

Tevatron crystal collimation experiment (T-980)

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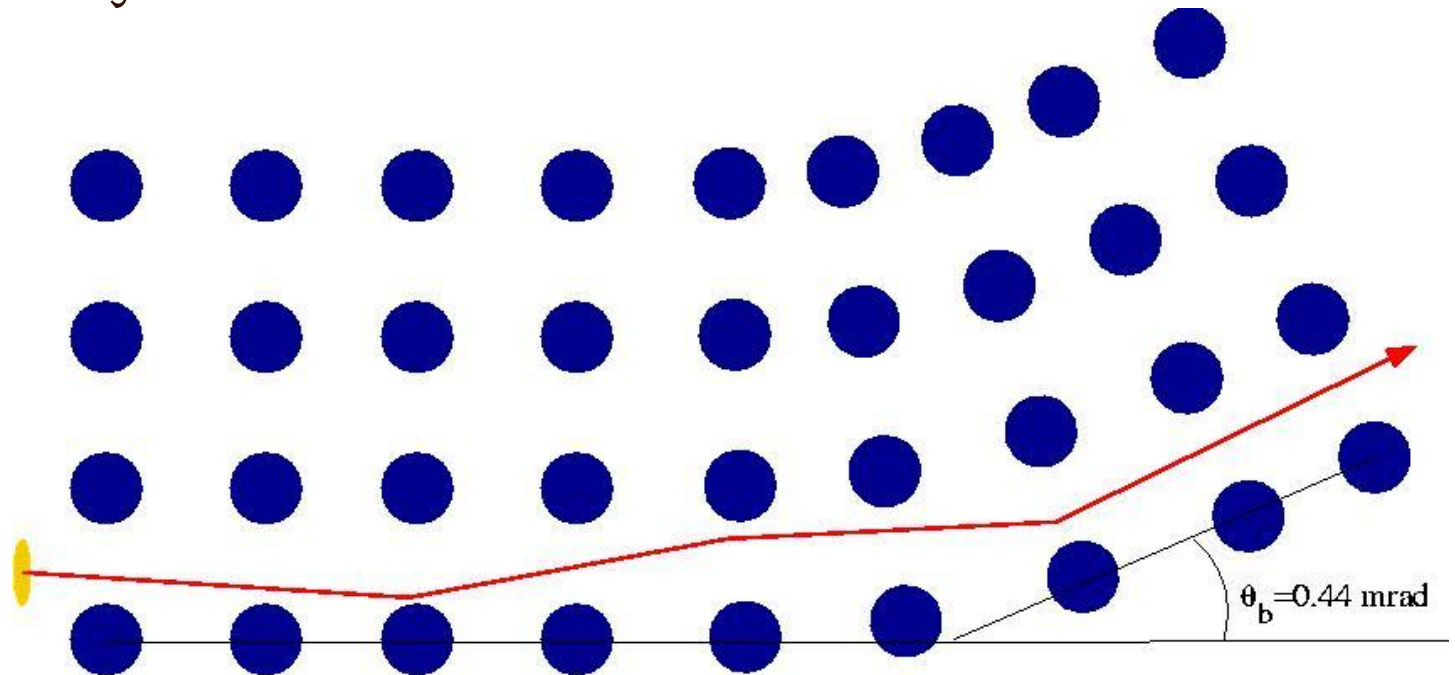
Tevatron crystal collimation experiment

New approach to remove beam halo, reducing heat load on cold magnets. Proposed to be used in next LHC collimator upgrade (approximately 2015). Main advantage – can remove beam halo in 1 pass with higher efficiency.



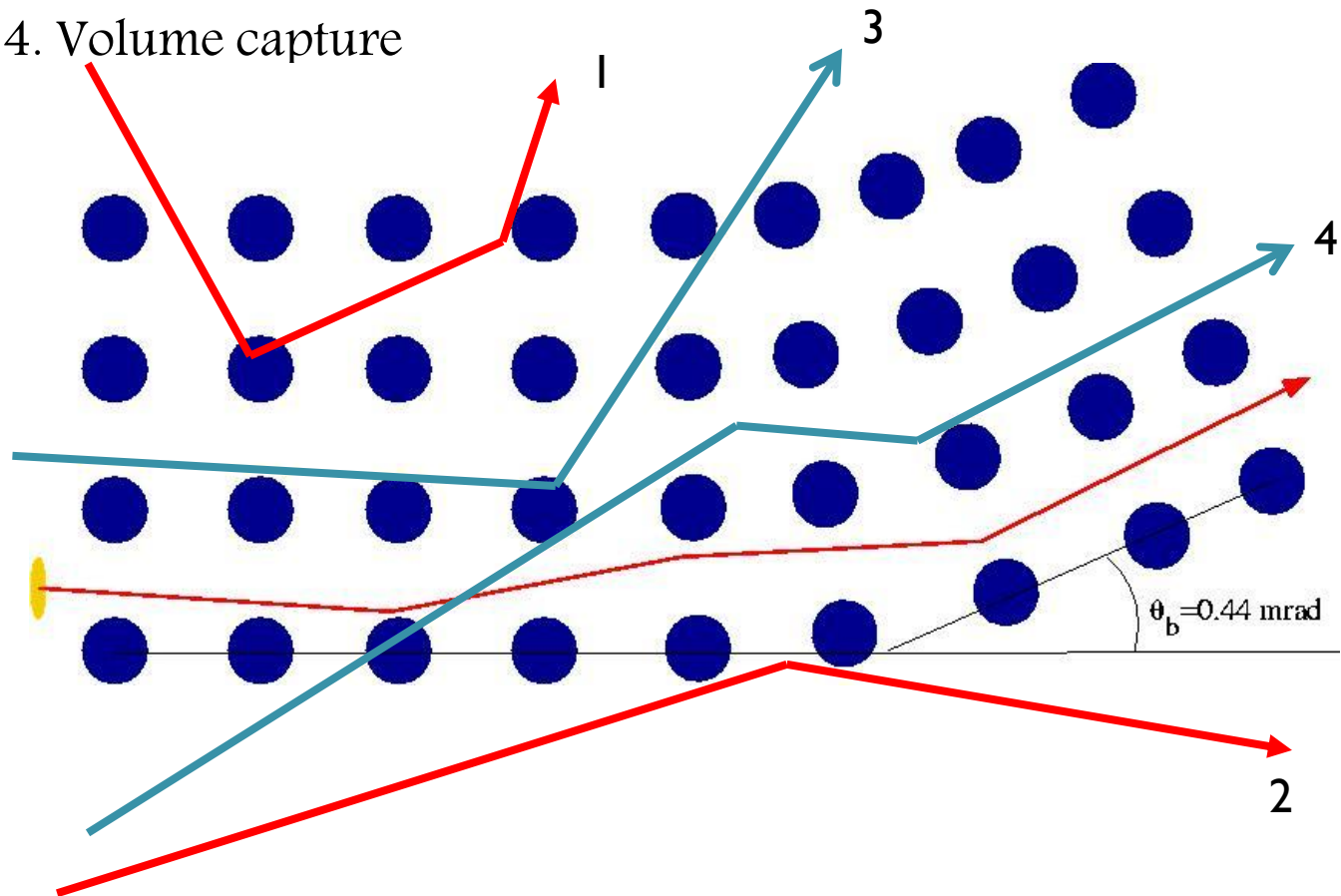
Crystal channeling

If particles entering a crystal are properly aligned to the crystal planes, they will follow the planes, even if the crystal is bent.



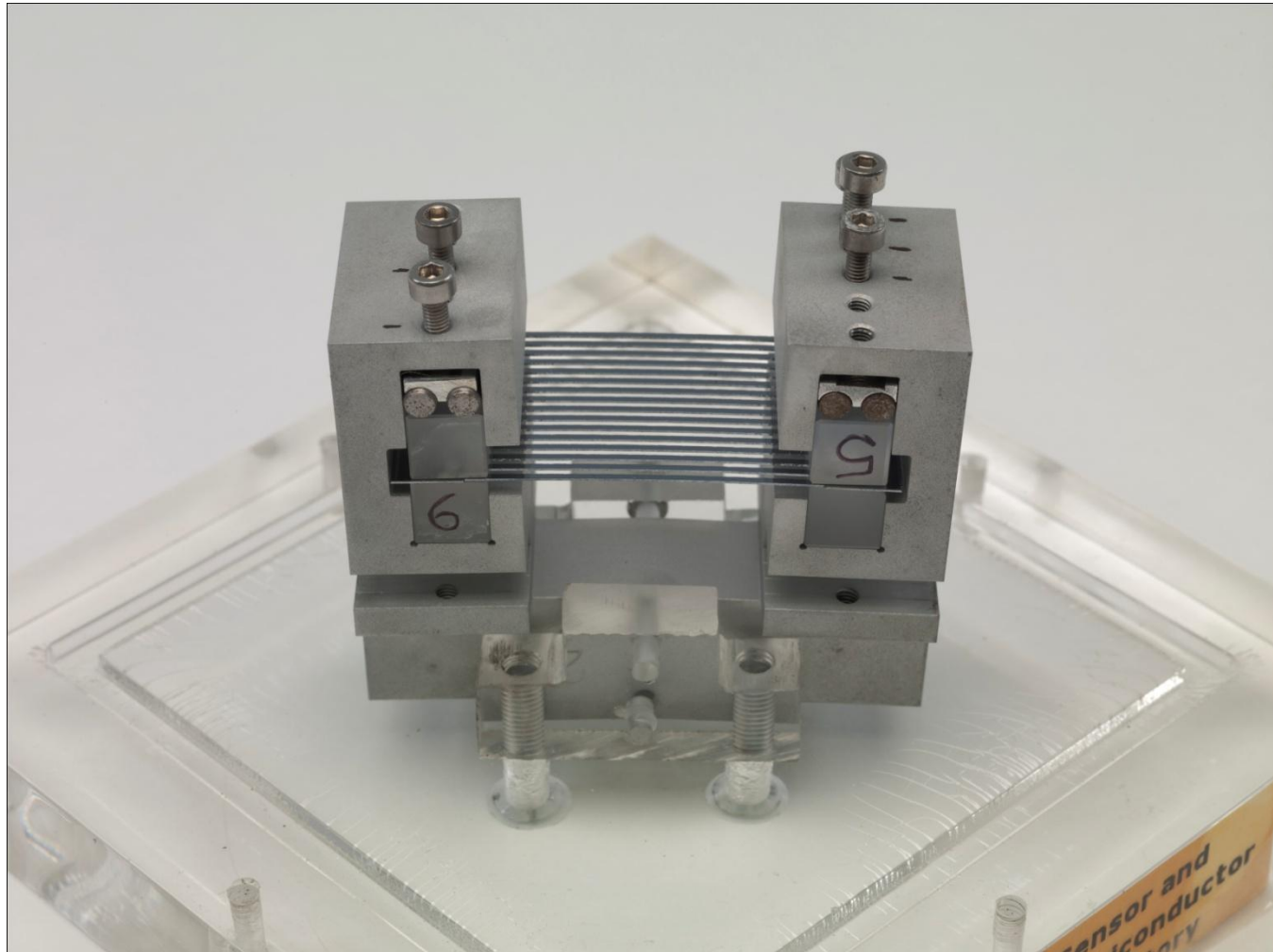
Other processes in a bent crystal

- 1. Amorphous orientation
- 2. Volume reflection
- 3. De-channeling
- 4. Volume capture



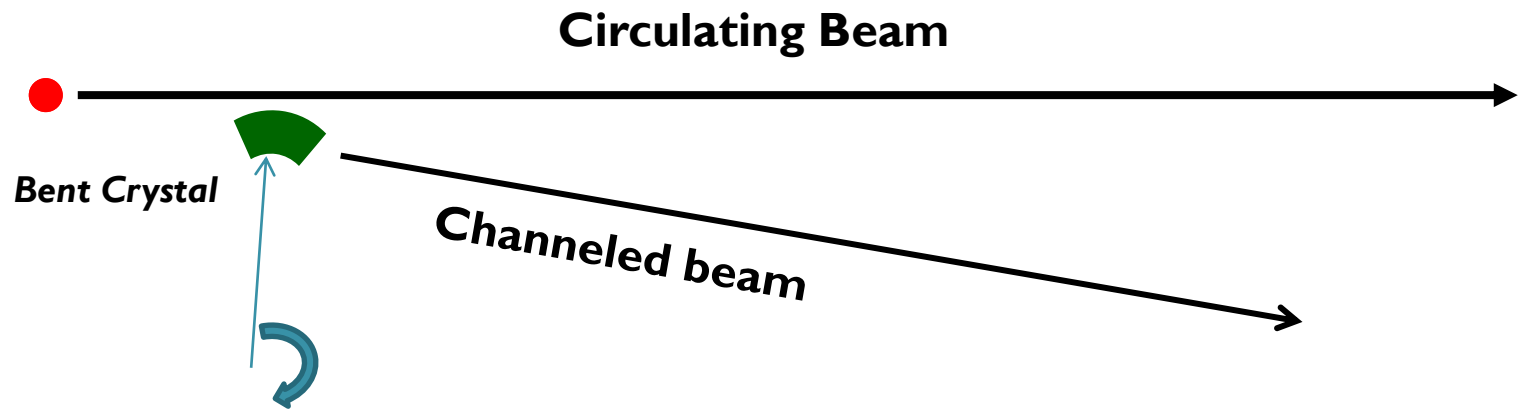
Example of a crystal

Multi-strip silicon crystal (16 strips)

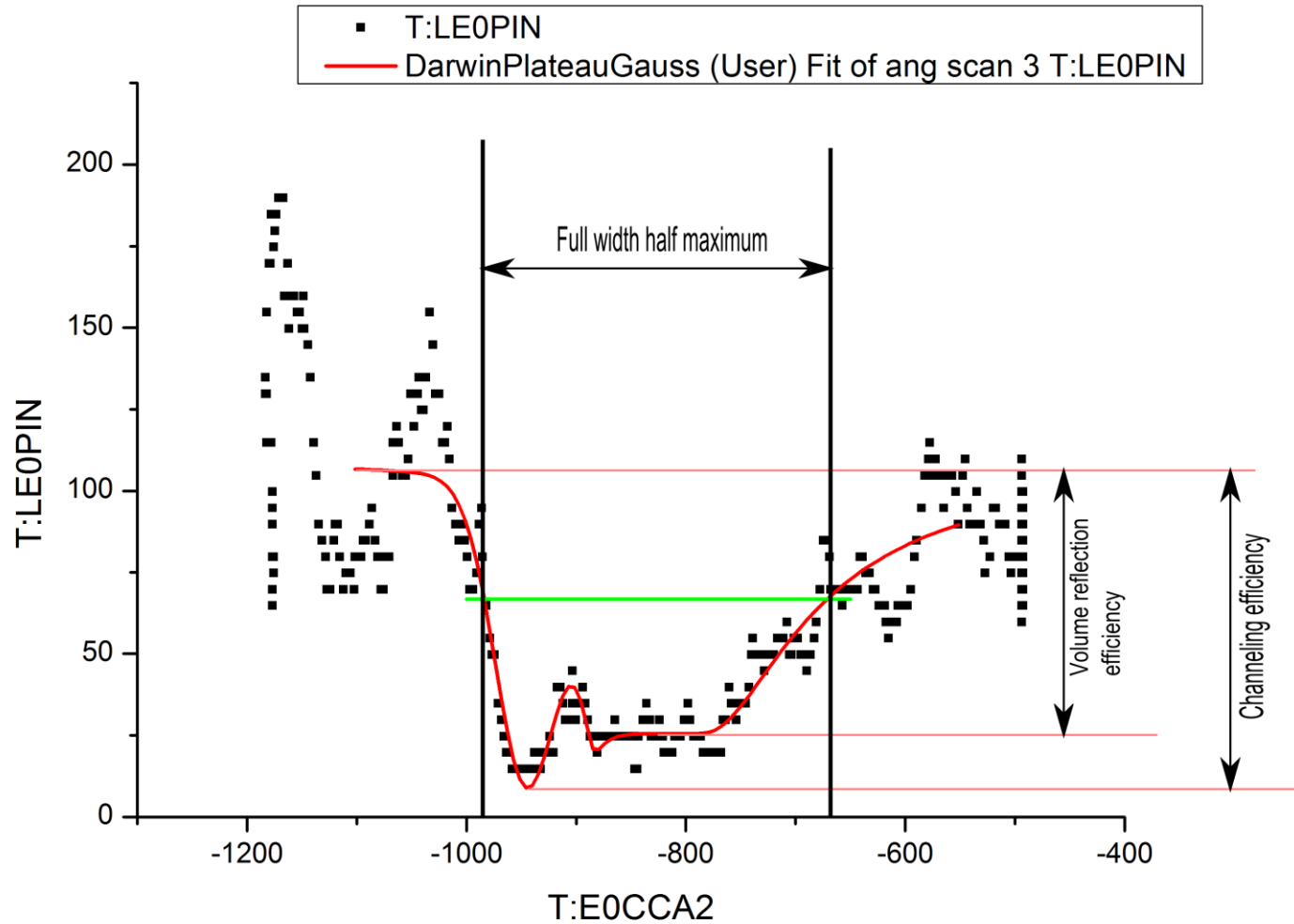


System setup – angle scan

Angle of crystal in respect to the beam is changed. Crystal goes to “channel” or “volume reflection” mode.



Angle scan data and results



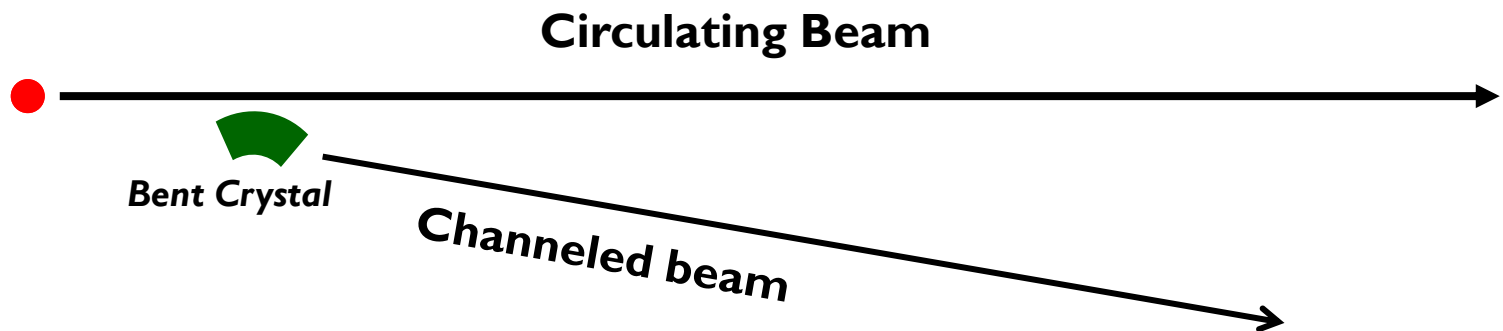
Fitting the data

- Function for fitting: combination of Darwin plateau and a Gaussian.
- Parameter of a “width” is determined as full width on a half of volume reflection efficiency.
- Also “sigma” parameter for Gaussian and width of plateau are listed.
- Efficiency calculated in percents. 100% corresponds to from zero to y_0 level.



System setup - collimator scans

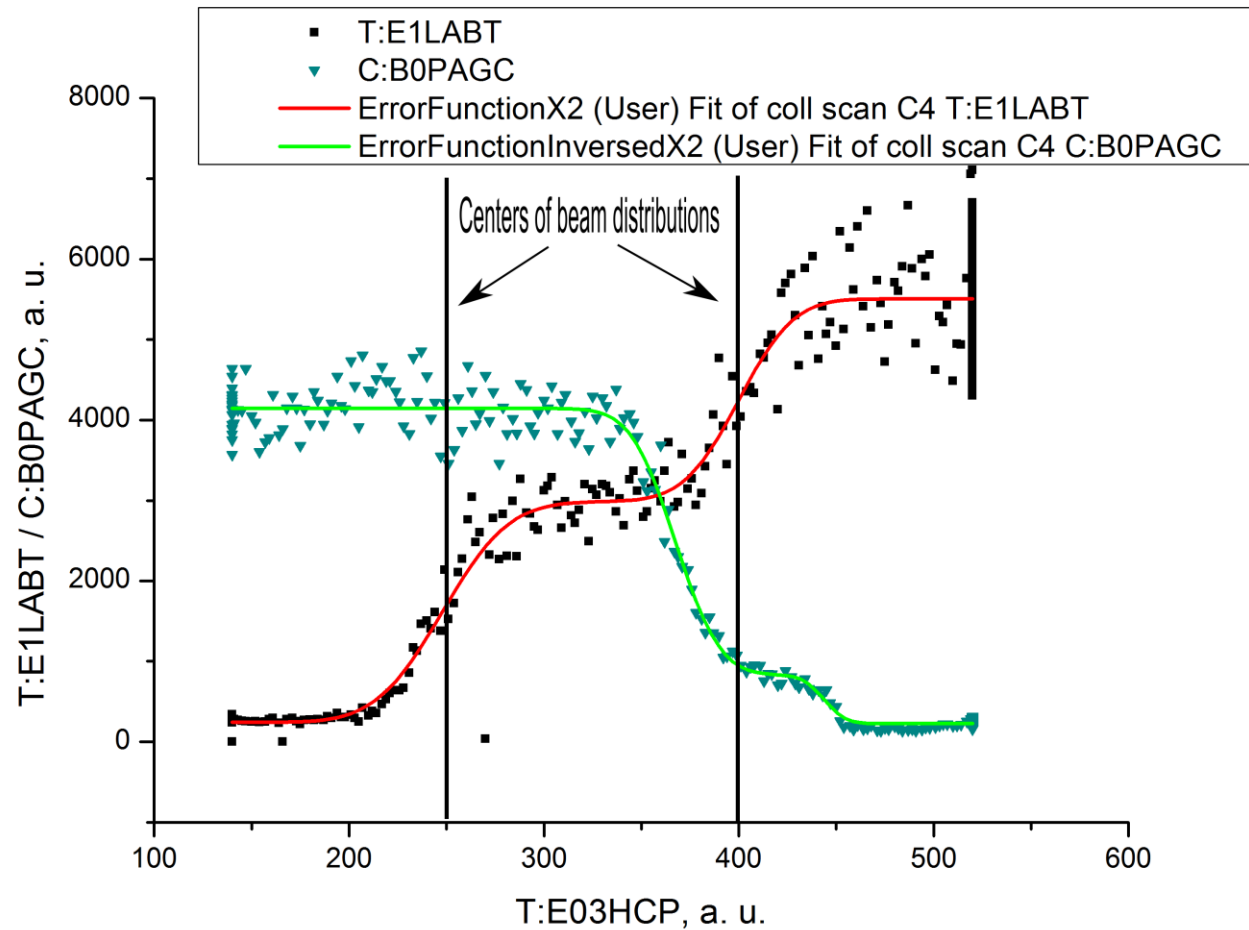
- Collimator is moved to find a distribution of channeled or reflected beam and a displacement between main and channeled/reflected beam



Collimator



Collimator scan data and results



Fitting the data

- Depending of a beam profile, different number of Error functions was used.
- Fitting gives a displacement between channeled/reflected beam and the main beam, so gives a channeling/reflection angle, connected with crystal bend angle.
- It looks like there are aperture effects between E1 and B0.



Results

The data from 2005 till 2010 is analyzed: angle scans and collimator scans.

Simulation data was analyzed and showed right choice of fitting functions.

Gaussian profile of channeling efficiency vs. angle confirmed.

Numerical data for 3 crystals and plots are linked to T-980 collaboration website.



Experimental results

Parameters	Crystal		
	O-05-09	MS-08-09	O-BNL-02
Channeling peak position, experimental, urad	-961 (+/- 9 (stat) +/- 2 (instr))	655 (+/- 10 (stat) +/- 3 (instr))	-
Channeling peak position, simulation, urad	-963 (+/- 2 (stat) +/- 1 (instr))	658.5 (+/- 2.1 (stat) +/- 1.3 (instr))	-
Channeling width, experimental, urad	16 (+/- 5 (stat) +/- 2 (instr))	59 (+/- 12 (stat) +/- 3 (instr))	-
Channeling width, simulation, urad	10.5 (+/- 1.2 (stat) +/- 1.1 (instr))	26 (+/- 2 (stat) +/- 1 (instr))	-
Full bend angle, experimental, urad	280 (+/- 54 (stat) +/- 100 (instr))	255 (+/- 29 (stat) +/- 6 (instr))	444 (+/- 22 (stat) +/- 108 (instr))
Full bend angle, expected, urad	360	200	410 (+/- 20)

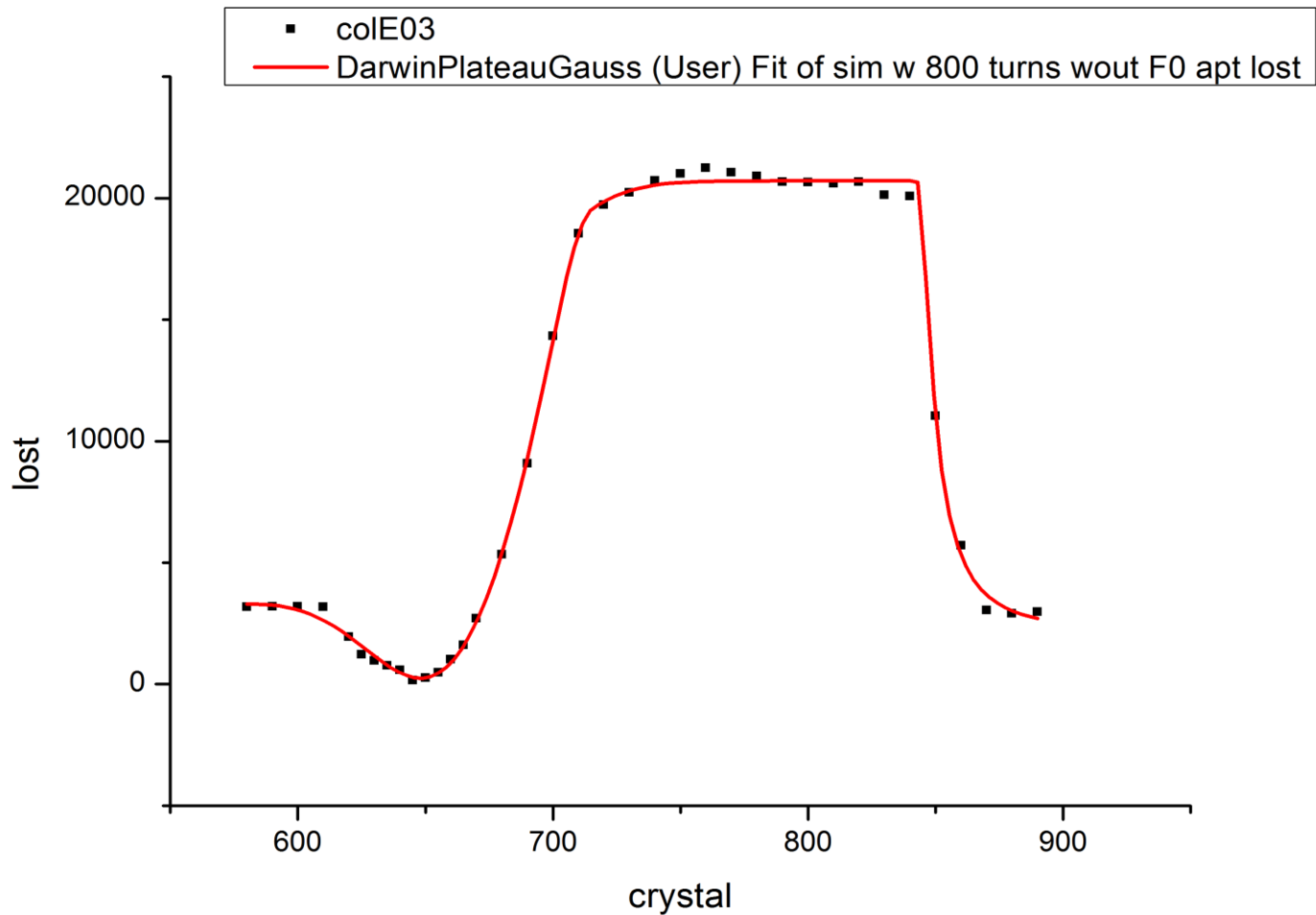


Thank you for attention



Extra slides

Simulation data



R-squared 0.999