Analysis of channeling for crystal STF110, runs 4372, 5508, 5693.

Run dates: 2017-05-16, 2017-10-21, 2017-10-26
Particle types: pions, pions, Xenon
Particle energies: 180 GeV, 180 GeV, 150 GeV

Francesco Forcher

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BE Beams Department

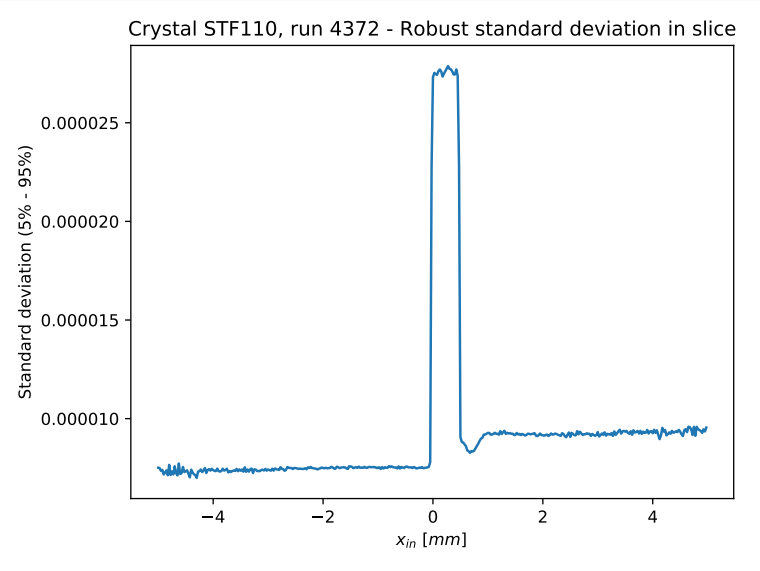
Introduction

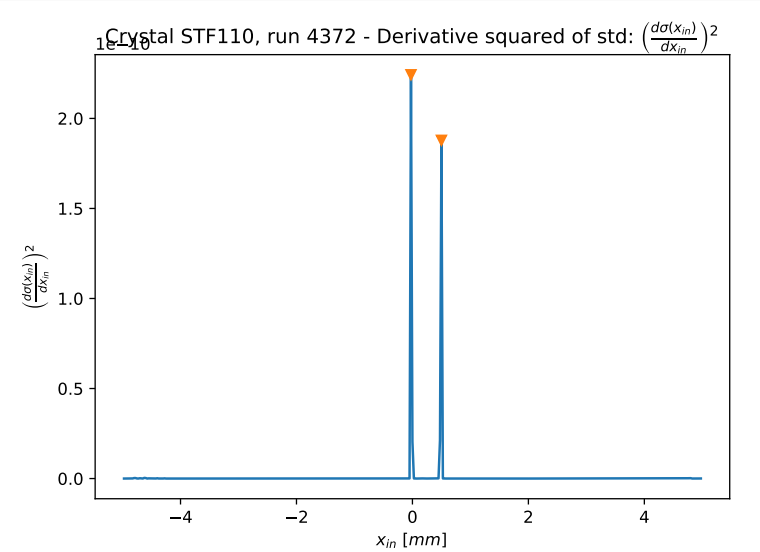
We chose to test the crystal STF110 because it is an LHC candidate, due to his low miscut and its bending. The crystal has been tested three times, we selected for each time an high-stat run in channeling. The run selected thus are:

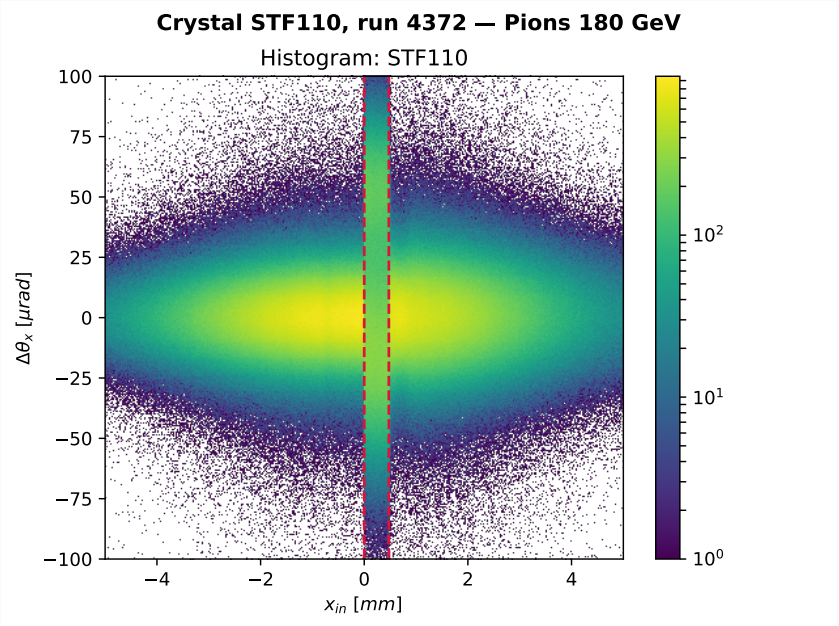
- Run 4372: Pions (180 GeV), on 2017-05-16
- Run 5508: Pions (180 GeV), on 2017-10-21
- Run 5693: Xenon (150 GeV), on 2017-10-26

The crystal has been heated between the first two runs, so we will also investigate the effects in time on the crystal parameters.

Geometrical cuts analysis

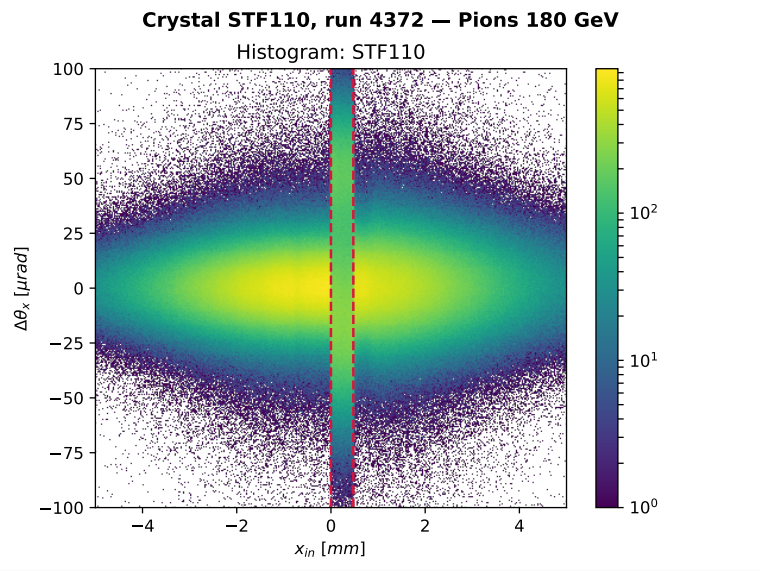


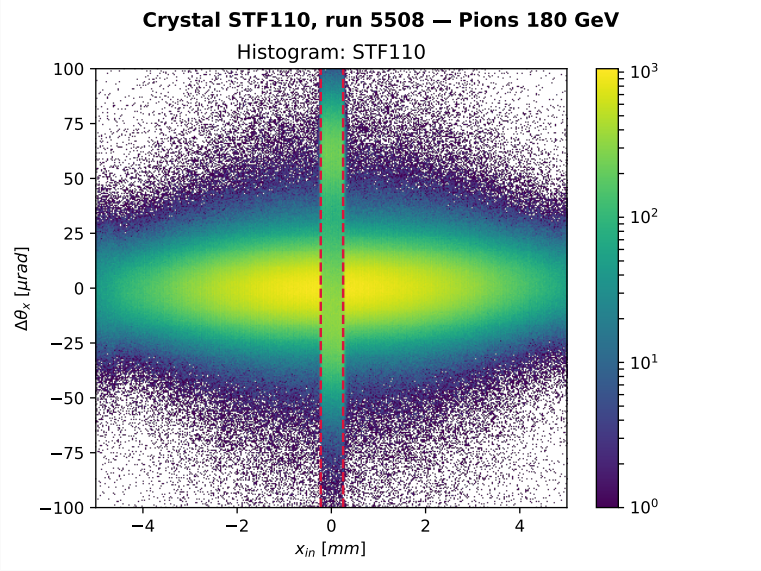


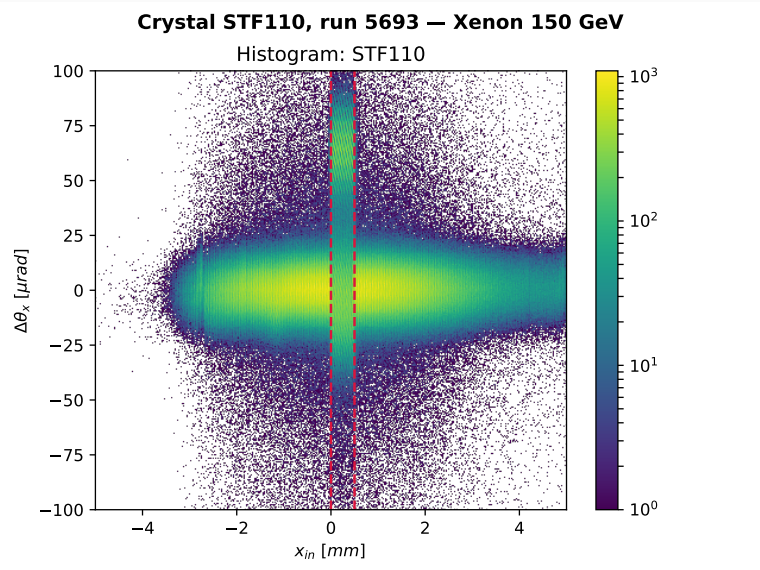


Geometrical cuts in x selected by calculating a robust $\sigma(x_{\text{in}})$ and searching for the plateau caused by increased scattering in the crystal. The edges have been detected by finding the two highest peaks in the derivative squared of $\sigma(x_{\text{in}})$.

Geometrical cuts



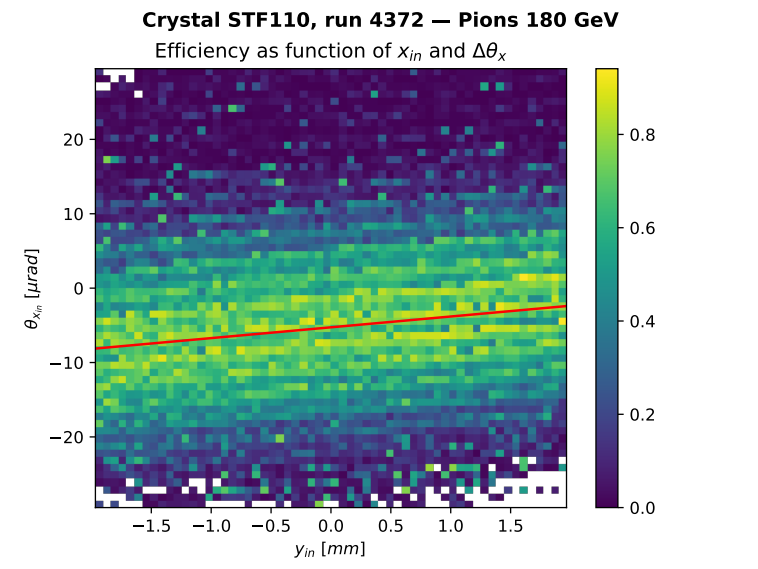


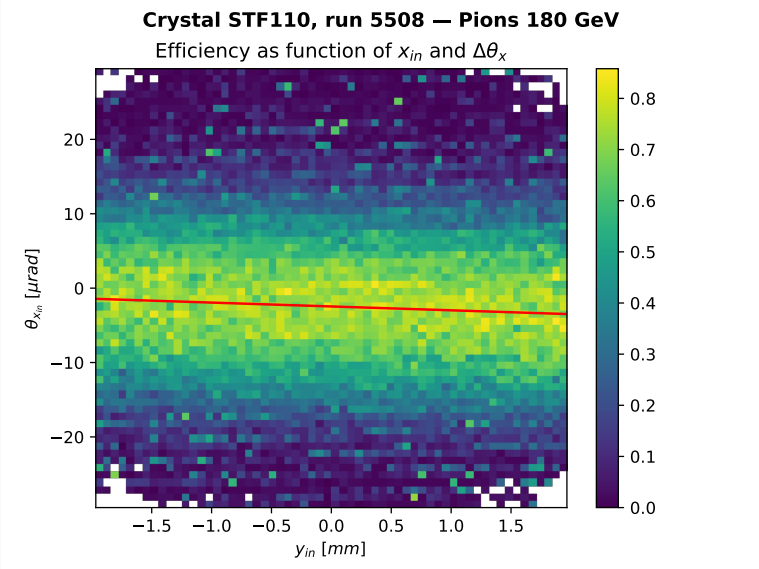


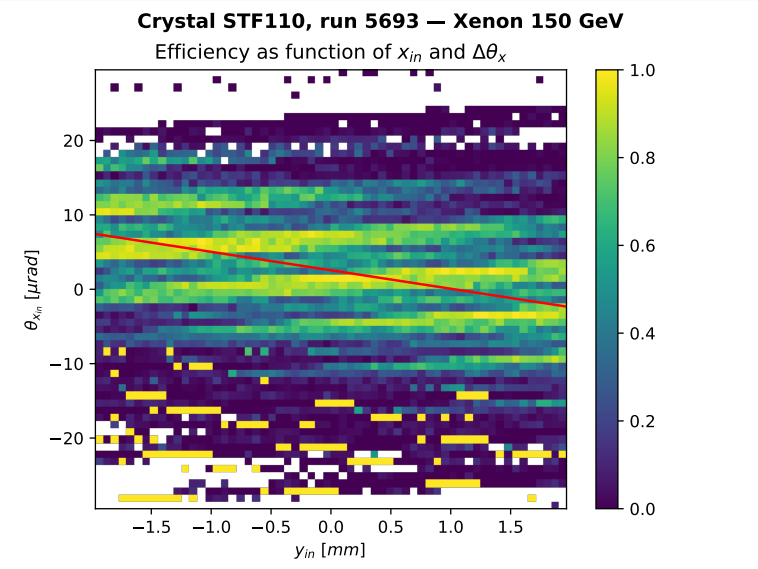
Geometrical cuts in x:

- 4372: 0.0 →0.5 [mm]
- 5508: -0.225 →0.25 [mm]
- 5693: 0.0 →0.5 [mm]

Torsion analysis: efficiency



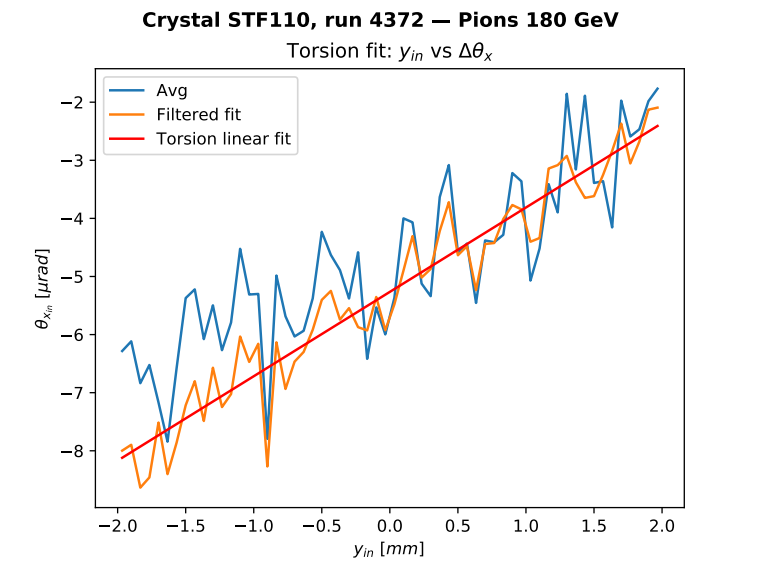


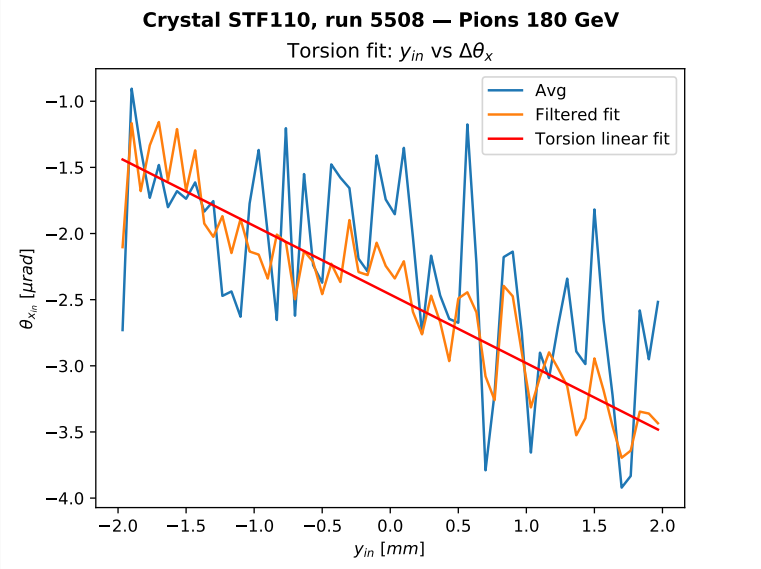


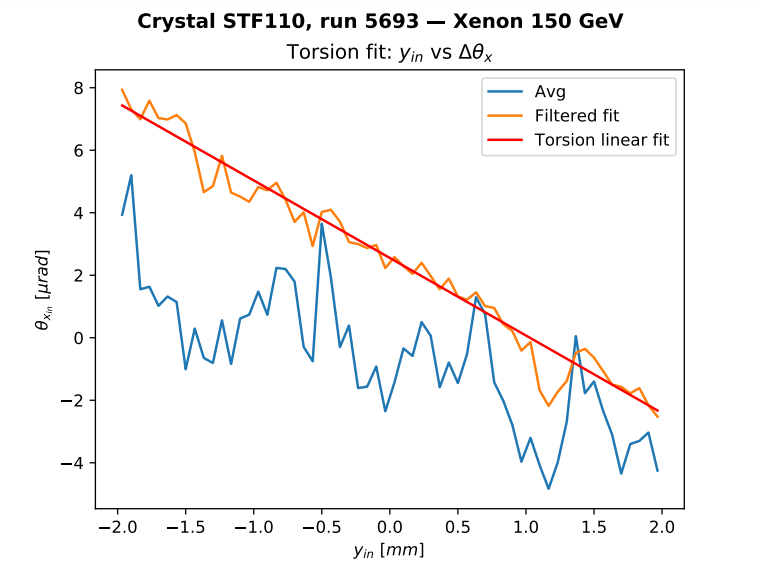
Run	Torsion	Offset
4372	1.45 ± 0.06	-5.26 ± 0.07
5508	-0.52 ± 0.03	-2.46 ± 0.03
5693	-2.48 ± 0.06	2.55 ± 0.07

Torsion correction — Run 4372: Pions (180 GeV) • Run 5508: Pions (180 GeV) • Run 5693: Xenon (150 GeV)

Torsion analysis: torsion fit

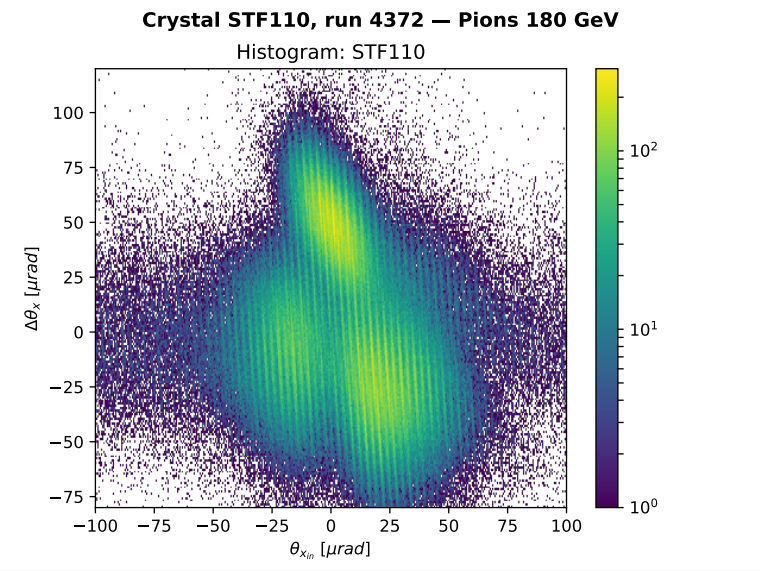


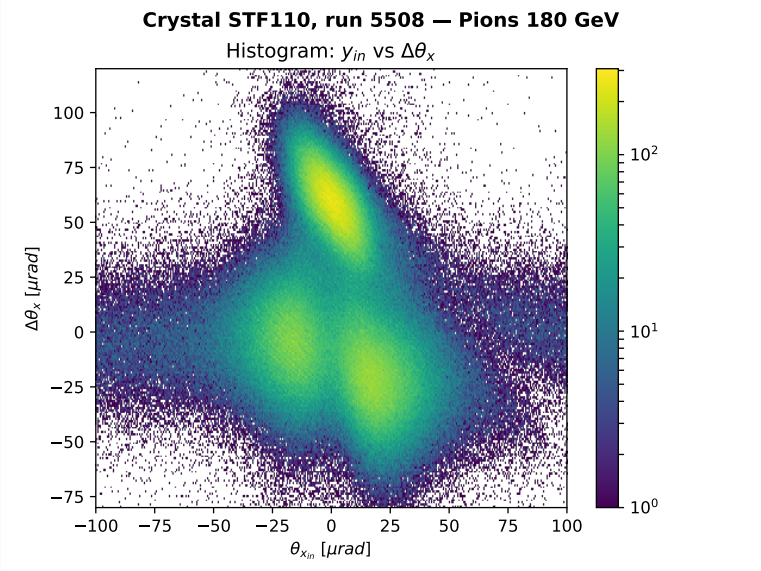


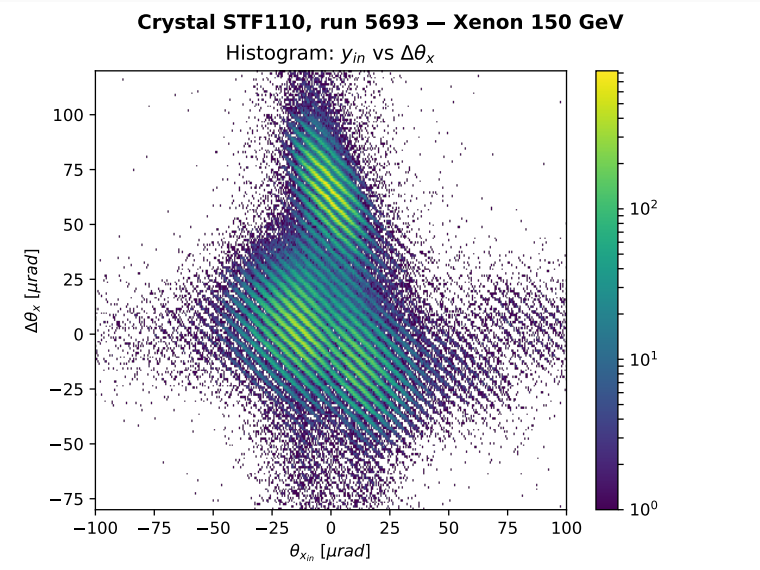


Robust fit: the efficiency slices have been fitted minimizing a “Cauchy loss function”: minimize a logaritmic function of residuals $\sum_{i=1}^{n} \ln\left(1 + \left(\phi(x_i, \mu, \sigma) - y_i\right)^2\right)$ to greatly reduce outlier influence. Compare blue standard fit with improved orange fit.

Torsion analysis: corrected histogram

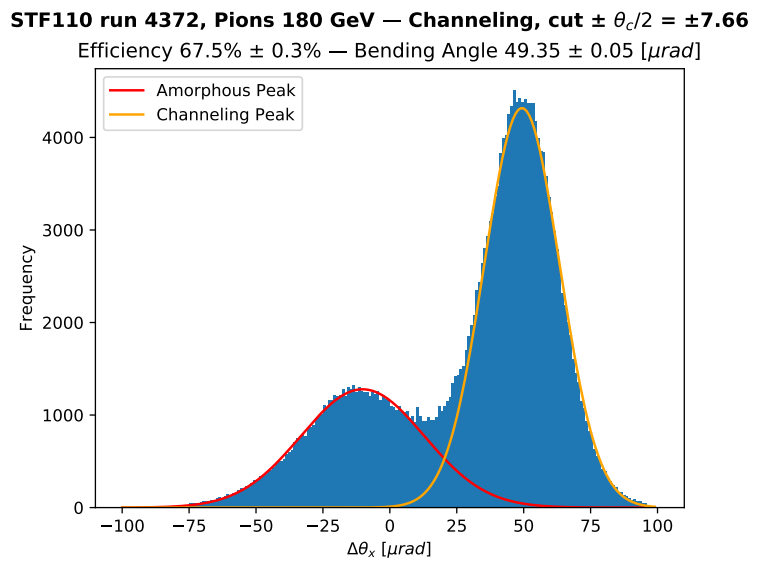


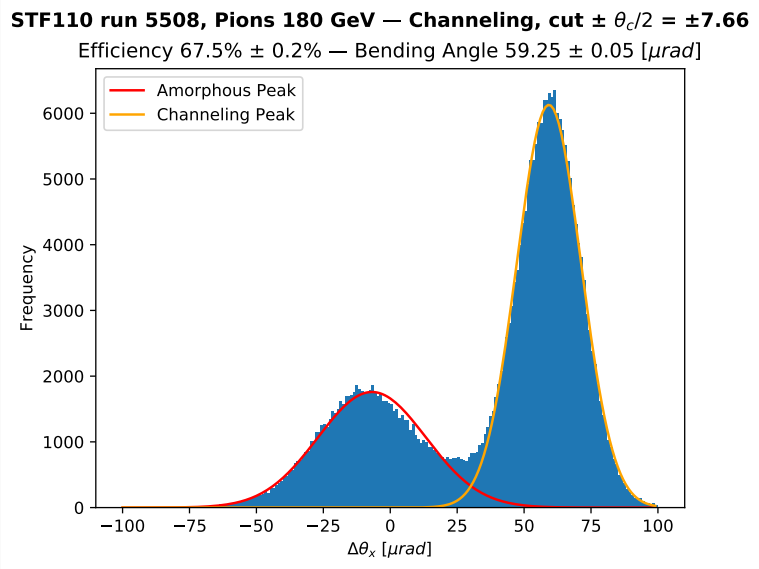


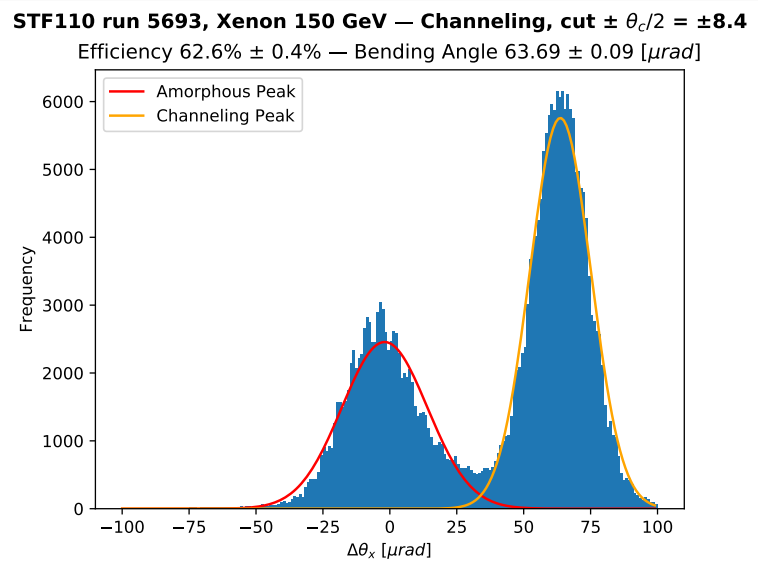


The corrected histograms.

Channeling fit: cut at $\pm\frac{\theta_c}{2}$: half critical angle

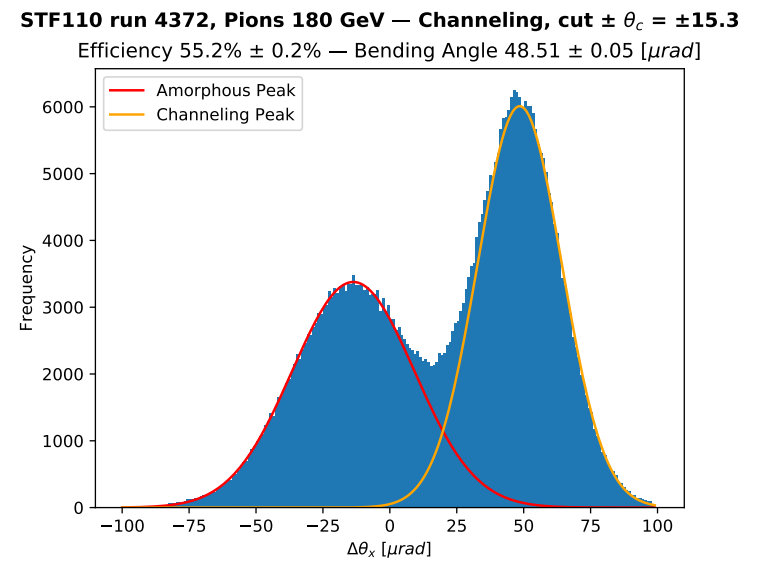


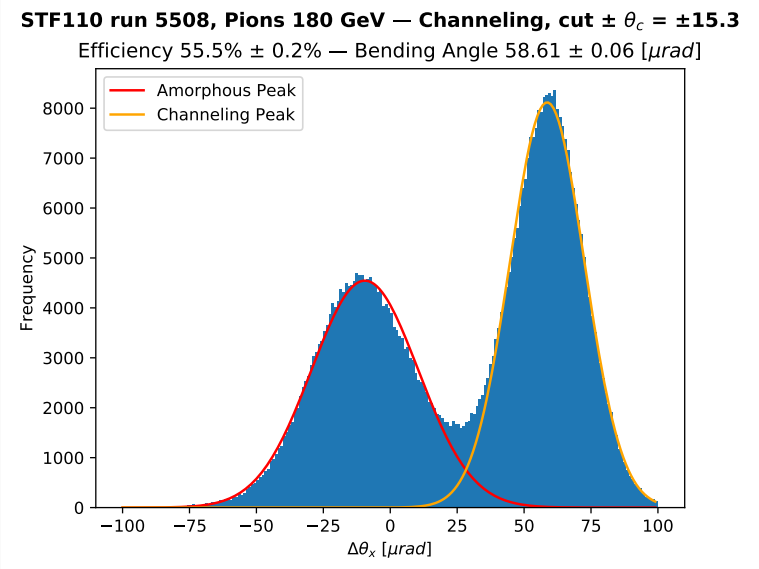


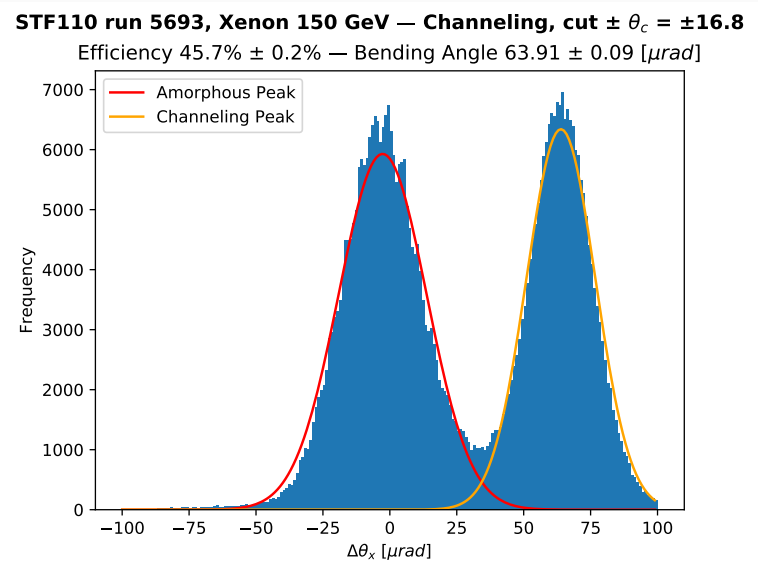


Run	Efficiency%	θ_b [μrad]
4372	67.5 ± 0.3	49.35 ± 0.05
5508	67.5 ± 0.2	59.25 ± 0.05
5693	62.6 ± 0.4	63.69 ± 0.09

Channeling fit: cut at $\pm\theta_c$: critical angle

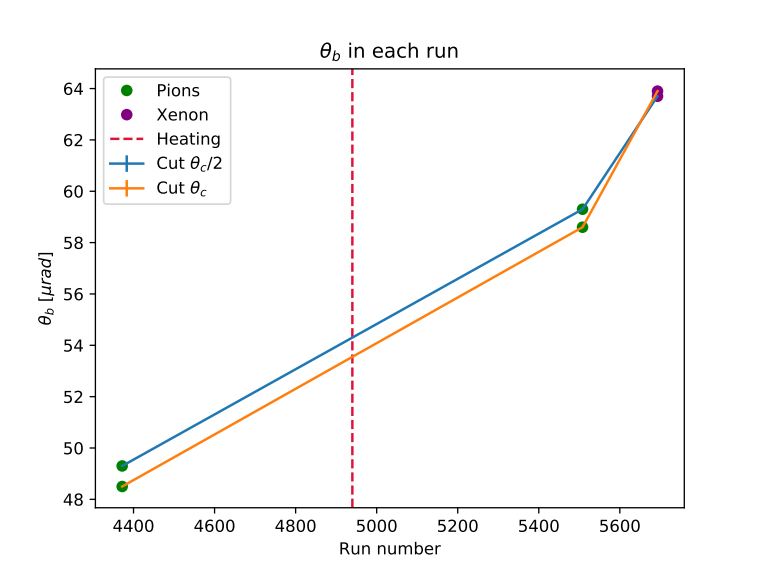


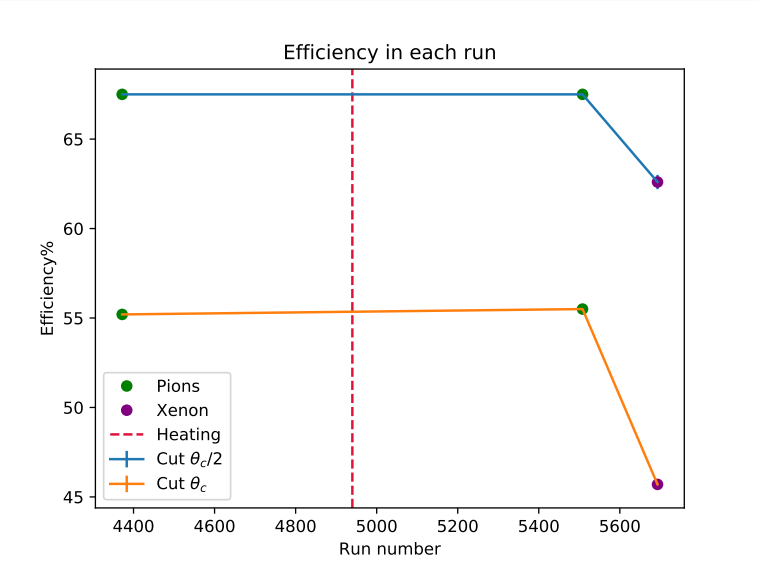




Run	Efficiency%	θ_b [μrad]
4372	55.2 ± 0.2	48.51 ± 0.05
5508	55.5 ± 0.2	58.61 ± 0.06
5693	45.7 ± 0.2	63.91 ± 0.09

Crystal parameters in time





Here are plotted the efficiency and the bending angle for the crystal STF110, calculated for each of the three runs. The heating is shown between the first two runs.
The error bars are present but very small, in the plots they do not appear clearly outside of the points.

Conclusions

To conclude, we tested the crystal STF110 because its nominal characteristics (miscut, bending) would satisfy the requirements for installation in LCH.

We examined the stability of the bending after a thermal cycle, and found that the bending angle changed in a statistically significant way, before and after the cycle. Moreover, the angle appear to increase by another 5 μrad during the week of testing.