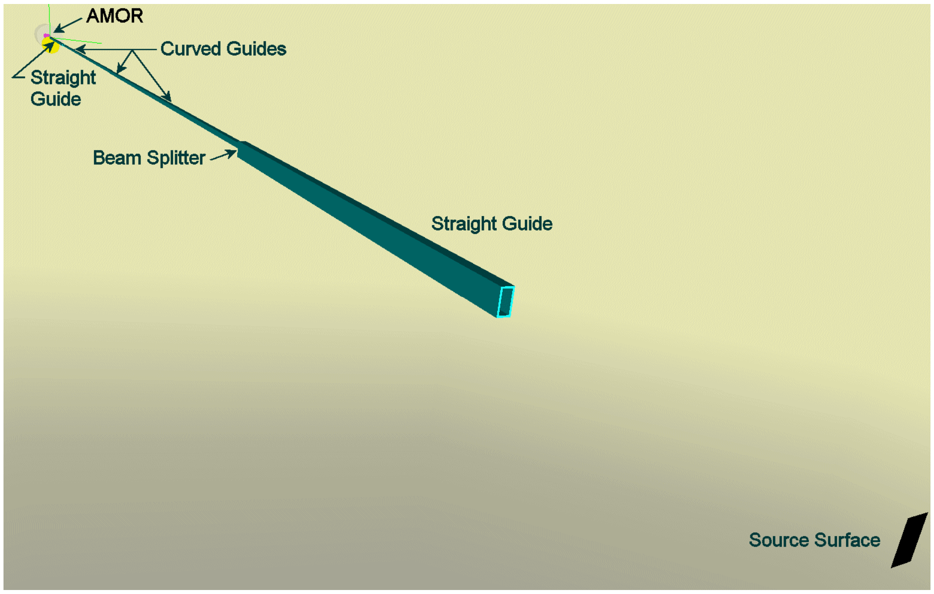
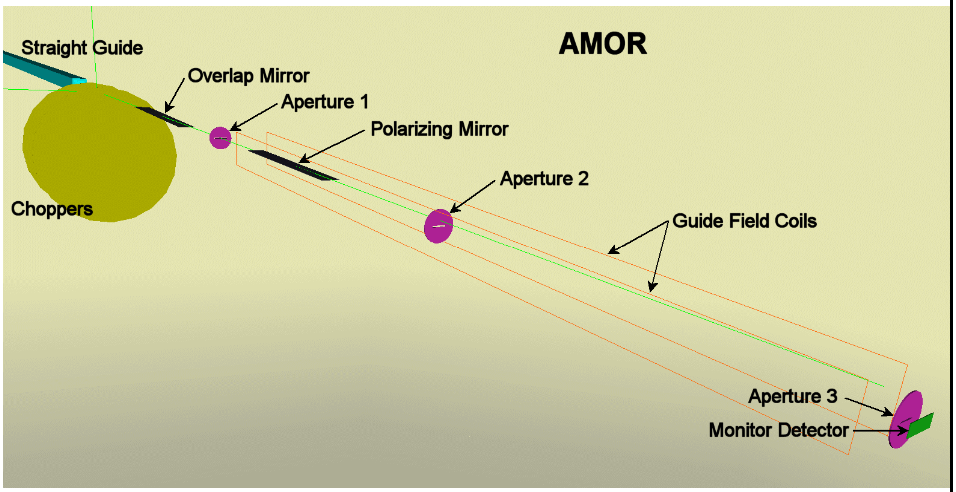
# Simulation of AMOR at SINQ




Neutron Instrument Simulation Package 1 http://PASeeger.com

# Simulation of AMOR at SINQ




Neutron Instrument Simulation Package 2 http://PASeeger.com

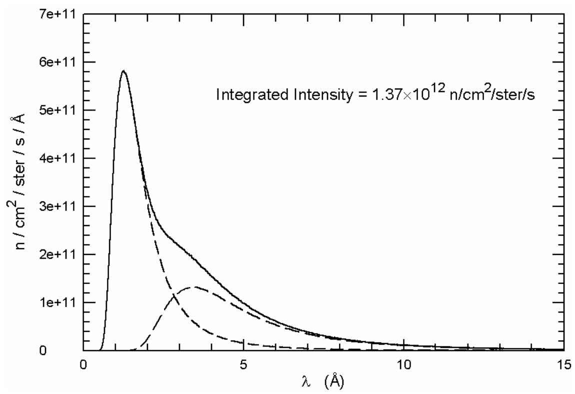
# Simulation of AMOR at SINQ

### Source Spectrum

NISP uses direct sampling of the sum of two Maxwellian distributions. One random number is used to select which Maxwellian, then three additional random numbers sample that energy distribution:

```
A = ran(iseed)
B = ran(iseed)
C = ran(iseed)
E = -
E0[ln(A)+ln(B)cos²(πC/2)]
```

Real*8 random numbers are used. On a 2.8-GHz PC, the execution time is 0.72 µs per neutron.



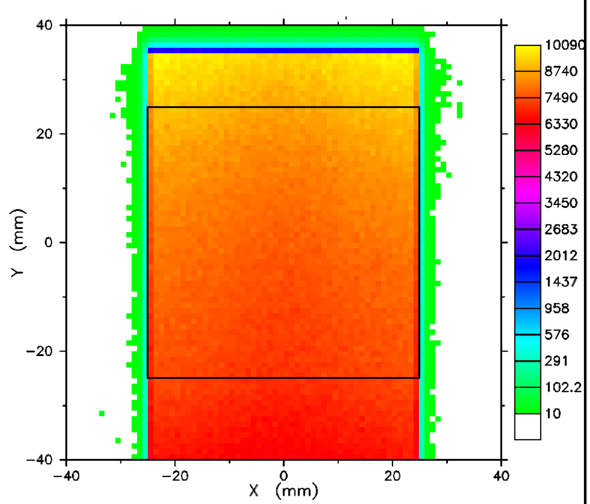



# Simulation of AMOR at SINQ

### X–Y @ End of Guide 1 (beam splitter)

The first guide section includes two beams, with AMOR having the upper portion. The intensity scale is quadratic (proportional to statistical uncertainties). The 50×50 mm² square box shows the opening of the AMOR curved guide. Since measurements are generally made with a low-efficiency monitor with 1/v sensitivity, we also estimate the λ-weighted count rate (normalized to 2200 m/s).

Energy on target: 6.640E-4 MW-s
Sum of neutrons: 2.989E7
Sum in 50×50 mm²: 1.987E7
λ-weighted sum: 5.499E7
mean wavelength: 4.977 Å
**flux @ 0.57 MW = 1.026×10⁹ n/s/cm²**

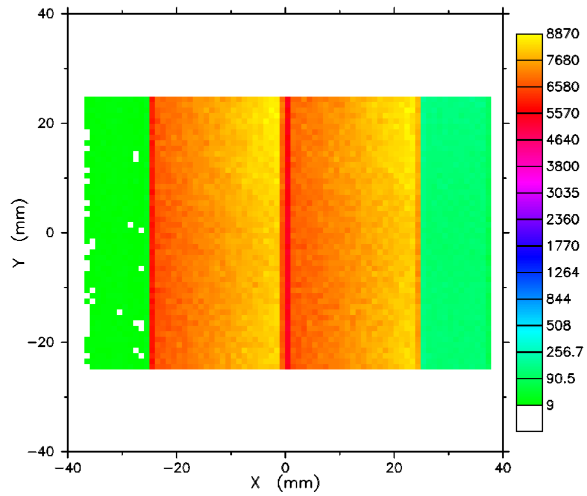


## Simulation of AMOR at SINQ

**X–Y after Guide 2, Section 1**

The guide curves to the left, so there are more neutrons escaping on the right side. The guide also has a central blade forming two channels with supermirror reflectors on the sides. This section is 10 m long, with a radius of curvature of 1234 m. Neutron histories were split at the beginning of this section.

Energy on target: 1.328E–3 MW-s
Sum of neutrons: 1.876E7
Sum in 50×50 mm²: 1.866E7
λ-weighted sum: 7.133E7
mean wavelength: 6.871 Å

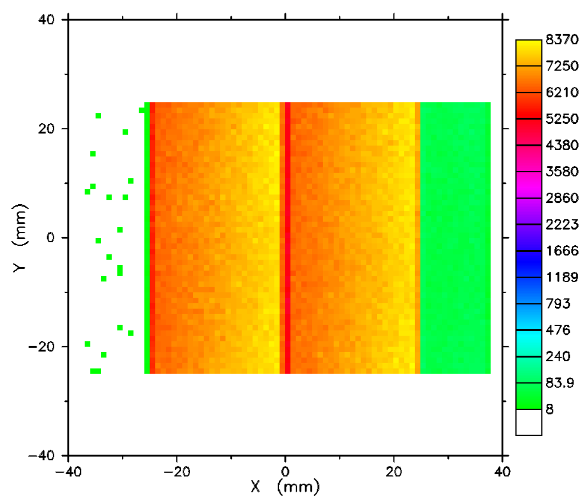





## Simulation of AMOR at SINQ

**X–Y after Guide 2, Section 2**

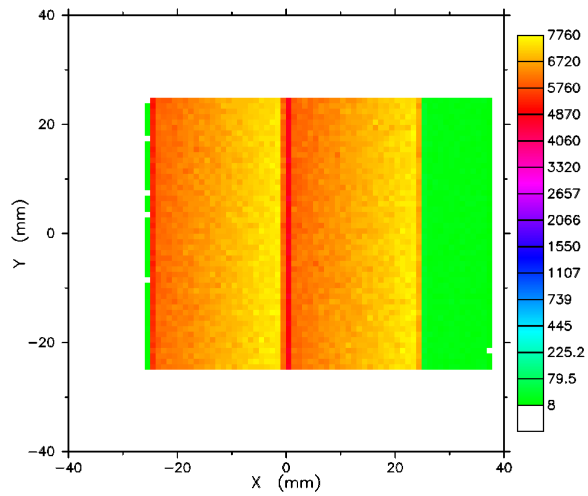
Energy on target: 1.328E–3 MW-s
Sum of neutrons: 1.793E7
Sum in 50×50 mm²: 1.788E7
λ-weighted sum: 6.975E7
mean wavelength: 7.015 Å



## Simulation of AMOR at SINQ

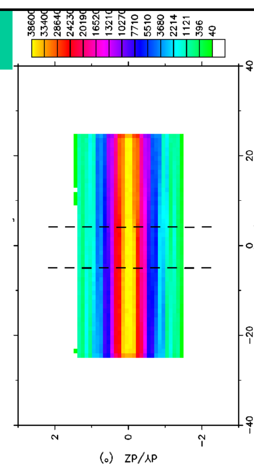
**X–Y @ End of Curved Guide 2**

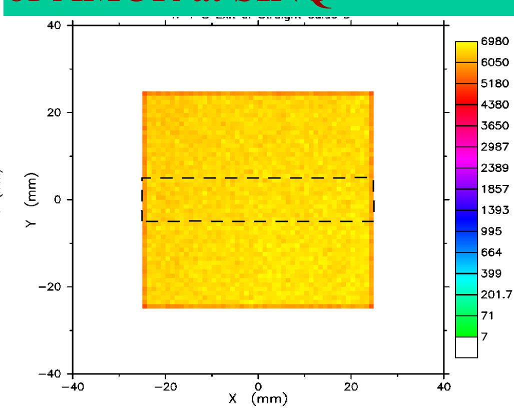
Energy on target: 1.328E–3 MW-s
Sum of neutrons: 1.670E7
Sum in 50×50 mm$^2$: 1.669E7
λ-weighted sum: 6.676E7
mean wavelength: 7.194 Å
**flux @ 0.57 MW = 2.87×10$^8$ n/s/cm$^2$**




**N**eutron **I**nstrument **S**imulation **P**ackage 7 http://PASeeger.com

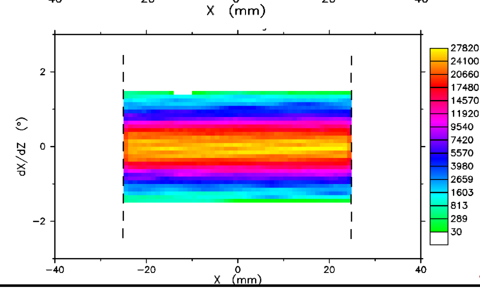
## of AMOR at SINQ



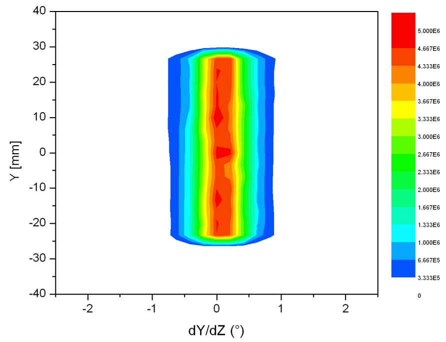

**X–Y @ End of Straight Guide 3**

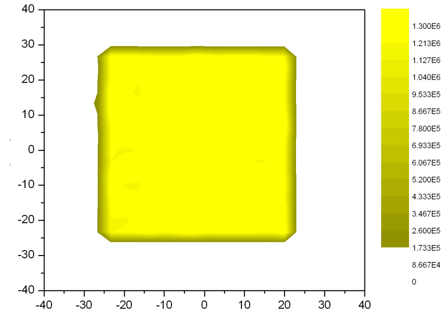
The 3.56-m straight guide has removed most of the intensity fluctuations seen at the end of the curved guides. The dashed box is 10 mm high and 50 mm wide, representing the acceptance of the remainder of the instrument. To improve statistics downstream, the y values at this surface may be compressed by a factor of 5, and the time-of-flight scale may be compressed by a factor of 12 to cover the opening times of the choppers. Another option is to create a new "source" here.



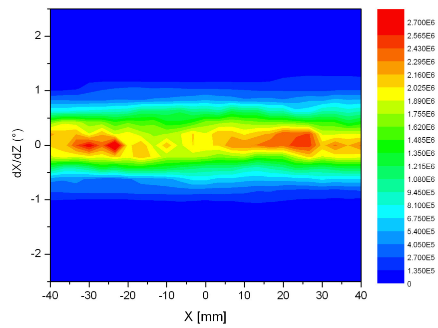

.com

## Simulation of AMOR at SINQ



**McStas**



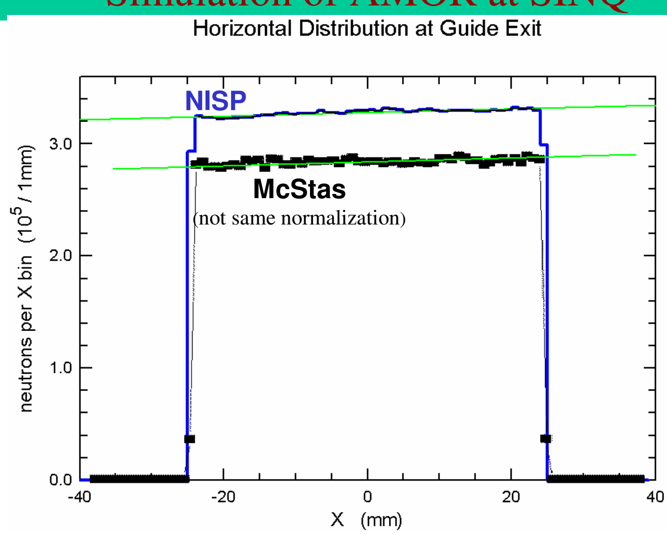

**Execution Times**

For $10^6$ neutron histories at the exit of the guide system:

**NISP** 55 min @ 1.2 GHz
**McStas** ? min @ 3.5 GHz

Neutron Instrument Simulation Package

## Simulation of AMOR at SINQ



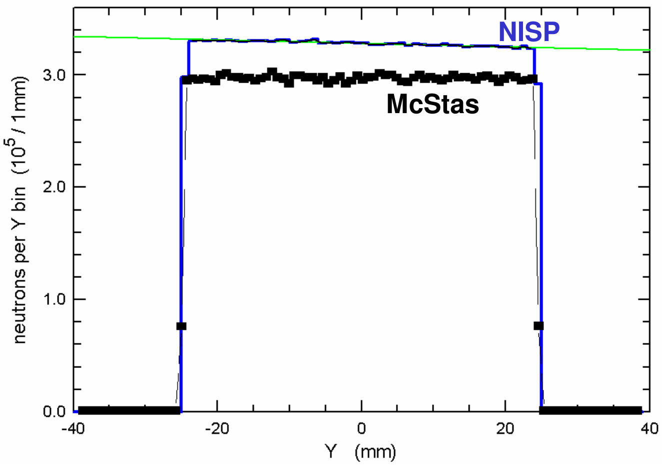

**X @ End of Guide 3**

There is a linear variation of intensity across the width of the guide exit, but the major variations with x seen at the end of the curved guide have been smoothed out. We will ignore this variation when we create a source at this position. Although there are distinct patterns in the X-phase indicating correlations between x-position and x-divergence, the average over all x can be used because the sample and detectors do not have x-sensitivity.

Neutron Instrument Simulation Package 10 http://PASeeger.com

## Simulation of AMOR at SINQ

Vertical Distribution at Guide Exit



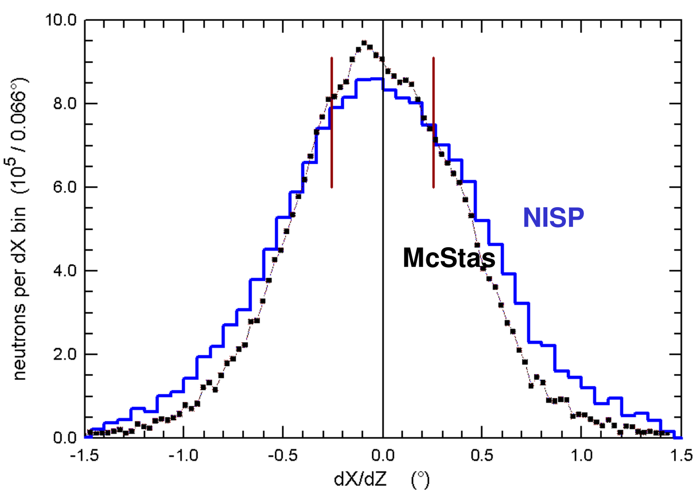

**Y @ End of Guide 3**

There is also a slight variation of intensity in the vertical direction, which will be ignored when a source is created at this location. On the basis of this plot and also the constancy of the Y-phase plot above, we assume that the y-divergence is *not correlated* with y-position. This independence allows us to average the full 50-mm height of the guide exit to normalize flux per mm$^2$.

**Note:** if gravity is turned off, the slope of this distribution is *flat*.

## Simulation of AMOR at SINQ

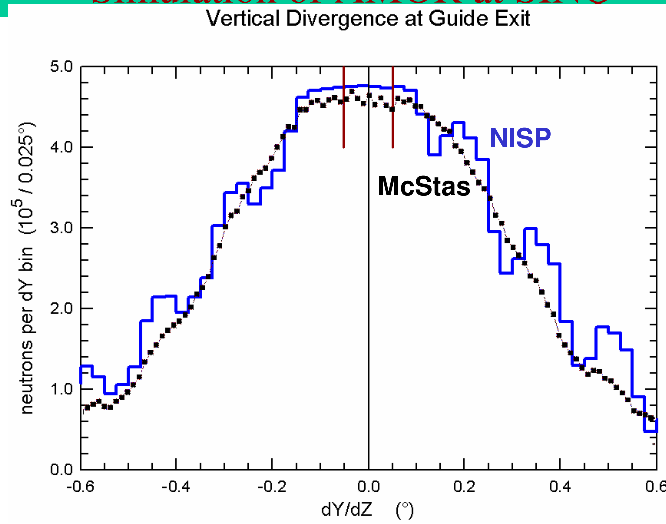
Horizontal Divergence at Guide Exit




**dX/dZ @ End of Guide 3**

To determine the “brightness” at the end of the guide system, we average over a solid angle that is representative of the acceptance of the subsequent AMOR collimation system. For the horizontal divergence the range of averaging is about ± 0.26°. Although the distribution is not constant over this range, the effect on the result will be negligible because the instrument does not measure in the X direction.

## Simulation of AMOR at SINQ



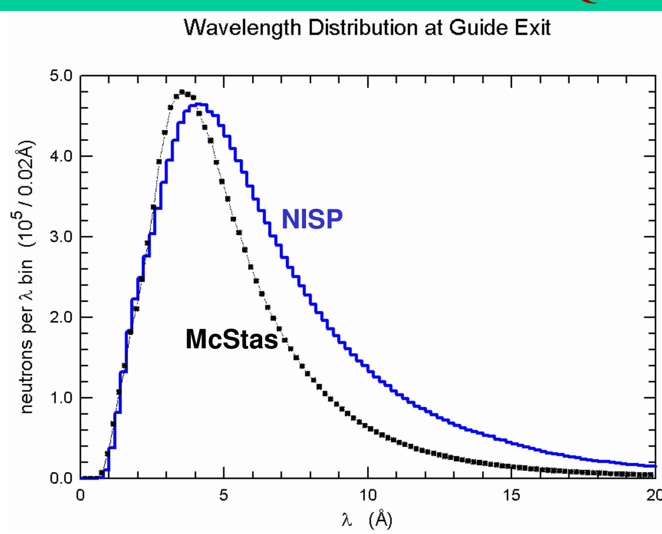

**dY/dZ @ End of Guide 3**

The solid angle used to average the brightness is 16.00 µster, and is a rectangle 5 times as wide as tall. The vertical distribution is quite flat across the narrow range determined the collimation. The sum of neutrons in this solid angle is 9.349E5, or 5.72% of the total flux. The normalized brightness is

**brightness: $1.760\times10^4$ n/(MJ-mm$^2$-µster)**

This is a remarkably large fraction of the initial moderator brightness, 2.44E4 n/(MJ-mm$^2$-µster).

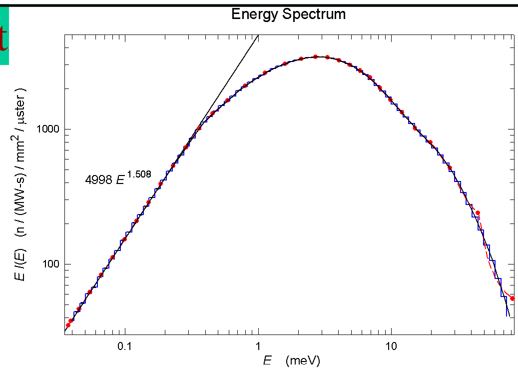
## Simulation of AMOR at SINQ




**Wavelength @ End of Guide 3**

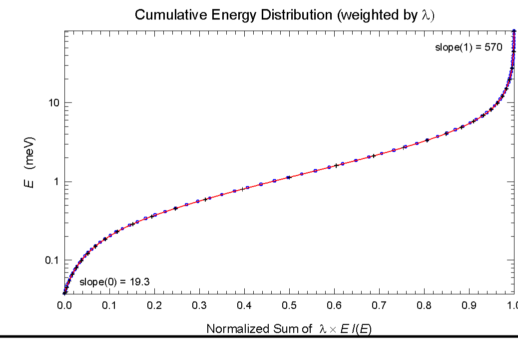
This distribution is used to generate source neutron energies at the end of the guides, by interpolation of a random number in the cumulative distribution of a log-log plot. The intensity shown on the plot represents $1.33\times10^{-3}$ MW-s of energy on target, in the full guide exit area of 50×50 mm$^2$. To normalize to n/s/bin at 0.57 MW, multiply by 430 /s.

## Simulat



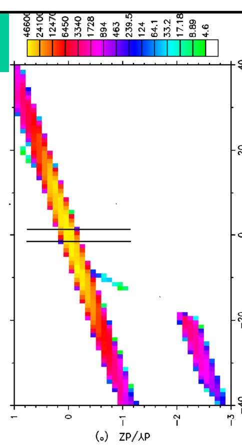

**Energy @ End of Guide 3**

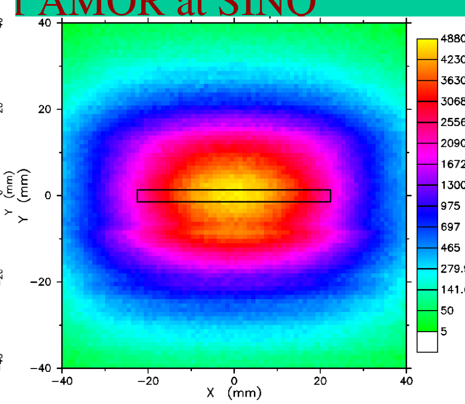
To generate good statistics through the instrument, without having to track millions more neutrons through the guide system, we define a new source at the exit of straight guide 3. The usual form for NISP energy-spectrum tables is a spline fit to the cumulative distribution of log(E), weighted by λ. The upper plot shows the histogram of neutrons in log(E) bins, and the result of interpolating in the final spline fit. The lower curve shows the cumulative data (blue circles), the spline nodes (black +), and the spline curve (red line). To use the table, a uniform random deviate is chosen for the abscissa and the log(E) is interpolated in the spline. Because the sum is λ-weighted, the statistical weight of the chosen energy is set proportional to 1/λ.




Neutron Instrument Simulation Package ...eger.com

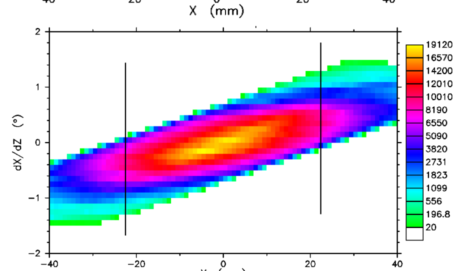
## ...f AMOR at SINQ



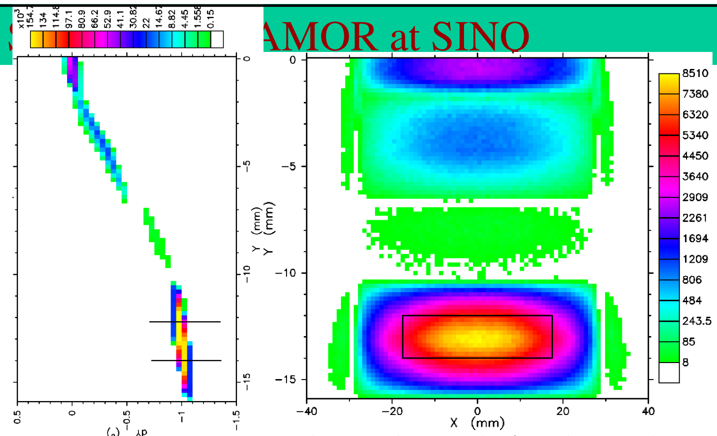

**X–Y @ Entrance of Aperture 1**

Following the frame-overlap mirror, long-wavelength neutrons have been reflected downward. The only visible evidence is a tiny tail in the Y phase plot. The box (and the corresponding lines in the phase plots) represents a slit 2.8 mm high and 45 mm wide. These plots were made without using the new source file, to show the complete distributions of the dispersions present in the beam before the first collimation slit.




Neutron Instrument Simulation Package 16 http://PASeeger.com

## AMOR at SINQ




### X–Y @ Entrance of Aperture 2

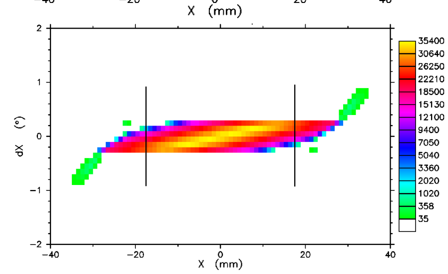
Note that the Y-scale on this and subsequent plots is expanded by a factor of 5. The box (and the lines on the phase plots) represents a slit 1.8 mm high and 35 mm wide, centered 13.1 mm below horizontal.

Energy on target: 4.85 MW-s

Sum in 35×1.8 mm²: 1.995E6

λ-weighted sum: 6.555E6

mean wavelength: 5.908 Å



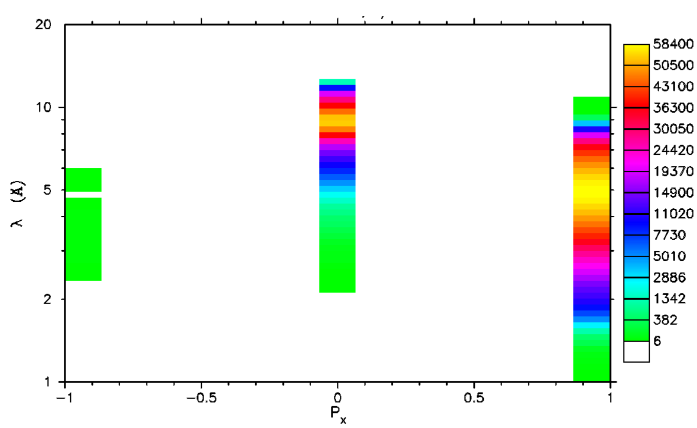



## Simulation of AMOR at SINQ

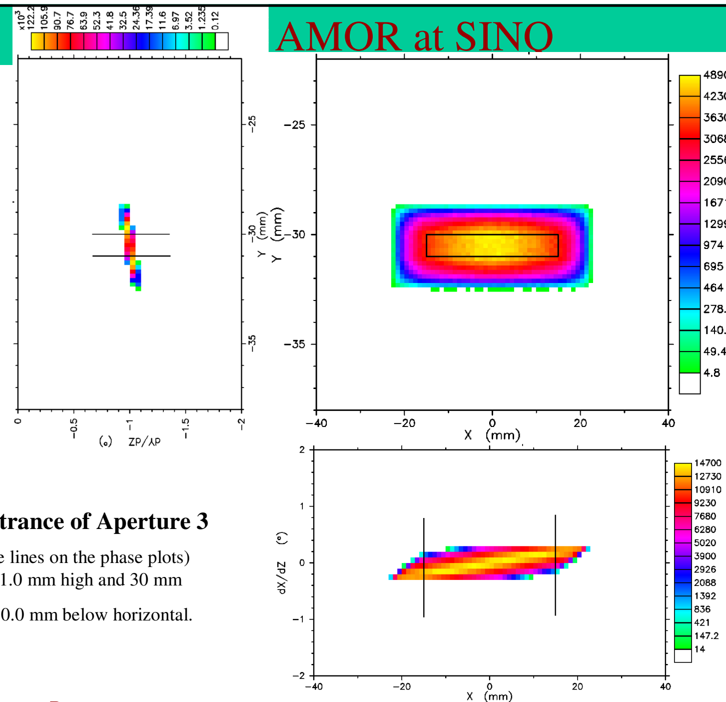
### Polarization @ Exit of Aperture 2

Since the polarization mirror is within a magnetic field, every neutron striking it is decomposed into spin components parallel and anti-parallel to the field, with $P_x$=+1 and $P_x$=−1 respectively. Each component is allowed to reflect, and both histories are followed. The plot shows a high degree of polarization at short wavelengths, decreasing at long wavelengths because both spin states reflect.

A possible improvement in the algorithm would be *not* to split in the cases where both (or neither) reflect, but to leave P = 0 for those neutrons.



# AMOR at SINQ

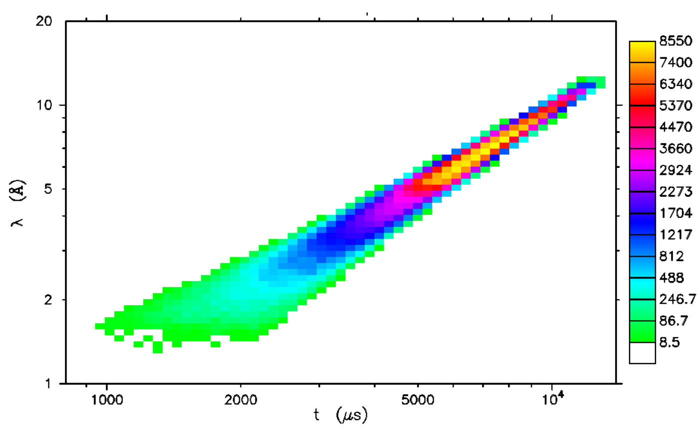



**X−Y @ Entrance of Aperture 3**

The box (and the lines on the phase plots) represents a slit 1.0 mm high and 30 mm wide, centered 30.0 mm below horizontal.

Neutron Instrument Simulation Package 19 http://PASeeger.com

# Simulation of AMOR at SINQ




**TOF-λ @ Exit of Aperture 3**

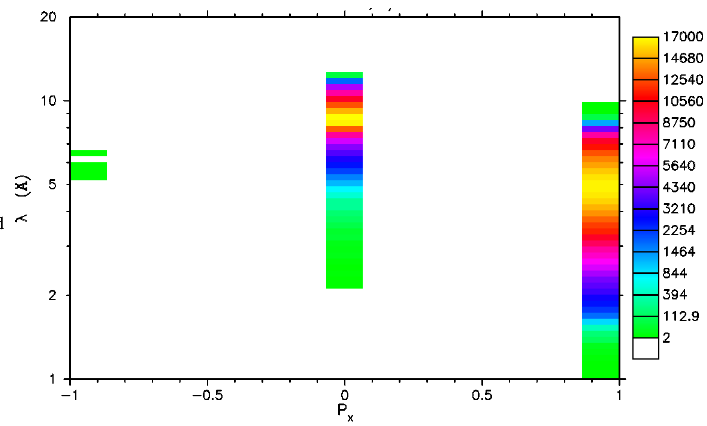
Energy on target: 4.85 MW-s
Sum in 30×1.0 mm$^2$: 6.124E5
λ-weighted sum: 20.091E5
mean wavelength: 5.899 Å

Neutron Instrument Simulation Package 20 http://PASeeger.com

# Simulation of AMOR at SINQ

**Polarization @ Exit of Aperture 3**

Neutron polarization has been maintained by a guide field generated by rectangular coils. Because the field is not uniform, some depolarization may occur. Whenever it is sampled, the x-component of the polarization of each tracked history will be either +1 or −1, or 0 if the neutron has no preferred orientation. When the neutron interacts with a polarized medium, it will be separated into two spin states with weights proportional to probabilities of the states.






# Simulation of AMOR at SINQ

**Polarization @ Exit of Aperture 3**

The expectation value of the x-component of the polarization vector, as a function of wavelength. Error bars are based on the binomial distribution, and are generally smaller than the symbols.

**Number of histories = 417674**
**Execution time = 2 hr 0 min (1.2 GHz)**