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Current status and future development of neutron science facilities at China Advanced Research Reactor(CARR)

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ABSTRACT

A 60 MW tank-in–pool inverse neutron trap type research reactor CARR has been built at China Institute of Atomic Energy in China. The maximum unperturbed thermal neutron flux is expected to be $8x10^{14}n/cm^2/s$ in the reflector. A 30 × 60 m^2 guide hall has also been constructed and a 20K liquid hydrogen cold source is being built. Nine tangent horizontal beam tubes will be used for neutron science experiments. Seven instruments in the reactor hall and three in the guide hall, will be built at the Phase I, and six of them are expected to go commissioning in 2010.

1. The China Advanced Research Reactor

CARR has been constructed in China Institute of Atomic Energy, located in the southwestern area of Beijing, about 37 kilometers away from the central of Beijing. It is a 60 MW tank-in-pool inverse neutron trap type reactor using D_2O reflector, expected to yield an maximum undisturbed thermal flux of 8×10^{14} $n/cm^2/s$. CARR is a multipurpose research reactor, its main applications include neutron scattering, isotope production, silicon dopping, neutron activation analysis, fuel element test, fundamental nuclear physics and so on. It has 9 horizontal beam tubes and 25 vertical channels. Now CARR is ready to go critical, which is expected to be the first half of 2010.

2. Neutron Scattering Project at CARR

1.1. Phase I of instrumentation

Neutron Scattering Laboratory is responsible for neutron scattering and radiography research programs, with 7 of 9 horizontal beam tubes of CARR. 2 single and 4 dual beam lines are for neutron science instruments, and 1 beam line is for the cold neutron source. Cold neutrons could be tranfered to the neutron guide hall (30×60 m^2) via 4 neutron guides [1], and the cross sections are 30mm×150 mm and 50mm×200 mm respectively. At the initial stage, 10 instruments are being constructed at the phase I, and the others are also expected to come after approval from government. The schematic layout is shown in Fig. 1.

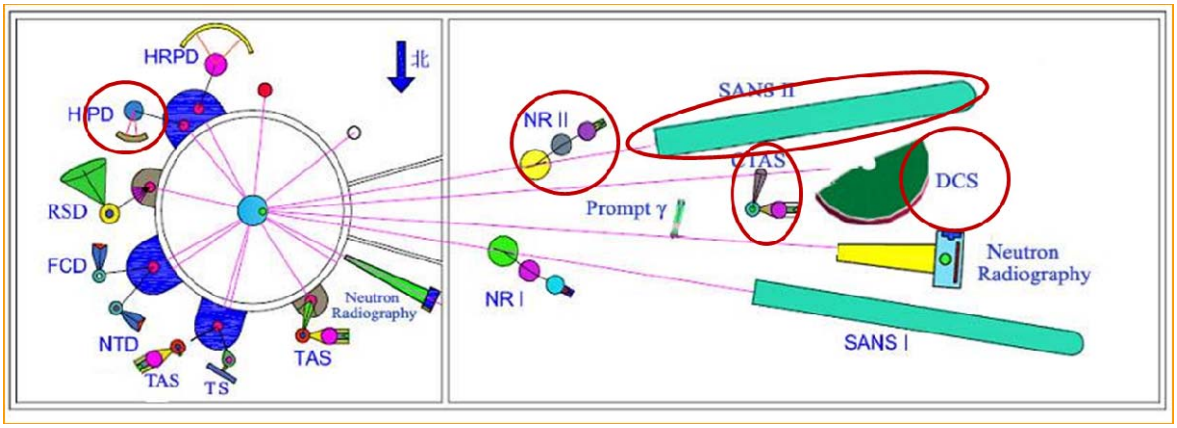

Fig. 1 The schematic layout of the neutron science instruments at CARR

As shown in Fig. 1 the first ten instruments are high resolution powder diffractometer (HRPD), residual stress diffractometer (RSD), four circle diffractometer(FCD), neutron texture diffractometer(NTD), triple axis spectrometer (IOP-CIAE TAS) cooperated with Institute of Physics, triple axis spectrometer (TAS-FJZ) cooperated with Juelich center for neutron science Germany, thermal and cold radiography, neutron reflectometer (NR1) and small angle neutron scattering diffractometer (SANS-ICCAS) cooperated with Institute of Chemestry(ICCAS).

HRPD is totally designed and fabricated in China, whose designed □d/d resolution is 2×10^{-3}, the monochromator is a vertical focusing Ge(115), which produces the 1.886 Å incident wavelength. 64 ^{3}He pencile type detectors are used and the coverage angle is from 5°to 170°. The main components, such as the monochromator shielding, sample table, detector arm and detectors are ready, it is expected to be completed in August of 2010.

Most of RSD's main components were built in China except of the sample table and test rig, which were relocated from Studsvik reactor in Sweden, the monochromator is Si (311) and its take off angel can be changed continuously from 40° to 110°. This instrument has also been strongly supported by IAEA and German partners , and is expected to be finished in August of 2010.

CIAE had signed an agreement with Juelich cooperating on relocating three instruments, a TAS, a FCD and a NTD, to CARR. Non-actived parts of these three instruments had arrived at CIAE two years ago. Although the transferring of the lightly actived parts is a little bit behind of schedule, they were put on the ship in March 2010 and expected to arrive at CIAE in May. The dancing floor of TAS has been built and motion control system has been successfully verified in 2009. Their commissioning will start around July 2010.

Cooperating with Pengcheng Dai's group in Institute of Physics (IOP) , Chinese Academy of Sciences(CAS), a new TAS with continuously changeable incident energy is initiated and funding is also confirmed. The instrument conceptual design is almost done and supported by FRM II. The fabrication of components will start in 2010.

In 2009, a thermal and a cold imaging facilities were decided to be funded. The physical designs were almost done. A CIAE scientific delegation visited to FRM II last year, and the cooperation between two institutes were also discussed.

At the end of 2009 three neutron guides were installed, which were provided by the Mirrortron in Hungary. And a reflectometer (RF-ICCAS)and a small angle neutron scattering instrument (SANS -ICCAS) were constructed simultanously, which are led by Prof. Han, a chief scienstist in Institute of Chemistry, Chinese Academy of Sciences, supported by Ministry of Science and Technology (MOST) and CAS.

1.2. Phase II of instrumentation

At the beginning of 2010, a Phase II instrumentation plan has been proposed. Five instruments (a reflectometer, a small angle neutron scattering instrument, a cold triple axis spectrometer, a disc chopper spectrometer and a high intensity powder diffractometer) with sample environments and infrastructure are planned.

3. Summary

As one of the major applications of CARR, ten neutron instruments are being designed and constructed in the Phase I based on national and international cooperation. CARR is expected to go critical in the first half of 2010. As a potential user facility, researchers coming from China and abroad are all welcome after the commissioning. Further comments, suggestions and cooperations are also very welcome.

5. References

1. D.F. Chen, Y.T. Liu, C. Gou, C.T. Ye, Development of neutron scattering on 60 MW research reactor in CIAE, Physic B 385-386 (2006) 966-967.