微型脉冲强子源项目月报 (CPHS monthly)

强子应用及技术中心（HATC） 2010 年 3 月

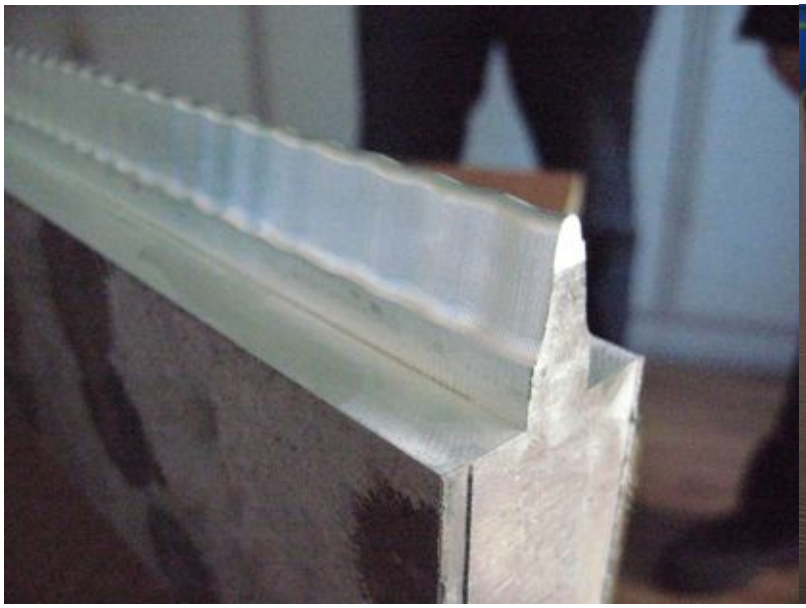
一、项目部总结(韦杰,关遐令,龙振强)

1.1 Monthly highlights

1. The June 2009 International Mini-Workshop at Tsinghua not only kicked off the CPHS Project but also fermented the notion of cooperation among compact-neutron-source enthusiasts at many places in the world. Our exchanges with Indiana (USA), Hokkaido and Kyoto (Japan), and KAERI (Korea) in the past months have reinforced such idea. Propitiously the ICANS-XIX in March 2010 at Grindelwald, Switzerland offered an opportune occasion to consolidate an alliance, and in a satellite meeting in Zurich on March 13 organized by HATC-Tsinghua, we celebrated the establishment of the **Union for Compact Accelerator-driven Neutron Sources (UCANS)**. The seven initial members—those in attendance—are: from the USA Indiana University, from Japan the High Energy Accelerator Research Organization (KEK), Hokkaido University, Kyoto University and RIKEN, from China Beijing University and Tsinghua University, with additional potential members from Argentina, Korea, Germany and elsewhere. Jack Carpenter of Argonne National Laboratory will serve as a spokesman of UCANS. In view of the actively ongoing works on accelerators, target-moderators, instruments and optics, all members felt a genuine need for frequent meetings. Certainly, UCANS is not exclusive of but actually complementary to ICANS. The first meeting is scheduled to be held at Tsinghua, Beijing in August 2010.

在清华大学强子应用及技术中心的倡议下，国际微型加速器驱动中子源联盟（UCANS）成立。目前起始成员包括美国印第安那大学、日本高能加速器研究机构 KEK、日本北海道大学、日本京都大学、日本理化学研究所、北京大学及清华大学七所院校，协调人为美国 Argonne 国家实验室的 J. Carpenter 和清华大学龙振强教授。上图为各成员组织代表在瑞士苏黎世聚会时的合影。首届 UCANS 会议将于今年 8 月在北京清华大学举行。

2. After the finalization of the physical design of the radio-frequency quadrupole linac (RFQ) last month, an aluminum prototype of the vane tip has been fabricated at the Kelin Co. Lmt. in Shanghai to verify the precision in machinery. A copper prototype of the vane tip will be fabricated next. The CPHS accelerator team, our expert consultants from Los Alamos, and engineers of Kelin have worked closely to realize the new design concepts.



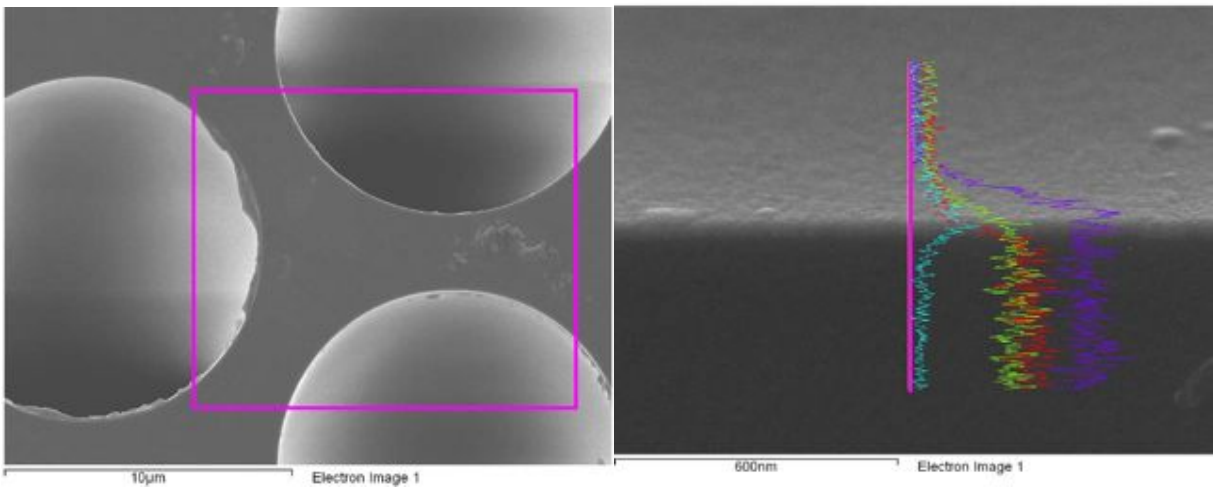
在上个月清华大学 CPHS 加速器团队和美国原洛斯阿莫斯国家实验室（Los Alamos）专家们完成了射频四极直线加速器 RFQ 的物理设计后，上海克林公司加工出 RFQ 主极头的铝模样机以验证机械加工精度（见上图）。接下来将加工铜制极头样机，CPHS 加速器团队、前洛斯阿莫斯专家及上海克林的技术人员正密切合作以实现新的设计理念。

3. A bandwidth-limiting neutron chopper is under development at the Department of Engineering Physics of the Tsinghua University. The chopper disk, the motor, and the controller are shown below. Tests are underway to evaluate the adhesion and integrity of the boron-carbide and resin composite on the aluminum-alloy body under various operating conditions.

Parameters	Data	Notes
Rotating speed	50Hz/25Hz	"
Control rate of speed	4Hz/min	"
Phase control accuracy	± 10μs	"
Disk radius R	300mm	"
Cut out of the disk θ	~90°	"
Thickness of the disk	4mm	At the edge
Neutron absorber	B_4C or other choices,	~ 1mm on each side of the disk
Window for neutron beam	80 x 80 mm	
Shell thickness of window	0.4 mm	Al alloy
Dynamic balancing	National standard (rigid rotor)	"
Environment temperature	15-50°C	"
Chamber vacuum	< 10 Pa	"
Electric power	220V/380V 50Hz	"

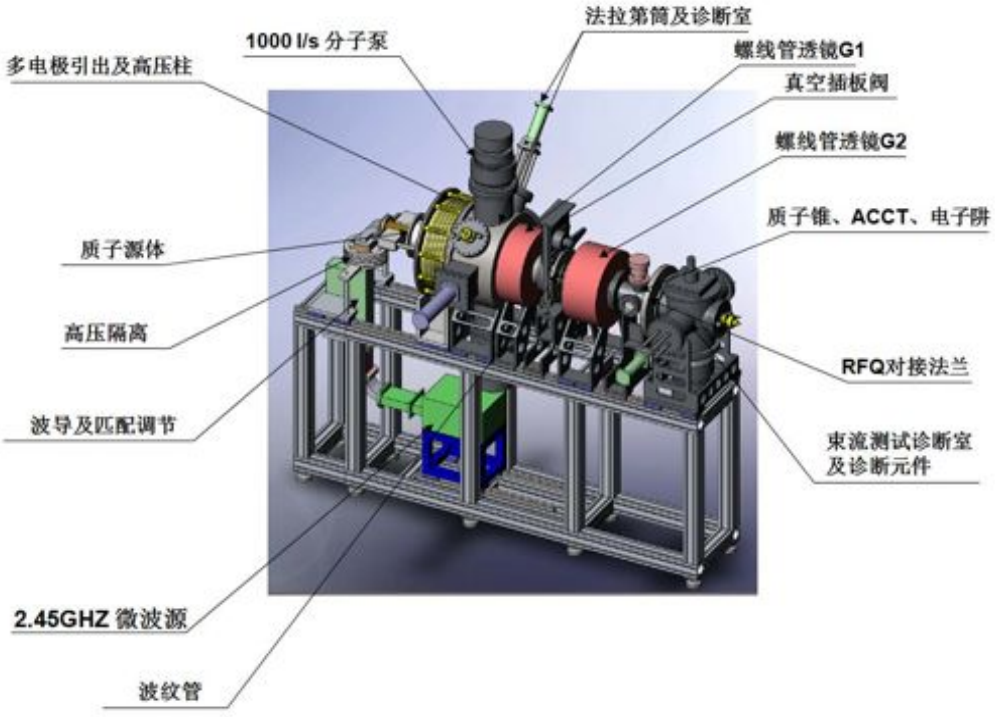
清华大学工程物理系技术物理所张小章教授带领的小组正在进行 CPHS 所需的带宽中子斩波器研制。如上图所示，已制作出斩波器转盘、精密电机和控制器。对碳化硼树脂合成物的强度测试及合成物在铝合金转盘上的粘合牢固度测试正在进行中。中子斩波器对于产生脉冲冷中子至关重要，亦为 CPHS 长束团装置的特色之一。

4. Progress has been made on the development of incorporating a neutron-electron converter in the micro-channel-plates (MCP) to be used as a key component of a novel neutron detector. Microscopic analysis with backscattered-electron scan indicated successful coating of $^{nat}Gd_2O_3$. Further development of ^{10}B coated MCP is planned.



清华大学工程物理系核技术研究所杨祎罡副教授带领的小组完成了中子探测转换器微通道板（MCP）的镀膜研制。背散射电子扫描的显微分析结果表明，在 MCP 微孔镀材料 Gd_2O_3 膜是成功的，接下来将用 ^{10}B 进行镀膜研制。这一系列研究对于寻找可能替代氦-3 管的中子探测器的国际协作有十分重要的意义。

5. After several iterations and optimization, the design of the ion source and low-energy-beam-transport for CPHS is finalized. Z. Feng is stationed at the Institute of Modern Physics, CAS at Lanzhou to learn and to work on the ion source system. The first beam to be delivered by the ion source at Tsinghua University is expected to be around the summer of year 2011.



经过多次的优化和计算，离子源和低能束流输运段的最终设计方案确定，研制全面开始。博士生冯哲常驻在兰州中国科学院近代物理研究所从事离子源系统的学习和工作。预计于 2011 年夏季，CPHS 离子源将在清华大学安装调试完毕并引出质子束流。

6. As a new member of the International Collaboration of Advanced Neutron Source (ICANS), the Department of Engineering Physics of Tsinghua University sent 10 faculty members and students to the 19th meeting of the ICANS at Grindelwald, Switzerland. Three invited talks and four posters were presented concerning the CPHS project, the target station, the small-angle neutron scattering instrument, the neutron imaging and radiography station, radiation shielding and protection, and neutron detector R&D. Six papers were accepted for publication in the ICANS Proceedings.

作为国际先进中子源组织（ICANS）的新成员单位，清华大学工程物理系 10 名教师及博士生参加了在瑞士格林德尔瓦尔德召开的第十九届 ICANS 会议。本届会议清华大学共有 3 篇口头报告和 4 篇张贴文章，内容涵盖 CPHS 项目概述、靶站、小角散射谱仪、中子成像及辐照、辐射屏蔽防护和中子探测器研究等，6 篇文章被收录随后出版。ICANS 会议于 1977 年发起，目前每 2 至 3 年召开一次，上次于 2007 年在我国广东省东莞市召开。本次 ICANS 会议有约 200 人参加，主要来自 ICANS 的 14 个成员单位。

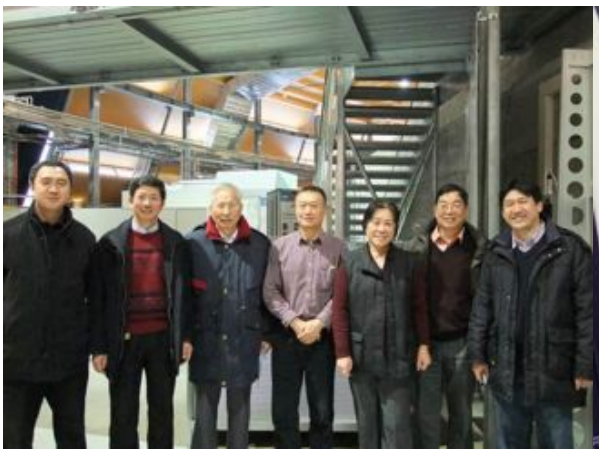
7. J. Wei was invited to participate in a Neutron Facility Directors' Meeting at the Institut Laue-Langevin in Grenoble, France. Directors of major neutron facilities in Europe, the US, Australia, Japan, and China met and discussed possible solutions to the global shortage of heliem-3 gas that is needed for neutron detectors, common software platforms for data reduction, and data policy. To address the Helium-3 supply crisis, the detector working groups were established to globally coordinate the studies of alternative techniques to helium 3-based detectors for neutron scattering applications. Tsinghua University officially joined the detector working group that focuses on the development of doped/coated micro-channel-plate neutron convertor-based and BF3-gas detectors.

韦杰应邀参加在法国格勒诺布尔 ILL 研究所召开的国际中子源主任会议。全球由于反恐形势严峻，需要大量氦-3 用于探测，从而使得可用于中子散射装置的氦-3 气体严重缺乏。这次，来自欧洲、美国、澳大利亚、日本和中国的中子源负责人首次在一起讨论全球合作，寻求解决替代氦-3 的新的探测中子的方法。清华大学正式加入了替代氦-3 探测器技术的研究工作组，重点研究掺杂/镀膜微通道板中子转换器以及氦-3 和三氟化硼填充气体探测器。

8. The 2nd Review of the CPHS Project by the International Advisory Committee was held in Zurich, Switzerland. Members of the review committee include D. V. Baxter (Indiana University, USA), J. M. Carpenter (Argonne National Laboratory, USA), K. Hirota (RIKEN, Japan), Y. Iwashita (Kyoto University, Japan), Y. Kiyanagi (Hokkaido University, Japan), H. M. Shimizu (KEK, Japan), and P. Sokol (Indiana University, USA). The Committee heard and commented on the overview update of the Project since the last review and progress and/or problems in the design of the target-moderator-reflector system, the SANS & imaging/radiography beamlines and radiation shielding. The committee's report is attached in the appendix of this month's report.


借众多国际专家在瑞士参加 ICANS 会议的机会，我们在瑞士苏黎世进行了清华大学微型脉冲强子源（CPHS）第二届国际顾问委员会评审。委员会成员包括美国印第安纳大学的 D. V. Baxter 和 P. Sokol ，美国阿贡国家实验室的 J. M. Carpenter ，日本理化学研究所的 K. Hirota ，日本京都大学的 Y. Iwashita，北海道大学的 Y. Kiyanagi ，日本高能加速器研究机构 KEK 的 H. M. Shimizu。这次评审中，评委们用一整天的周末时间听取项目组的报告，对目前靶站、谱仪系统的进展作了中肯的评价和建议，对项目的顺利进行意义重大，委员会的评审报告见月报附录。第一届 CPHS 国际顾问委员会曾于 2009 年 6 月在北京清华大学举行，审订了 CPHS 装置的基本参数及技术路线。下一届评审预计将于今年 8 月在北京举行。

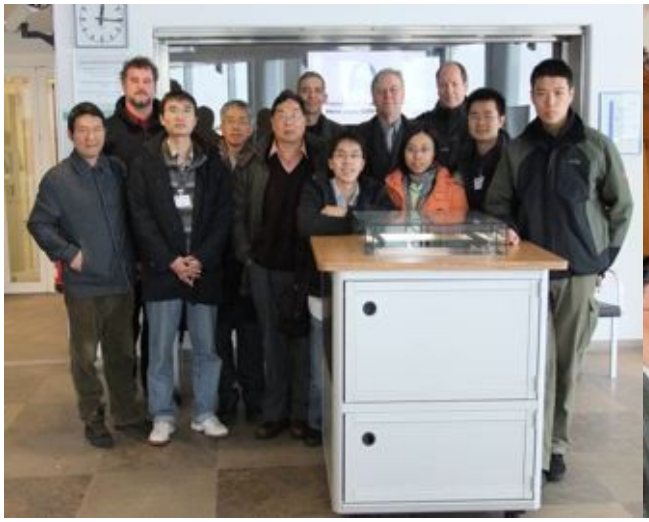
9. The CPHS delegation visited the SINQ spallation neutron facility at the Paul Scherrer Institut (PSI), Switzerland. PSI hosts world's most powerful steady-state spallation neutron source, state-of-the-art 3-D scanning proton therapy facility, and a 3rd generation synchrotron radiation light source. The neutron imaging & radiography facility was of particular interest to the CPHS team.




清华大学 CPHS 代表团参观访问了瑞士 PSI 研究所的 SINQ 散裂中子源设施，同时参观的还有来自中国原子能科学研究院的成员。瑞士 PSI 装置为目前世界上束流功率最高的稳态散裂中子源，由回旋加速器加速质子至 590 MeV 打靶，其质子束流功率达到 1.2 MW。SINQ 装置上发展的中子成像技术一流。同时，PSI 研究所正在进行基于回旋加速器成功进行质子医疗，其三维适型点扫描技术在世界上处于领先水平。该研究所还拥有一座第三代同步辐射光源，即瑞士光源（SLS）。

10. The CPHS delegation visited the FRM-II neutron facility of the Technical University of Munich (TUM), Germany. TUM has a prestigious tradition of developing innovative research reactor technology, neutron-scattering instrumentation, optics, and basic & applied neutron applications. The FRM-II is one of the premier steady-state reactor sources serving neutron users in Europe and elsewhere. During the two day's visit, the CPHS delegation was warmly received by the host. Further collaboration is under

discussion in accordance with an existing memorandum-of-understanding between the Technical University of Munich and Tsinghua University.




CPHS 代表团参观访问德国慕尼黑工业大学 FRM-Ⅱ中子设施。FRM-II 是一座基于热功率为 20 MW 的研究反应堆的中子源，其通过有效慢化实现的冷中子源及超冷中子源尤具特色。在两天的访问中，CPHS 成员受到了热情接待，有机会同中子源及中子散射实验专家详细讨论、学习。在慕尼黑工业大学和清华大学的合作备忘录的框架下，后续合作正在探讨中。

11. P. Pearce of CERN visited Tsinghua University and had extensive discussions with the CPHS accelerator team on the design of the CPHS linac RF system

    欧洲核子研究组织（CERN）的 P. Pearce 访问清华大学，与 CPHS 加速器团队就 CPHS 直线射频系统的设计进行了探讨、建议。

12. N. Catalan-Lasheras and Y. Papaphilippou of CERN visited the Department of Engineering Physics of the Tsinghua University. N. Catalan-Lasheras gave a seminar titled “LHC Commissioning Status”. Y. Papaphilippou gave a seminar titled “CLIC Damping Ring and CERN PS2 Designs”.


欧洲核子研究组织（CERN）的 N. Catalan-Lasheras 和 Y. Papaphilippou 访问清华大学工程物理系。N. Catalan-Lasheras 做了题为《LHC Commissioning Status》的报告，介绍大强子对撞机 LHC 近期的进展及遇到的问题和困难。Y. Papaphilippou 的报告题为《CLIC Damping Ring and CERN PS2 Designs》，主要介绍 CERN 的远期发展项目。

13. J. Wei participated in the 2010 accelerator technical advisory committee (A-TAC) review of the J-PARC

project at Tokai, Japan. A-TAC reviews of the construction phase were held annually from 2001 to 2009. The 2010 review is the first one to cover the operation phase of the J-PARC project.

韦杰参加了 2010 年日本质子加速器研究实施（J-PARC）加速器技术顾问委员会（A-TAC）的评审。自 2001 年-2009 年，该项目每年举行一次施工阶段的评审，2010 的是 J-PARC 工程运行阶段的第一次评审。

14. X. L. Guan participated in science and technology committee meeting of the Cooler Storage Ring at IMP, CAS at Lanzhou.

关遐令赴兰州参加了中国科学院近代物理研究所冷却储存环学术委员会会议，主要讨论近物所今后的发展及大科学工程规划。

15. J. Wei was awarded the First ACFA/IPAC (Asian Committee for Future Accelerators / International Particle Accelerator Conference) prize, for the recognition of an individual (with no age limit) having made significant, original contributions to the accelerator field. The prize cites the recipient's accomplishments "for his exceptionally creative contributions to the design, construction and commissioning of circular accelerators, in particular RHIC [Relativistic Heavy Ion Collider], SNS [Spallation Neutron Source], LHC [Large Hadron Collider] and CSNS [China Spallation Neutron Source], and for numerous significant developments in the field of beam dynamics".

韦杰获首届 ACFA/IPAC（亚洲未来加速器委员会/国际粒子加速器大会）个人奖。获奖评语是"表彰他在环形加速器的设计、施工和运行方面极富创造性的贡献，尤其是在相对论重离子对撞机（RHIC）、美国散裂中子源（SNS）、欧洲大型强子对撞机（LHC）及中国散裂中子源（CSNS）的贡献，以及他在束流动力学领域的诸多重大的发展"。

二、项目进展

2.1 加速器(关遐令)

2.1.1 离子源(冯哲)

离子源及LEBT各个原件的加工和订购已经开始，部分原件的订购已经完成，相关的调试和诊断实验也正在进行，具体明细如下表：

1. 近物所负责设备

系统名称	目前状况
离子源	结构及性能试验中
微波系统	DC-break-80kV，已到货
馈入窗体	试验中
磁体及引出系统	试验中
束流传输元件	
GLASER（含电源）	设计完，加工准备中
双向校正磁铁（含电源）	设计完，加工准备中
束诊元件	
Alison 发射度测量仪	设计完，待加工
荧光靶	设计完，待加工
法拉第筒	设计完，待加工
ACCT	结构已确定，订货联系中
其他	
LEBT 诊断室,管道	加工联系中
LEBT 波纹管	待定货