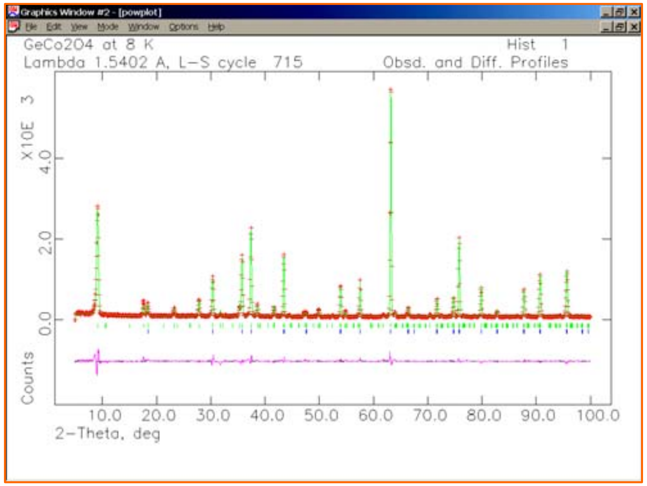
美国国防部近年基础研究计划：
材料科学方面各军种特别关心的问题

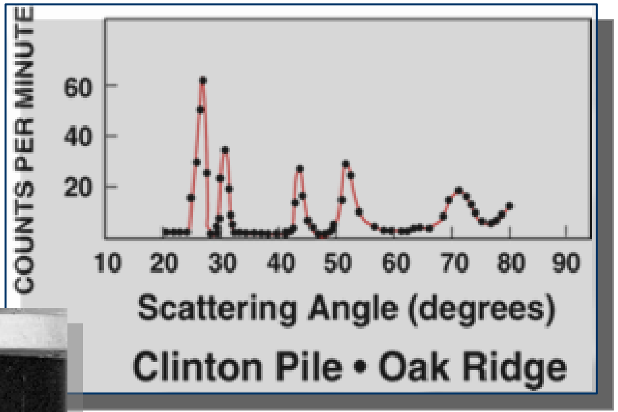
	领域	陆军	海军	空军
结构材料	老化系统	制造科学	海上腐蚀、氧化和疲劳	高温疲劳断裂
	飞机结构	装甲反装甲材料	舰船和潜艇用的先进材料	航空航天蒙皮
	先进装甲	柴油发动机材料	声学阻尼结构	飞机老化
	舰船和潜艇	炮管衬套材料	分层设计材料	功能梯度材料
	船体及机械			超音速蒙皮
				均衡材料性质
		先进复合材料；粘接和结合；摩擦学；陶瓷；金属间化合物。		
功能材料	成像声纳	缺陷工程	铁素体薄膜，铁电材料	
	通信	光学设备	金刚石，声学材料	纳入化学、电子学、物理学和力学基础研究领域
	目标捕获	红外探测器	活性材料，电子组装材料	
	数据存储器与传感器	生物防御材料	超导材料	
		智能材料		
		光电子学；磁性材料。		

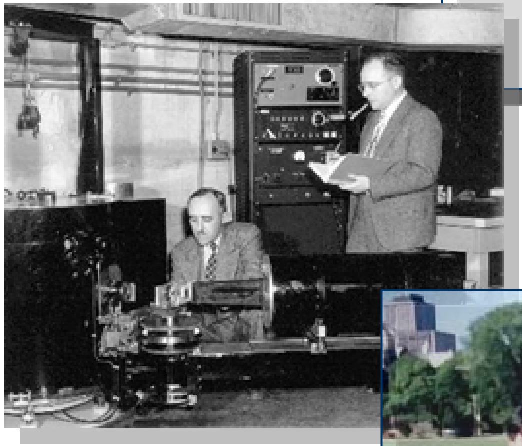
绝大多数领域可由中子散射技术覆盖

中子衍射技术



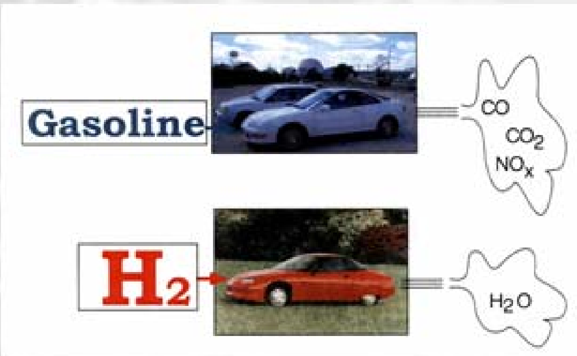




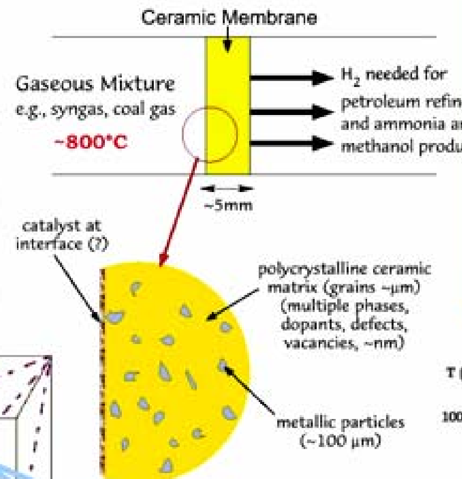


Courtesy by NIST at HRPD

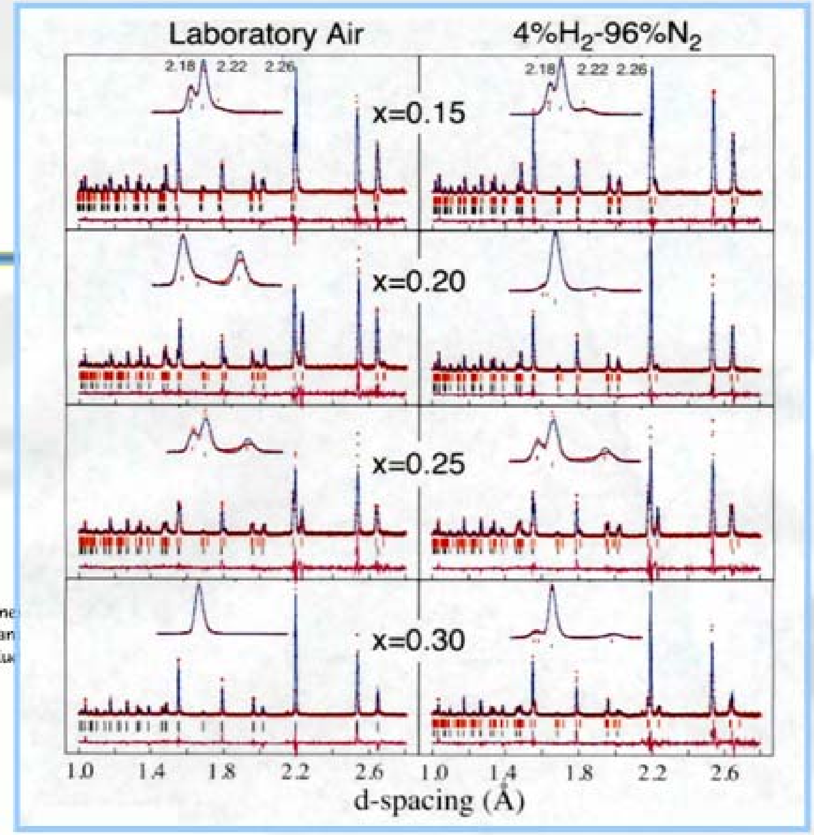
YBCO-应用前景



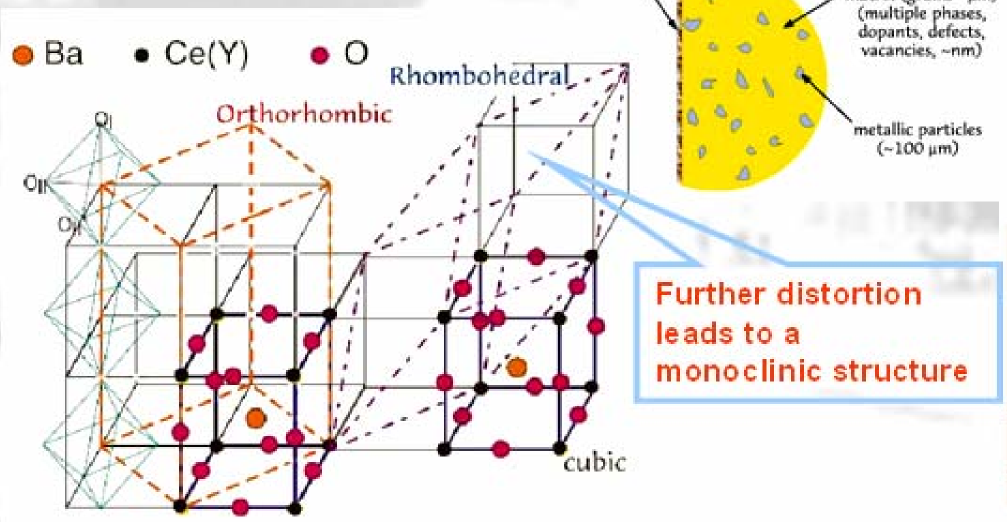
Gasoline
CO
CO_2
NO_x
H_2
H_2O



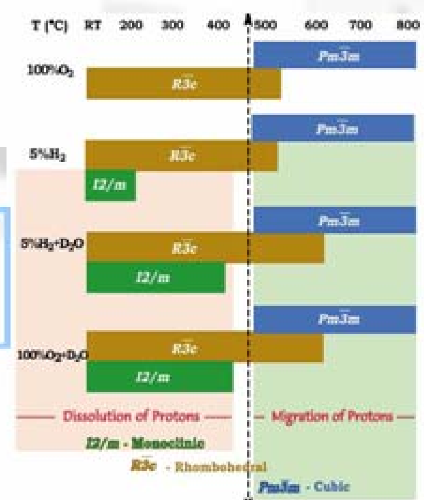
Ceramic Membrane
Gaseous Mixture
e.g., syngas, coal gas
~800°C
H_2 needed for
petroleum refine
and ammonia an
methanol produ
~5mm
catalyst at
interface (?)
polycrystalline ceramic
matrix (grains ~μm)
(multiple phases,
dopants, defects,
vacancies, ~nm)
metallic particles
(~100 μm)



Laboratory Air
$4\%H_2-96\%N_2$
2.18
2.22
2.26
x=0.15
x=0.20
x=0.25
x=0.30
1.0
1.4
1.8
2.2
2.6
d-spacing (Å)

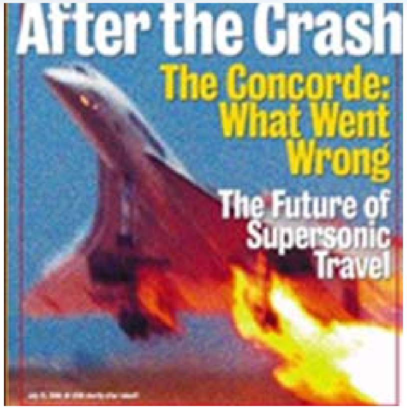


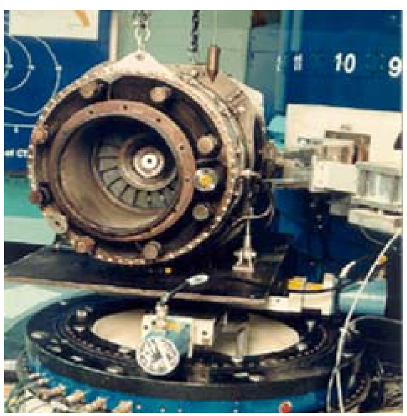
Ba
Ce(Y)
O
Rhombohedral
Orthorhombic
cubic
Further distortion
leads to a
monoclinic structure

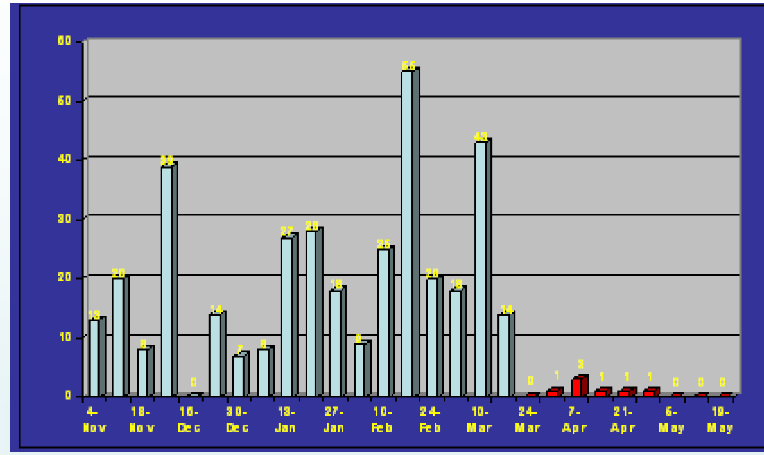


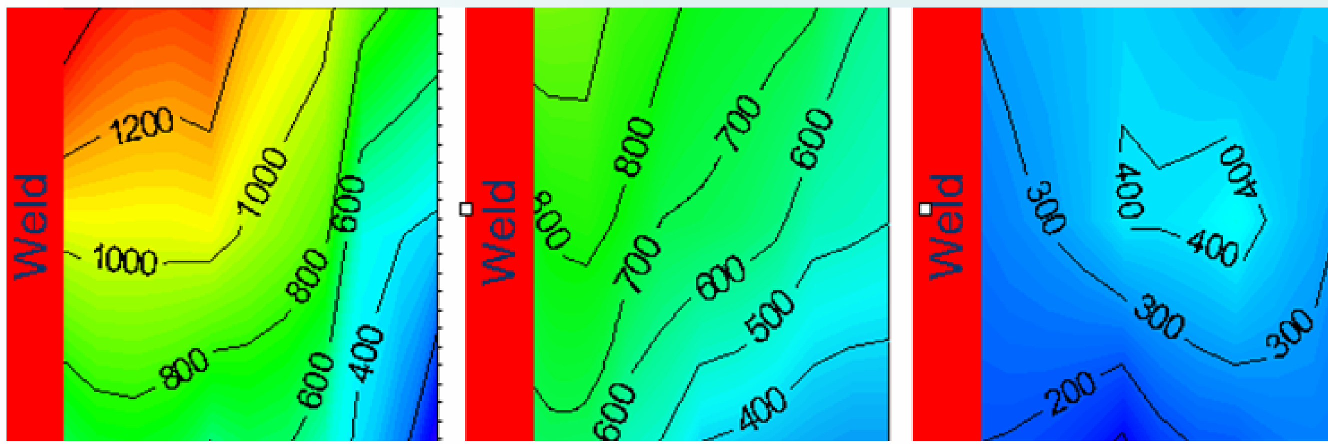
T (°C)
RT
200
300
400
500
600
700
800
$100\%O_2$
$5\%H_2$
$5\%H_2+D_2O$
$100\%O_2+D_2O$
$Pm\bar{3}m$
$R\bar{3}c$
$I2/m$
Dissolution of Protons
Migration of Protons
$I2/m$ - Monoclinic
$R\bar{3}c$ - Rhombohedral
$Pm\bar{3}m$ - Cubic

例一：深度三维无损残余应力测量









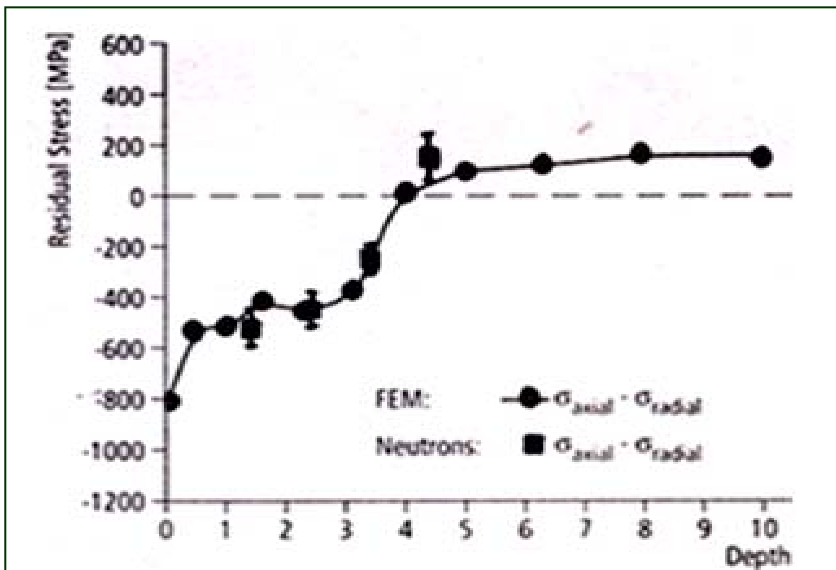
飞机涡轮的叶片与轮盘的焊接应力测量

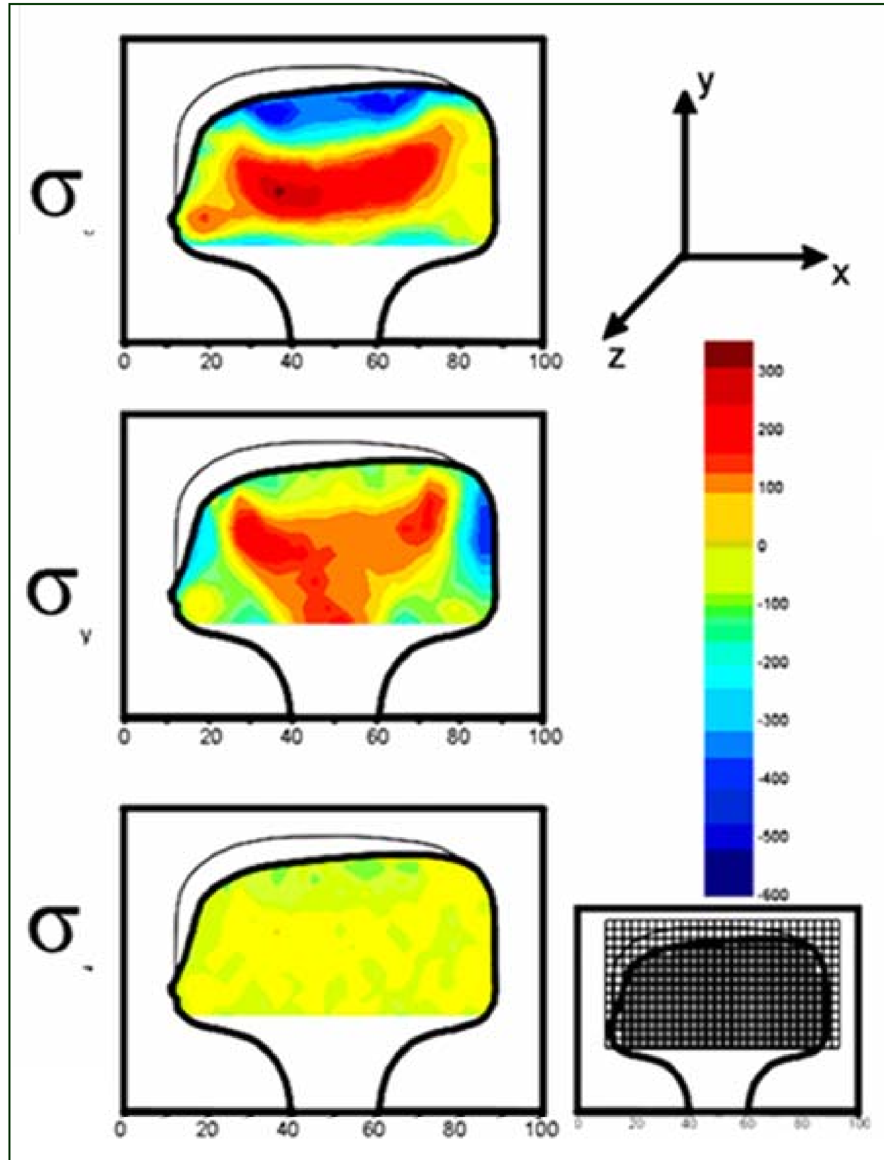
利用中子散射技术进行应力测量研究改进工艺后事故率大大降低

Why neutrons

Transmission Through a ¼-inch Plate

Material	Neutron	X-ray
Al	94%	zero
Fe	46%	zero
Al_2O_3	78%	zero
ZrO_2	75%	zero





Neutron Residual Stress Measurements for Improved Safety of Gas Pipelines

Michael Law[1,2], Thomas Gnaeupel-Herold[1,3], Vladimir Luzin[1,4], Henry J. Prask[1]
[1]NIST Center for Neutron Research, [2]Australian National Science and Technology Organization, [3]University of Maryland, Dept. of Materials Science and Engineering, [4]SUNY Stony Brook

Residual Stress and Safety in Pipelines

2007 fireball from a corrosion failure, New Mexico

Safety - Gas pipelines have an enviable safety record in transporting energy; this is due to detailed materials characterization and stress analysis. The focus on lighter, stronger steels and higher design factors increases the technical challenges with respect to analysis and testing

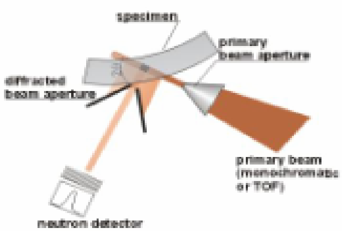
Crater due to stress corrosion cracking, Washington state

Rupture in pipeline testing

Consequences of failure- Internal gas pressure has huge stored energy. If the gas ignites, the resulting fireball can be catastrophic.

Modes of failure – fracture, fatigue, stress corrosion cracking. Failures are affected by residual stress in the pipeline after manufacture and welding.

Non-destructive Evaluation by Neutron Diffraction



Gage volume size of 1x1x1 mm³ enables thru-thickness depth profiling. Most importantly, no drilling, etching or other material removal is required.

BT-8 residual stress measurement rig. Axial stress.

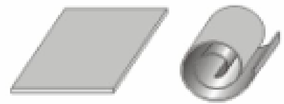
BT-8 residual stress measurement rig. Hoop stress

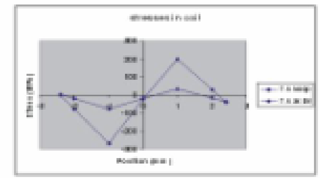
This work - Residual stresses were investigated by neutron diffraction measurements at various stages in the manufacturing process :- the strip the pipes are formed from, the finished pipe, and the stresses arising from welding these pipes together to make a pipeline.

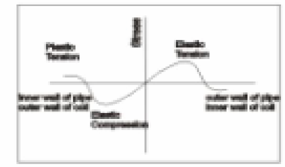
Residual Stress in Pipelines - From Plate Stock to Welded Pipes

Pipe Manufacturing Process | Resulting Stress State | Qualitative Prediction

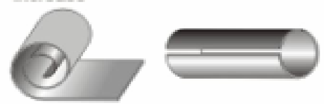
Plates are coiled, strength increase by work hardening

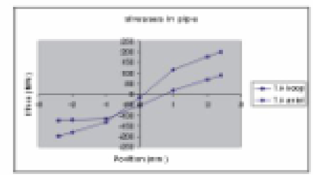


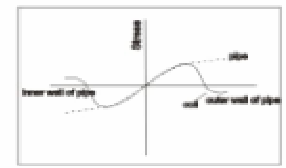




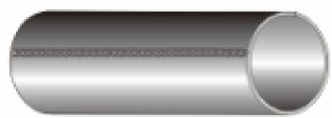
Coil is unbent, then fed into pipe mill
More workhardening and further strength increase

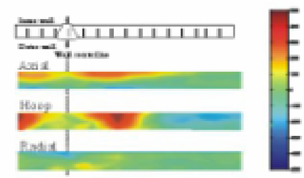




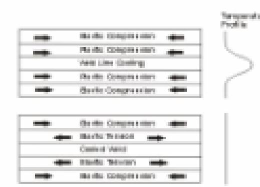


Longitudinal seam welding, followed by compressive sizing and finally hydro-static expansion

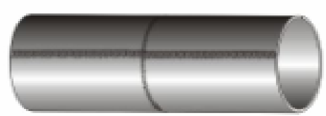


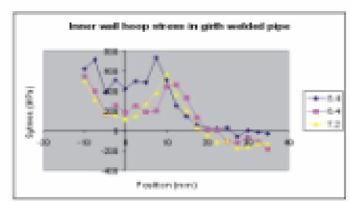


Results - welding – Thermal



Girth welding to connect individual sections





Results - Pipe – Significant stresses come from the rolling and pipe forming operations, up to 2/3rds of the yield strength. This stress field is then modified by the residual stresses from welding.

Conclusions – Significant stresses come from pipe manufacture. These stresses may be higher than the operating stresses in the pipe. It is essential to understand the evolution of these stresses and modify manufacturing processes to ensure integrity. Neutron methods can be used to measure these at a range of wall positions, and with good accuracy. As the economic and human costs of failure can be immense, the benefits of understanding residual stresses, and of altering manufacturing and joining processes to minimize them can be substantial..

科学意义和作用：中子能直接研究工程（大）试样

不锈钢的晶格应变与疲劳断裂

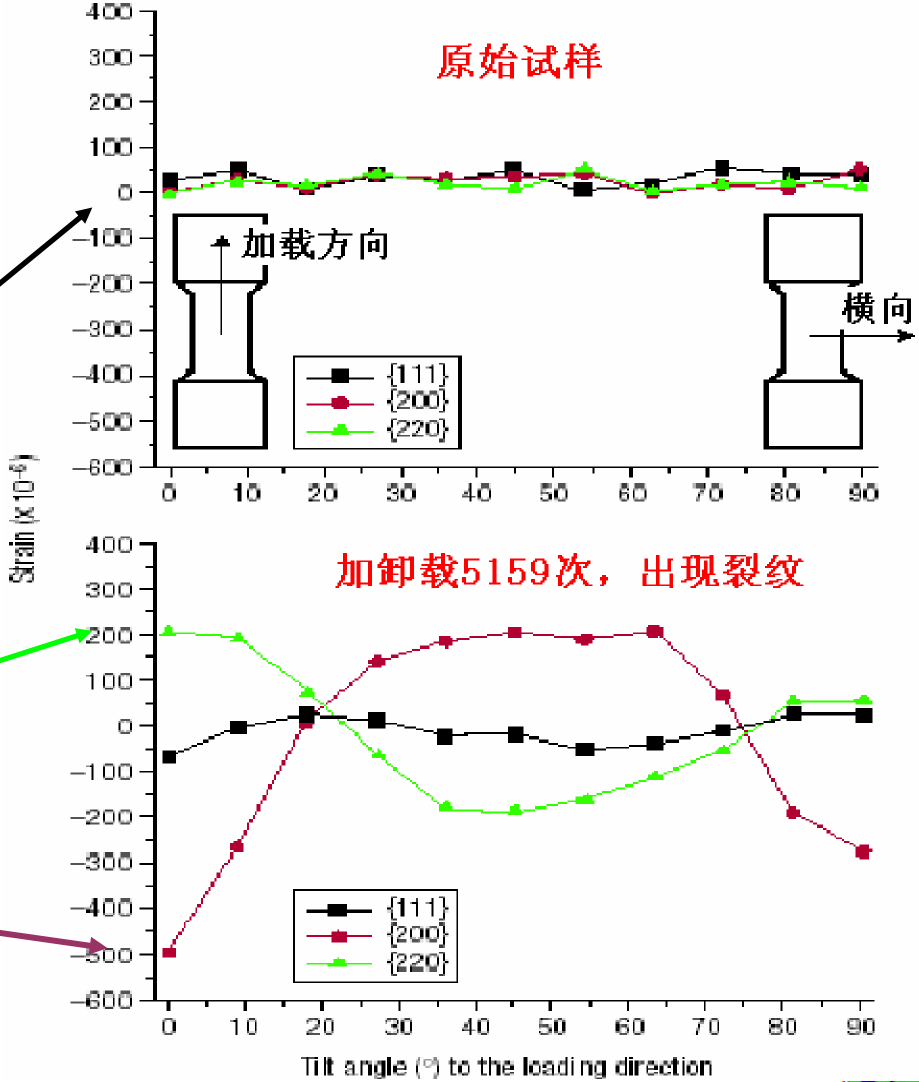
Y.D. Wang, et al.(王循礼),
Nature Materials, 2, 103
(2003)

实验地 Argonne（美）

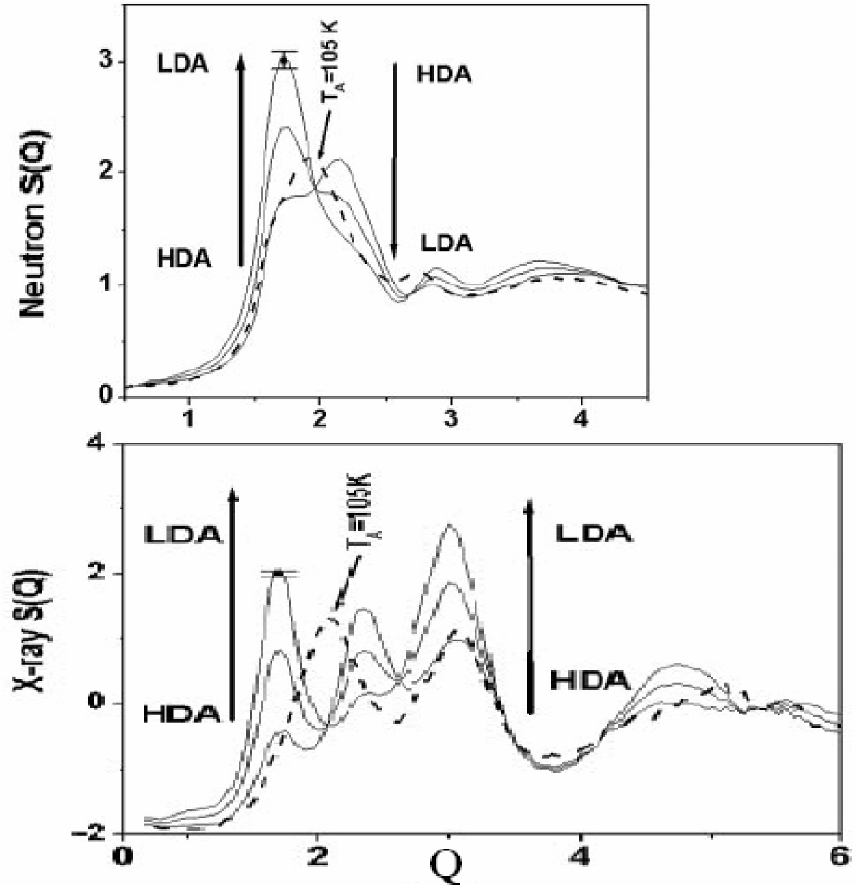
样品截面 12x30mm^2

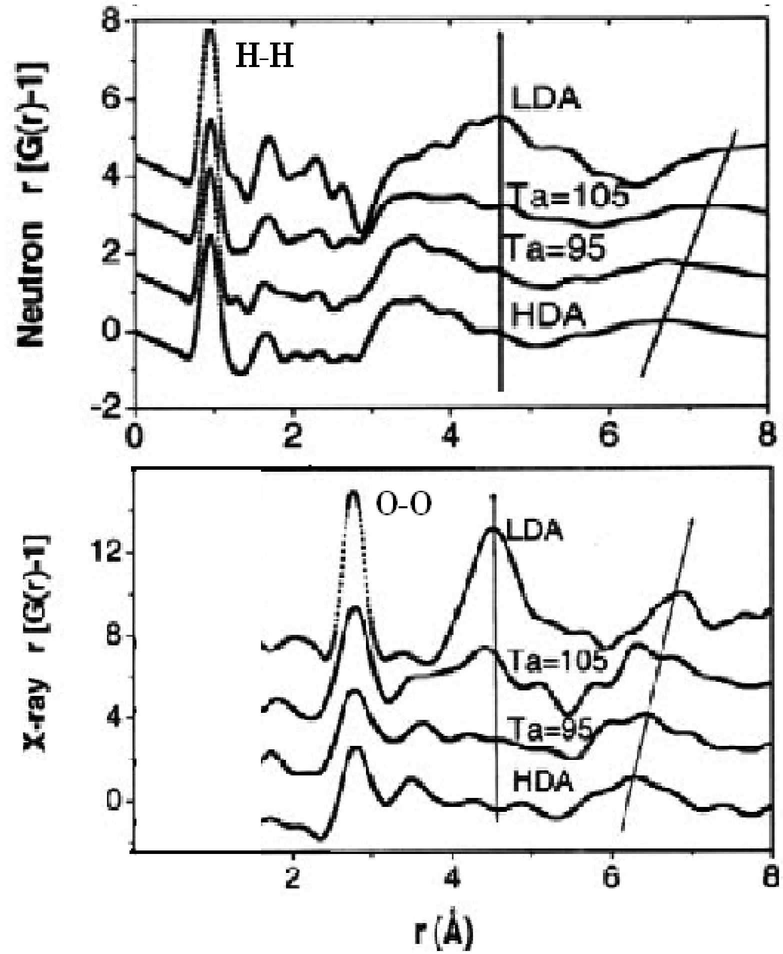
各种取向的晶粒均无应变

（110）//加载的晶粒伸长，
（100）//加载的晶粒缩短，。。
导致了晶粒间的应力.



意义和作用：中子能分辨出轻元素（低温冰中的H键）





低温下的亚稳态冰　C. A Tulk et al., Science 297, 1320 (2002)

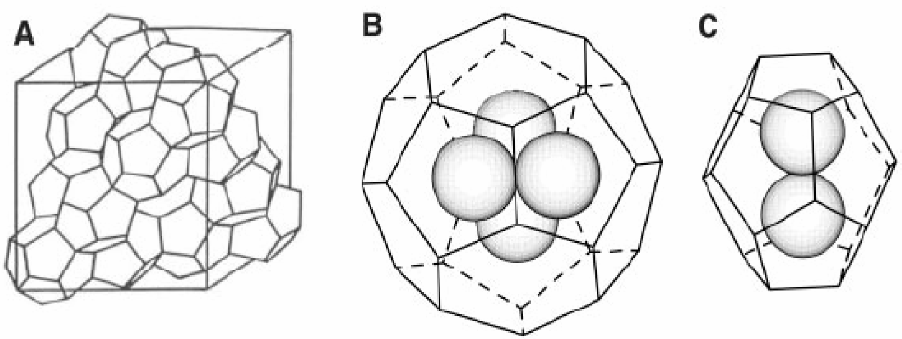
实验地 Argonne（美）　LDA(低密度非晶相）；HAD（高密度非晶相）

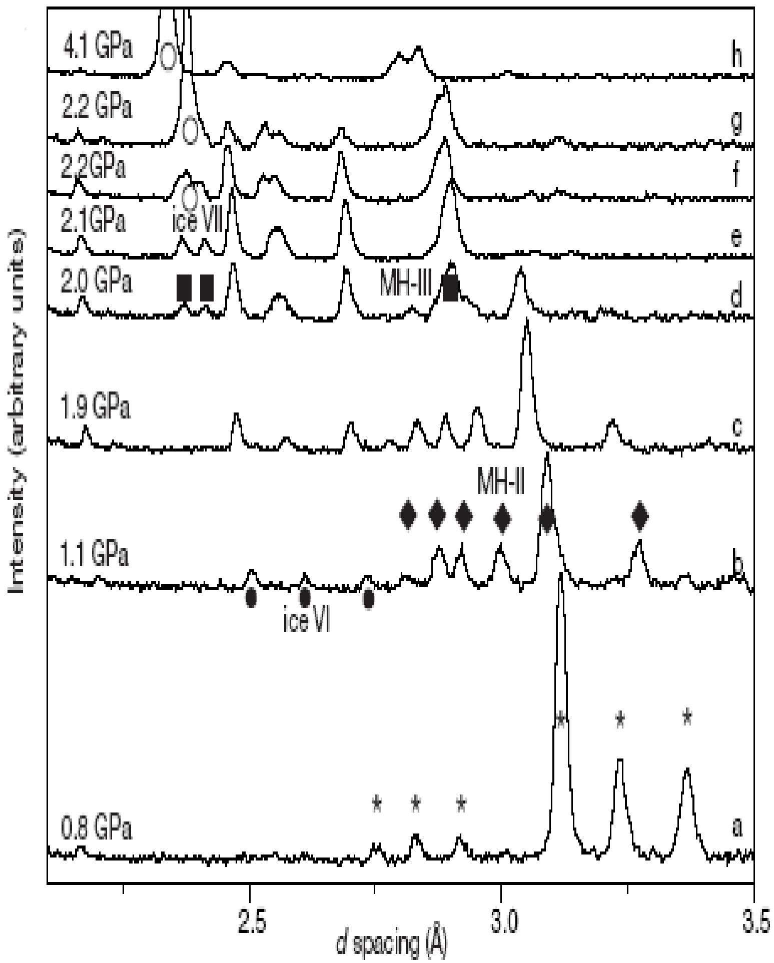
科学意义和作用：中子能分辨出轻元素

笼形水合物中的CH4和H2

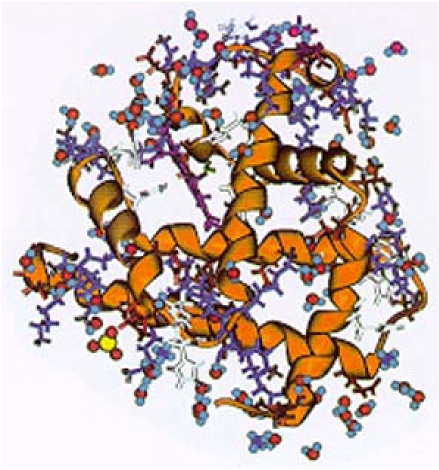
W. L. Mao et al.(毛河光),
Science 297, 2247 (2002);
实验地 Los Alamos（美）

- 可燃冰中CH4和H2的取向和多重结构，储藏能力，稳定性和释放条件（压力，温度等）

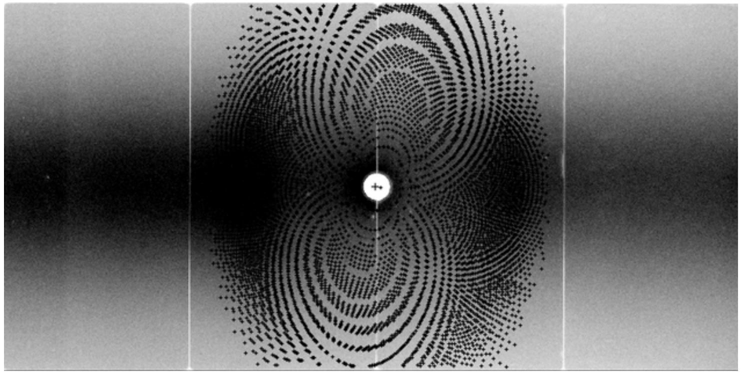




H in Protein and Drug Design



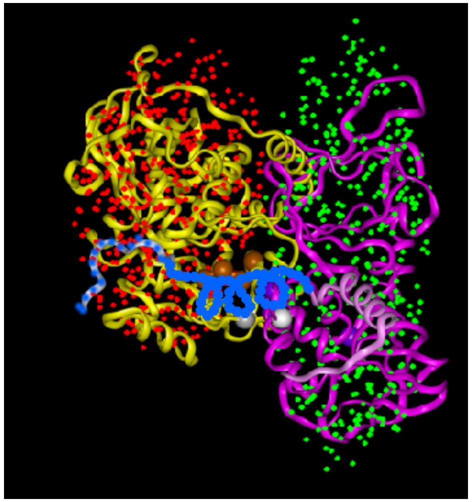
Water on monoxymyoglobin
Cheng and Schoenborn, Acta. Cryst. 1990



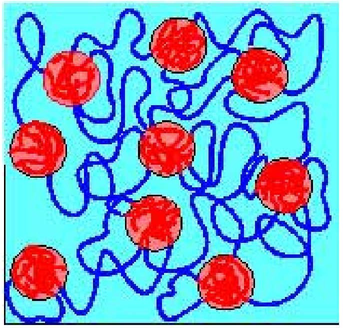
- AIDS
- Arthritis and Inflammation
- Cancer
- Diabetes Mellitis
- Heart Diseases
- Parkinson's Disease
- Sleeping Sickness
- Immune Diseases
- Antivirals
- Novel Methodologies

Soft Condensed Matter

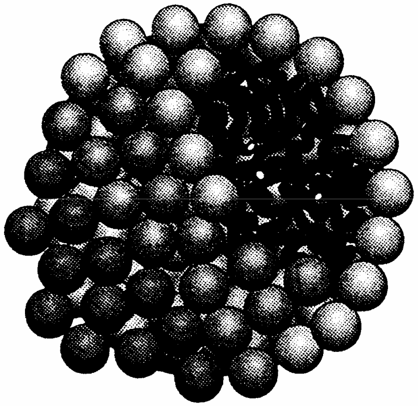
Proteins, DNA



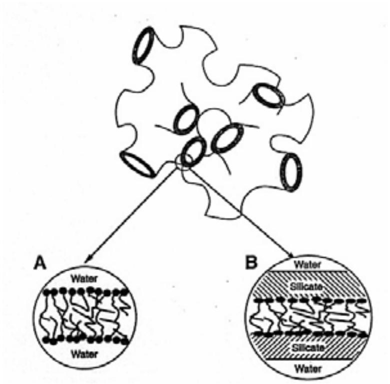
Block Copolymers



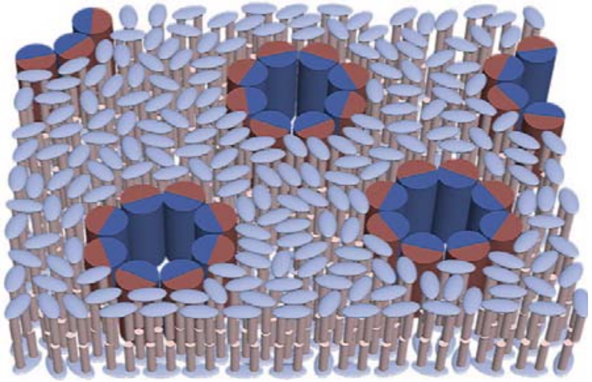
Micelles



Aerosols

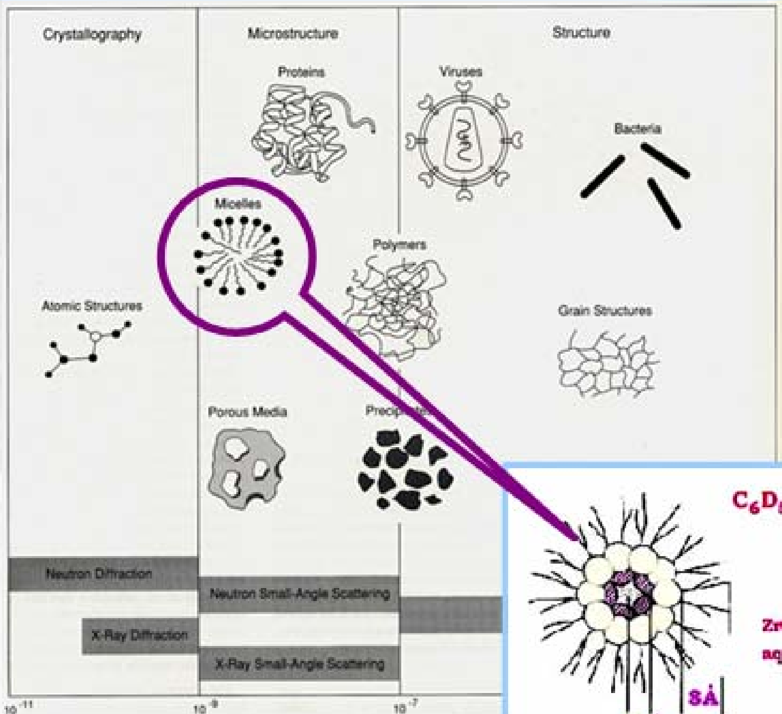


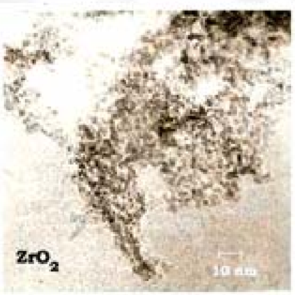
Thin Films and Membranes

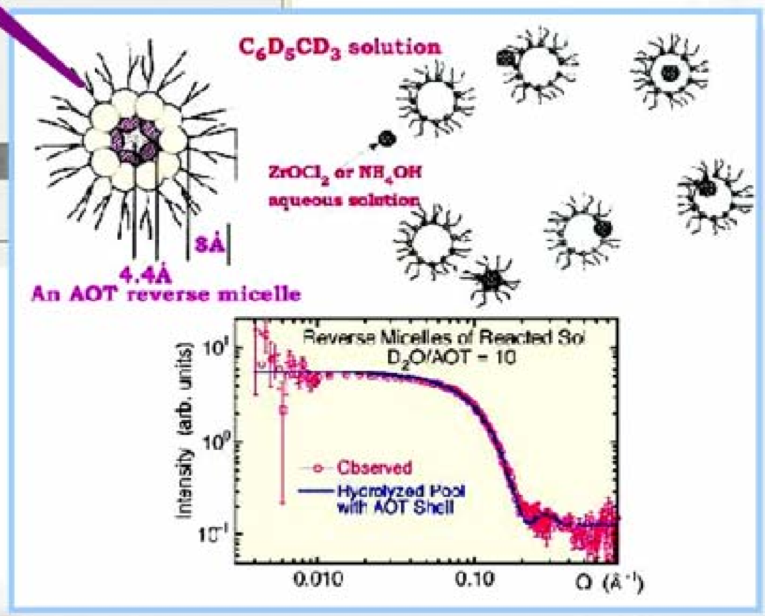


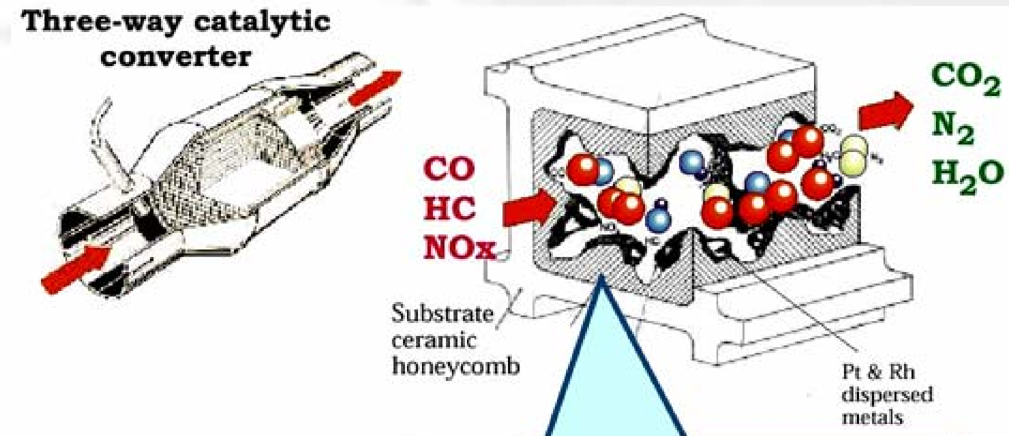
Complex Fluids

Nanophase ZrO_2 SANS studies









Oxide support washcoat

Contained high-surface-area Al_2O_3, ZrO_2 & CeO_2

TOYOTA

UofL

Nagoya Institute of Technology

中国原子能科学研究院 CHINA INSTITUTE OF ATOMIC ENERGY

科学意义和作用：用中子研究大分子运动

高分子液体流动中大分子的转动（尺度8-15 nm）

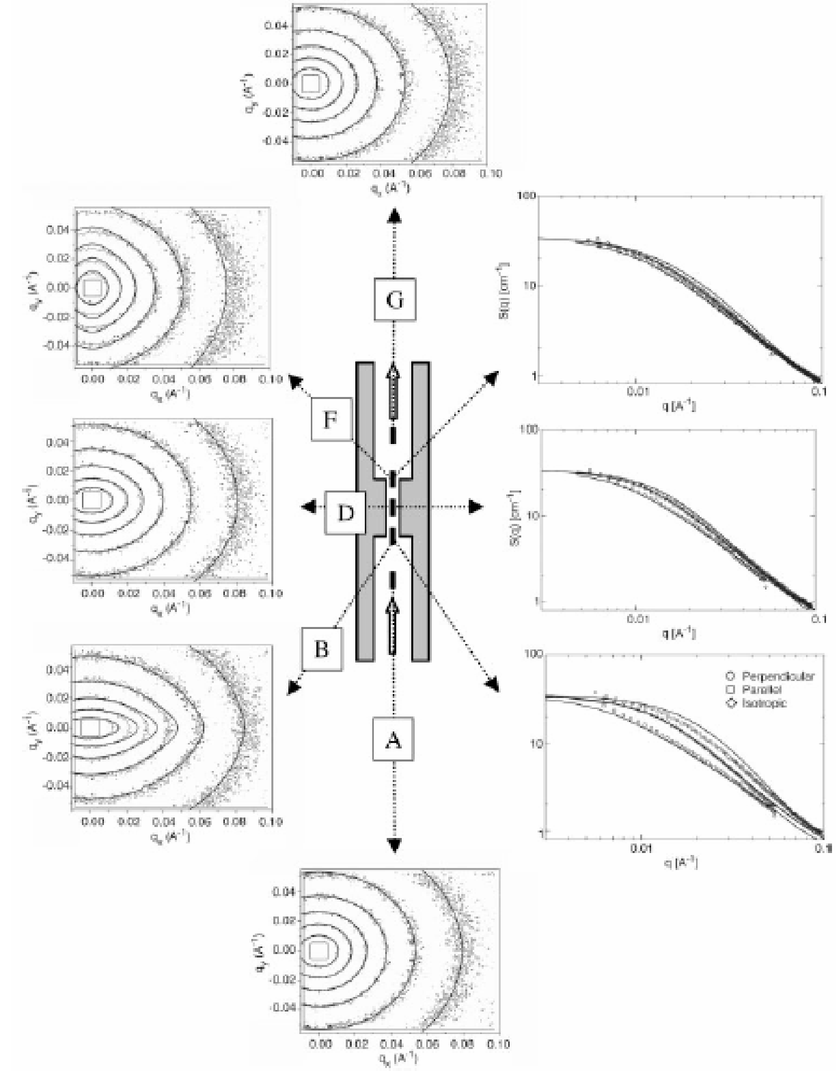
J. Bent et al.,

Science 301, 1691 (2003)

实验地 Grenoble（法）

在隙缝的进口，出口和内部，高分子流动的响应都有非线性是因为大如整个高分子链有迴旋转动.

为何用中子才能探测到：大分子的转动频率很低



中子小角散射的应用:

应用实例之一

飞机引擎叶片在高温运行条件下的老化测试

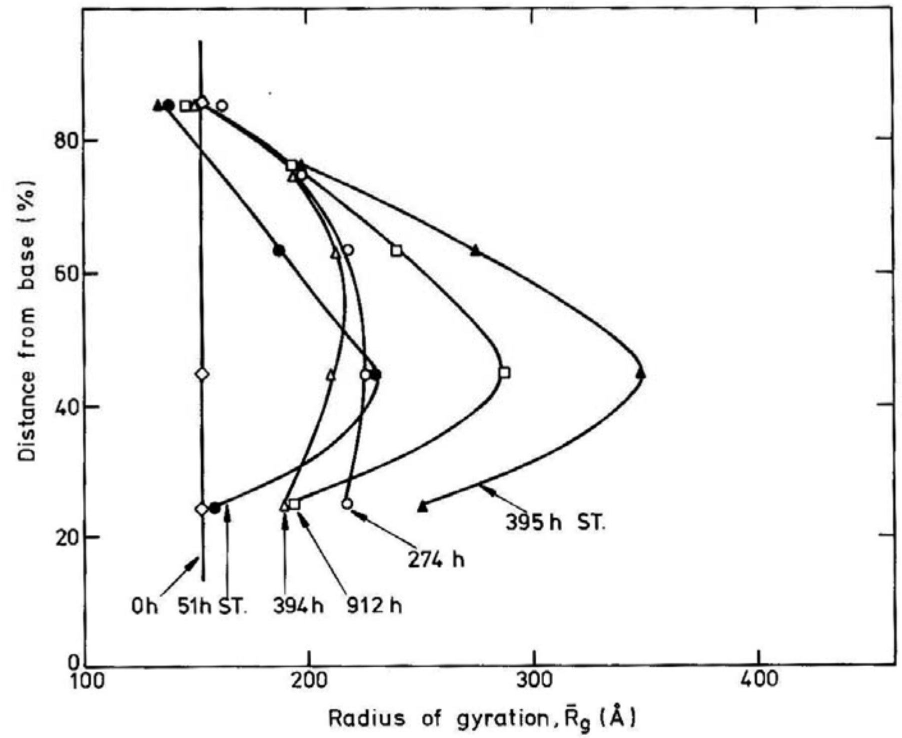
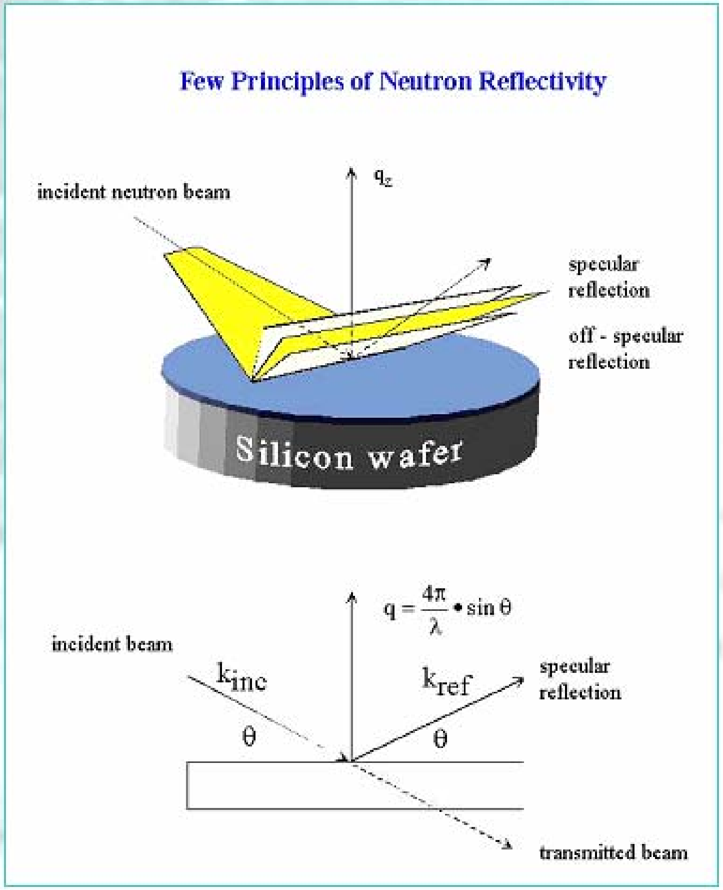


FIG. 15. The mean radius of gyration of the precipitate hardening phase in nickel-based turbine blades. After many hours in service, the precipitate size grows most rapidly in the central region of the blade where the stresses are greatest. [From Galotto *et al.*[54]]

中子反射应用



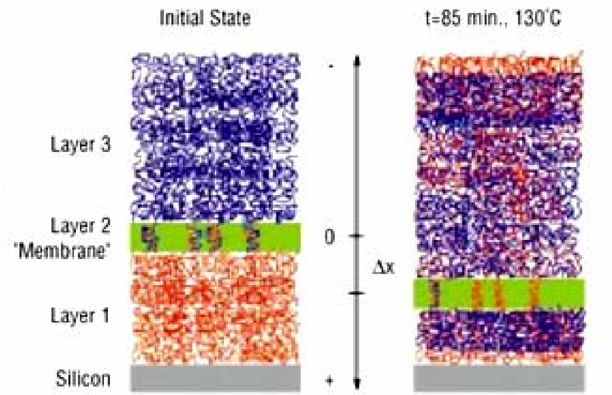


FIGURE 1. Schematic drawing of the sample geometry for Air//hPS/IPCC(34 wt% PS)/dPS//SiO_2/Si. Red (dPS) and blue (hPS) are used to distinguish between isotopically different polymer chains. The membrane (green) is displaced by Δx from its original position as hPS and dPS mix during annealing.

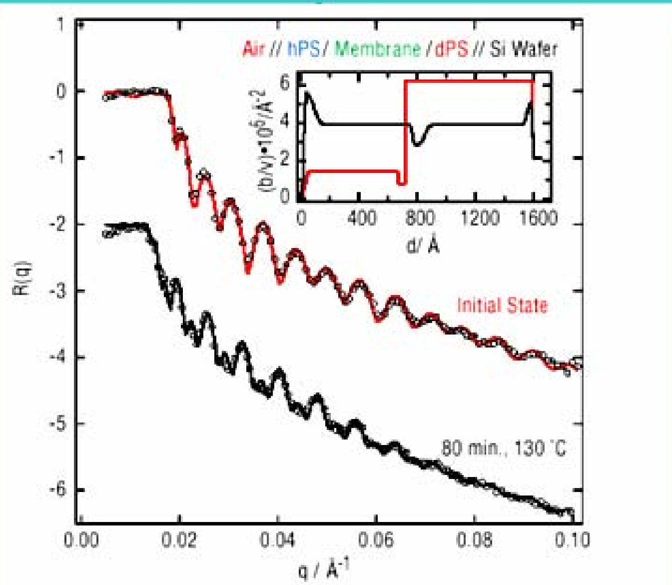
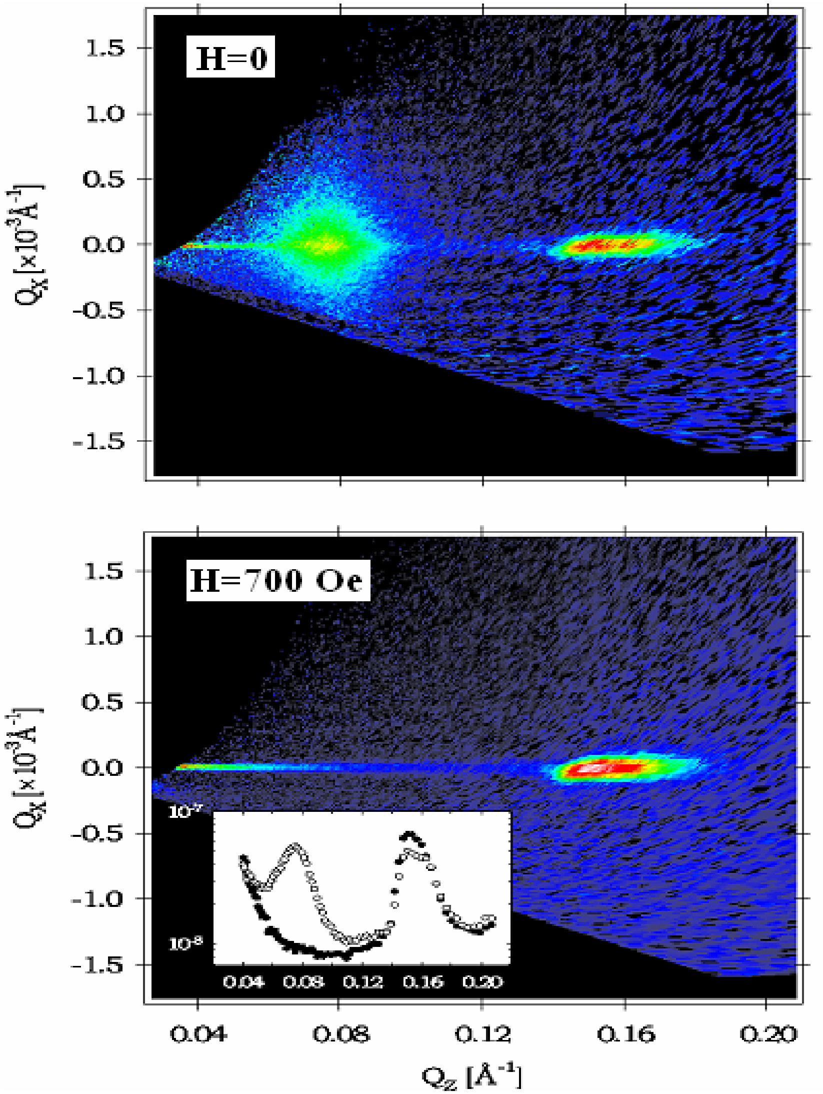


FIGURE 2. Neutron reflectivity data for initial and final state of the sample Air//hPS/IPCC(34wt% PS)/dPS//SiO_2/Si. The lines are the best fit to the data. The corresponding sld profiles are shown in the insert.

中国原子能科学研究院
CHINA INSTITUTE OF ATOMIC ENERGY

科学意义和作用：GMR多层膜结构与磁结构

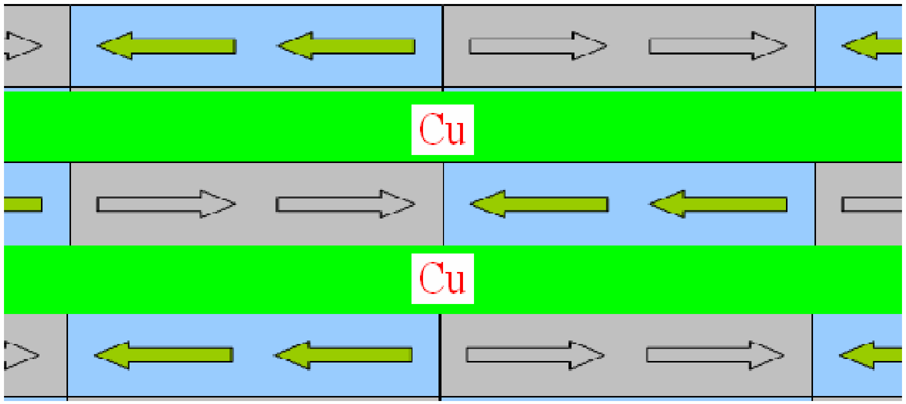


多层膜[Co(20A)/Cu(20A)]x50

Langridge et al, PRL85(2000) 4964

实验地 ISIS（英）

中子揭示了退磁状态（H=0）时沿垂直方向形成反铁磁耦合



科学意义和作用：适合探测原子动态过程的能量动量关系

同步辐射（X射线/光子）：

$$E=ch/\lambda$$

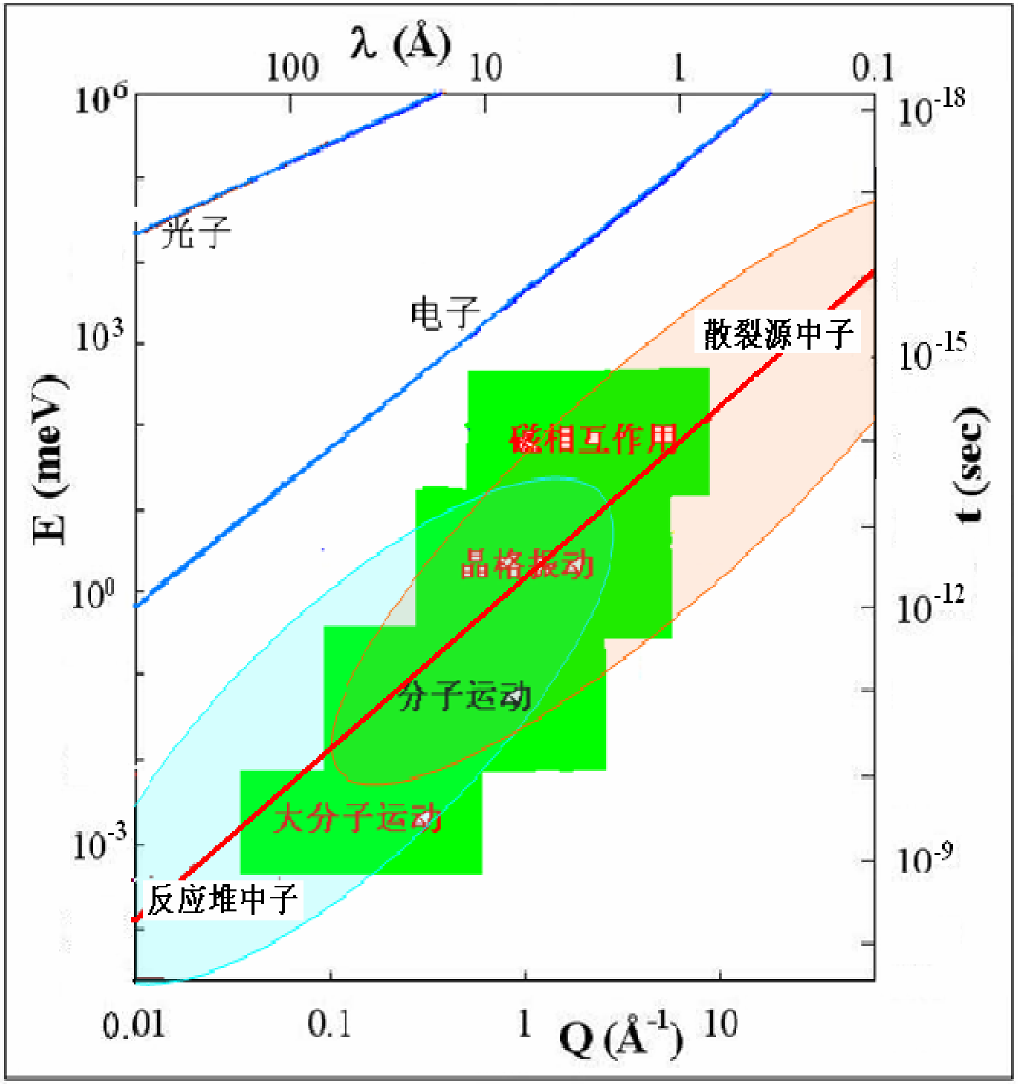
中子/电子：

$$E=h^2/(2m\lambda^2)$$

波长 (nm)	X射线 (eV)	中子 (meV)
1	1240	0.82
10	124	0.0082
100	12.4	0.000082

用非弹性散射研究动态过程时，因动量守恒，对能量分辨率提出了不同要求：

用光子测电子(XPS)
用电子测原子分子(表面，EEL)
用中子测原子分子
用光子测原子分子



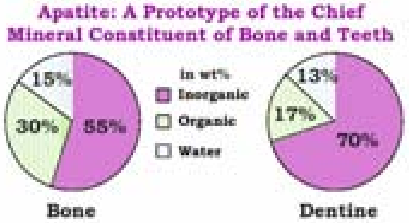
中子非弹性射研究-HAP

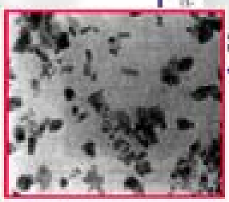
Bone Turnover: Formation of Young Bone Crystals and Resorption of Aged Crystals

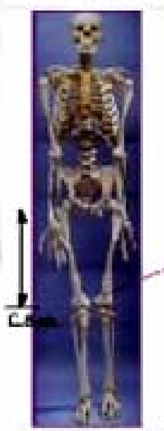
Melvin J. Glimcher, Yaotang Wu & Liisa Spearing
Harvard Medical School, Children's Hospital

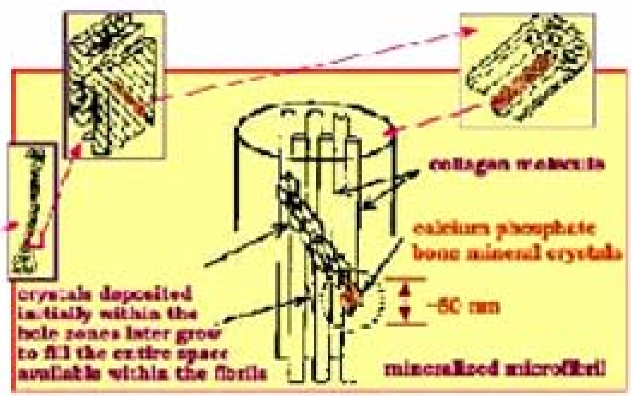
Christian Rey
Institut National Polytechnique de Toulouse

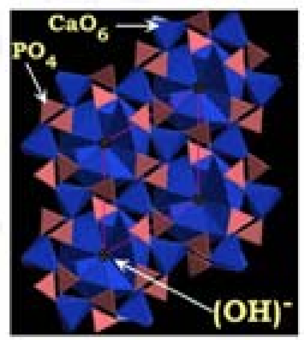
Sow-Hsin Chen
MIT

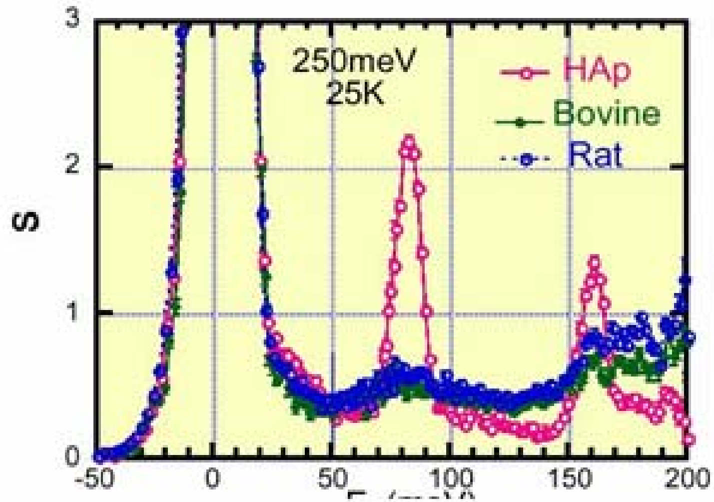


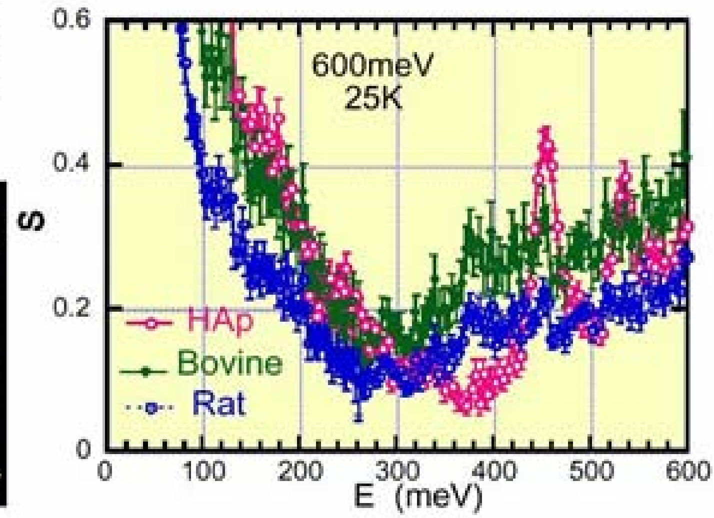








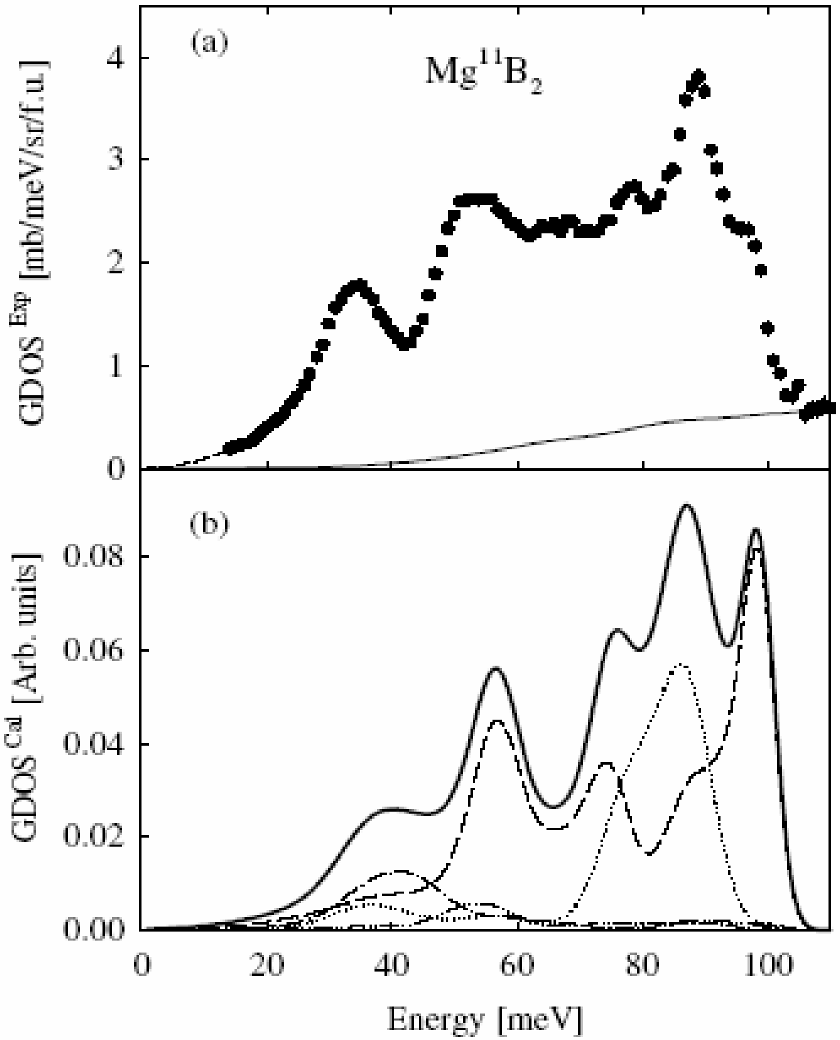




NSL CIAE

科学意义和作用：用中子研究晶格的振动

MgB_2 的声子态密度
R.Osborn et al.
PRL **87**, 017005 (2001))
实验地 Argonne（美）



较强的电声子作用导致了
高超导转变温度

为何用中子才能探测到：晶格振动的波长很短(波长0.2 nm)

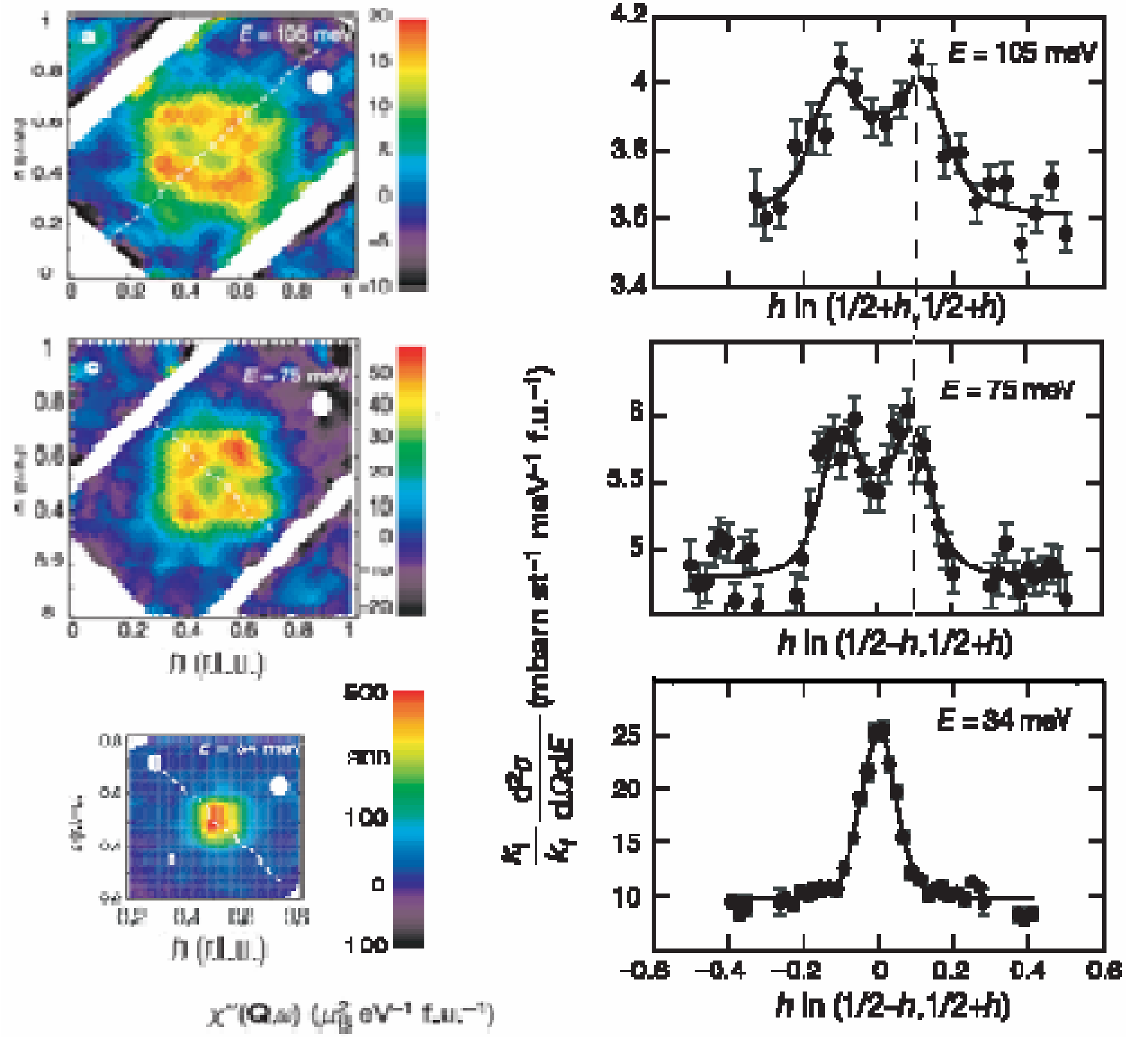
科学意义和作用：用中子研究高温超导体中的磁激发

$YBa_2Cu_3O_{6+x}$超导体的磁激发
S.M.Hayden et al.(戴鹏程)
Nature 429,531 (2004)
实验地 ISIS（英）

结果：中子能量(E ＞ 66 meV)产生磁激发.

为何用中子才能探测到：是磁激发，而且波长很短

为什么说这是：‘美国科学家到国外做中子实验的耻辱’



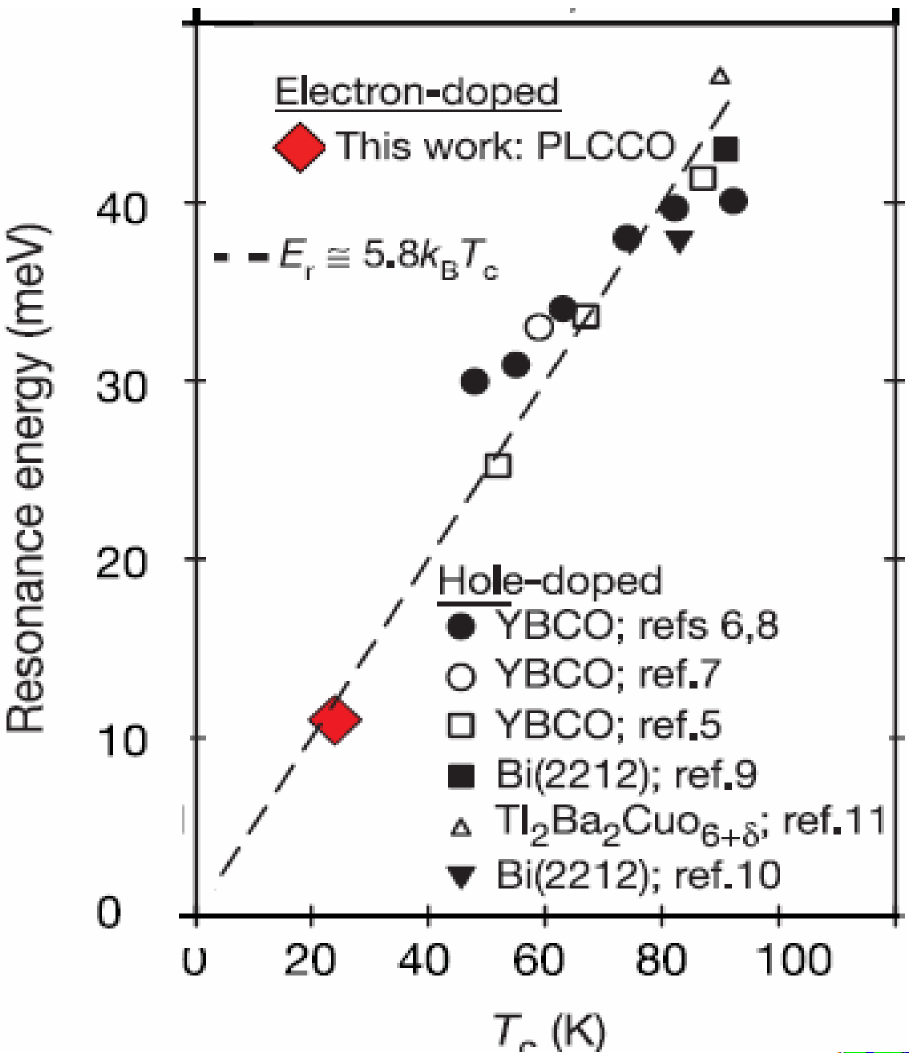
科学意义和作用：用中子研究高温超导体中的磁激发

氧化物超导体的磁激发能与转变温度的关系

S. D. Wilson, et al.(戴鹏程), Nature 442, 4857 (2006)

结果：磁激发在空穴和电子超导体中都普遍存在，而且激发能与超导转变温度有密切关系。

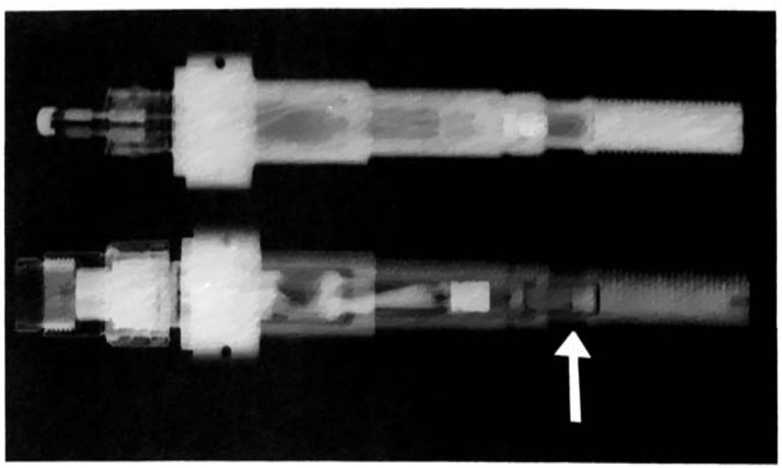
推论与意义：可能是磁激发导致了电子配对；是高温超导机理的试金石。



中子照相

- 一般利用热中子。但在有些情况下冷中子（λ≥4 A）或共振中子效果更好
- 在应用上常和 x 射线照相互补

	X	N
对重元素(Pb,Bi,U)的穿透	不易	易
橡胶、油脂、水在金属中的反差		大
掺杂改变灵敏度	不可	可以
应用于放射性环境	不可	可以



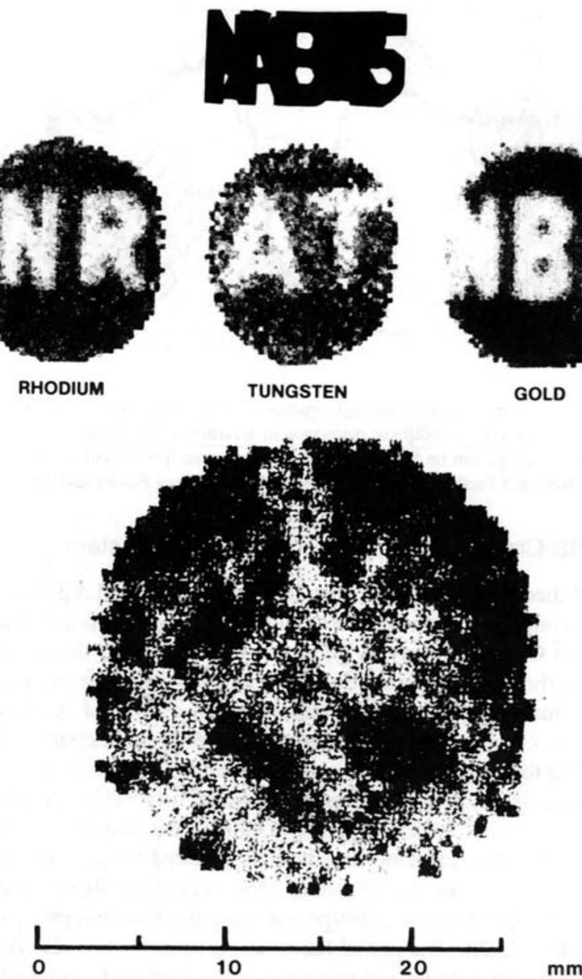
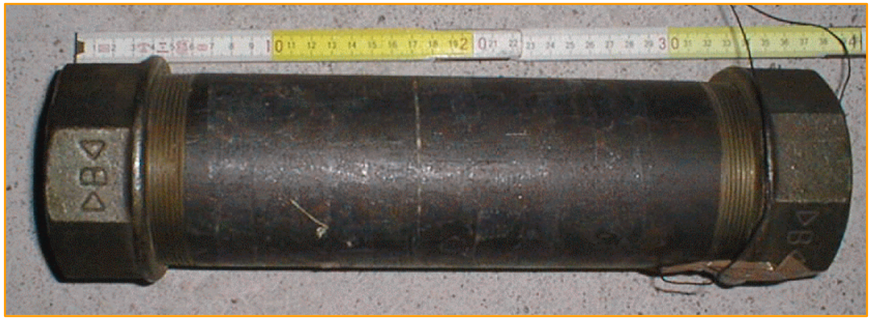
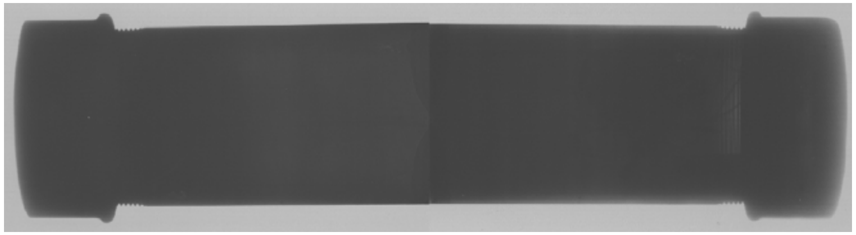


FIG. 9. A x-ray (upper) and resonance neutron (middle) radiographs of a composite sample comprising letters formed from three elements. The separated images show no interference. They were obtained using neutrons with 1.26 eV, 4.16 eV, and 4.91 eV energies, respectively. The lower figure shows a resonance radiograph of the silver within a silver braze. The image is formed using the 5.2 eV absorption resonance of silver. Results were taken on the National Bureau of Standards electron accelerator. [From Schrack[32] and Schrack *et al.*[33]]

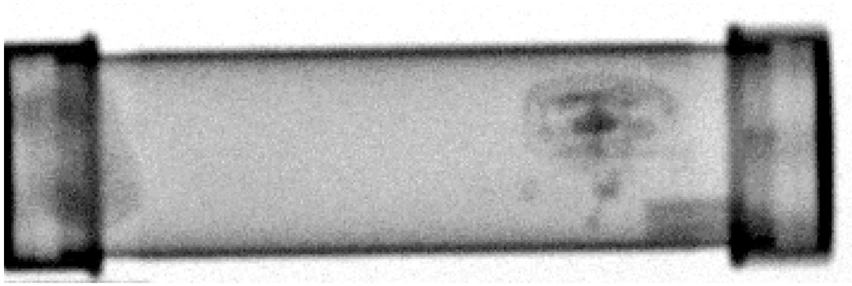
中子照相



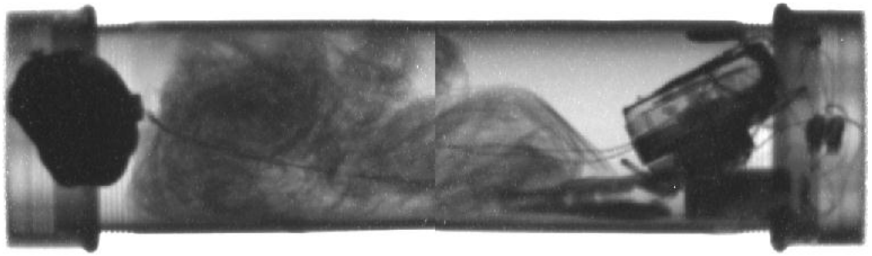
炸弹事物照片：钢桶壁厚为8毫米



150 KeV 的 X 射线照片

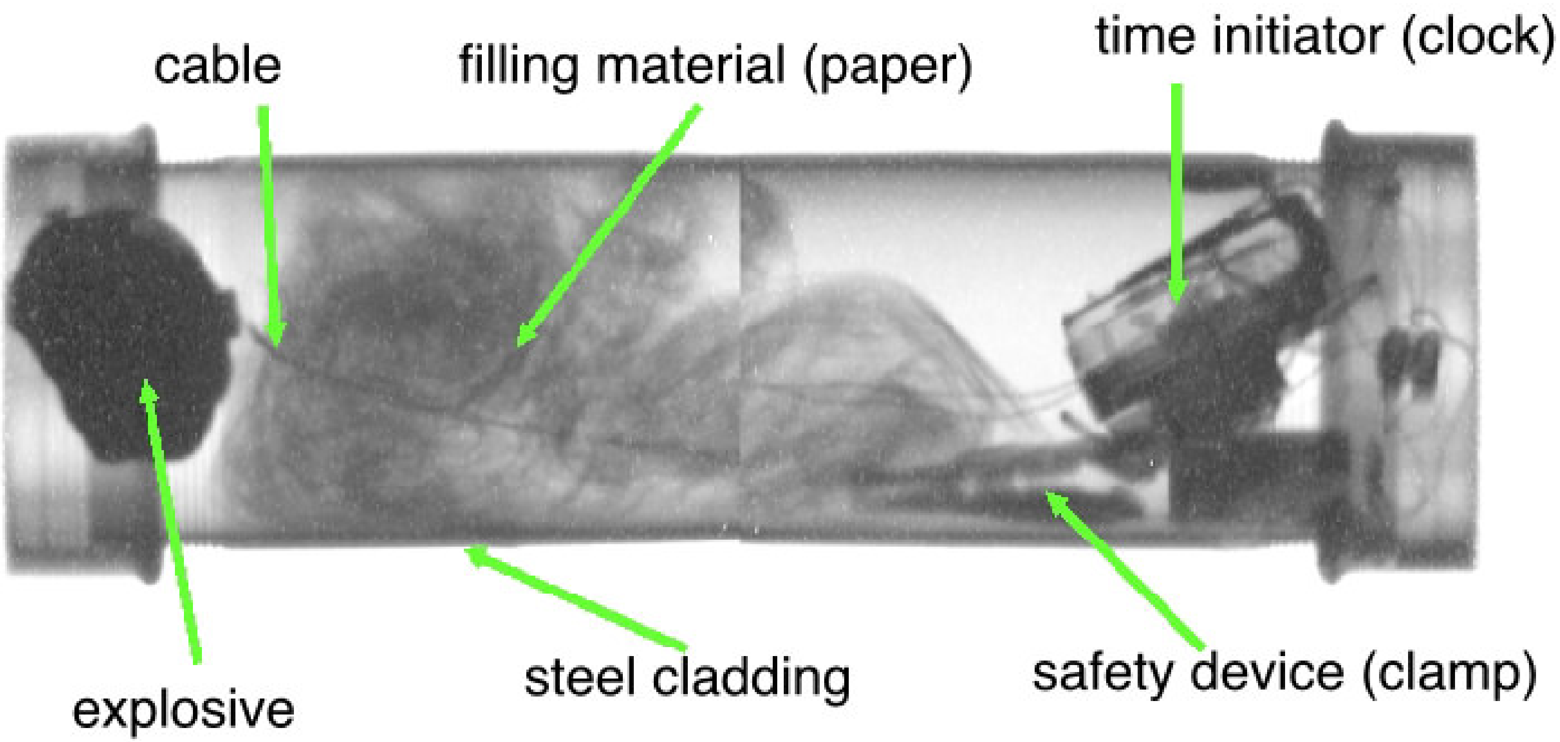


硬伽玛射线照片(1.2 MeV Co-60）



中子照相

NSL CIAE


cable
filling material (paper)
time initiator (clock)
explosive
steel cladding
safety device (clamp)

- 放射性材料的中子照相

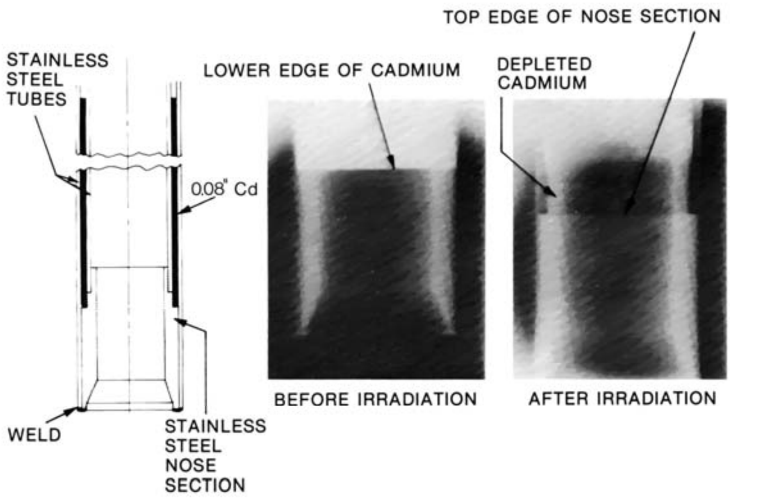


Fig. 1.21 Neutron Radiographs showing Burn-up of Cadmium in Vertical Control Rods.

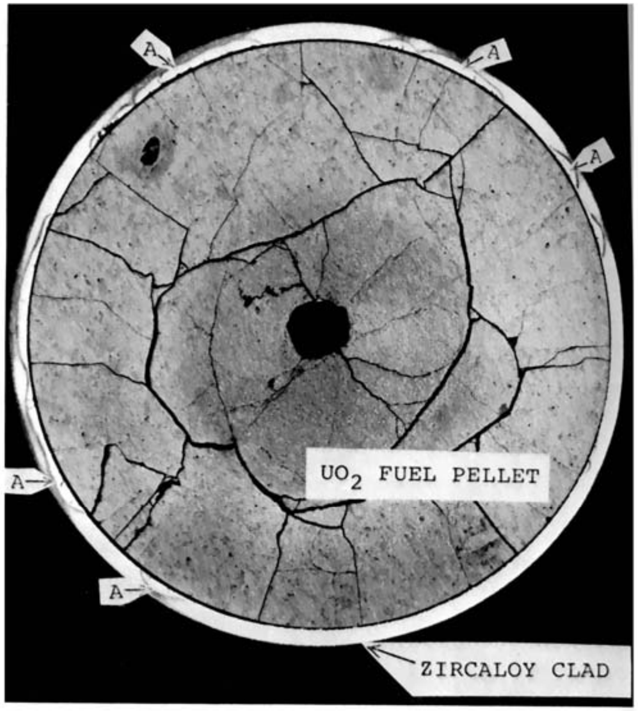


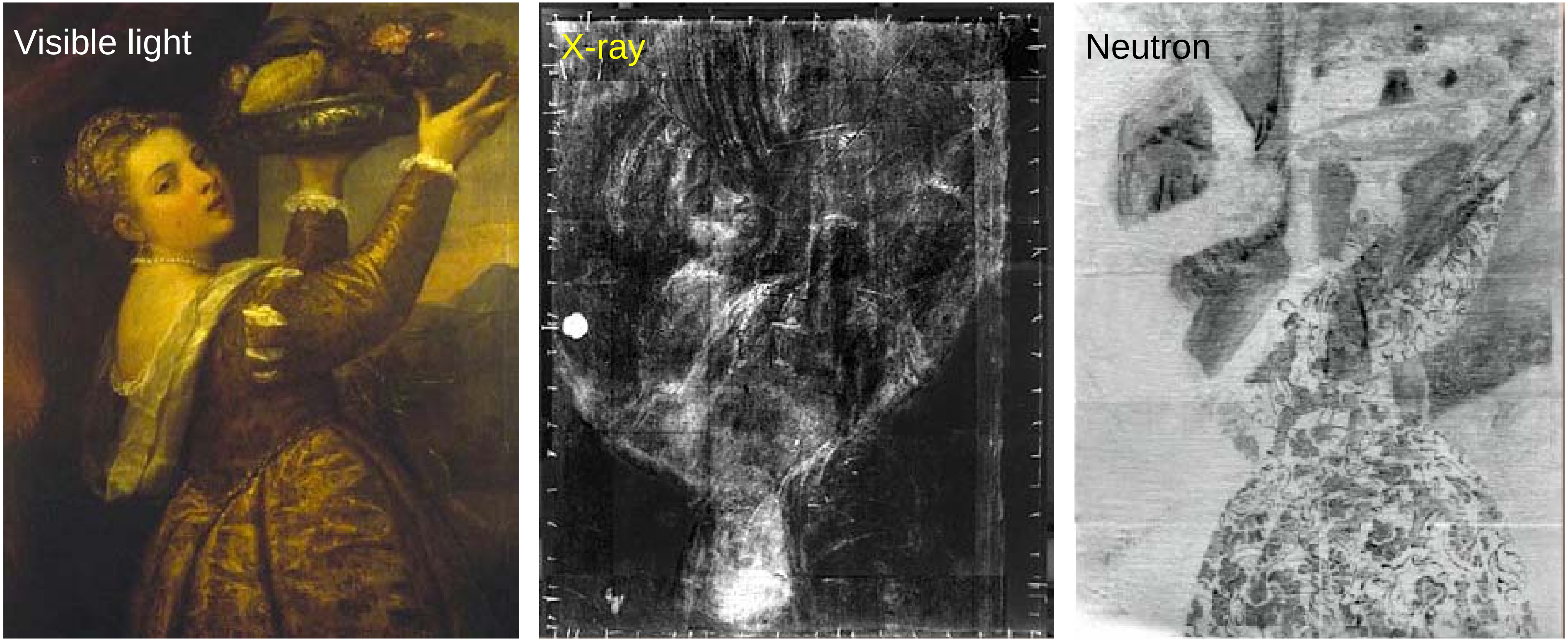
FIG. 3—*Transverse section through the middle element in Figs. 1 and 2. The claddi[ng] [h]as hydrided internally, for example, at the locations marked* A *(×7.5).*

反应堆控制棒老化检测

反应堆燃料元件检测

Neutron Capture Induced Radiography（赌石？）

For example non-distructive analysis of old printings to verify authenticity, examine techniques, discover hiddened images, etc. Neutrons captured/activated by certain elements may emit gamma rays of specific energies. This technique provides imaging and chemical information.



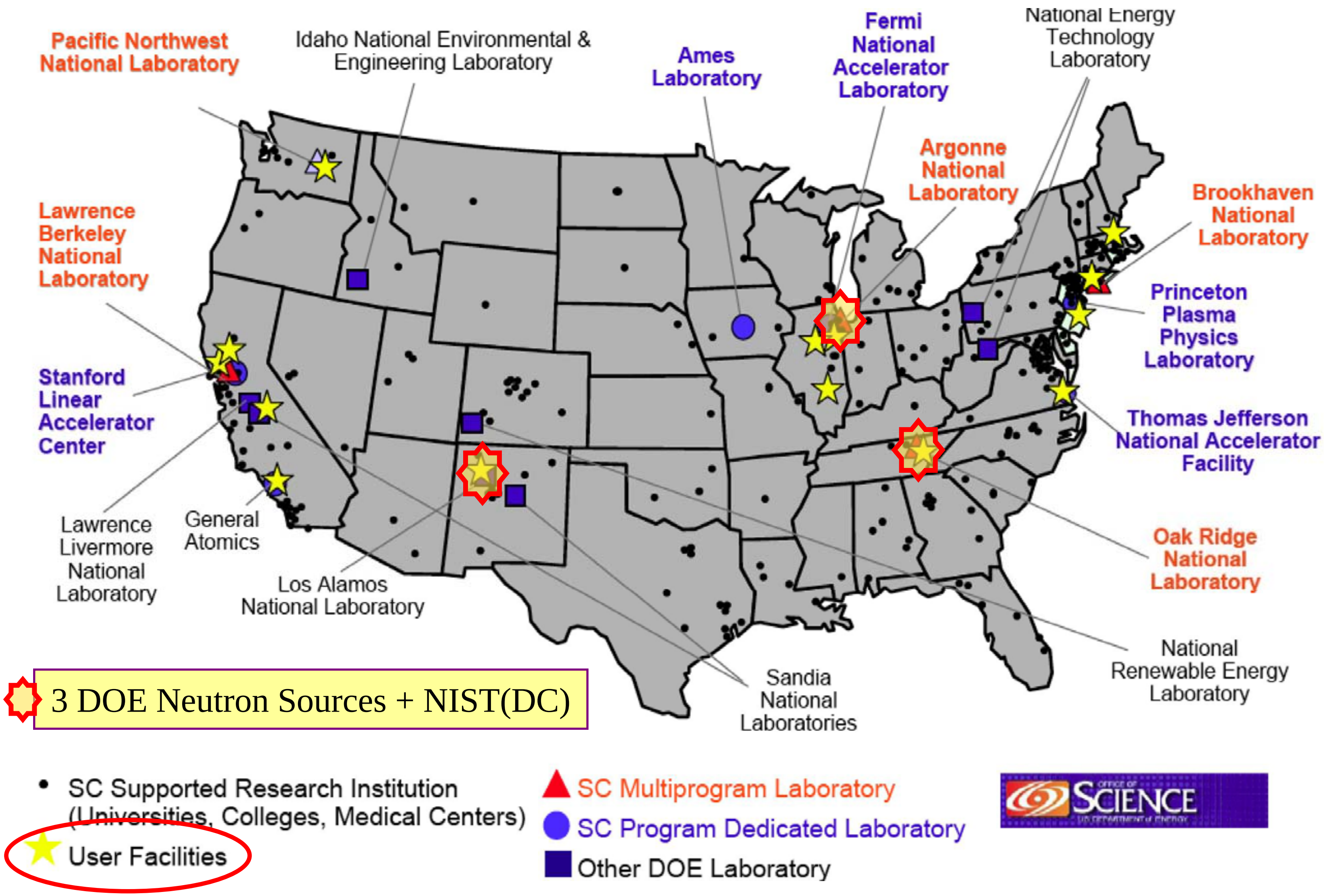
Titian's "Women with a fruit bowl"

中子应用领域的扩展

中子散射的研究成果

——过去40年间中子散射的发展与革新

DOE Funded National Facilities for Basic & Applied Research



For Neutron Scattering, Pulsed Spallation Sources have Recently Overtaken Reactors

- At reactors we use a narrow wavelength band of neutrons all the time
- At pulsed sources we can often use a broad wavelength band from each pulse and do not have to “throw neutrons away”

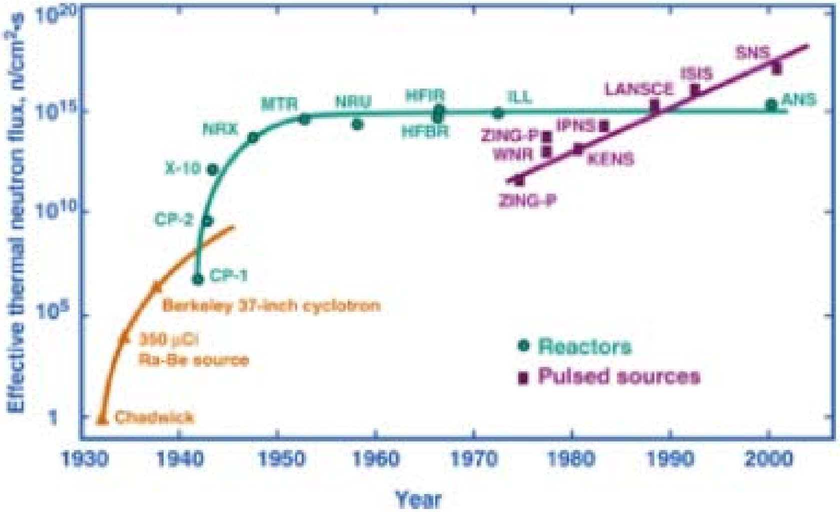
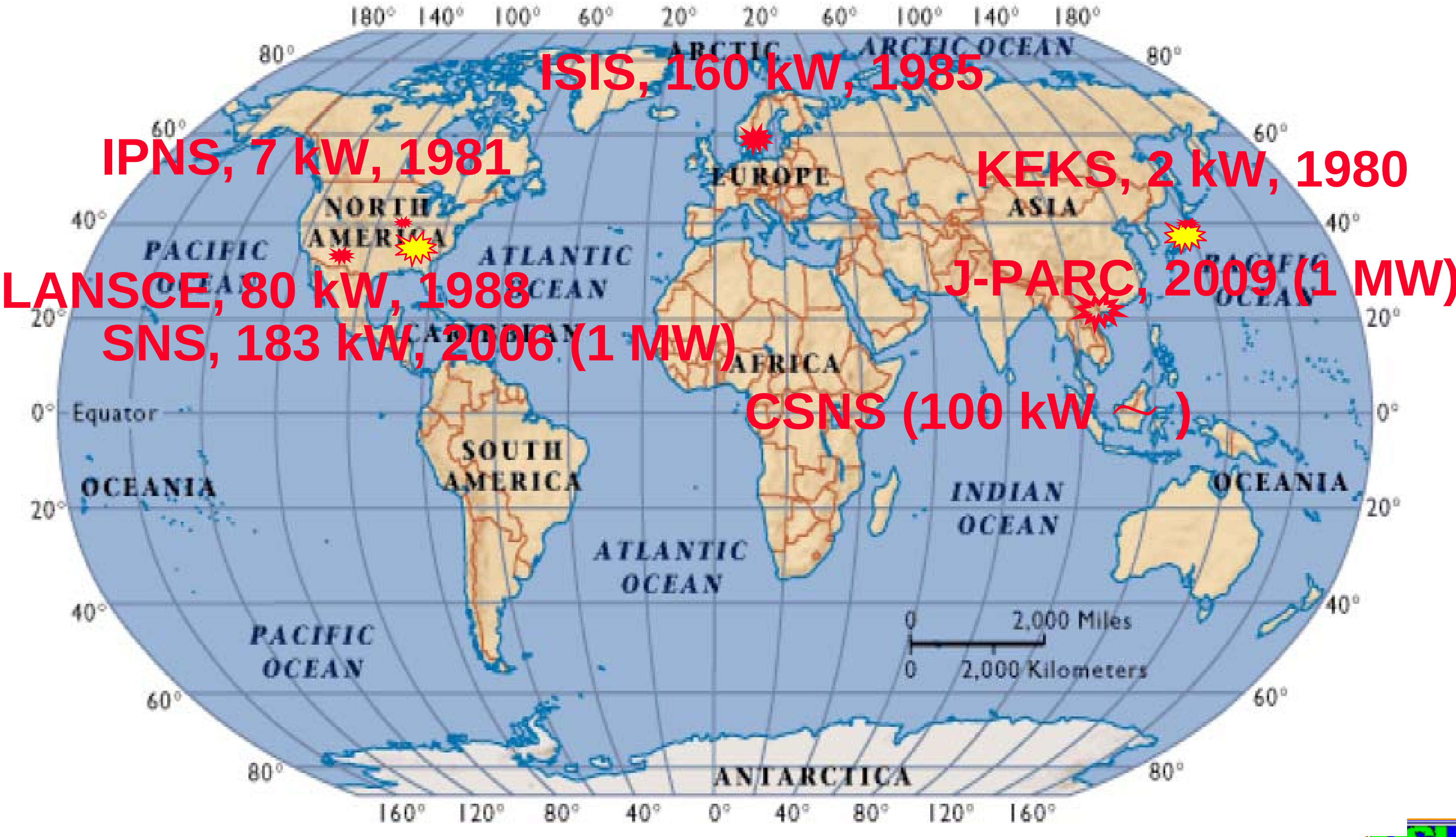


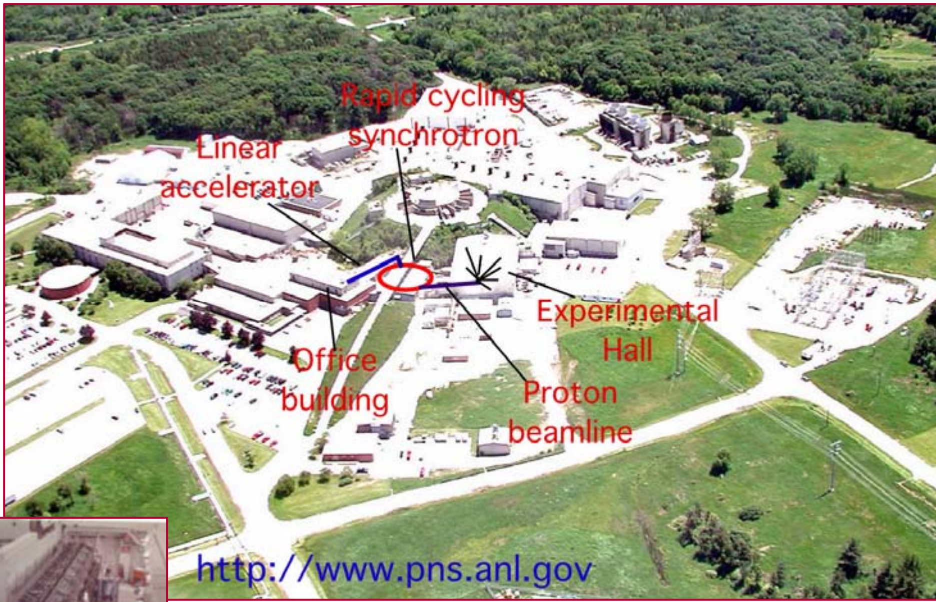
Figure from Skold & Price

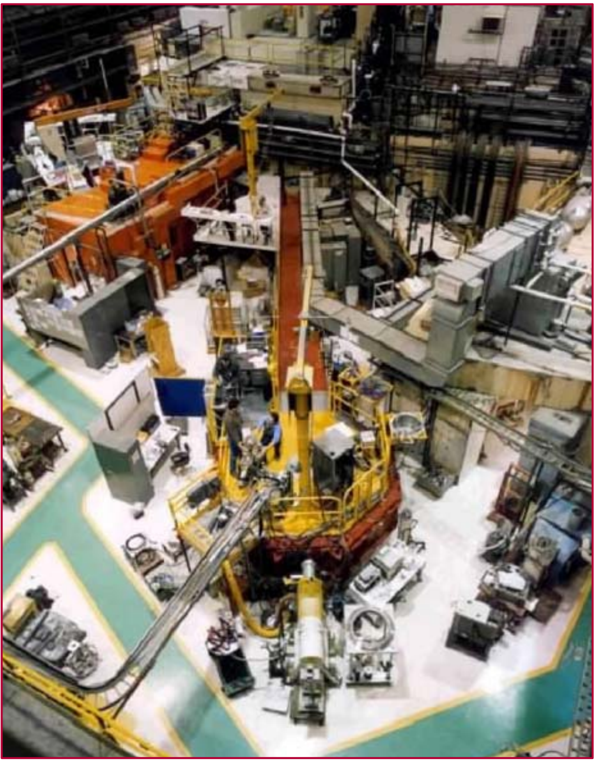
世界上的六台脉冲散裂中子源

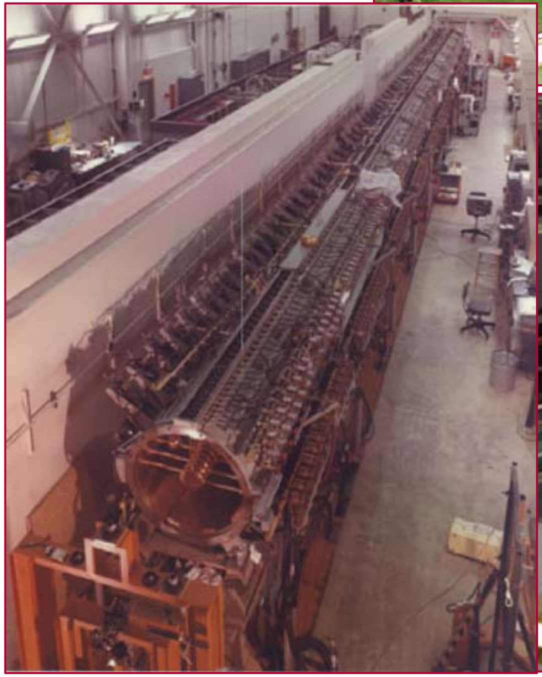


ANL:The Intense Pulsed Neutron Source (IPNS)

- The first spallation neutron source in the USA (The second in the world)
- The most scientifically productive neutron user facility within the USDOE system
- Hosting about 400 users each year
- Celebrated the 25th anniversary in June 2006



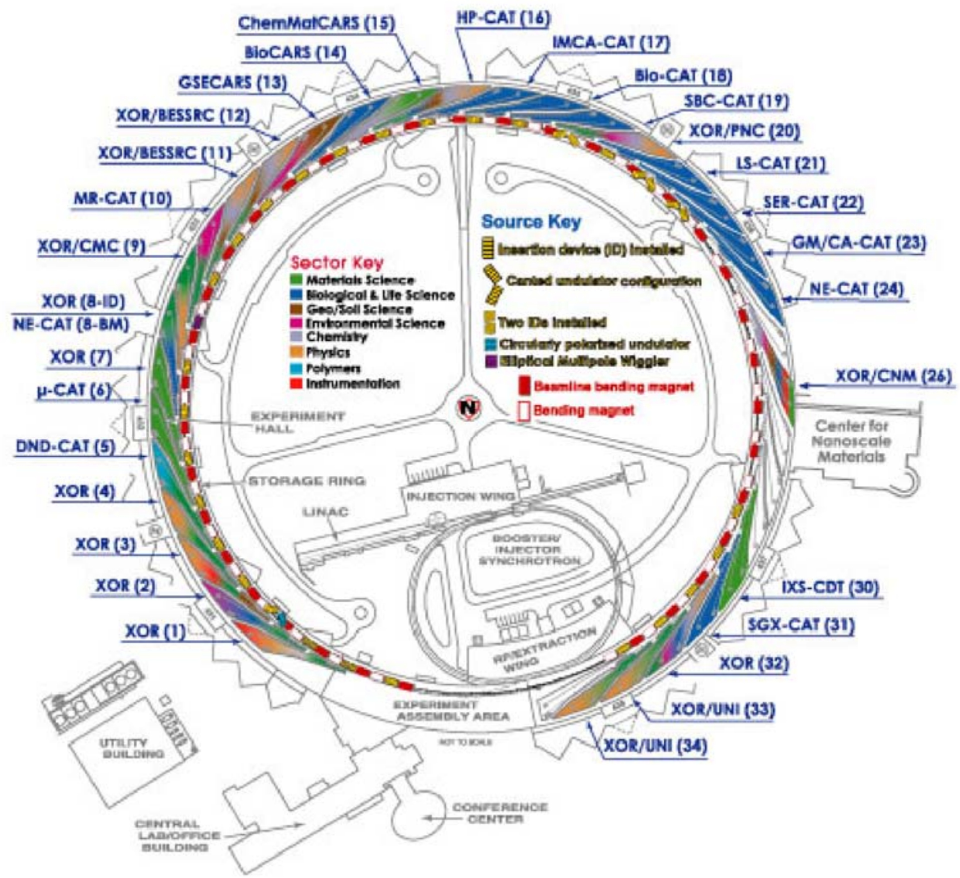




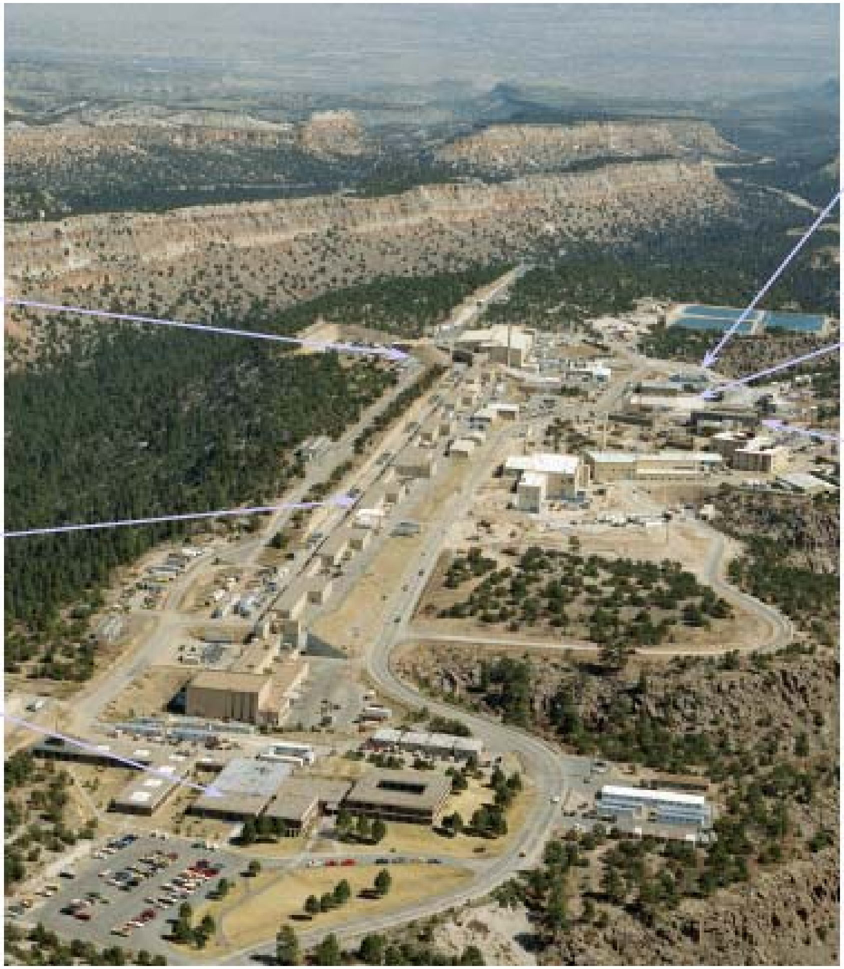
CIAE

ANL:The Advanced Photon Source

- APS construction cost: $467 million (1990)
- Operating budget: ~$90 million per year (since 1995)
- Number of staff: ~450
- Outer diameter of the experiment hall: 390 meters

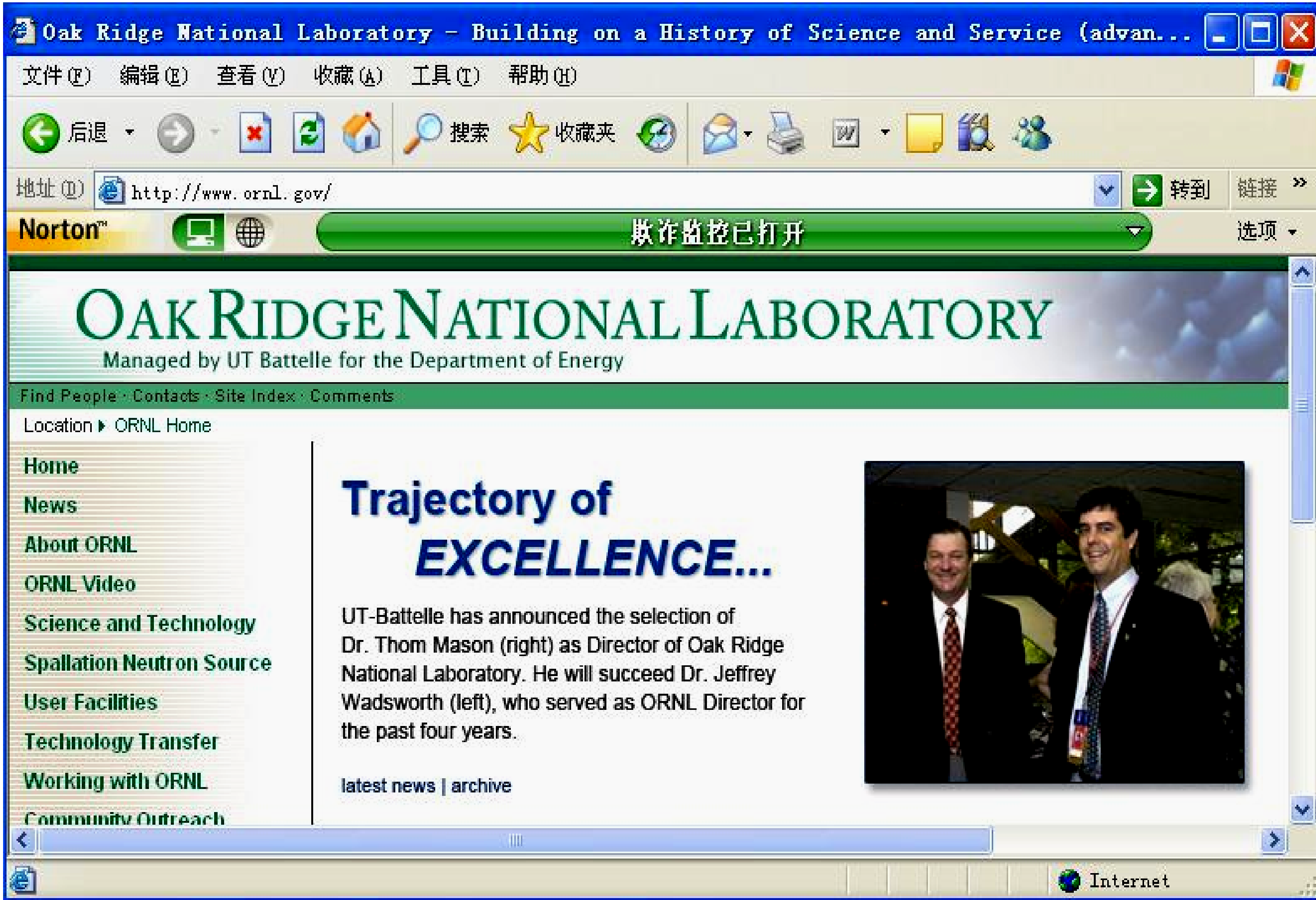


Los Alamos Neutron Science Center



美国散裂中子源 SNS

- 2006年工程验收的同时，升级工程批复（投资1.6亿美元）
- 年运行经费1.6亿美元，另同时建纳米中心和超级计算中心


Oak Ridge National Laboratory - Building on a History of Science and Service (advan...
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ORNL Video
Science and Technology
Spallation Neutron Source
User Facilities
Technology Transfer
Working with ORNL
Trajectory of
EXCELLENCE...
UT-Battelle has announced the selection of Dr. Thom Mason (right) as Director of Oak Ridge National Laboratory. He will succeed Dr. Jeffrey Wadsworth (left), who served as ORNL Director for the past four years.
latest news | archive
Internet

日本散裂中子源 JSNS (J-PARC)

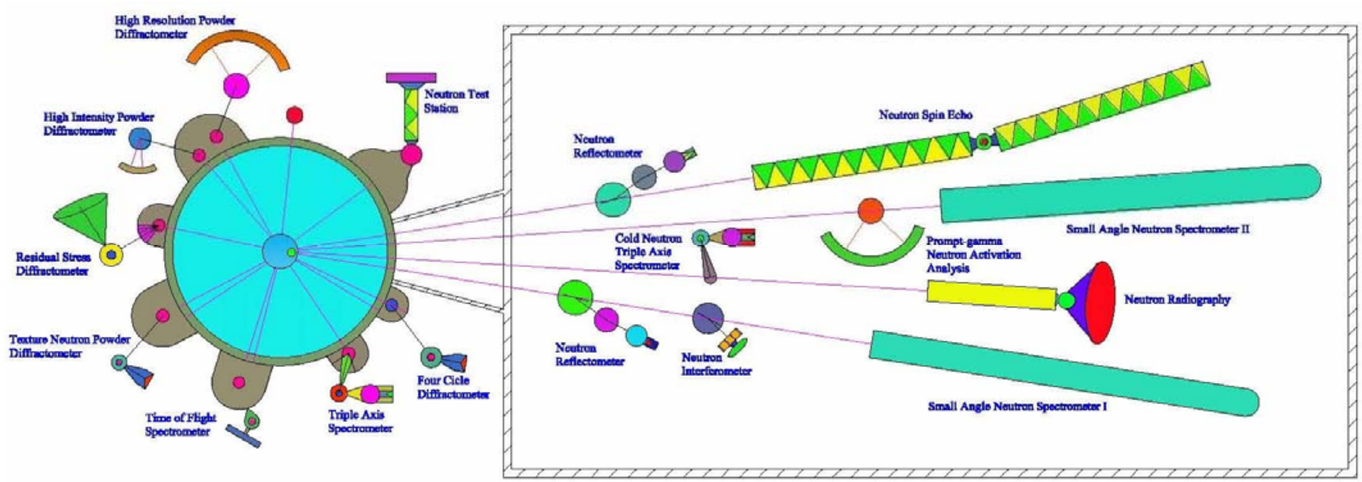
- 自2001年始，一期投资1527亿日元、二期规划363亿日元预计2009年建成
- 装置与居民区最近距离约200米

英国散裂中子源ISIS

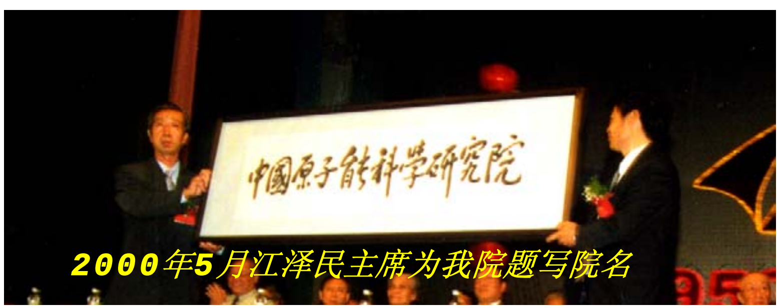
- 每年约700个实验，1700名科研和工业界用户
- 正投资约1.5亿英镑建第二靶站，并规划升级

中国原子能院四大科学平台

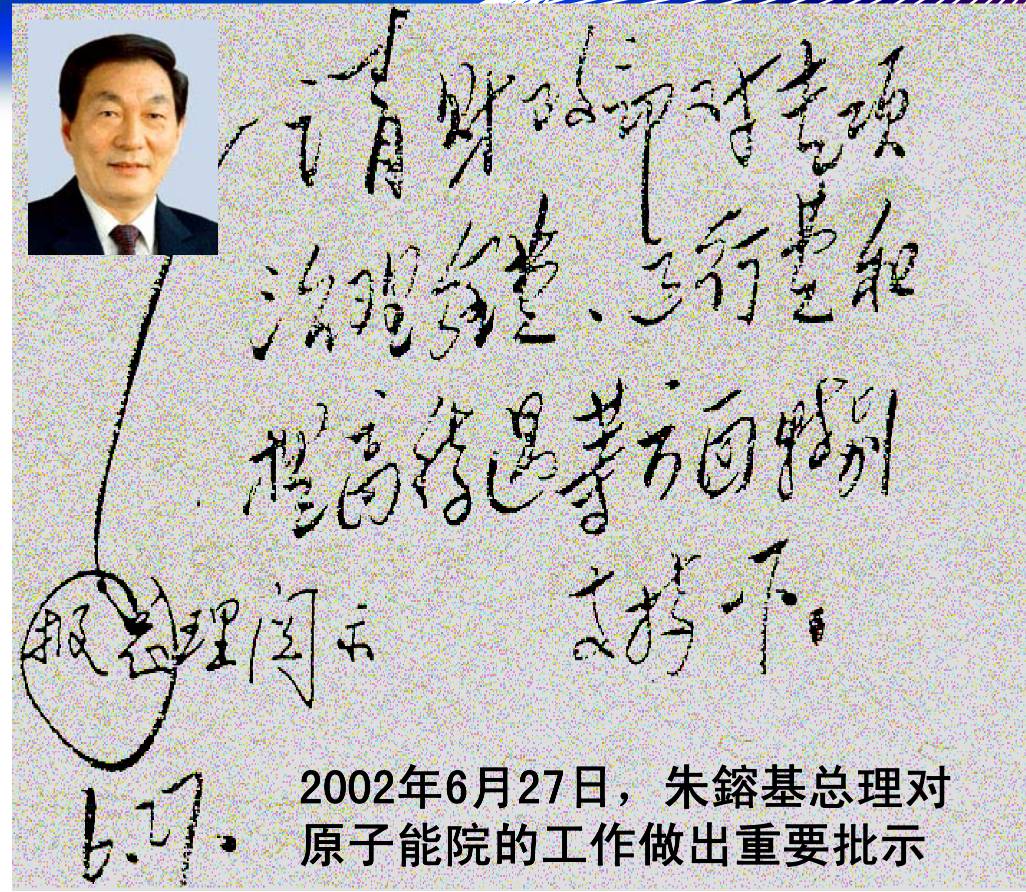
中国原子能科学研究院中子散射工程项目



- 依托**60MW**中国先进研究堆，为国民经济和国防工业的应用提供先进的中子散射技术。
- 第一期工程正在建设八台中子散射设备（高分辨粉末、残余应力谱仪、三轴谱仪、四圆谱仪、织构谱仪、反射谱仪、小角谱仪、飞行时间谱仪）。
- 为生命科学、材料科学、物理、化学、化工、地矿、环境、工程等方面的研究和应用。



2000年5月江泽民主席为我院题写院名



2002年6月27日，朱镕基总理对原子能院的工作做出重要批示

1958年，毛主席向全中国人民和全世界人民宣布："中国从此进入原子能时代！"

创新性工作造就了68位两院院士

- 王淦昌、彭桓武、邓稼先、于　敏、何泽慧、黄祖洽、叶铭汉、赵忠尧、李德平等
- 汪德熙、黄胜年、丁大钊、王乃彦、王方定、张焕乔、杨应昌、阮可强等
- 分离组建了15个院所
- 科技和管理人才遍布全国

中国原子能科学研究院
CHINA INSTITUTE OF ATOMIC ENERGY

四、中子全截面的测量

为了检定"跃进一号"晶体谱仪的性能，初步测量了 Rh 和 Cd 的有效全截面，测量时所用的晶体单色器分别为 SiO_2(31$\bar{4}$0) 和 NaCl(200)。

所用的样品分别为 Rh 和 Cd 的金属片，Rh 片厚度为 3.66 × 10^{20} 原子/厘米²；1.098 × 10^{20} 原子/厘米²；2.196 × 10^{20} 原子/厘米²，Cd 片厚度为：2.57 × 10^{20} 原子/厘米²；4.73 × 10^{20} 原子/厘米²；5.36 × 10^{20} 原子/厘米²。

测量采用一般的穿透法，除测量有样品和没有样品时的单能中子束强度外，对于每一个 θ 角，还在晶体偏离布拉格角位置的情况下测量了相应的本底。

测量结果分别如图 5，图 6 所示，Rh 和 Cd 的共振峰相应地出现在 E_0 ~ 1.27 电子伏和 E_0 ~ 0.175 电子伏，实验值的 σ_0 相应地为 4400 巴恩及 7800 巴恩。由于这些测量都带有初次考验仪器性能的性质，我们没有对样品成分进行任何分析，也没有对高级反射效应作相应的修正。因此，也不打算对结果作进一步的分析。

Cd 的全截面曲线在 0.2 电子伏以下用虚线画出的部分表示由于高级效应的存在，测量结果受到了一些歪曲。

进一步的测量工作，正在进行中。

[致意] 作者对何泽慧先生在本工作进行中经常关怀与支持表示谢意。并感谢黄志娴、李仲芳等同志，他们直接负责谱仪设计及施工任务，给予工作很大帮助。

"跃进一号"中子晶体谱仪

戴传曾 叶春堂 张焕乔 黄治俭 周友朴 朱家瑄

去年大跃进中，我们设计并制成了一台平面中子晶体谱仪，本文将简略地介绍这台仪器的概貌和初步调整后的性能以及在调整过程中所得到的初步结果。

限于篇幅，我们不准备再重复许多文献（例如文献[1]）中已谈得很多的基本原理。

一、仪器机械结构及工作概况的简单描述

图 1 是"跃进一号"的工作示意图。从反应堆水平实验孔道内引出的中子束经过准直后入射到平面单晶体上，经过晶体的布拉格(Bragg)衍射而产生的单能中子束通过另一个准直器后再入射到探测器上。

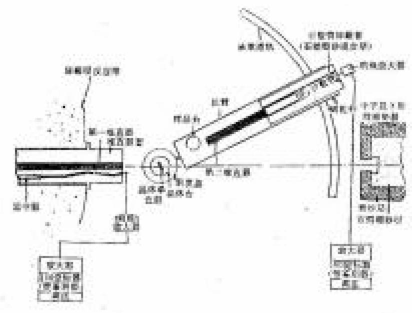


图 1 "跃进一号"中子晶体谱仪工作示意图

用来准直入射中子束的是安装在重水反应堆水平实验孔道中的第一准直器。这个准直器长 180 厘米，是 Soller 型的，由 19 个平行狭缝组成，狭缝高 5 厘米，宽 0.15 厘米。狭缝间用 0.015 厘米厚的钢片隔开，狭缝通道的上下二端用 0.15 厘米厚的硬铝固定钢片的位置。整个准直器用冷装配方法[2]在液体氮中加工制成。它的水平发散角 α_1 ~ 2.8′，第二准直器长 100 厘

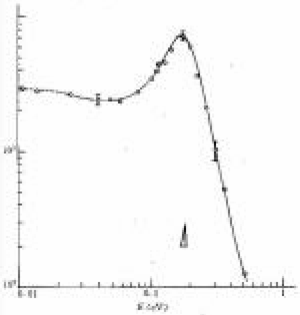
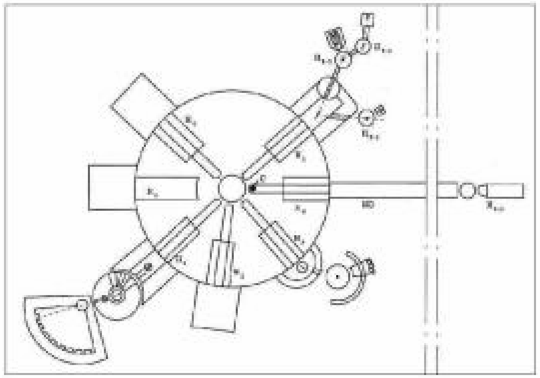


图 6 Cd 的有效全截面曲线

（图中虚线表示高级效应较显著部分，应加以修正）



1957 年，我们搬到了北京西南郊的坨里新基地（1958 年一堆一器在这里建成后，近代物理所改名为原子能所）。我负责搞一个晶体谱仪，准备检测从反应堆孔道出来的中子。这工作是我提出来的，因为反应堆作为中子源的利用，探测中子，进行中子截面测量，是很重要的一个方面的工作。

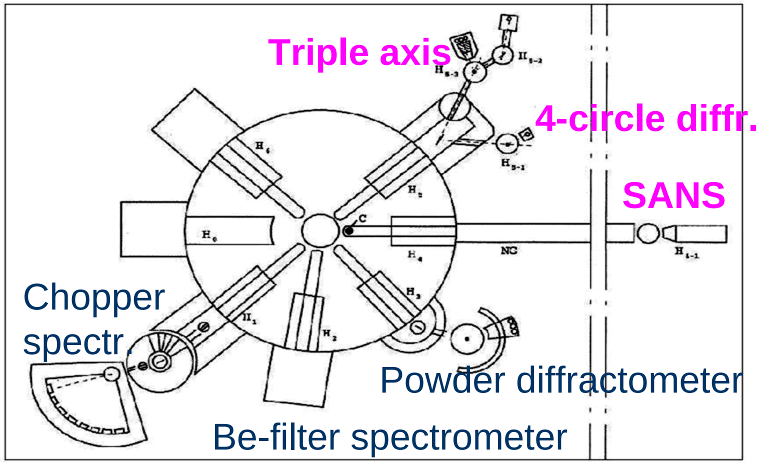
在中子物理方面，开始主要是带张焕乔、叶春堂等设计一台中子晶体谱仪。从完成设计后，只花了五个月时间，就安装好，而且测得了一些材料，如镉、银、铟等的截面数据，使我们的工作大大前进了一步，这些数据和当时日内瓦和平利用原子能会议上发表的截面图很一致，我们感到很高兴。

后来，我们又请钱所长从部队弄来了一个高射炮底盘，设计出了一个中子衍射谱仪。为了使其轻快些，精度高一些，我们跟光机所合作，得到王大珩所长的大力支持，只花了 9 个月左右时间，制成了我国第一台中子衍射谱仪。据当时从匈牙利来的一位研究所所长泡尔院士讲，在社会主义阵营里，他还没有见过像我们这样高精度的中子衍射仪。当然，这里面包含着光机所同志们的功劳。我们利用这台设备开展了中子衍射研究工作。

重水研究堆 (HWRR)
The Heavy Water Research Reactor

Begun operation in 1958

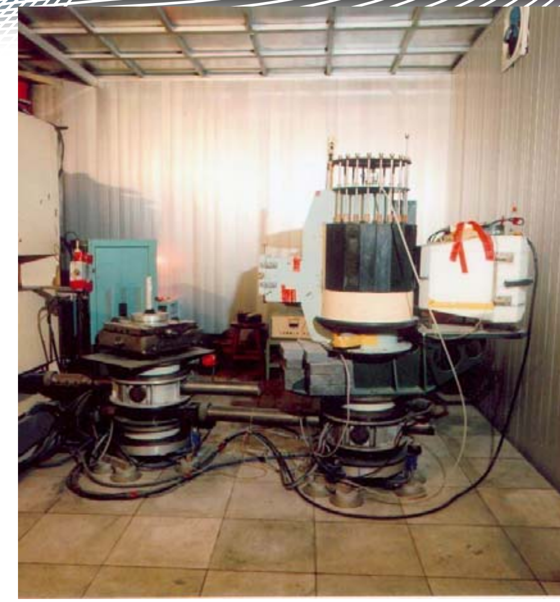
- Fuel enrichment : 2% ^{235}U
- Power: 7MW (maximum power: 10MW)
- Maximum thermal neutron flux in core: $1.2 \times 10^{14} n/cm^2/s$
- **Upgraded in 1979-1980 to 10 MW, $2.8 \times 10^{14} n/cm^2/s$**
- **Jointly responsible to scientific programs with the neutron group from Institute of Physics, CAS**



By 2008, HWRR will be 50-year old, time to retire perhaps!

靶站谱仪工程中心

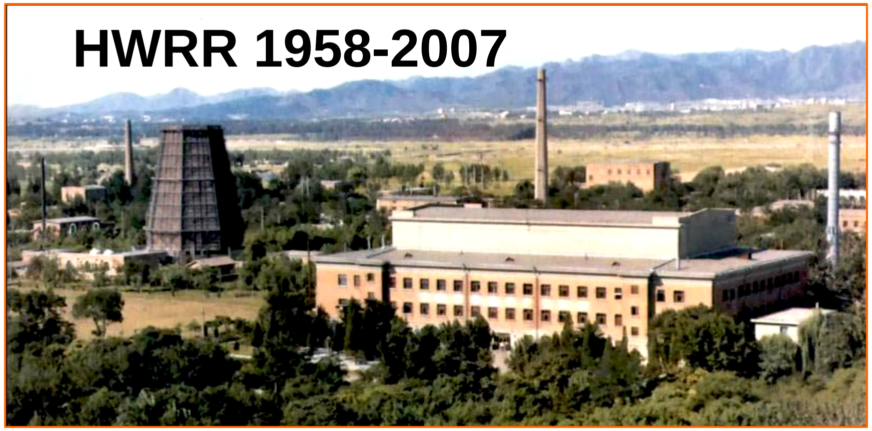
- 中子散射协作组：
  1980年以来，与法国LLB实验室、原子能院合作，在原子能院101堆上设计、建造并运行了单晶衍射、小角散射和三轴等三台先进谱仪。（获科学院科技进步二等奖）

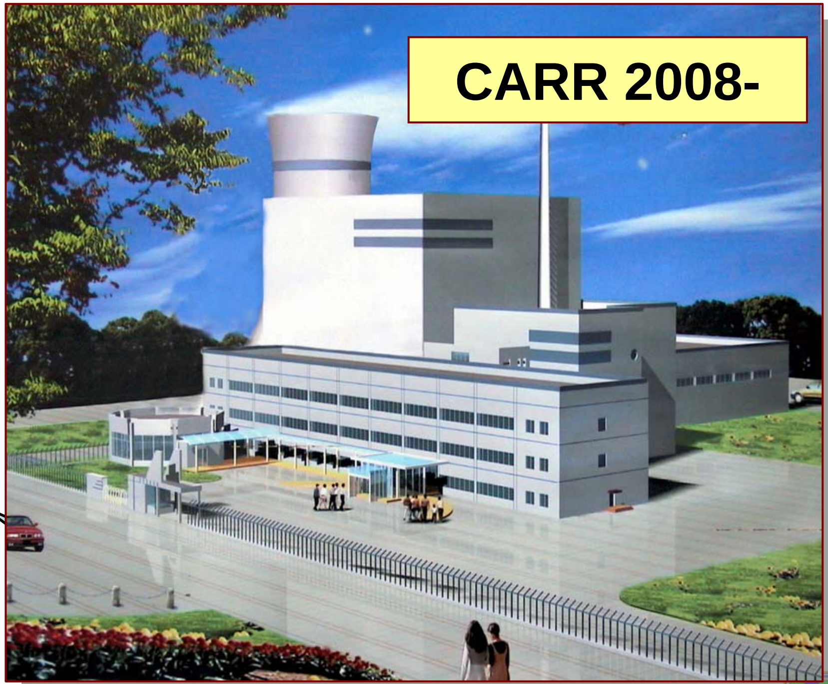


Main research activities

- Crystallographic and magnetic structures of rare-earth-iron permanent magnetic alloys were studied by neutron powder diffraction, and the studies are mainly foc used on the R_2Fe_{17} and RFe_{12} series, the atom occupancies and magnetic moment s of magnetic atom were obtained by the Rietveld analysis program.
- Powder neutron diffraction studies and measurement of neutron inelastic scatteri ng spectra of high-Tc superconductor, such as Hg – 1223, $YBa_2(Cu_{1-y}Co_y)_3O_x$ and $YBa_2Cu_3O_{6+\delta}$.
- Small angle neutron scattering study of biology sample has been also done, e.g. The association effect for studies of Human Serum Albumin under different conce ntration of Zinc ion[Zn^{2+}].
- Single crystal structure analysis of non-linear optical material has been done on F our Circle Diffractometer, such as Deuterium (Hydrogen) L-Arginine Phosphate m onohydrate D(H)LAP. In this investigation, the length of hydrogen bond and mole cular structural formula have been determined .
- Lattice dynamics studies of functional materials (such as Invar alloys, shape me mory alloys): Generalized phonon densities of states (PDOS) on amorphous $Fe_{90-x}Co_xZr_{10}$ (x=10 and 40) were measured by time of flight spectrometer at room temp erature. The results show that the generalized PDOS below 17meV become soft a t the Invar concentrations.


Chāng Píng
Shùn Yì
Beijing
International
Airport
5th
Ring
Road
6th
Ring
Road
Mén Tóu Gōu
Tōng Zhōu
4th Ring Road
Yì Zhuāng
Fáng Shān
Dà Xīng


HWRR 1958-2007

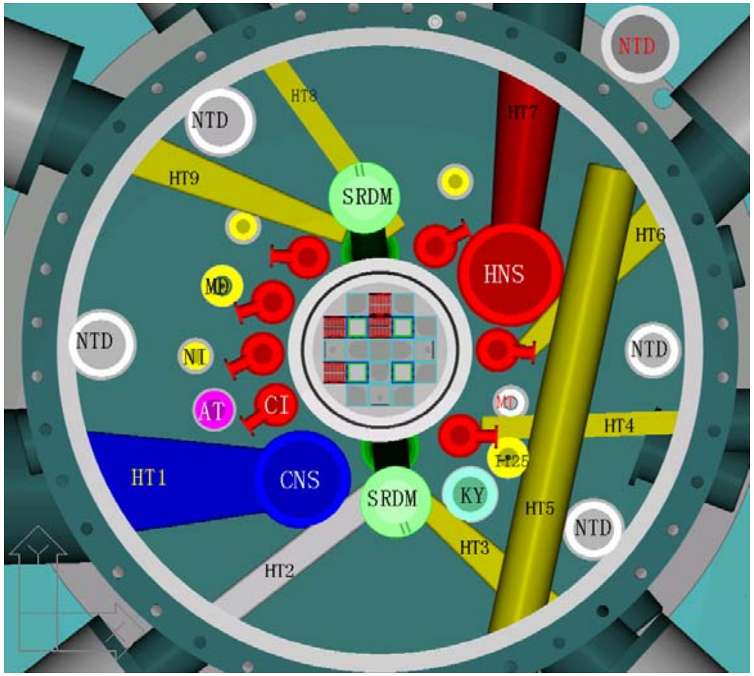

CARR 2008-

中国先进研究堆(CARR)
The China Advanced Research Reactor

Key Parameters

- 反应堆功率 60 MW
- 中子通量 Max undisturbed thermal neutron flux ($n \bullet cm^{-2} \bullet s^{-1}$)
  - **$1x10^{15}$ (in reactor core)**
  - $8x10^{14}$ (at heavy-water reflector)
- 铀浓度 19.75 wt% U^{235} enrichment

CARR is a user facility. Neutron scattering for material characterization is a major research program at CARR open to users from universities, industry and government labs.



9 horizontal beam tubes

HT1 views the LH_2 cold neutron source (CNS)

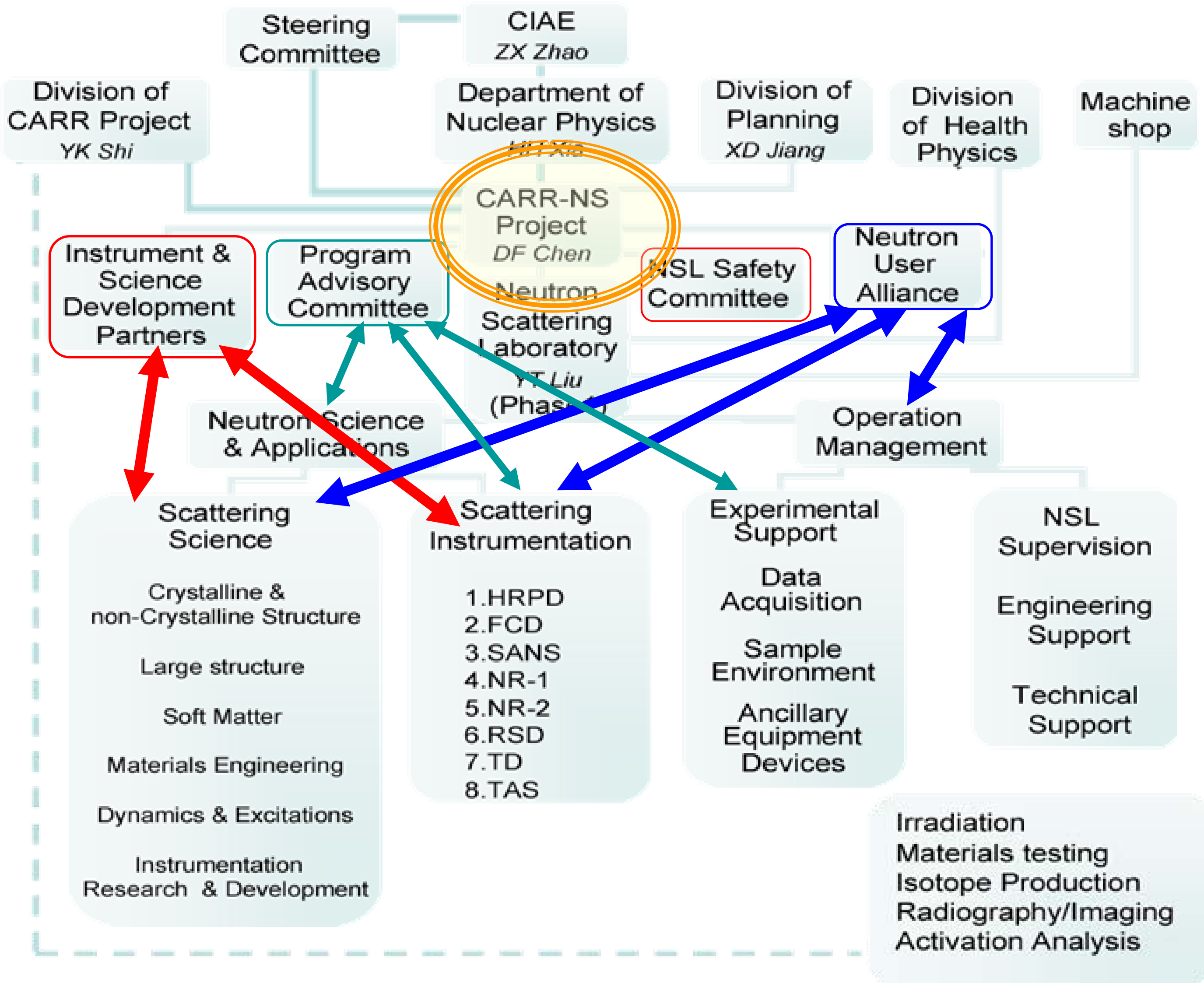
HT3-9: thermal neutron beams

HT2: A multi-filtration beam tube

Space reserved for future hot source (HNS)

Additional 25 vertical channels

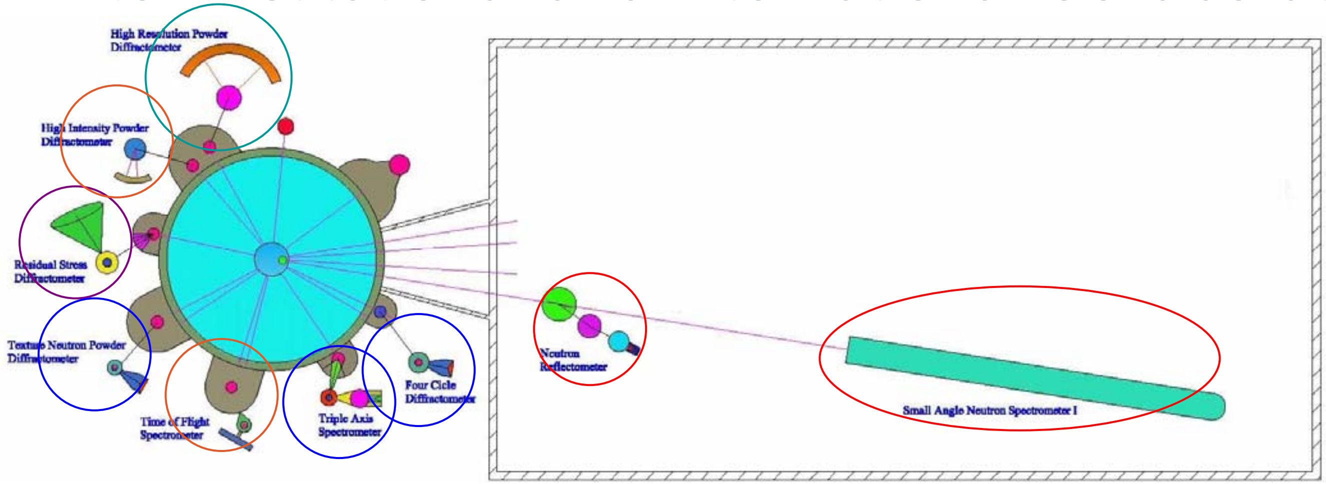
Organization Chart of Neutron Science Project



里程碑 Milestones of NSL-CIAE

- 1957 建成我国第一台中子衍射谱仪
  - First neutron diffractometer built in China
- 1980 成立NSL-CIAE，与中科院合作引进三台谱仪
  - NSL-CIAE found and collaborated with IOP, CAS
- 2001 CARR 开始建造，投资7.7亿人民币。中子散射经费3500万，建造8台谱仪。改五三新两导管。
  - CARR was started by the budget of 770M RMB yuan (100MUS$), and 8 NS instruments on CARR with a budget of 35M RMB yuan (4.6MUS$)
- 2002 完成三个新谱仪的物理设计。
  - Finished physical design for three new NS machines
- 2003 建造高分辨粉末衍射谱仪
  - HRPD fabrication
- 2005 国家大科学平台工程和瑞典谱仪启动，经费3600万，部分国内加工
  - Propose collaborating project with Charles Han (IoC) supported by MOST (5MUS$) / Main parts of REST transported from Sweden
- 2006 召开第一届中美中子散射会议和德国谱仪引进启动
  - First US-China meeting on neutron science and technology / SV30 relocation from FZJ under discussion (10MUS$)
- 2007 第一届国际和国内顾问委员会
  - First Domestic & International Advisory Committee on NSL-CARR

中子散射工程一期谱仪建设：
NSL PHASE I: A Developing Model of Inter-Institutional and International Collaboration



小角和反射：A ***30-m SANS*** Instrument and a horizontal-sample-geometry ***Reflectometer***: Co-developed with Institute of Chemistry, CAS led by Prof. Charles Han, receiving gracious assistance from NIST, USA.

应力谱仪：A ***Residual Stress Diffractometer***: Majority of components contributed by the reactor from Studsvik, Sweden in collaboration with Dr. Ru Lin Peng.

三轴、四园和织构:A ***Triple-axis Spectrometer***, a ***Four-circle Single-crystal Diffractometer***, and a ***Texture Diffractometer***: Imported from FZ-Jülich, Germany under an international agreement of cooperation.

高分辨衍射:A ***High-resolution Powder Diffractometer***: Being designed and built at CIAE.

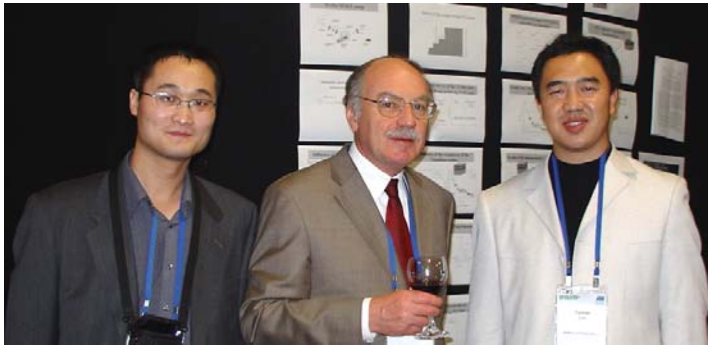
高强度粉末和飞行时间：A ***High-Intensity Powder Diffractometer*** and a ***TOF Spectrometers***: To be upgraded from existing components at HWRR.

HRPD

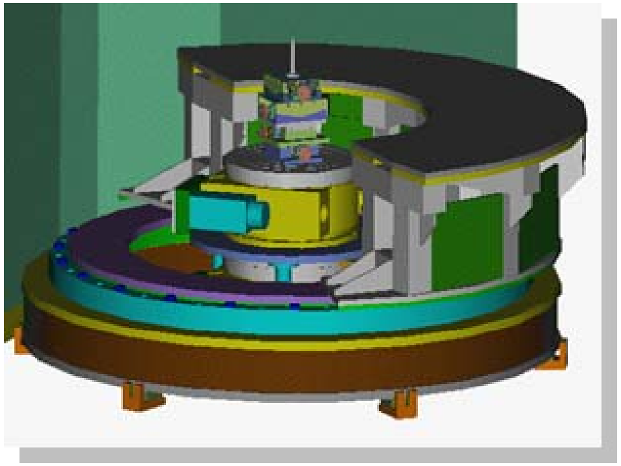
$\Delta d/d=2\times 10^{-3}$，Able to determine the crystal structure with unit cell volume1000Å^3，and including 150 structural refinement parameters。

Design criteria：

Theory of conventional multi-collimator high resolution powder diffractometer

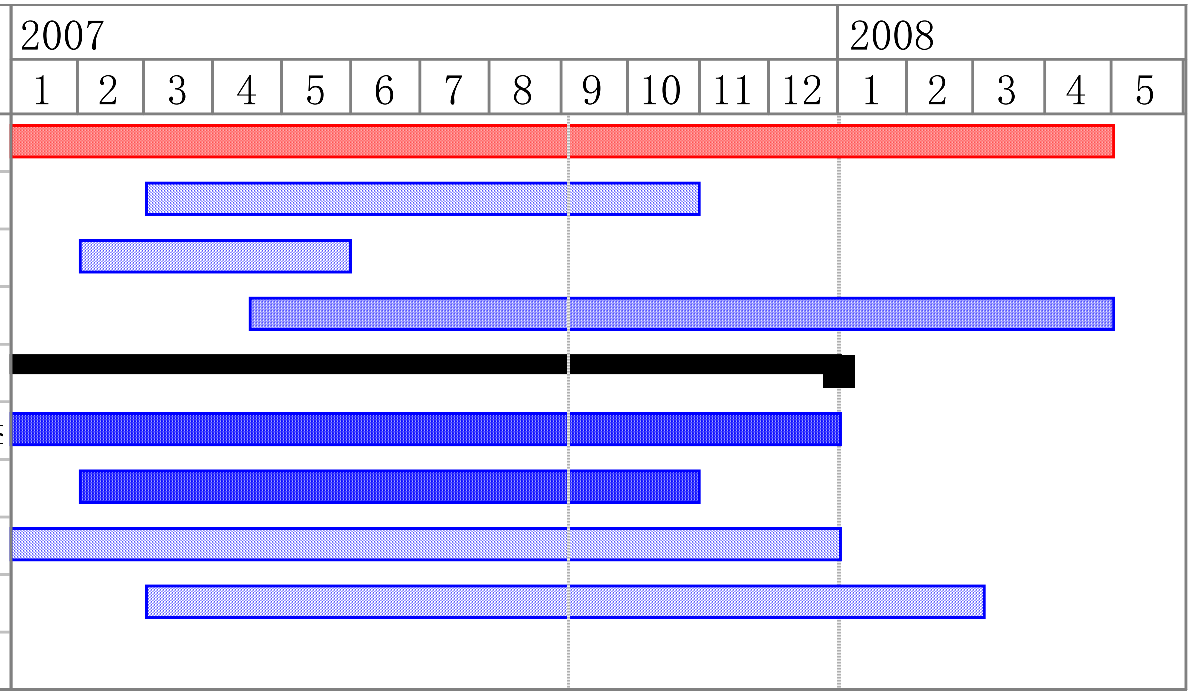


Alan.W.Hewat



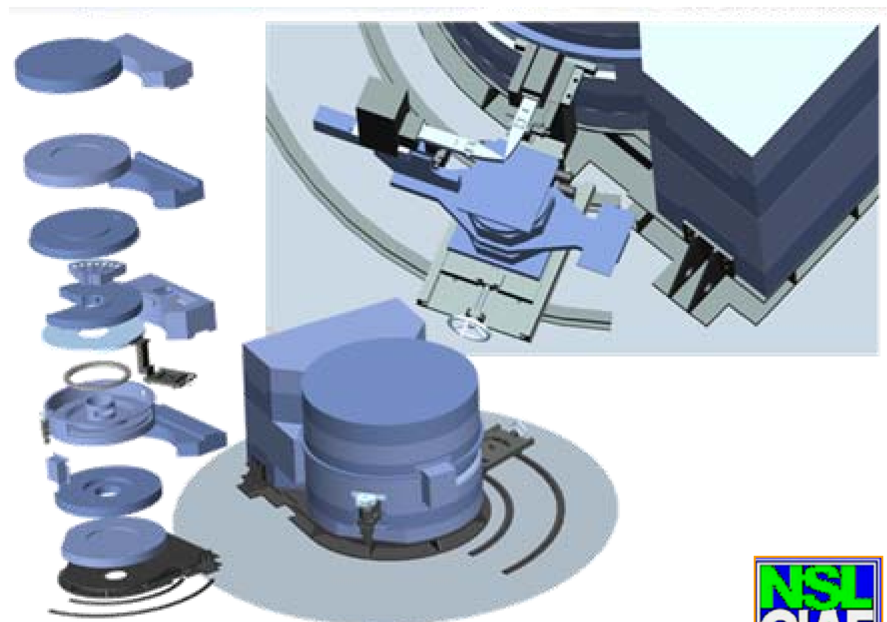
Project Schedule 2007

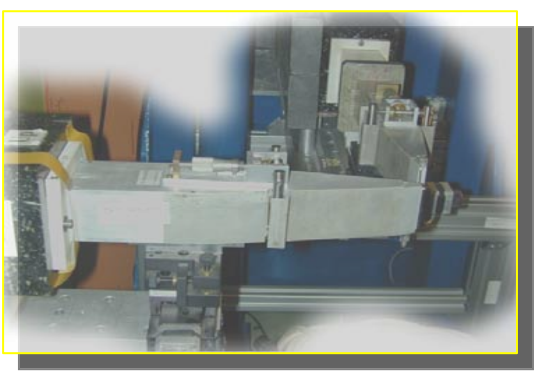
标识号	Mission
1	HRPD Schedule 2007
2	Motion stages
3	Detector
4	Electronics
5	monochromator
6	Ge crystal hot-press
7	V.F.Device
8	Mono. Shielding
9	Software



RSD

- Monochromator
- Monochromator shielding
- Sample table
- Detector
- Control software
- Slit system
- Ancillary equipments





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陈东风主任收

中国原子能科学研究院:

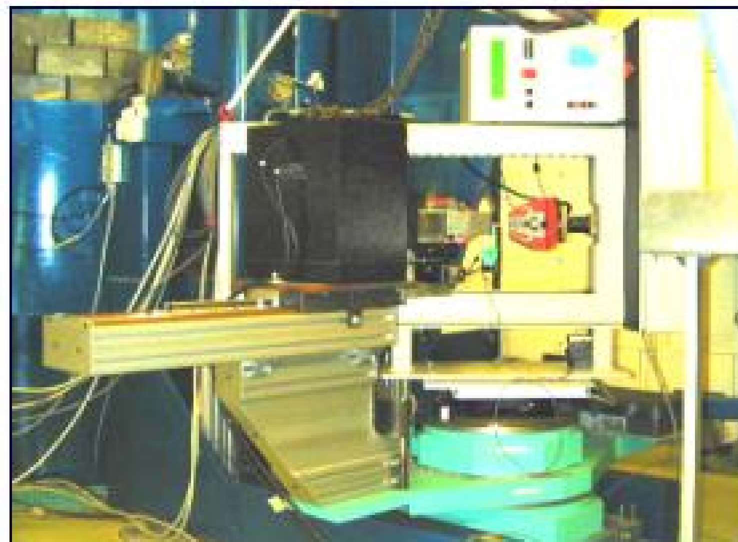
贵单位中子散射研究室最近所开展的采用中子衍射技术测定残余应力的试验研究对我单位开展表面强化残余应力场的测定与研究具有重要的意义和航空零件表面完整性的研究对此技术有很大的需求，希望贵单位和我单位能够在残余应力方面进行合作研究和推广中子衍射残余应力测定技术在工业上的应用。

中国航空工业第一集团公司
北京航空材料研究院
2005年8月1日

NSL CIAE

Different set-ups on REST



应用实例

在应用上，有时希望织构尽可能小；有时又希望通过一定工艺、使材料形成某种特定的织构

Figure 3. Aluminium beverage cans. On the small sample, ears are marked by arrows.

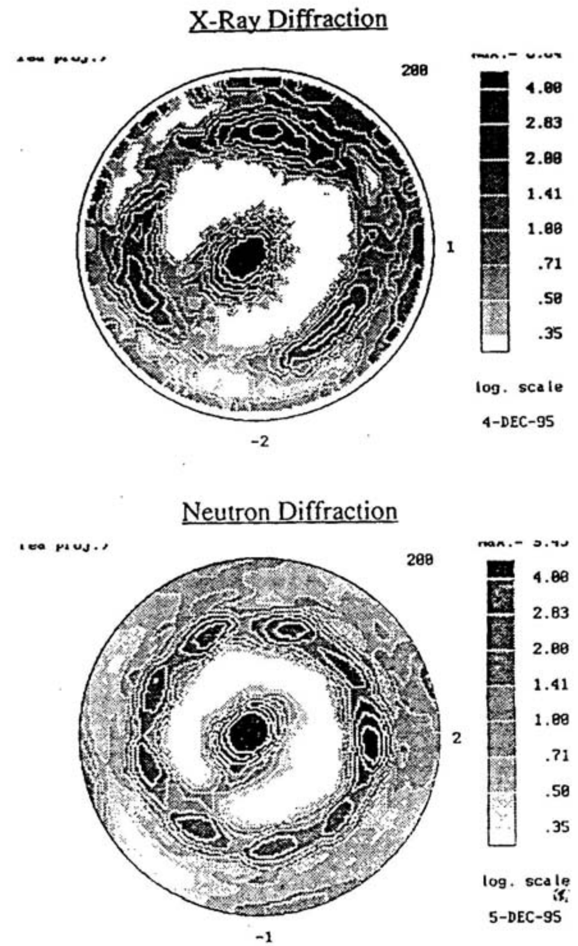
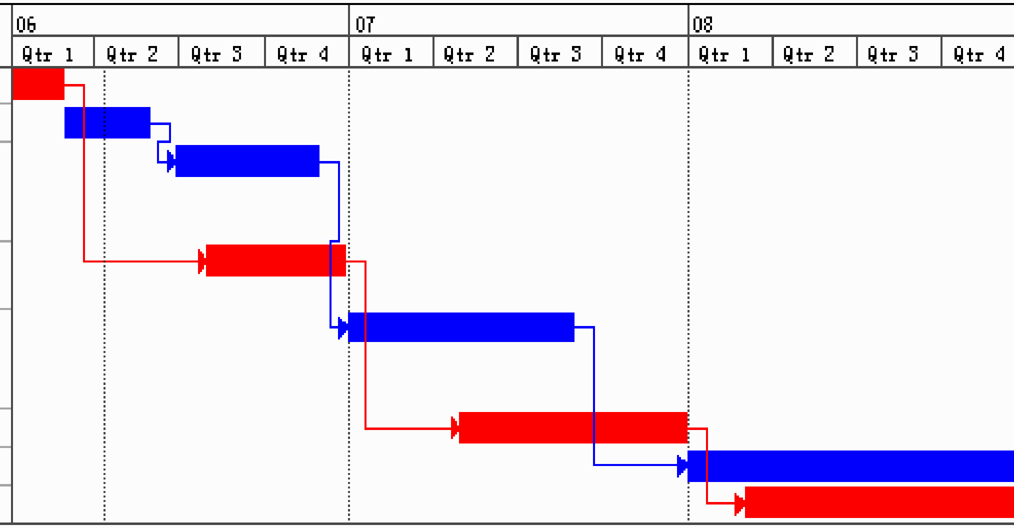


Fig. 3. X-ray and neutron pole figures of upset-forged tantalum showing the difference between the surface and bulk textures.

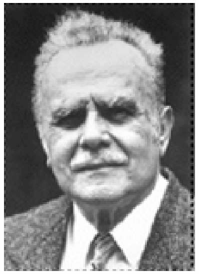
进展计划

ID	Task Name
1	瑞典谱仪机械主体与电子学系统接口的探索恢复
2	调研，设计，购买材料拉伸压缩装置
3	在粉末谱仪上测量不同材料(Fe, Al, 高强度钢)的衍射峰漂移量与拉力大小关系，验证利用中子衍射峰的漂移测量残余应力方法的可行性
4	瑞典谱仪转台部分配置相应的驱动和控制系统，测试具体精度大小
5	在粉末谱仪上测量高强度钢和型号7050Al样品内残余应力分布，进一步验证利用中子衍射峰漂移测量应力方法的可行性，并为这些材料的性能提供有用的数据
6	完成单色器和位置灵敏探测器关键部件设计方案
7	编写良好用户界面的残余应力测试程序和数据处理程序
8	完成中子衍射应力谱仪屏蔽体设计方案

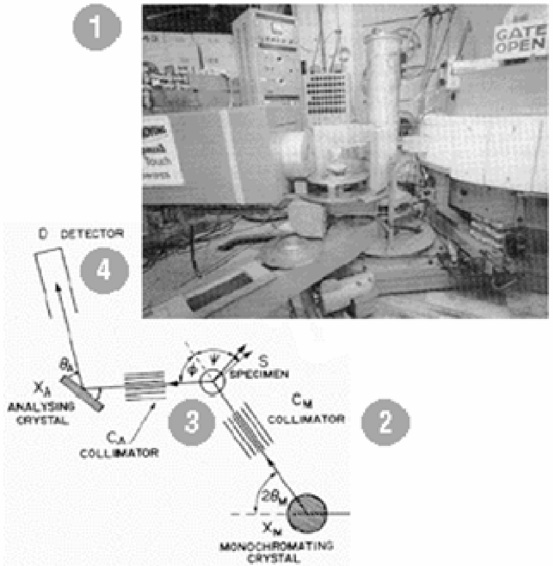


Project: Project3
Date: Wed 06-04-12

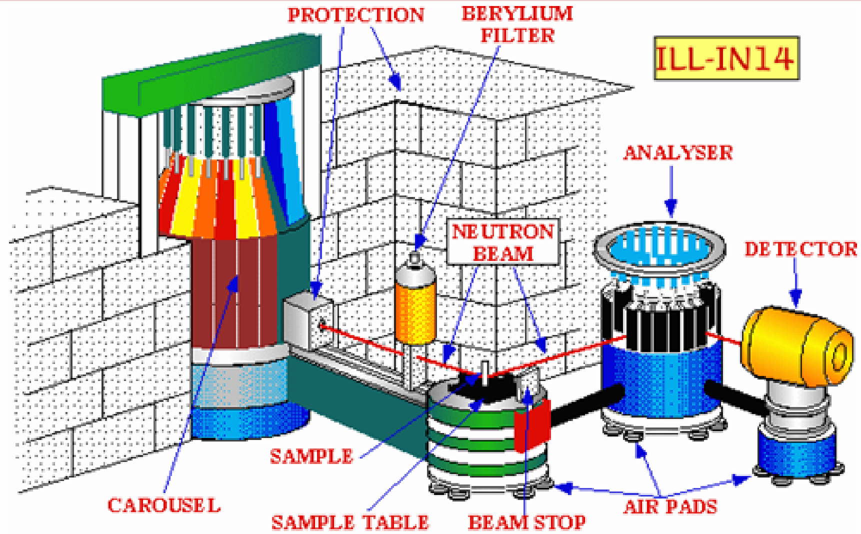
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

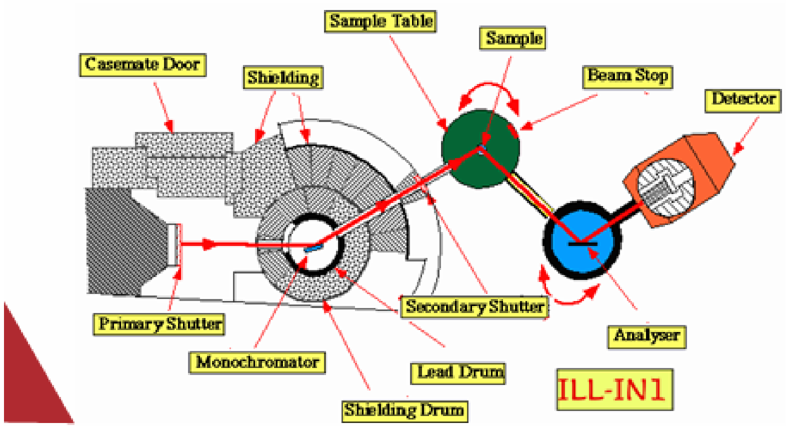


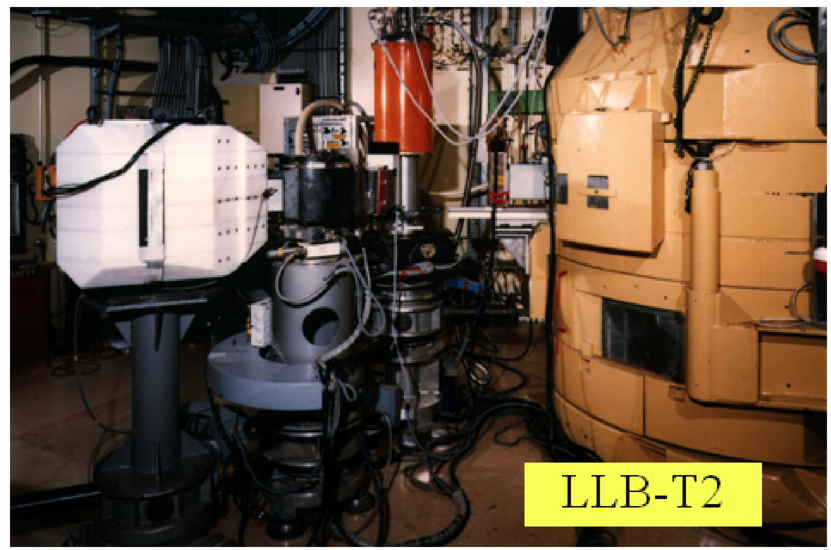
Bertrand N. Brockhouse's original TAS (1959)



http://www.nobel.se/physics/laureates/1994/index.html
http://www.science.ca/scientists/scientistprofile.php?pID=4 (3 of 4





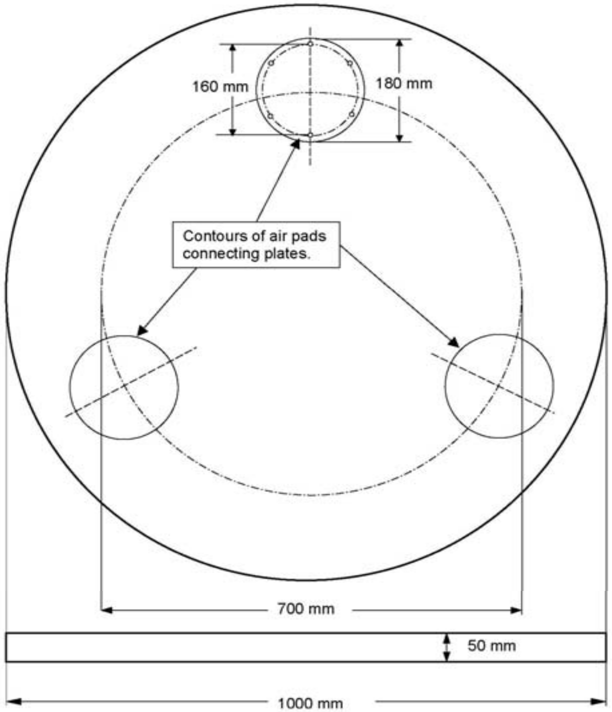


TAS&FCD

Cooperation with Juelich

The German neutron instruments in FZJ

- **New commissioned thermal neutron triple axis spectrometer in 2005.**
- **Twined four circle diffractometers have been dedicated in condensed matter research steadily for more 20 years.**



The drawing is not necessarily to scale! Only the numbers matter!

The outer diameter of the air pad connecting plates is 180 mm. This number is not critical.

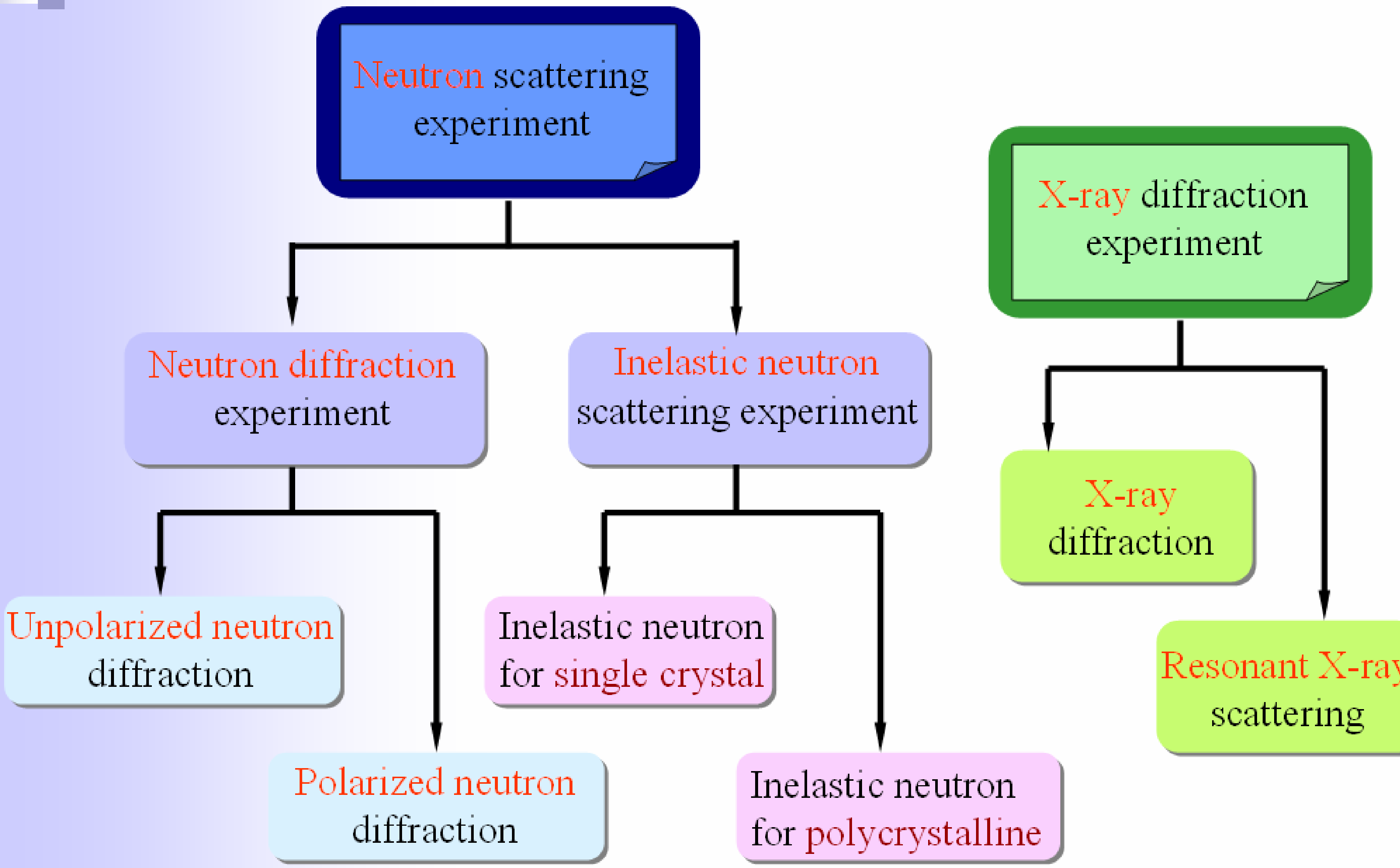
The six M6 tapped holes to be machined into the base plate in order to fix the air pads to the base plate lie on a diameter of 160 mm, 60° apart from each other. The 160 mm should be kept to within ± 0.2 mm. The through bores on the air pads have a diameter of 7 mm. (Your machine shop people can of course wait until the air pads have arrived.)

Granite dancing floor

Waveness: 0.5mm within 30cm

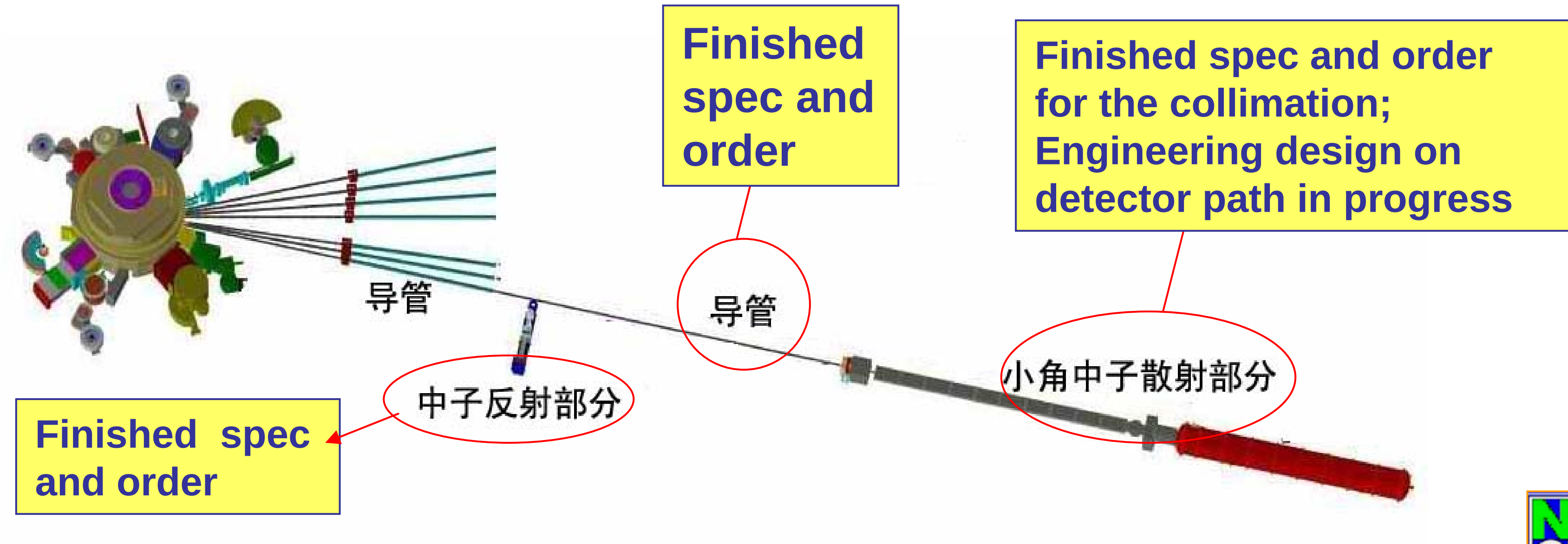
Slope: 1mm within 1000mm

Experiments



SANS

- Basic design of SANS and Reflectometer are based on the NIST design
- Neutron guides spec and order
- Collimations design, spec and order
- Detector selection and order
- Others (guide hall constructions, utilities, shielding design）



中国科学院化学研究所公函

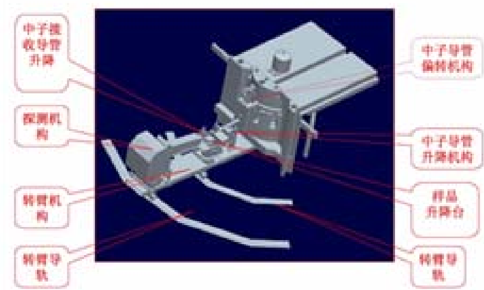
中国核工业集团公司，中国原子能研究院：

由中国科学院牵头，中国科学院化学所、物理所与中国原子能研究院联合申请中国科技部"国家科技基础条件平台建设项目-中子散射谱仪中心建设"项目，已经经过初步审查和答辩程序。该项目的正式文本将于11月2日递交科技部审批，需要各家共建单位及其主管部门盖章。

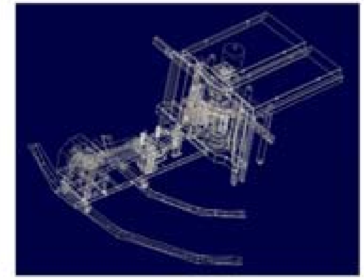
希望贵单位予以大力支持，共同促进本项目的顺利完成！

该项目的具体情况请见文本附件。

Reflectometer outside view

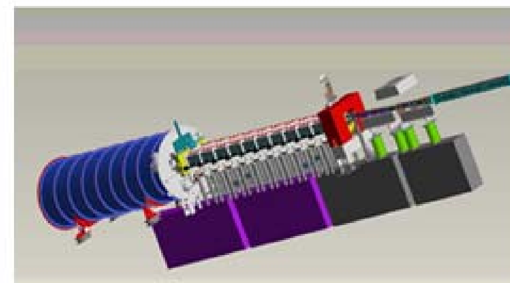


Reflectormeter-3d structure view



NIST

SANS- 3d view

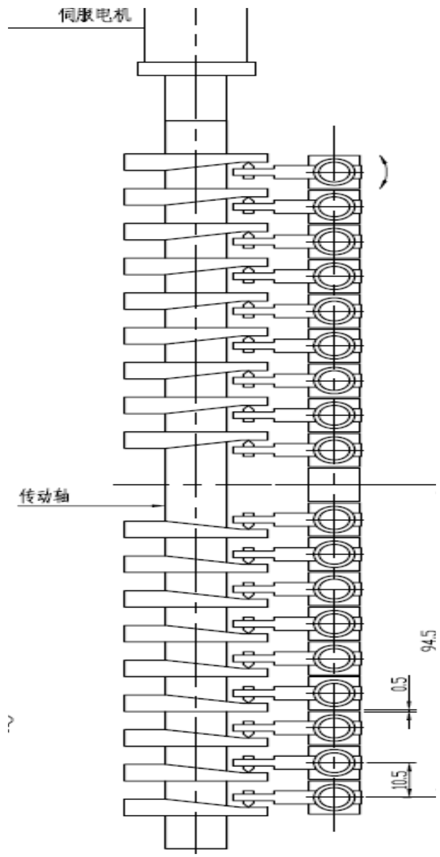


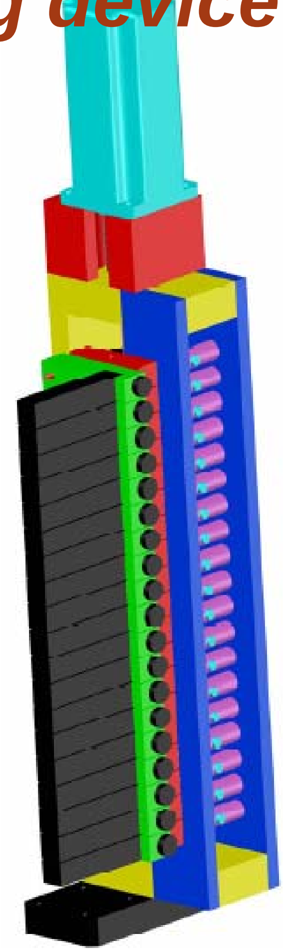
SANS-3d structure view

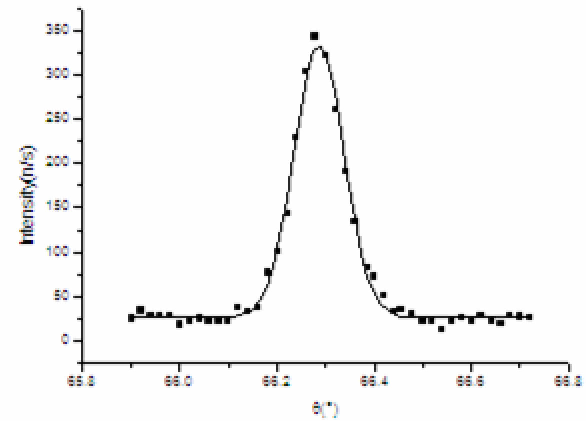
NSL CIAE

关键部件研制
Monochromator

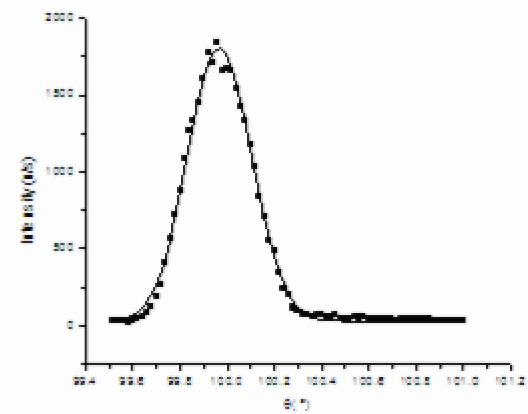
- ***Vertical focusing device***







Rock Curve of Perfect Ge Crystal
Mosaic 6”



Rock Curve of hot-pressed Ge Crystal
Mosaic 17’

- Hot-pressed Ge crystal Ongoing

Dr. HW Xiao

压 YaPTRON

Integration of High *P-T* Neutron Diffraction & *Neutron Radiography/Tomography with Acoustic Elasticity, Thermo-Calorimetry, Deformation Texture/Rheology*

Pressure/Temperature Research Online Neutron

Prof. Zhao Yusheng

Visiting Scientist, Peking University

Staff Scientist LANSCE-12, MS-H805; Los Alamos National Laboratory, Los Alamos, NM 87545;

Phone: (505)-667-3886, Fax: (505)-665-2676, E-Mail: yzhao@lanl.gov

Proposed Instrument development beamline

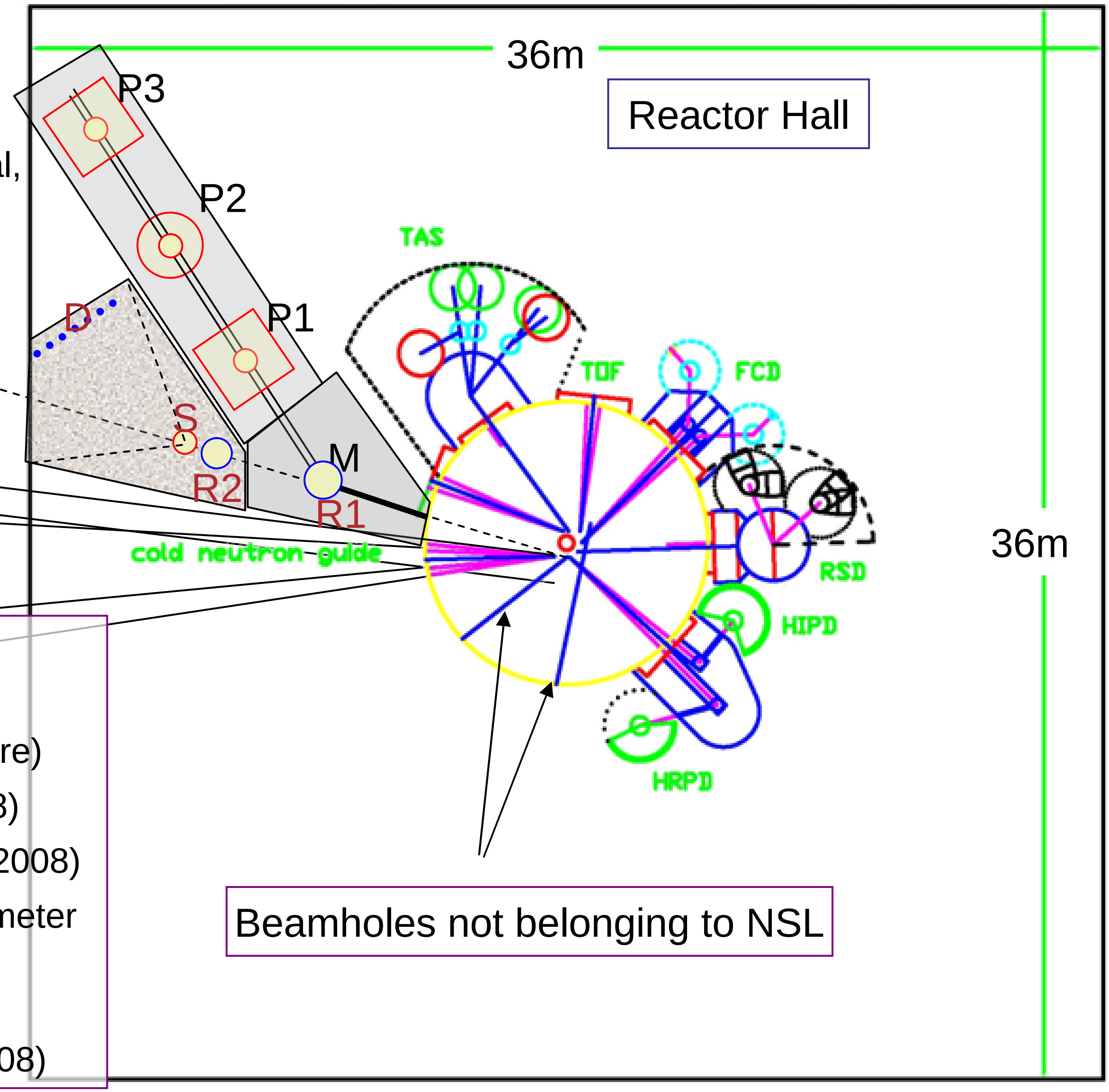
Phase 1 (2008-): A 3-port line for rotor,crystal, polarizer, detector,… development

Phase 2 (2009-): TOF instrument testing

Phase 3 (2009-): Cold neutron optics & imaging testing station

CNP

Cold Neutron Guide Hall



Committed beamlines

TAS: Triple-axis spectrometer (2008)

TOF: Time-of-flight spectrometer (future)

FCS: Four-circle diffractometers (2008)

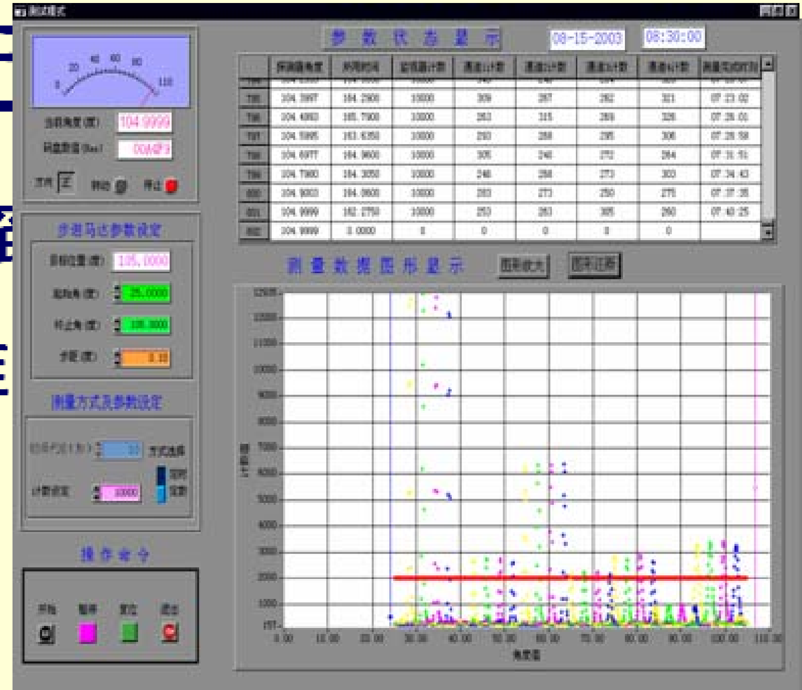
RSD: Residual stress diffractometer (2008)

HIPD: High-intensity powder diffractometer

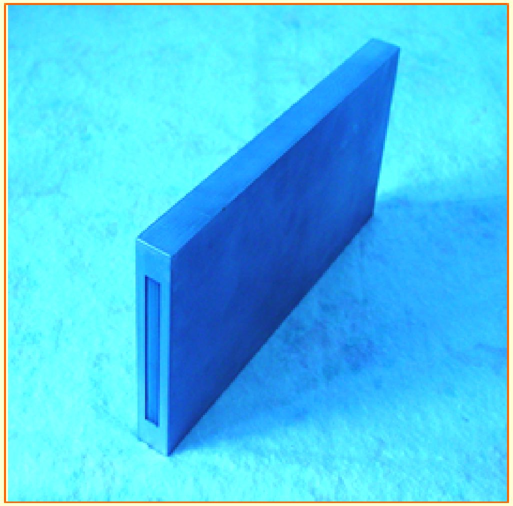
HRPD: High-resolution powder diffractometer (2008)

Beamhole for cold neutron guides (2008)

NSL CIAE

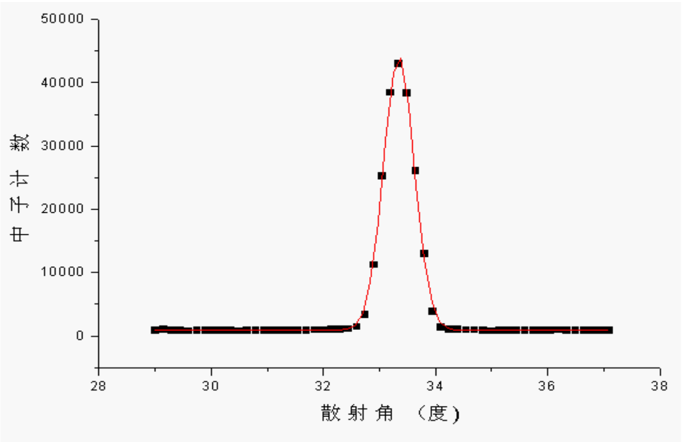


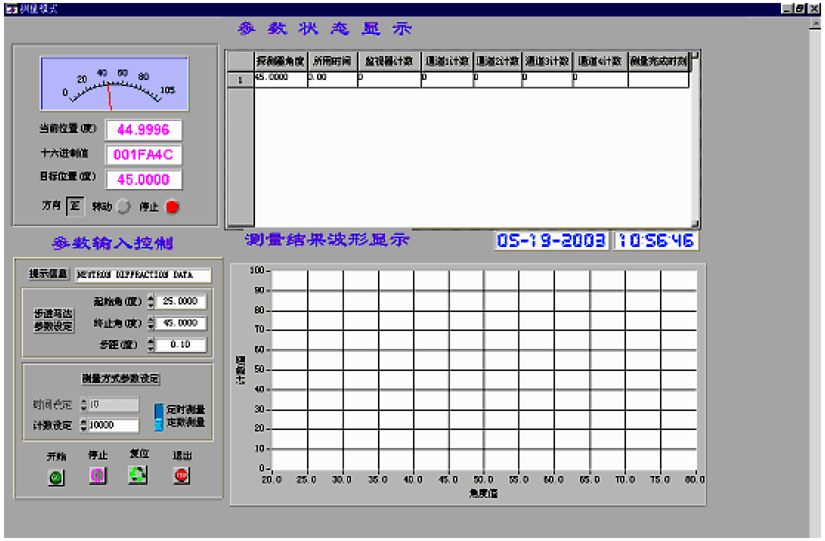
参 数 状 态 显 示
08-15-2003
08:30:00
步进马达参数设定
测量方式及参数设定
操 作 命 令
测 量 数 据 图 形 显 示
图形放大
图形还原

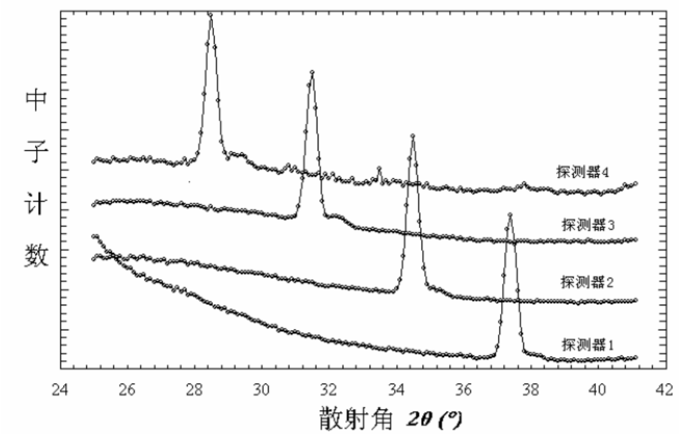


2003 4 10

升级后测量效率和分辨率显著提升

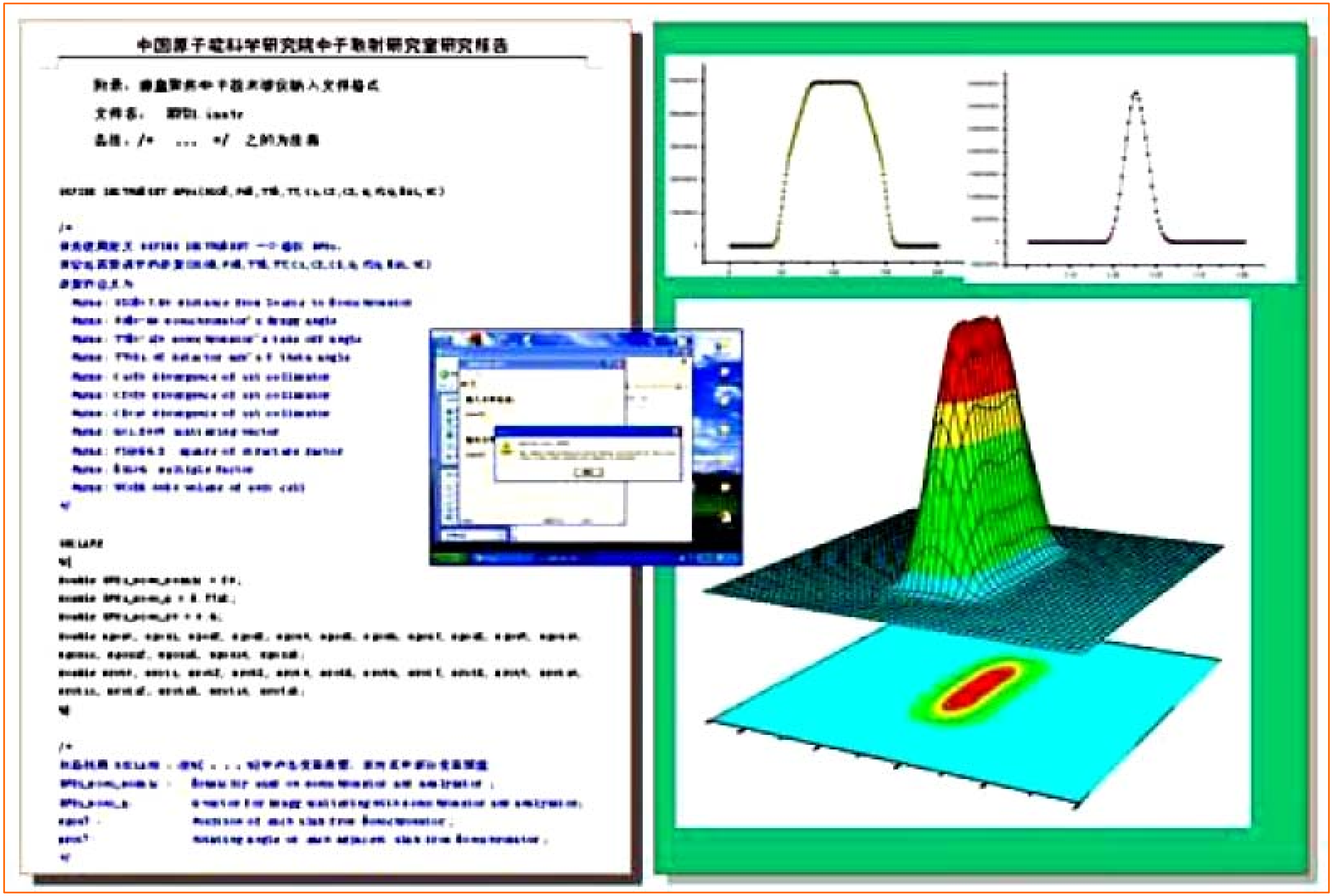




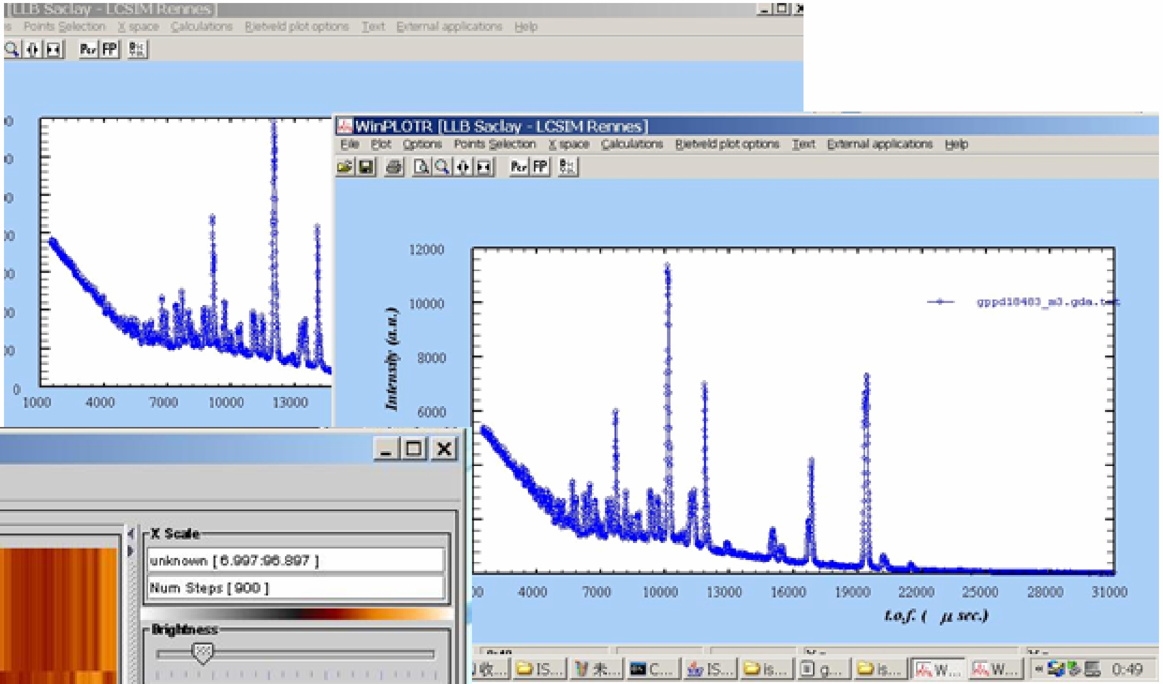


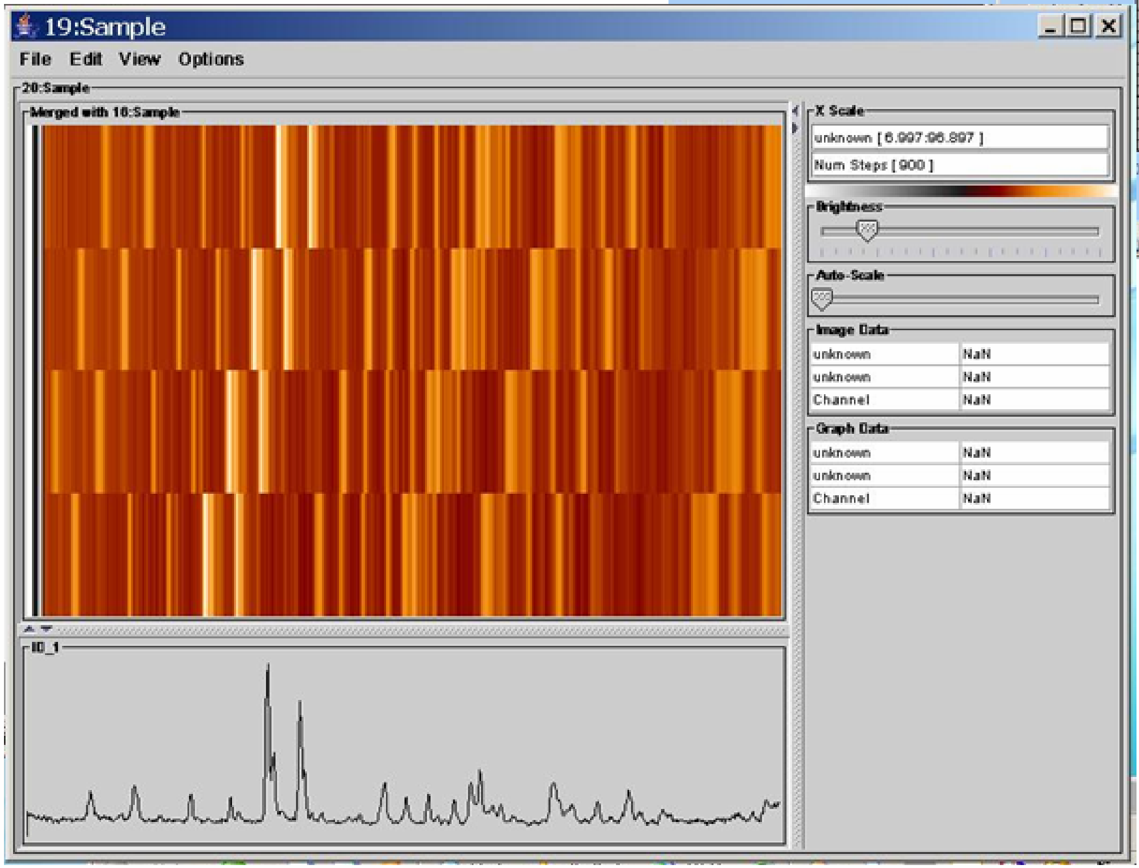
探测器	峰位（度）	峰宽（度）	峰高
1	37.383（2）	0.341（5）	14484
2	34.488（4）	0.333（8）	15523
3	31.473（6）	0.337（13）	14937
4	28.493（4）	0.318（7）	14373

MC simulation



ISAW





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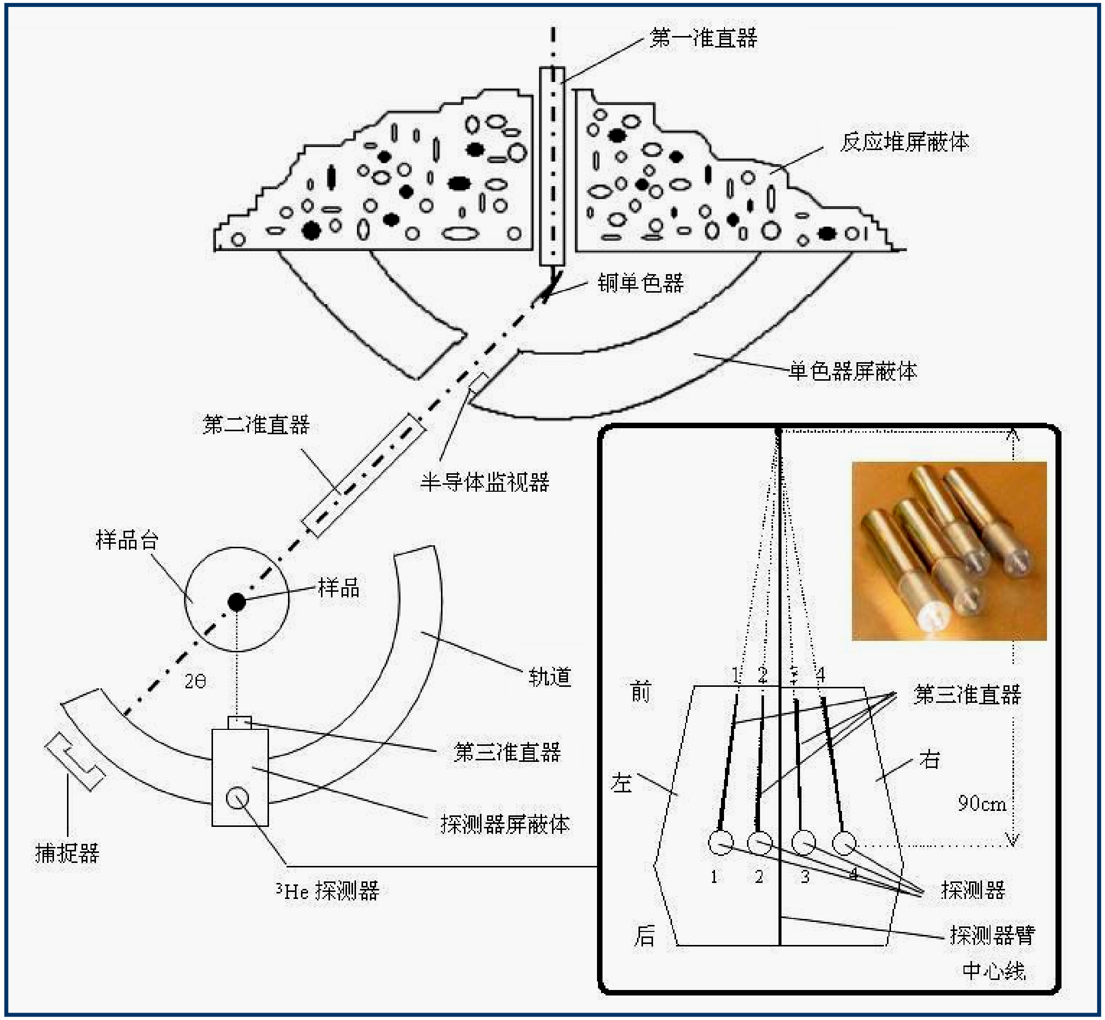
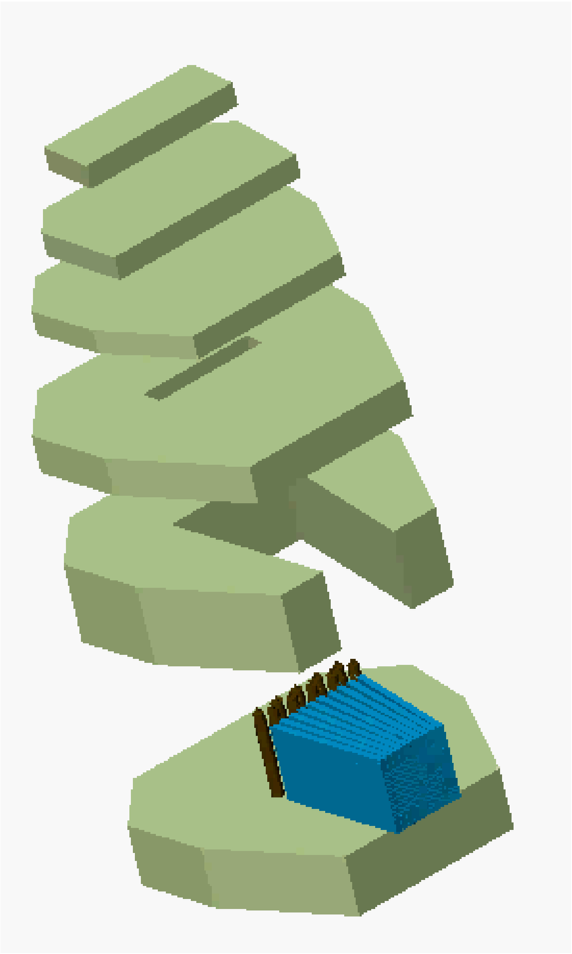
L. Zhang

J. H. Li

3rd Phase Upgrading

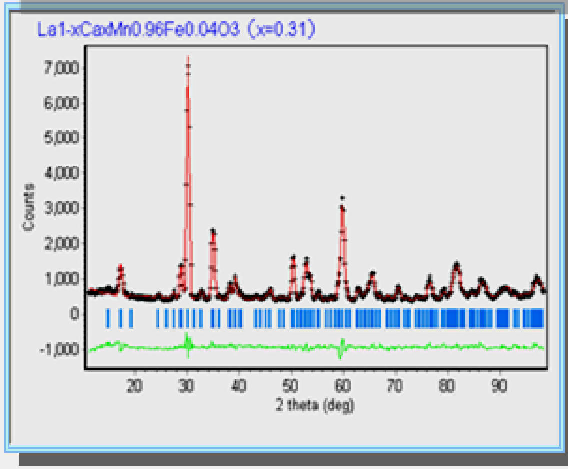


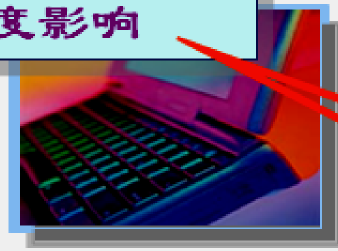


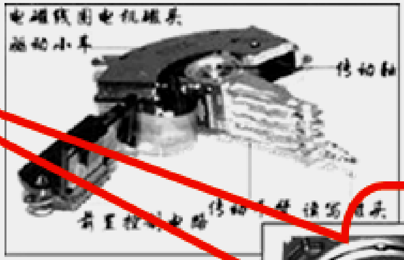
$La_{1-x}Ca_xMn_{0.96}Fe_{0.04}O_3$

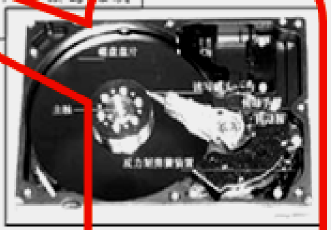
中国科学院物理所
磁学国家重点实验室

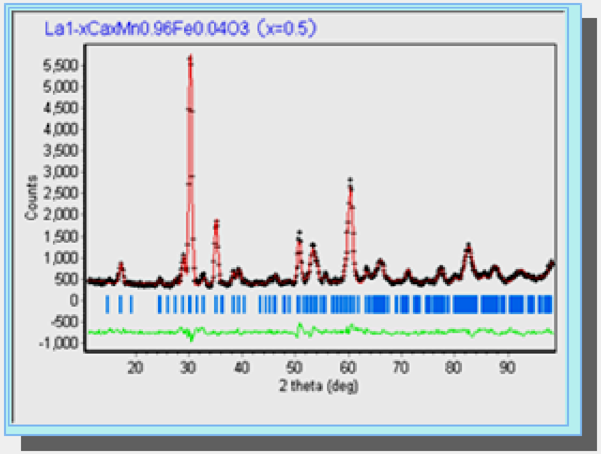
性能不受信息读取速度影响

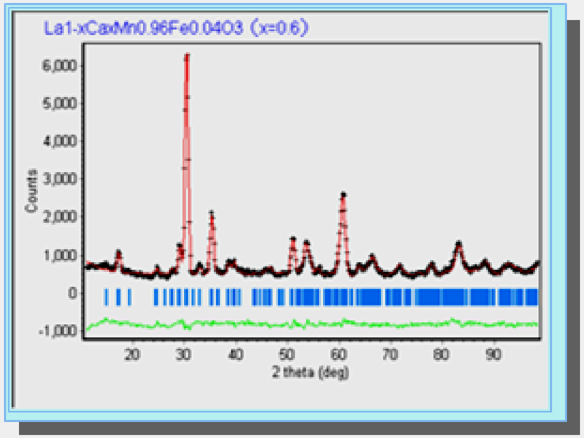




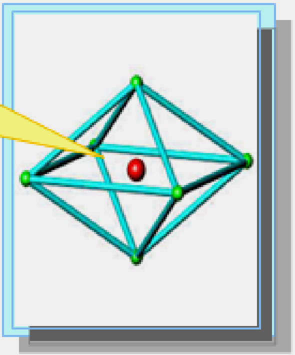


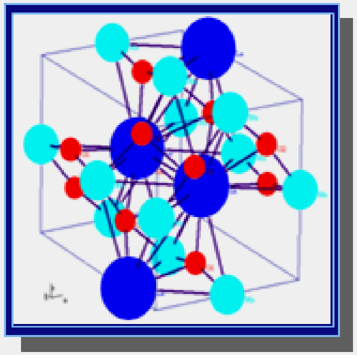






锰氧键的键长和？？？





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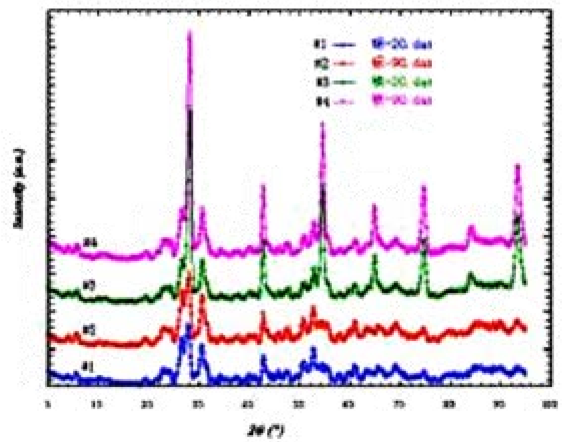
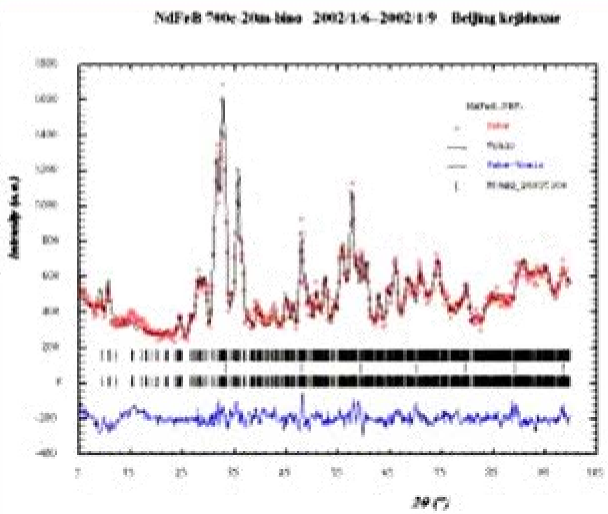
纳米复合永磁材料

$Nd_2Fe_{14}B/\alpha\text{-}Fe$



$$\delta(2\theta) = \frac{k\lambda}{D\cos\theta}$$



Complex 3:29 Series

1 $Nd_{3-x}Y_xFe_{27.8}Mo_{1.2}$ (1.5)

2 $Nd_{3-x}Y_xFe_{27.5}Ti_{1.5}$

3 $Nd_{3-x}Y_xFe_{27.5}Ti_{0.8}Mo_{0.4}$

4 $Nd_{2.1}Y_{0.9}Fe_{27.5}Ti_{1.5-x}Mo_x$

5 $Nd_{3-x}Dy_xFe_{27.5}Mo_{1.2}$

6 $Nd_{3-x}Dy_xFe_{27.5}Ti_{0.8}Mo_{0.4}$

7 $Nd_{2.1}Dy_{0.9}Fe_{27.5}Ti_{1.5-x}Mo_x$

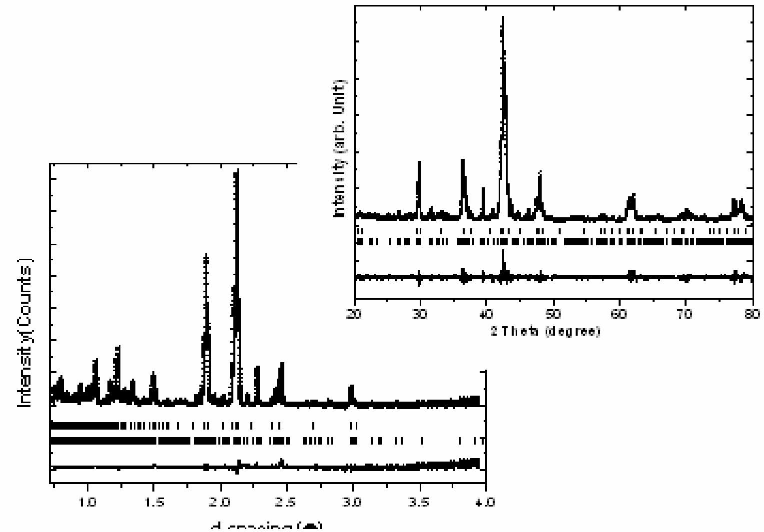
8 $Nd_3Fe_{27.5}Ti_{1.5-x}Nb_x$

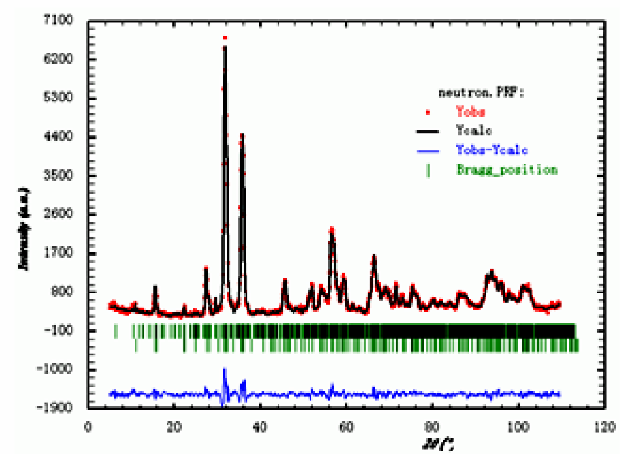
9 $Nd_3Fe_{27.5}Mo_{1.5-x}Zr_x$

10 $Nd_3Fe_{27.5}Ti_{1.5-x}Zr_x$

11 $Y_{3-x}Dy_xFe_{27.5}Ti_{1.5}$

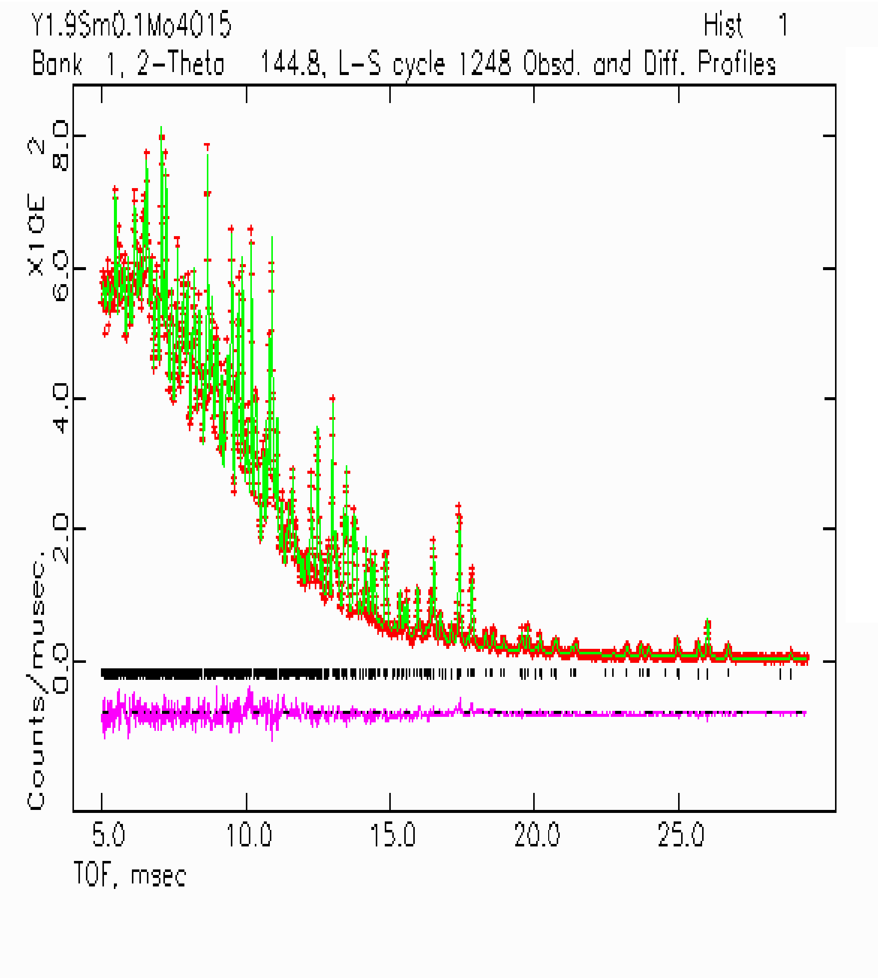
12 $Y_{3-x}Dy_xFe_{27.8}Mo_{1.2}$

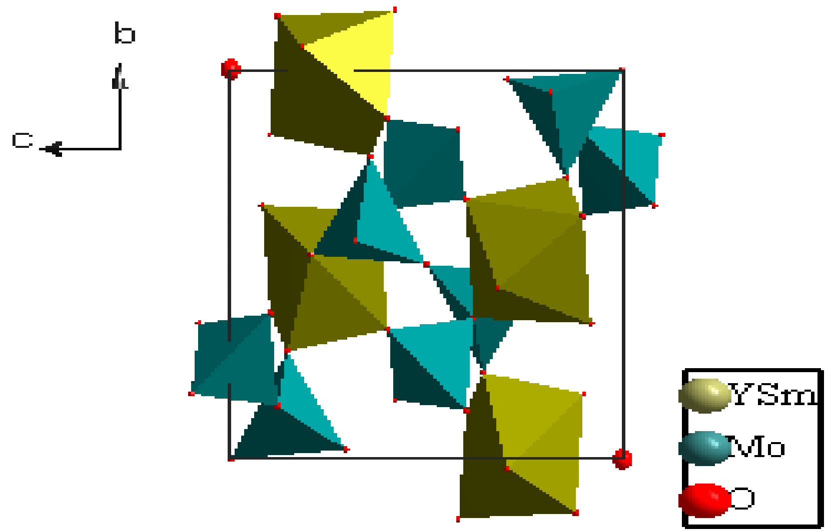




Dr. S. B. Han

Y2-xSmxMo4O15 (X=0.0-0.8)





Dr. H.Wang

& Z.X Yu

培养期间发表论文和专著情况（包括题目、发表时间、刊物名称）：

发表论文 40 余篇：

1. X. F. Liu, J. Y. Lv, S. B. Han, J. Peng, H. Wang, Z. B. Hu, D. F. Chen, Y. J. Xue, and J. H. Li, J. Appl. Phys. 98, 013537 (2005)

2. X.F. Liu, S.B. Han, J.Y. Lv, X.J. Li, Z.B. Hu, D.F. Chen, Y.J. Xue and J.H. Li, Journal of Alloys and Compounds (in press).

3. X.F. Liu, D.F. Chen, Y.M. Hao, J.Y. Lv, S.B. Han, Y.J. Xue, J.H. Li and Z.B. Hu, Journal of Alloys and Compounds (in press).

4. J. Y. Lv, S. B. Han, X. F. Liu, X. J. Li, Z.B.Hu, J. H. Li, Y. J. Xue and D. F. Chen, J. Appl. Phys. 98 (2005) 33903.

5. J. Y. Lv, X. F. Liu, S. B. Han, X. J. Li, Z.B.Hu, J. H. Li, Y. J. Xue, D. F. Chen, Physics B, (accepted).

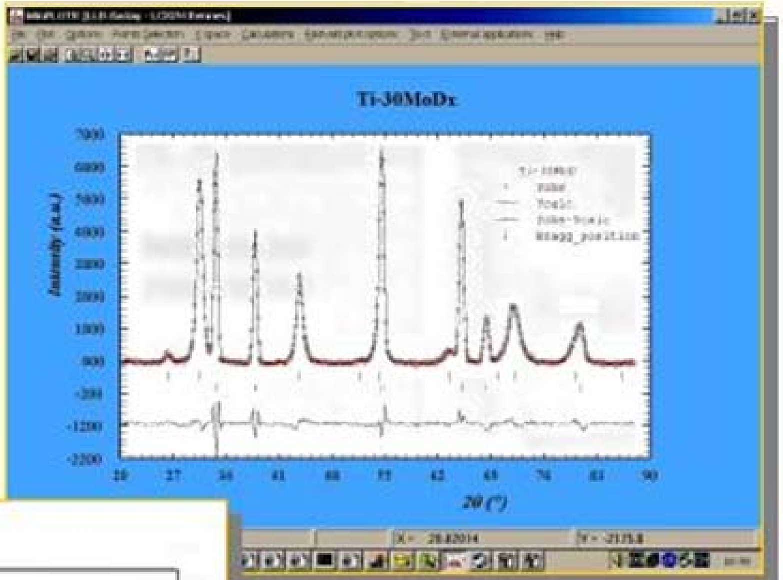
6. S.B. Han, J.Y. Lv, X.F. Liu, J. Peng, D.F. Chen, Y.J. Xue, J.H. Li and Z.B. Hu, J. Alloys Comp.(in press)

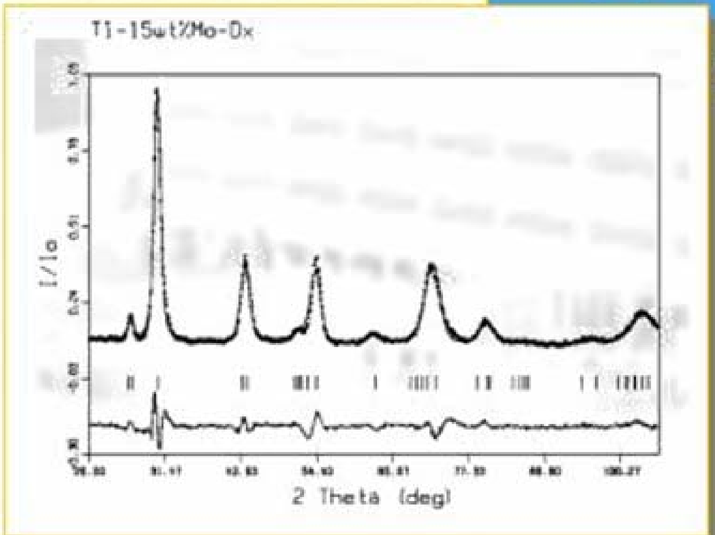
7. S.B. Han, J.Y. Lv, X.F. Liu, J. Peng, X.J. Li, D.F. Chen, Y.J. Xue, J.H. Li and Z.B. Hu, Phys. B. ,367/1-4 pp. 275-281.

8. S.B. Han, X.F. Liu , J.Y. Lv, J. Peng, Y.M.Hao, D.F. Chen, Y.J. Xue, J.H. Li and Z.B. Hu, , J. Magn. Magn. Mater. (accepted).

9. S B Han, J Y Lv, X F Liu, J Peng, X J Li, D F Chen, Y J Xue, J H Li and Z B Hu, J. Phys.: Condens. Matter. (accepted).

10．L.Zhang, D.F.Chen*，Atomic Energy Science and Technology Vol 36 No.6(2004)84 （in Chinese）





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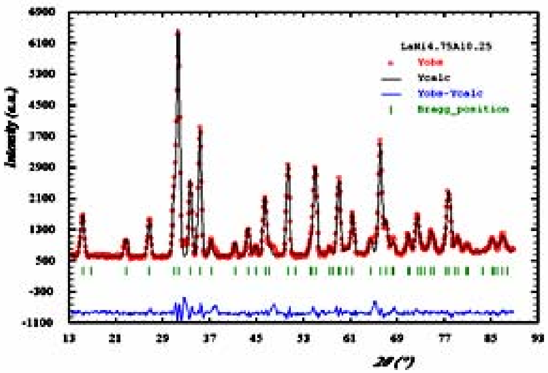
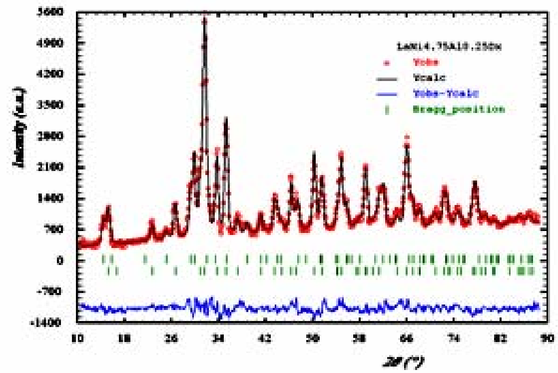
Institute of Metal Research Chinese Academy of Sciences

中国原子能科学研究院
CHINA INSTITUTE OF ATOMIC ENERGY

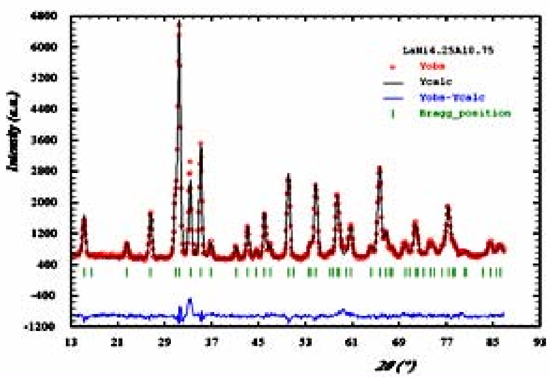
中国工程物理研究院



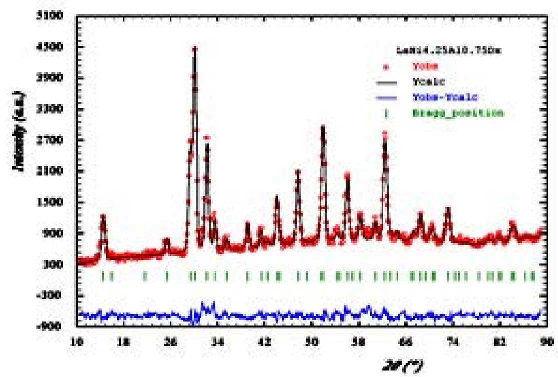
LaNi4.75Al0.25
Yobs
Ycalc
Yobs-Ycalc
Bragg_position
Intensity (a.u.)
2θ (°)



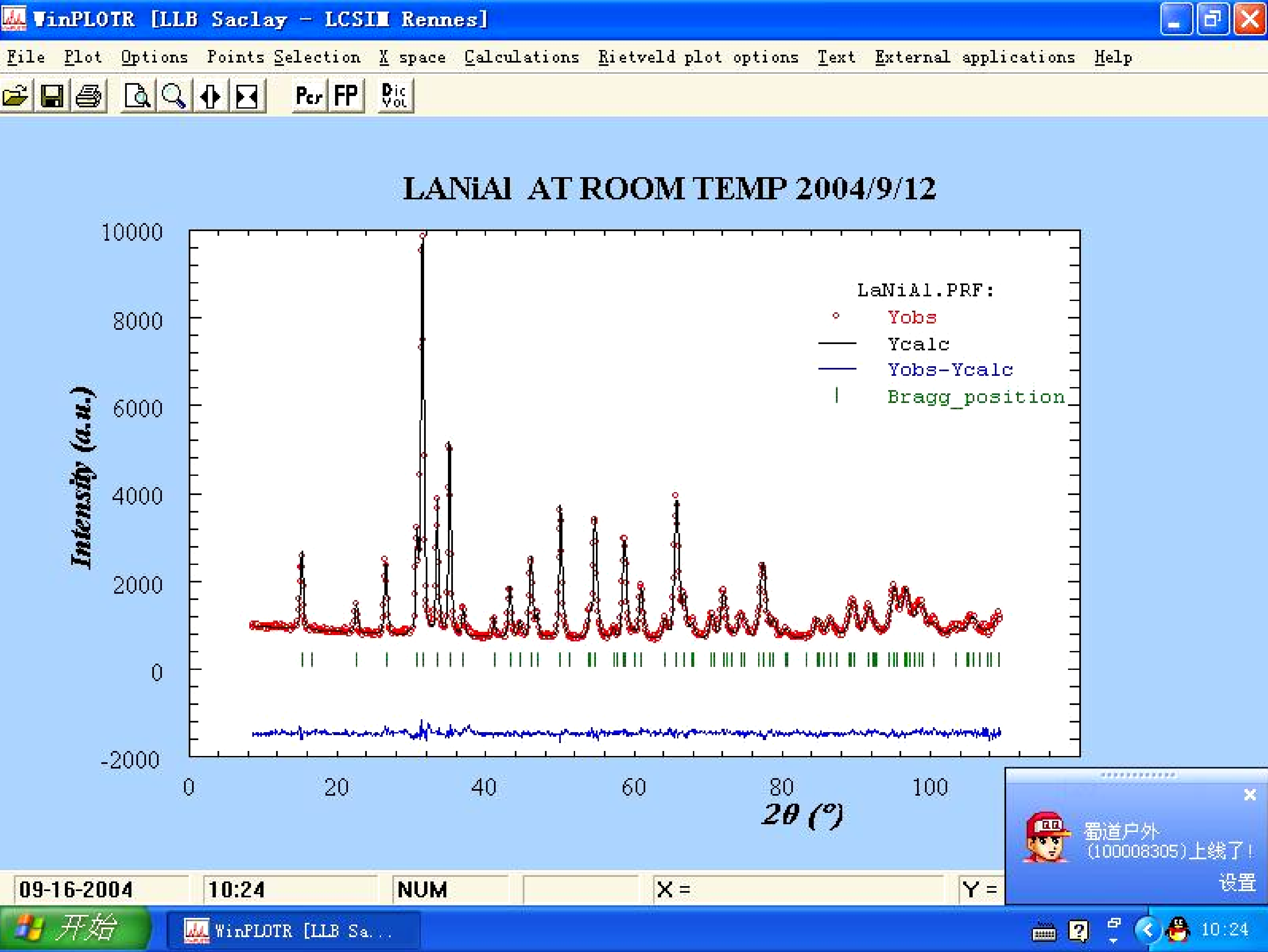
LaNi4.75Al0.25Dx
Yobs
Ycalc
Yobs-Ycalc
Bragg_position
Intensity (a.u.)
2θ (°)



LaNi4.25Al0.75
Yobs
Ycalc
Yobs-Ycalc
Bragg_position
Intensity (a.u.)
2θ (°)



LaNi4.25Al0.75Dx
Yobs
Ycalc
Yobs-Ycalc
Bragg_position
Intensity (a.u.)
2θ (°)


WinPLOTR [LLB Saclay - LCSIM Rennes]
File Plot Options Points Selection X space Calculations Rietveld plot options Text External applications Help
Pcr FP Dic Vol
LANiAl AT ROOM TEMP 2004/9/12
LaNiAl.PRF:
Yobs
Ycalc
Yobs-Ycalc
Bragg_position
Intensity (a.u.)
10000
8000
6000
4000
2000
0
-2000
0
20
40
60
80
100
2θ (°)
09-16-2004
10:24
NUM
X =
Y =
蜀道户外
(100008305)上线了!
设置
开始
WinPLOTR [LLB Sa...
10:24

International Users Feedback

ND analysis - 西欧(ISO)

文件(F) 编辑(E) 查看(V) 工具(T) 邮件(M) 帮助(H)

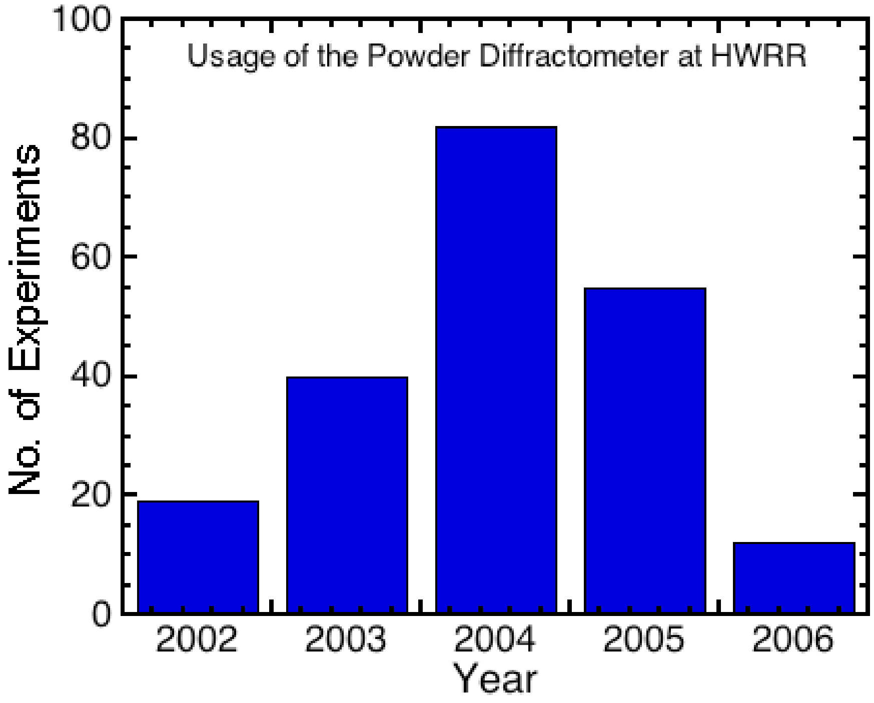
答复 全部答复 转发 打印 删除 上一封 下一封 地址

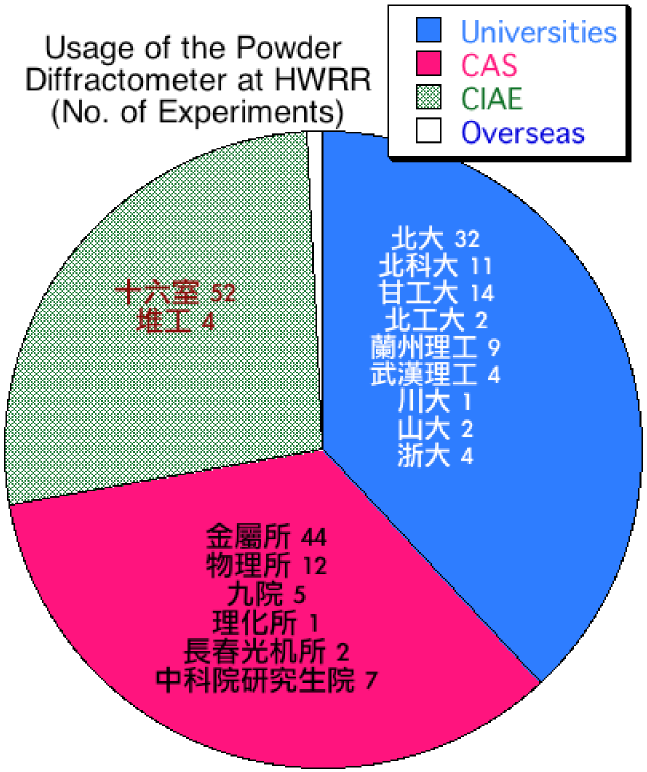
发件人: Fermin CUEVAS
日期: 2004年9月17日 22:22
收件人: dongfeng
主题: ND analysis

Dear DongFeng,
We have analyzed your ND data and we are quite satisfied with their quality as regards diffaction statisitcs, resolution and angle range. We notice that you need long time for getting good statistics but the results are fine. Both Michel Latroche and me are quite happy with these results. We will think sending you samples as soon as we will face new problems concerning structural determination of stable hydrides and or intermetallic compounds.

NSL CIAE

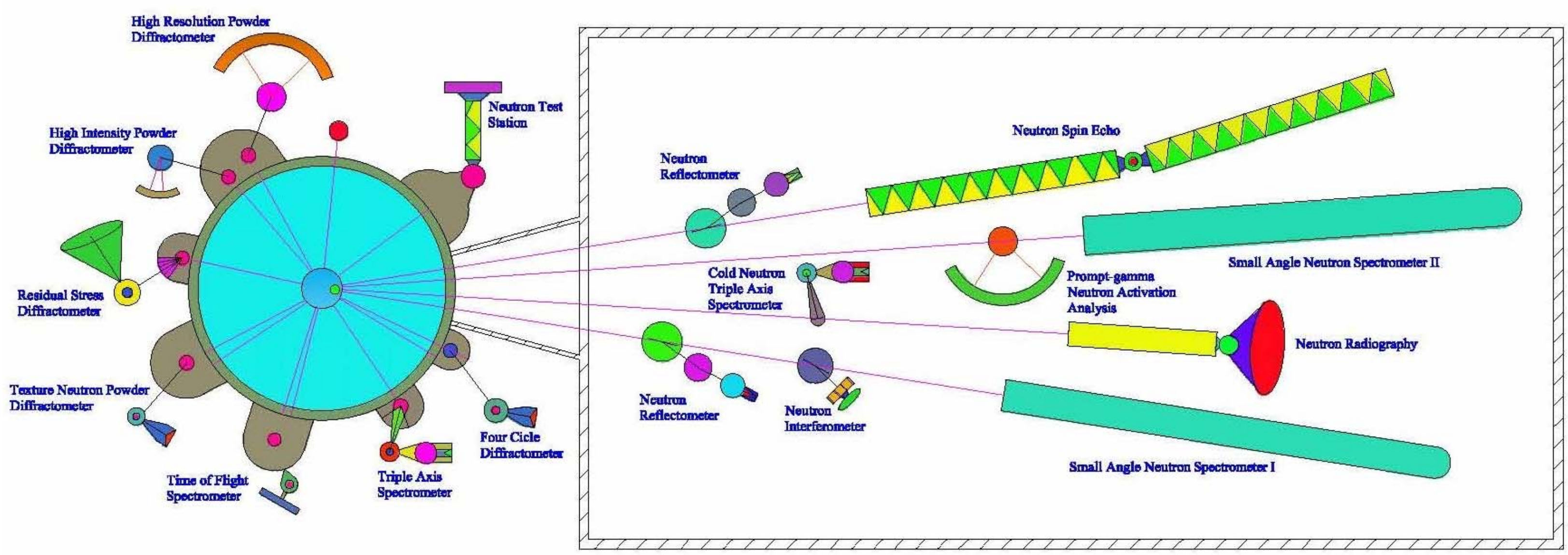
Recent Neutron Powder Diffraction Experiments Carried out at HWRR





By 2008, HWRR will be 50-year old, time to retire perhaps!

NSL-CARR Instrumentation and Science: Future Development Through User Involvement and International Cooperation



Following the practice at modern facilities, we are in the process of developing a uniform policy, transparent to users and interested groups from universities, industry and government labs.

1. Submission of a *Letter of intent to CARR*
2. Establishment of an *Instrument Development Team*
3. Review by a *Scientific Facility Advisory Committee*
4. Extensive involvement of scientific user communities

We plan to consult international experts like yourselves for advice and reviews

NSL CIAE

The US-China Workshop Series on Neutron Scattering Science and Technology: The Inaugurating Meeting

November 12-15, 2006
Beijing, China

Sponsored by US National Science Foundation
China Institute of Atomic Energy
Chinese Academy of Sciences

This inaugurating meeting and the subsequent reciprocal meeting in the

1 st US-China NS Workshop

International Meeting on

Neutrons and Grand Challenges of Nanoscience, Energy Research, and Computation

November 16-18, 2006
Xi'an, China

Hosted & sponsored by Hebei University of Technology
Co-sponsored by China Institute of Atomic Energy

CIAE

Mission Statement of NSL-CARR:

NSL is dedicated to serve neutron users from China and abroad for materials research with reliably optimized, progressively upgradable, and safely operated facilities and a devoted staff.

NSL的任务是通过提供可靠地优化、不断地升级、安全地运行和尽职尽责地服务于国内外材料研究领域的用户。

International Advisory Committee

September 21-22, 2007 in Liangxiang, Beijing, China

- Chun-Keung Loong, Chair *(Argonne, USA),*
- Sow-Hsin Chen *(MIT, USA),*
- Yasuhiko Fujii *(J-PARC, Japan),*
- Alan J. Hurd (Los Alamos, USA),
- Winfried Petry (FRM II, Germany),
- Roger Pynn (U. Indiana, USA),
- Uschi Steigenberge (ISIS, UK), and
- Michael Steiner (HMI-Berlin, Germany).
- Kenneth W. Herwig (*Oak Ridge, USA*), Shane J. Kennedy (*Bragg Inst., Australia*), and Dan A. Neumann (*NIST, USA*), could not attend the meeting

Unprecedented Opportunities in Nanoscience, Advanced Materials, Energy-related Systems, and Biology

We commend

- **CIAE on its leadership and support of the CARR Project**
- **NSL on the outstanding progress in designing and constructing 5 reactor instruments that will be ready on day 1 of CARR operation & 2 instruments operational at the completion of the cold source.**
- **NSL on realizing 4 out the 5 instruments through international collaborations which will contribute strongly to the initial success.**

The Phase I neutron-scattering instruments are all internationally competitive. NSL has the potential to produce scientific excellence and to demonstrate the capability of becoming a successful user facility at CIAE at a level that has never happened before in China.

Prerequisites for Producing Excellent Neutron Science

- **CARR must operate stably and reliably for more than 200 days per year.**

- **The cold source must function properly in conjunction with the reactor operation.**

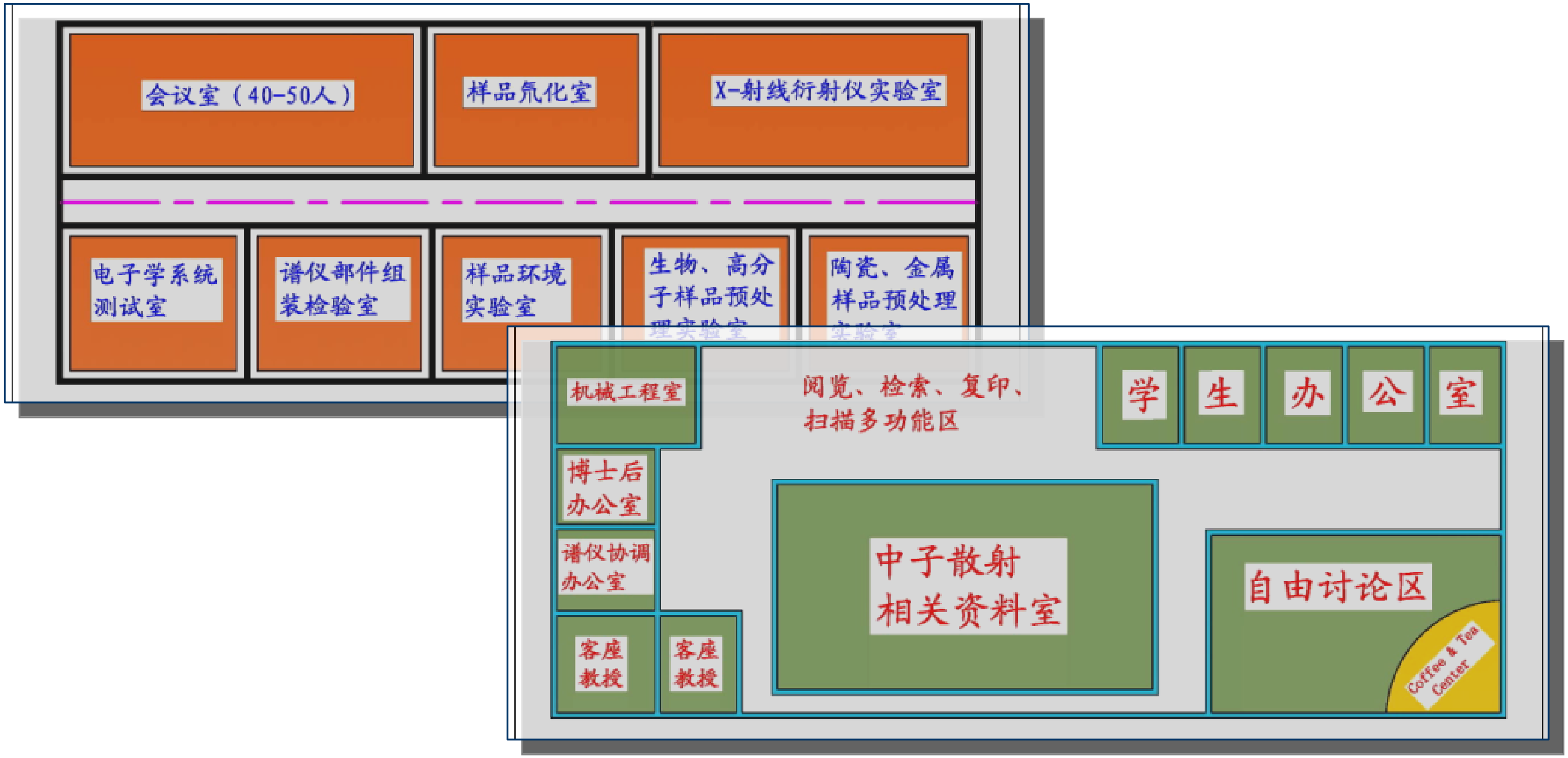
- **The cold source must be adequately funded if the facility is to be scientifically successful.**

Domestic Advisory Committee

April 5-6, 2007 in CIAE, Beijing, China

- **Jianhua LIN, Chair** ***(Peking University),***
- **Charles HAN** ***(Institute of Chemistry, CAS)***
- **Wenquan WANG** ***(Jilin University),***
- **Biao WANG** ***(Zhongshan University),***
- **Jiyang WANG** ***(Shandong University),***
- **Chunlin ZHANG** ***(Jinan University),***
- **Yuanbai CHEN** ***(Institute of high energy physics, CAS),***
- **Haiqing LIN** ***(Hongkong Chinese University)***

NSL CIAE


会议室（40-50人）
样品氘化室
X-射线衍射仪实验室
电子学系统测试室
谱仪部件组装检验室
样品环境实验室
生物、高分子样品预处理实验室
陶瓷、金属样品预处理实验室
机械工程室
阅览、检索、复印、扫描多功能区
学
生
办
公
室
博士后办公室
谱仪协调办公室
客座教授
客座教授
中子散射相关资料室
自由讨论区
Coffee & Tea Center

依托 CARR-NSL联合申报973项目准备会

- 初步拟定申请题目为“中子衍射技术在基础和应用领域的研究”，以强关联、工程应力和方法学三个方面为重点。
- 发起单位:北京大学、山东大学、中科院物理所和原子能院
- 建议人：张焕乔，龙振强，林建华，章综，王鼎盛，左铁镛，高松，杨应昌，严纯华，赵予生，郭之虞，梅良模，王继扬，张久兴，王彪，李志兵，赵宇亮，柳卫平，夏海鸿，陈东风，王芳卫，杨金波，王颖霞，李国宝，杜红林，刘蕴韬，陶举洲等

Thanks For all of your support

Support from International NS Community

Thanks!