Strong Gravity EU FP7-SPACE Research Project

WP4

Comptonization models: Spectra and Polarization

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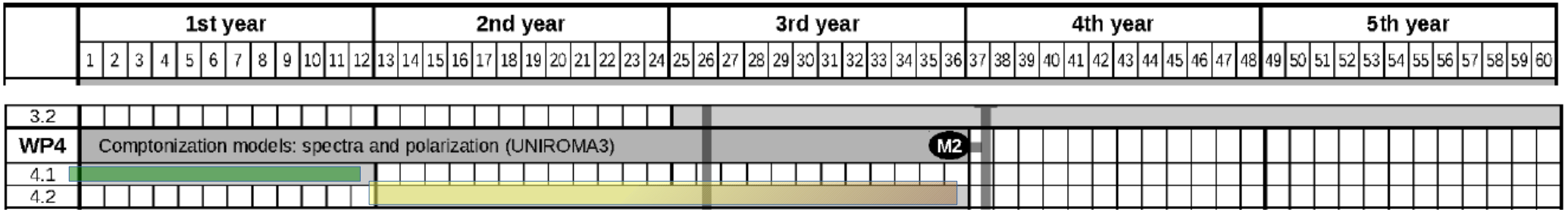
STRONGGRAVITY
EU FP7-SPACE research project 312789 2013 - 2017

Outline

- WP4 goals and timeline
- Results
- Where we are
- Future Work

WP4 goals and timeline



Description of work (possibly broken down into tasks), and role of participants

4.1 We will develop a new code to compute the spectrum and polarization of the continuum emitted in a corona of hot electrons via inverse Compton on UV/Soft X-ray photons emitted from the accretion disc. The code will be fully special relativistic and applicable to any electron and photon energy. The code will be modular, so that different geometries of the corona and/or photon distributions can be studied. Calculated spectra will be then compared to data from future broad band X-ray mission (like NuSTAR and ASTRO-H) and from the polarimetric mission GEMS. This task will be carried out at the UNIROMA3 node.

4.2 The code will then be coupled with the ray tracing code developed at AsU to take into account the general relativistic effects which are relevant in the vicinity of the black hole. This will permit a full, self-consistent description of hard X-ray emission in AGN and galactic black hole systems. This task will be carried out at the UNIROMA3, AsU and CNRS nodes.

Deliverables (brief description and month of delivery)

D4.1 Comptonization code available; month 12

D4.2 Comptonization code coupled with ray-tracing codes; month 30

D4.3 Presentation on a suitable conference; month 24-36 (according to a conference date)

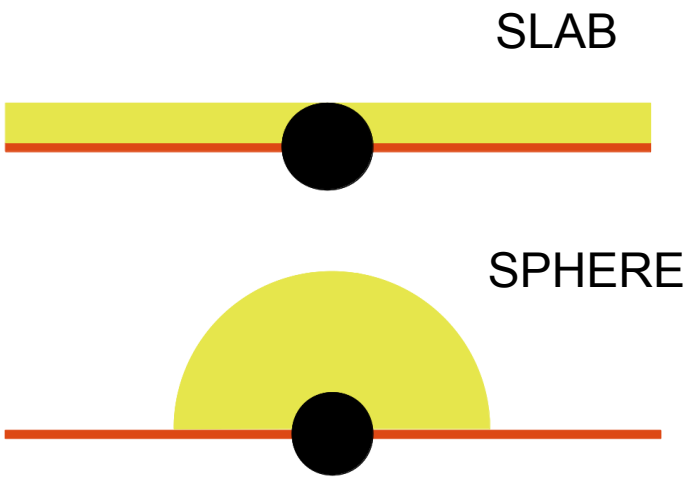
D4.4 Scientific paper; month 36 (submission)

Results

MoCA: a Monte Carlo code for Comptonization in Astrophysics

Main feature:

- Fully special relativistic (K-N cross-section, Maxwell-Juttner distribution)
- Modular (different corona geometries and compact object)
- Include polarization



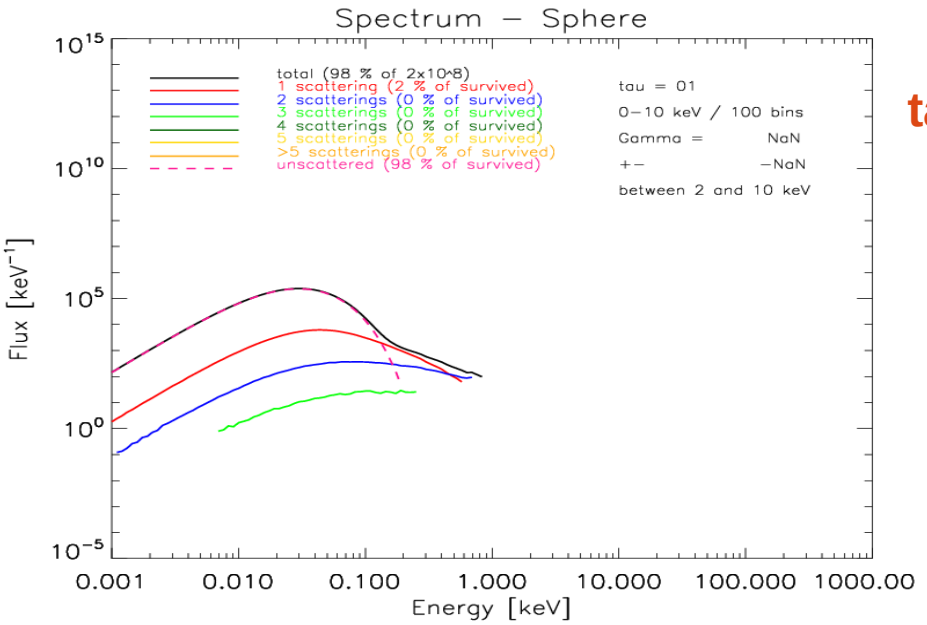
Source

MTBB disc emission including
- limb darkening effect
- initial polarization

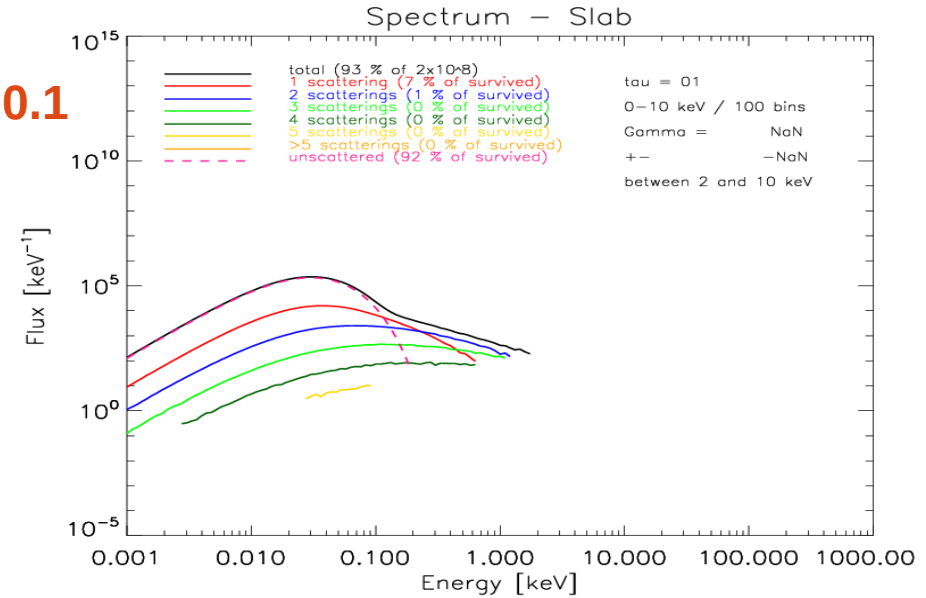
Monochromatic emission

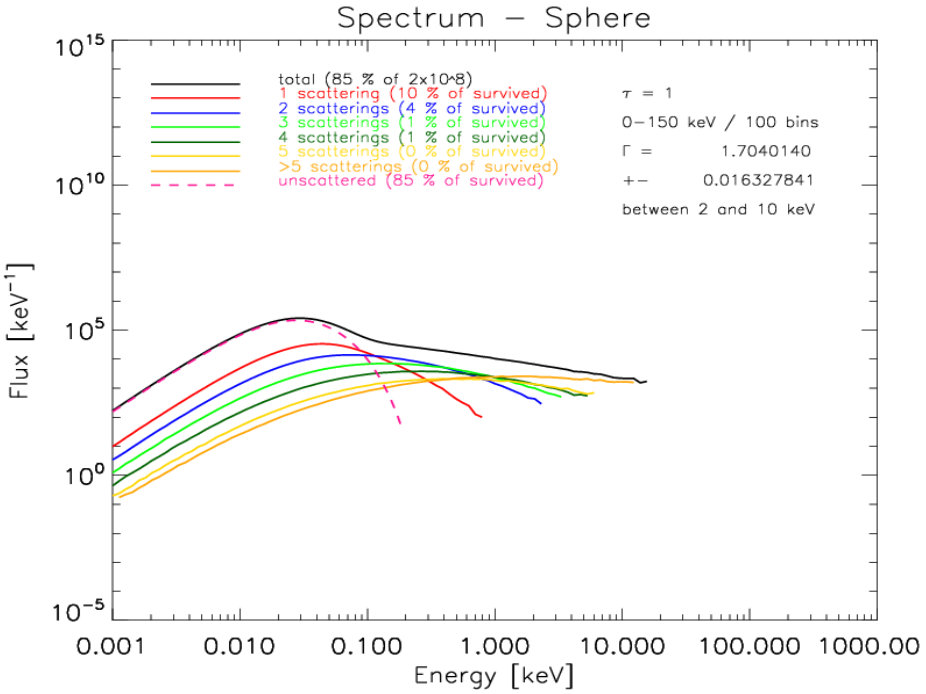
Result

- the spectra -

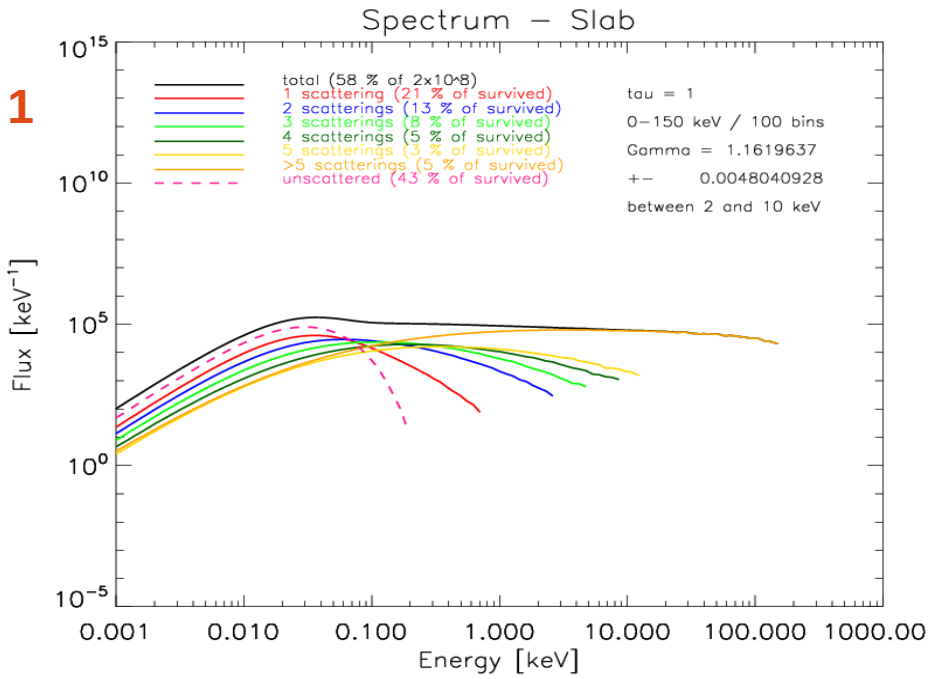


tau = 0.1



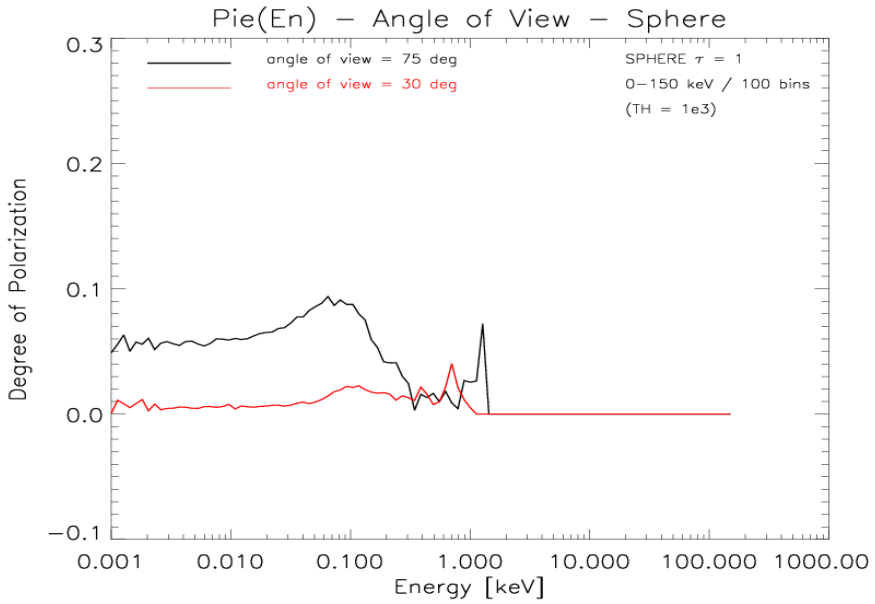


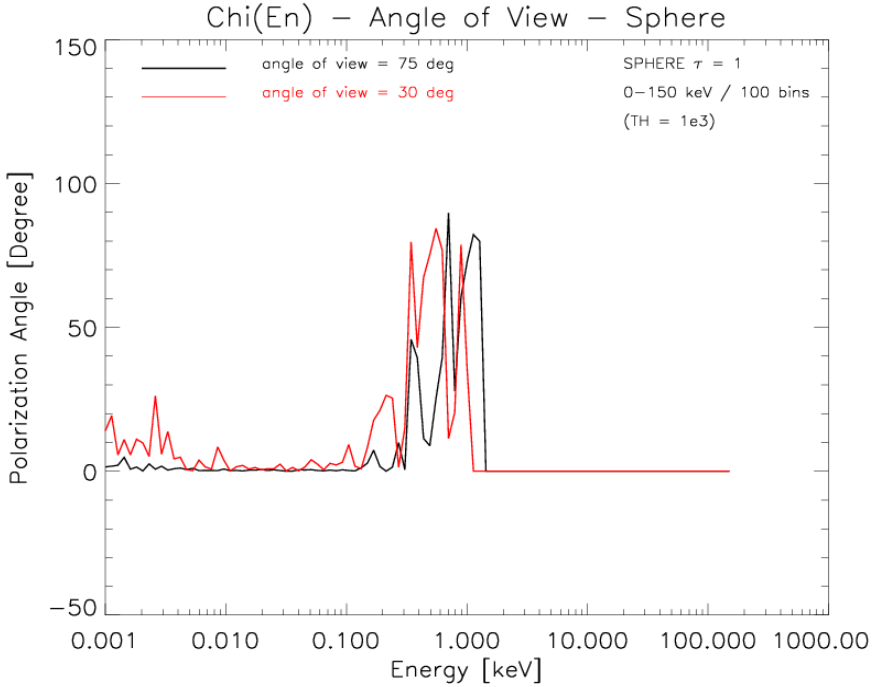
tau = 1



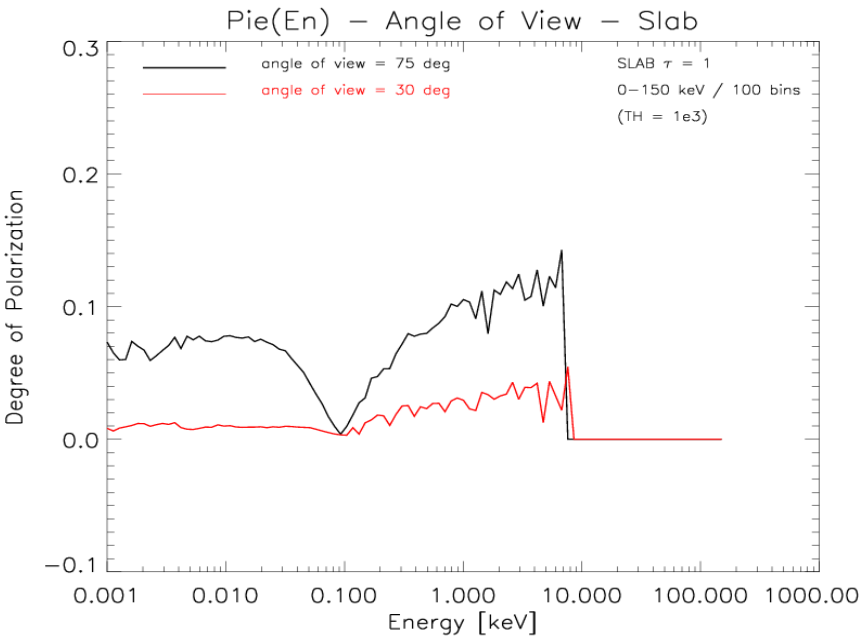
Result
- the polarization -

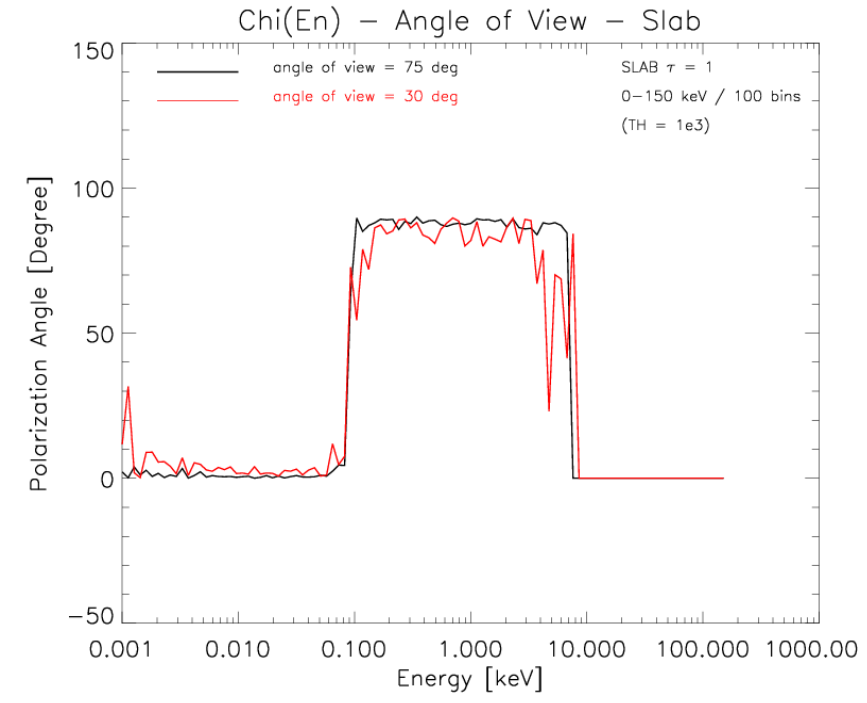
Sphere / tau = 1





Slab / tau = 1





Where we are

Componization code delivered in month 12, as planned.

Problems encountered: the code is very slow

Measure taken: code translated from IDL to Fortran

Next step (coupling with a GR ray tracing code) well under way.

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Where we are

In order to include Michal Bursa's ray tracing routine several upgrades and changes has been introduced :

- the code has been translated from IDL to Fortran 90: it is ~10x faster (binary compilation + licence-free for parallelization) and contains an interface to call photon trace C routine

- the source can be pointlike and the emission can be a power law (useful for testing polarization and comptonization)

- Polarization can be turned on/off

- The whole RFs system has changed: global (Boyer-Linquist), local and electron

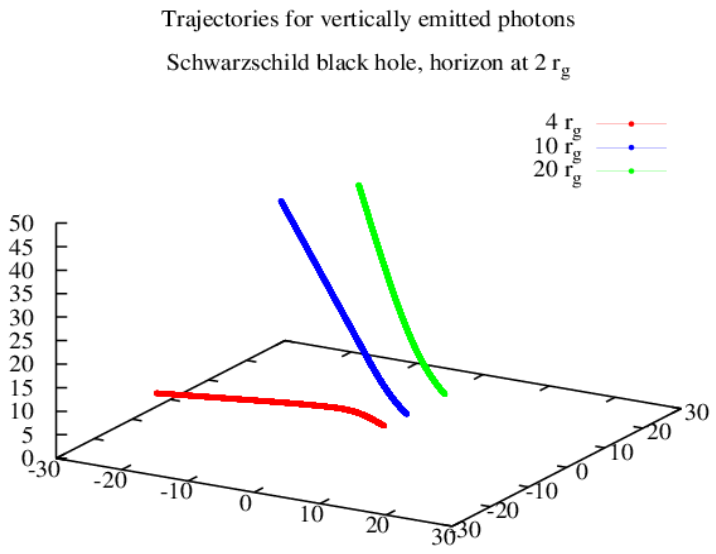
- The flight time of the photon can be registered (for time lags simulations)

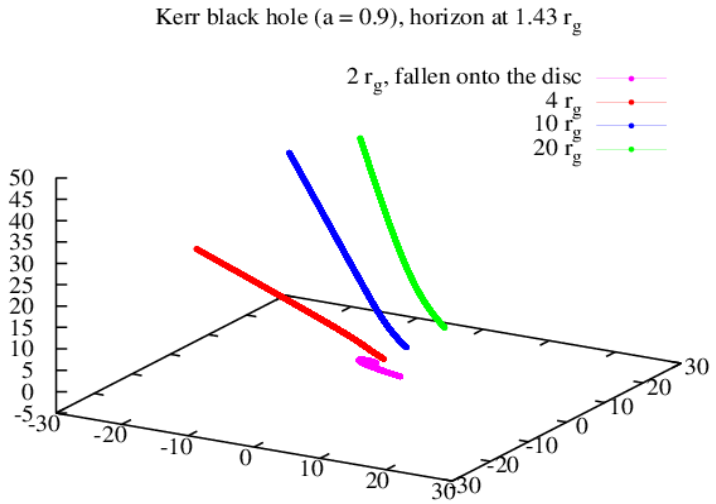
- Keplerian rotation of the disc

- The new scattering approach allows the corona to rotate and be inhomogenious

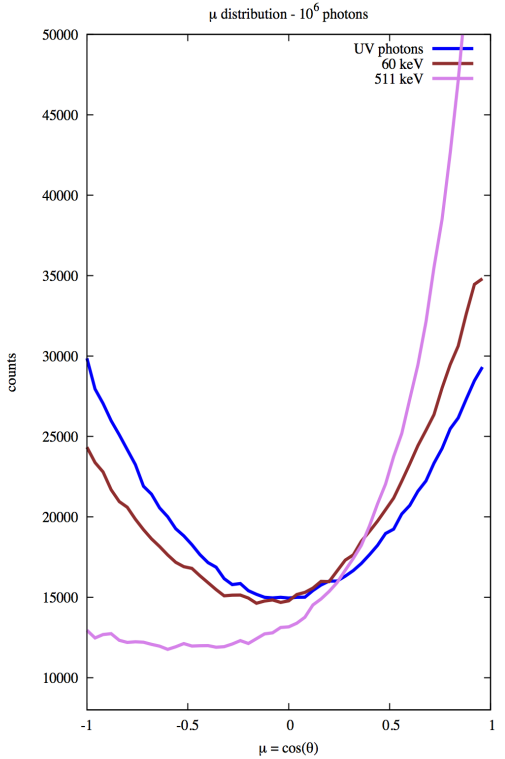
Where we are

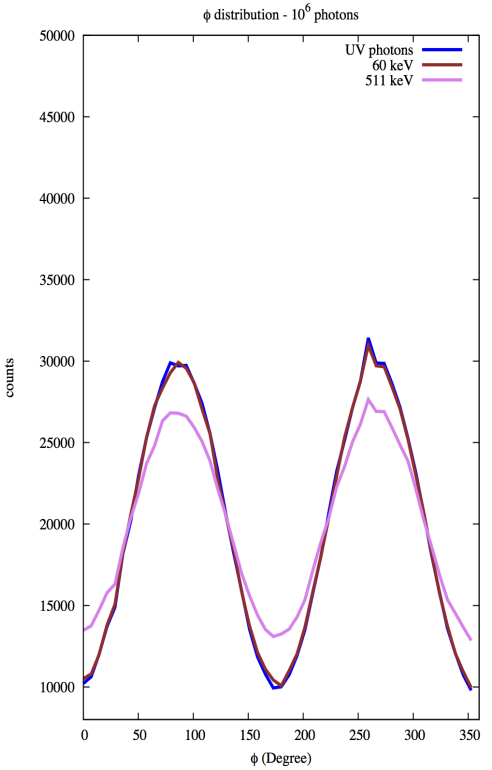
The photon trace routine seems to work properly:

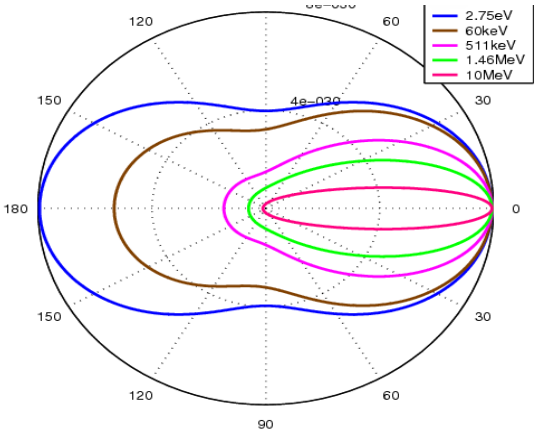




As well as the sampling of scattering angles with the new approach:







Future work

- Include parallel transportation of the polarization vector in photon trace routine (by Michal Bursa)

- Modify photon trace routine to turn on/off General Relativity

F. Tamborra will spend 2 months in Prague in order to complete the tasks mentioned above.

The second deliverable is expected to be produced by month 30, as planned.