INVESTIGATIONS OF THE ILC UNDULATOR SPECTRUM WITH HUSR

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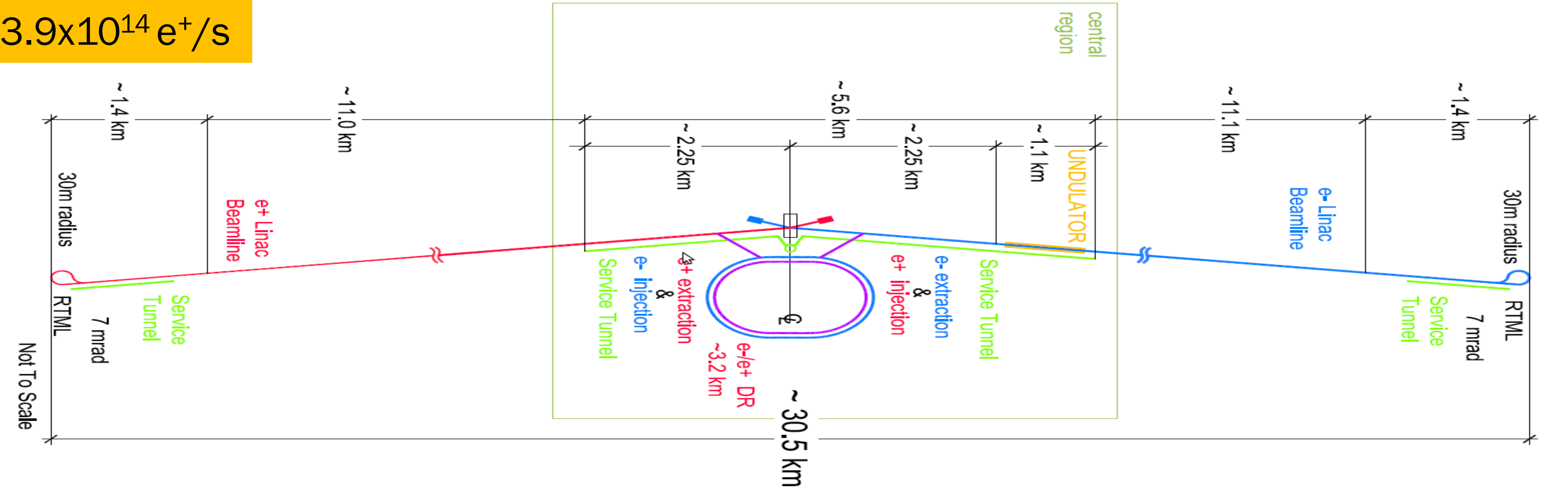
INTRODUCTION

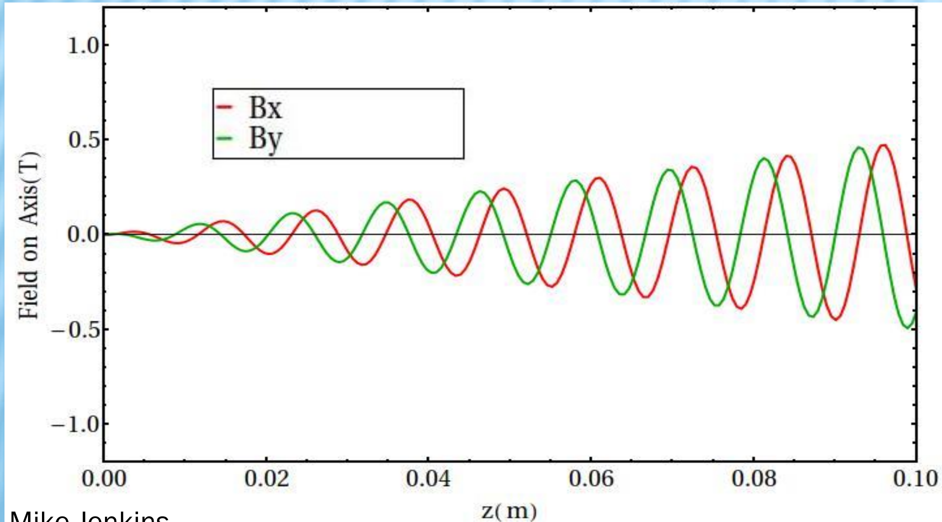
- Required γ flux (approximately 10^{16} γ/s) for high-luminosity electron-positron colliders such as the ILC.
- The TDR parameters for the baseline source at 150 GeV are assumed throughout this talk.
- Mike Jenkins presented some work from HUSR at POSIPOL12.
- Mike's talk focused on positron production and realistic magnets.

3.9×10^{14} e^+/s

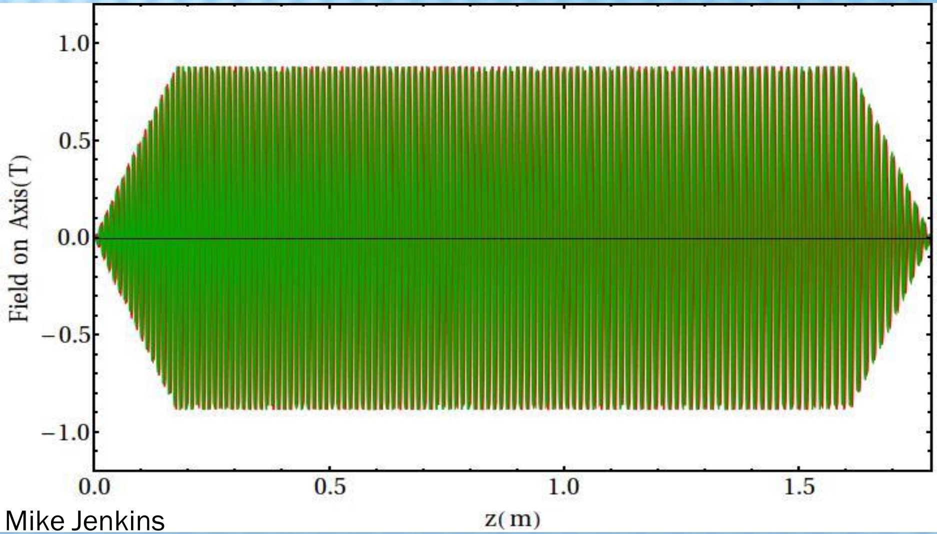


SIMULATING UNDULATOR PHOTON SPECTRA

- HUSR simulates a photon spectrum from an arbitrary magnetic field map.
- Using different arbitrary maps is possible in HUSR e.g. include errors in the magnet, tapering, etc.



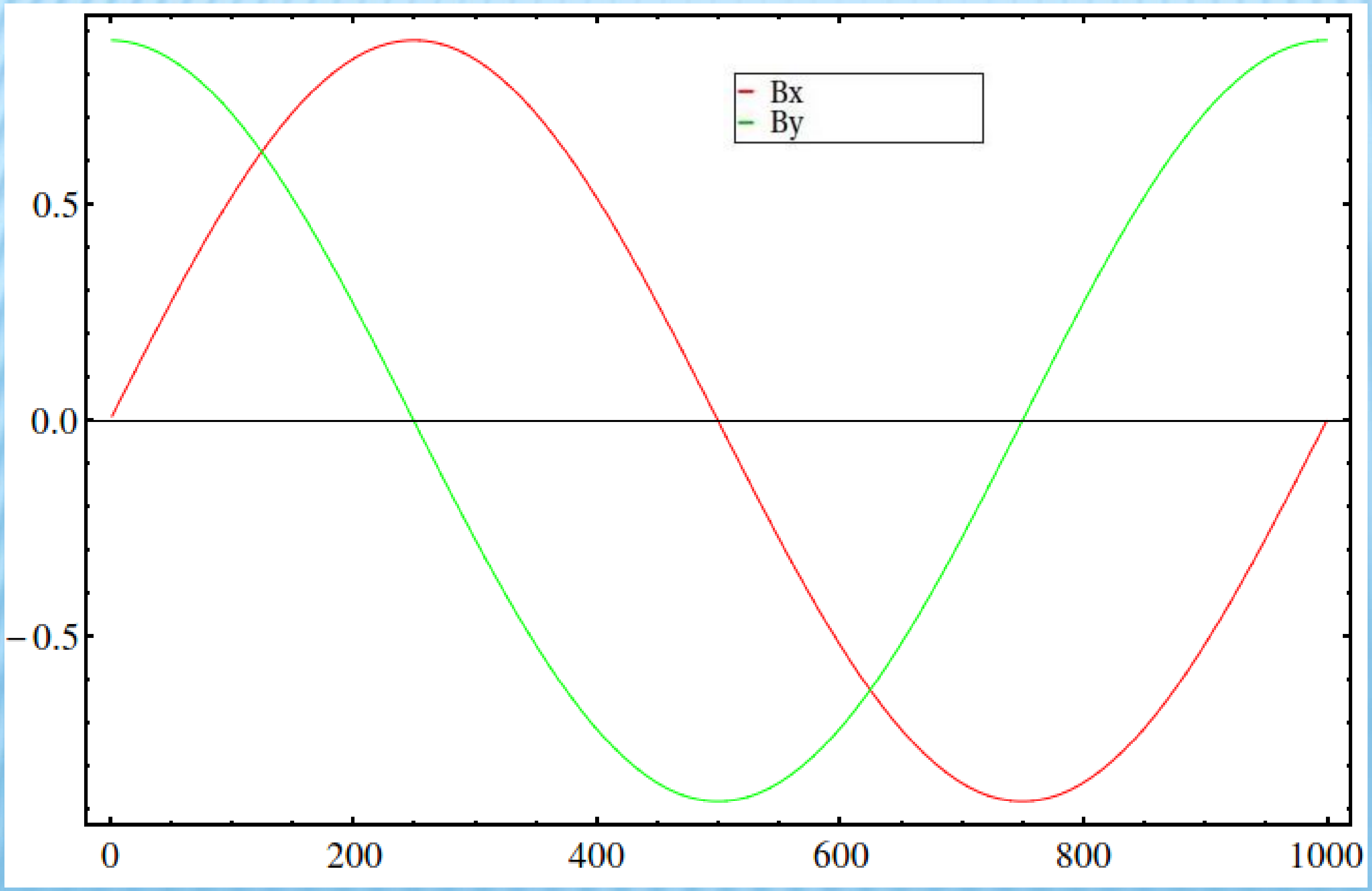
Mike Jenkins



Mike Jenkins

SIMULATING UNDULATOR PHOTON SPECTRA

- Initially we use an ideal helical undulator.



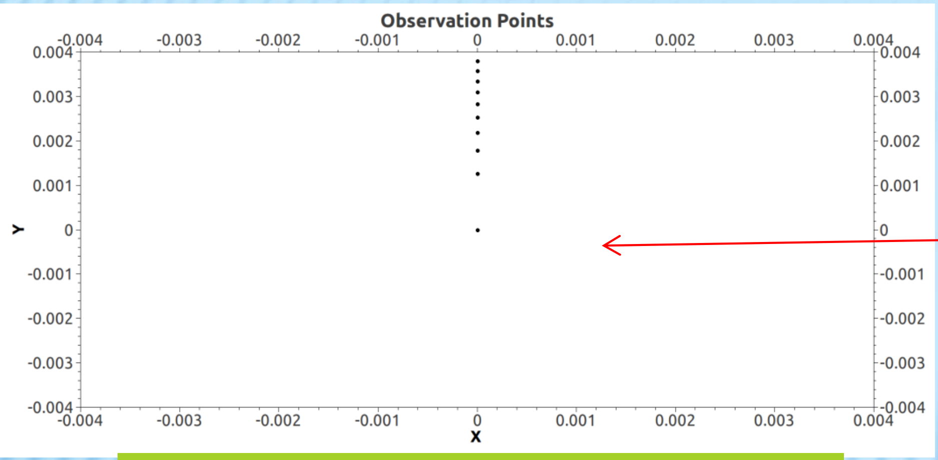
$$B_x = B_0 \sin\left(\frac{2\pi z}{\lambda_u}\right)$$

$$B_y = B_0 \cos\left(\frac{2\pi z}{\lambda_u}\right)$$

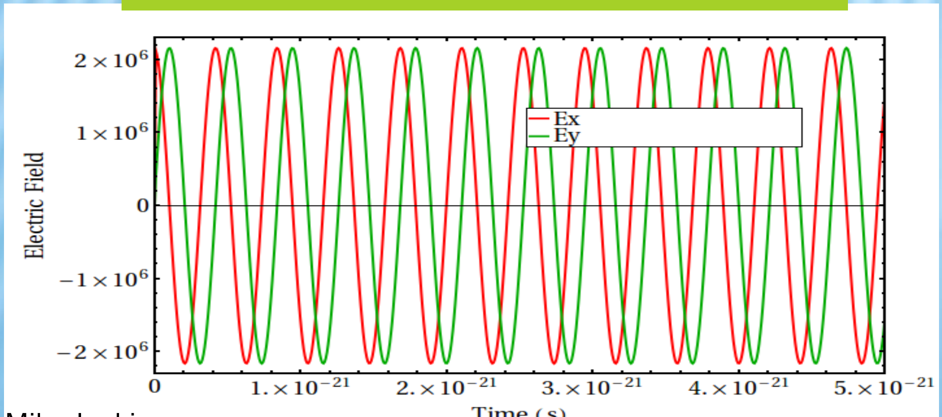
B_0=0.88 T

HUSR: PHOTON SPECTRA

HUSR developed at Cockcroft Institute by David Newton



e.g. Electric field from the 1st observation point



Mike Jenkins

Generate a Lie map from a B field defined on a 3d mesh.

Track electron(s) through the Lie Map.

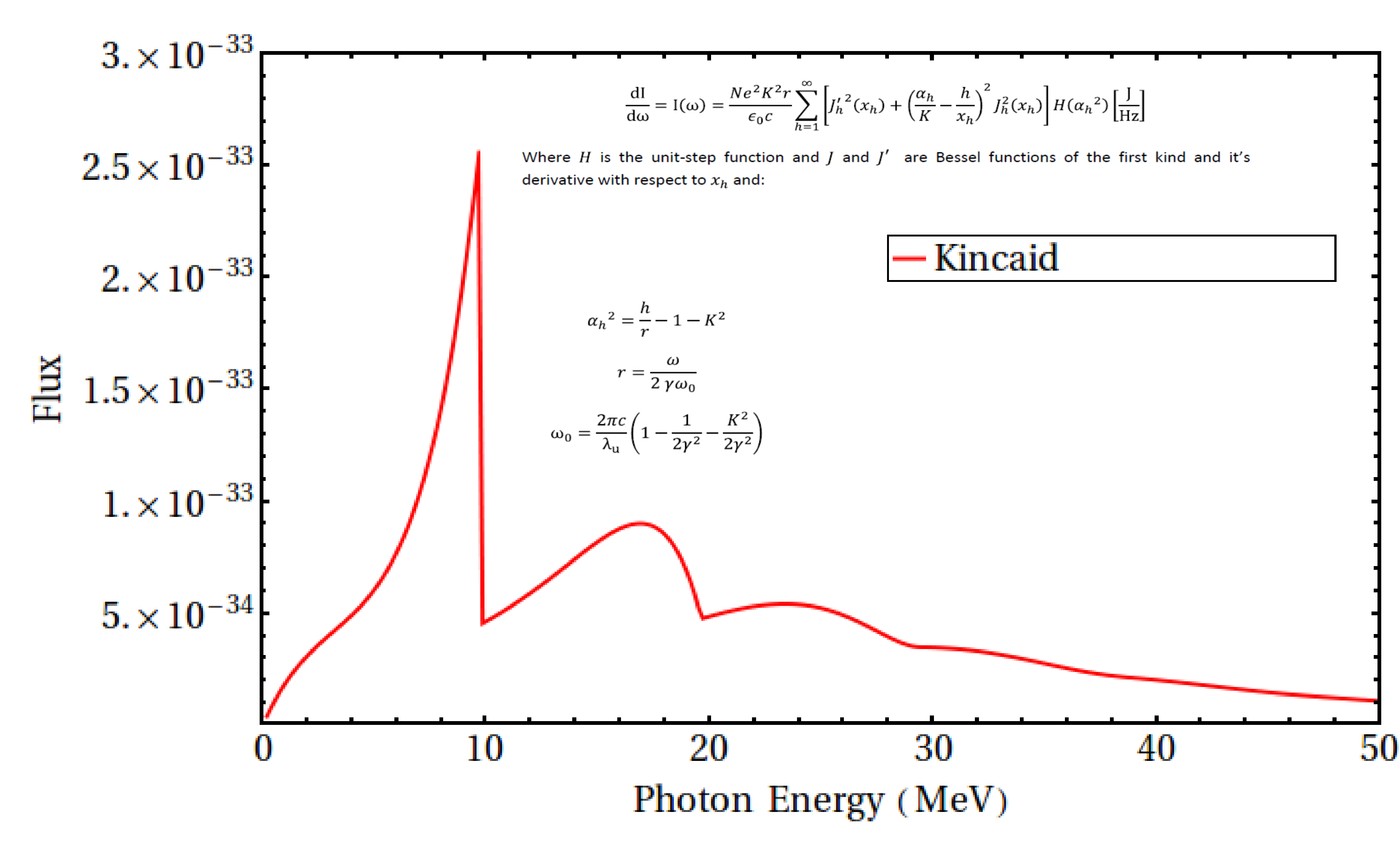
Set observation points

Calculate the retarded potential from electron(s).

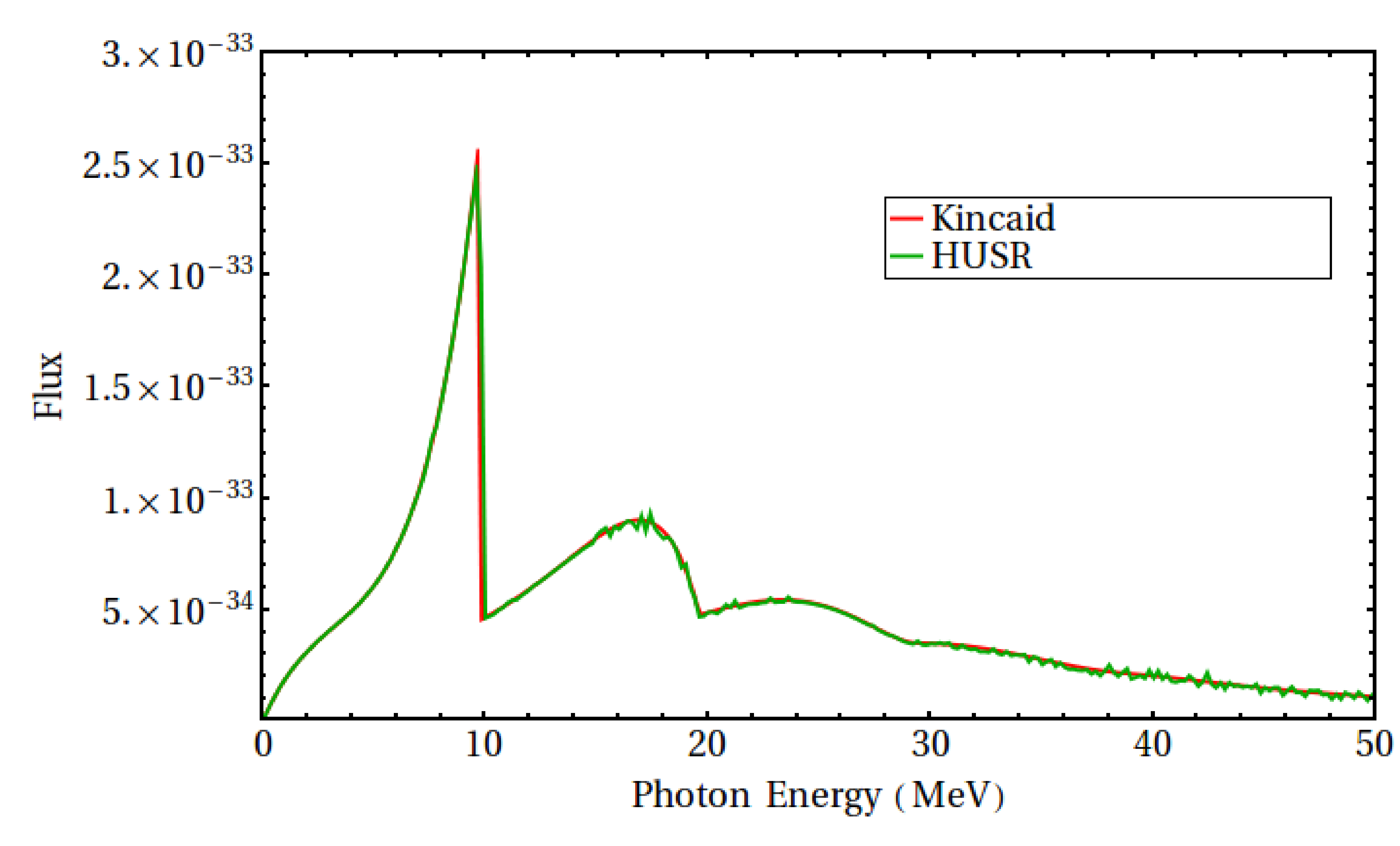
From the retarded potential calculate the electric field at each observation point as a function of time.

Calculate the frequency spectrum of the observed radiation by Fourier transforming the field.

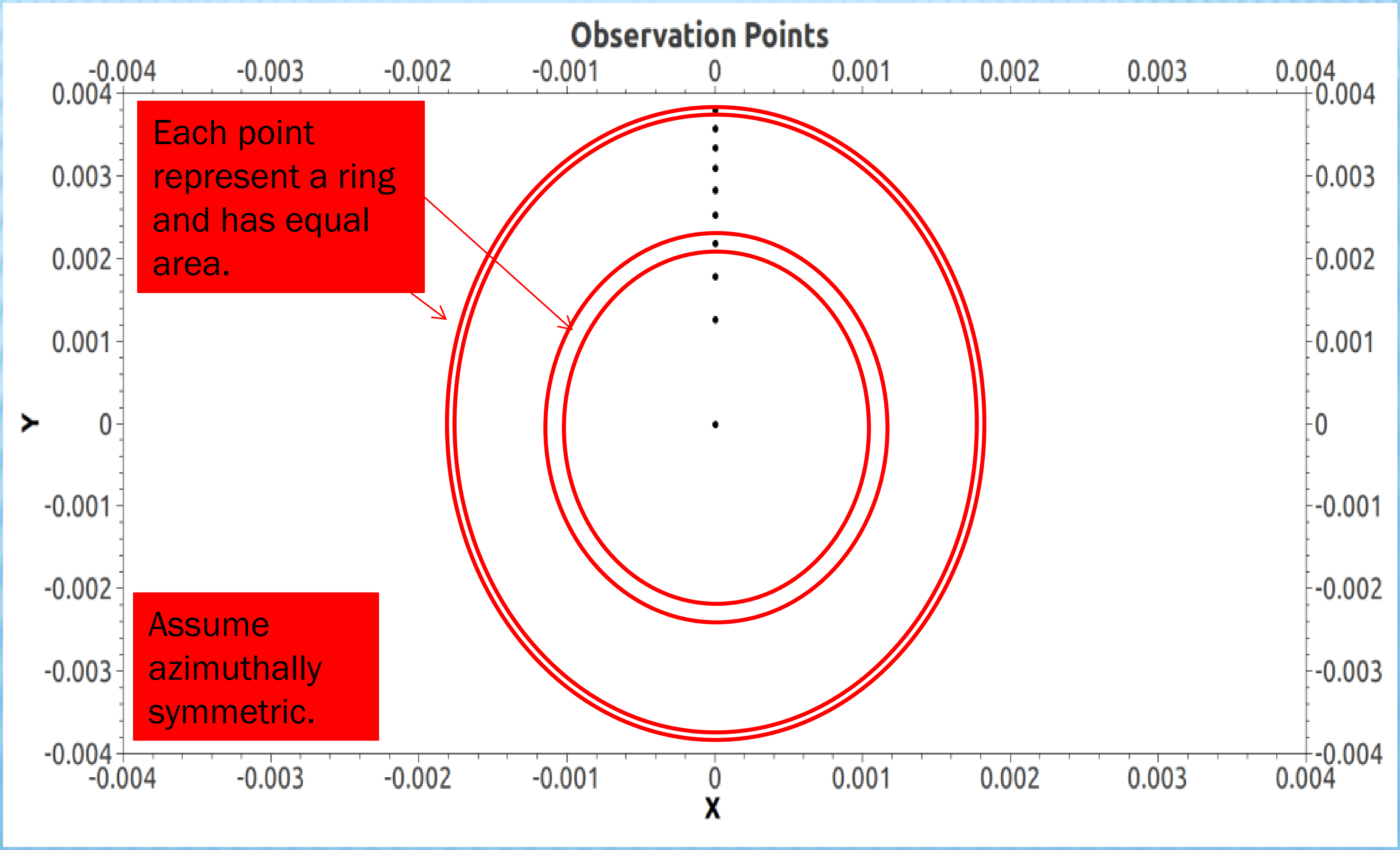
BENCHMARKING HUSR



BENCHMARKING HUSR

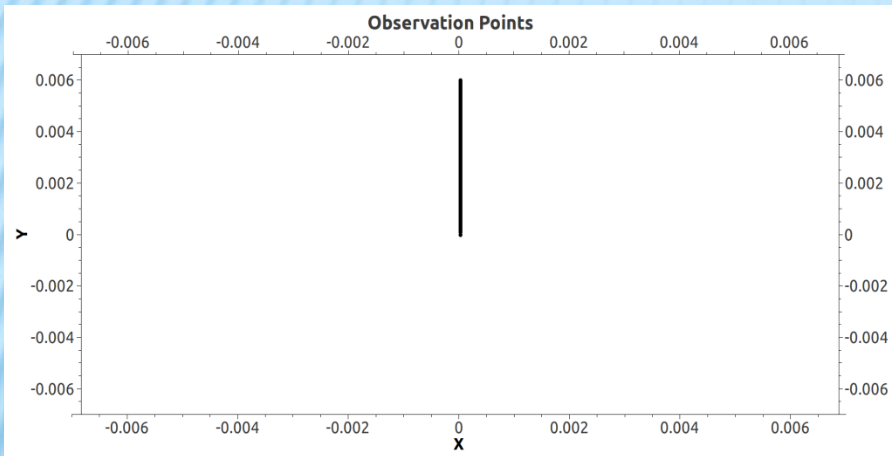


OBSERVATION POINTS

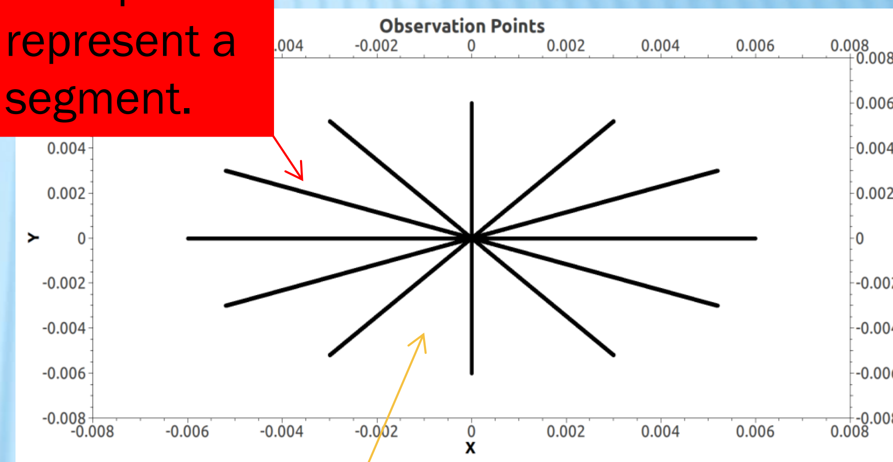


RECENT EXTENSIONS TO HUSR

We changed the algorithm for setting the observation points



Each point represent a segment.



Low resolution

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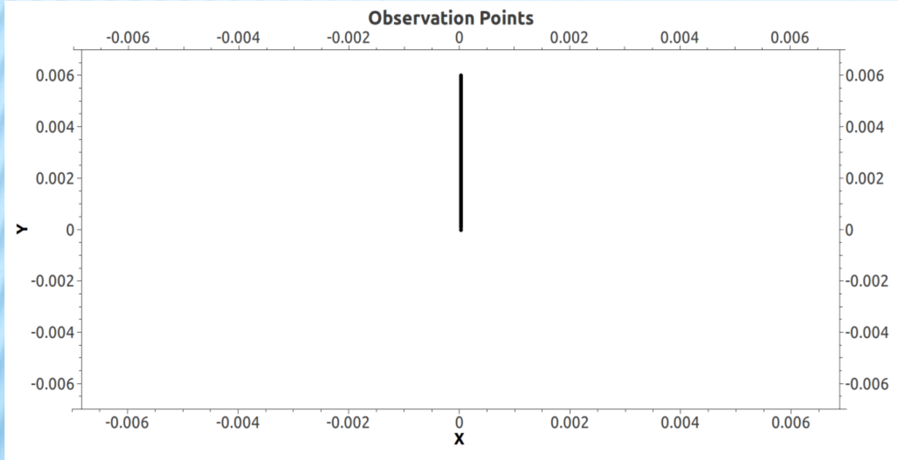

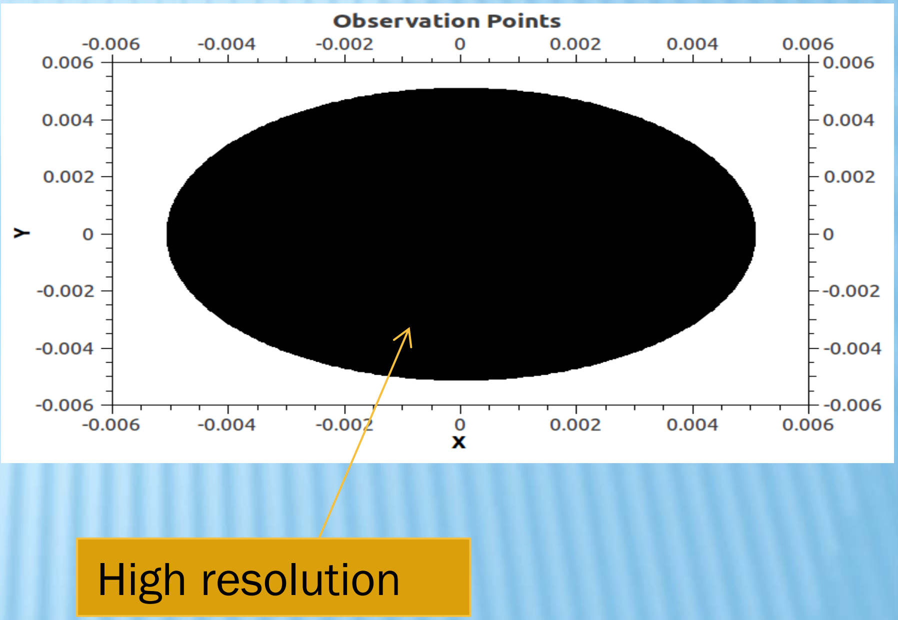

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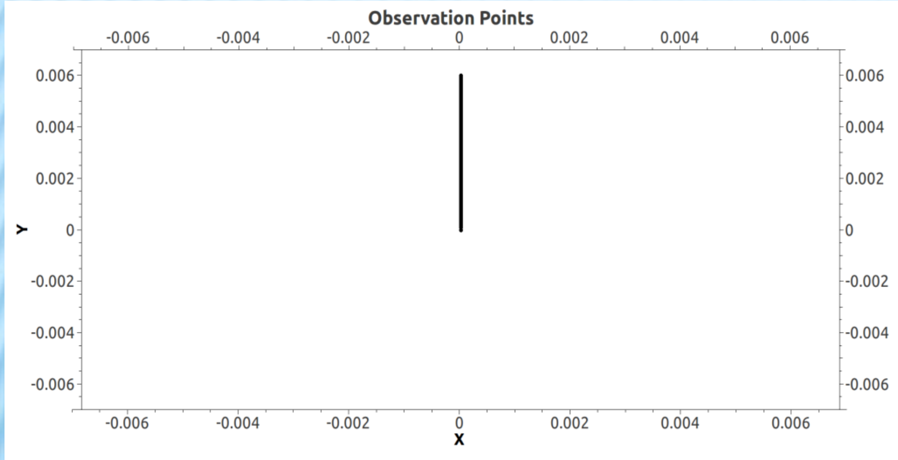

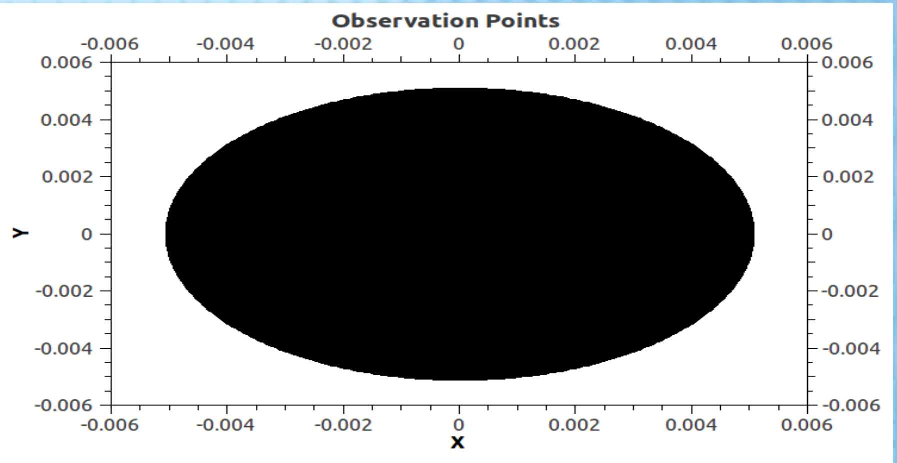

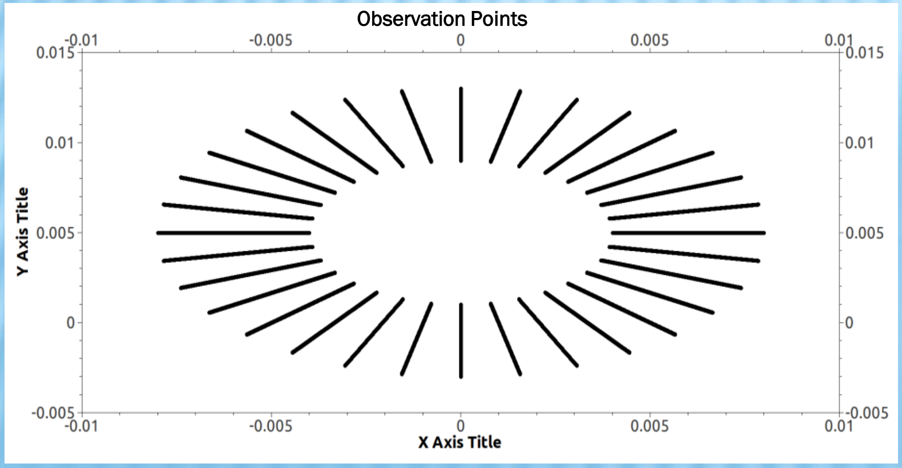

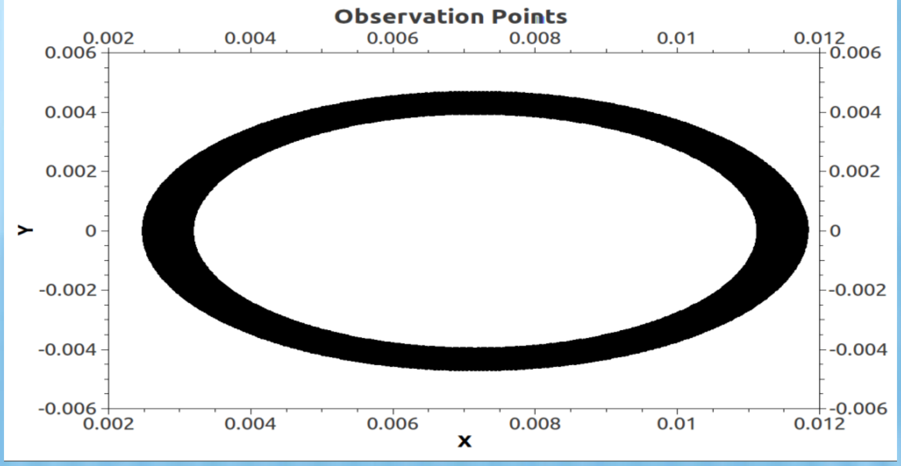

CURRENT GAMMA-RAY SOURCES AND THEIR APPLICATIONS

- HIGS (10^8 photon/s, Bandwidth 5%-10%) at Duke University, USA.
- ELI-NP is being designed (~10^{13} photon/s, Bandwidth 0.3%).
- Energy bandwidth $\Delta E_\gamma/E_\gamma$ is very important (narrow bandwidth is better).

Basic Nuclear Physics

- Nuclear resonance fluorescence (NRF) technique.
- Giant Dipole Resonance (GDR).

Industrial applications

- Radiographical techniques such as gammagraphy and Computerized Tomography (CT).

Instrumentation

- Photon beams can be used for precise calibration of specialized detectors such as dosimeters, gamma ray lenses, etc.

Production of radio isotopes

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Using gamma ray to image materials

Instrumentation

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Approximately 93% of the photon beam will pass through the target

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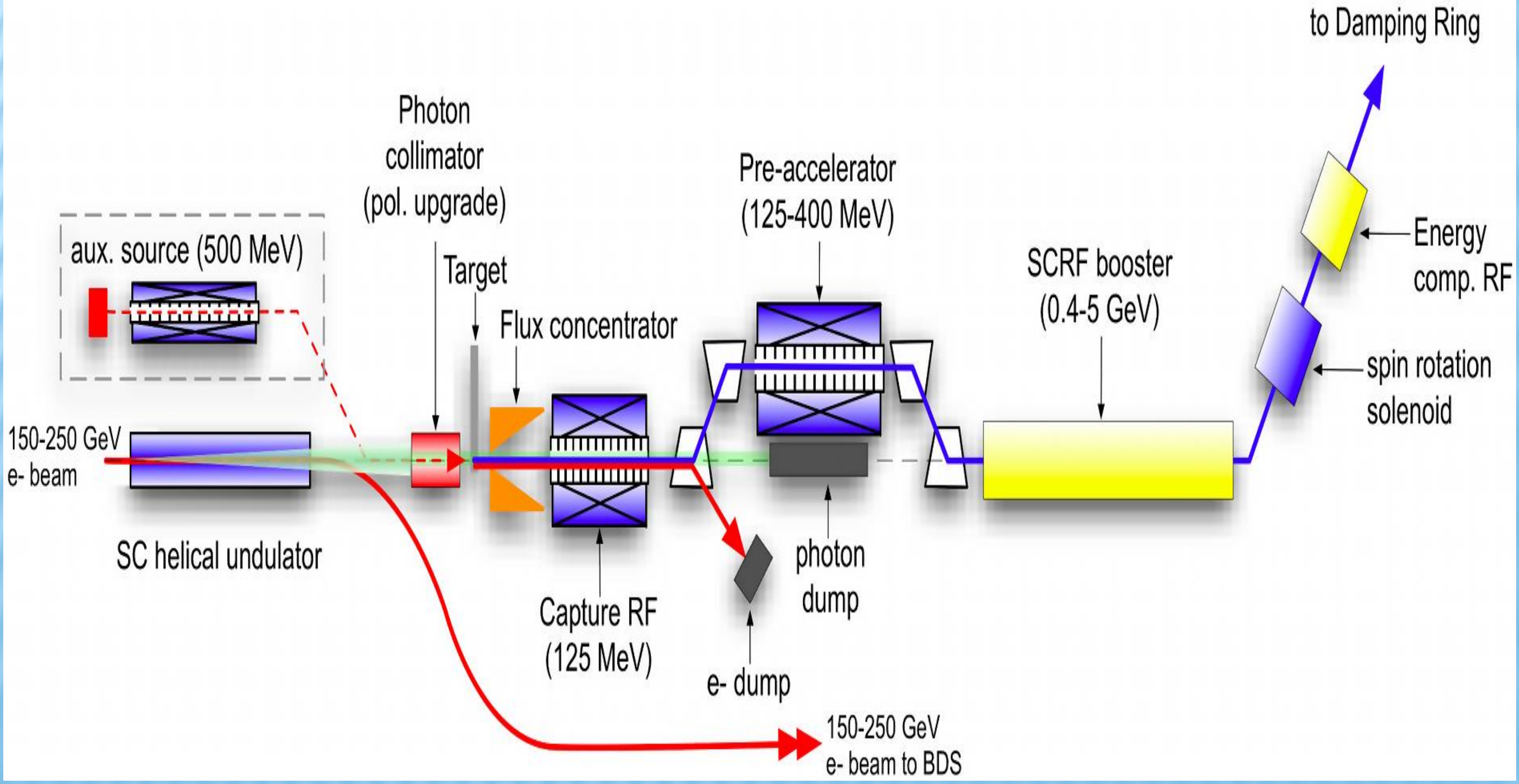

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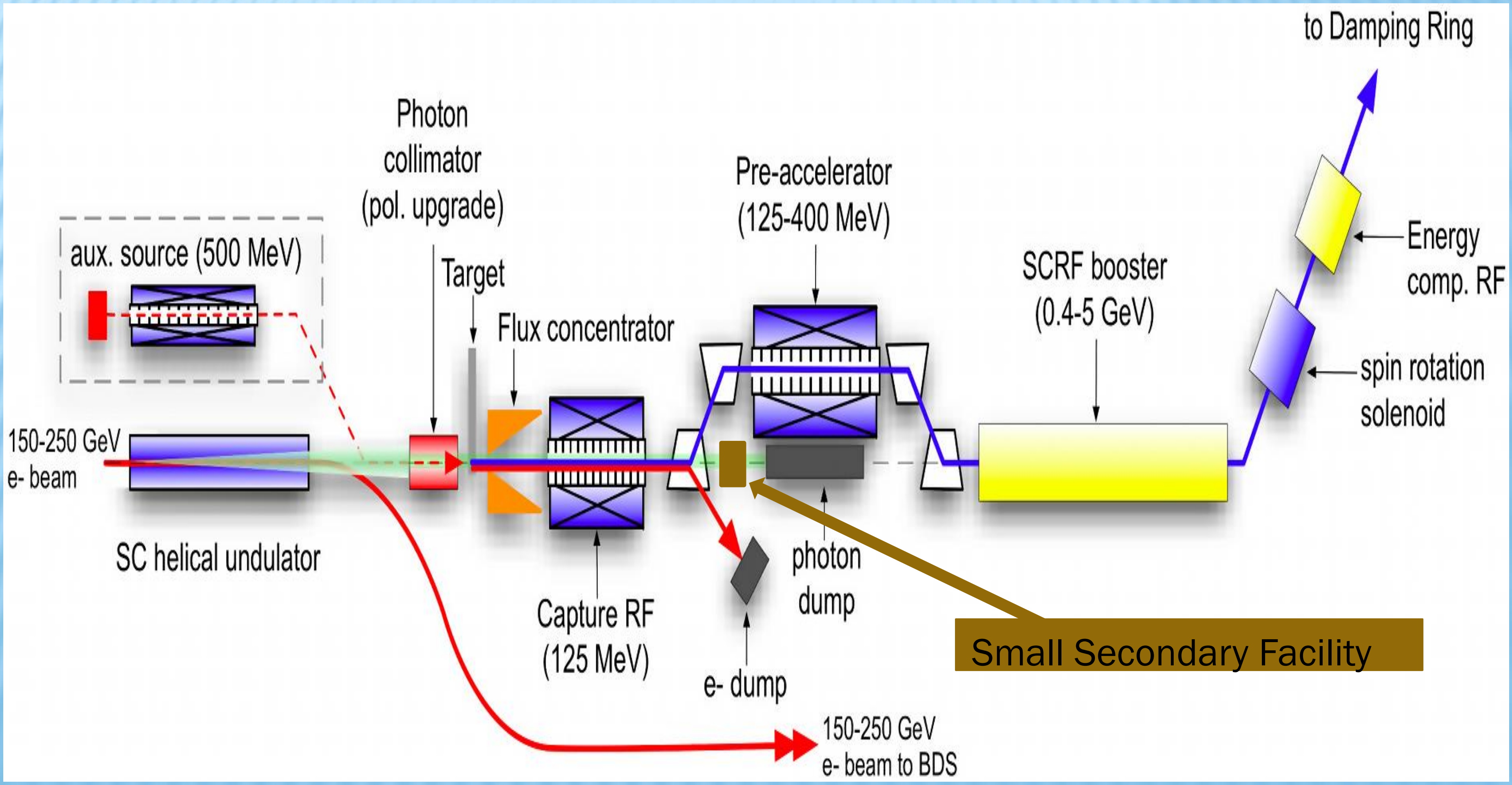
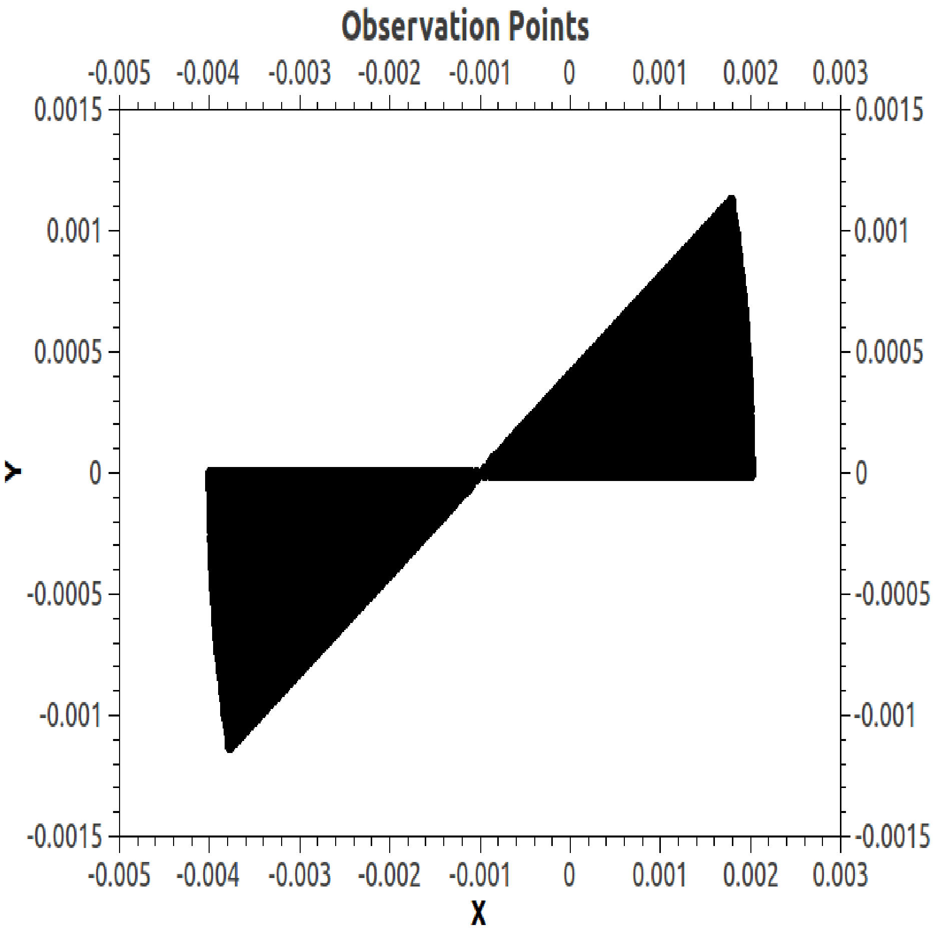
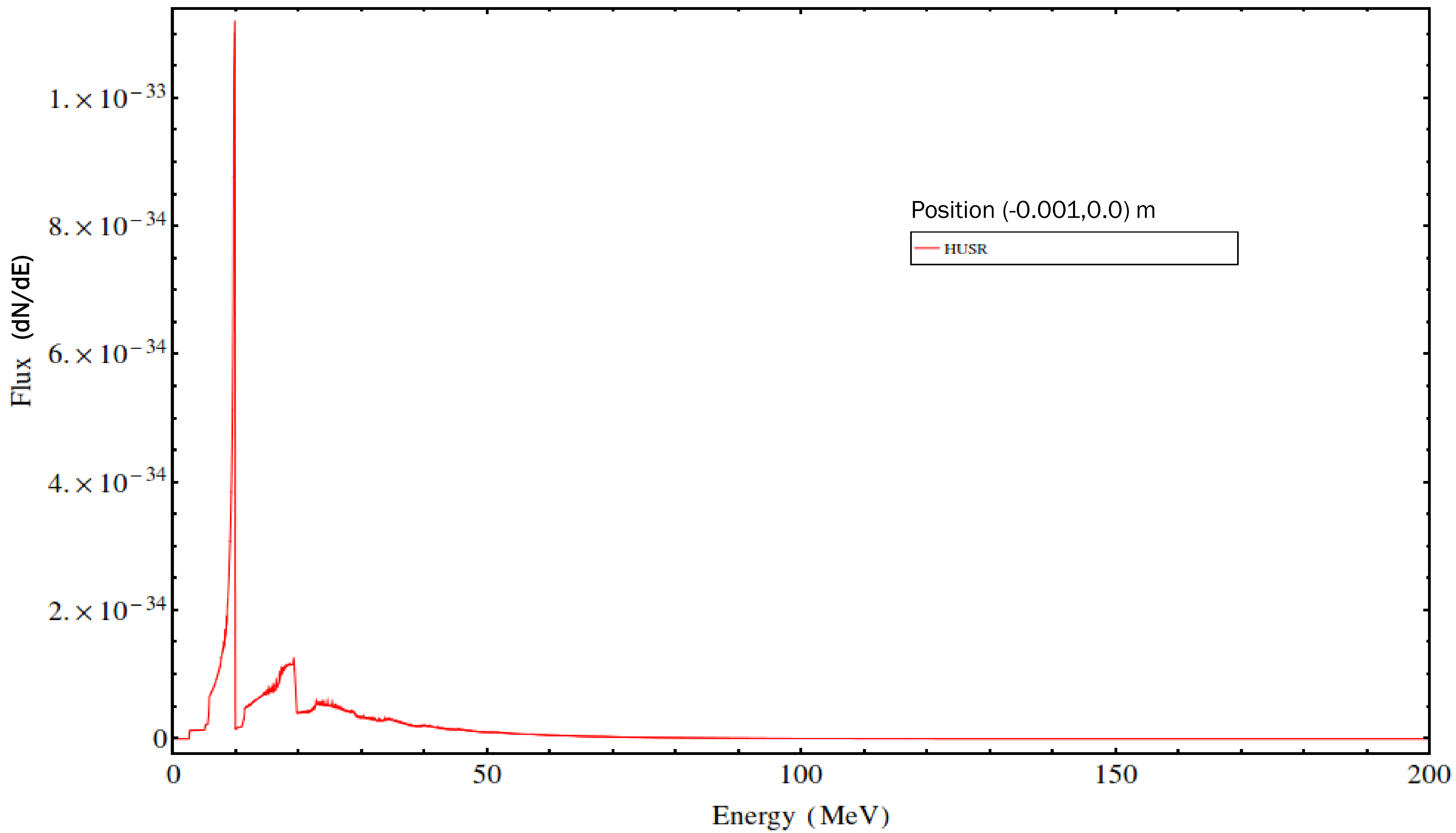


"HOURGLASS" SHAPED APERTURE

We investigated different shapes to see if we obtain a narrow bandwidth.



HOURGLASS SPECTRUM



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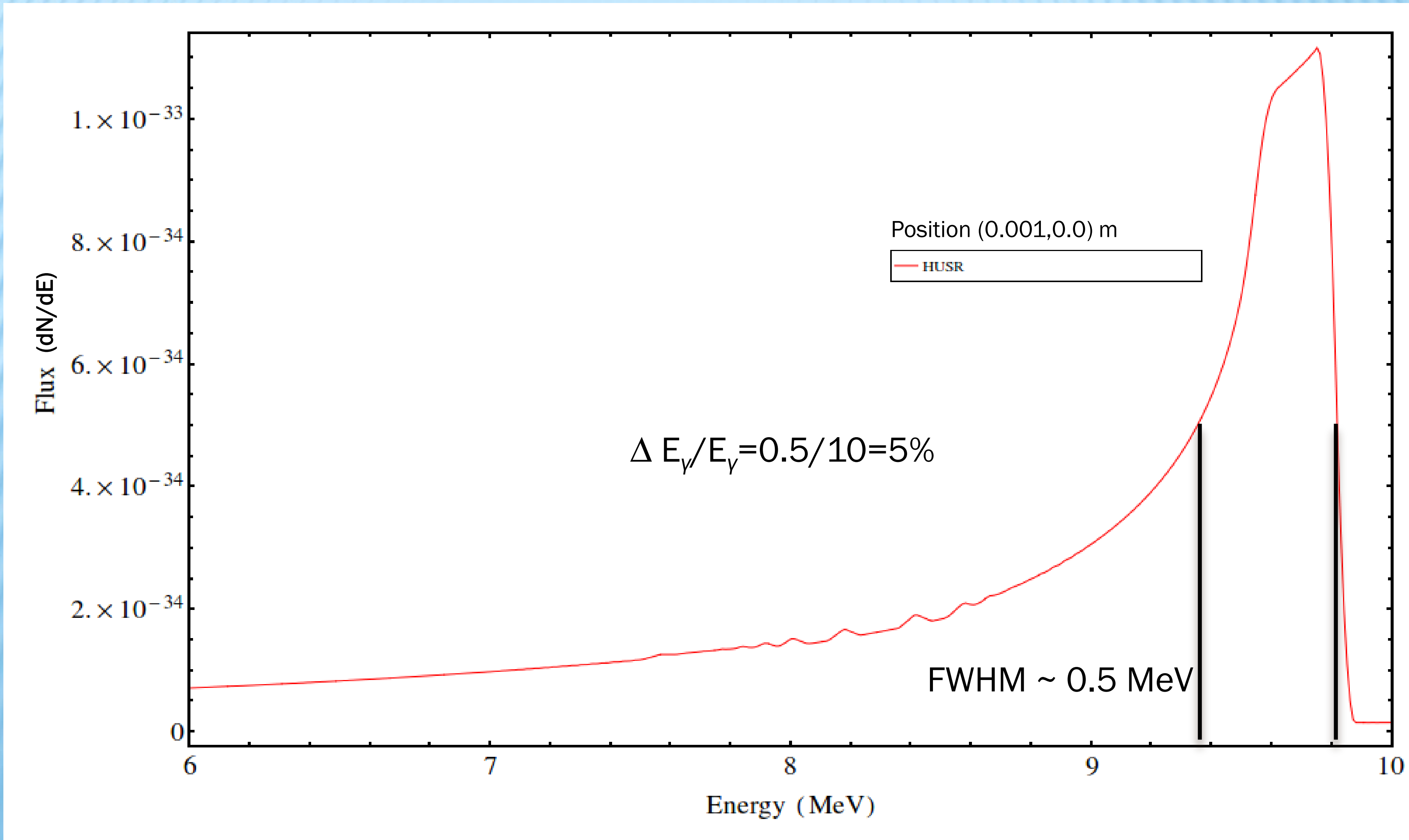

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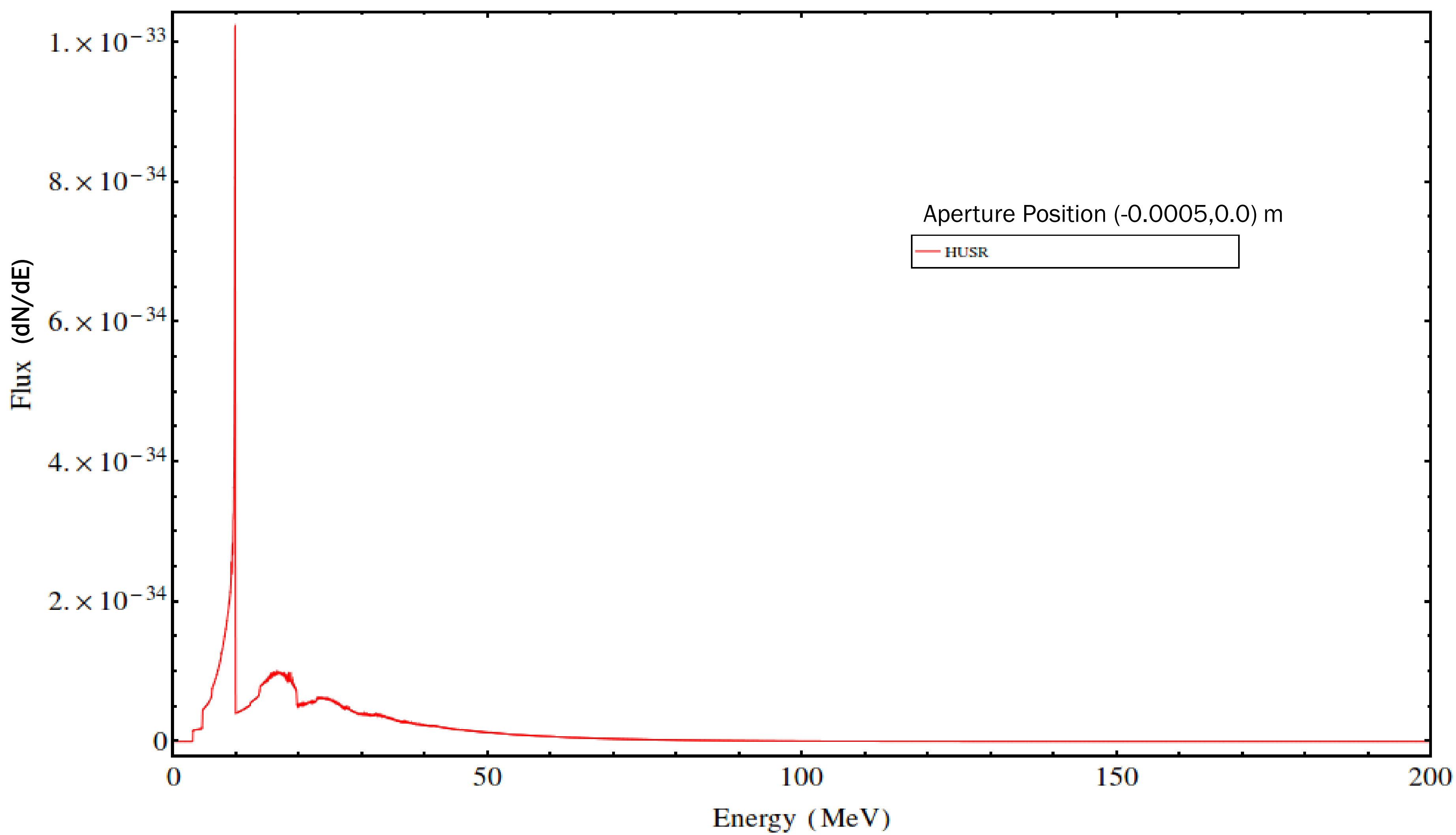

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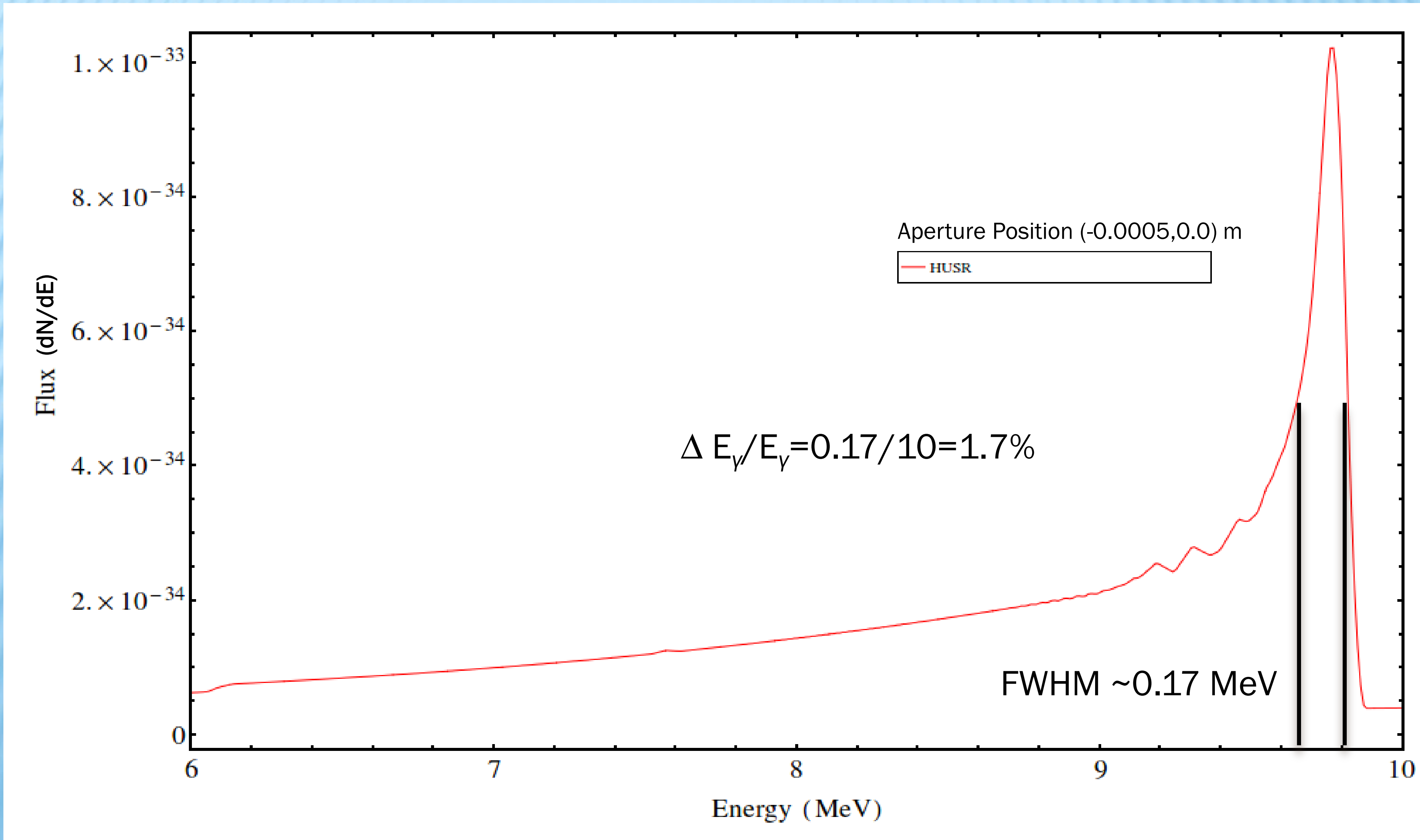

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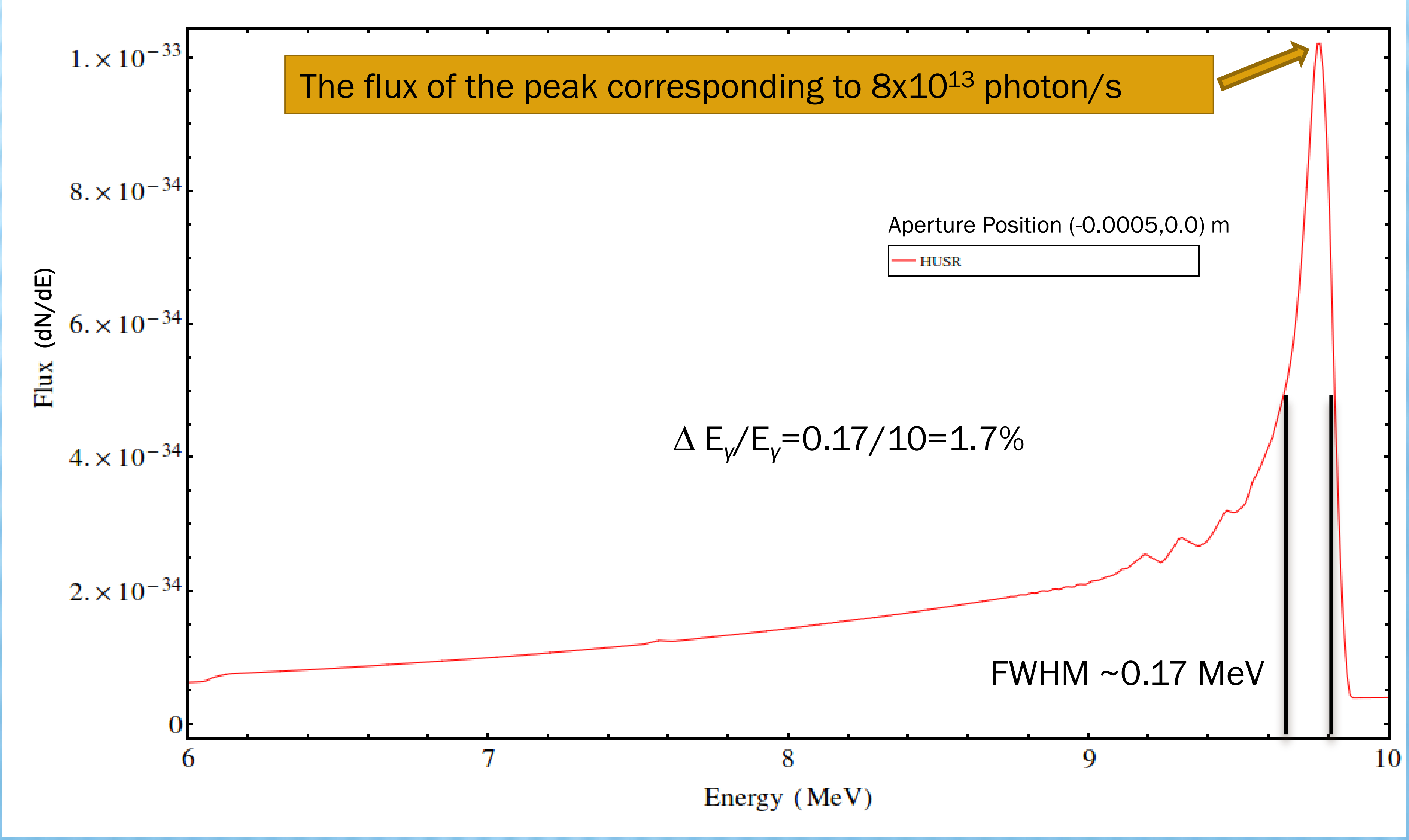
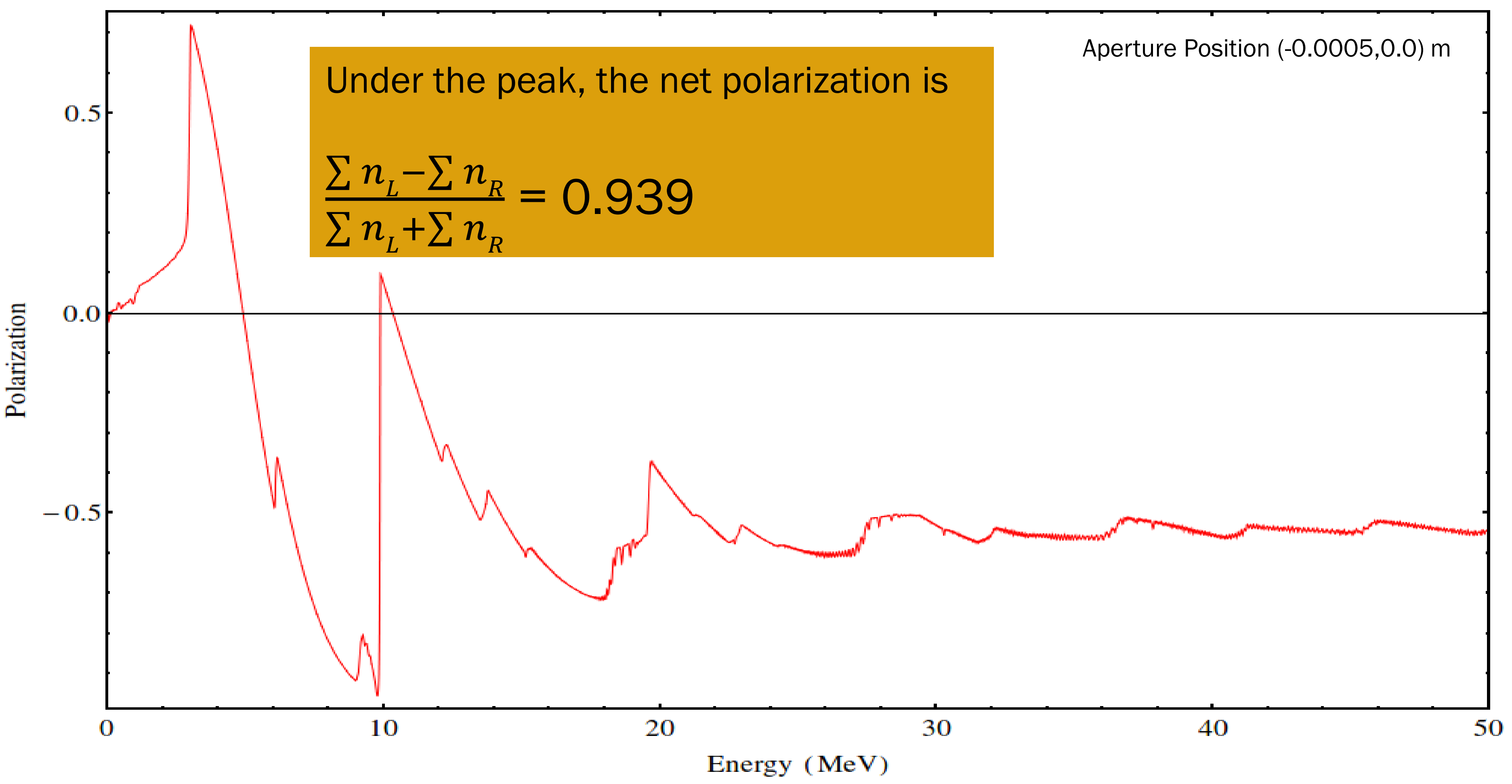
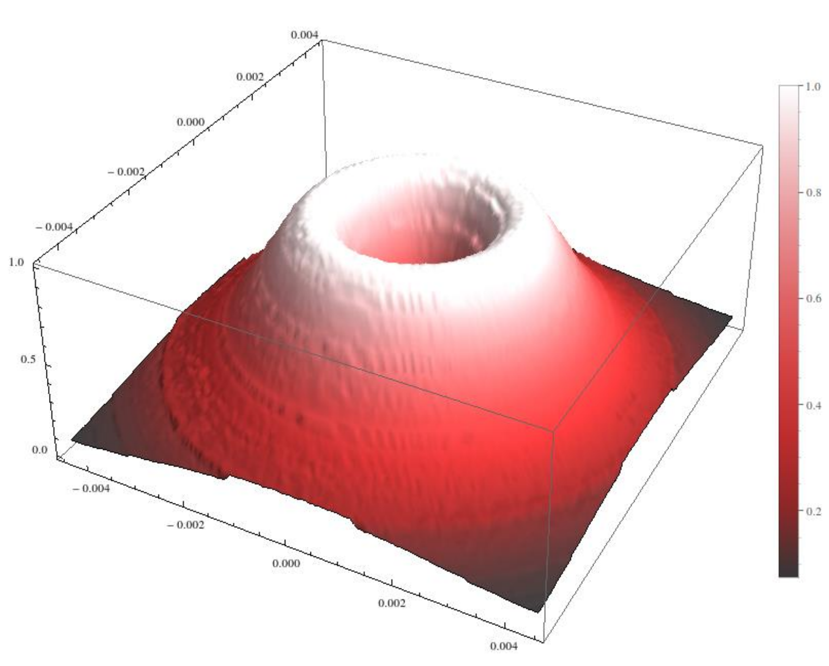


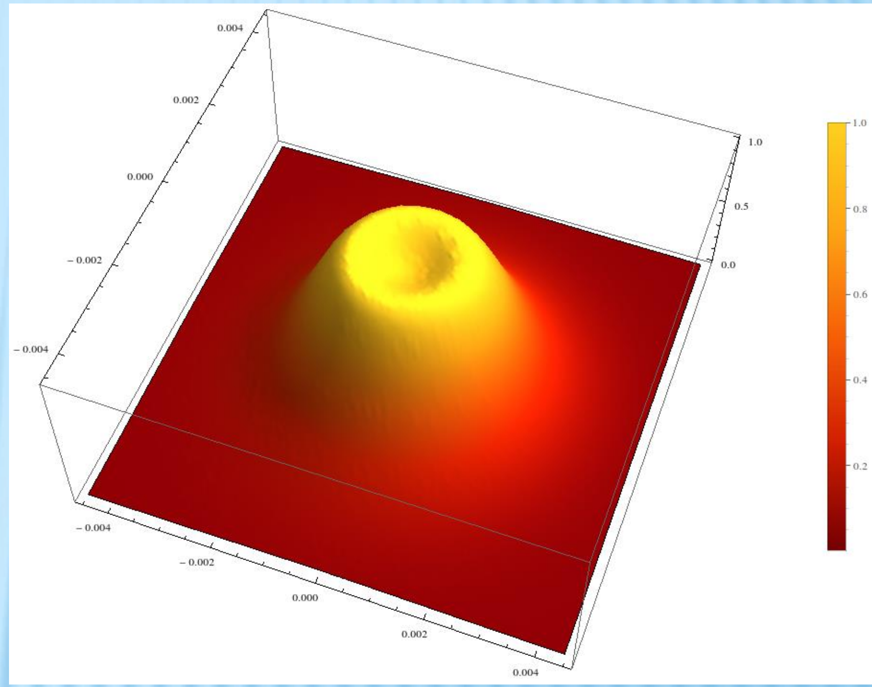
POLARIZATION



IDEAL UNDULATOR PHOTON DISTRIBUTIONS



Average Energy



Flux

SUMMARY AND FUTURE WORK

- Good agreement between HUSR and Kincaid for an ideal undulator.
- New version (GSR) now in development.
- Further investigations ongoing on how the spectrum changes after the target.
- Good chance of using the remaining photon flux to do “something else” with it.

Thanks for your attention !

BACK UP SLIDES

HUSR: PARTICLE TRACKING

HUSR utilizes Lie maps in the tracking of particles through a magnetic field