EUROPEAN SPALLATION SOURCE

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

What is Neutron Scattering Science?

Thermal and Cold Neutrons:
meV, NOT MeV!

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

Details/Resolution

High-intensity spallation sources

Plus many reactor sources, including ILL, Grenoble - worlds leading research reactor

(Note that many existing sources planning upgrades presently)

The ESS Site

The ESS Site

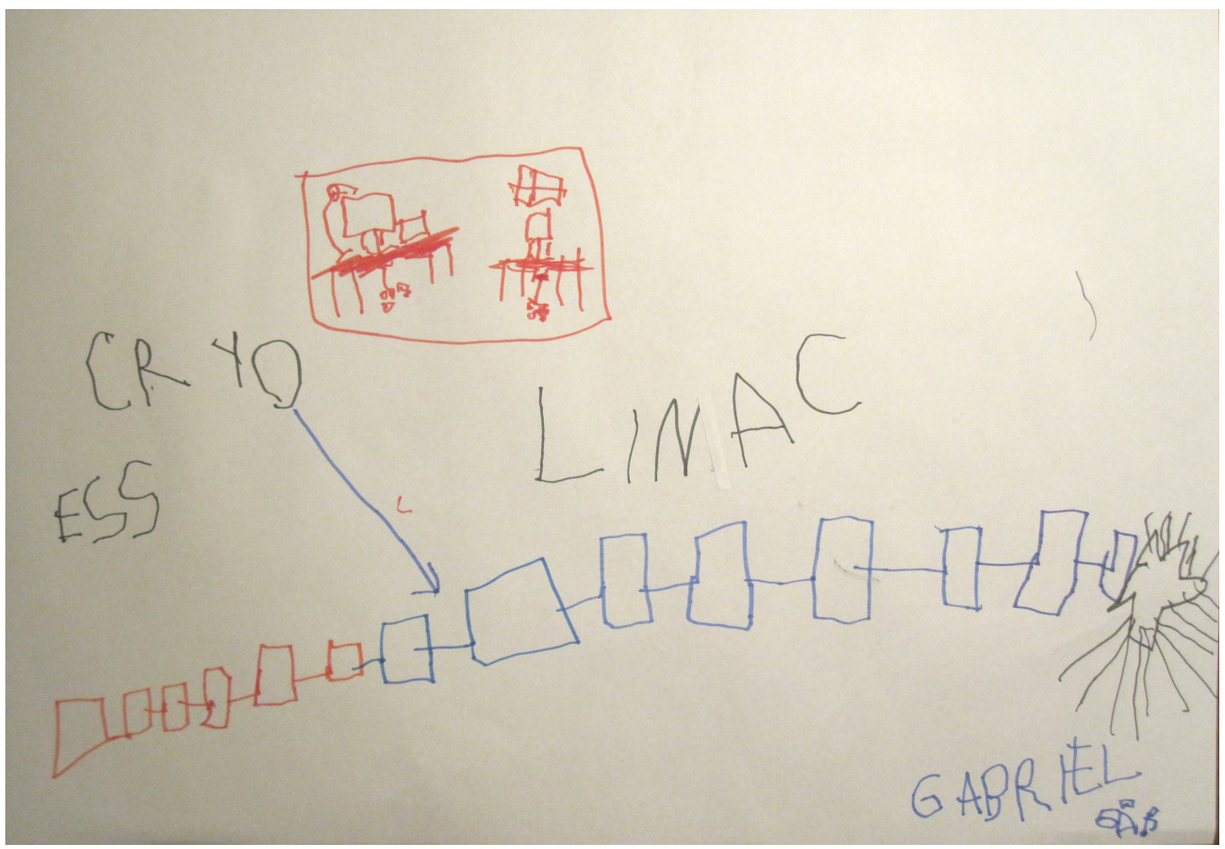

Lund
ess-scandinavia.eu & www.webbkameror.se
2012-10-23 CEST 07:35:10
webbkameror.se
EUROPEAN
SPALLATION
SOURCE
23 October 2012

ESS Technical Design Report

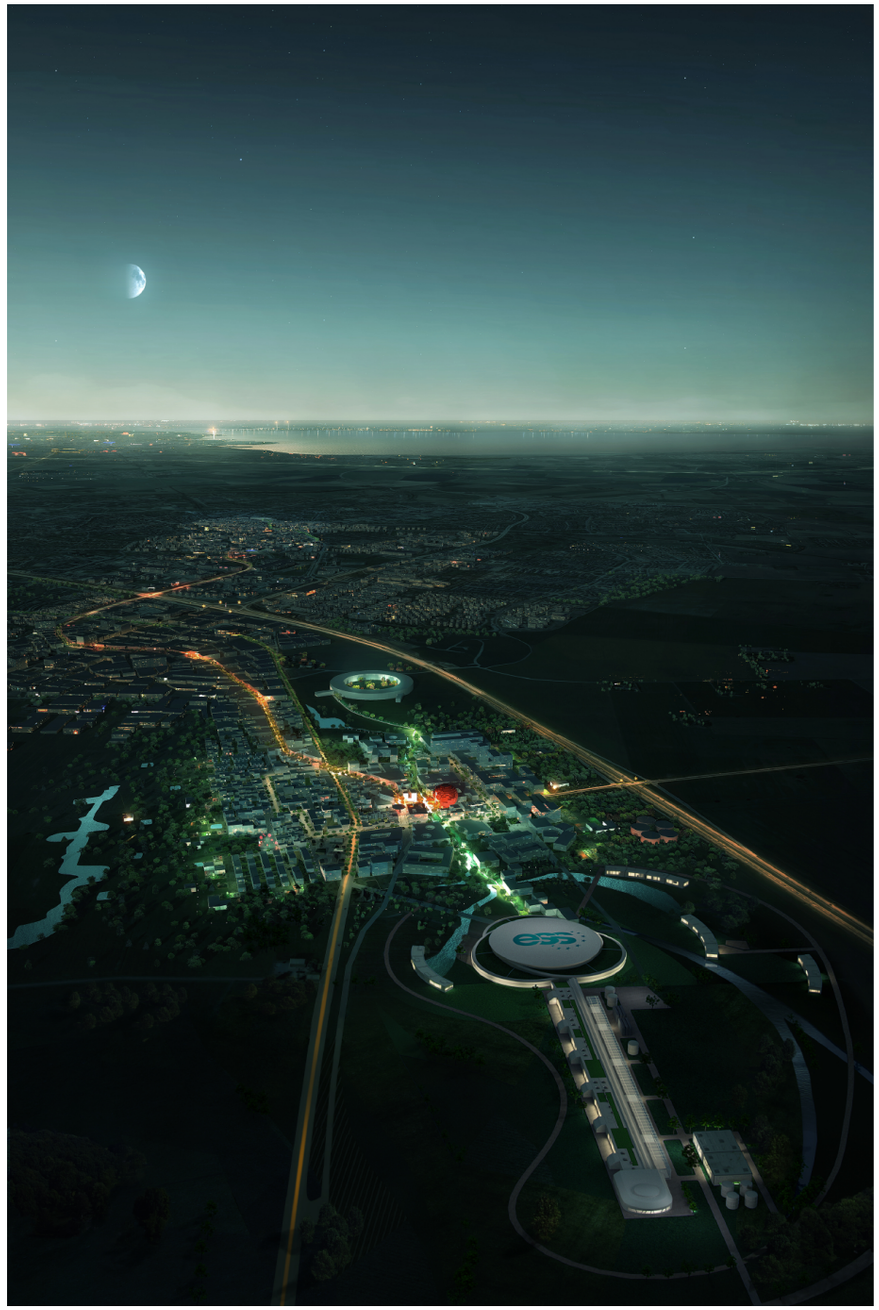
- (700 page) TDR released: available on ESS website
- Will serve as a baseline for construction

Feb '12

ESS Conceptual Design Report



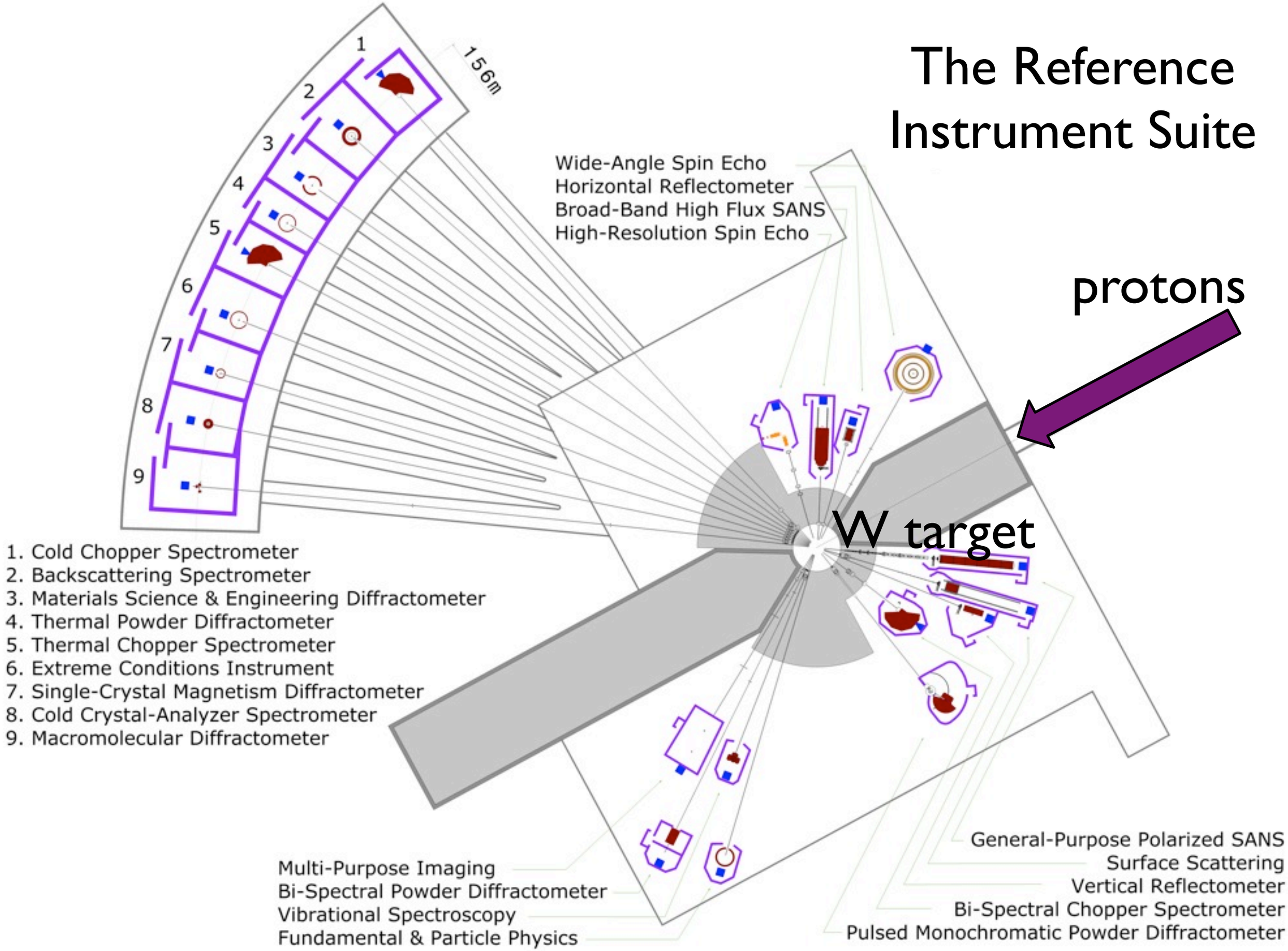
ESS Technical Design Report



Release 2.0

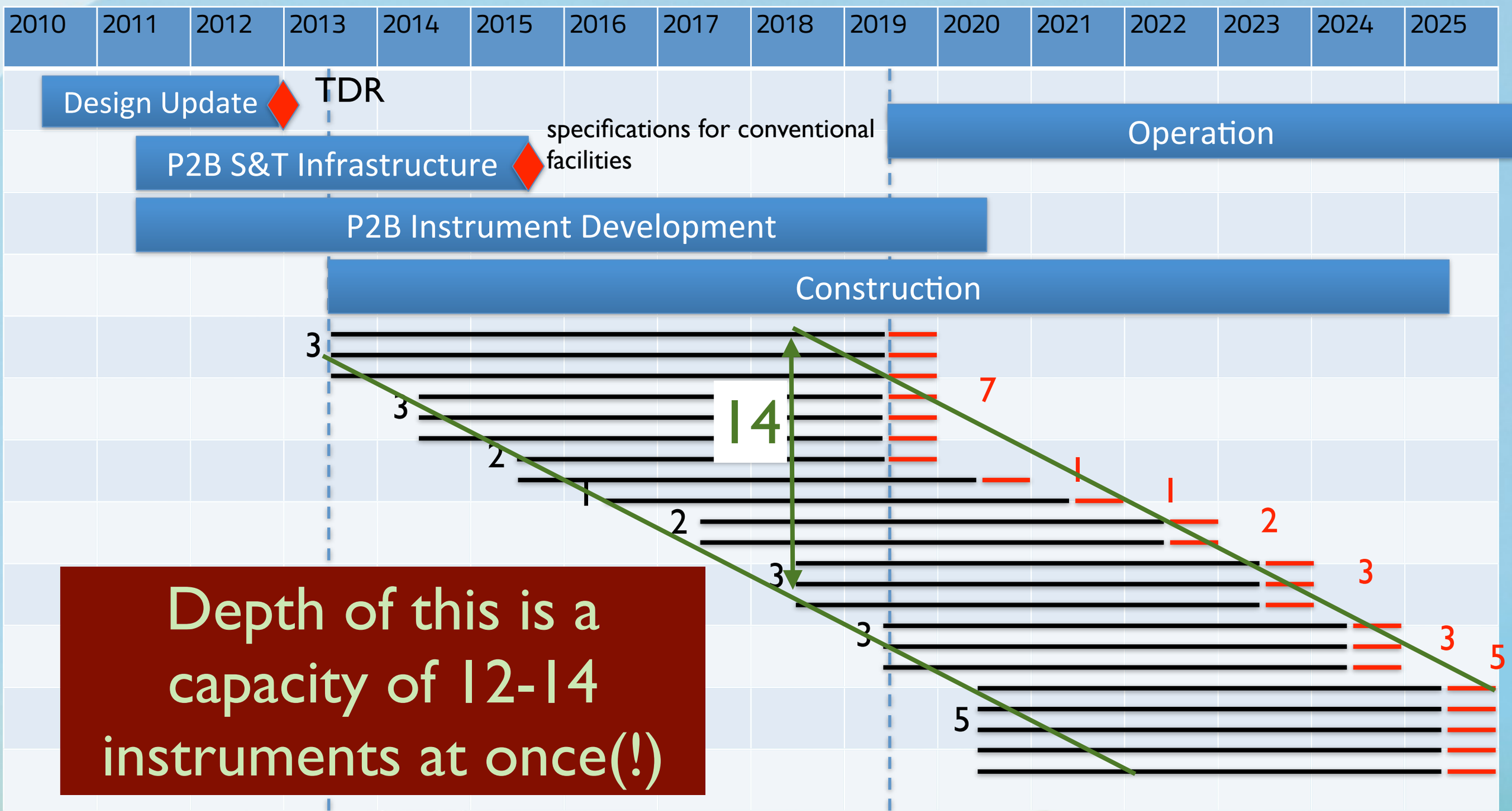
February 5, 2013

The Reference Instrument Suite



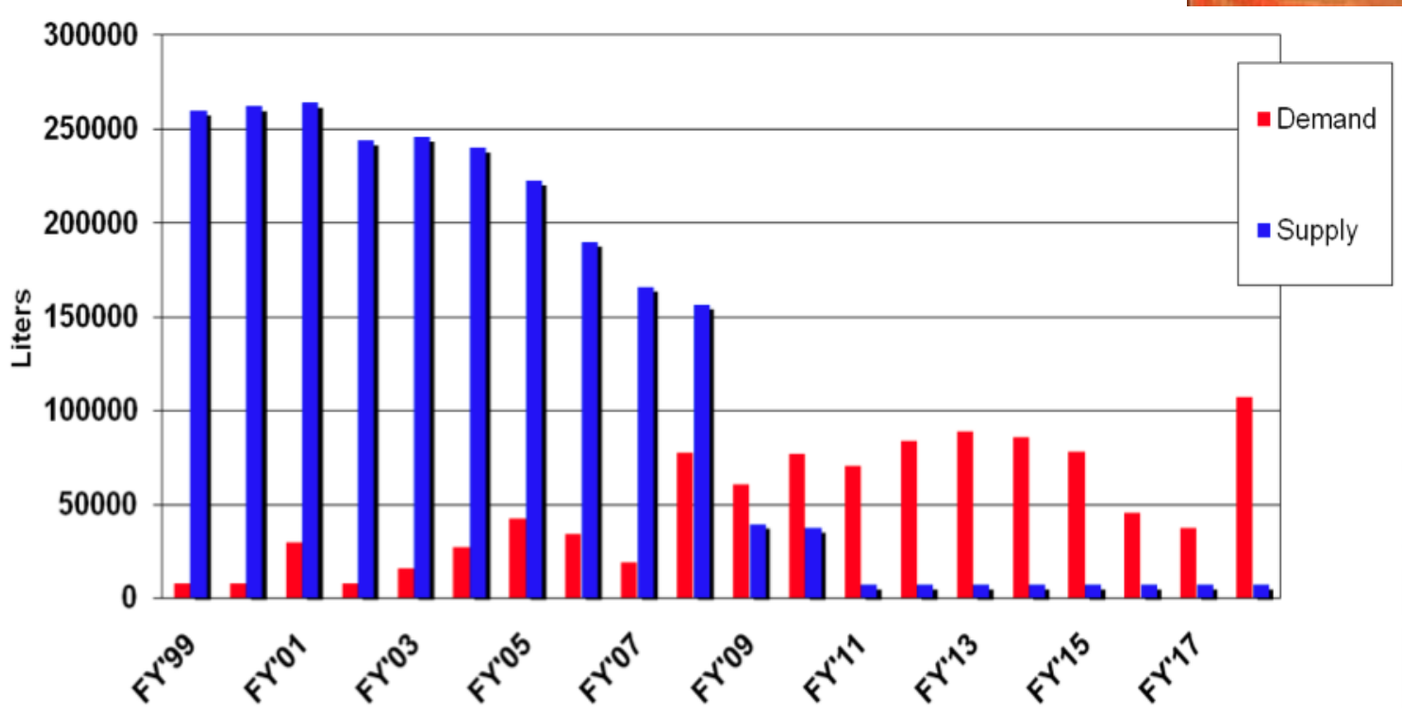
ESS Timeline

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 ... ?

Detector Requirements for Baseline TDR Suite

Instrument	Detector Area [m^2]	Wavelength Range [Å]	Time Resolution [μs]	Resolution [mm]
Multi-Purpose Imaging	0.5	1-20	1	0.001 - 0.5
General Purpose Polarised SANS	5	4-20	100	10
Broad-Band Small Sample SANS	14	2-20	100	1
Surface Scattering	5	4-20	100	10
Horizontal Reflectometer	0.5	5-30	100	1
Vertical Reflectometer	0.5	5-30	100	1
Thermal Powder Diffractometer	20	0.6-6	<10	2x2
Bi-Spectral Powder Diffractometer	20	0.8-10	<10	2.5x2.5
Pulsed Monochromatic Powder Diffractometer	4	0.6-5	<100	2 x 5
Material Science & Engineering Diffractometer	10	0.5-5	10	2
Extreme Conditions Instrument	10	1-10	<10	3x5
Single Crystal Magnetism Diffractometer	6	0.8-10	100	2.5x2.5
Macromolecular Diffractometer	1	1.5-3.3	1000	0.2
Cold Chopper Spectrometer	80	1 -20	10	10
Bi-Spectral Chopper Spectrometer	50	0.8-20	10	10
Thermal Chopper Spectrometer	50	0.6-4	10	10
Cold Crystal-Analyser Spectrometer	1	2-8	<10	5-10
Vibrational Spectroscopy	1	0.4-5	<10	10
Backscattering Spectrometer	0.3	2-8	<10	10
High-Resolution Spin Echo	0.3	4-25	100	10
Wide-Angle Spin Echo	3	2-15	100	10
Fundamental & Particle Physics	0.5	5-30	1	0.1
Total	**282.6**			

Estimates

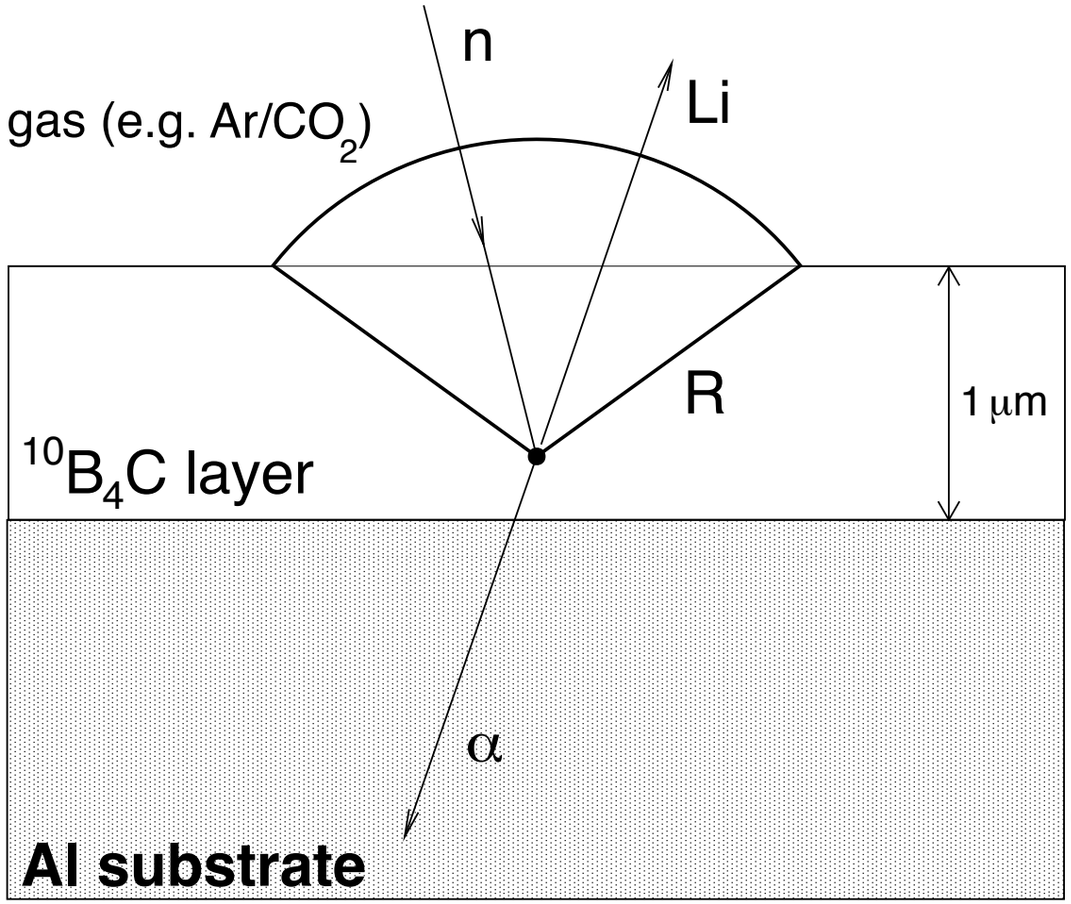
Table 2.5: Estimated detector requirements for the 22 reference instruments in terms of detector area, typical wavelength range of measurements and desired spatial and time resolution.

- Specifications very varied:
- Resolutions cm to microns
- Rate: mHz - MHz
- Size: few cm^2 to 100m^2

- Superior to what is state-of-the-art at existing neutron sources

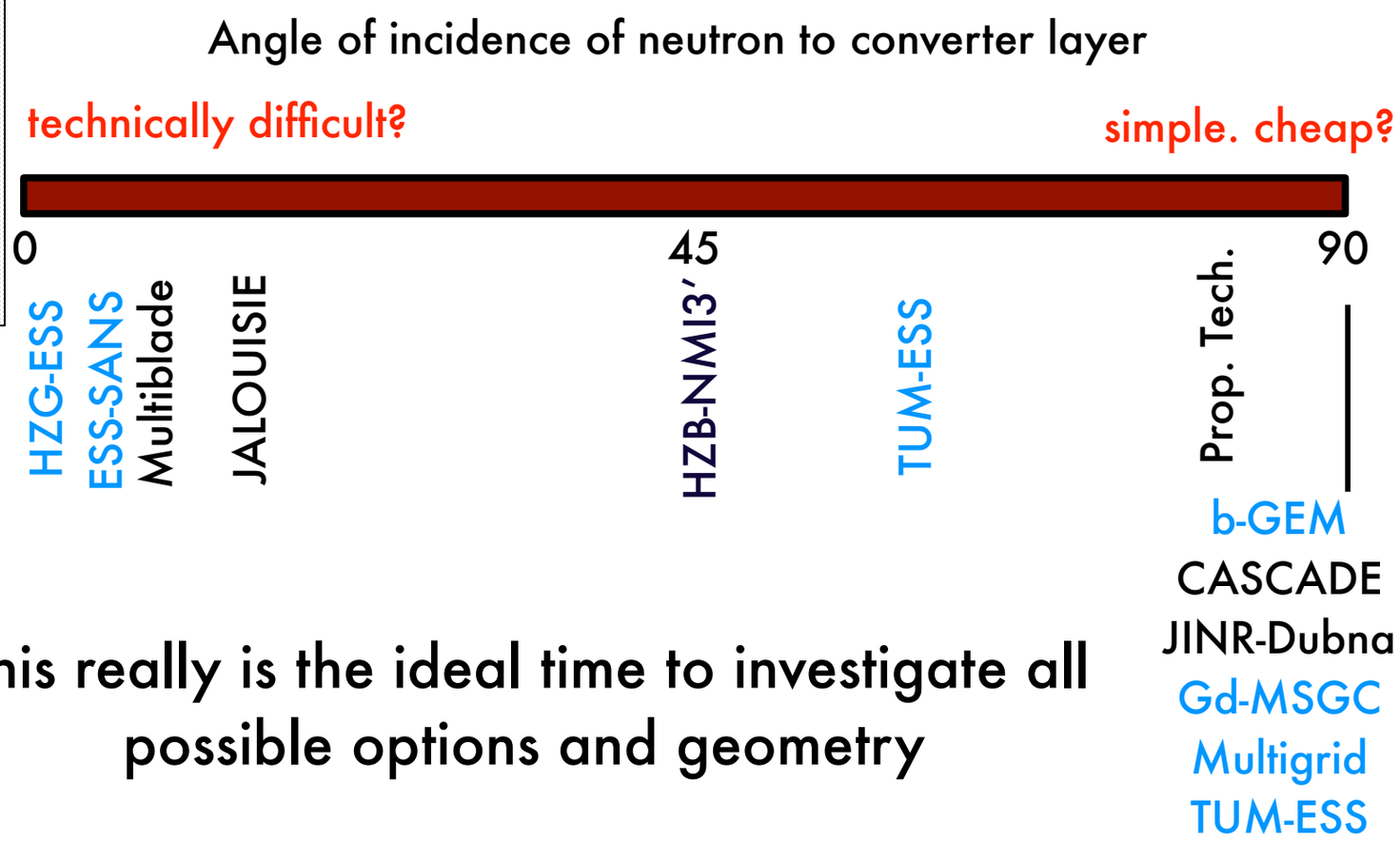
- MPGD's probably have a role to play for res< few mm and high rates

B-10 Thin Film Detectors: Where are we with prototypes?



- ^{10}B has a neutron absorption of 70% compared to ^{3}He at λ = 1.8 Å
- ^{nat}B contains 80 at.% ^{11}B and 20 at.% ^{10}B
- $^{10}B + n \rightarrow {}^{7}Li + \alpha + 2.3$ MeV

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



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

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ESS – Linkoping U collaboration

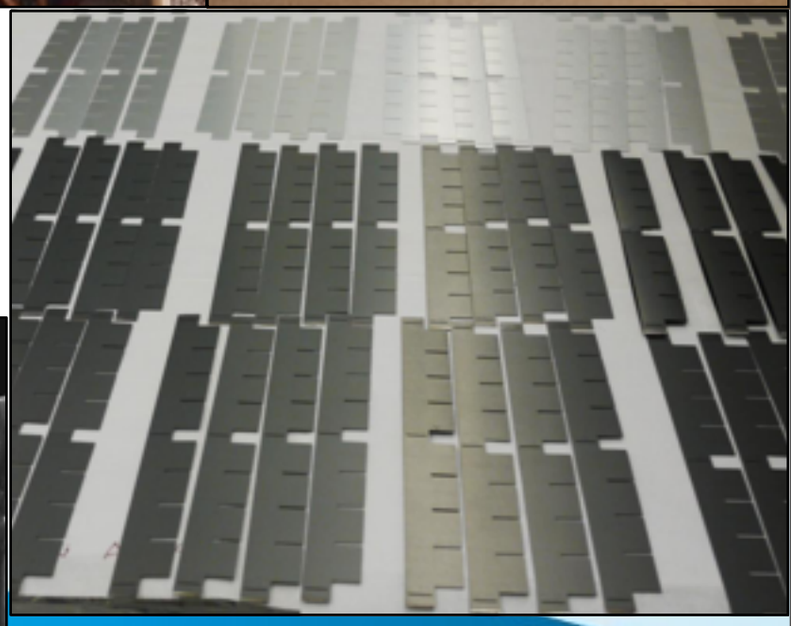
DC magnetron sputtering: $^{nat}B_4C$, $^{10}B_4C$

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

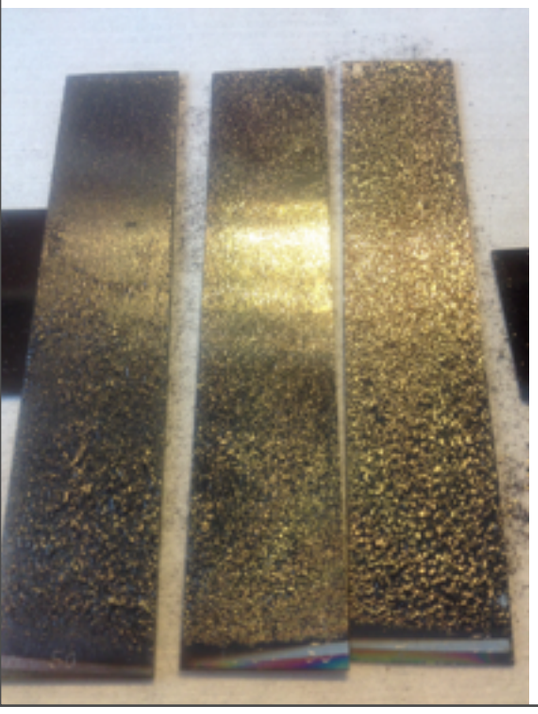
C. Höglund, et. al., J. Appl. Phys. **111**, 104908 (2012)

- 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, ...

interdisciplinary



Purchasing deposition machine now: aim >>1000m^2/year



~3 μm $^{10}B_4C$

The ESS Detector Group (July 2013)

Anton Khaplanov

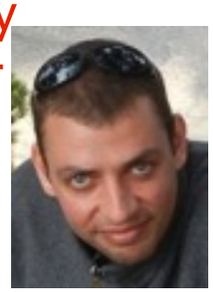
ILL
FR

Carina Höglund
Mewlude Imam

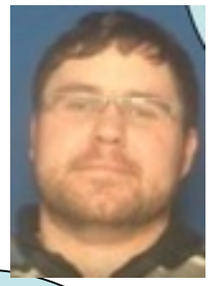
Linköping
SE

ESS-Lund
SE

7 full ESS employees today
Expect to be 12 next year



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



IFE
NO

Isabel Llamas
Xiao Xiao Cai
Thomas Haraldsen

Björn Nilsson
Julius Scherzinger

MAX-lab+
Lund U
SE

(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

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 ... ?