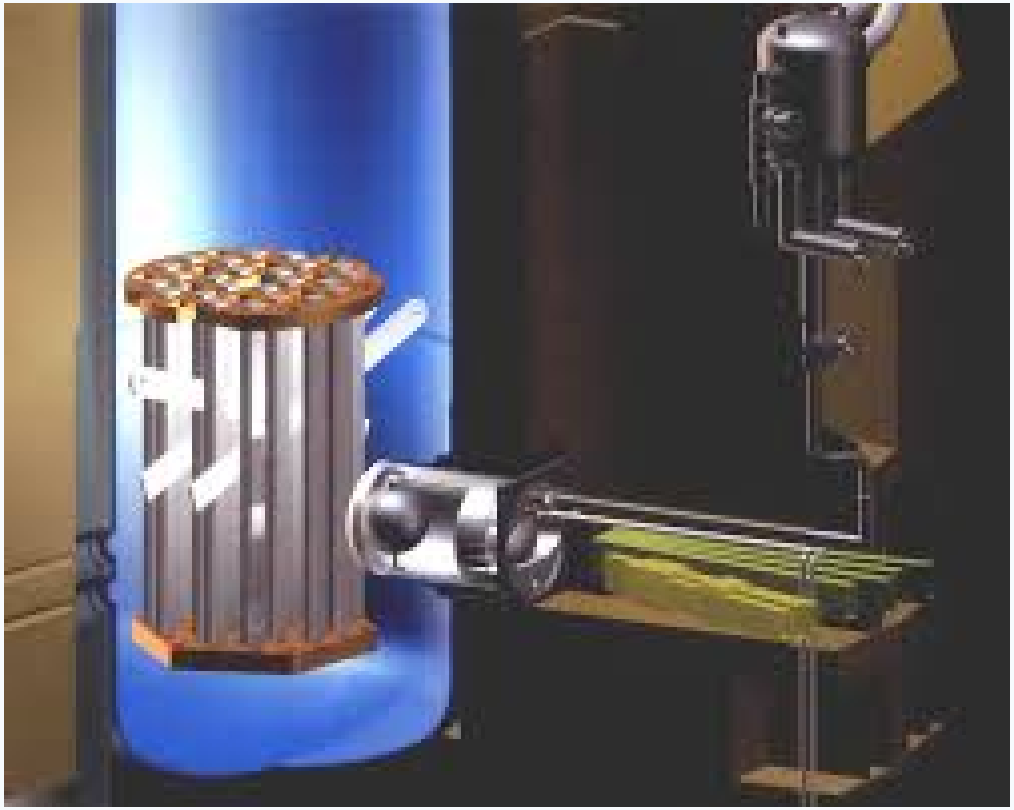
Monte-Carlo Exploration of Focused Neutron Guide and Monochromator Geometries

Samantha Isaac

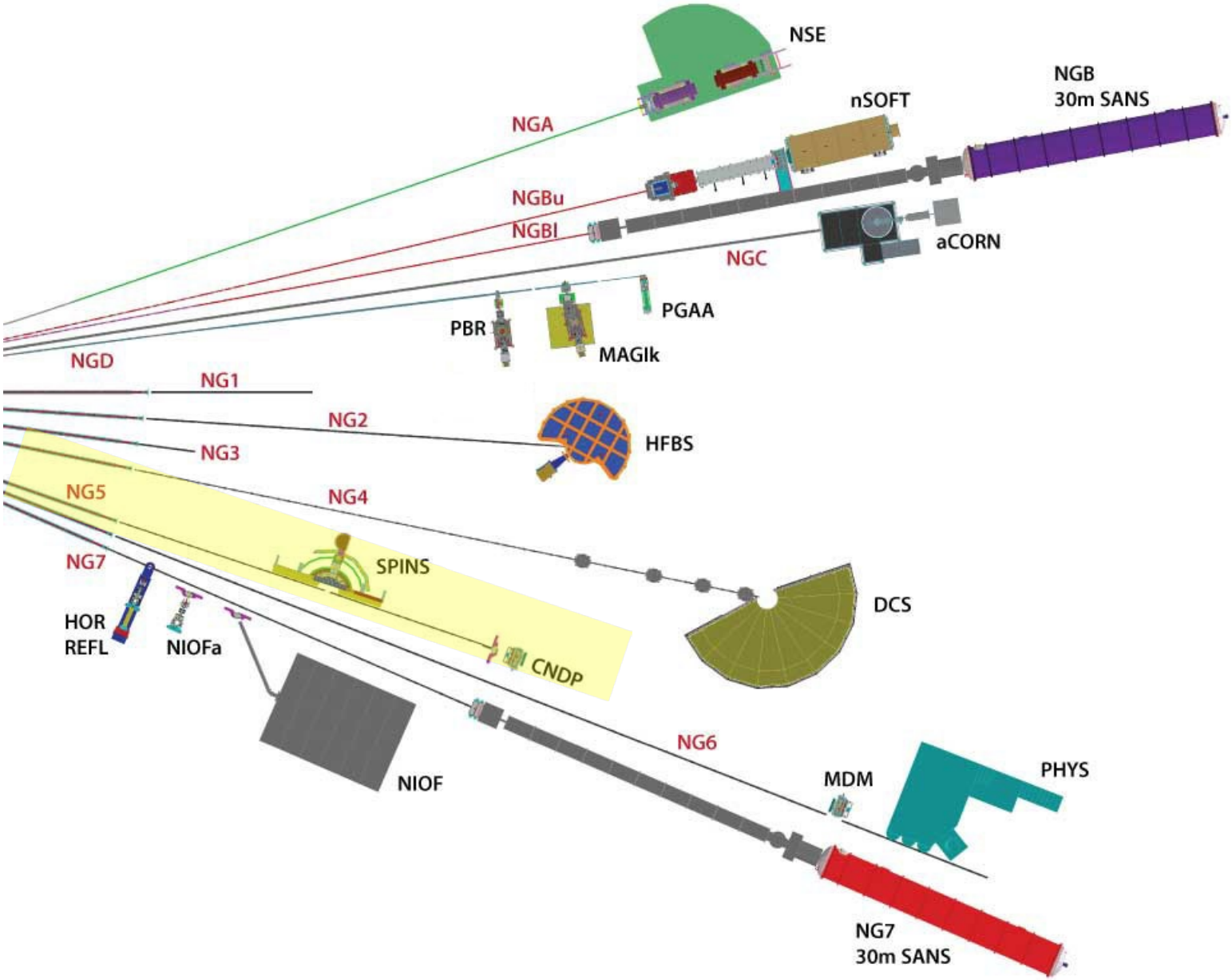
Mentor: Leland Harriger

New Cold Source

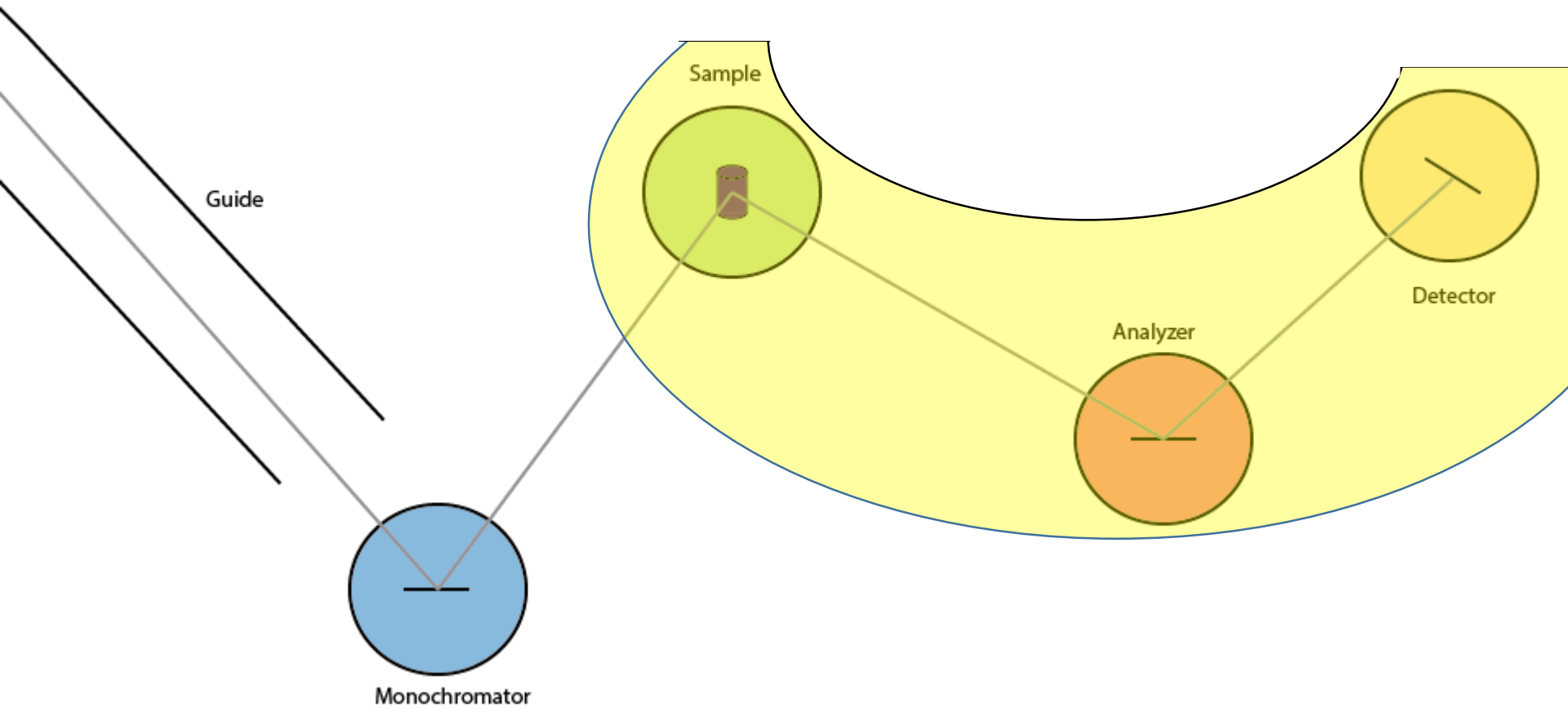


- A new cold source will be replacing the current cold source
- This produces most of the cold neutrons used at the NCNR

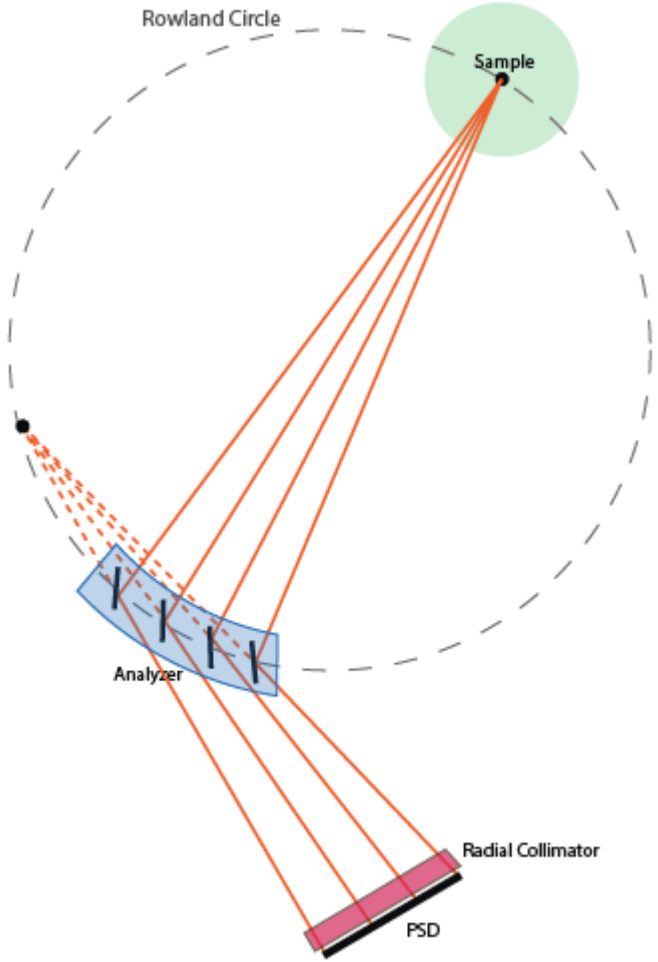
Replacing NG5 and SPINS



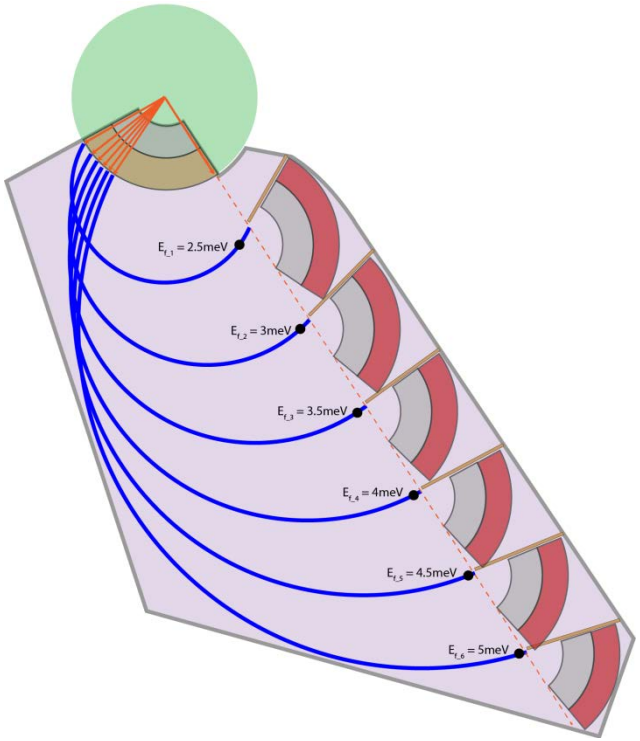
Replacing NG5 and SPINS



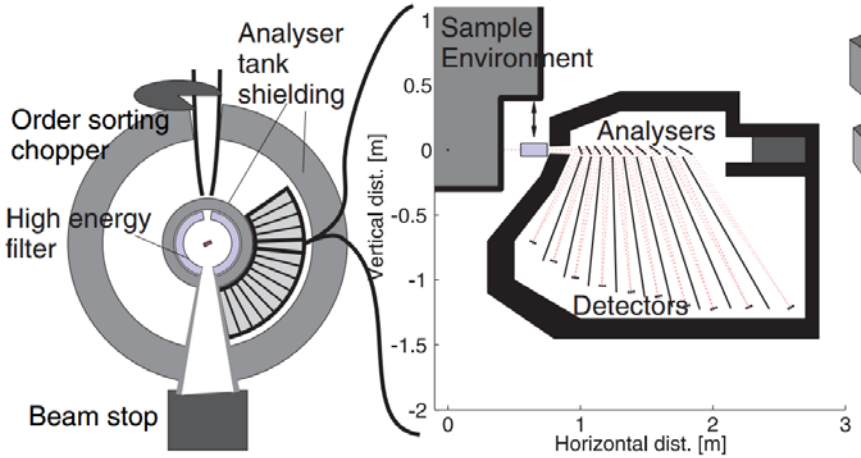
Replacing NG5 and SPINS

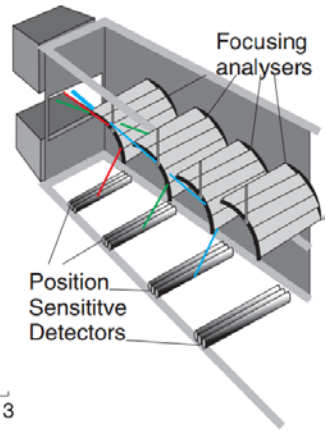


LEAF

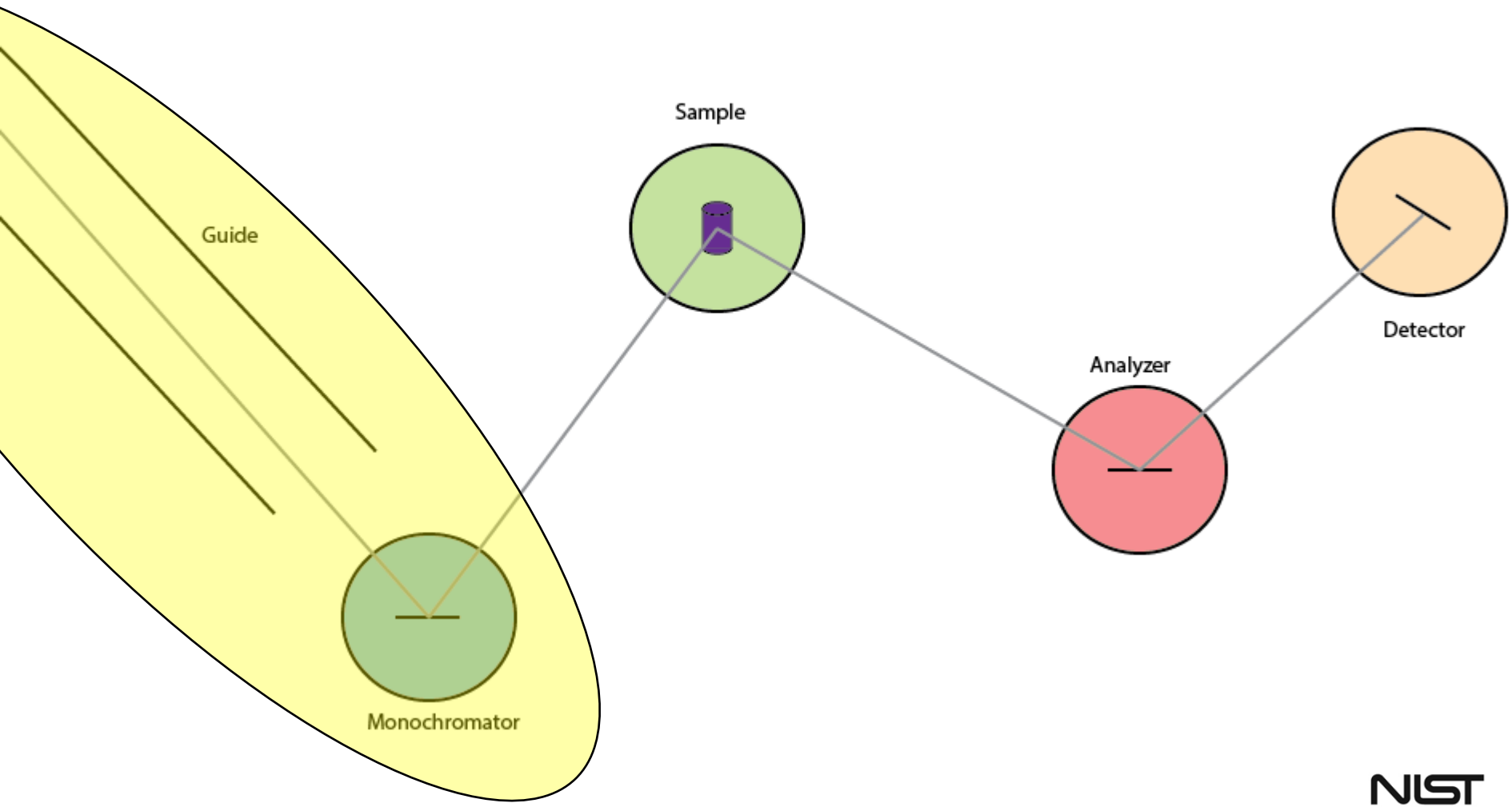


CAMEA





Primary Spectrometer

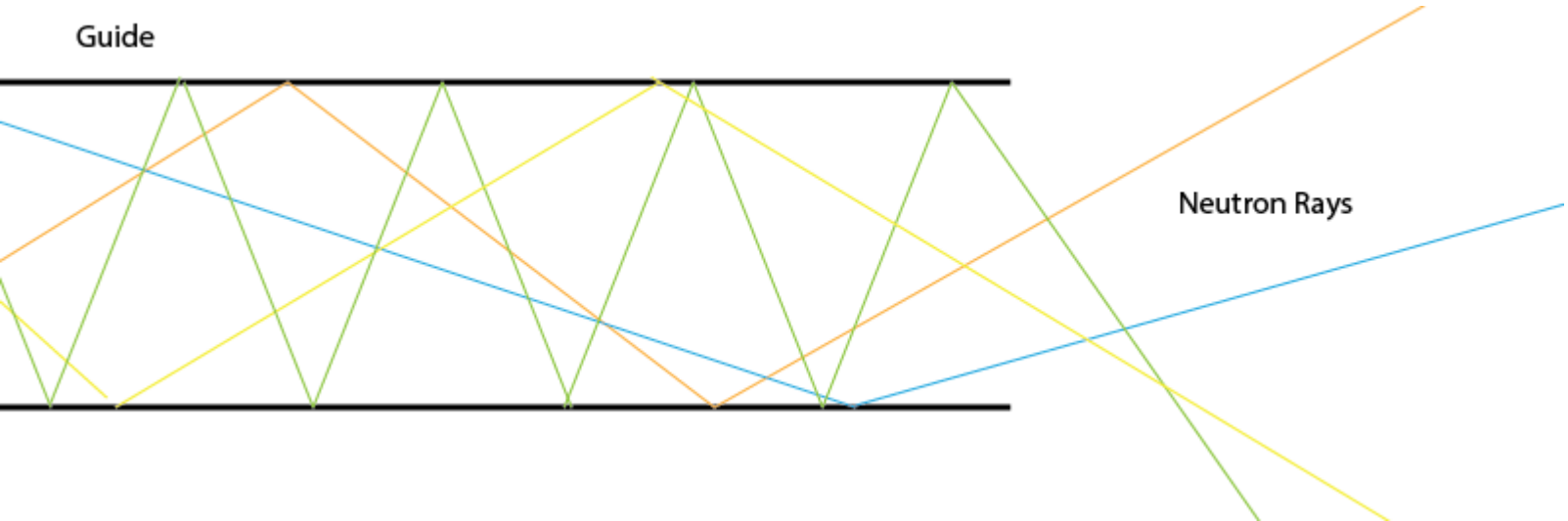


Software used

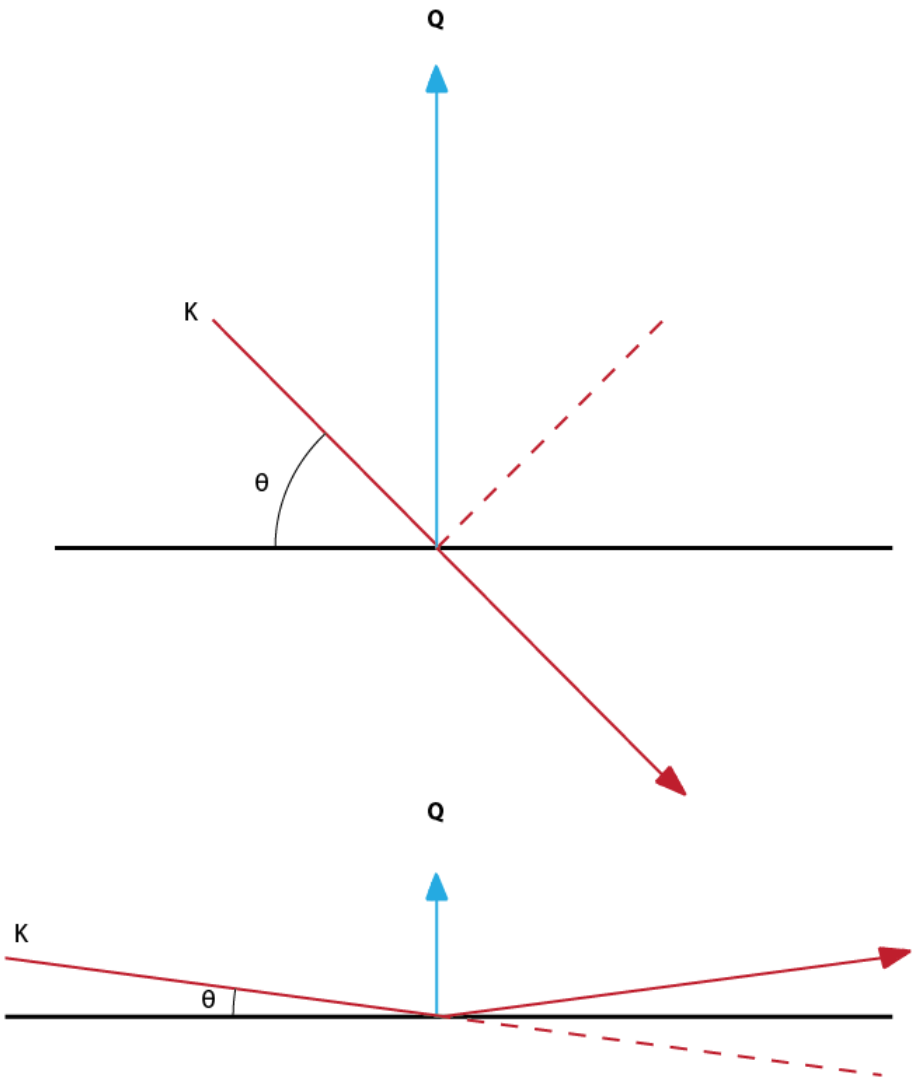
- Mcstas
  - http://www.mcstas.org/
- Guide_bot_distribution
  - Courtesy of Mads Bertelsen
- iFit
- NCNR Rocks Cluster

NG5

- NG5 is a 41 meter long straight rectangular guide
- Neutron guides contain coatings that line the inner walls that allow the neutrons to bounce down the guide
- Coated in Ni58



Momentum Transfer



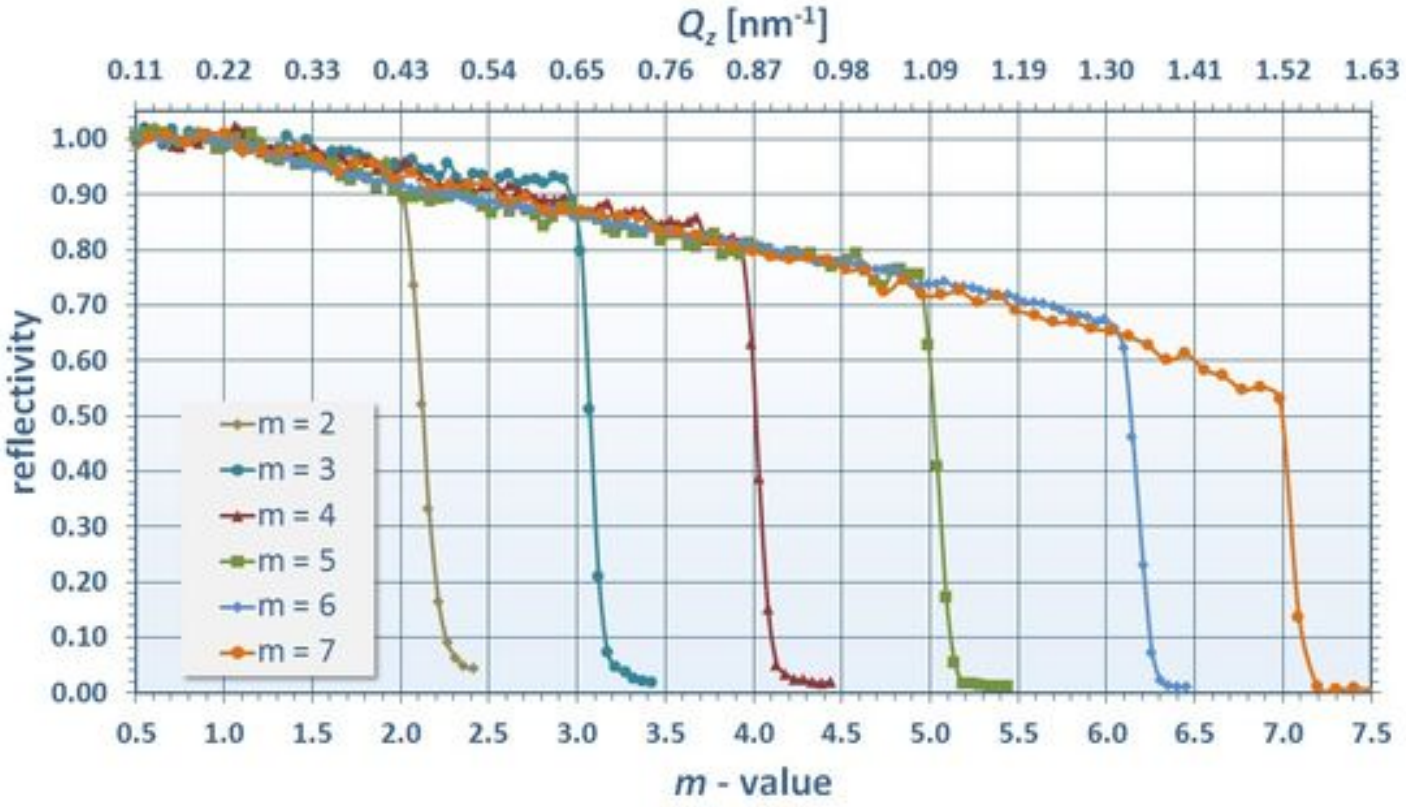
- The momentum and collision angle determine the momentum transfer (Q)

$$Q = 2K\,sin\theta$$

$$sin\theta \approx \theta$$

Guide Coatings

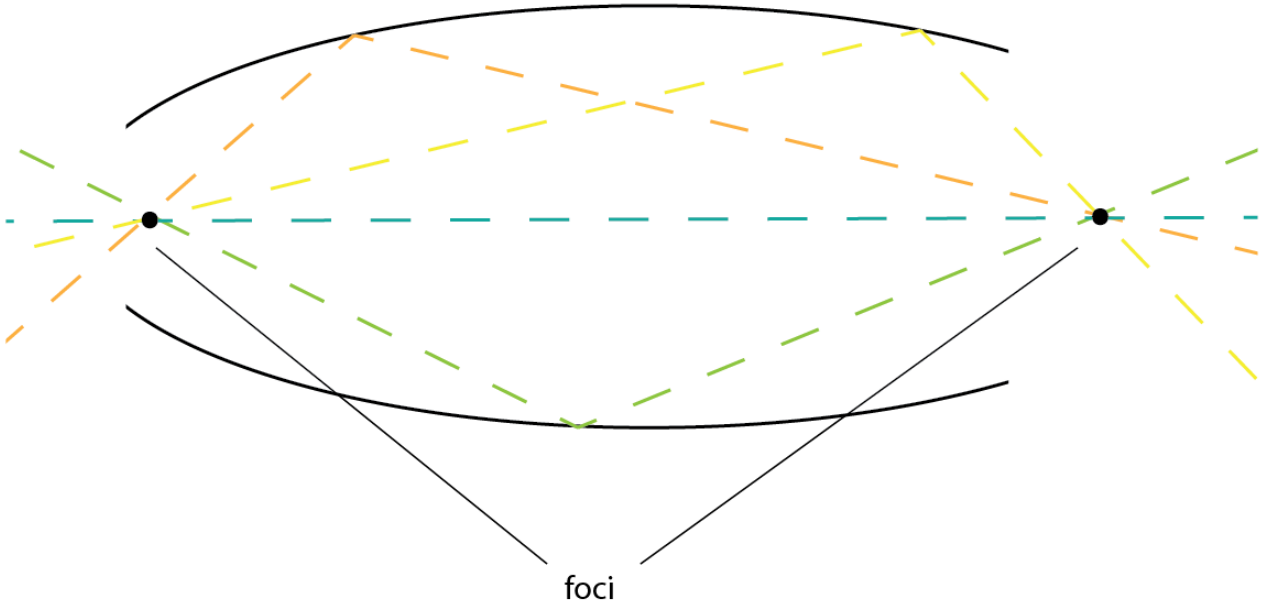
- Increasing m-value is one way of increasing flux



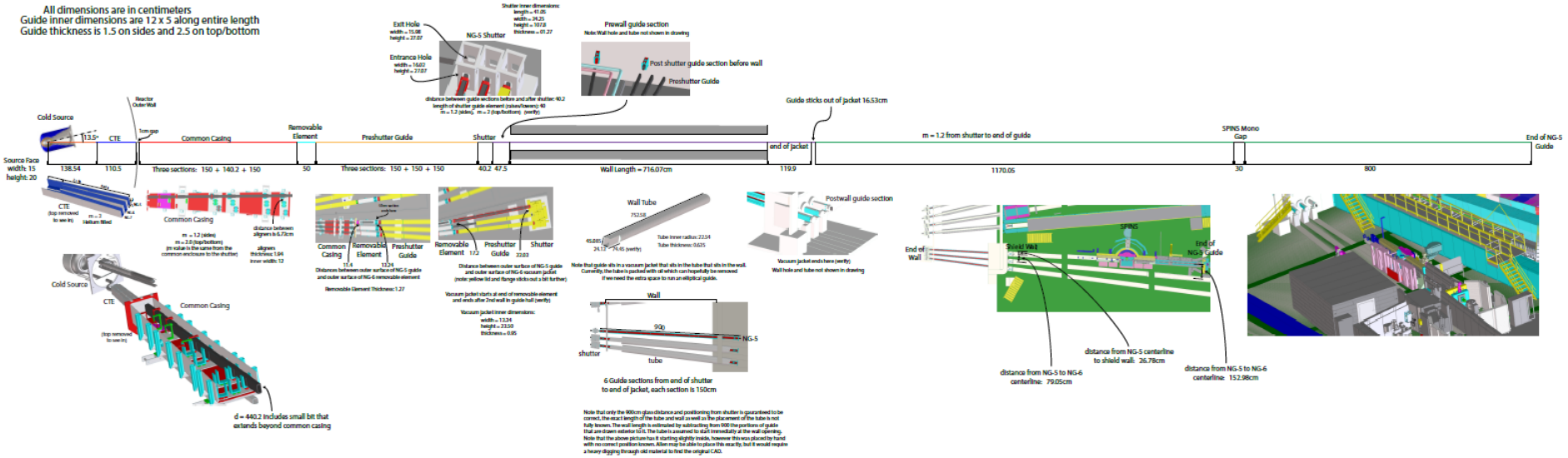
Source: Swiss Neutronics

Ballistic Ellipse

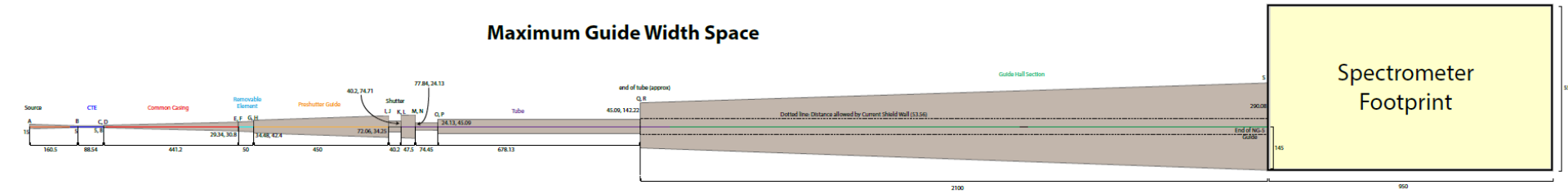
- Use a ballistic elliptical geometry
- Each neutron should ideally only bounce once down the guide



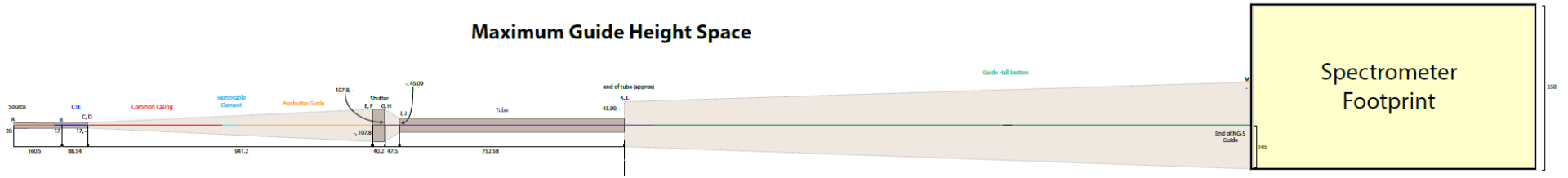
All dimensions are in centimeters
Guide inner dimensions are 12 x 5 along entire length
Guide thickness is 1.5 on sides and 2.5 on top/bottom

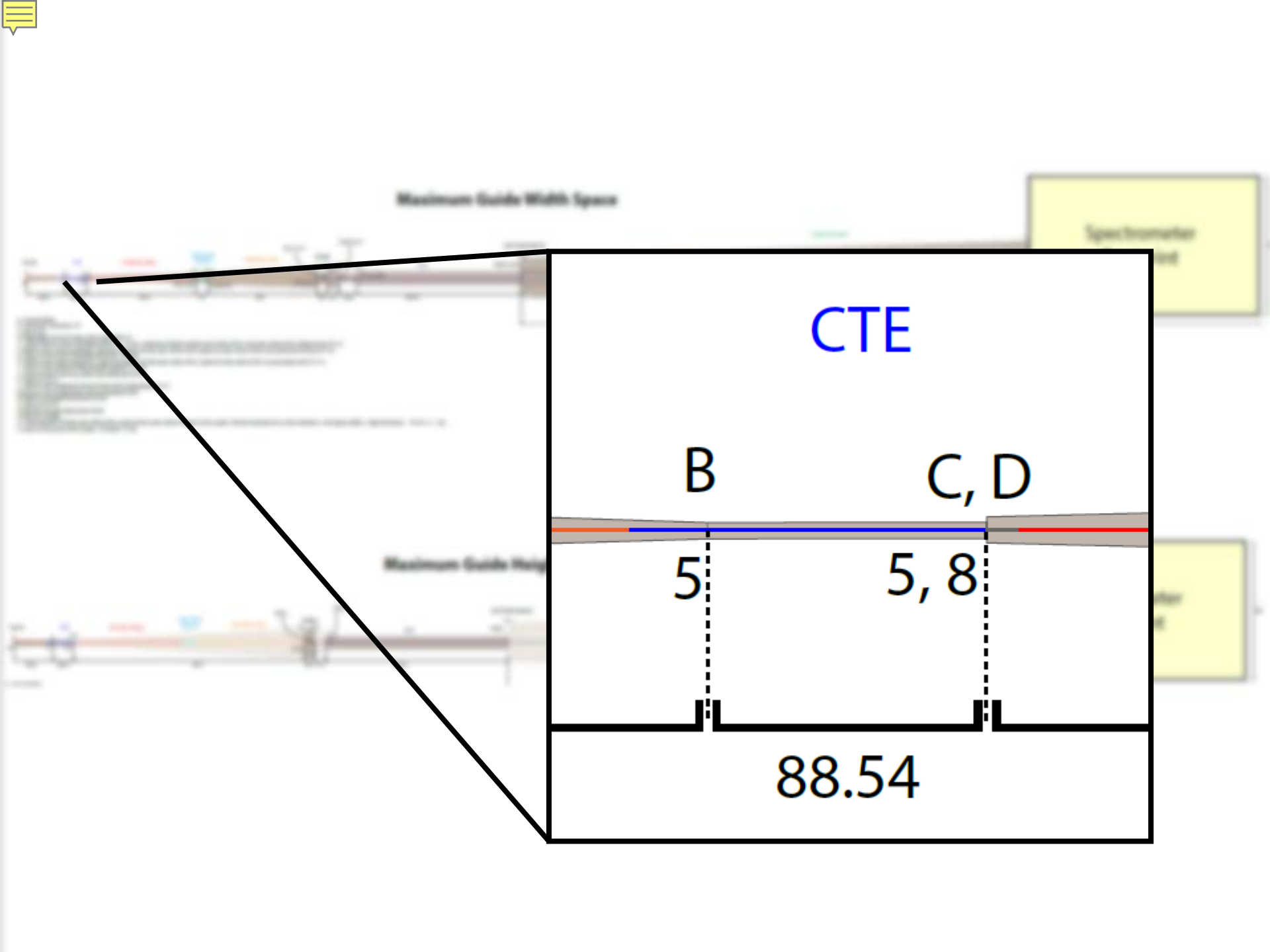


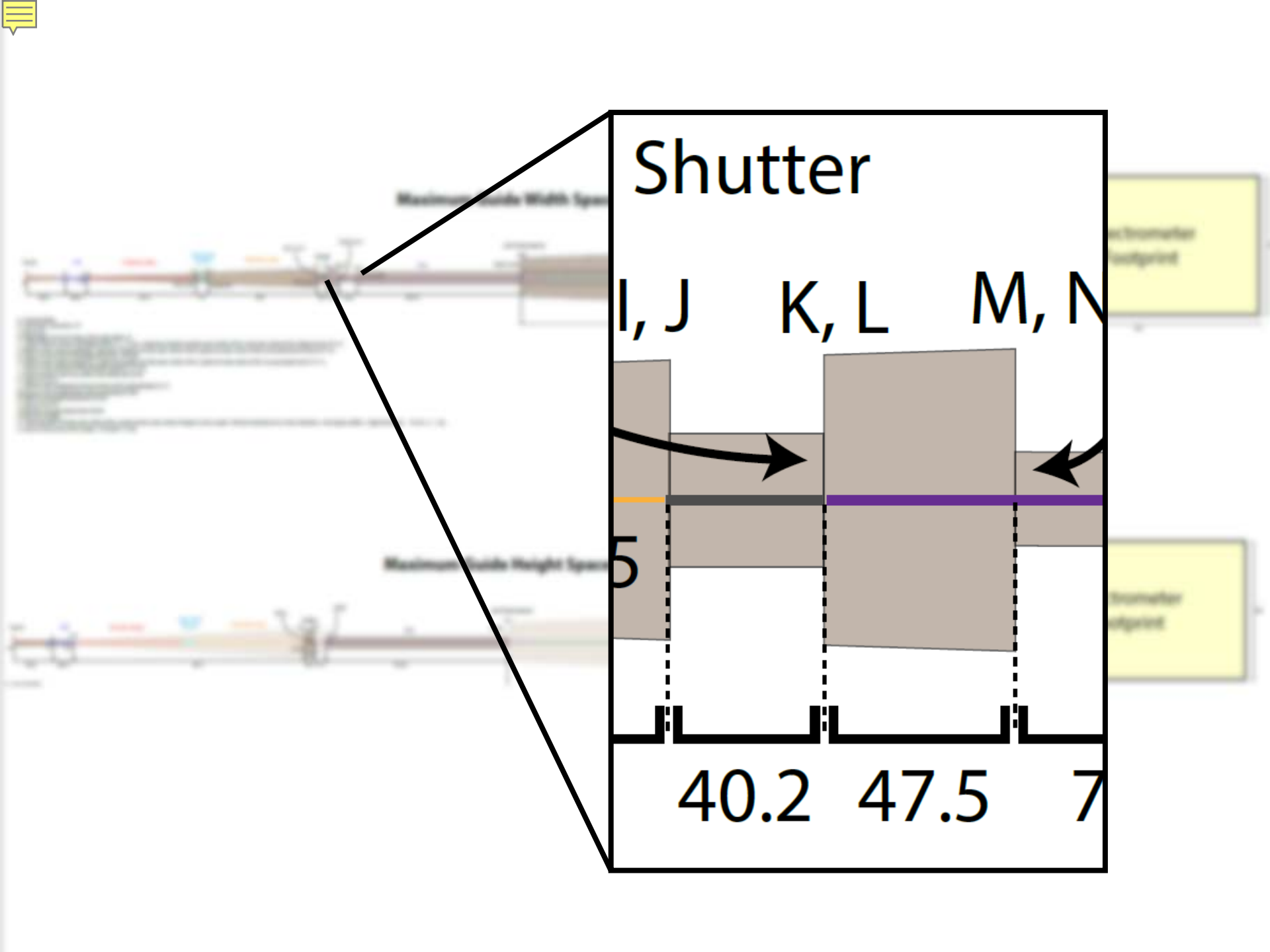
Maximum Guide Width Space

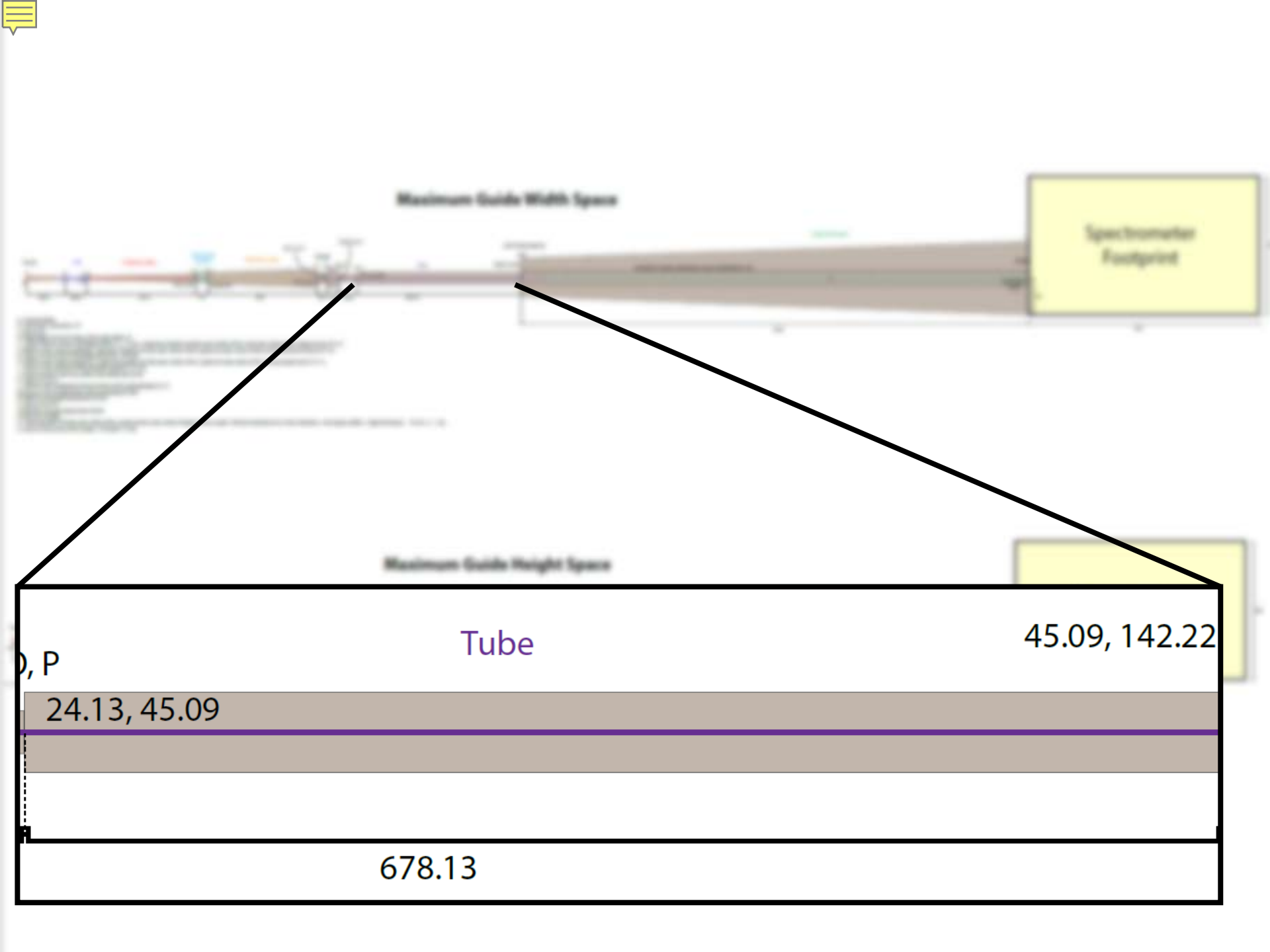


Maximum Guide Height Space

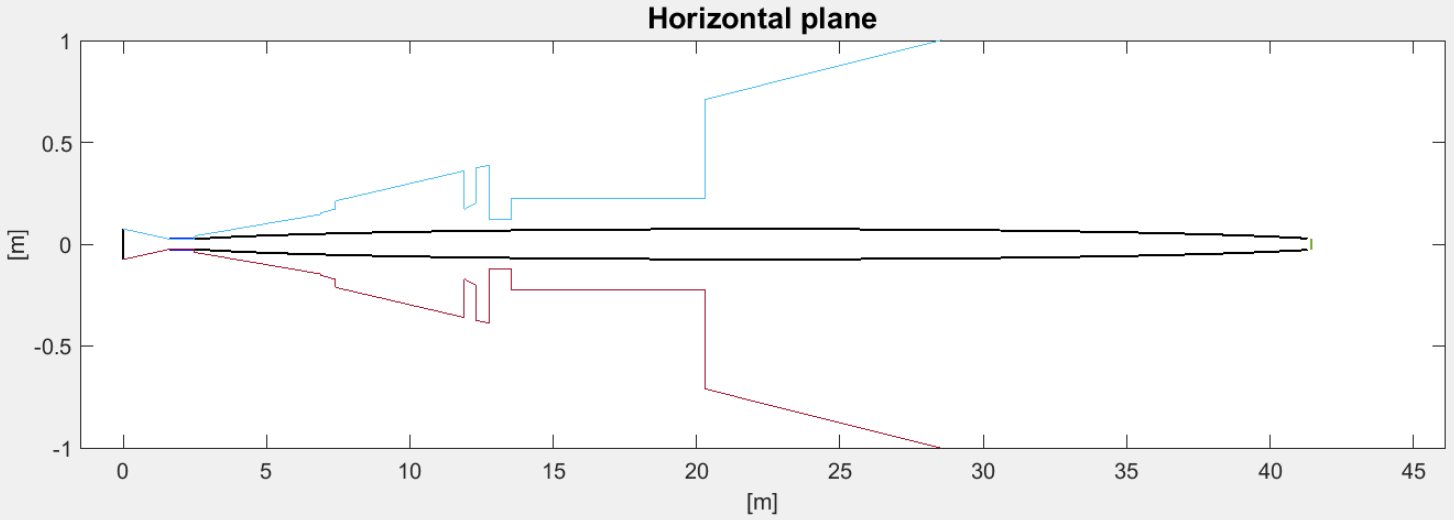


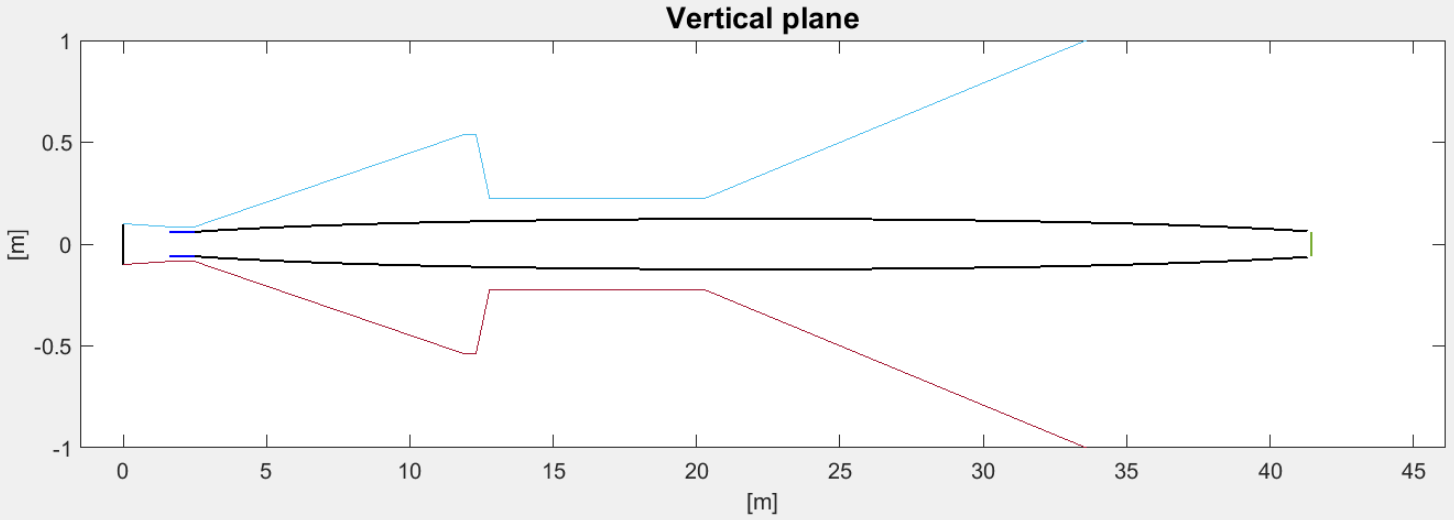

CTE
B
C, D
5
5, 8
88.54


Shutter
I, J
K, L
M, N
5
40.2
47.5
7

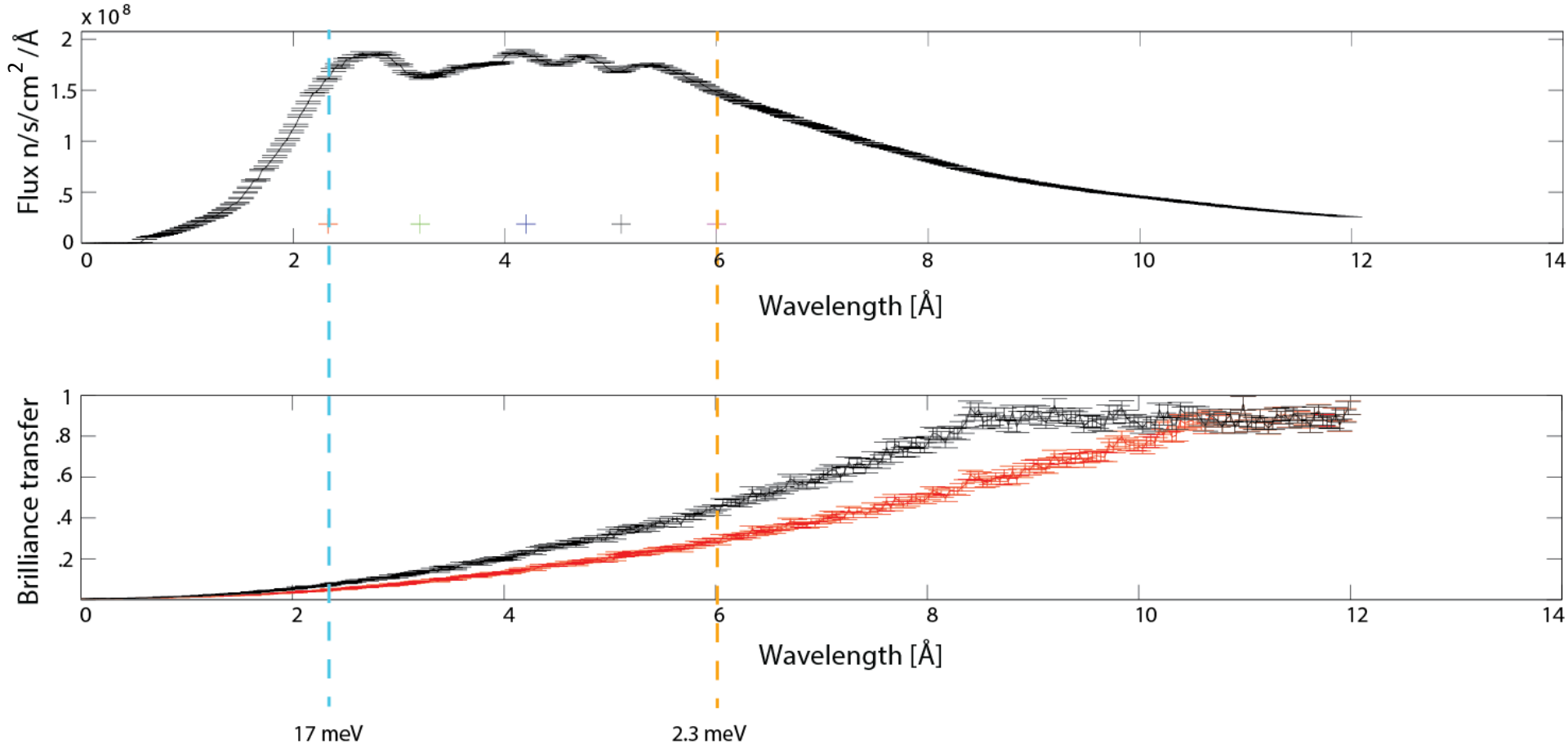

Tube
45.09, 142.22
24.13, 45.09
678.13

Ballistic Ellipse





NG5 Baseline



2.3 meV: 1.5e8 Flux , 30% brilliance transfer

17 meV: 1.6e8 Flux , 6% brilliance transfer

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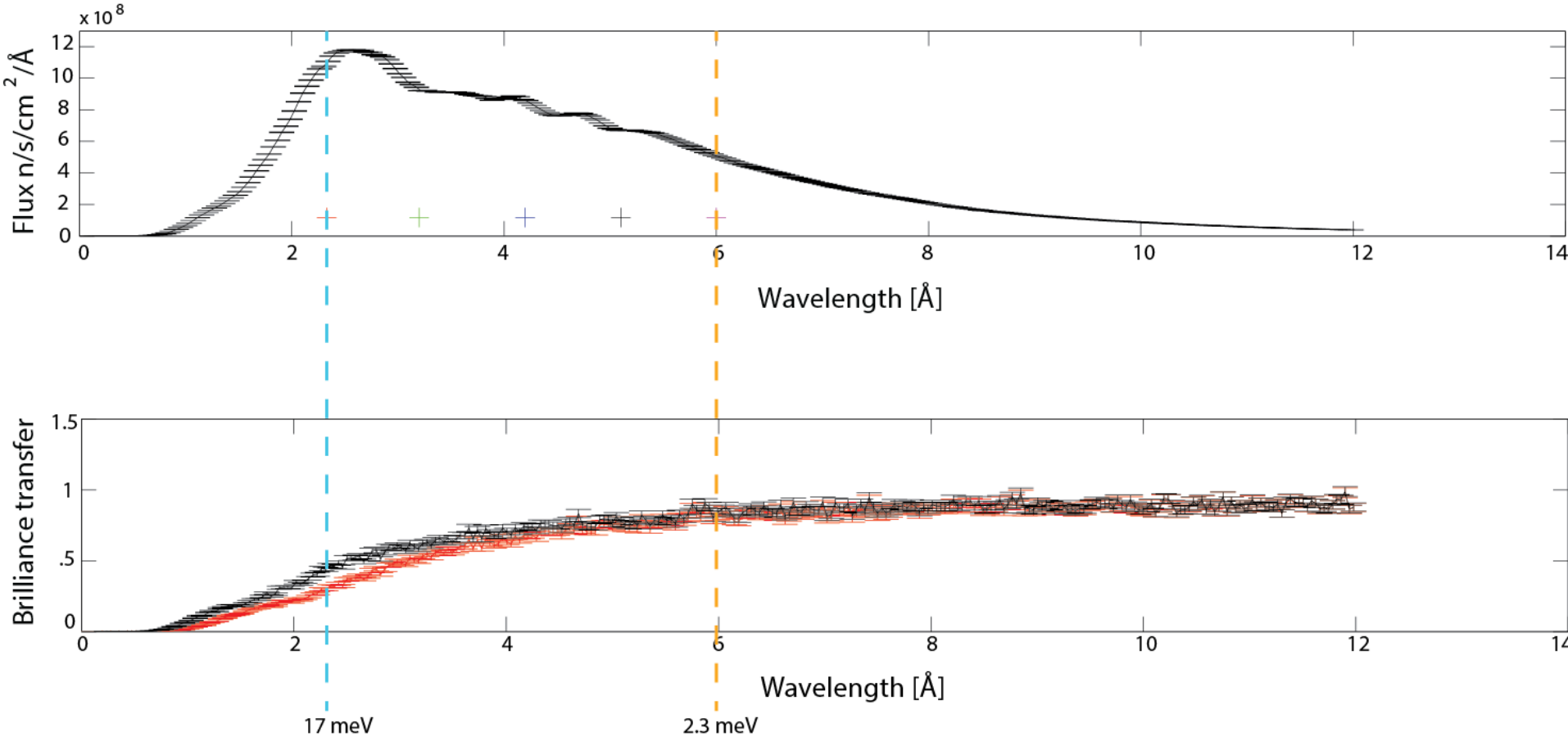
Ballistic Ellipse



2.3 meV: 5e8 Flux , 80% brilliance transfer

17 meV: 11e8 Flux , 45% brilliance transfer

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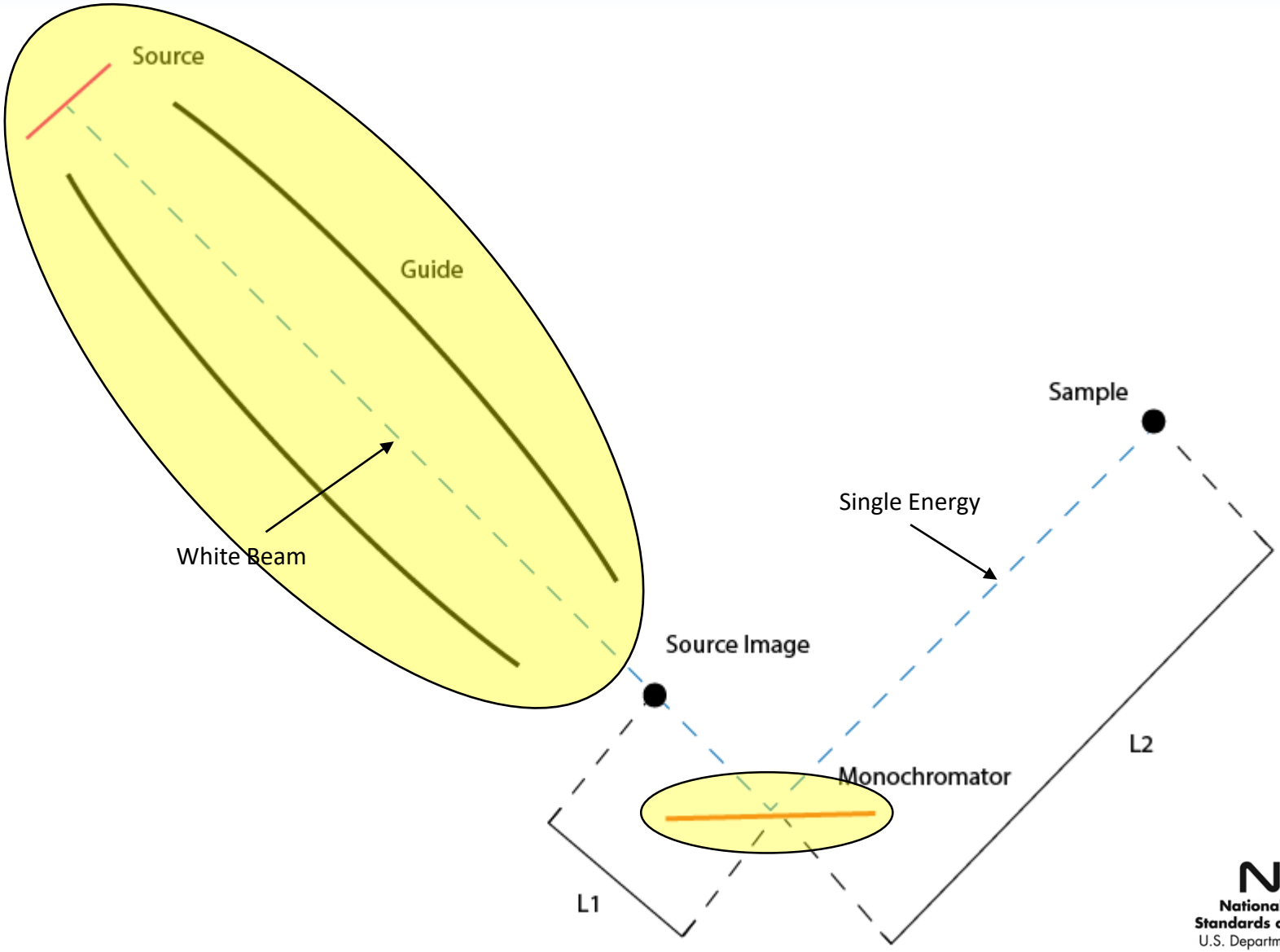
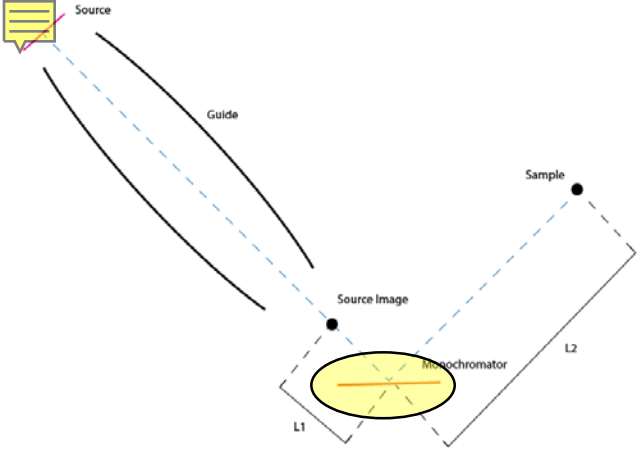
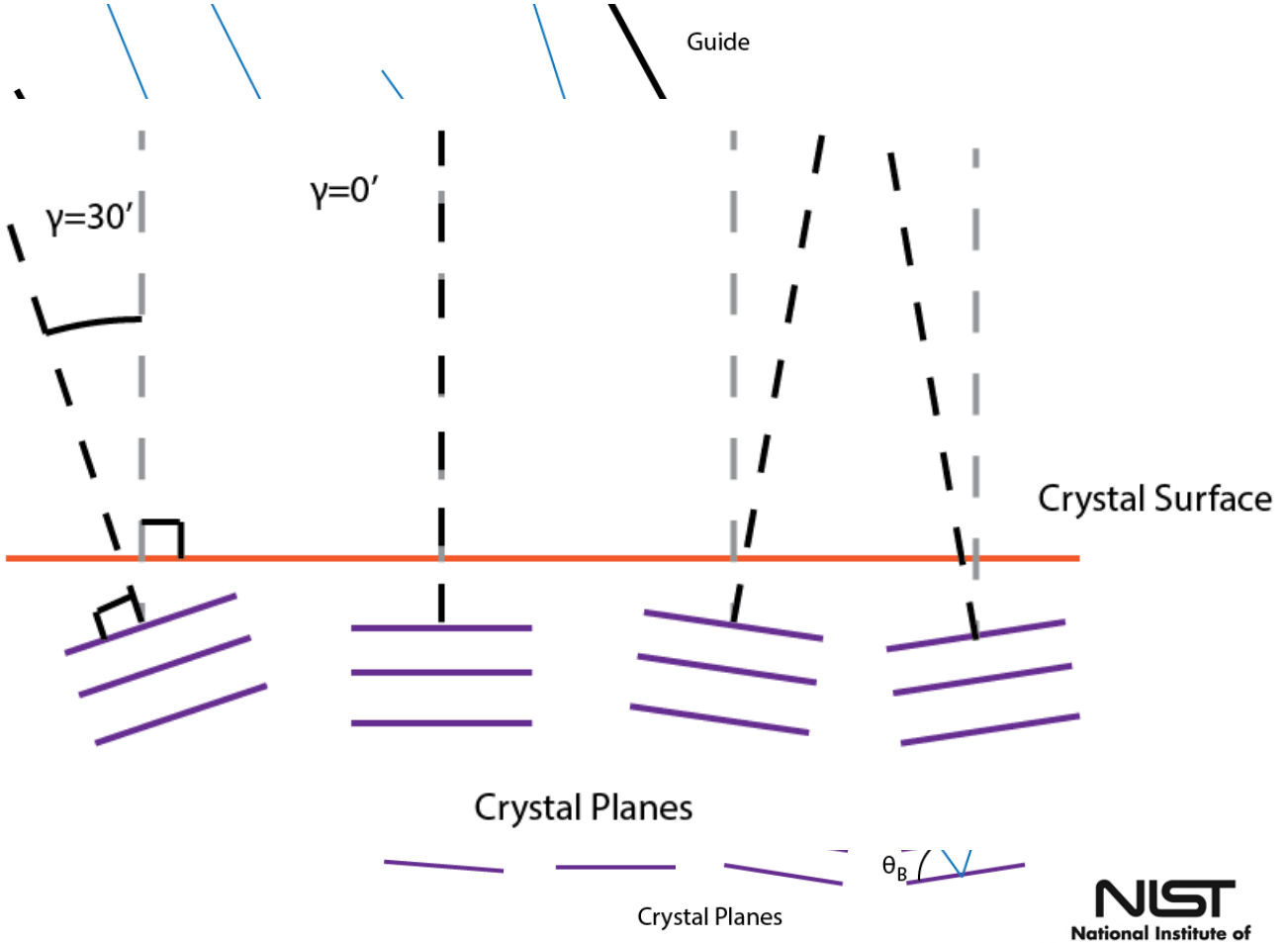
U.S. Department of Commerce

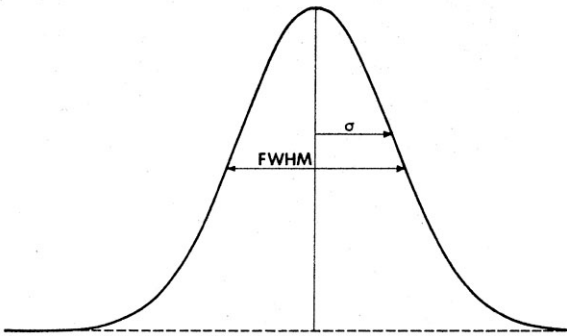
Monochromator Optimization



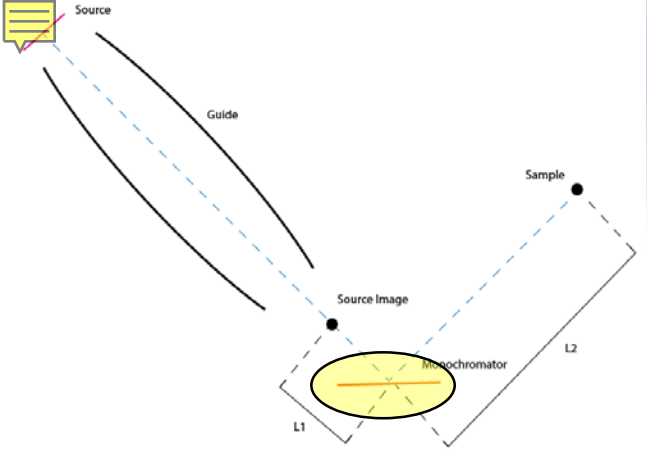
Mosaic Optimization



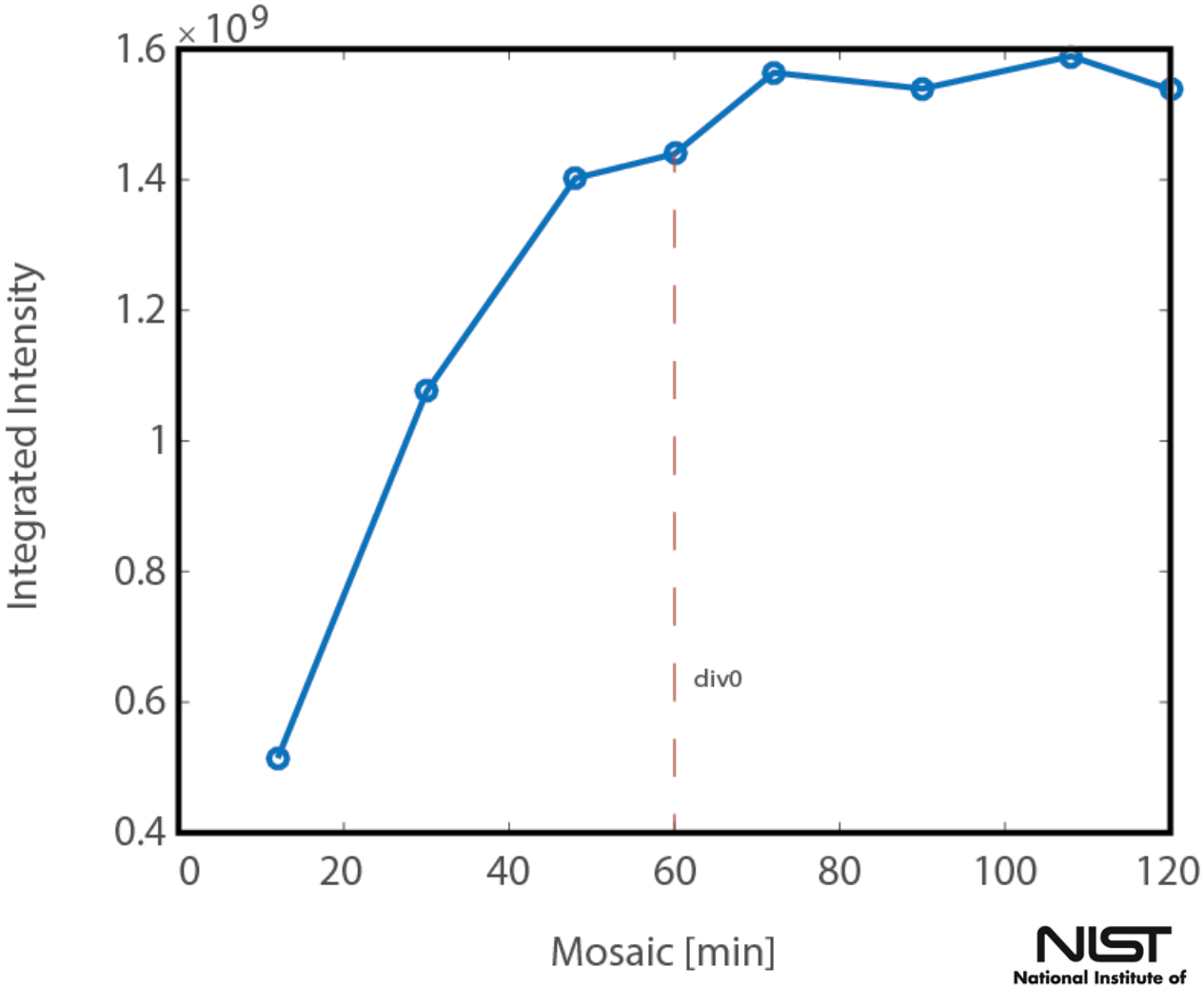




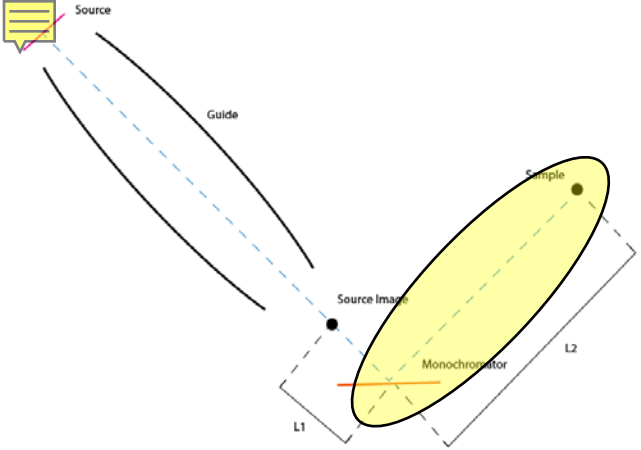
Mosaic Optimization

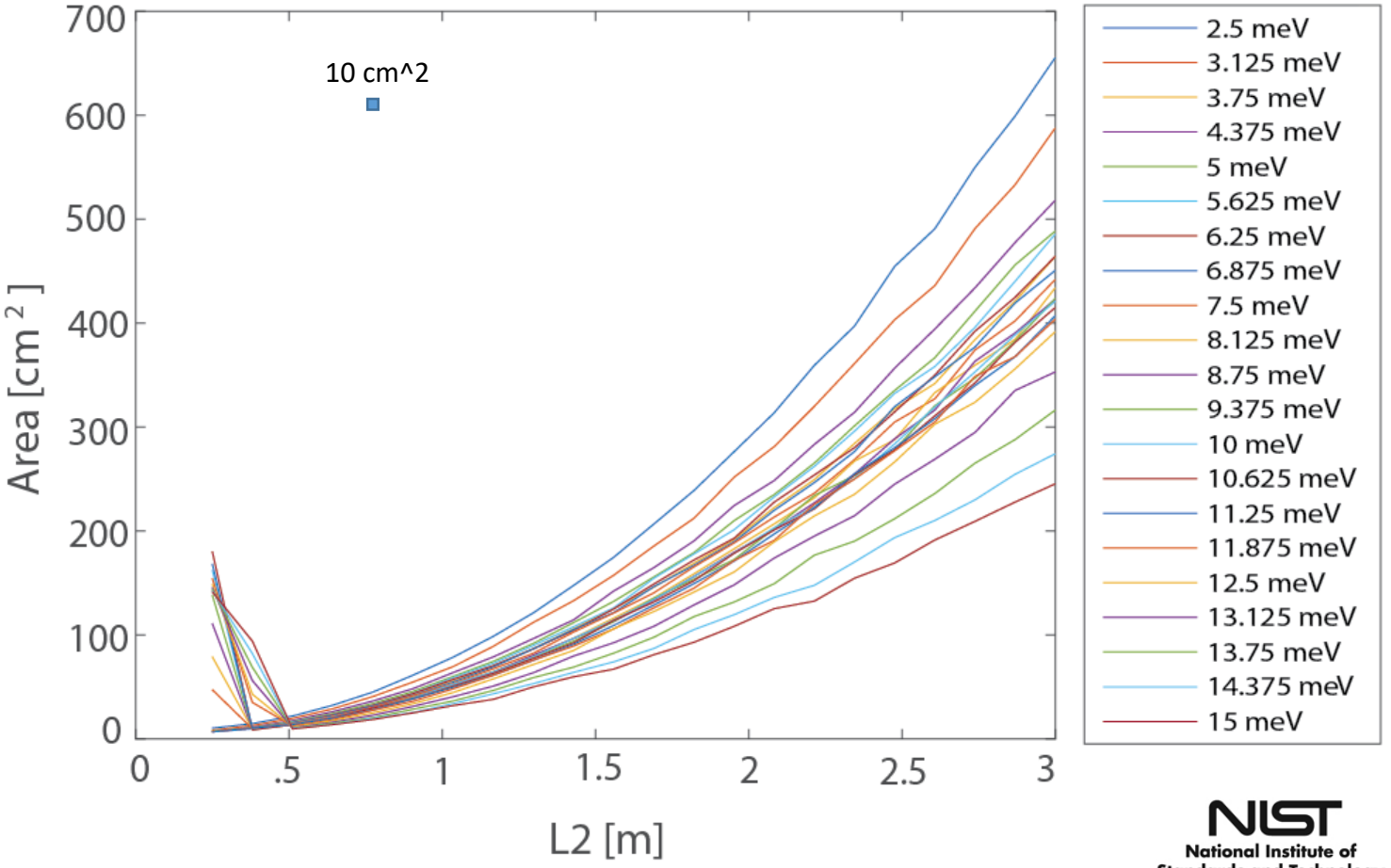


- Historically 30 minutes has been used



Flat Monochromator





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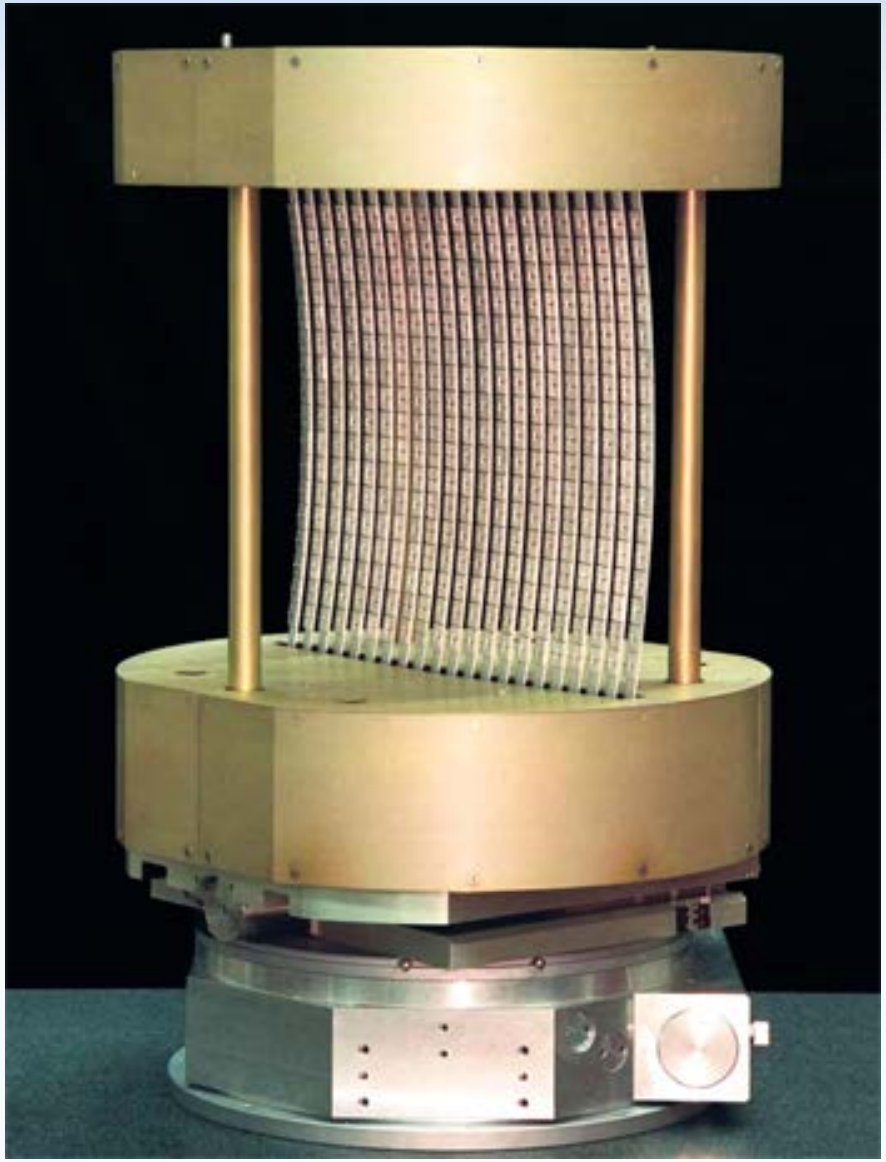
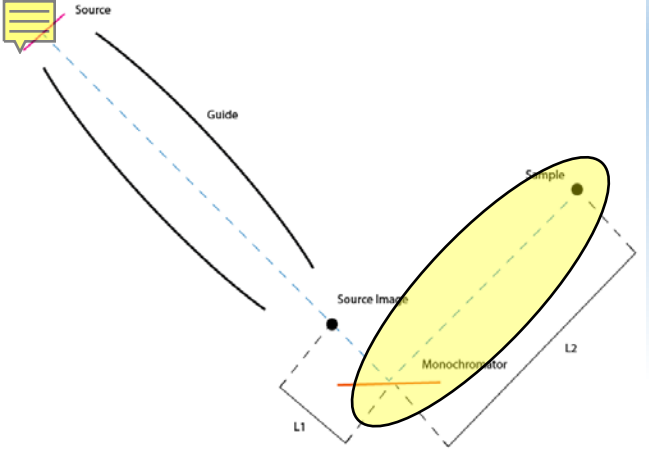
Doubly Focusing Monochromator

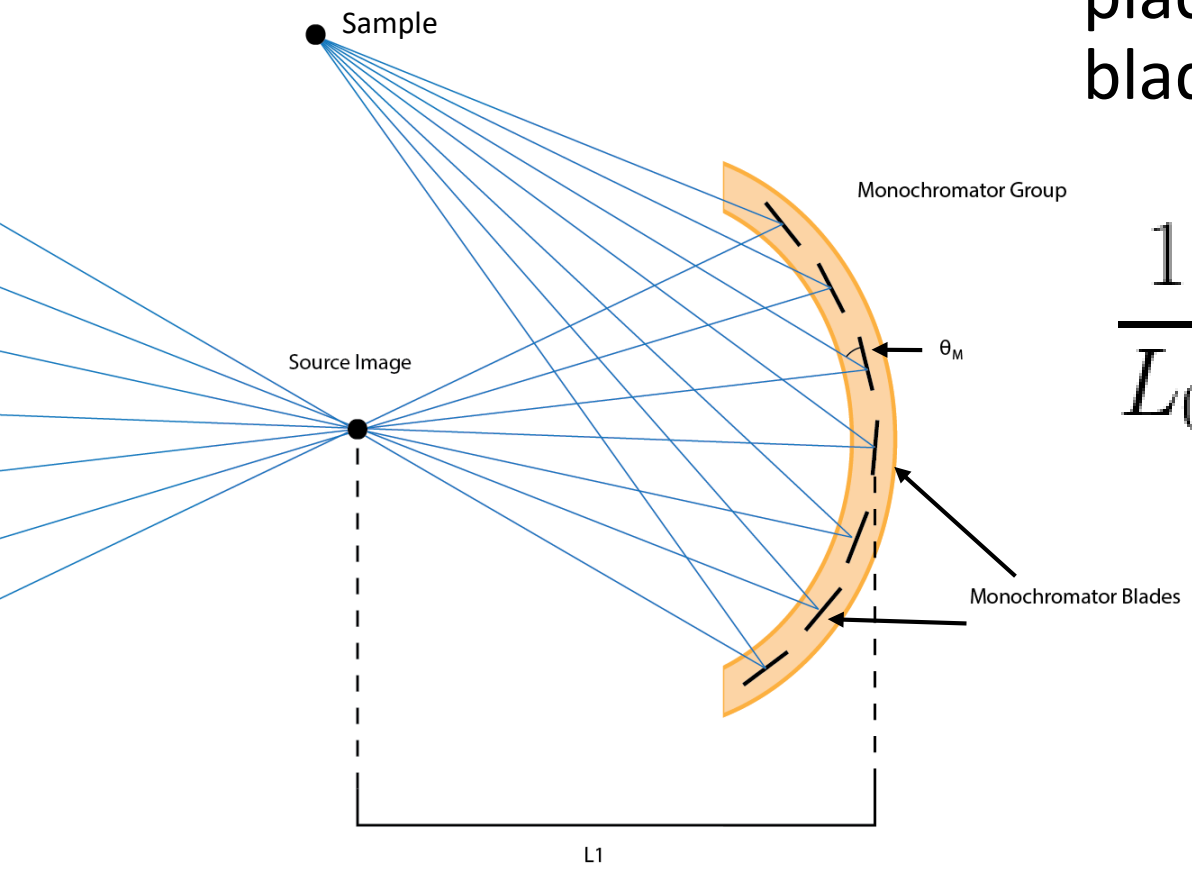


Source: Johns Hopkins University

Vertical Focusing

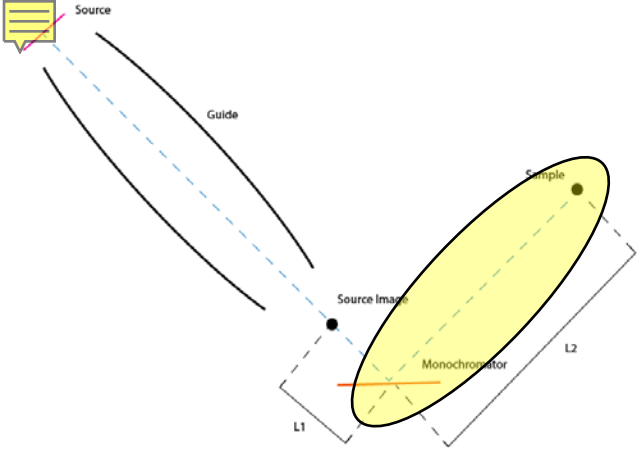


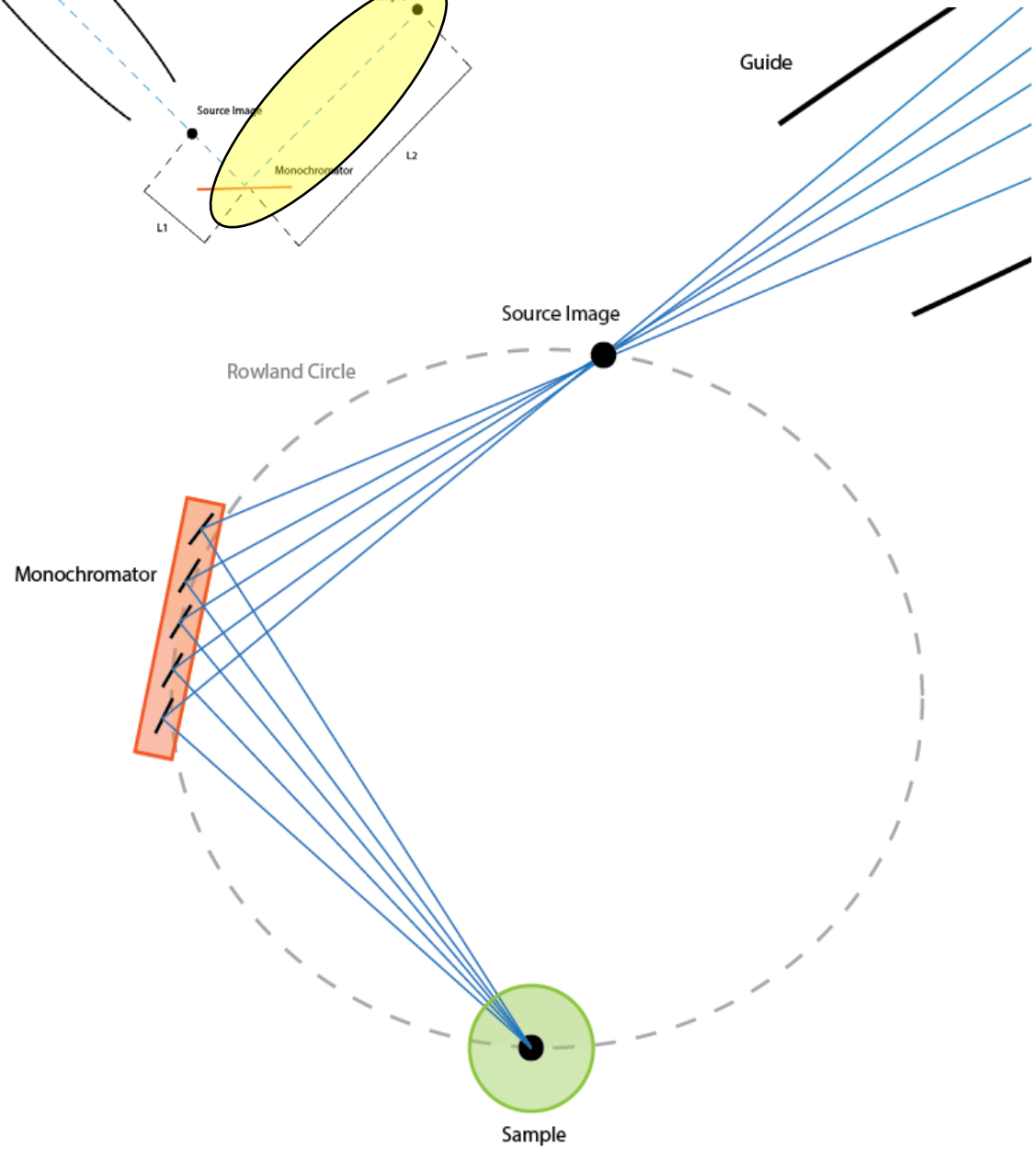
- Use Lens Maker Eqn. to place and rotate individual blades



$$\frac{1}{L_0} + \frac{1}{L_1} = \frac{2sin\theta_M}{R}$$

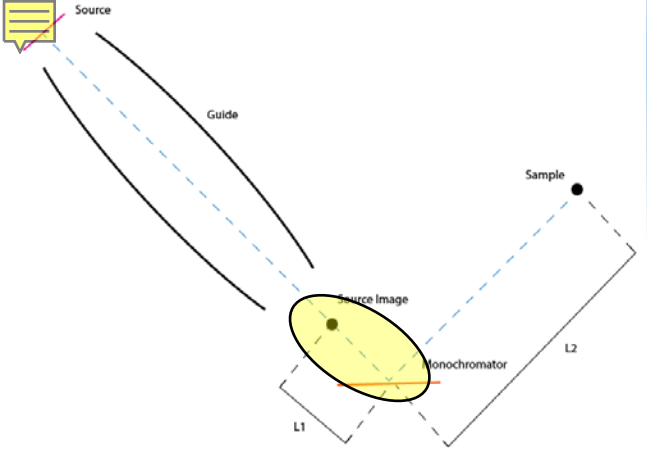
Horizontal Focusing

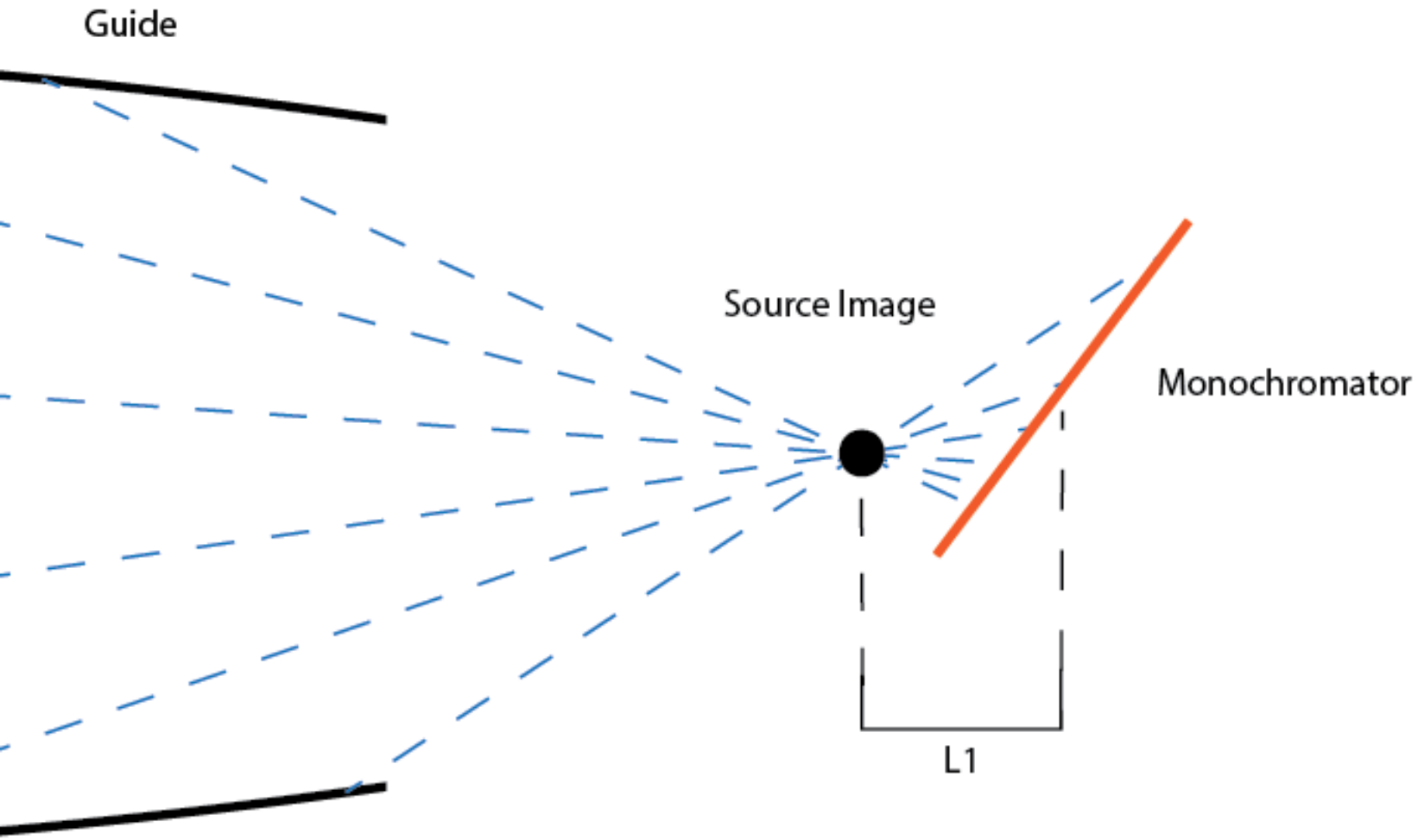




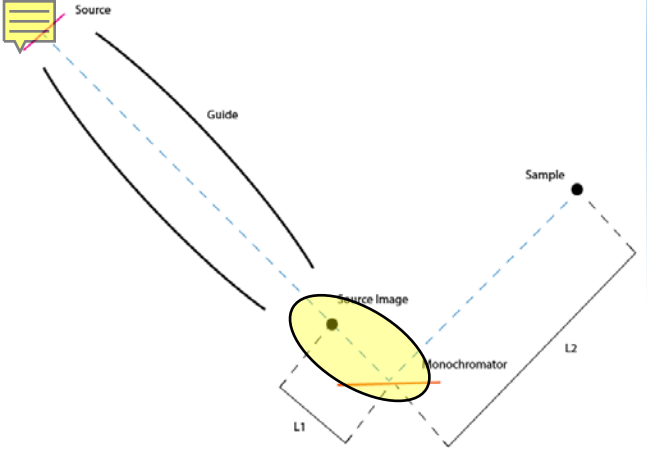
- Blade group lays tangent to Rowland circle

Source Image

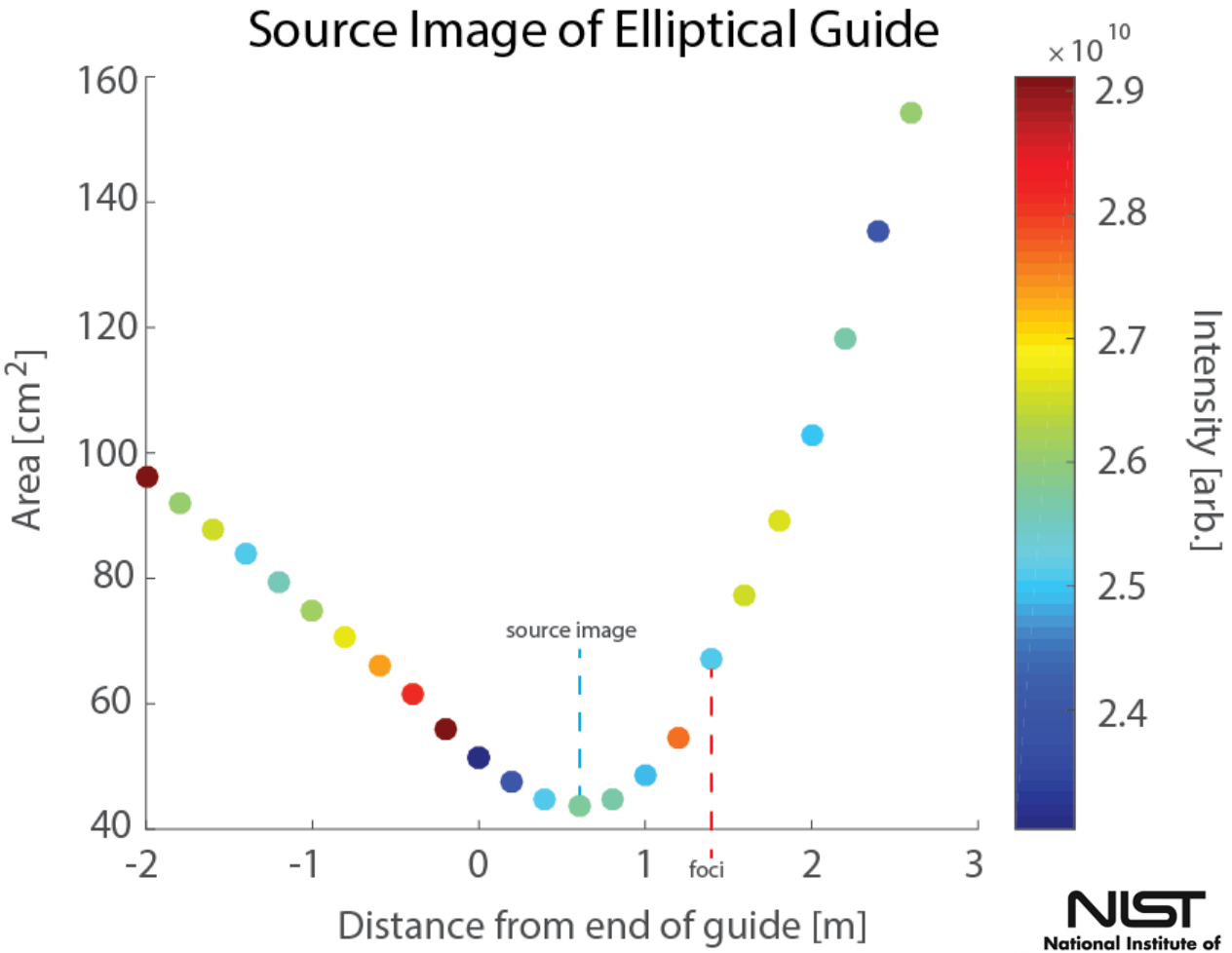




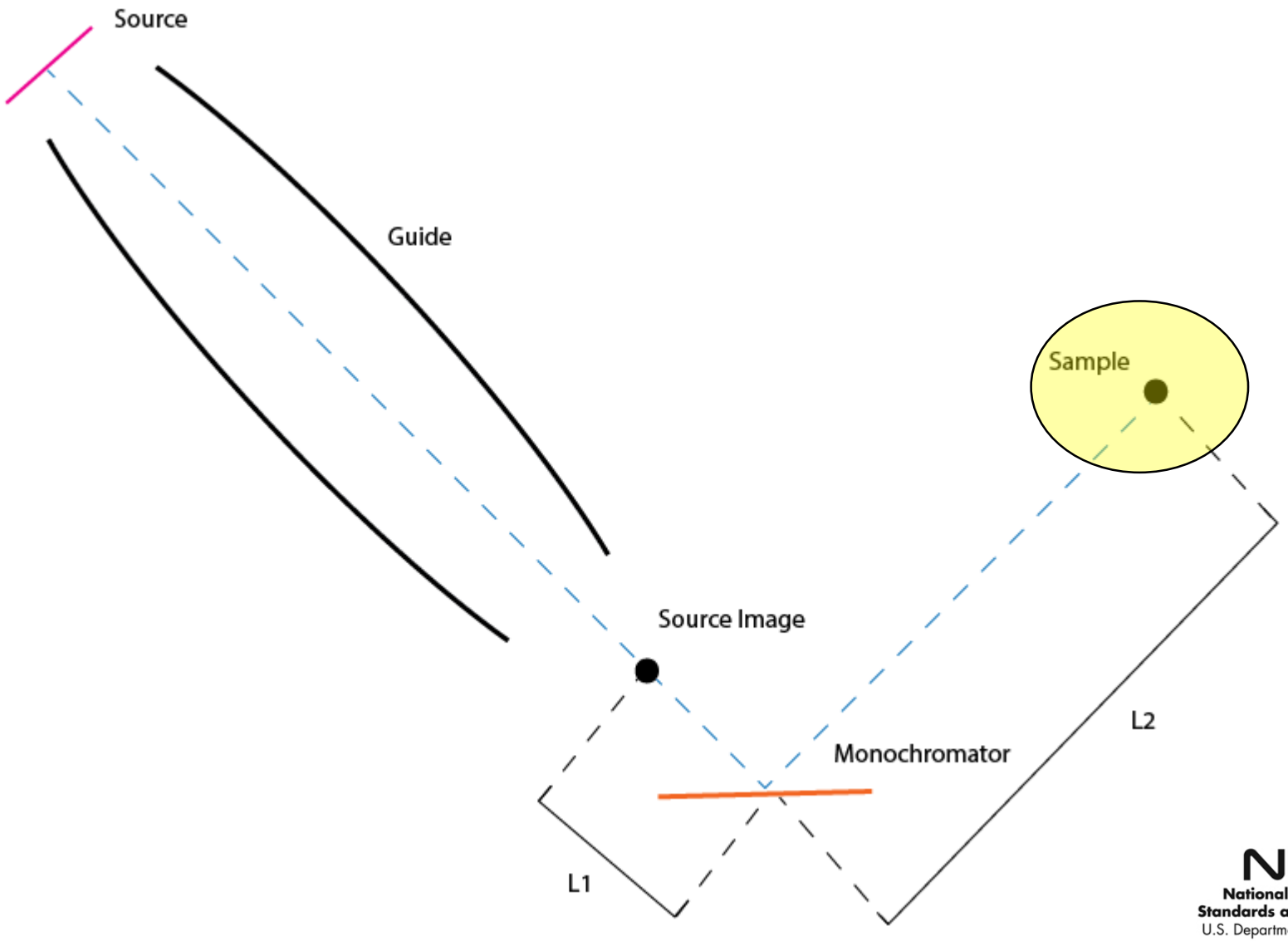
Source Image



- The focal point of the elliptical guide is NOT where the source image is produced



Monochromator Results



Future Plans

- Compare intensities at sample position of flat monochromator with optimized focused monochromator.
- Integrate the monochromator into guide optimization
- Vary the m-value of the coating along the ellipse
- Build the best guide/spectrometer ever

Acknowledgments

- Leland Harriger
- Mads Bertelson
- Jeff Lynn
- Julie Borchers, Joe Dura, and all SURF Directors
- NSF and CHRNS

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