SANS BATAN: Improvement the Neutron Intensity by Focusing Optics

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Research Reactors in Indonesia

- 30 MW (1987)
- 250 kW (1965); 1 MW (1971); 2 MW (2000)
- 100 kW (1971)
The Reactor – G.A. Siwabessy (RSG – GAS)

Descriptive parameters of RSG – GAS

Power: 30MW (Thermal)
Neutron Flux at core: $2.5 \times 10^{14}$ cm$^{-2}$ s$^{-1}$

Core
Active core volume (dm$^3$): 180
Active core height (cm): 60
Loading (Kg $^{235}$U): 8.675
Number of fuel elements: 40
Number of control elements: 8
Fuel type: $^{235}$U enriched: 19.75%
$^{235}$U density (g cm$^{-3}$): 2.96
Moderator / coolant: H$_2$O

Neutron Beam ports: 6 (2 Tangential & 4 Radial)
Neutron beam instruments

(DN1-M) RSM: Diffractometer for Residual Stress Measurement
(DN2) FCD/TD: Four Circle Diffractometer/Texture Diffractometer
(SN1) TAS: Triple Axis Spectrometer
(RN1) NRF: Neutron Radiography Facility
(DN3) HRPD: High Resolution Powder Diffractometer
(SN2) SMARTer: Small-Angle Neutron Scattering Spectrometer
(SN3) HRSANS: High-Resolution Small-Angle Neutron Scattering Spectrometer

Coating
Ni-58

Cross section
33 x 90 mm²

Radius of curvature
3926 m (NG1)
6979 m (NG2)

Total length
49 m (NG1)
77.5 (NG2)
BATAN’s Neutron Scattering Facilities

Diffractometers
SANS
HRSANS
Neutron Radiography

Triple Axis Spect.
The time-line of 36 m SANS BATAN

The first 5-year (1992 – 1997)

1992 : Commissioned
1992 – 1996 : Testing, setting up & calibration > wavelength, resolution
1997 : IAEA Workshop > Porasil sample
        Dr. P.S. Goyal (BARC) & Dr. A. Wiendenmann (HMI)
Country Report

The time-line of 36 m SANS BATAN

The second 5-year (1998 – 2004)

1998 – 2003 : Calibration > AgBE, Porasil, Polymers
               Setting up > pinhole, collimator, etc.

2003 – 2004 : Off > main computer problem & TDC for data acquisition
The time-line of 36 m SANS BATAN

The third 5-years (SMARTer)

2005 – recent: Optimizing, alignment, calibration > AgBE, porasil, polymers, polystyrene nanoparticles, magnetic & biological samples, etc.
A new controlling & acquisition system
A new instrumental setting
Data reduction & data analysis software
Reporting & collaborations

It is an implementation of a **5-year in-house work**.

2008 – 2009: TDC (RISØ) module damaged

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Country Report

The time-line of 36 m SANS BATAN
How the 36 m SANS BATAN has improved

(BATAN)

(End 2006)

Porous silica

Porous CPG-10-75
Data was taken using SMARTer
11 December 2006
How the 36 m SANS BATAN has improved

2001

2006

SANS-U
Background

Dr. Kohlbrecher’s (IAEA Expert Mission – December 2006) recommendations:

- Modify the beam stopper & rubber cover.
- Test a new monitor detector & pre-amp.
- Build a new system for preset count exp. (hardware & software)!
- Make a new sample aperture.
- Modify the live on data acquisition program.
- Modify the data reduction program.
- Make a new system for 6 sample changers with temp. control (software).
- Build a new sample exchanger.
- Do some experiments to optimize the SMARTer!
- Flux measurements!
- Local, regional & international network (CRP, TC, etc)
Background

Monodisperse polystyrene nanoparticle

2nd IAEA RC Meeting, Kuala Lumpur, July 2 – 4, 2009

Edy Giri Rachman Putra (2009)
Background

The resolution increase:
- Increasing $L_1$ and $\lambda$

SANS needs cold neutron!

Old data
- $L_1 = 8$ m; $L_2 = 13$ m
- $L_1 = 13$ m; $L_2 = 13$ m

A new beam stop system
- $L_1 = 18$ m; $L_2 = 18$ m
Objectives

CRP project:

- To stimulate and to initiate more further the improvement and development of 36 m SANS BATAN

- To explore the possibility of applying the focusing devices on the collimation system of 36 m SANS BATAN

- To establish SANS experiments in materials science & biology research in the wide-scattering-vector-range using 36 m SANS BATAN

(Self-assembly mechanism)

(Improved production and utilization of short pulsed, cold neutrons at low-medium energy spallation neutron sources; CRP Project)
The work plan as proposed

- Mapping the neutron flux by gold foil method (NAA) or others in various instrument settings.

- Implementing and testing the detector monitor, pre-Amplifier and its electronics system.

- Doing some measurements on the standard samples for absolute scale measurements.

- Explore the possibility of implementing a cold source.

- Simulation using a Monte Carlo calculation program to design a new collimator by applying a focusing device
  - Perhaps a compound or magnetic focusing lens should be considered for accessing lower q.
  - Work to expand the local user base for the instrument.
Neutron flux measurement

Maximum flux at sample position at reactor power of **15 MW**
Lambda (\(\lambda\)) = 3.2 Å : Neutron flux (\(\phi\)) = \(7.4 \times 10^6\) n cm\(^{-2}\) s\(^{-1}\)
Lambda (\(\lambda\)) = 3.9 Å : Neutron flux (\(\phi\)) = \(5.2 \times 10^6\) n cm\(^{-2}\) s\(^{-1}\)
Lambda (\(\lambda\)) = 5.7 Å : Neutron flux (\(\phi\)) = \(2.6 \times 10^6\) n cm\(^{-2}\) s\(^{-1}\)

**SANS**
Better, (high) resolution at a higher neutron wavelength

**SANS needs**
High intensity at low \(q\)-range (\(L_2 = 18\) m) > **focusing**
High intensity at higher \(\lambda\) > **cold neutron**
Neutron flux measurement at 15 MW

Flux at the end of neutron guide
$6.57 \times 10^8 \text{ cm}^{-2} \text{ s}^{-1}$
Dr. Epung S. Bahrum (2008)

Vanadium sample can, Debye Scherrer sample model and Maxwellian distribution profile model have been simulated with the intention of being familiar with the McStas program.
The proposed works in the coming years

- Training Course / On Job Training (OJT) on MonteCarlo calculation program (McStas) – theory and applications, through IAEA Expert Mission (2009)

- Simulation using a MonteCarlo calculation program (McStas) to calculate the theoretical intensity and profile patterns at SANS spectrometer with a various configuration (2009 – 2010)

- Simulation using a MonteCarlo calculation program (McStas) to design a new SANS collimation system by applying an optical focusing lens device (2010).

- Implementation of the detector monitor, pre-Amplifier and its electronics system for present count data acquisition (2010)
The proposed works in the coming years

Present

Proposed work