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NB5 GP-SANS preliminary optics design

Thomas Huegle
J. Lee Robertson

August 2022

OAK RIDGE National Laboratory

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Neutron Technologies Division

GP-SANS PRELIMINARY OPTICS DESIGN

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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831
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ABSTRACT

This report describes the calculations and simulations to determine the optimal guide coatings for the NB5 (GP-SANS) beam line post beryllium reflector changeout. The reported guide performance meets the GP-SANS scientific requirements document [1].

1. Instrument description

1.1 PHYSICAL LAYOUT

The NB5 Beamline utilizes the center bottom part of the cold guide main shutter as described in [2]. Its initial direction is along the center line of the cold source beam tube. Starting directly after the main shutter, the remaining beam line uses a guide. The guide has a square cross section of 4 x 4 cm^2. At 4.63 m after the main shutter, the beam is diverted by 2° by means of an optical filter, followed by another straight guide section with 22.7 m length. At the end of this a velocity selector (VS) is placed. After the velocity selector, the beam line consists of 8 consecutive guide sections ("collimator sections", each 2 m in length), each sitting on a sled with three positions: guide in, aperture in, and empty. The sample can be placed freely in the sample area, which makes the next fixed reference point the entrance window of the detector tank.

Name	Start (along flightpath)	Description	Length
Source		HFIR cold Source	
Main shutter		Channel 2, with guide	0.6
Instrument Start	0.0		
Guide1	0.0	m=1	4.63
Optical filter	4.63	m=4 (outer side), m=1 (top/bottom), m=0 (inner side), rotated by 1° against Guide1	1.29
Guide2	5.92	m=1, rotated by 1° against Optical Filter	22.7
Velocity Selector Gap	28.62	Exact layout TBD	1.11
Guide2 extension		Within Velocity Selector Gap, m=1	~0.18
Velocity Selector		Within Velocity Selector Gap	0.25
Flux measurement	28.62 + 0.9	Position at which desired flux is defined	
8 Collimator Boxes	29.73	m=1, can individually be moved into beam	8 x ~2m
Tank Window	48.58	SANS tank window	

1.2 OPERATION

The beamline can move the 8 consecutive guide pieces in and out of the beam to adjust the beam intensity reaching the sample by manipulating the beam divergence. If intensity was not an issue, the instrument would achieve its best performance by measuring at very long wavelengths (~20AA) and at very low divergences (no collimations section in, a setting often referred to as N=0, where N is the number of collimation sections used). In reality, the flux at long wavelengths is often too low. The instrument can increase its flux on sample by two methods: Shifting to lower wavelengths (due to the shape of the cold source's spectrum), and moving more collimator sections in. Usually, the shift to lower wavelengths is done first, and only if this is not enough the divergence is increased.

The most relevant instrument configurations for the guide optimization are therefore:

- N=0, λ=20Å
- N=0, λ as close to the spectral peak flux as possible
- N=7, λ as close to the spectral peak flux as possible

The last collimator section (N=8) is rarely used, since the source does not provide enough high divergence neutrons for it to reflect onto the sample. Due to other limitations, "as close to the spectral peak as possible" means 3Å. Following the last collimation section with a guide piece in the beam, the next collimation section is usually set to insert its circular aperture into the flight path.

1.3 MCSTAS MODEL

See also Appendix A. The instrument was modeled in McStas using the cold source, beam tube and main shutter description developed by Lee Robertson. The precise starting point of the guide system was provided by the engineering group. All guides described hereafter have a square cross section of 4x4 cm^2, and a clearance of 0.5 mm is assumed between consecutive guide sections. The initial straight guide section (Guide1) is described by 5 individual pieces (4 x 1 m, 1 x 0.634 m). The "optical filter" which diverts the beam by 2° consists of 2 straight guide sections (1 x 1 m, 1 x 1.292 m), rotated by -1° from the original beam direction. This is followed by another straight guide section ("Guide2", 22 x 1m, 1 x 0.7m). The following gap intended for the Velocity Selector measures 1.111 m. At the time of this writing, the layout of the Velocity Selector gap is not finalized, but will likely include an 18 cm guide extension to reduce the length of the gap, as well as a newly purchased Airbus Velocity Selector with a rotor length of 25 cm.
Downstream of this, the beam line consists of 8 "Collimator Sections". Each section starts with an oversized aperture ("InterGuide Shield") which is irrelevant for the actual ray tracing aspect of the simulation, but is in reality one of the few parts accessible by the Survey& Alignment group, and therefore acts as the reference point for comparing placement in McStas and installed components. Precise locations of the InterGuide Shields were provided by Survey& Alignment and reflect the as-built, currently existing instrument. After the InterGuide Shields, the McStas model gives the choice of inserting either an "Entrance Aperture" (a circular slit of 20 mm radius) or two guide sections (1 m each). The exception is the first Collimator Section, where an additional choice is an Entrance Aperture with a radius of only 10 mm. This setting is sometimes referred to as "N = -1" and defines the lowest divergence the instrument can achieve. The 8^{th} collimator section is rarely used and will likely be removed in a future upgrade.
The instrument has no defined sample position, the sample can be freely moved in the sample area. Therefore, the next fixed point in the instrument is the Vacuum Tank Window at 18.846 m from the start of the collimator sections. In all calculations in this report, the sample was placed 20 cm upstream of the Vacuum Tank Window. The standard sample size is 1.2 cm in diameter.

2. ANALYTICAL CALCULATIONS

Using simple geometry, we can calculate the maximal reflection angle of a neutron between the end of the 7^{th} collimator piece and the bottom of the sample as *tan(0.026m/4.4255m)=0.34°*. At the optical filter, the maximal reflection angle is therefore 1.34°. Figure 1 shows the relationship of m-Value and Wavelength for these two reflection angles. To get optimal reflection of all 3Å neutrons, the system will require m=1.2 in all the straight guide sections, and m=4.5 in the optical filter. Since the collimator sections (as the last straight guide sections) are currently at m=1 and there are no plans in the foreseeable future to upgrade them, the instrument could also go for m=1 in all straight guide sections and m=4.0 in the optical filter.

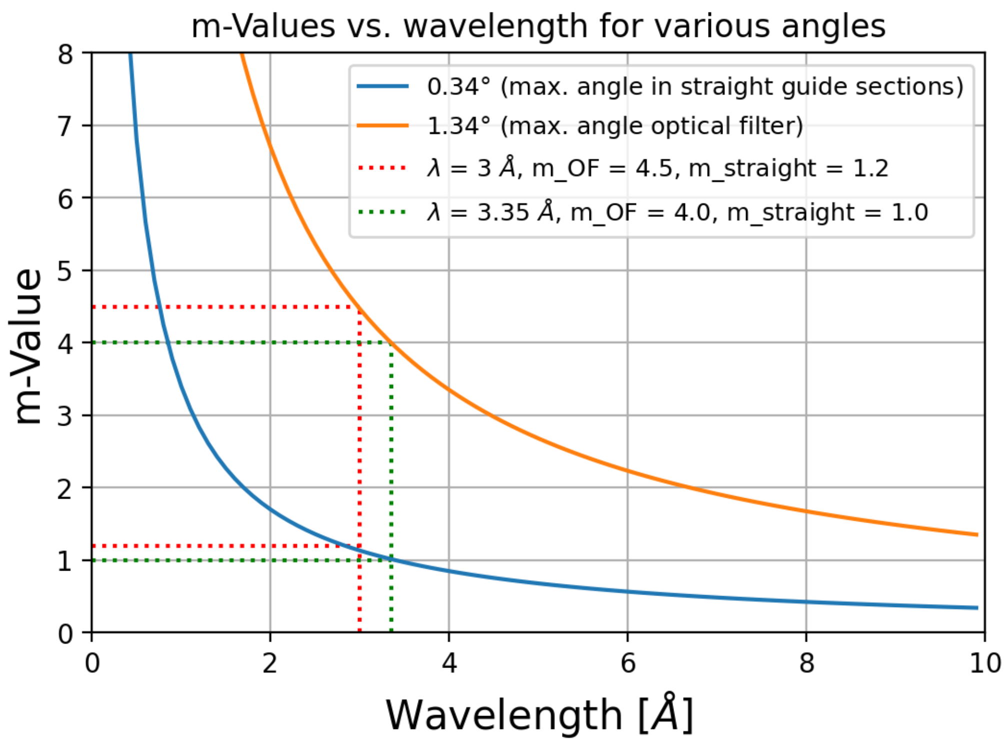

Figure 1. Relation between wavelengths and the m-Values necessary for perfect reflection under certain angles. Dotted lines: m-Value options for the optical filter based on an ideal instrument (red: defined by wavelength cutoff 3.0Å) and an instrument re-using the current collimator sections (green: defined by straight sections: m=1).

3. MCSTAS CALCULATIONS

3.1 SIMULATIONS

For a detailed description of the source and main shutter used, see [2].
McStas simulations were performed for the following options ("straight sections" includes the collimator sections):

- Current Instrument: m=1 (straight sections) / m=3 (optical filter)
- Re-using the current collimators: m=1 (straight sections) / m=4 (optical filter)

Theoretical optimum: m=1.1 (straight sections) / m=4.5 (optical filter)

3.2 RESULTS

Spectra were simulated at various points along the instrument. Table 1 sums up the integrated flux results for the simulations that are discussed in detail in the following sections.

Table 1. Simulated integrated flux for 3 guide options for various locations and settings in the instrument.

	Wavelength-Integrated Flux [n/s/cm^2]		
Position (Area) / **Guide option**	**Velocity Selector (→3.2.1) (16 cm^2)**	**Sample, 0 collimator sections (→3.2.2.1) (π*0.6^2 cm^2)**	**Sample, 7 collimator sections (→3.2.2.2) (π*0.6^2 cm^2)**
Current Instrument	1.24x10^9	4.55x10^7	5.79x10^8
Re-use collimators	2.10x10^9	8.97x10^7	9.87x10^8
Theoretical optimum	2.10x10^9	8.96x10^7	9.86x10^8

3.2.1 Velocity Selector

The simulated flux results at the end of the velocity selector gap are plotted in Figure 2. This position was defined by Ralph Moon [3] as “90 cm downstream of the Guide2 Exit”, which is equivalent to “21.88 cm upstream of the first collimator section’s InterGuide Shield”. The results show that significant gains can be had at short wavelengths by increasing the m-Value of the optical filter (Fig. 2,3). No significant difference in the region of interest (3-20Å) can be seen between the spectrum resulting from the theoretically optimal m-Values (1.1-4.5-1.1) and the one obtained by re-using the current collimators (1-4-1).
The overall improved performance of ~30% at longer wavelengths (Fig. 3) at this position compared to the currently existing instrument is due to:

- the added guide in the main shutter
- 18 cm of additional guide in the velocity selector gap (the new VS will be shorter than the current one).

The integrated flux numbers are summarized in Table 1 for all simulations.

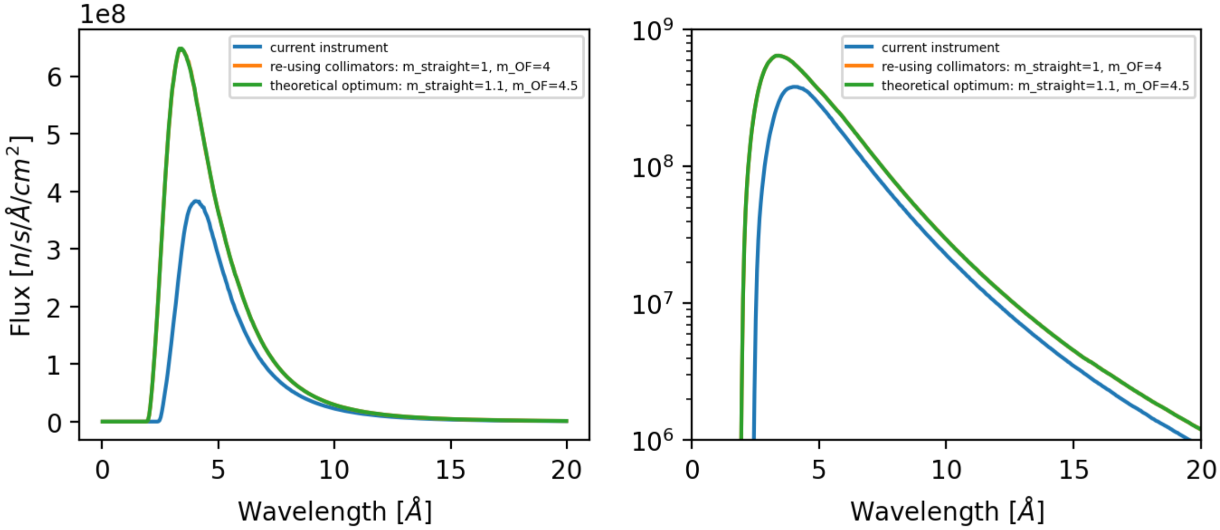

Figure 2. Simulated flux at the end of the velocity selector gap for several guide coating options. Left: linear y-scale, right: logarithmic y-scale. The guide exit has a cross section of 16cm^2.

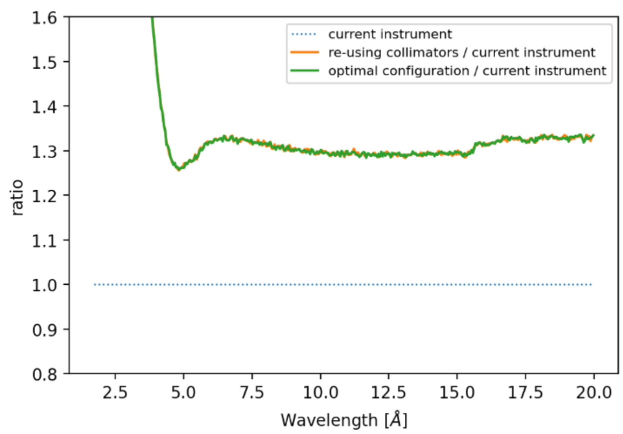

Figure 3. Increase in flux compared to current instrument at the velocity selector. Dotted line: Current instrument (100%), orange: re-using current collimator sections, m=1 (straight sections) / m=4 (optical filter); green: theoretical optimum, m=1.2 (straight sections) / m=4.5 (optical filter).

3.2.2 Sample Position

All sample simulations assume a sample radius of 6 mm. The sample position was arbitrarily chosen to be 20cm upstream of the tank window. The flux at the sample location was simulated using two settings for each of the three guide options:

- 0 collimator sections in (high resolution/low flux mode)
- 7 collimator sections in (low resolution/high flux mode)

3.2.2.1 0 collimator sections

When using 0 collimator sections, the flux at short wavelengths will be substantially improved in the post-HBRR instrument (Fig.4, 5). Minor improvements can be seen at long wavelengths. No discernable difference exists between the "theoretical optimum" guide and the "re-using the current collimators" option. The integrated flux numbers are summarized in Table 1 for all simulations.

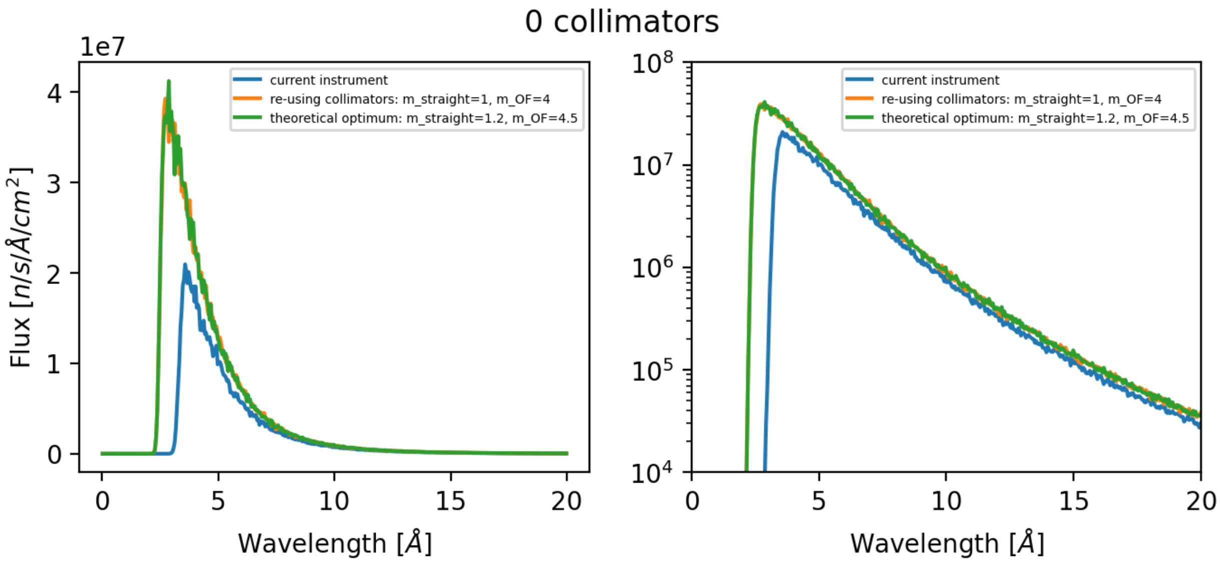

Figure 4. Simulated flux on sample for several guide coating options. Left: linear y-scale, right: logarithmic y-scale. The sample has a radius of 6 mm.

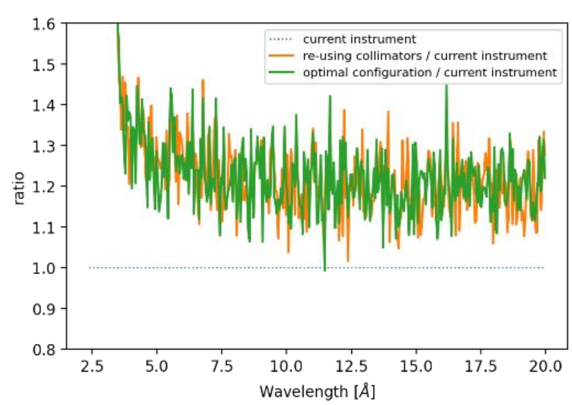

Figure 5. Increase in flux compared to current instrument at the sample. Dotted line: Current instrument (100%), orange: re-using current collimator sections, m=1 (straight sections) / m=4 (optical filter); green: theoretical optimum, m=1.2 (straight sections) / m=4.5 (optical filter).

3.2.2.2 7 collimator sections

When using 7 collimator sections, the flux at short wavelengths will be substantially improved in the post-HBRR instrument (Fig 6, 7). Minor improvements can be seen at long wavelengths. No discernable difference exists between the "theoretical optimum" guide and the "re-using the current collimators" option. The integrated flux numbers are summarized in Table 1 for all simulations.

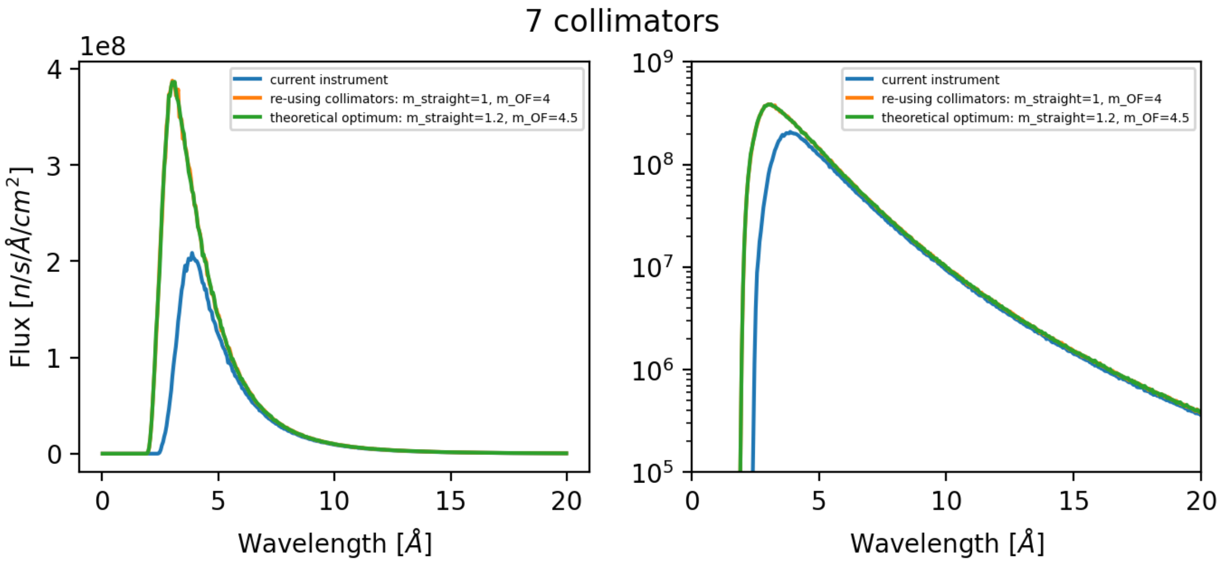

Figure 6. Simulated flux on sample for several guide coating options. Left: linear y-scale, right: logarithmic y-scale. The sample has a radius of 6 mm.

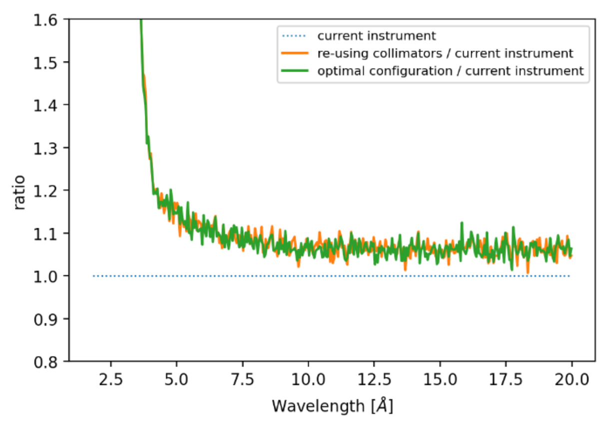

Figure 7. Increase in flux compared to current instrument at the sample. Dotted line: Current instrument (100%), orange: re-using current collimator sections, m=1 (straight sections) / m=4 (optical filter); green: theoretical optimum, m=1.2 (straight sections) / m=4.5 (optical filter).

4. SUMMARY

Two different guide coating options for the post-HBRR GP-SANS guide system were simulated and compared to the currently existing instrument's performance. The HBRR GP-SANS scientific requirements document [1] requests 3.25 x 10^{10} n/s flux at the velocity selector position. This requirement will be met by both guide coating options (simulated flux at the velocity selector position: 3.36 x 10^{10} n/s for both cases). No difference in performance was found in the regions of interest (3-20 Å, sample radius 6 mm) between the guide coating options of either using m=1 in the straight sections and m=4 in the optical filter, or using m=1.2 in the straight section and m=4.5 in the optical filter.

5. REFERENCES

[1] Lisa DeBeer-Schmitt, Cassie Sabens, *HFIR Beryllium Reflector Replacement Project Science Requirements Document for NB5 GP-SANS*, NB5-SR-00-0001,.

[2] Matthew J. Frost et al, *Ray-Tracing Simulations Characterizing the Performance of the Proposed HFIR HB4 Main Shutter*, ORNL-TM-2021/2181, Oak Ridge National Laboratory (August 2021).

[3] R. A. Moon, ORNL internal memo, 2007.

APPENDIX A. McStas Instrument file

```
/******************************************************************************
*
* Instrument: NB-5
*
* %Identification
* Written by: Lee Robertson (robertsonjl@ornl.gov)
* Modified by: Thomas Huegle (hueglet@ornl.gov)
* Date: 22may2018
* Modified: 19sept2022
* Origin: ORNL
* McStas Version 2.X
* %INSTRUMENT_SITE: ORNL
*
* %Description
* NB-5 Beamline.  The New General Purpose SANS Instrument (matching current geometry
with sample position pushed back by ~3m)
*
*******************************************************************************/

DEFINE INSTRUMENT GP_SANS_tally()
DECLARE
%{
double VS_Central_Wavelength =        12.0;        //Wavelength of the neutrons
transmitted by the velocity selector in Angstroms.  Disk rotation speed is calculated
from this.
double VS_Tilt_Angle =                0.0;        //Rotation of the whole velocity
selector about a vertical axis passing through its center in degrees.

int          N =    0;        //Number of collimator guide sections translated into
the beam.
double Collimator1_Entrance_Aperture =  0;        //Aperture in front of the guide in
collimator section #1 (vaild values = 0, 20, 40)
double Collimator2_Entrance_Aperture =  0;        //Aperture in front of the guide in
collimator section #2 (vaild values = 0, 40)
double Collimator3_Entrance_Aperture =  0;        //Aperture in front of the guide in
collimator section #3 (vaild values = 0, 40)
double Collimator4_Entrance_Aperture =  0;        //Aperture in front of the guide in
collimator section #4 (vaild values = 0, 40)
double Collimator5_Entrance_Aperture = 0;        //Aperture in front of the guide in
collimator section #5 (vaild values = 0, 40)
double Collimator6_Entrance_Aperture = 0;        //Aperture in front of the guide in
collimator section #6 (vaild values = 0, 40)
double Collimator7_Entrance_Aperture = 0;        //Aperture in front of the guide in
collimator section #7 (vaild values = 0, 40)
double Collimator8_Entrance_Aperture = 40;        //Aperture in front of the guide in
collimator section #8 (vaild values = 0, 40)
double sampleRadius = 0.006;
double Sample_to_Detector_Distance = 19;        //Distance in m from the sample to the
detector.
int m_straight = 1;
int of_mx = 4;
int of_my = 1;
double       IN2M = 25.4 / 1000.0;   // Unit conversion from inches to meters
char   shutter_filename[255];

//These parameters will only be used by Lee Robertson't tally components:
int Tally =       0;
int    tally_flag;
```

```
int    tally_neutron_index;
int    tally_number_of_events;
int    tally_event_component_index[400];
int    tally_event_component_type[400];
double tally_event_position[400][3];
double tally_event_velocity[400][3];
double tally_event_weight[400];
double tally_reflection_q[400];
int    tally_reflection_mirror_index[400];
FILE   *tally_event_list_fp;
int    tally_number_of_components;
int    tally_component_index[400];
int    tally_component_type[400];
char   tally_component_name[400][255];
char   tally_module_name[400][128];

%}

INITIALIZE
%{
  Wavelength_Min =               0;        //Minimum neutron wavelength to be
generated.  Should be chosen to with respect to VS_Central_Wavelength
  Wavelength_Max =               20;        //Maximum neutron wavelength to be
generated.  Should be chosen to with respect to VS_Central_Wavelength
  sprintf(shutter_filename,"%s","../hb4-cold-source-2024/main_shutter_S2.off");

//This section will only be used by Lee Robertson't tally components:
  tally_flag = Tally;
  char tally_output_file_name[255];
  if (tally_flag == 1)
  {  sprintf(tally_output_file_name, "%s", "GPSANS_neutron_event_list.dat");
     tally_event_list_fp = fopen(tally_output_file_name, "w");
     if (tally_event_list_fp == NULL)
     {
         printf("Error opening file %s!\n", tally_output_file_name);
         exit(1);
     }
  }
%}

TRACE

//*******************************************************************************
*********************************************
// Define the absolute instrument coordinate system with the origin at the center line
of the reactor pressure vessel.
// Many of the drawings of the HB-4 beamtube use this as the reference.
// The positive Z-axis is along the beamtube centerline.
// The positive Y-axis is pointing up.
// The positive X-axis is pointing to the left looking down the beamtube toward the
reactor core. (Right handed coordinate system)

COMPONENT Pressure_Vessel_CL_Coordinate_System = Progress_bar()
  AT (0.0, 0.0, 0.0) ABSOLUTE

//*******************************************************************************
*********************************************

%include "../hb4-cold-source-2024/HB4_Beamtube.instr"  // ORNL-TM-2021/2181

//*******************************************************************************
*********************************************
```

```
%include "../hb4-cold-source-2024/HB4_Main_Shutter.instr"  //ORNL-TM-2021/2181

//************************************************************************************
************************************************
//
// Guide1
//
//************************************************************************************
**********************************************

COMPONENT NB5_Beam_Coordinate_System = Arm()
  AT (-0.001787004, -0.0050, 4.653991) RELATIVE Source
  ROTATED (0.0, -0.022, 0.0) RELATIVE Source

COMPONENT NB5_Guide1_Entrance_Mask = Slit(xwidth=0.040, yheight=0.040)  // Block the
neutrons that will not enter the guide before characterizing the beam at the guide
entrance
  AT (0.0, 0.0, 0.0) RELATIVE NB5_Beam_Coordinate_System

COMPONENT NB5_Guide1_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0.0, 0.0, 0.0) RELATIVE NB5_Beam_Coordinate_System

COMPONENT NB5_Guide1_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0.0, 0.0, 1.0005) RELATIVE PREVIOUS    //The 0.5mm gap is for installation
clearence

COMPONENT NB5_Guide1_3 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0.0, 0.0, 1.0005) RELATIVE PREVIOUS    //The 0.5mm gap is for installation
clearence

COMPONENT NB5_Guide1_4 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0.0, 0.0, 1.0005) RELATIVE PREVIOUS    //The 0.5mm gap is for installation
clearence

COMPONENT NB5_Guide1_5 = Guide(w1 = 0.040, h1 = 0.040, l = 0.634, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0.0, 0.0, 1.0005) RELATIVE PREVIOUS    //The 0.5mm gap is for installation
clearence

// Create reference position at the end of Guid1 + 0.5mm

COMPONENT NB5_End_of_Guide1_coordinate_System = Arm()
  AT (0.0, 0.0, 0.634 + 0.0005) RELATIVE PREVIOUS


//************************************************************************************
**********************************************
//
// Optical Filter
//
// The optical filter is a section of guide rotated by 1 degree from the previous
guide and is used to deflect the beam by 2 degrees
// The total length must be 2.292m to match the current GP SANS configuration
//************************************************************************************
**********************************************

COMPONENT NB5_Optical_Filter_Coordinate_System = Arm()
  AT (0.0, 0.0, 0.0005) RELATIVE NB5_End_of_Guide1_coordinate_System
  ROTATED (0.0, -1.0, 0.0) RELATIVE NB5_Beam_Coordinate_System
```

```
COMPONENT NB5_Optical_Filter_1 = Guide_channeled(w1 = 0.040, h1 = 0.040, l = 1.0, R0 =
0.99, Qc = 0.0219, alphax = 3.044, alphay = 3.044, mx = of_mx, my = of_my, W = 0.0025)
  AT (0.0, 0.0, 0.0) RELATIVE NB5_Optical_Filter_Coordinate_System

COMPONENT NB5_Optical_Filter_2 = Guide_channeled(w1 = 0.040, h1 = 0.040, l = 1.292, R0
= 0.99, Qc = 0.0219, alphax = 3.044, alphay = 3.044, mx = of_mx, my = of_my, W =
0.0025)
  AT (0.0, 0.0, 1.0005) RELATIVE PREVIOUS    //The 0.5mm gap is for installation
clearence


//************************************************************************************
********************************************
//
// Guide2
//
// Define a new coordinate system for the second straight guide section along the beam
direction defined by the optical filter.
//************************************************************************************
********************************************

COMPONENT NB5_Guide2_Coordinate_System = Arm()
  AT (0.0, 0.0, 2.292 + 0.0015) RELATIVE NB5_Optical_Filter_Coordinate_System // The
gap is added on for installtion clearance
  ROTATED (0.0, -1.0, 0.0) RELATIVE NB5_Optical_Filter_Coordinate_System

COMPONENT NB5_Guide2_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 0) RELATIVE NB5_Guide2_Coordinate_System

COMPONENT NB5_Guide2_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_3 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_4 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_5 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_6 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_7 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_8 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_9 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence
```

```
COMPONENT NB5_Guide2_10 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_11 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_12 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_13 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_14 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_15 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_16 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_17 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_18 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_19 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_20 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_21 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_22 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

COMPONENT NB5_Guide2_23 = Guide(w1 = 0.040, h1 = 0.040, l = 0.7, R0 = 0.99, Qc =
0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 1.0005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

// Generate a reference position at the end of Guide2
COMPONENT NB5_End_of_Guide2_Coordinate_System = Arm()
  AT (0, 0, 0.7005) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence


//*************************************************************************************
*********************************************
```

```
//
// Velocity Selector gap
//
//*******************************************************************************
*********************************************

COMPONENT NB5_Guide2_extension = Guide(w1 = 0.040, h1 = 0.040, l = 0.181, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  AT (0, 0, 0) RELATIVE PREVIOUS  // The 0.5mm gap is for installation clearence

// Simulate the helical disk velocity selector bought from Mirrortron
// New VS coordinates according to Cassie, New VS params according to Bill:

//~ COMPONENT VS_center_csys = Arm()
  //~ AT (0, 0, 0.412318 + 0.081 - 0.04) RELATIVE NB5_End_of_Guide2_Coordinate_System
  //~ ROTATED (0, VS_Tilt_Angle, 0) RELATIVE NB5_End_of_Guide2_Coordinate_System

//~ COMPONENT VS   = Selector(xwidth = 0.04,  yheight = 0.04, length = 0.25, nslit =
72, d=0.0004, radius=0.12, alpha = 48.3, nu = 3956 * 48.3 * DEG2RAD / 2 / PI /
VS_Central_Wavelength / 0.25)
  //~ AT (0, 0, -0.25/2) RELATIVE VS_center_csys
  //~ ROTATED (0, 0, 0) RELATIVE VS_center_csys

/// Guide2_Exit_plus90cm detectors, xwidth=0.04, yheight=0.04, bins=400, Lmin=0,
Lmax=20, maxDiv=3.0 ///

COMPONENT DetectorPack_Guide2_Exit_plus90cm = Arm()
  AT (0.0, 0.0, 0.9) RELATIVE NB5_End_of_Guide2_Coordinate_System

    COMPONENT Guide2_Exit_plus90cm_Flux = Monitor(xwidth = 0.04, yheight = 0.04)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Image = PSD_monitor(nx = 400, ny = 400, filename =
"Guide2_Exit_plus90cm_image", xwidth = 2*0.04, yheight = 2*0.04)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Spectrum = L_monitor(nL = 400, filename =
"Guide2_Exit_plus90cm_spectrum", xwidth = 0.04, yheight = 0.04, Lmin = 0, Lmax = 20)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Vertical_Divergence = Hdiv_monitor(nh = 400,
filename="Guide2_Exit_plus90cm_vertical_divergence", xwidth = 0.04, yheight = 0.04,
h_maxdiv = 3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
      ROTATED (0.0, 0.0, 90.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Horizontal_Divergence = Hdiv_monitor(nh = 400,
filename="Guide2_Exit_plus90cm_horizontal_divergence", xwidth = 0.04, yheight = 0.04,
h_maxdiv=3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
      ROTATED (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Divergence_Map = Divergence_monitor(nh = 400, nv =
400, filename="Guide2_Exit_plus90cm_divergence_map", xwidth = 0.04, yheight = 0.04,
maxdiv_h = 3.0, maxdiv_v = 3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Horizontal_Phase_Space_Map = DivPos_monitor(nh =
400, ndiv = 400, filename="Guide2_Exit_plus90cm_horizontal_phase_space_map", xwidth =
0.04, yheight = 0.04, maxdiv_h = 3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Vertical_Phase_Space_Map = DivPos_monitor(nh = 400,
ndiv = 400, filename="Guide2_Exit_plus90cm_vertical_phase_space_map", xwidth = 0.04,
yheight = 0.04, maxdiv_h = 3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
      ROTATED (0.0, 0.0, 90.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Vertical_divergenceMonitor_xL =
DivLambda_monitor(xwidth = 0.04, yheight = 0.04, nL=400, nh = 400, filename =
"Guide2_Exit_plus90cm_vertical_divLambda_map", maxdiv_h = 3.0, Lmin = 0, Lmax = 20)
```

```
      AT (0, 0, 0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
      ROTATED (0.0, 0.0, 90.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
    COMPONENT Guide2_Exit_plus90cm_Horizontal_divergenceMonitor_xL =
DivLambda_monitor(xwidth = 0.04, yheight = 0.04, nL=400, nh = 400, filename =
"Guide2_Exit_plus90cm_horizontal_divLambda_map", maxdiv_h = 3.0, Lmin = 0, Lmax = 20)
      AT (0, 0, 0) RELATIVE DetectorPack_Guide2_Exit_plus90cm
      ROTATED (0.0, 0.0, 0.0) RELATIVE DetectorPack_Guide2_Exit_plus90cm


//*************************************************************************************
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//
// Collimator Sections
//
//*************************************************************************************
**********************************************

COMPONENT Collimator_Section_Coordinate_System = Arm()  // Set to be the end of
Guide_2 because that is the reference used for the data from the millwrights
  AT (0.0, 0.0, 22.7115 + 1.11312 - 0.002) RELATIVE NB5_Guide2_Coordinate_System
  ROTATED (0.0, 0.0, 0.0) RELATIVE NB5_Guide2_Coordinate_System

// Collimator Guide Section #1

COMPONENT NB5_Collimator1_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)   // See Drawing M11540-0N-332-E0 Rev0
  AT (0.0, 0.0, 0) RELATIVE Collimator_Section_Coordinate_System

COMPONENT NB5_Collimator1_Entrance_Aperture_20mm = Slit(radius = 0.010)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator1_Entrance_Aperture == 20)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator1_InterGuide_Shield

COMPONENT NB5_Collimator1_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-320-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator1_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.003) RELATIVE NB5_Collimator1_InterGuide_Shield

COMPONENT NB5_Collimator1_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 0)
  AT (0.0, 0.0, 0.004) RELATIVE NB5_Collimator1_InterGuide_Shield

COMPONENT NB5_Collimator1_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 0)
  AT (0.0, 0.0, 0.004 + 1.0005) RELATIVE NB5_Collimator1_InterGuide_Shield


// Collimator Guide Section #2

COMPONENT NB5_Collimator2_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)     //See Drawing M11540-ON-332-E Rev0
  AT (0.0, 0.0, 2.0535621) RELATIVE NB5_Collimator1_InterGuide_Shield

COMPONENT NB5_Collimator2_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator2_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator2_InterGuide_Shield
```

```
COMPONENT NB5_Collimator2_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 1)
  AT (0.0, 0.0, 0.028579) RELATIVE NB5_Collimator2_InterGuide_Shield

COMPONENT NB5_Collimator2_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 1)
  AT (0.0, 0.0, 0.028579 + 1.0005) RELATIVE NB5_Collimator2_InterGuide_Shield


// Collimator Guide Section #3

COMPONENT NB5_Collimator3_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)     //See Drawing M11540-ON-332-E Rev0
  AT (0.0, 0.0, 2.0300162) RELATIVE NB5_Collimator2_InterGuide_Shield

COMPONENT NB5_Collimator3_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator3_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator3_InterGuide_Shield

COMPONENT NB5_Collimator3_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 2)
  AT (0.0, 0.0, 0.004613) RELATIVE NB5_Collimator3_InterGuide_Shield

COMPONENT NB5_Collimator3_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 2)
  AT (0.0, 0.0, 0.004613 + 1.0005) RELATIVE NB5_Collimator3_InterGuide_Shield


// Collimator Guide Section #4

COMPONENT NB5_Collimator4_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)   // See Drawing M11540-0N-332-E0 Rev0
  AT (0.0, 0.0, 2.0312634) RELATIVE NB5_Collimator3_InterGuide_Shield

COMPONENT NB5_Collimator4_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator4_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator4_InterGuide_Shield

COMPONENT NB5_Collimator4_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 3)
  AT (0.0, 0.0, 0.008233) RELATIVE NB5_Collimator4_InterGuide_Shield

COMPONENT NB5_Collimator4_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 3)
  AT (0.0, 0.0, 0.008233 + 1.0005) RELATIVE NB5_Collimator4_InterGuide_Shield


// Collimator Guide Section #5

COMPONENT NB5_Collimator5_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)   // See Drawing M11540-0N-332-E0 Rev0
  AT (0.0, 0.0, 2.0298156) RELATIVE NB5_Collimator4_InterGuide_Shield
```

```
COMPONENT NB5_Collimator5_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator5_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator5_InterGuide_Shield

COMPONENT NB5_Collimator5_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 4)
  AT (0.0, 0.0, 0.008926) RELATIVE NB5_Collimator5_InterGuide_Shield

COMPONENT NB5_Collimator5_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 4)
  AT (0.0, 0.0, 0.008926 + 1.0005) RELATIVE NB5_Collimator5_InterGuide_Shield  // The
0.5mm gap is for nstallation clearence


// Collimator Guide Section #6

COMPONENT NB5_Collimator6_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)   // See Drawing M11540-0N-332-E0 Rev0
  AT (0.0, 0.0, 2.0325106) RELATIVE NB5_Collimator5_InterGuide_Shield

COMPONENT NB5_Collimator6_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator6_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator6_InterGuide_Shield

COMPONENT NB5_Collimator6_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 5)
  AT (0.0, 0.0, 0.011923) RELATIVE NB5_Collimator6_InterGuide_Shield

COMPONENT NB5_Collimator6_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 5)
  AT (0.0, 0.0, 0.011923 + 1.0005) RELATIVE NB5_Collimator6_InterGuide_Shield


// Collimator Guide Section #7

COMPONENT NB5_Collimator7_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)   // See Drawing M11540-0N-332-E0 Rev0
  AT (0.0, 0.0, 2.0318044) RELATIVE NB5_Collimator6_InterGuide_Shield

COMPONENT NB5_Collimator7_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator7_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator7_InterGuide_Shield

COMPONENT NB5_Collimator7_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 6)
  AT (0.0, 0.0, 0.010368) RELATIVE NB5_Collimator7_InterGuide_Shield

COMPONENT NB5_Collimator7_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 6)
  AT (0.0, 0.0, 0.010368+ 1.0005) RELATIVE NB5_Collimator7_InterGuide_Shield  // The
0.5mm gap is for installation clearence
```

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// Collimator Guide Section #8

COMPONENT NB5_Collimator8_InterGuide_Shield = Slit(xmin = -0.021, xmax = 0.021, ymin =
-0.021, ymax = 0.031)   // See Drawing M11540-0N-332-E0 Rev0
  AT (0.0, 0.0, 2.0303388) RELATIVE NB5_Collimator7_InterGuide_Shield

COMPONENT NB5_Collimator8_Entrance_Aperture_40mm = Slit(radius = 0.020)   // See
Drawings M11540-0N-321-E-Rev0 and See Drawings M11540-0N-316A-E-Rev1  NOTE: There
apertures are reversed on M11540-0N-316A-E-Rev1
  WHEN (Collimator8_Entrance_Aperture == 40)
  AT (0.0, 0.0, 0.002) RELATIVE NB5_Collimator8_InterGuide_Shield

COMPONENT NB5_Collimator8_Guide_1 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 7)
  AT (0.0, 0.0, 0.008274) RELATIVE NB5_Collimator8_InterGuide_Shield

COMPONENT NB5_Collimator8_Guide_2 = Guide(w1 = 0.040, h1 = 0.040, l = 1.0, R0 = 0.99,
Qc = 0.0219, alpha = 3.044, m = m_straight, W = 0.0025)
  WHEN (N > 7)
  AT (0.0, 0.0, 0.008274 + 1.0005) RELATIVE NB5_Collimator8_InterGuide_Shield  // The
0.5mm gap is for installation clearence


//~ // Generate a reference position at the end of the Collimator Sections
COMPONENT NB5_End_of_CollimatorGuides_Coordinate_System = Arm()
  AT (0, 0, 1.0) RELATIVE PREVIOUS

COMPONENT NB5_Collimator8_InterGuide_Shield_Last = Slit(xmin = -0.021, xmax = 0.021,
ymin = -0.021, ymax = 0.031)   // See Drawing M11540-0N-332-E0 Rev0
  AT (0.0, 0.0, 2.03) RELATIVE NB5_Collimator8_InterGuide_Shield


//*************************************************************************************
**********************************************
//
// Sample Area
//
//*************************************************************************************
**********************************************

COMPONENT NB5_SANS_Tank_Window_Coordinate_System = Arm()  // Coordinates from
millright data on the collimator sections
  AT (0.0, 0.0, 19.958959 - 1.11312) RELATIVE Collimator_Section_Coordinate_System

COMPONENT NB5_Sample_Position_Coordinate_System = Arm()
  AT (0, 0, -0.200) RELATIVE NB5_SANS_Tank_Window_Coordinate_System  //The 20cm in
front of the tank window is aribitray since this position is adjustable from the end
of guide 8 to the sample is just a guess.

COMPONENT NB5_Sample_Position_Image_Before_Aperture = PSD_monitor(nx = 400, ny = 400,
filename = "NB5_Sample_Position_image_before_aperture", xwidth = 0.2, yheight = 0.2)
  AT (0.0, 0.0, -0.003) RELATIVE NB5_Sample_Position_Coordinate_System

COMPONENT NB5_Sample_aperture = Slit(radius=sampleRadius)
  AT (0.0, 0.0, -0.001) RELATIVE NB5_Sample_Position_Coordinate_System

/// Sample detectors, xwidth=0.02, yheight=0.02, bins=400, Lmin=0, Lmax=20, maxDiv=3.0
///

COMPONENT DetectorPack_Sample = Arm()
```

```
  AT (0.0, 0.0, 0.0) RELATIVE NB5_Sample_aperture

    COMPONENT Sample_Flux = Monitor(xwidth = 0.02, yheight = 0.02)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Image = PSD_monitor(nx = 400, ny = 400, filename =
"Sample_image", xwidth = 2*0.02, yheight = 2*0.02)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Spectrum = L_monitor(nL = 400, filename = "Sample_spectrum",
xwidth = 0.02, yheight = 0.02, Lmin = 0, Lmax = 20)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Vertical_Divergence = Hdiv_monitor(nh = 400,
filename="Sample_vertical_divergence", xwidth = 0.02, yheight = 0.02, h_maxdiv = 3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
      ROTATED (0.0, 0.0, 90.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Horizontal_Divergence = Hdiv_monitor(nh = 400,
filename="Sample_horizontal_divergence", xwidth = 0.02, yheight = 0.02, h_maxdiv=3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
      ROTATED (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Divergence_Map = Divergence_monitor(nh = 400, nv = 400,
filename="Sample_divergence_map", xwidth = 0.02, yheight = 0.02, maxdiv_h = 3.0,
maxdiv_v = 3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Horizontal_Phase_Space_Map = DivPos_monitor(nh = 400, ndiv = 400,
filename="Sample_horizontal_phase_space_map", xwidth = 0.02, yheight = 0.02, maxdiv_h
= 3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Vertical_Phase_Space_Map = DivPos_monitor(nh = 400, ndiv = 400,
filename="Sample_vertical_phase_space_map", xwidth = 0.02, yheight = 0.02, maxdiv_h =
3.0)
      AT (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample
      ROTATED (0.0, 0.0, 90.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Vertical_divergenceMonitor_xL = DivLambda_monitor(xwidth = 0.02,
yheight = 0.02, nL=400, nh = 400, filename = "Sample_vertical_divLambda_map", maxdiv_h
= 3.0, Lmin = 0, Lmax = 20)
      AT (0, 0, 0) RELATIVE DetectorPack_Sample
      ROTATED (0.0, 0.0, 90.0) RELATIVE DetectorPack_Sample
    COMPONENT Sample_Horizontal_divergenceMonitor_xL = DivLambda_monitor(xwidth =
0.02, yheight = 0.02, nL=400, nh = 400, filename = "Sample_horizontal_divLambda_map",
maxdiv_h = 3.0, Lmin = 0, Lmax = 20)
      AT (0, 0, 0) RELATIVE DetectorPack_Sample
      ROTATED (0.0, 0.0, 0.0) RELATIVE DetectorPack_Sample

FINALLY
%{

%}

END
```