Simulation Benchmarks for experiments at the BOA PSI beamline

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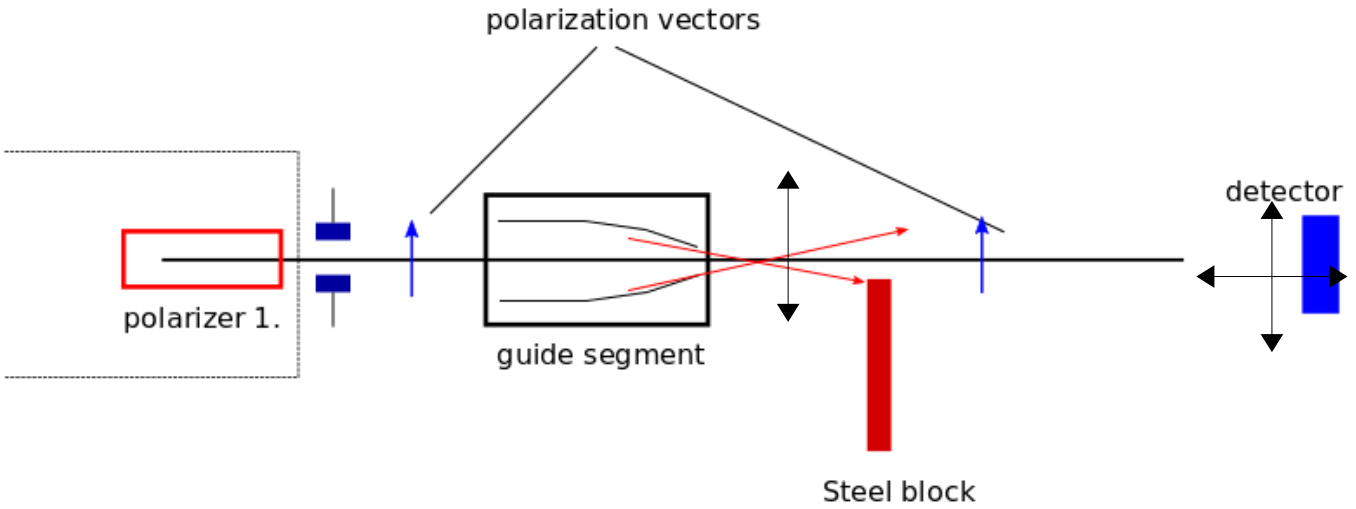
Experimental tests @BOA PSI

- Two experiments/measurements at the BOA test beamline at PSI.
  1. Benchmark measurements to evaluate software connections and background estimate calculation procedures.
     1. Generate “artificial” background by partially blocking a part of the beam
     2. Measure the beam going through a supermirror plate, to evaluate background created by intensity lost in a guide.
  2. Measure the response of a partially polarized beam impinging on a supermirror analyzer device to benchmark polarized supermirror response in McStas (and other codes)

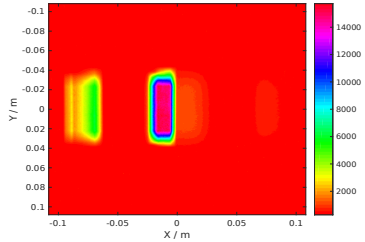
Experiment 1.1



3 beam paths – 2 reflected on either side-wall of the guide, 1 unreflected
We collected data at 2 detector distances. One closer where all 3 paths are present, and 1 further away to get better signal separation. Only 1 path present on the detector at them time.

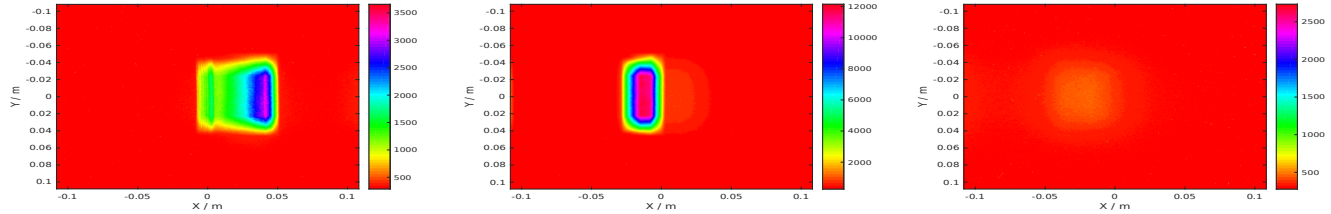
Example of raw data

Detector in near position, catching all 3 beam paths



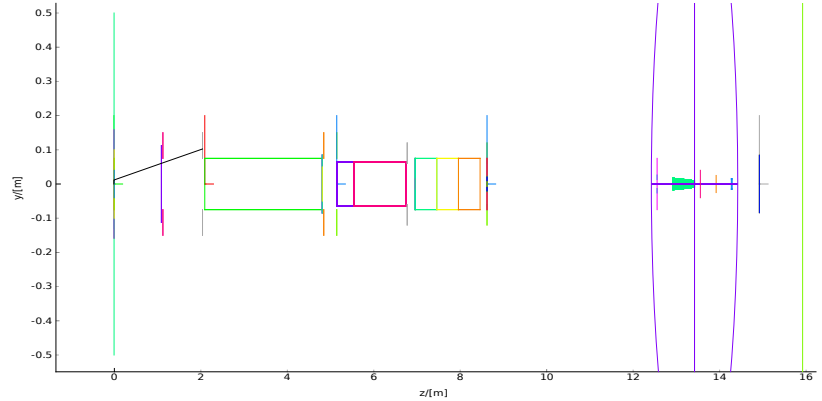
- Steel block placed to obstruct ½ of the central “blob”
- Some transmission evident. (By design)
- Will generate minor background contrib. through Bragg-scattering

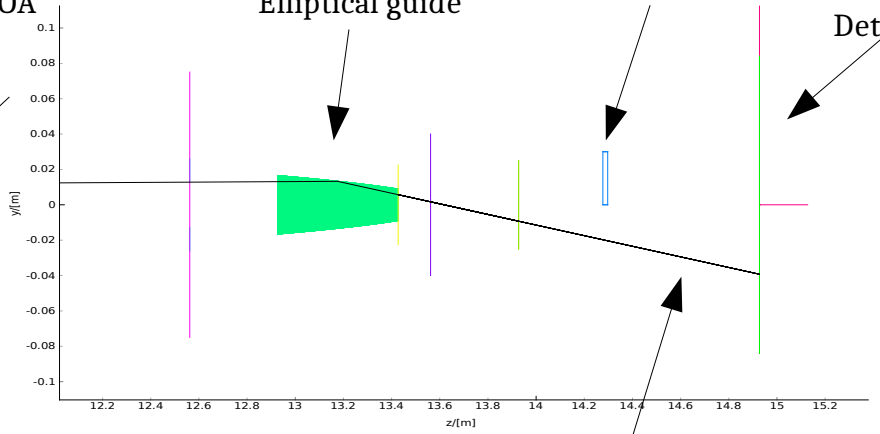
Detector in far position, only 1 path on each detector screen



Visual trace of instrument

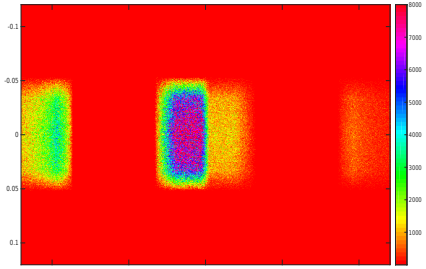
McStas (mcdisplay) sketch of the simulated BOA
Right is a blow-up of the experimental cave.





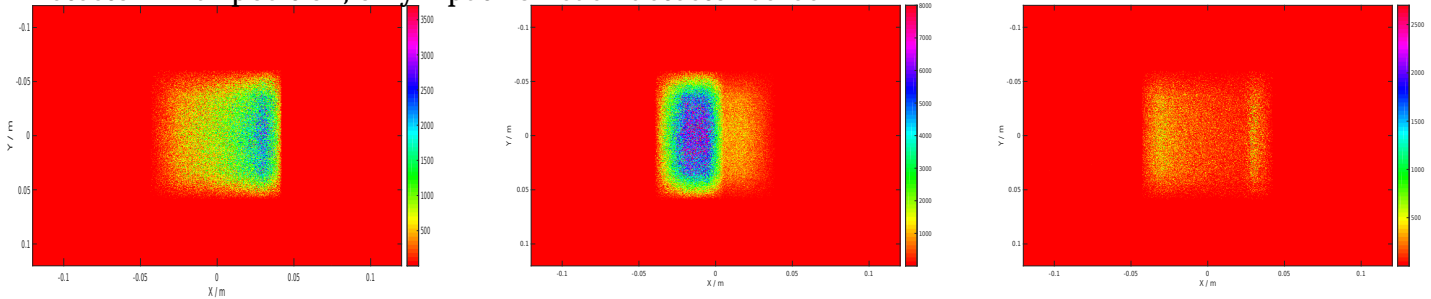
McStas model results

Detector in near position, catching all 3 beam paths



- Steel block placed to obstruct ½ of the central “blob”
- Some transmission evident. (By design)
- Detector position not calibrated
- Count time not calibrated.
- Qualitatively similar
- No detector efficiency model

Detector in far position, only 1 path on each detector screen



PSI Measurements MCNP part

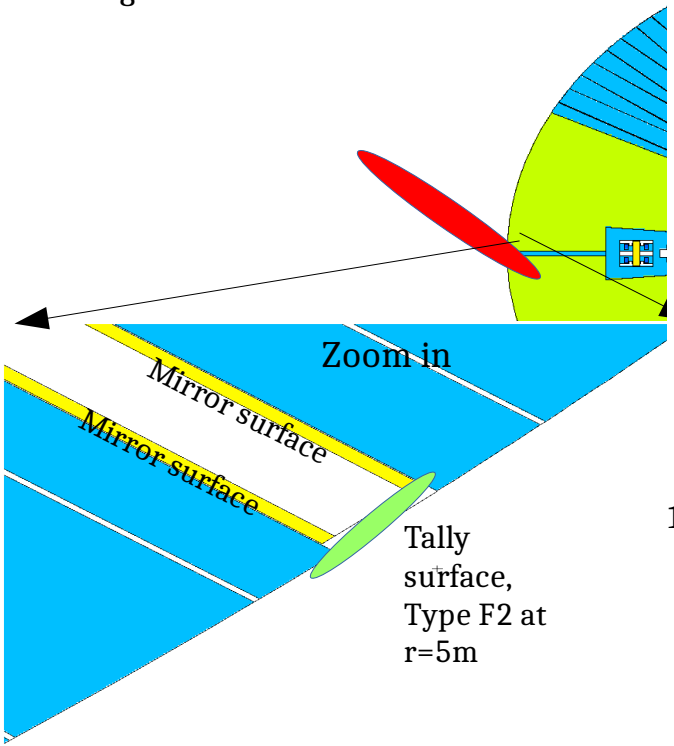
1) mcnpx with supermirrors
2) modelling lens setup

Visual trace of instrument

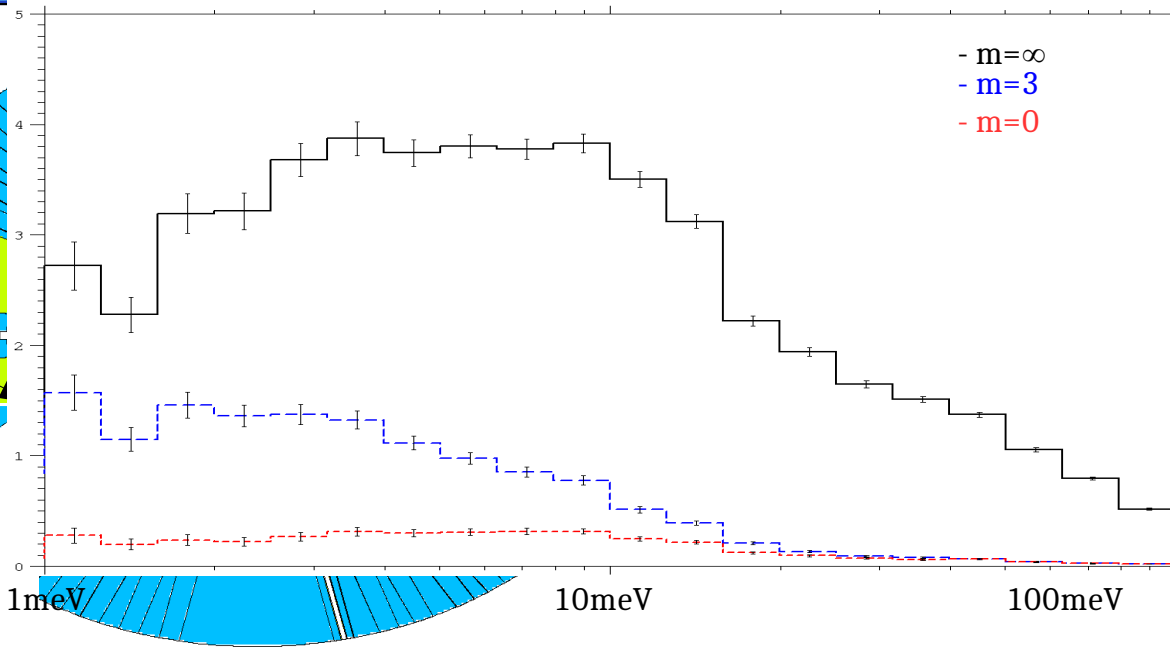
- The story of this software:
  - Original implementation of Franz Gallmayer et al, ported to MCNPX a few years back(Esben B Klinkby). Ryan Bergman/Emmanouela Rantsiou made a MPI functioning version, which was finally compiled on the ESS cluster (Esben B Klinkby & Erik B Knudsen)

Supermirrors validation

ESS target monolith

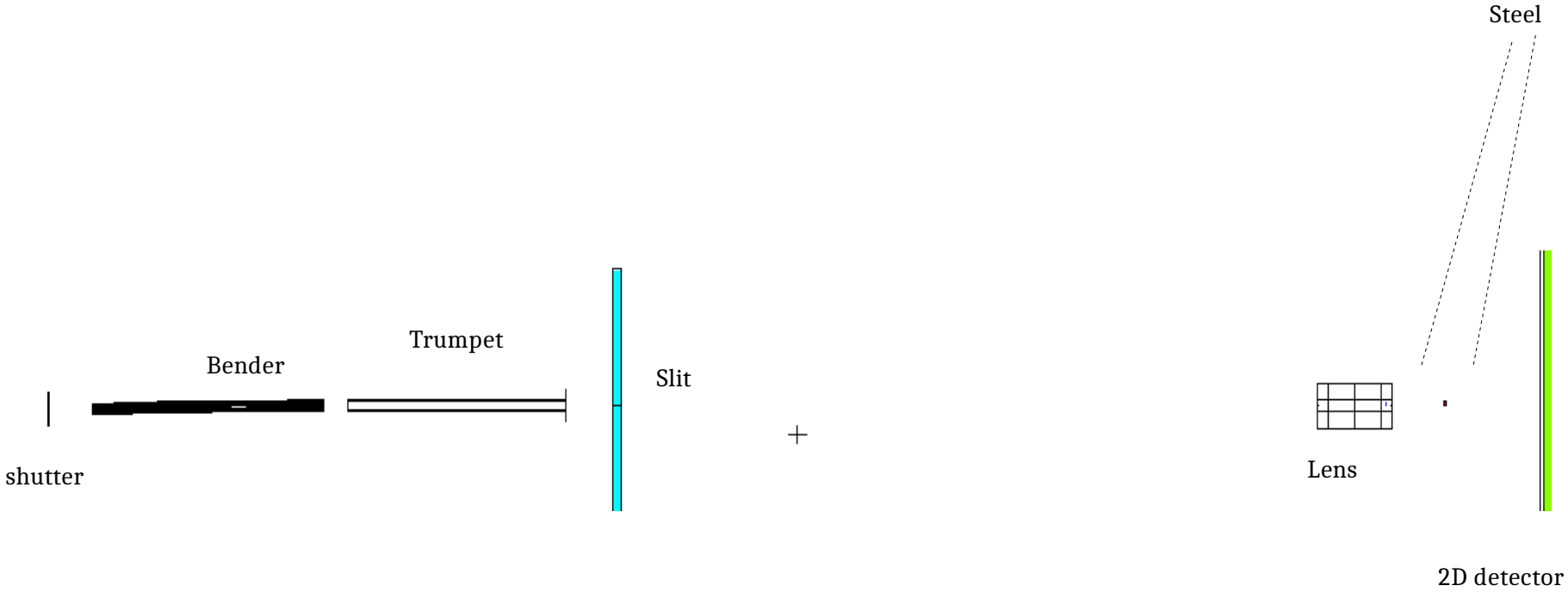


Tally surface, Type F2 at r=5m

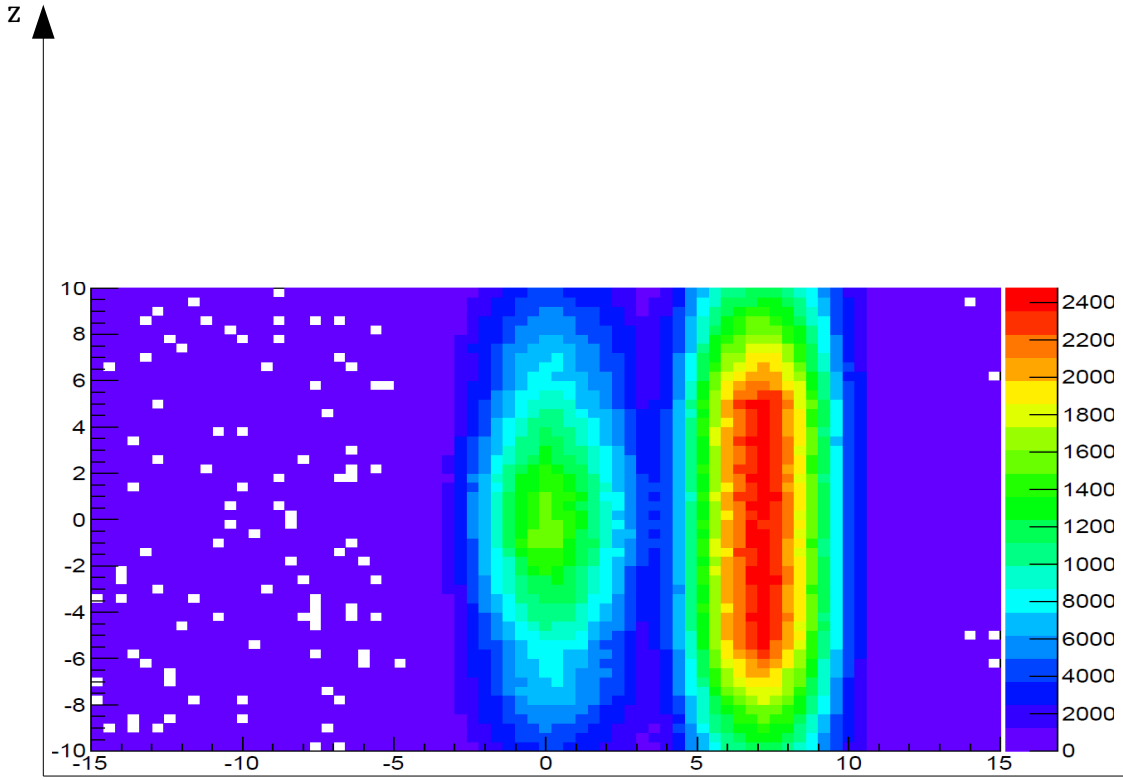


Expected behaviour ✓

MCNP-only model of obstruction exp.



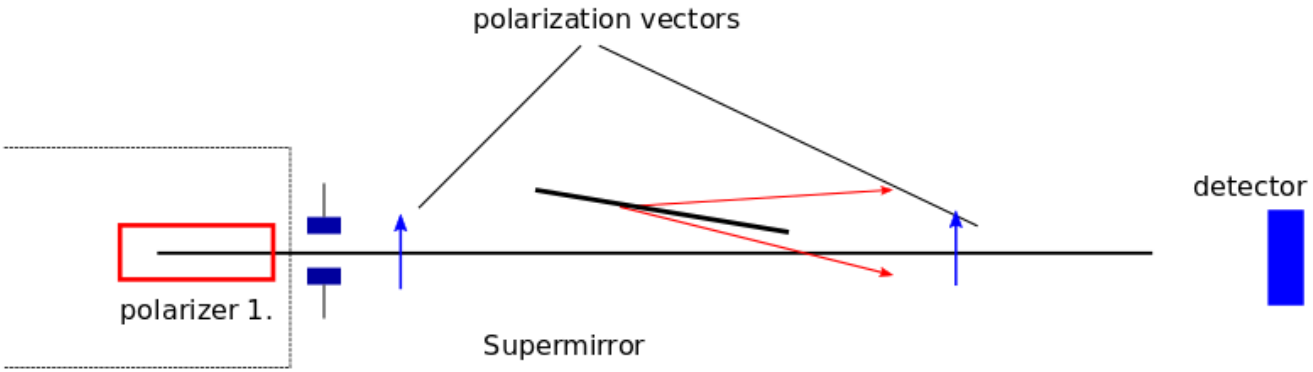
MCNP-only modelling of experiment 1.1 - Results



- Steel block placed to obstruct ½ of the central “blob”
- Some transmission evident. (By design)
- Detector position not calibrated
- Count time not calibrated.
- Qualitatively similar

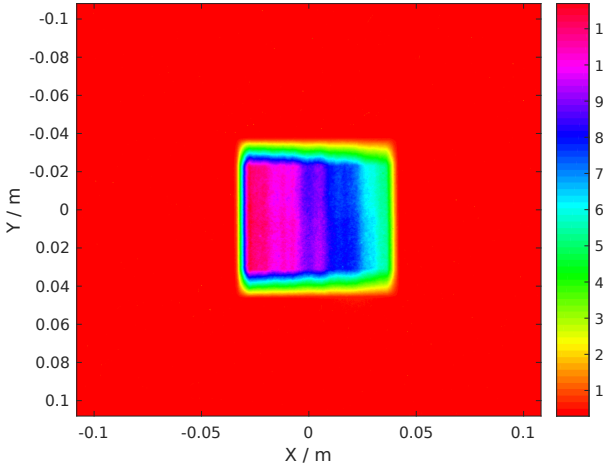
Note: detector position (i.e. the x coordinate) is arbitrary

Experiment 1.2



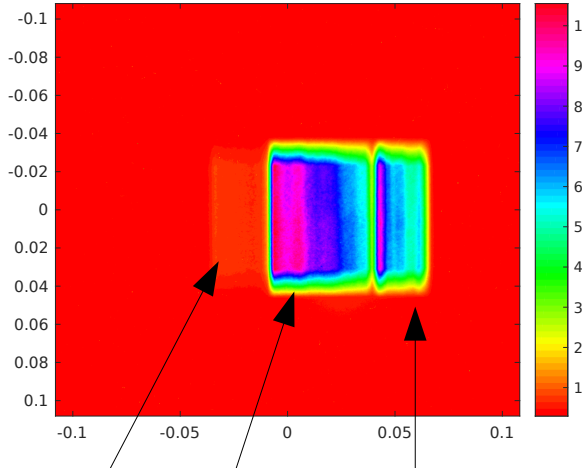
Experiment Raw data

Mirror: -2 deg. rot



Direct beam, mirror rotated out of the way

Mirror: 0.6 deg. rot

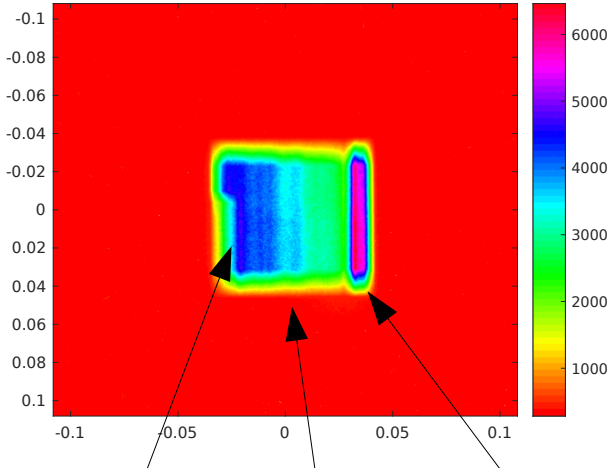


through beam

Direct beam

reflected beam

Mirror: 2.6 deg. rot



Extra absorption caused by Al support stucture.

through beam

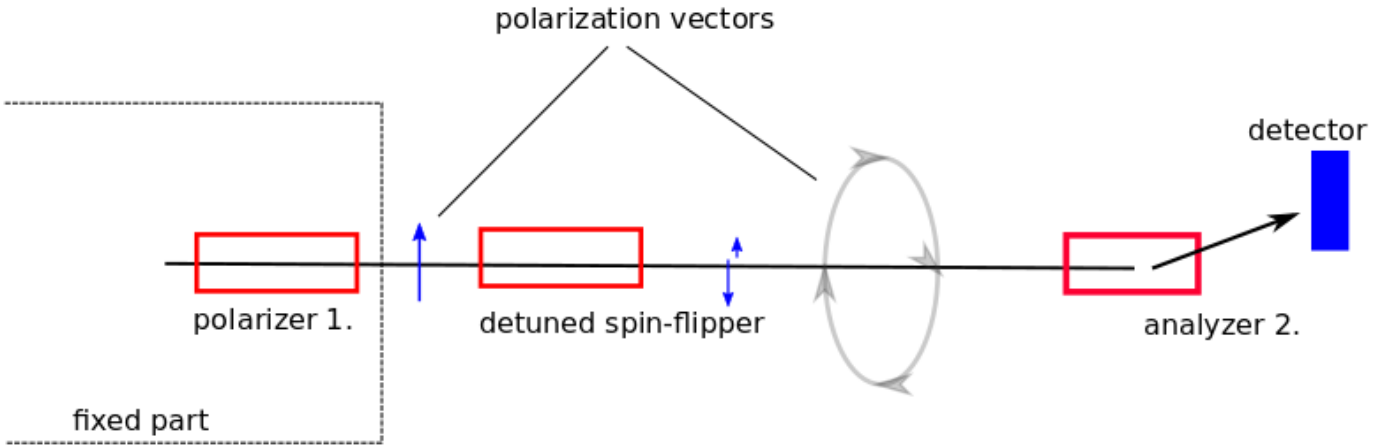
Direct beam

Experiment 1 Conclusions

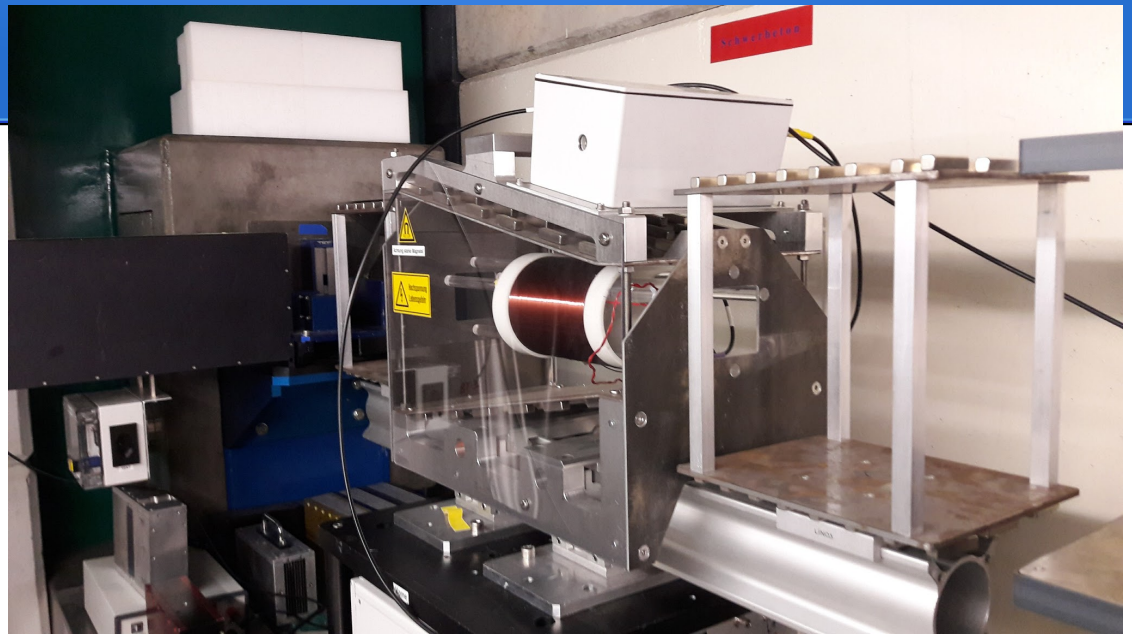
- The data so far shows qualitative good agreement with simulations. More work to match pure McStas and MCNP closer, but looks promising.
- Given the pure simulations we intend to switch back and forth between MCNP and McStas to demonstrate software connections (partial deliverable of Eu project SiNE2020) while still having experimental validation in terms of this experiment.
- Needs more work for publication
- Considered the deliverable D8.4 A for SINE2020 WP8

Experiment 2

- Purpose: To generate a reference benchmark dataset for simulations of partially polarized beams.
- Using the HYSPEC prototype polarizer as analyzer.



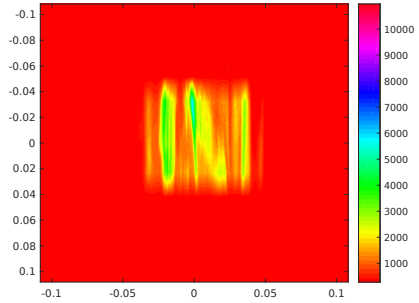
The Spin-flipper



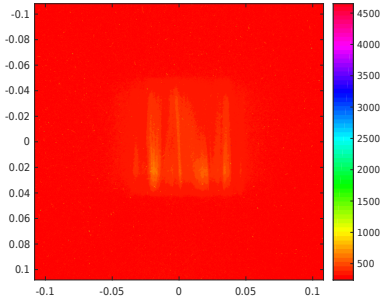
- Scan the driving voltage of the spin-flipper to create incomplete flip, and hence a partially polarized beam.
- The partially polarized beam is then analyzed using the prototype of the analyzer developer by PSI for HYSPEC

Example Data

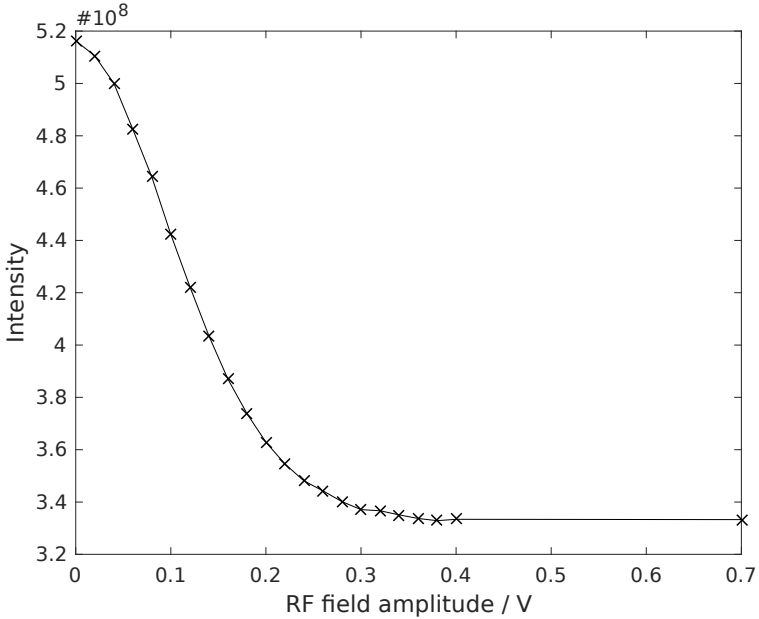
SF off



SF on

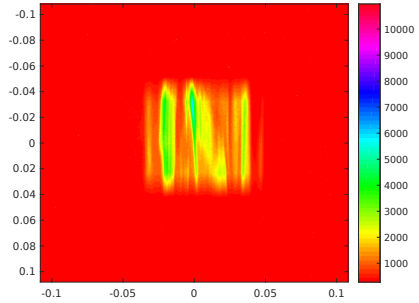


- The incoming polarization is “up”
- Detuning the spin-flipper results in lower intensity transmitted through the analyzer.
- The analyzer blade structure is visible on PSD

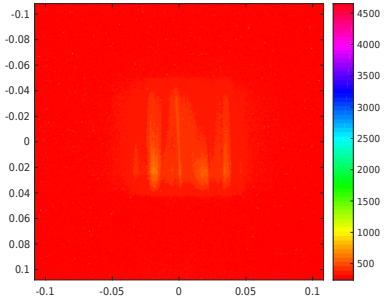


Example Data

SF off

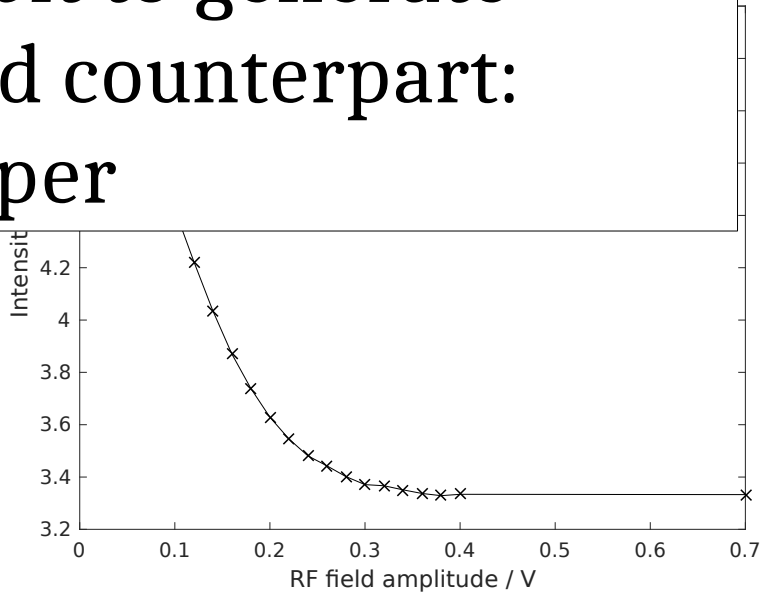


SF on

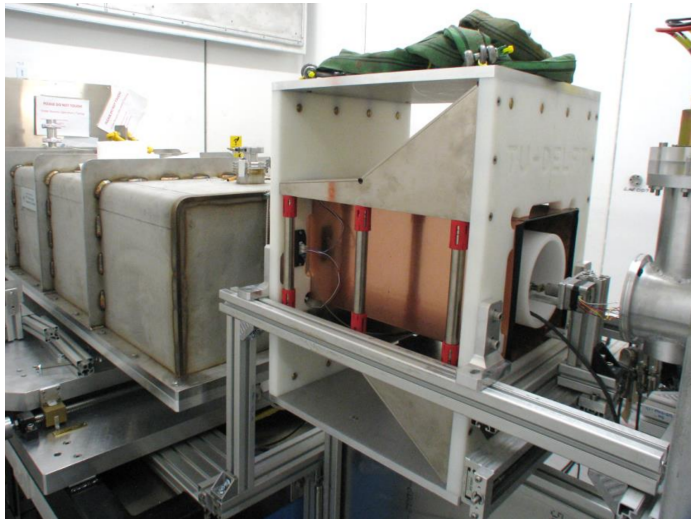


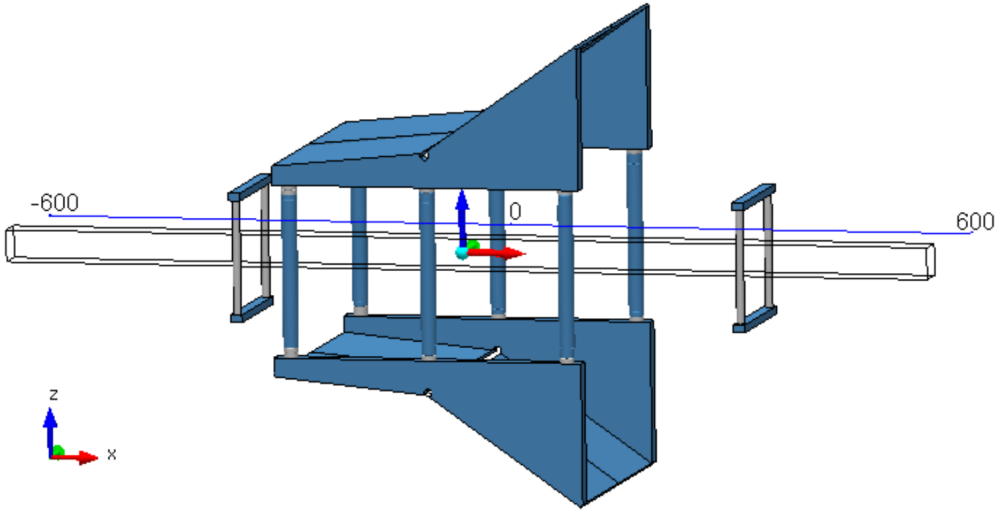
- The incoming polarization is “up”
- Detuning the spin-flipper results in lower intensity transmitted through the analyzer

Missing bit to generate simulated counterpart: Spin-flipper



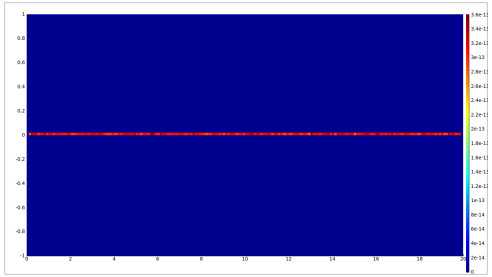
Simulation of SF – baby steps

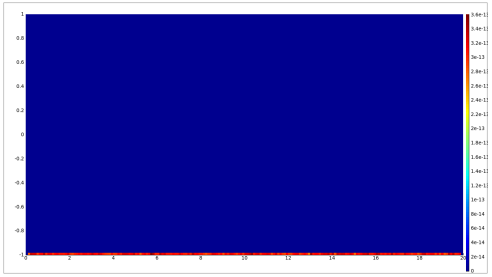


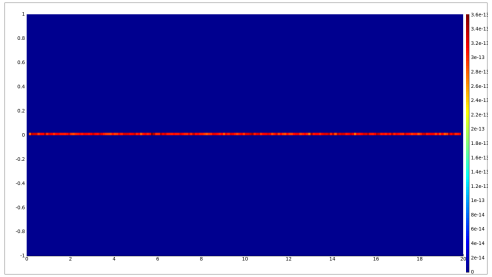


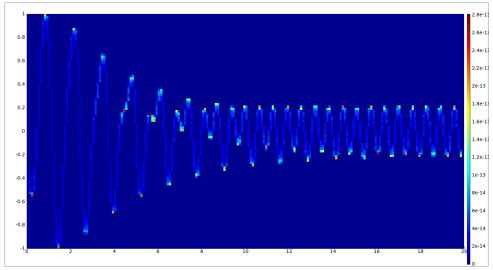
Pictures courtesy of J. Plomp & M. Thijs

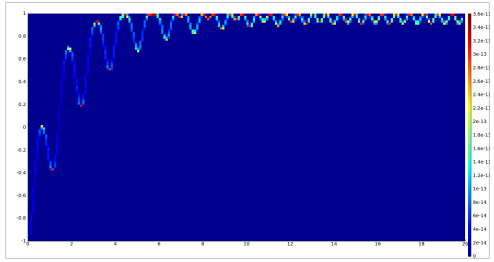
Simulation of SF – “box” fields.

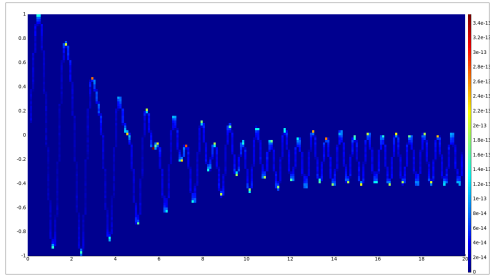




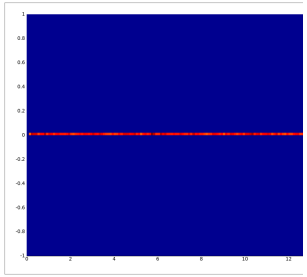


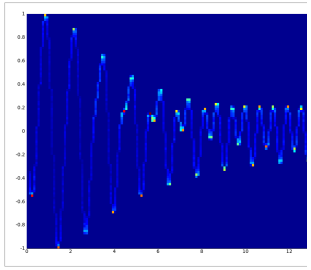


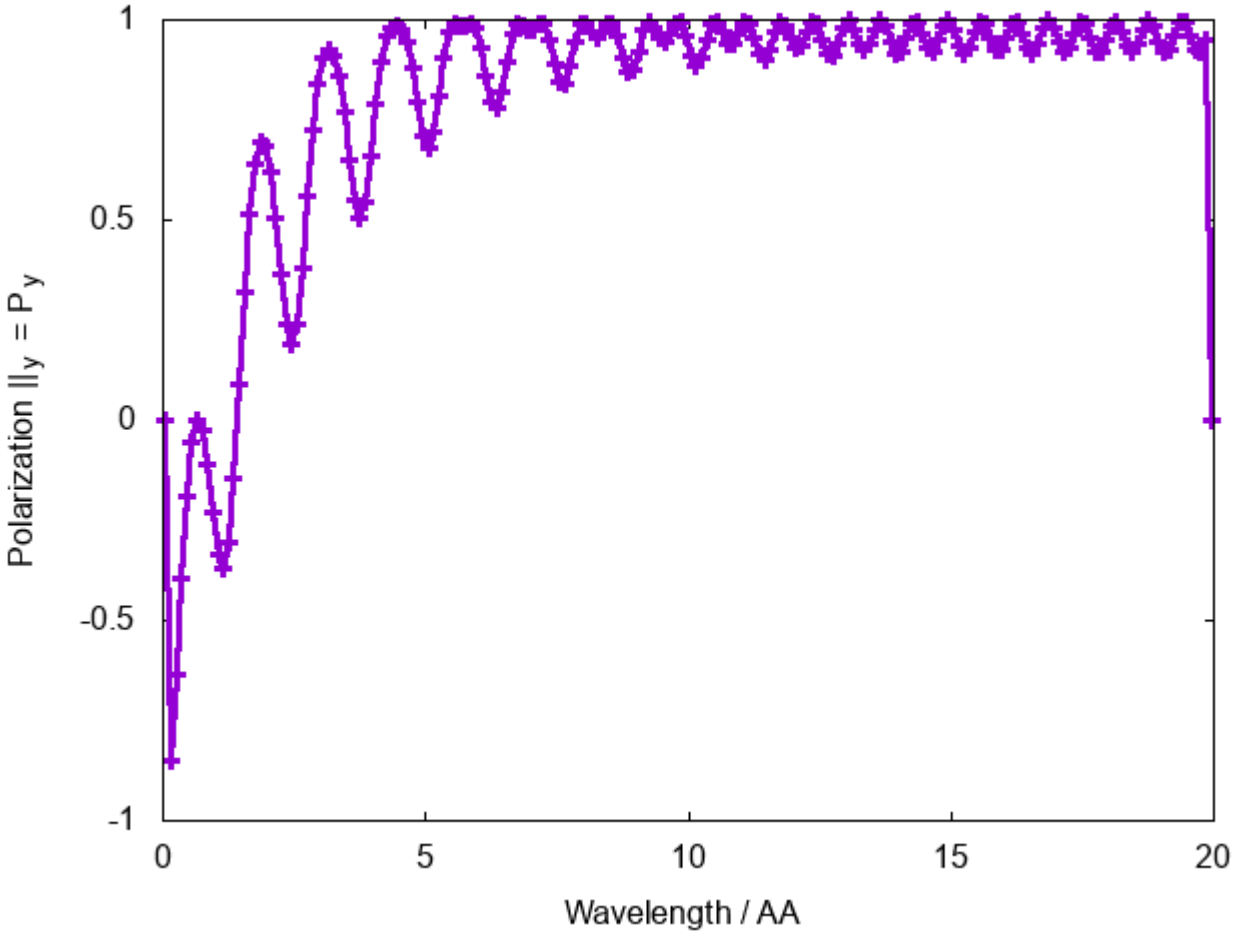




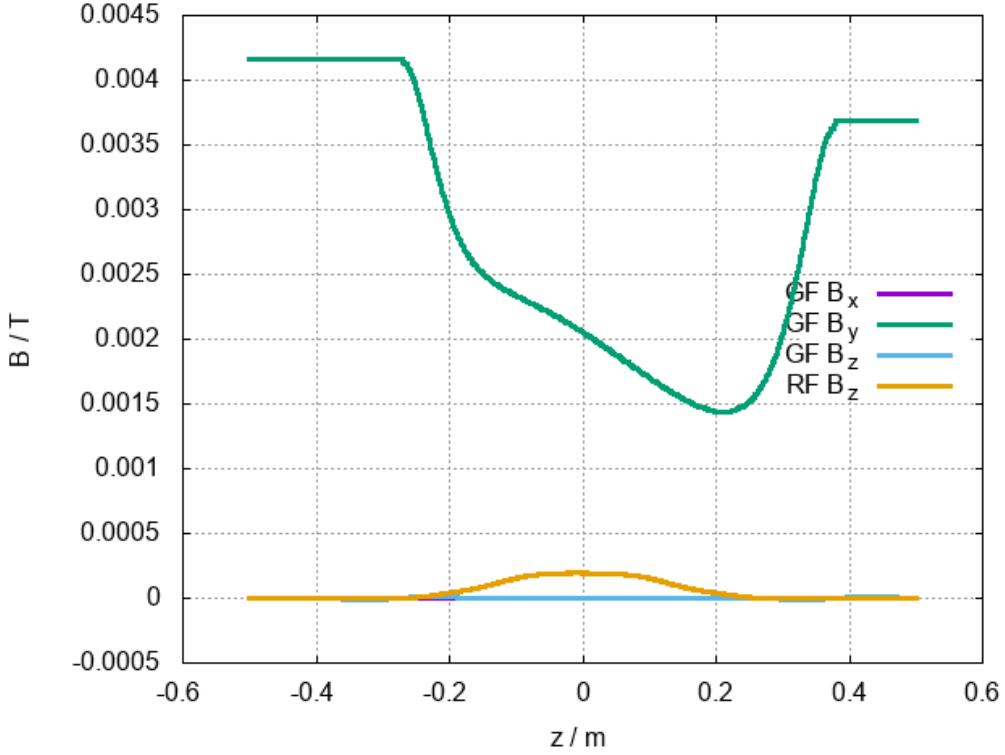
Simulatio







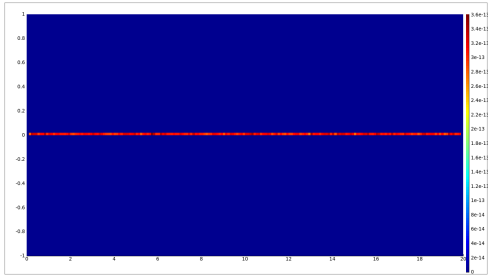
Simulation of SF – baby steps

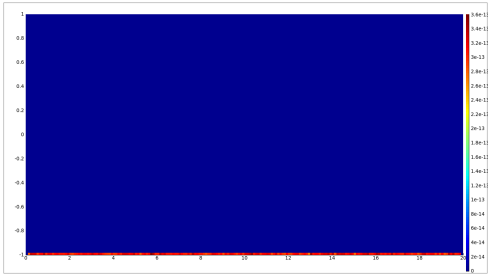


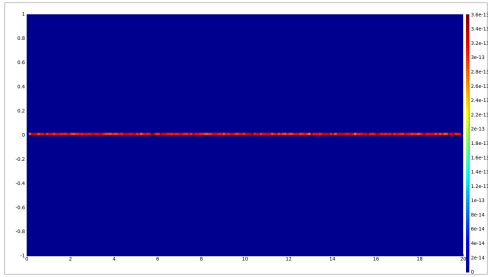
Express RF-field in rotating frame

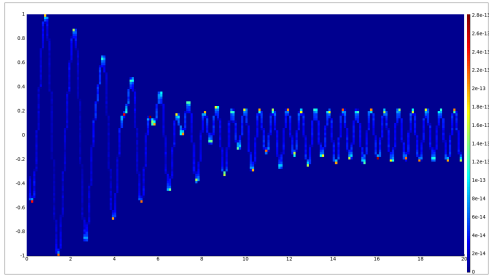
Fields calculated by MagNet (M. Thijs)

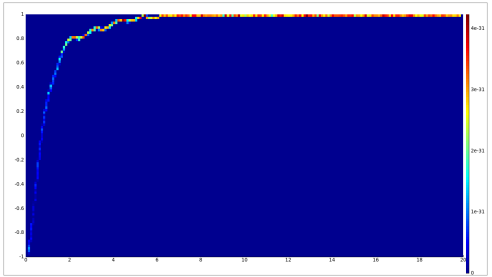
Simulation of SF – calculated fields.

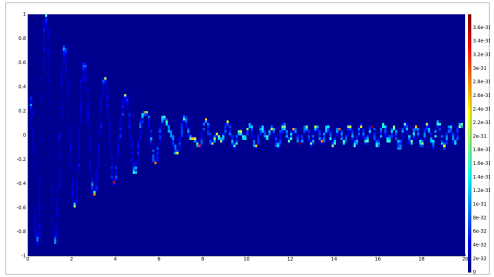




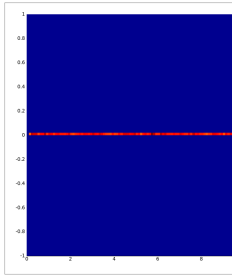


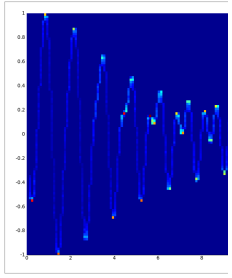


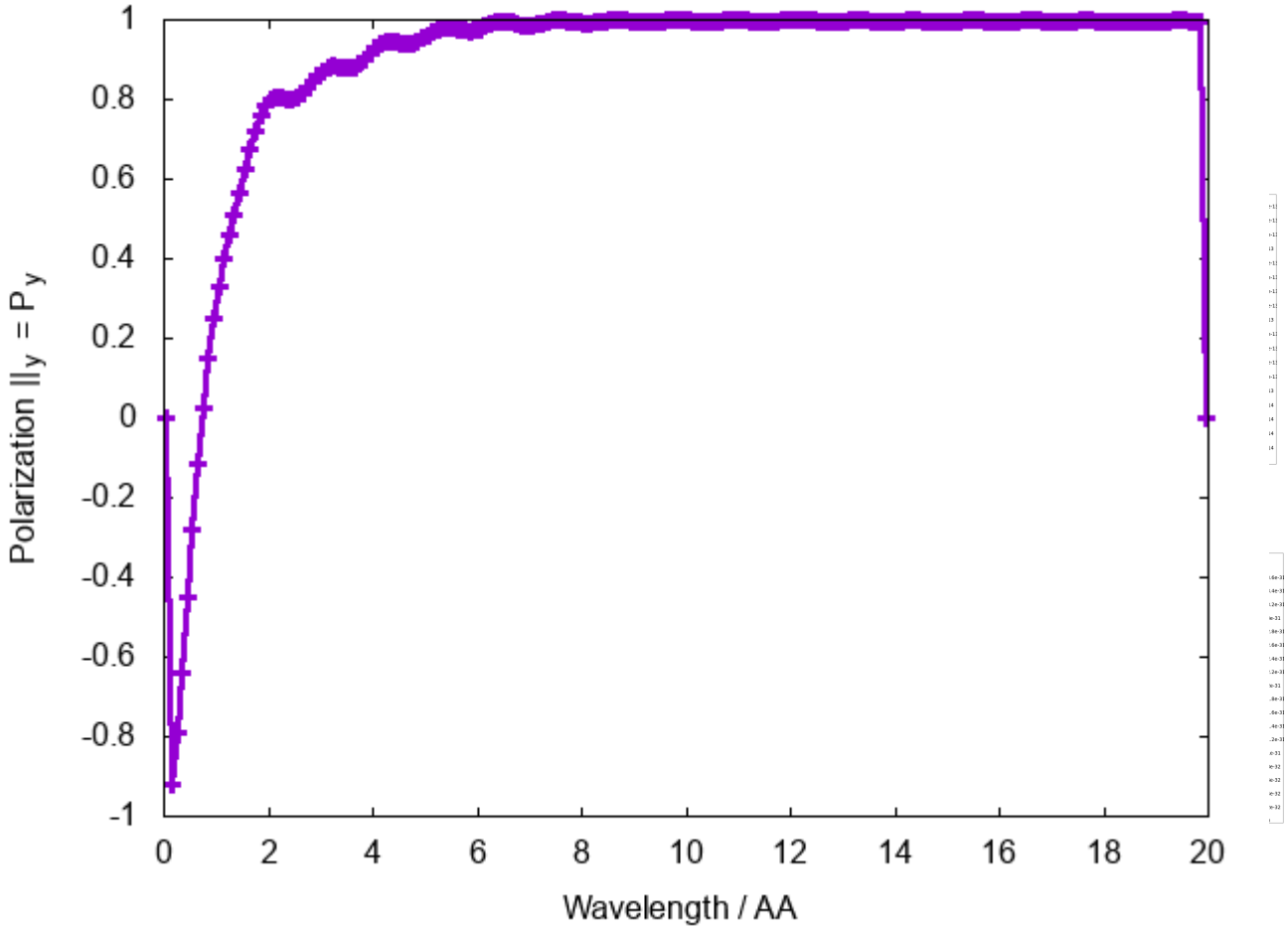




Simula






Polarization ||y = Py
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
2
4
6
8
10
12
14
16
18
20
Wavelength / AA

Experiment 2 Conclusions

- A set of well curated data for partial polarization is now available
- Initial data analysis looks good.
- Spin-flipper model exists now in McStas.

- Reference is requested by several facilities.