NEUTRON BEAM FACILITIES AT RTP

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Abstract. Reaktor TRIGA PUSPATI (RTP) is a 1MW research reactor located in Malaysian Nuclear Agency, Bangi, Selangor, Malaysia. RTP was commissioned in June 1982. In 1985, Neutron Radiography (NR) facility was commissioned at beamport#3 of RTP. This facility was refurbished in 2017 with new collimator and shielding bunker. Small Angle Neutron Scattering (SANS) facility was installed in 1995 and experienced upgrading through in-house design systems throughout the years. New facilities such as Neutron Diffraction (ND), Boron Neutron Capture (BNC) research and Prompt Gamma Neutron Activation Analysis (PGNAA) facility are now under development at RTP. This paper discusses the characteristics of these neutron beam facilities which were used in their designs.

Objective: To increase the research and development (R&D) works using neutron beam from Reaktor TRIGA PUSPATI (RTP).

Background. Neutron beam from RTP has the potential to be used in research works. Each of the neutron beam facilities in Reaktor TRIGA PUSPATI (RTP) was developed using the neutron spectra available. With four beamports and one thermal column, the quality these neutron beams were design with followings:

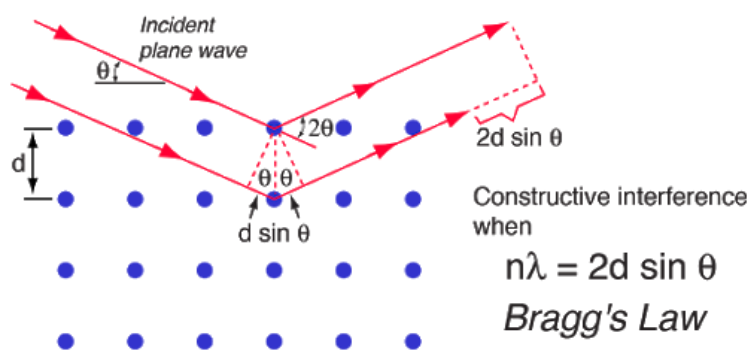
(i) Collimator with gamma and fast neutron filters used
(ii) Neutron energy exiting the beamport
(iii)Shielding design for the neutron beam instrument

The design of item (i) to (iii) were selected to give each of the beamport the quality needed for its targeted purpose such as:

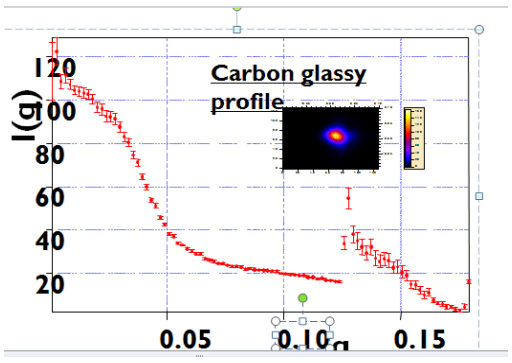
- Neutron Radiography (NR),
- Small Angle Neutron Scattering (SANS), Neutron Diffraction (ND),
- Boron Neutron Capture (BNC) research and
- Prompt Gamma Neutron Activation Analysis (PGNAA)
- in the schematic diagram below.

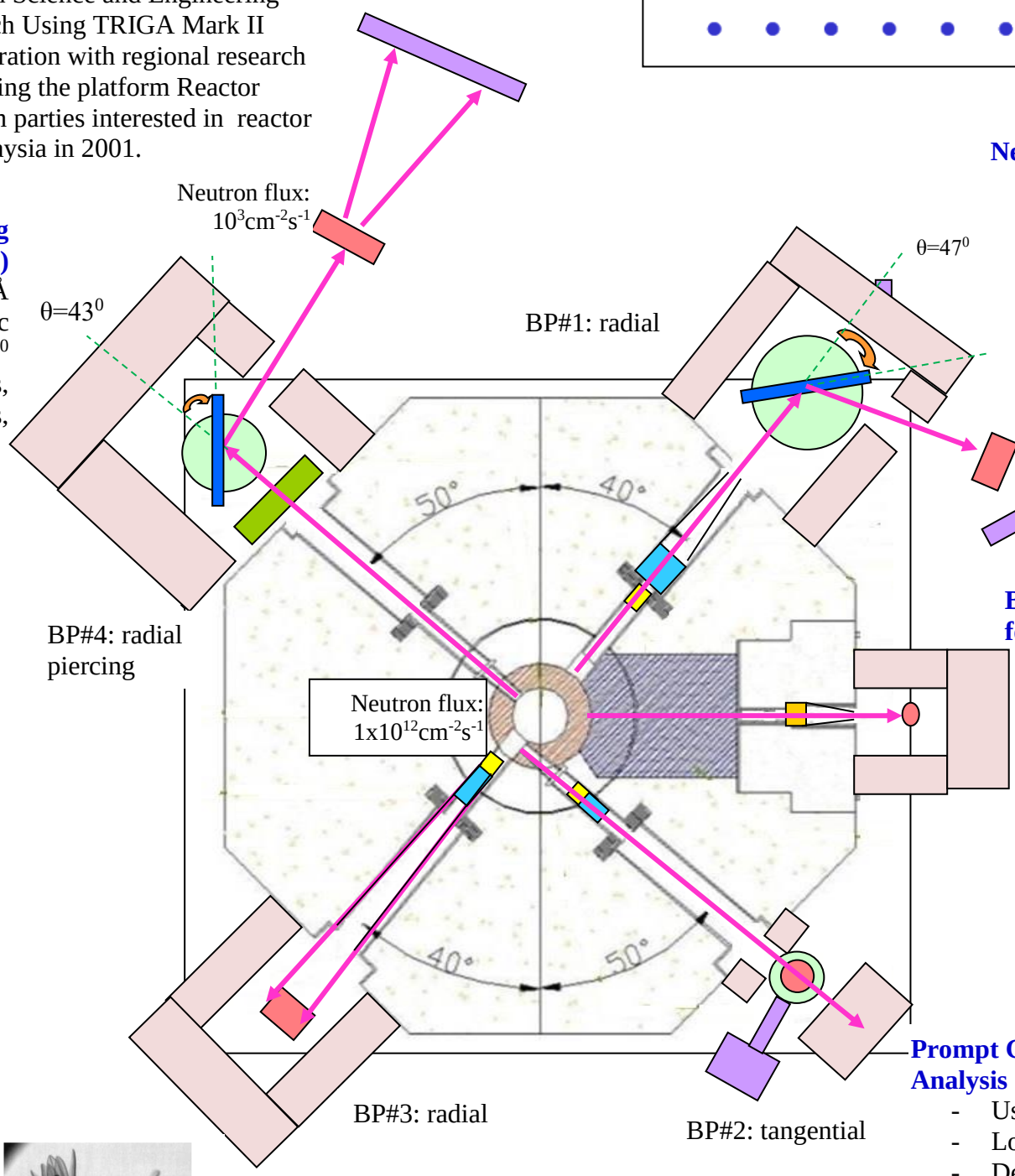
The designs were developed and fabricated as a results of IAEA TC MAL 1012 (Capacity Building in Basic Neutron Science and Engineering for Education, Training and Research Using TRIGA Mark II Research Reactor), research collaboration with regional research institutions and local universities using the platform Reactor Interest Group (RIG), a loosely form parties interested in reactor utilization initiated by Nuklear Malaysia in 2001.

How neutron scattering works:
Bragg's Law that calculates the neutron scattering angle off a lattice:

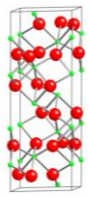


Small Angle Neutron Scattering (SANS)
Wavelength: ≥4.5 Å
flux: 10^3 n/cm^2/sec
Take-off angle θ=43^0
Type of samples: colloid, porous, hydrogeneous,



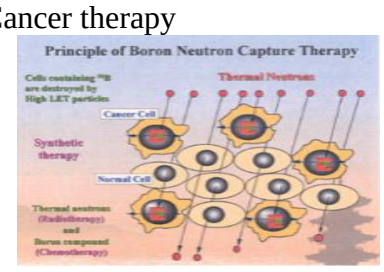


Neutron Diffraction
- Si(220) monocromator
- Take-off angle θ=47^0
- Energy max: 1.7MeV
- Suitable for powder diffractometer



Al_2O_3

Boron Neutron Capture (BNC) for Research)
- Thermal and epitermal neutron flux
- Cancer therapy



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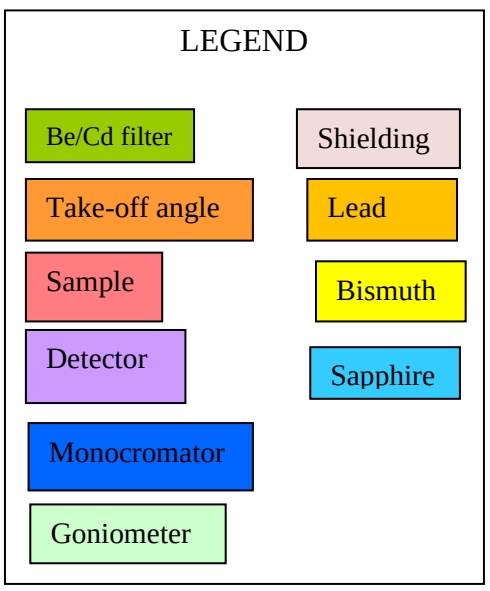
LEGEND



Neutron Radiography (NR)
- Low background gamma
- Thermal neutrons flux: 10e4 cm^{-2}s^{-1} at sample position
- Online digital imaging with CCD neutron camera
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Prompt Gamma Neutron Activation Analysis (PGNAA)
- Uses prompt gamma for
- Low direct gamma
- Determine light trace elements e.g. Cl, Fe, Si, S, Al, H, C, B, O, N, Ca, Cd, Gd, in cement, shale oil, antique, pyrolutic materials, water quality