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Education, Instrumentation Development and Industrial Applications Relevant to Compact Accelerators and Neutron Sources

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Sun Yat-Sen University, Guangzhou, China

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One of the largest universities in South China

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Background & Scope

China lacks neutron sources and experience of neutron scattering instrumentation…until now….

China Advanced Research Reactor (CARR)
China Spallation Neutron Source (CSNS)
Compact Pulsed Hadron Source (CPHS)

Chinese universities lack neutron science and user network in both scale and scope…..until now….

Tsinghua University, Peking University,…
SYSU

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Opportunities in the South

The China Spallation Neutron Source is located in Dongguan City, <100 km from Guangzhou

Rapid expansion of the Chinese nuclear power industry in the South, especially in Guangdong Province

Strengthening tie in economy and academia in the Pearl River Delta Region – Guangzhou, Hong Kong, & Macau

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China Guangdong Nuclear Powder Group

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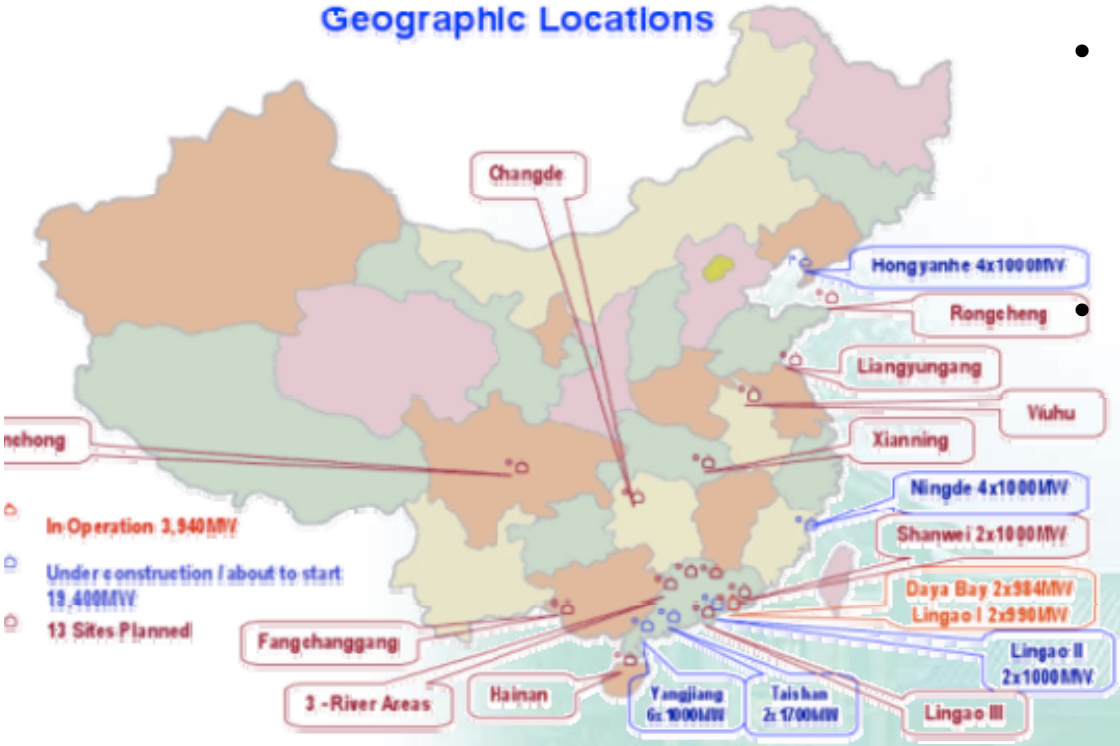
CGNPC Nuclear Projects



- To reach nuclear power capacity of 40 million kilowatts by 2020, *50% in Guangdong Province*.
- (CGNPG) owns Daya Bay and Ling Ao Nuclear Power Station with nearly 4,000 Megawatts capacity.

- CGNPG and Areva of France signed a US$11.86 billion civil nuclear energy cooperation and further joint venture in nuclear technologies
- Strong interest in proton radiotherapy—therapy facilities and nuclear medicine involving local and university hospitals are under consideration.

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Nuclear and Neutron (N&N)

A Sino-French Institute of Nuclear Engineering & Technology at SYSU's Zhuhai Campus

- In addition to nuclear energy, SINET is keen to build up R&D programs in neutron science and technology.

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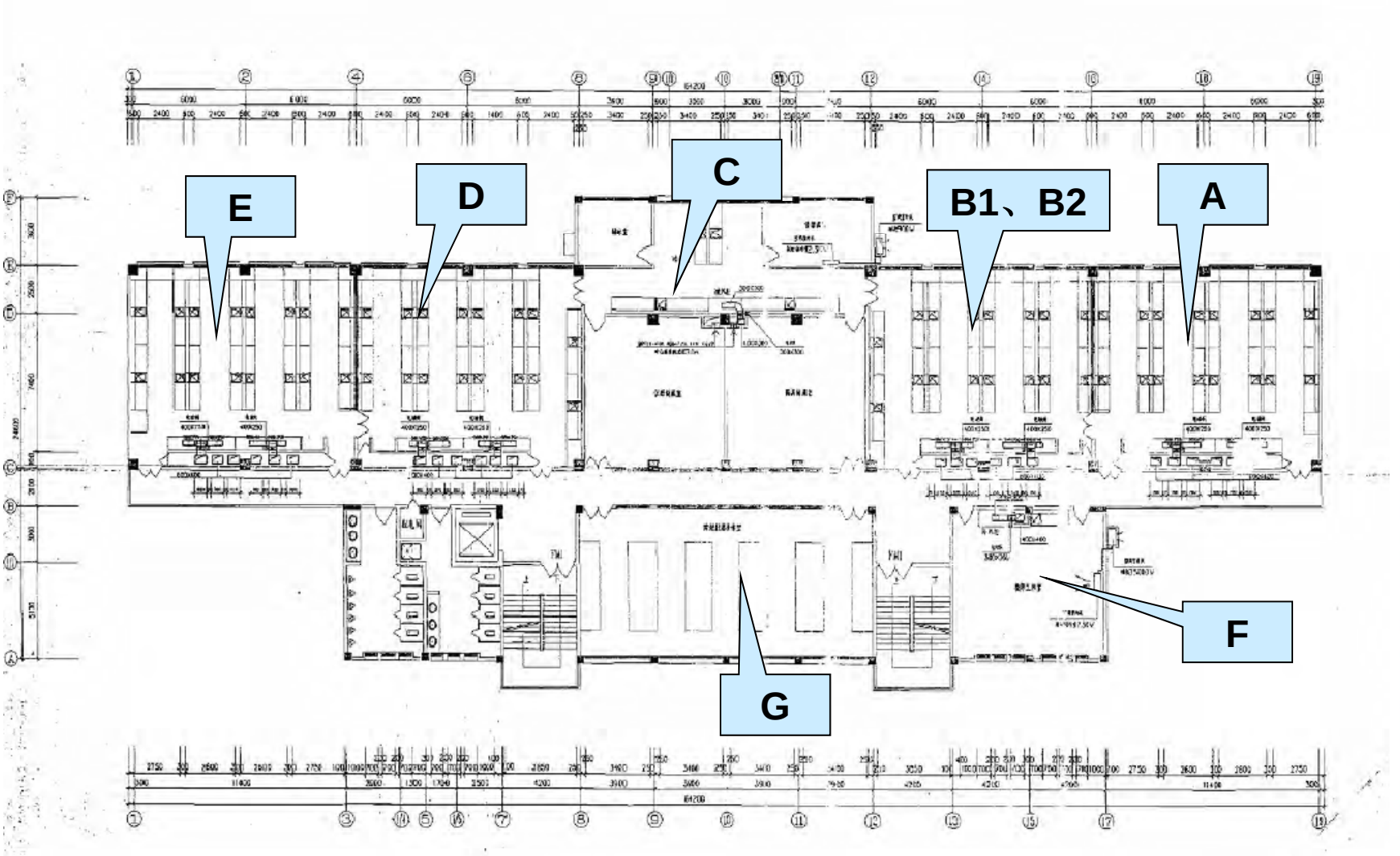
A New Home for N&N Research



珠海校区化学实验大楼一层平面图

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Floor Plan

F1: A, B1—Neutron detector development & benchmarking

B2—Materials preparation lab

C—Nuclear electronics lab (+ clean room)

D—Precision processing lab

E—Reserve area for future staff

F—Staging area for nuclear materials & secure storage

F2: Radiation dosimetry and protection labs

F3: Advanced materials and critical techniques for nuclear energy applications, thermohydraulics lab

6F: Conference & exhibition facility

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Funding & Expenditure (planning stage)

~$7M (5000万元) from Guangdong Province

- 核辐射探测及防护实验室（4100万元）
  - 中子探测器测试平台 2500万元
    - -离子源+RFQ+中子靶 2000万元
    - -其他测试设备及环境改造 500万元
  - 中子探测器研发平台 1300万元
    - -涂硼材料研发 400万元
    - -闪烁体材料及器件研发 300万元
    - -核电子学超净实验室 300万元
    - -精加工中心 300万元
  - 核电站环境监测系统研发平台 300万元

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Funding & Expenditure

- 核材料及新一代核能关键技术实验室 （**700**万元）

（预留**600**万元，用于引进人才的配套经费）

- 核电站设计、运行及安全仿真实验室 （**200**万元）

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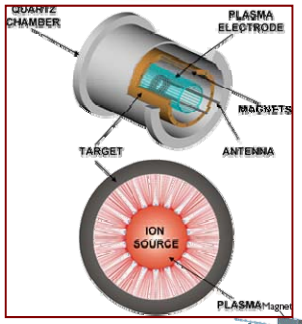
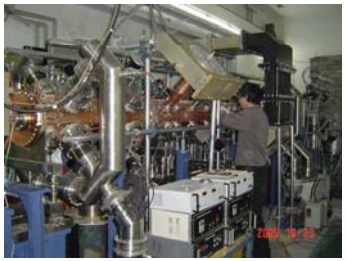
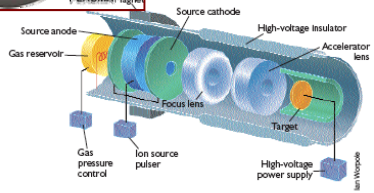
Challenges: How to Proceed?





Compact neutron generators, RFQ-driven sources



一般密封的辐射同位素源:例如自发裂变**Cf-252**, α–中子**Pu-Be**源

10^{10} P.E.T. Isotope Production

BNCT Cancer Treatment

10^{9} Medical N-Gamma Imaging

Online Letter and Parcel Inspection

Land Mine Detection

Neutron Radiography

10^{8} Industrial On-Line and Off-Line Solids and Fluids PGNAA

Online Mineral Quality Monitoring PGNAA

Mail and Parcel Bomb Detection

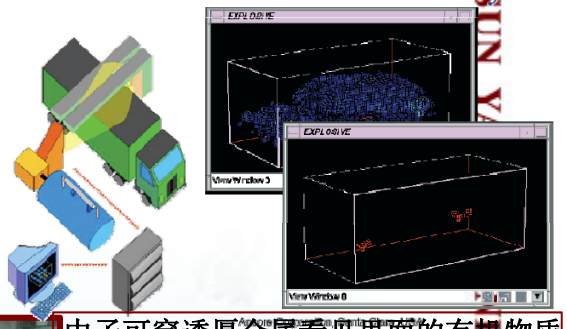
Exploration Bore Hole Slurry Analysis

10^{7} Safeguards Inspection (Nuclear and Chemical Weapons)

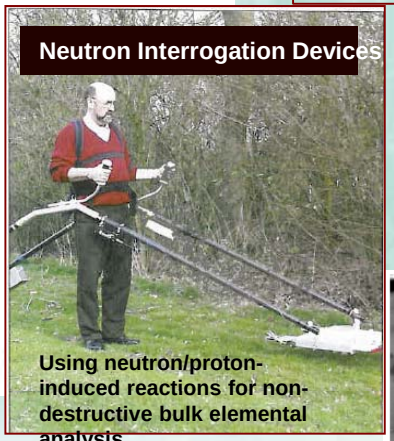
Online Moisture in Coal and Coke Measurement

Radiochemistry Labratories (Analytical Labs) Global Analysis Firms

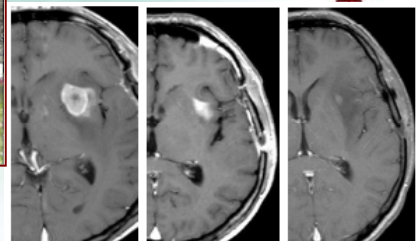
PFNA - Pulsed Fast Neutron Analysis



中子可穿透厚金属看见里面的有机物质

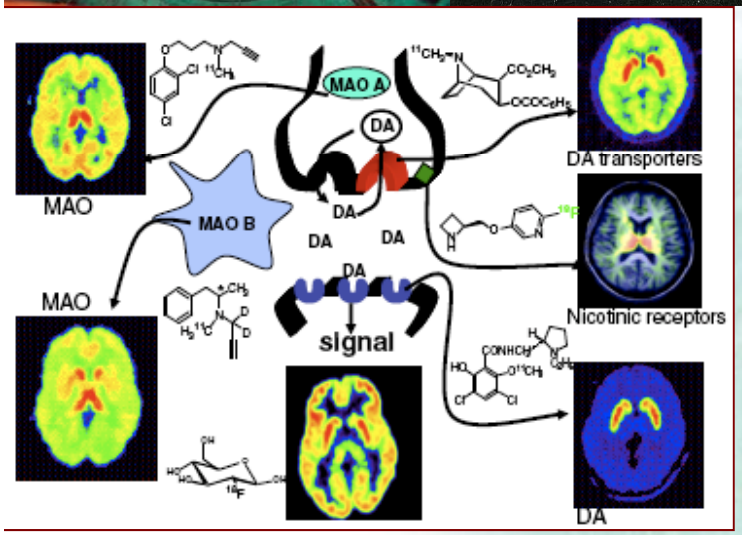


中子俘获治疗 Boron Neutron Capture Therapy (BNCT)



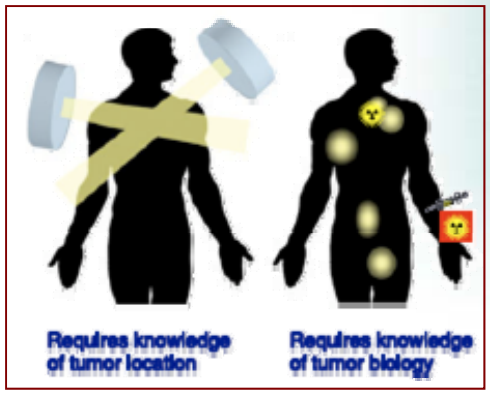
BNCT前　BNCT后一个月　BNCT后三个月

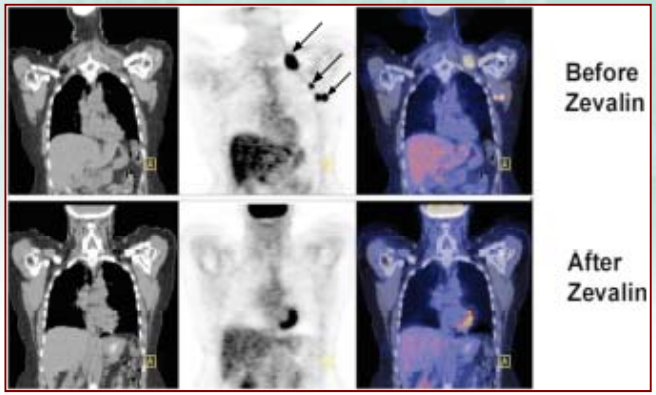
Challenges: How to Proceed?



由瑞典Leksell教授始创于1968年的**Gamma Knife®**利用**Co-60**放射源治疗瘤肿，成本US$6百万(M)，每年运作费$1.12M

中国上海GammaStar Medical Group, LTD 于1995出产的**Gyro Knife®**，也是用**Co-60**放射源。





食物辐照

用途	食品	辐射量 (kGy)
消除微生物和细菌	香料、淀粉、酶配制	3-10
巴氏消毒	肉、禽、贝、药草	2-7
延长贮藏期限	水果、蔬菜、鱼、肉	0.5-5
消灭寄生虫	肉、鱼、谷物、干果	0.2-3
抑制发芽	洋葱、蒜、马铃薯	0.03-0.14

Challenges: How to Proceed?

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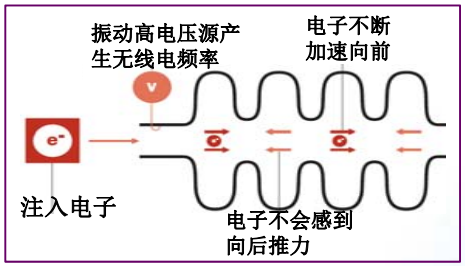
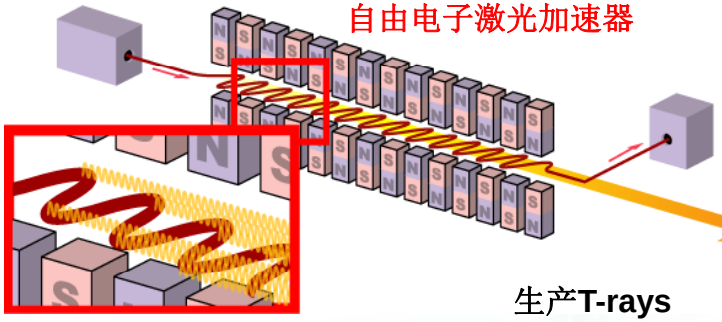
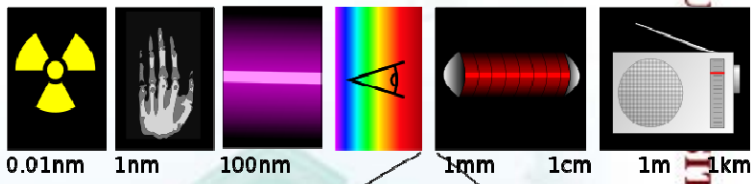
超导技术与工艺

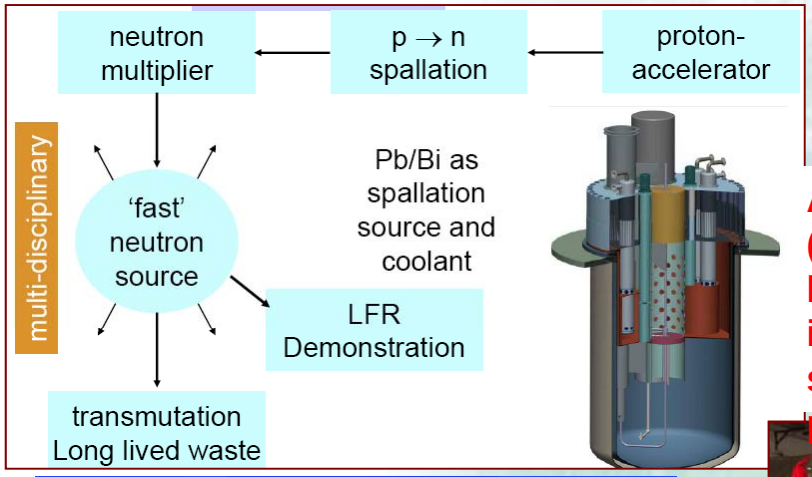


自由电子激光加速器

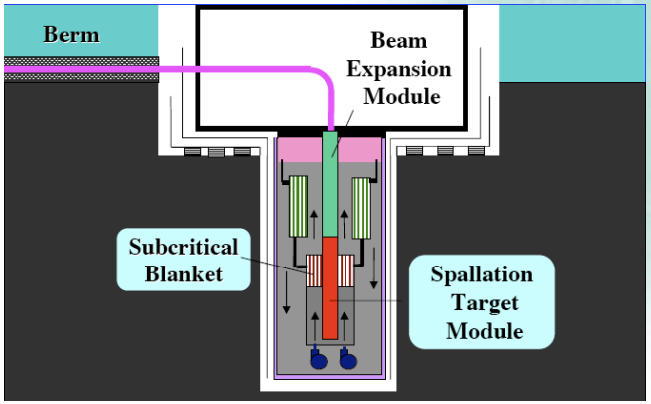


生产T-rays





Accelerator-Driven Systems (ADS) to transmute long-lived radioisotopes in used nuclear fuel into shorter-lived fission products

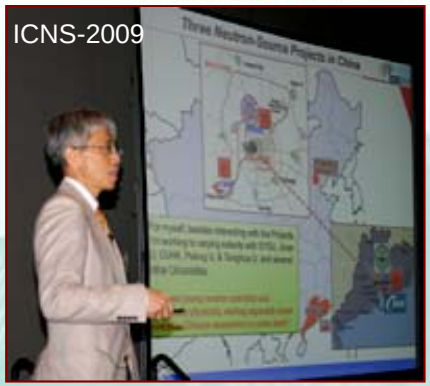


自由电子激光产生T-Rays (terahertz radiation)，可用于探测物体内部的三维结构。ThruVision®产品。

International Collaboration, e.g., UCANS

- 2007年11月 - Fukuoka, Japan：**出席日本中子散射学会第七届年会 ,并作邀请报告**
- 2008年8月 - 珠海：**核物理与中子科学及工程技术国际会议……**.*Neutron News* **20**(2), 7 (2009)
- 2008年10月 - 北京：**出席** Asia Science Seminar**并作邀请报告**
- 2009年2月 - 台灣宜蘭：**出席亞太中子散射協會第二屆行政会议**
- 2009年5月 - Knoxville, USA：**出席中子散射国际会议，就中国在先进中子源方面的发展作邀请报告……**.*J. Phys. Conf. Series*
- 2009年11月 - 香港：**协助广东及香港物理学会举办中子及核物理科学技术研讨会**
- 2010年8月 - 北京：**参加首届微型加速器推动中子源国际联盟会议……**.*Neutron News*

International Workshop on Education and Research for Nuclear and Neutron Science & Technology
Nov 6-7,2008,Sun Yat-Sen University, Zhuhai, China




AONSA 2nd Executive Meeting, Feb 2009

, Indian

The First Workshop of the Union for Compact Accelerator-driven Neutron Sources, UCANS-I, Aug 15-18, Beijing, China

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Scientific Networking & Education

- 2008年8月 - KAIST, Korea：**参加亞太中子散射協會第一屆中子暑期学校**
- 2008年2月 - 中山大学理工学院：**开办中子散射科学应用课程**
- 2009年7月 - 北京大学：**于全国晶体学及晶体工程应用材料暑期训练班讲授中子衍射课程**

中大本科生缪平2009年毕业后现留学日本KEK-JAPC专读中子散射

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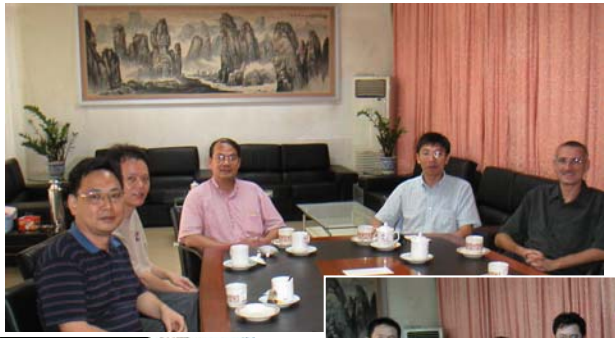
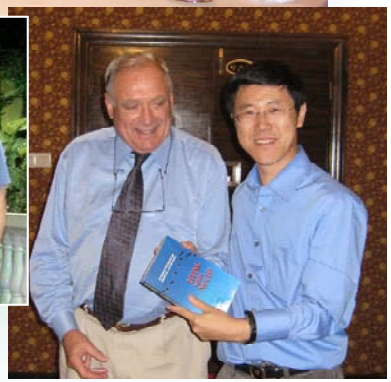
Exchange Activities

- 2008年3月 - Prof. M. Loewenhaupt, Technical University of Dresden, Germany
- 2008年4月 - Prof. F. Klose, ANSTO, Australia
- 2008年11月 - Dr. Jack Carpenter, ANL, USA
- 2008年11月 - Drs. L. Liu, RPI & Y. Liu, NIST, USA
- 2008年11月 - Prof. I. Guedes, U. Federal do Ceará, Fortaleza, Brazil
- 2009年12月 - 陶舉洲博士，中科院高能所
- 2010年7月 - Dr. Gerard C. L. Wong, UCLA, USA
- 2010年9月 - 李世亮博士，中科院物理所





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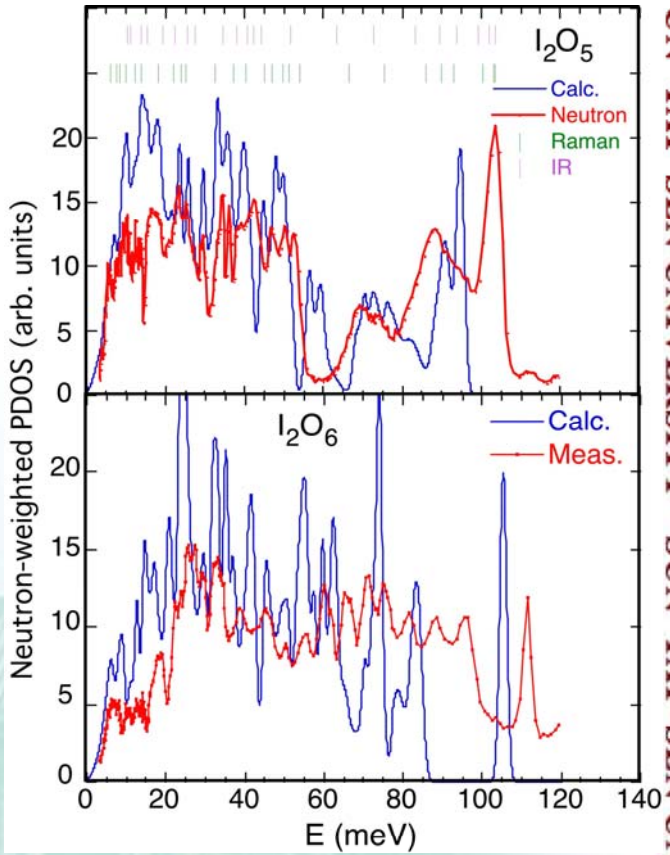
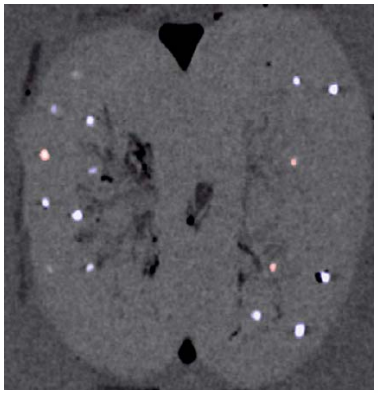
Ongoing Experiments with Strong International Collaboration

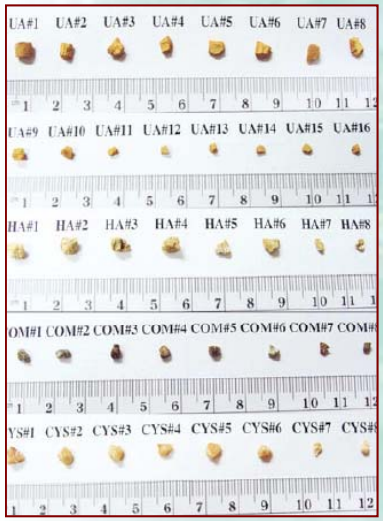
Collaborators: A. I. Kolesnikov et al. (SNS), P. Vashishta, et al., (USC)

- Neutron diffraction & inelastic scattering at SNS, ORNL: Crystal Structures, lattice dynamics, and thermodynamic properties of iodine oxides: A joint study of neutron, Raman, IR measurements and molecular-dynamics simulations
- Expt #IPTS-3104 at Spallation Neutron Source, Oak Ridge National Lab, USA: Lattice dynamics and bioactivity in kidney stone crystals.





Primak *et al.*



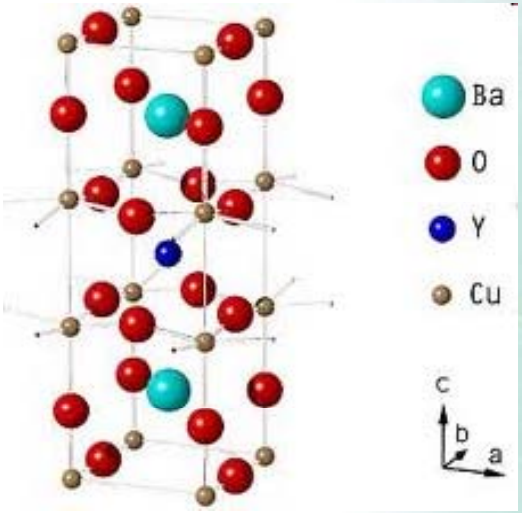
actual kidney stones from human patients, predominately crystalline calcium oxalate (CaOx) (70+%)

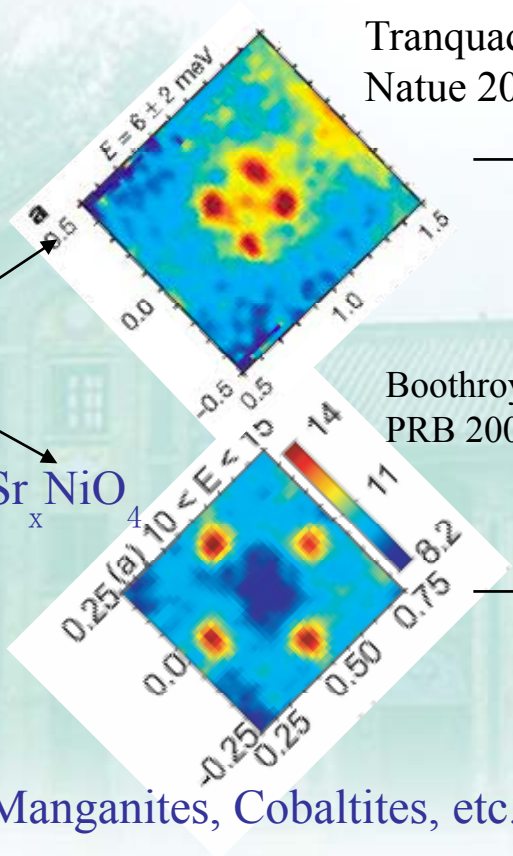
Kidney stones disease inflicts a substantial population globally, e.g., about 5% of adults in the United States (NHANES 1988-1994 statistics). An estimated 1 million cases of symptomatic kidney stone occur each year in the U.S., comprising about 1% of all hospital admissions. In 1993 it cost the US approximately $1.83B on direct and indirect treatment and evaluation of kidney stone disorder (NAMCS statistics).

Ongoing Experiments with Strong International Collaboration

Neutron studies of high-Tc & strong correlation systems
A new research group led by Prof. Daoxing YAO

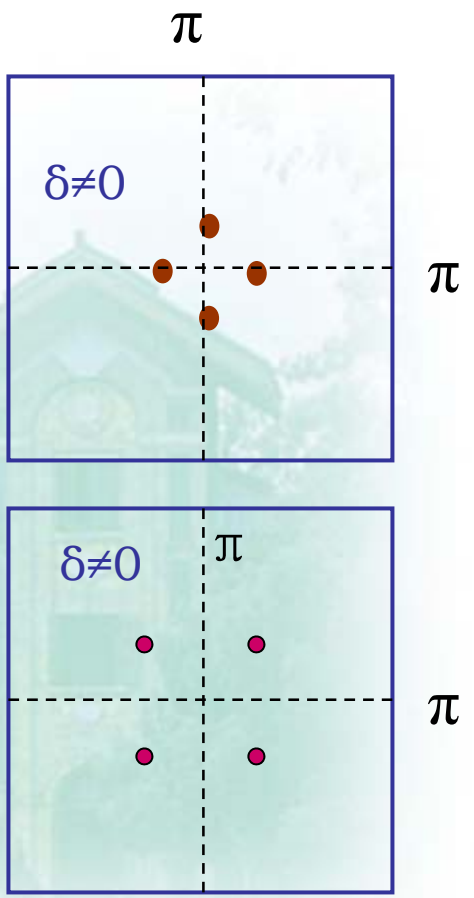
Hoping to expand to other disciplines….





Tranquada,et al.
Natue 2004

Boothroyd,et al.
PRB 2005



Manganites, Cobaltites, etc.

高温超导体
或者磁性晶体

中子散射

理论

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Thank You

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