Detectors Group at the European Spallation Source

ESS goal: to be the world’s best source of neutrons for the study of materials

RD51 Collaboration Meeting
5 Jul 2013

Richard Hall-Wilton
Detector Group Leader, ESS

fredag den 5 juli 2013
What is Neutron Scattering Science?

Complexity

Neutrons are
- low energy
- non-damaging
- penetrating
- broad wavelength range

ESS high intensity allows studies of
- complex materials
- weak signals
- important details
- time dependent phenomena

Thermal and Cold Neutrons: meV, NOT MeV!
High-intensity spallation sources

- J-Parc, Tokai-Mura 2008
- SNS, Tennessee 2008
- ESS, Lund 2019

Plus many reactor sources, including ILL, Grenoble - world's leading research reactor

(Note that many existing sources planning upgrades presently)
The ESS Site
The ESS Site

23 October 2012
ESS Technical Design Report

- (700 page) TDR released: available on ESS website
- Will serve as a baseline for construction

**ESS Conceptual Design Report**

**Feb ‘12**

Release 2.0
February 5, 2013
The Reference Instrument Suite

1. Cold Chopper Spectrometer
2. Backscattering Spectrometer
3. Materials Science & Engineering Diffractometer
4. Thermal Powder Diffractometer
5. Thermal Chopper Spectrometer
6. Extreme Conditions Instrument
7. Single-Crystal Magnetism Diffractometer
8. Cold Crystal-Analyzer Spectrometer
9. Macromolecular Diffractometer

Wide-Angle Spin Echo
Horizontal Reflectometer
Broad-Band High Flux SANS
High-Resolution Spin Echo

W target

Multi-Purpose Imaging
Bi-Spectral Powder Diffractometer
Vibrational Spectroscopy
Fundamental & Particle Physics

General-Purpose Polarized SANS
Surface Scattering
Vertical Reflectometer
Bi-Spectral Chopper Spectrometer
Pulsed Monochromatic Powder Diffractometer

protons
### ESS Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>2010</td>
<td>Design Update</td>
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<tr>
<td>2011</td>
<td>TDR</td>
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<td>2012</td>
<td>P2B S&amp;T Infrastructure</td>
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<td>2013</td>
<td>Instrument Development</td>
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<tr>
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</tr>
<tr>
<td>2025</td>
<td>Operation</td>
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2019: First 7 instruments on-line
2025: Full suite of 22 instruments on-line

Depth of this is a capacity of 12-14 instruments at once(!)
Old News Now...He-3 Crisis

Little or None Available
(comment: seems to be some naivety at the moment as stocks are being emptied rapidly)

Aside ... maybe He-3 detectors are anyway not what is needed for ESS?

eg rate, resolution reaching the limit ...

Crisis or opportunity ... ?

Since ca. 2009
Detector Requirements for Baseline TDR Suite

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Total 282.6

Table 2.5: Estimated detector requirements for the 22 reference instruments in terms of detector area, typical wavelength range of measurements and desired spatial and time resolution.
B-10 Thin Film Detectors: Where are we with prototypes?

An array of prototype designs at the moment (>10)

Angle of incidence of neutron to converter layer

- $^10\text{B}_4\text{C}$ layer
- $^7\text{Li}$
- $^1\mu\text{m}$
- $^6\text{Li}$
- $^7\text{Li}$
- $^3\text{He}$
- $^{10}\text{B}$
- $^{11}\text{B}$
- $^{10}\text{B}$
- $^{12}\text{C}$

$^{10}\text{B}$ has a neutron absorption of 70% compared to $^3\text{He}$ at $\lambda = 1.8$ Å

$^{nat}\text{B}$ contains 80 at.% $^{11}\text{B}$ and 20 at.% $^{10}\text{B}$

$^{10}\text{B} + n \rightarrow ^7\text{Li} + \alpha + 2.3$ MeV

This really is the ideal time to investigate all possible options and geometry

A lot of ongoing R+D now: a lot of prototyping and results
10-Boron Carbide Thin Films for Neutron Detection

ESS – Linkoping U collaboration

DC magnetron sputtering: $^{\text{nat}}\text{B}_4\text{C}, \text{ }^{10}\text{B}_4\text{C}$

• 2-side coated substrates, Good adhesion on Al, Si, etc.
• High density, Minimal impurities, Thickness control and uniformity
• Large area depositions, Patent


• Boron Carbide has high internal stress: Many attempts by other groups failed
• Expertise of Linkoping thin film group
• 3 publications from this collaboration, several in preparation
• Also working on CVD processes, Gd deposition, ...

Purchasing deposition machine now: aim $>>1000\text{m}^2$/year

$\sim 3\ \mu\text{m} \ ^{10}\text{B}_4\text{C}$

Interested in samples?
Please contact us!

$^{10}\text{B}_4\text{C}$

$1\ \mu\text{m}$

$\text{Si}$
The ESS Detector Group

Anton Khablanov

Carina Höglund
Mewlûde Imam

Richard Hall-Wilton (group leader)
Kalliopi Kanaki
Thomas Kittelmann
Scott Kolya
Luis Ortega
+1 (Sep13)

Björn Nilsson
Julius Scherzinger

31 Dec 2010, detector group comprised of ... Carina!
RED colour: 100% of salary comes from ESS
BLACK colour: 50% from ESS, 50% local

detector lab space in Lund exists about to acquire electronics and mechanical workshops

(31 Dec 2010, detector group comprised of ... Carina!)
What is our interest in RD51?

• To us, it appears that there is a significant role for MPGDs in future detectors for neutron scattering
• There are synergies to be gained by joining RD51

• Present involvement in MPGDs through in-kind contributions to ESS:
  • b-GEMs (group led by Milan-Bicocca)
  • Gd-MSGCs (Helmholz-Zentrum Berlin)
• Looking to expand what is being done

Look to actively investigate prototypes and application developments:
• Neutron detectors for cold and thermal neutrons
• To begin with, have started a discussion with CERN PH/DT that ESS fund a CERN fellow on this topic starting soon

Request Membership for:
• Richard Hall-Wilton
• Scott Kolya
• Carina Hoglund
• Kalliopi Kanaki
• Thomas Kittelmann

Look forward to contributing in the future ...
thank you ... ?