Summary of Findings of ESS Working Group on Indirect-Geometry Instruments

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We looked at six instruments, covering a very wide range of science and energy scales:

- Backscattering
  0.4 μeV - polished Si 111
  1.4 μeV - unpolished Si 111
  17 μeV - PG 002
- Constant-**Q** (PRISMA)
- Vibrational Spectroscopy (TOSCA)
- eV spectroscopy (eVS)

Given the choice between the three proposed ESS targets, all six instruments identified the 50Hz short-pulse target as their first choice. 2 instruments chose the 10Hz short-pulse target as the second option. 2 instruments chose the long-pulse target as the second option.

0.4 meV backscattering

- polished Si 111 analysers in near-backscattering
- 7m diameter

The possibility of using mica 002 instead of Si was tested and found to be uncompetitive. The 10Hz target was found to be of no interest, as the dynamic range is not limited by the source repetition rate. This energy resolution can only be obtained with a pulse-shaping chopper. Assuming this chopper is placed at 6.3m from the moderator gives the following results for the dynamic ranges and time-integrated fluxes of neutrons at the elastic energy:

	Δλ/ΔE	Φ(/cm2/s/Å)	Φ(res=1.4μeV)
ESS cold coupled mod. (50Hz)	0.4Å/300μeV	$5x10^7$	$3x10^8$
ESS long-pulse target	1.2Å/900μeV	$7x10^6$	$5x10^7$
HFBS(NIST) res=0.8μeV	22μeV	$5x10^6$	
IN16(ILL) res=0.35μeV	30μeV	$5x10^5$	

The last two columns show the fluxes that can be obtained by slowing down the pulse-shaping chopper to relax the resolution.

1.4 meV backscattering

- unpolished Si 111 analysers in exact backscattering
- 4m diameter
- timing chopper
- poisoned moderator
- Li=175m guide m=1.2

This instrument represents the highest resolution that can be obtained without the use of a pulse-shaping chopper. The following results are obtained for the dynamic ranges and time-integrated fluxes of neutrons at the elastic energy:

	Δλ/ΔE	Φ(/cm2/s/Å)
ESS cold poisoned mod. (50Hz)	0.5Å/0.3meV	$7x10^7$
ESS cold poisoned mod. (10Hz)	2.3Å/2.1meV	$1.3x10^7$
HFBS(NIST) res=1.0μeV	72μeV	$5x10^6$

17 meV backscattering

- Cooled PG 002 analysers in near-backscattering
- 2m diameter

This is very similar to IRIS at ISIS. A large range of combinations of flux and dynamic range was found. The choice must be dictated by the scientific case. The following results are obtained for the dynamic ranges and time-integrated fluxes of neutrons at the elastic energy:

	$\Delta\lambda/\Delta E$	Φ(/cm2/s/Å)	Φ(res=25μeV)
ESS cold coupled mod. (50Hz)	0.7Å/0.4meV	$9x10^8$	
ESS cold decoupled mod (50Hz)	2.3Å/2.1meV	$3x10^8$	
ESS cold coupled mod (10Hz)	3.4Å/4.8meV	$1.9x10^8$	
ESS cold coupled mod PS (50Hz)	0.7Å/0.4meV	$4x10^8$	$4x10^8$
ESS long-pulse target PS	1.8Å/1.2meV	$3x10^8$	$6x10^8$
IN13(ILL) res=8μeV	0.4meV	$6x10^5$	
IRIS(ISIS) res=17μeV	2.0Å	$3x10^6$	

Instruments marked "PS" indicate use of a pulse-shaping chopper at 6.3 m. For these instruments, the last column shows the fluxes that can be obtained by slowing down the pulse-shaping chopper to relax the resolution.

Constant-Q scans in single crystals

- PG 002 analysers with variable & individually adjustable take-off angles
- At least 20 arms with at most 1º separation
- Measure along direction of constant **Q**
- Possibility of doing a large fraction of TAS-type measurements

This is a novel instrument, aimed at the possibility of doing a large fraction of the experiments currently performed on triple-axis instruments. The resolution and flux are less tuneable, as they are mainly given by the position in (**Q**,ω)-space. The optimal moderator and repetition rate are not yet clear, but ~25Hz appears best. The reduced dynamic range from a pulse-shaping chopper is probably not acceptable, which rules out the long-pulse target.

Vibrational spectroscopy spectrometer

- banks of PG 002 analysers with E_f=3.3meV
- L_i=17m 2θ=135º

This instrument is very similar to TOSCA at ISIS and aims at measuring the full incoherent density of states, particularly in hydrogenous systems. This requires a large dynamic range which rules out the use of pulse-shaping choppers. It also requires good resolution which then rules our the long-pulse target. The preferred moderators are poisoned water or decoupled hydrogen. In terms of repetition rate, 50Hz is probably more useful, but 10Hz is also interesting for a high-resolution version.

Resonance high-energy spectrometer

- ^{238}U resonant absorption E_f=6.67eV
- L_i=12m 25º<2θ<150º

To match primary and secondary resolution, the time width must be less than 1 μs which is not feasible with pulse-shaping choppers, so the long-pulse target is ruled out. The ideal repetition rate is of the order of 1 kHz, so the 50Hz target is the preferred option. The moderator must be poisoned; coupling and temperature are unimportant for this instrument.