A comparison of the options for the location of the HYSPEC instrument

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Executive Summary

HYSPEC is an approved instrument in the SNS suite of spectrometers for inelastic neutron scattering, with a projected location on beamline 14B in the SNS experimental hall. In order to accommodate other instruments on beamlines 14A and 15 the option has been floated to re-locate HYSPEC either outside of the experimental hall/building or on to beamline 10. We have carried out Monte Carlo simulation to assess the degradation in performance of moving HYSPEC from its current location and made some estimates of the cost of such moves. If HYSPEC were moved to beamline 10 then there would be a substantial, and unacceptable, loss of flux for HYSPEC experiments. For example, at 3.6meV, the integrated flux at the sample position for HYSPEC on beamline 10 is only 14% of that in its current position on beamline 14B, and at 15meV it is only 20%. The flux is not recovered until the incident energy is well above 60meV. Beamline 10 is therefore an unacceptable option.

If HYSPEC is moved outside of the SNS experimental hall, but remaining on beamline 14B, the incident flight path will extend from 25m to at least 35m. The Monte Carlo simulation results show that if the HYSPEC secondary instrument is simply moved “as is”, with a secondary flight path of 4.5m then for the same resolution conditions the flux at the sample position will fall by between 25 and 35% depending on energy. If the secondary flight path is lengthened from 4.5m to 7.5m then, by running the choppers at a lower frequency, it is possible to recover the same flux at the sample as was obtained the 25m location inside the SNS experimental hall. Moving the HYSPEC instrument outside of the experimental hall will incur extra, and substantial, costs that are not contained in the budget for the HYSPEC instrument. We estimate that these will be, at least, $2.7M to move HYSPEC “as is”, and $4.9M to extend the secondary flight path to 7.5m.

In summary, the highest performance and most cost effective solution for HYSPEC is to remain in its currently allotted position inside the SNS experimental hall on beamline 14B. The option of moving to beamline 10 is completely unacceptable on grounds of performance loss. If the HYSPEC instrument is moved out of the SNS experimental hall it is possible to fully compensate the flux at the sample by extending the secondary flight path (sample to detector bank) to 7.5m and running the disk choppers more slowly. If the secondary flight path distance is left at 4.5m the loss of flux at the sample is 25 to 35%. The options of moving out of the SNS experimental hall will incur significant extra costs, which are not covered by the current HYSPEC budget (which relates to construction inside the SNS experimental hall on beamline 14B). If these options are to be implemented then a commitment to the funding of these additional costs must be obtained.

1) Introduction

This report sets out the results of a comparison of various beamline models for the HYSPEC instrument to be installed at the Spallation Neutron Source, Oak Ridge National Laboratory. HYSPEC is a direct geometry instrument for inelastic neutron scattering. It's primary mission is the study of excitations in small single crystal specimens in the energy transfer range 0 to 60meV. In order to match the large, high intensity beams, from the SNS with the small sample size HYSPEC utilizes a focusing "monochromator" crystal to concentrate the relevant neutrons from the SNS beam onto the small sample. In figure 1 a generic layout for HYSPEC is shown.

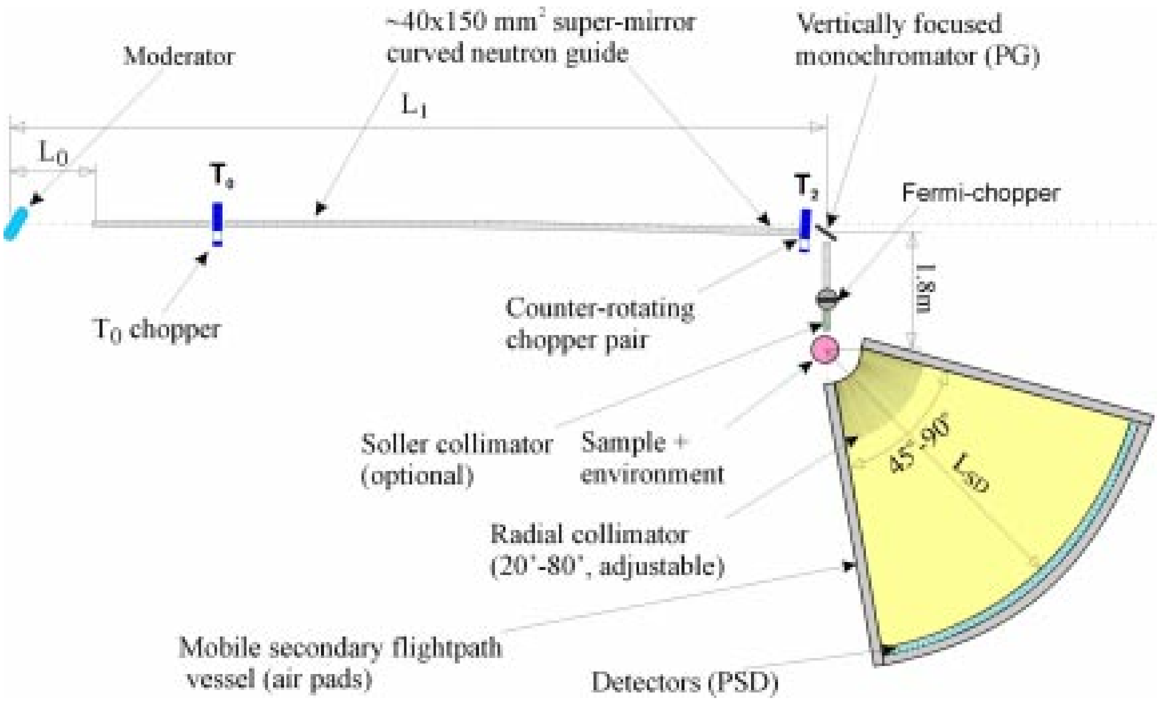


Figure 1: The generic form of the HYSPEC instrument

The white neutron beam from the SNS moderator is carried by a supermirror guide (which may be curved) a distance L_1 to a counter rotating disk chopper pair that monochromates the beam. After the disk chopper the neutron beam is incident on a focusing monochromator crystal array that focuses the (monochromatic) neutron pulse onto the sample position, 1.8m away. In order to reflect the monochromatic neutron pulse the crystal array must be set for Bragg's law with a scattering angle $2\theta_M$ that is dependent upon the neutron energy. Thus the sample position, and also the array of detectors, must be able to be rotated about a vertical axis through the monochromator crystal.

The neutron pulse that is incident on the sample will be scattered by the various allowed inelastic processes in the sample into an array (bank) of position sensitive detectors (PSD's). The final energy of the neutrons is determined from the final flight time of the scattered neutrons from the sample to the detector(s). Consequently, the distance L_{SD} from sample to detector, together with the time width of the monochromatic pulse that is incident on the sample, determines the analyzer energy resolution. Together with the incident pulse energy width it defines the overall energy resolution of the instrument.

The energy and time width of the incident pulse is governed by the combination of the burst time of the counter rotating disk chopper pair and the distance L_1, and to an extent by the slowing down time of the neutron pulse emerging from the moderator. If the slowing down time of the moderator, for the particular neutron energy, is longer than the burst time of the counter rotating disk chopper pair then one maximizes the intensity through the chopper.

The layout of the HYSPEC instrument (cf. Figure 1) on the floor area for the SNS instruments is governed by the choices for L_1, L_{SD} and $2\theta_M$. The latter has a desirable range of $14° < 2\theta_M < 90°$, and as a consequence it is the case that for some choices of $2\theta_M$ that HYSPEC has a considerable footprint on the floor perpendicular to the direction of the incident beamline. Clearly the degree of interference with neighboring beamlines will be governed by the distance L_1, the shorter L_1 the greater is the potential interference, the larger L_1 the lesser is the potential interference. At the same time the parameter L_1 is a primary factor in determining the flux at the sample position, and also a significant factor in determining the energy resolution of the instrument. The other significant factors in determining the flux at the sample are the choice of the moderator, the configuration of the supermirror guide and the burst time of the counter rotating disk chopper pair. The other significant factors in determining the energy resolution are the distance L_{SD} and the burst time of the counter rotating disk chopper pair.

Optimizing the choices of L_1 and L_{SD} to find values which accommodate HYSPEC on the SNS floor area without interfering with other instruments, but which also maximizes the overall performance of HYSPEC has been the purpose of this study. A number of configurations corresponding to different L_1 and L_{SD} combinations have been studied by Monte Carlo simulation to determine intensity and resolution characteristics, and also been assessed for other performance criteria. The overall outcome of this study is reported in the remainder of this report, which is set out as follows. In section 2 we briefly review some of the background on HYSPEC, its scientific mission and how it relates to the other inelastic neutron scattering instruments proposed for SNS. Section 3 describes the configurations (options) proposed for HYSPEC and which have been studied for this report. Section 4 reports the Monte Carlo results for the flux at the sample and energy resolution for each of these configurations and section 5 reports other considerations for the performance of the instrument. In section 6 we indicate some of the possible variations on the instrument configurations that we have not yet had time to investigate, but which may be able to enhance the performance even further. Finally section 7 contains an evaluation of the different configurations in terms of their performance and estimates of the cost to build each configuration. Finally a conclusion is given in section 8. Some extra material on polarization analysis is given in an appendix.

2) Background and scientific Case

HYSPEC’s role in the SNS suite of inelastic neutron scattering instruments is as a medium resolution ($\Delta E/E_I \sim 3 \rightarrow 10\%$) spectrometer in the thermal energy range ($E_I \sim 3.6 \rightarrow 90$meV) specializing in dealing with small single crystal specimens. A comparison of the performance (flux on sample) of the proposed SNS inelastic instruments when operated with the same resolution has been carried out by Granroth and Abernathy[2] and is summarized in Figure 2. In the thermal energy range HYSPEC is able to concentrate more neutron flux on the sample by utilizing the focusing “monchromator” array of crystals. The comparison reported in ref.[2] was carried out for a 20mm x 20mm size sample, which by single crystal specimen sizes is a large crystal, for smaller samples (typically 5mm x 5mm) the gain would be even higher.

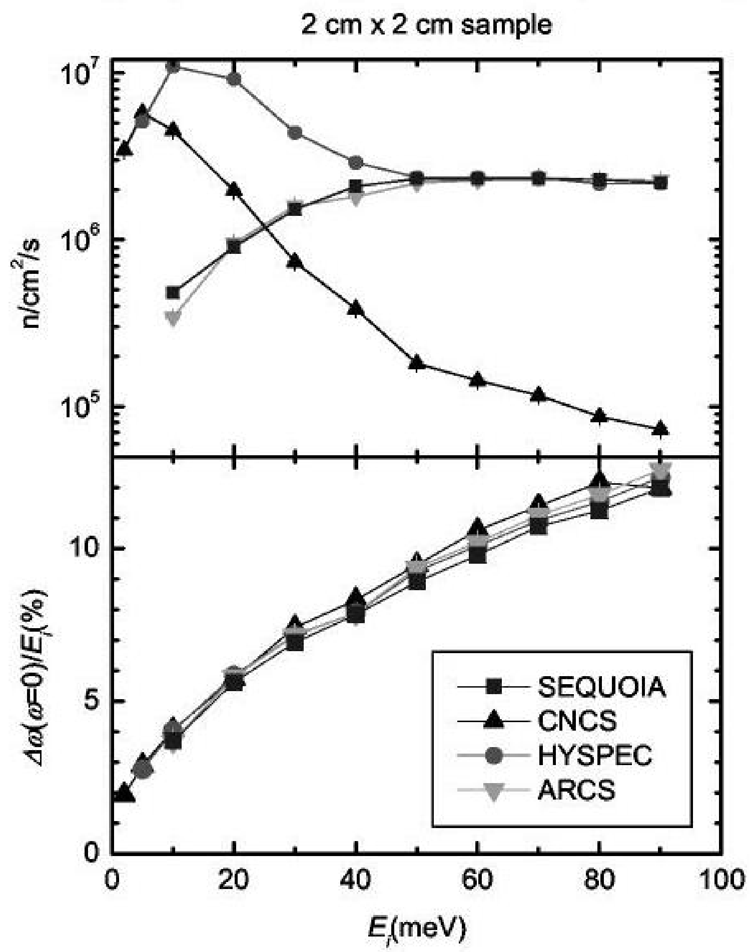


Figure 2: Comparison of performance taken from Granroth and Abernathy[2]

In the thermal neutron energy range the excitations of specific interest are collective excitations, phonons and spin waves. The scientific case for an instrument to carry out measurements on such excitations at the SNS was made in the HYSPEC proposal to DoE[1] and we do not intend to repeat it here. However a flavor of the case can be gained from the list of contributed science sections from members of the HYSPEC IDT, which are listed below.

- Spin Dynamics in Nanostructures (J. J. Rhyne)
- Nanoscale Features of Functional Materials (V. Kiryukhin)
- Anomalous Phonon Behavior (S. Shapiro, G. Shirane)
- Complex Phases in the Intermetallic Alloys (C. Stassis)
- Correlated Phases in Many-Electron Systems (I. Zaliznyak, J. Tranquada)
- Strongly Correlated Electrons - New Challenges for Neutron Scattering (G. Lander, S. Nagler)
- High-Tc Superconductors and Advanced Polarization Analysis using TAS and TOF spectrometers (L.-P. Regnault)
- New Transition Metal Oxides (M. Greven)
- Quantum Critical Points (R. Osborn)
- Geometrically Frustrated Magnets (J. Gardner)
- Quantum Spin Systems (A. Zheludev)

It is also important to note that the HYSPEC proposal[1] also contained the option to use polarized neutron scattering over this thermal neutron energy range, in order to separate magnetic and nuclear scattering when necessary. In order to achieve this the pyrolitic graphite focusing monochromator crystal would be replaced by a focusing Heusler monochromator and an array of polarized supermirrors used in front of the bank of PSD's. In appendix A we give a brief description of how the bank of polarizing supermirors is used to perform the polarization analysis and what restrictions this sets on the detector bank. At this time HYSPEC is unique at the SNS as the only spectrometer having such a polarization analysis option.

3) The options for the HYSPEC instrument

The options we have considered for the HYSPEC instrument are outlined in Table 1 below. There are two moderator possibilities, a coupled H_2 moderator on beamline BL14B and a decoupled H_2 moderator on beamline BL10, two moderator to monochromator distances L_1, 25m and 35m and a range of values for the sample to detector distance L_{SD}. Each of the models is denoted by a label that concatenates the beamline, L_1 and L_{SD} values. In Figure 3 below we show the layout for model BL14B-25-4.5, which corresponds to HYSPEC inside the SNS building on beamline BL14B with a 4.5m sample to detector distance. As was noted earlier there is an interaction with the

Model label	Moderator	Distance – moderator to mono (L_1)	Distance – sample to detector (L_{SD})
BL14B-25-3.0	Coupled H_2	25m	3.0m
BL14B-25-4.5			4.5m
BL14B-35-4.5		35m	4.5m
BL14B-35-6.0			6.0m
BL14B-35-7.5			7.5m
BL10-25-4.5	De-coupled H_2	25m	4.5m

Table 1: Beamline configuration options considered for HYSPEC

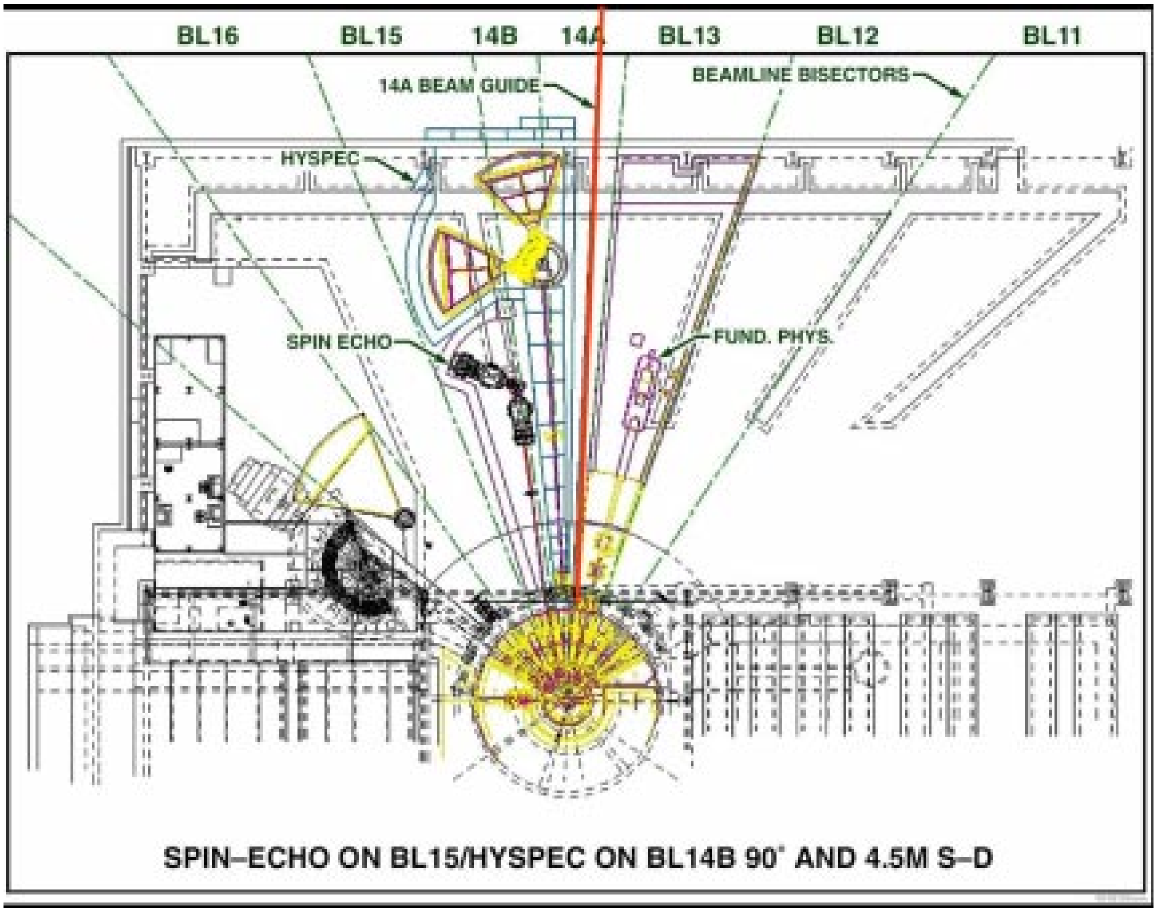
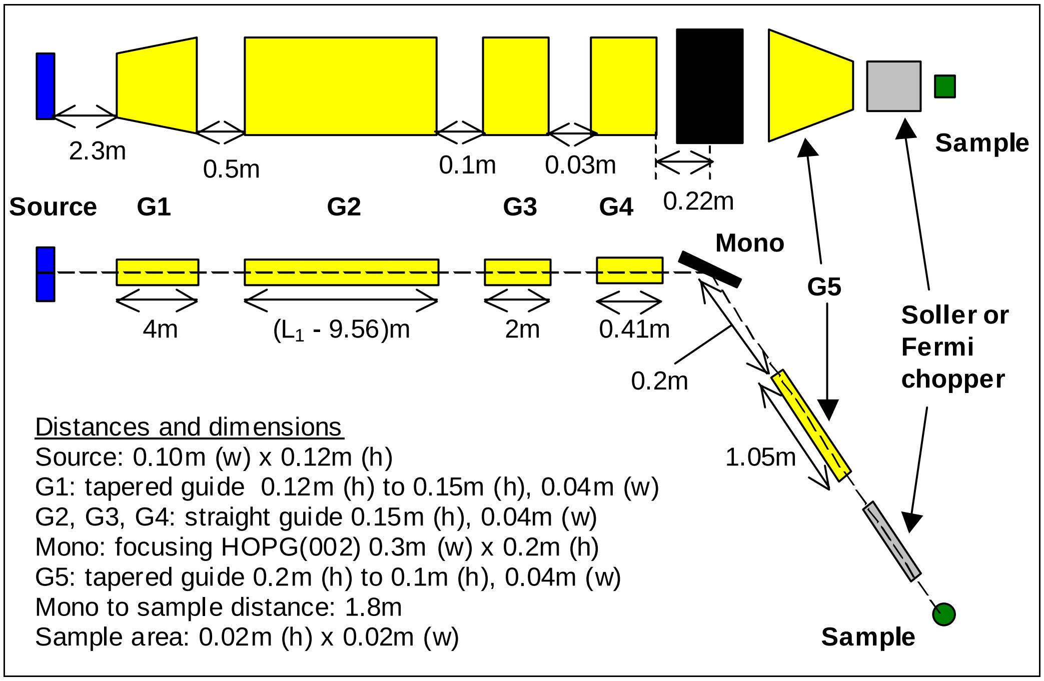


Figure 3: HYSPEC in the location for model BL14B-25-4.5

neighboring beamline BL15 with the HYSPEC detector “tucked in” behind the instrument on BL15. The model BL14B-25-3.0 has a very similar layout to that shown in Figure 3 but with a smaller sample to detector distance so that there is a larger separation from the sector of beamline BL16. The other configurations on moderator BL14B, BL14B-35-4.5, -6.0 and –7.5 have L_1 equal to 35m, which corresponds to moving the HYSPEC monochromator position outside of the wall of the SNS building. The final model considered BL10-25-4.5 places HYSPEC inside the SNS building on beamline BL10 which is to the right of beamline BL11 which is shown in Figure 3. Since there are no other beamlines to the right of BL10 there will be no interaction between the HYSPEC detector with other beamlines.

4) Performance results for flux and resolution

The performance of the different beamline options listed in Table 1 has been evaluated in terms of the flux at the sample position and the energy (at the elastic line) resolution of the scattering process, through a combination of Monte Carlo simulation techniques and analytical calculations. The Monte Carlo simulations have been carried out using the McStas simulation package[1]. The coupled and de-coupled H_2 moderators used in the simulations have been parameterized using the MCNP data of Erik Iverson[4] for these moderators, and the McStas input component for this data written by Garrett Granroth[5]. A schematic representation of the simulation model for HYSPEC from moderator (source) to sample position is given in Figure 4 below. The guide segments G1 to G5 are all m=3 supermirror coatings. The variation in the L_1 distance is accommodated in the length of the guide G2.



Distances and dimensions
Source: 0.10m (w) x 0.12m (h)
G1: tapered guide 0.12m (h) to 0.15m (h), 0.04m (w)
G2, G3, G4: straight guide 0.15m (h), 0.04m (w)
Mono: focusing HOPG(002) 0.3m (w) x 0.2m (h)
G5: tapered guide 0.2m (h) to 0.1m (h), 0.04m (w)
Mono to sample distance: 1.8m
Sample area: 0.02m (h) x 0.02m (w)

Figure 4: Schematic layout of the HYSPEC simulation model

The results for the flux at the sample position, and the energy resolution, for each of the beamline models are given in the following subsections.

Beamline 14B at 25m – BL14B-25-4.5 and BL14B-25-3.0

For the two cases where L_1 = 25m on the coupled-H_2 moderator, we have calculated the flux and resolution for various values of E_I using a frequency for the disk chopper of 300Hz. These results are given in Table 2 below.

	BL14B-25-4.5		**BL14B-25-3.0**	
E_I (meV)	Flux (n/cm^2/s)	Resolution ($\Delta E/E_I$)	Flux (n/cm^2/s)	Resolution ($\Delta E/E_I$)
3.6	1.8×10^6	2.2%	1.8×10^6	3.3%
15	7.9×10^6	4.5%	7.9×10^6	6.8%
30	2.9×10^6	6.4%	2.9×10^6	9.6%
60	1.1×10^6	9.0%	1.1×10^6	13.5%

Table 2: Flux at the sample and resolution for various E_I values with L_1 = 25m

We note that the disk chopper pair is already running at its maximum frequency and we cannot improve the resolution of these configurations by running the chopper pair faster. Instead a small Fermi chopper must be included after the monochromator to improve the energy resolution if this is required. For the BL14B-25-4.5 case the resolution without the Fermi chopper is acceptable for the majority of experiments and the Fermi chopper would only be required for high-resolution experiments. For the BL14B-25-3.0 case the resolution is such that the Fermi chopper would be required for most cases, with an associated loss in flux at the sample.

Beamline 14B at 35m – BL14B-35-4.5, BL14B-35-6.0 and BL14B-35-7.5

All of these models for HYSPEC correspond to a distance L_1 of 35m. If we simply extend the supermirror guide in length, while keeping the parameters for the counter rotating disk chopper, monochromator and detector bank the same, then the variation of the flux at the sample position with distance L_1 is as shown in Figure 5 below for energies of 15 and 60meV.

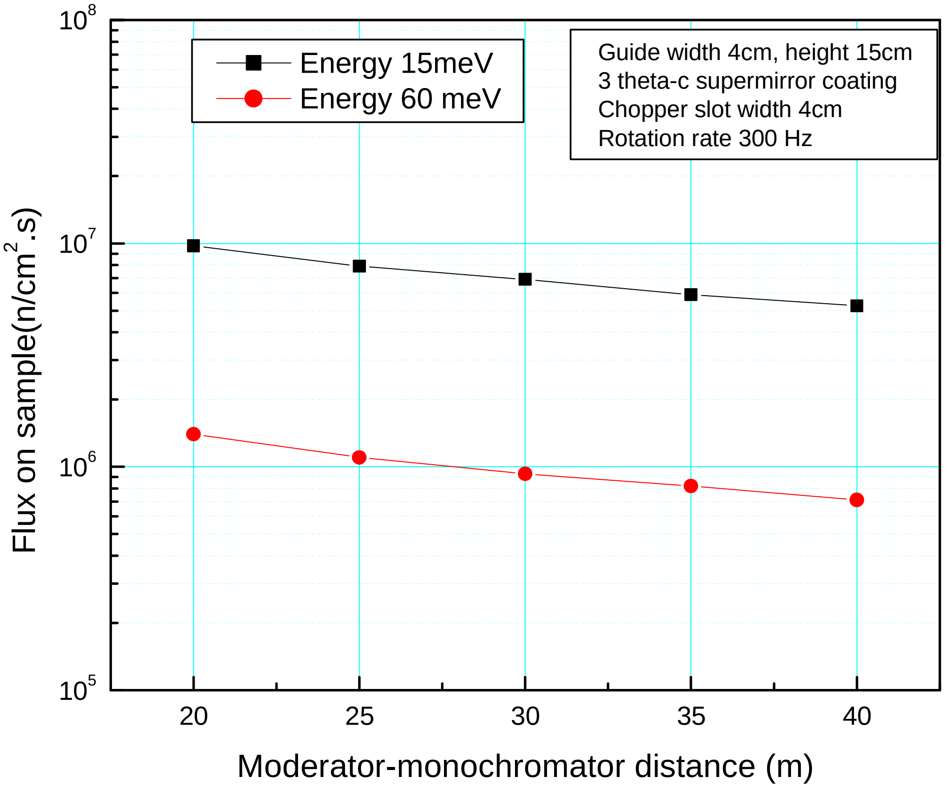


Figure 5: The variation of flux at the sample position with distance L_1

It should be noted that since the rotation rate and slot width of the counter rotating double disk chopper remains the same for each of the data points shown in Figure 5, so too does the burst time for the chopper. However since the neutron pulse from the SNS has further to travel as L_1 increases, the neutron energies in the pulse will become more widely dispersed and as a consequence, a fixed chopper burst time will correspond to a narrower bandwidth in energy with increasing L_1. The effect of this narrowing of the incident energy bandwidth on the resolution $\Delta E/E_I$ is relatively small since the secondary flight path distance L_{SD} = 4.5m dominates the energy resolution value. However it does have an effect on the value for the flux on sample, as can be seen in Figure 5.

There are two choices available in order to increase the incident energy bandwidth. These are either, to increase the slot width of the counter rotating disk chopper pair, or to change the rotational frequency of the disk chopper pair. In either case the effect is not just to increase the energy bandwidth but also to increase the time width of the incident (monochromatic) neutron pulse when it arrives at the sample. As a consequence this additional time uncertainty also increases the contribution to the energy resolution from the measurement of the final neutron energy, and in order to recover the same overall energy resolution, it is necessary to extend the sample to detector distance L_{SD}. In Figure 6 we show the variation of the energy resolution as a function of the chopper frequency, for the values of L_{SD} = 4.5m, 6.0m and 7.5m, at an incident neutron energy of 15meV.

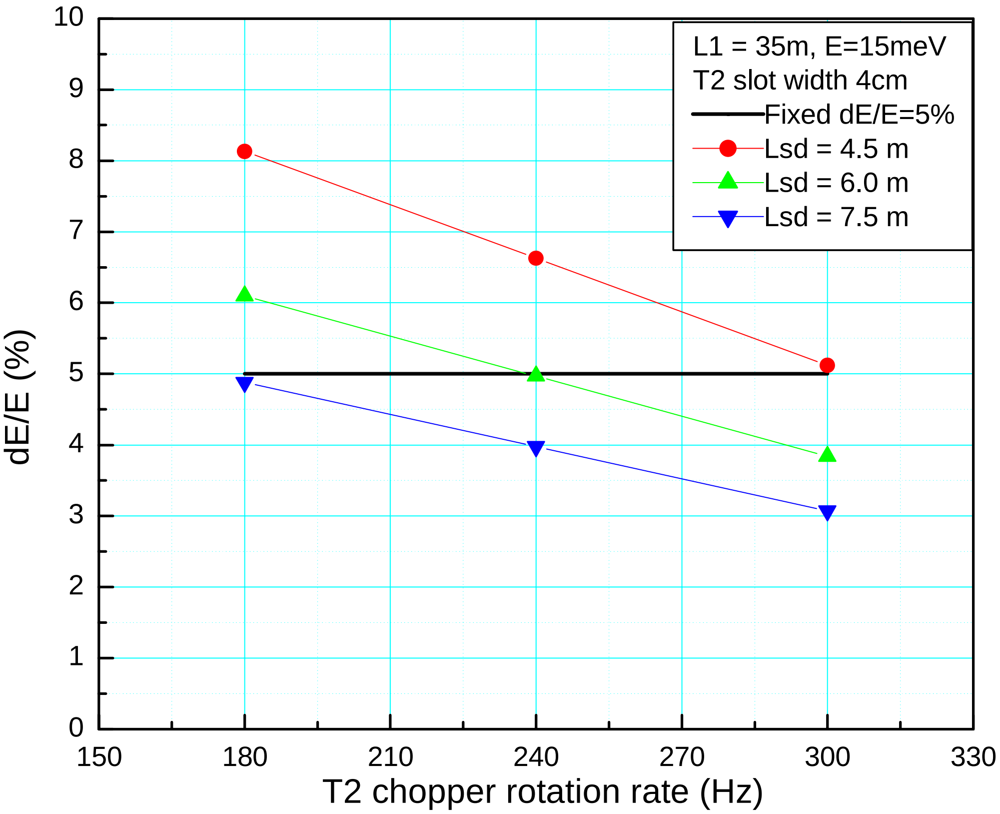


Figure 6: The variation of the energy resolution $\Delta E/E_I$ with the rotation frequency of the double disk chopper for different sample to detector distances L_{SD}.

From Figure 6 it can be seen that at a constant energy resolution of $\Delta E/E_I$ ~ 5% the corresponding chopper frequencies for L_{SD} = 4.5m, 6.0m and 7.5m are 300Hz, 240Hz and 180Hz respectively. If these values for L_{SD} and chopper frequency are used in the simulations then the resulting values for the flux at sample are given in Table 3 below.

E_I = 15meV with fixed resolution $\Delta E/E_I$ ~ 5%				
	Moderator to mono distance - L_1	**Sample to detector distance – L_{SD}**	**Chopper frequency**	**Flux at sample ($n/cm^2/s$)**
BL14B-25-4.5	25m	4.5m	300Hz	8.0×10^6
BL14B-35-4.5	35m	4.5m	300Hz	6.0×10^6
BL14B-35-6.0	35m	6.0m	240Hz	7.4×10^6
BL14B-35-7.5	35m	7.5m	180Hz	9.8×10^6

Table 3: The variation of the sample position flux (averaged over a 2cm x 2cm area at the sample position) for a fixed energy resolution of ~5%.

Also given in Table 3 is the equivalent result for BL14B-25-4.5 for comparison. It can be seen that at 15meV the loss in flux for BL14B-35-4.5 over BL14B-25-4.5 is only about 25%, while for BL14B-35-7.5 one essentially regains all of the flux one had for BL14B-25-4.5. In Table 4 we give similar results for an incident energy E_I = 60meV with a fixed energy resolution of $\Delta E/E_I \sim 8\%$.

E_I = 60meV with fixed resolution $\Delta E/E_I \sim 8\%$				
	Moderator to mono distance - L_1	**Sample to detector distance – L_{SD}**	**Chopper frequency**	**Flux at sample ($n/cm^2/s$)**
BL14B-25-4.5	25m	4.5m	300Hz	1.1×10^6
BL14B-35-4.5	35m	4.5m	300Hz	0.8×10^6
BL14B-35-6.0	35m	6.0m	240Hz	1.0×10^6
BL14B-35-7.5	35m	7.5m	180Hz	1.3×10^6

Table 4: The variation of the sample position flux (averaged over a 2cm x 2cm area at the sample position) for a fixed energy resolution of ~8%.

The results given in Table 4 are very similar in their overall structure to those in Table 3. The loss of flux in going from BL14B-25-4.5 to BL14B-35-4.5 is about 35%, while the flux is essentially recovered with model BL14B-35-7.5.

Beamline 10 at 25m – BL10-25-4.5

The performance of HYSPEC if placed on beamline BL10 that views the decoupled H_2 moderator can be assessed from Figure 7 below, which shows the variation of flux at the sample position as a function of the incident energy for BL10-25-4.5, BL14B-25-4.5 and BL14B-35-4.5. All of the points shown correspond to a frequency for the disk chopper of 300Hz and hence (to a reasonable approximation) the same energy resolution $\Delta E/E_I$ for the same incident energy E_I. As can be seen from Figure 7 the flux is substantially lower on the decoupled H_2 moderator than either of the cases BL14B-25-4.5 or BL14B-35-4.5 on the coupled H_2 moderator.

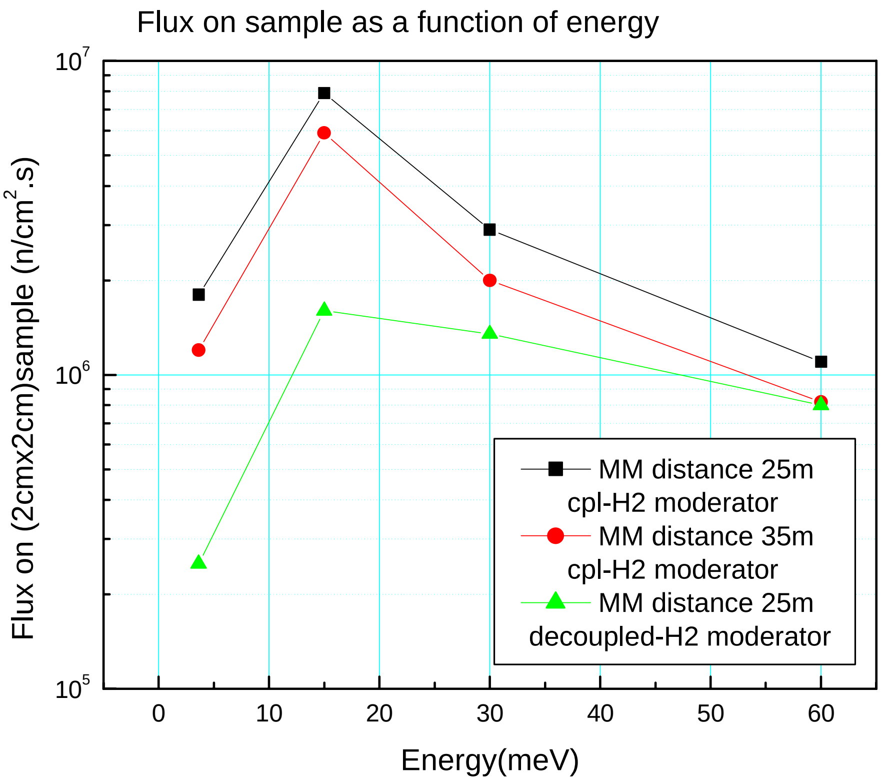


Figure 7: Energy dependence of the flux at the sample position for the coupled and de-coupled H_2 moderators

Since the simulations shown in Figure 7 have been performed for the same resolution $\Delta E/E_I$ at the same E_I values, it is clear that the decoupled H_2 moderator provides a significantly less attractive option than the configurations on the coupled H_2 moderator. In essence, this reflects the fact that HYSPEC is a medium resolution spectrometer, and is therefore a very poor match for the decoupled moderator, where the narrow (in time) neutron pulse, is much better suited to a high-incident-resolution instrument.

5) Other performance considerations

Although intensity and resolution are primary considerations for the performance of an instrument, there are other relevant factors that must also be included in an evaluation of the overall performance of an instrument. For each of the beamline options considered we have sought to itemize the main advantages and disadvantages of locating the instrument in this position

BL14B-25-4.5

Advantages	Disadvantages
• A high primary flux • Well matched primary and secondary spectrometers • Well matched to the coupled H_2 moderator pulse structure	• A potentially high background for weak inelastic neutron scattering (both in the hall in general and also from beamline BL15) • A limited range of monochromator angles because of other beamlines • The magnetic field restrictions in the hall will be a problem for polarization analysis experiments

BL14B-25-3.0

Advantages	Disadvantages
• A high primary flux	• Polarization analysis is not available because of the small value of L_{SD}. • Mismatched primary and secondary spectrometers • A potentially high background for weak inelastic neutron scattering (both in the hall in general and also from beamline BL15) • The magnetic field restrictions in the hall will be a problem for polarization analysis experiments

This configuration with a short sample to detector distance is unacceptable because it cannot facilitate polarization analysis in the secondary spectrometer. In the HYSPEC design[1] the two spin polarizations are only separated if the distance from the supermirror to the detector is 4m or greater. The situation is described in Appendix A. Thus a short detector (less than 4m) bank does not allow polarization analysis to be implemented on HYSPEC.

BL14B-35-4.5

Advantages	Dis-advantages
• The background will be lower, we expect at least a factor of 4x lower, almost certainly more than this • The full range of monochromator take off angles is available • A curved guide could be employed more effectively than for BL14B-25-4.5 to reduce background • The design of the monochromator drum shield is easier because the fast-neutron flux is lower • It may be possible to avoid the use of T_0 chopper with a curved guide	• The primary and secondary spectrometers are not optimally matched for the highest possible flux at sample/resolution combination.

BL14B-35-6.0 and BL14B-35-7.5

Advantages	Dis-advantages
• All the advantages of BL14B-35-4.5 • The Fermi chopper after the monchromator is not required because the disk chopper can be run at 300Hz to obtain a high resolution mode if required	• The mechanical design for secondary spectrometer is more challenging for a 6 or 7.5m bank (although doable) • The maintenance and operation of a large detector bank has a greater risk associated with it (more pieces, more things to go wrong)

BL10-25-4.5

Advantages	Dis-advantages
• The full range of monochromator take off angles is available	• A potentially high background for weak inelastic neutron scattering • The primary and secondary spectrometers are mismatched because of the narrow pulse width • Magnetic field restrictions in the hall

6) Options not considered here that require further work

There are a number of options, not considered so far, which may (or may not) enhance the performance of models BL14B-25-4.5, BL14B-35-4.5 and BL14B-35-7.5. These options are;

- Using a curved guide for background reduction. It may be possible with a curved guide to dispense with the need for a T_0 chopper.
- Using a ballistic guide expanding in both vertical and horizontal directions[5].
- An optimization of the focusing of the monochromator crystals for smaller samples, with an option to use either, or both, vertical or/and horizontal focusing.
- Using a Fermi chopper (before the monochromator) instead of the counter rotating double disk chopper pair, and employing time focusing techniques.
- Using only a Fermi chopper after the monochromator (no double disk chopper before the monochromator) and employing time focusing techniques.

7) Evaluation of the current options

The beamline models described in section 3 have been evaluated in terms of their performance and estimated additional cost. The results are given below.

Performance evaluation

In order to evaluate the performance the intensity and resolution results reported in section 4, and also the other performance criteria given in section 5 have been taken in to account. A ranking order of the performance of the models is given in Table 5 below, along with brief comments relating to the choice.

	Comments
BL14B-25-4.5	This model has a high flux at sample for good resolution. Polarization analysis is available. There are concerns about the background.
BL14B-35-7.5	This model has a flux at the sample comparable to BL14B-25-4.5 for the same energy resolution, but has a better background. Polarization analysis is available.
BL14B-35-6.0	This model has a flux at the sample lower than BL14B-35-7.5 but higher than BL14B-35-4.5. Polarization analysis is available.
BL14B-35-4.5	This model has a lower flux at the sample (65% – 75%) than BL14B-25-4.5 for the same energy resolution, but has a better background. Polarization analysis is available.
BL10-25-4.5	The flux loss from utilizing a decoupled moderator in this model makes this model uncompetitive.
BL14B-25-3.0	This model cannot be upgraded for polarization analysis.

Table 5: A ranking of the beamline models for HYSPEC based solely on the performance of the model.

Cost estimates

The model BL14B-25-4.5 corresponds to the model proposed to DoE[1] and as a consequence we have estimated the additional costs and savings for each of BL14B-35-4.5 and BL14B-35-7.5 over that of BL14B-25-4.5. These estimates are as follows.

BL14B-35-4.5

Extra 10m of m=3 guide and guide supports (inc. burden & contingency)	300k
Extra 10m of shielding (inc. burden & contingency)	900k
External building to house HYSPEC	1500k
Total extra cost	2700k

BL14B-35-7.5

Extra costs as for BL14B-35-4.5	2700k
Extra number of PSD detectors and electronics	1000k
Extra size and complexity of the detector housing etc. (inc. burden & contingency)	1200k
Total extra cost	4900k

8) Conclusions

The HYSPEC spectrometer was designed as a medium resolution instrument, capable of performing complete polarization analysis. It is therefore not surprising that the optimal configuration for HYSPEC is on a coupled H_2 moderator within the SNS experimental hall. Positioning HYSPEC on a decoupled moderator (BL10) is not an acceptable option because of the large loss of intensity. Locating HYSPEC on BL10 with the decoupled H_2 moderator would only provide 14% at 3.6meV, and 20% at 15meV, of the flux at the sample that is available on BL14B at 25m (BL14B-25-4.5).

If HYSPEC were moved outside of SNS experimental hall/building then there will be a substantial increase to the cost of the instrument. If L_{SD} is kept at 4.5m, the same value as inside the experimental hall, then we estimate this cost increase will be $2.7M. Keeping the same L_{SD} of 4.5m will sacrifice the intensity performance of the instrument by about 25 to 35%, but it may be possible to compensate for this loss in some experiments by instrumental design changes. An L_{SD} value of 7.5m would fully compensate for the intensity loss incurred by moving out of the building, but it would have an even higher additional cost, we estimate $4.9M. If this movement of HYSPEC out of the building is to be realistic then it is important to have a commitment for these additional funds or, at least, to have a plan on how the extra funds can be obtained.

The HYSPEC design team will look closely at cost estimates for moving the spectrometer outside the experimental hall. It is imperative that a decision about the placement of the instrument be made within 6 months, in order to proceed with the design of HYSPEC in a timely fashion.

References

[1] BNL proposal for HYSPEC, Formal Report BNL-52677
[2] G. Granroth and D. Abernathy, ICANS-XVI paper
[3] K. Nielsen and K. Lefmann, McStas manual
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[5] G. Granroth, private communication

Appendix A – Polarized Neutron Analysis

The polarization analysis option on HYSPEC utilizes a bank of polarizing supermirrors in front of the bank of PSD tubes to separate the two neutron polarizations. We have simulated the scattering/separation of the two neutron polarizations for different secondary flight path (sample to detector) lengths L_{SD} of 3.0m, 3.5m, 4.0m and 4.5m. The results are shown below in Figure 8.

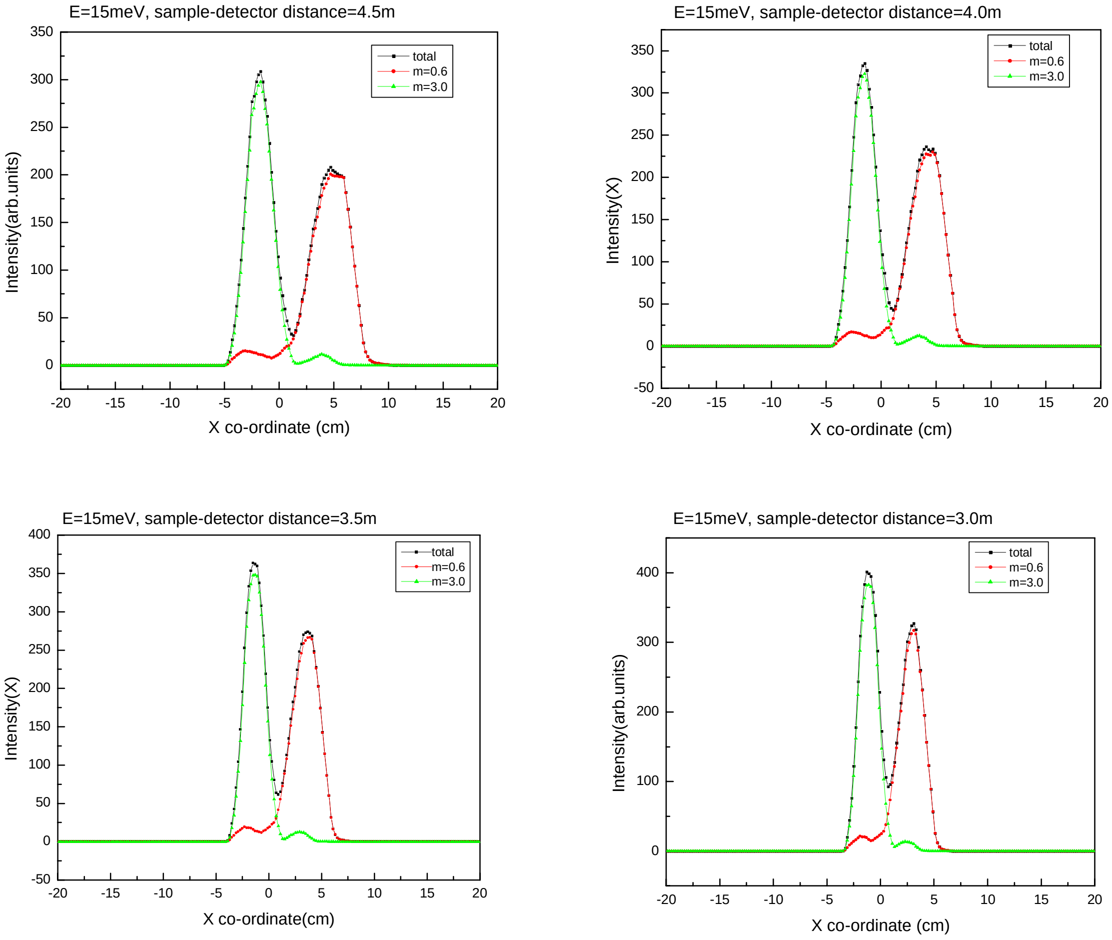

Figure 8: The spatial separation of the two polarization components for different sample to detector distances (L_{SD}).

The two polarizations only become sufficiently separated that they can be measured cleanly in two adjacent detector tubes for values of the secondary flight path $L_{SD} > 4.0$m. It should be noted that these are simulations, and therefore to some extent an idealized representation, it is likely that any practical factors that are not included in the simulation are more likely to smear the two peaks and make their separation more difficult. It would therefore be highly unwise to consider any situation other than the complete separation shown for 4.5m above.