Electron beam optimization for collimation

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GlueX statistics depend in part on:

- Photon beam polarization
- Run time
- Photon beam transmission through collimator

Good convergence at the collimator

- Higher polarization
- Better transmission ☺

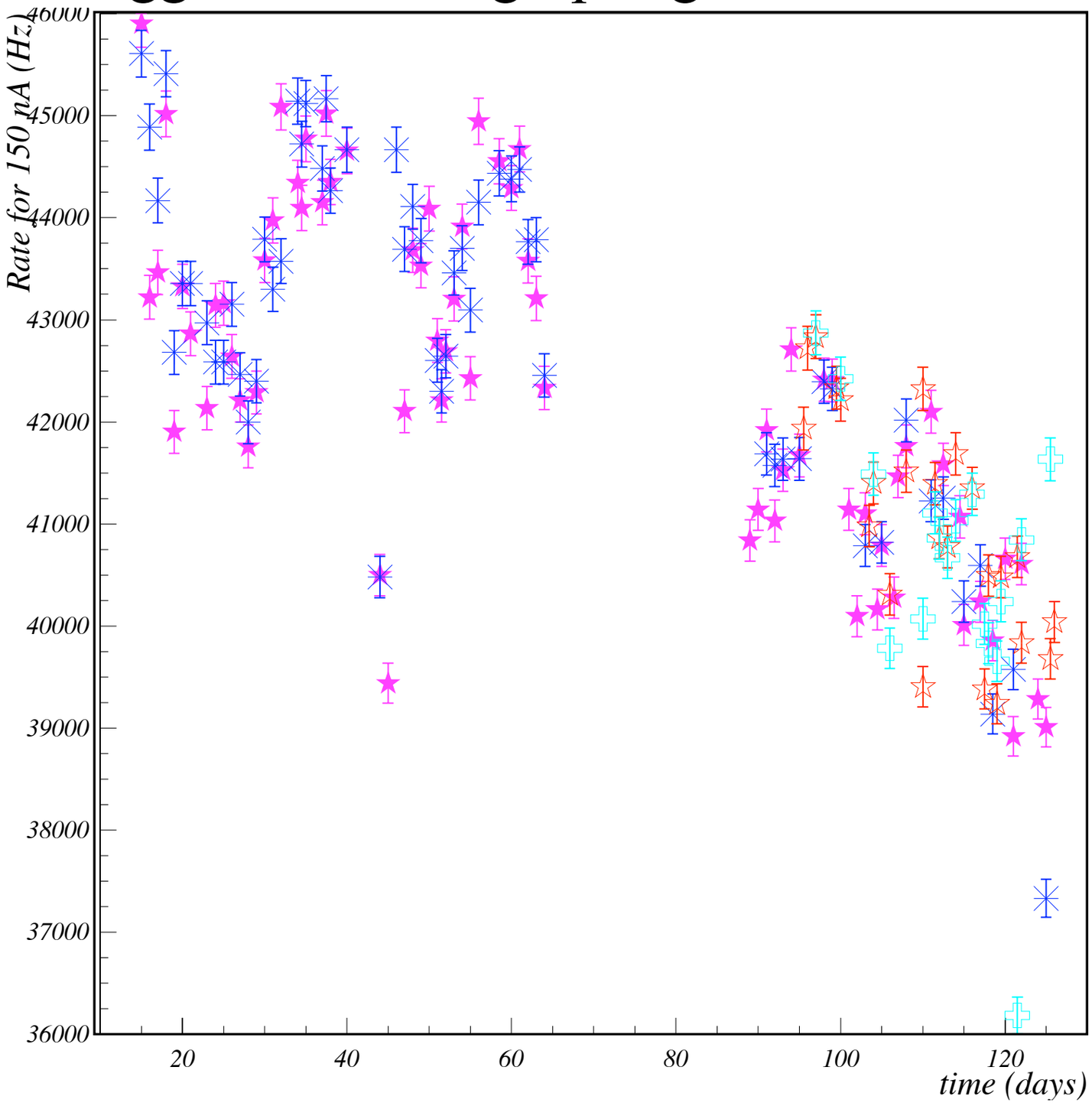
Time spent: ☹

- Optimize beam tunes (every few days)
- Verify beam tune (Harp scans, daily)

How to best optimize these factors was discussed during the Spring 2018 run.

Photon beam Transmission

Main trigger rate during Spring 2018 run



- Diamond, thin converter
- (Diamond, thick converter)/1.6
- (Amorphous, thin converter)×1.25
- (Amorphous, thick converter)×1.12

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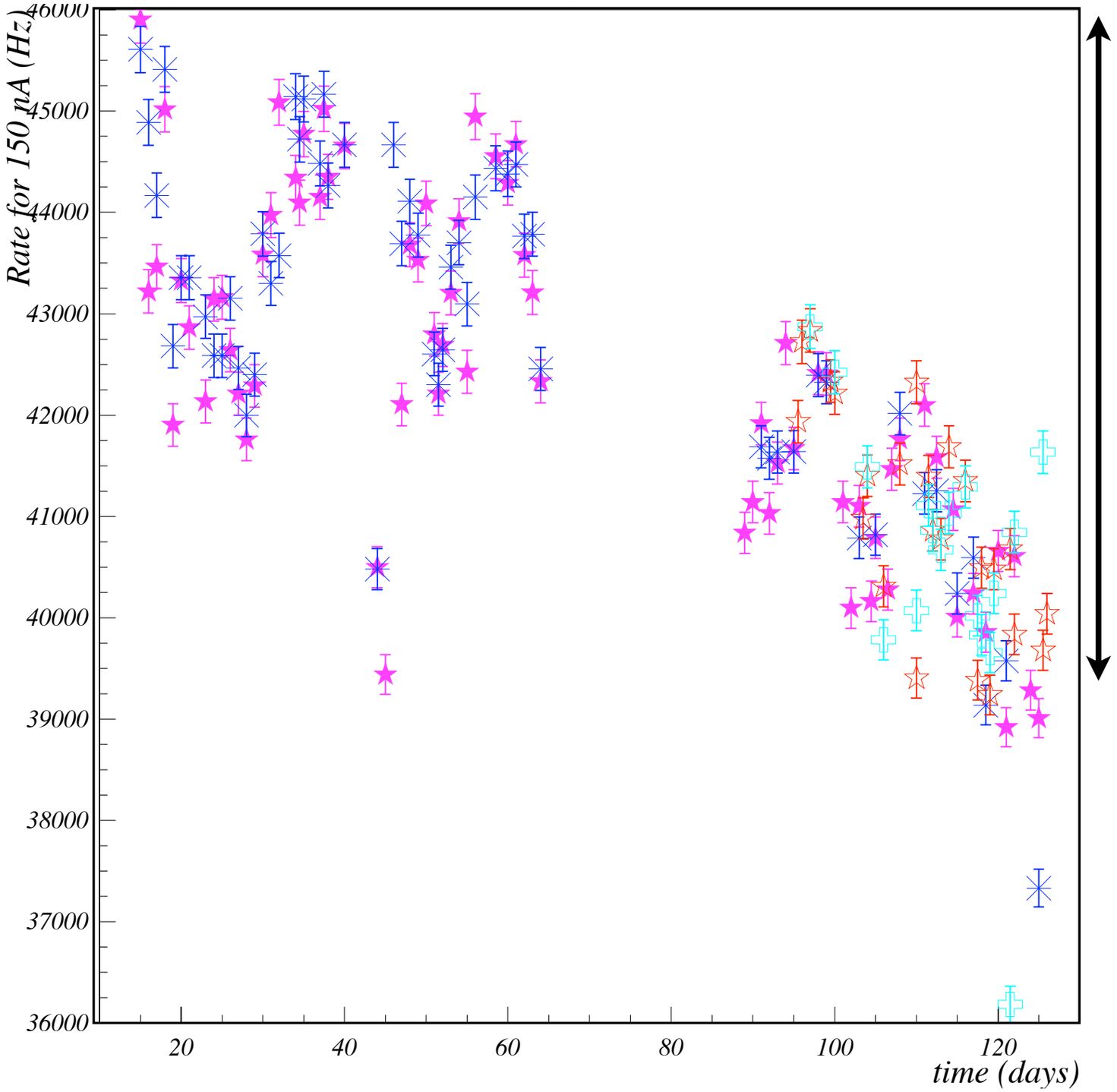

-16% change over the Spring run period.

(PS scalers rates give a similar change:-15%)

Cannot be all due to degraded beam spot size

With 5mm collimator. Would presumably be more unstable with 3.4mm colimator.

Photon beam Transmission

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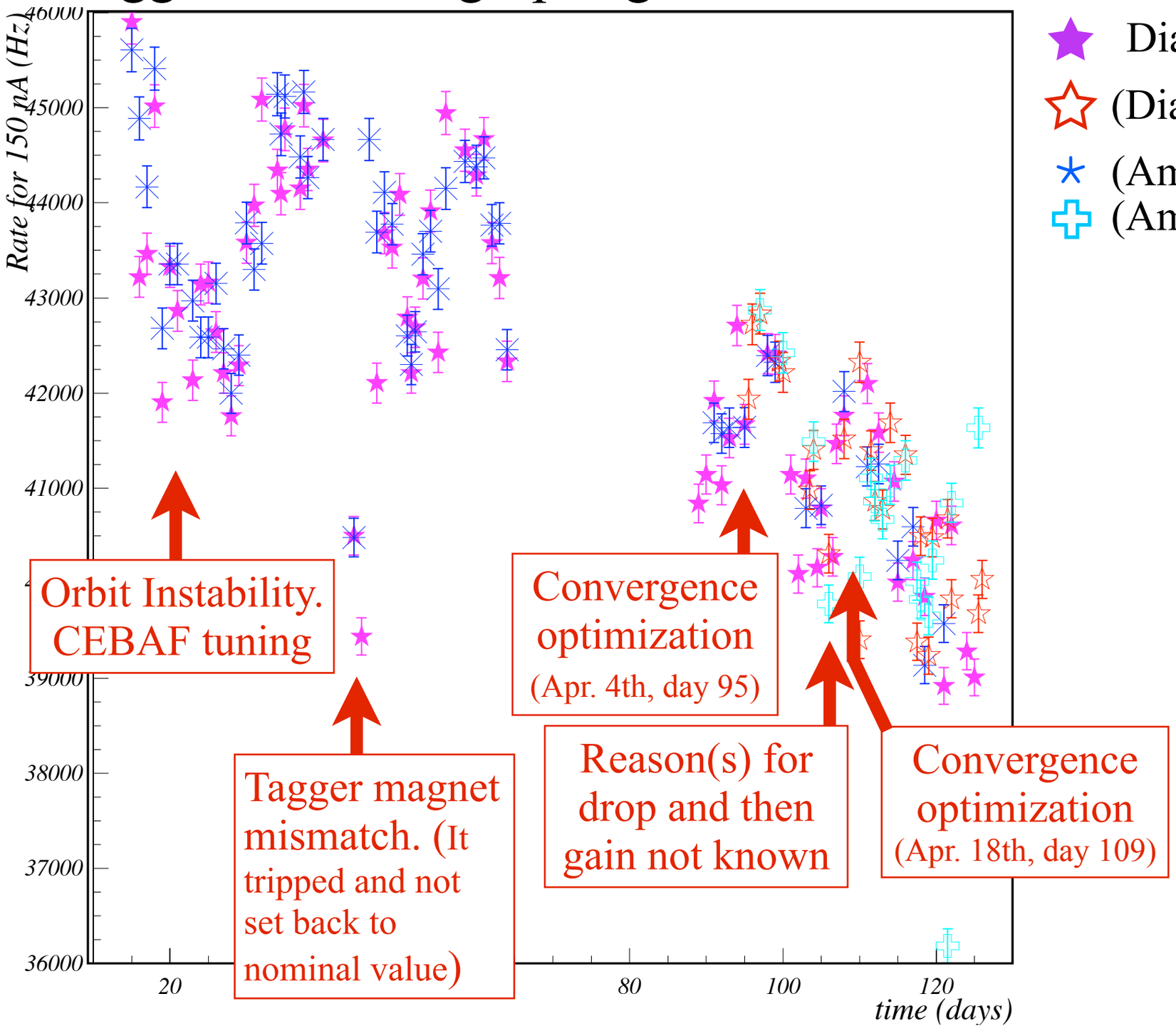

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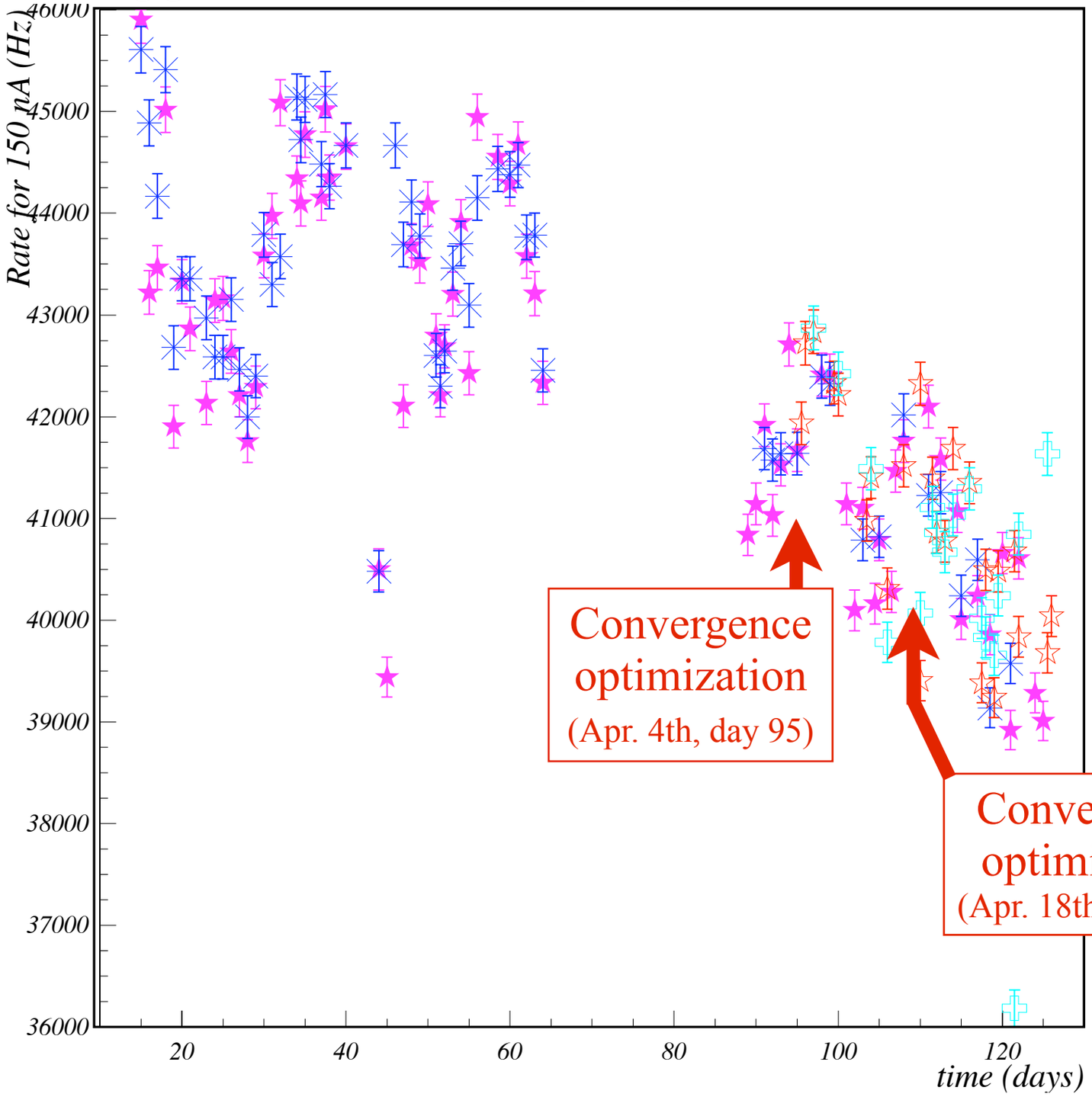

★ Diamond, thin converter

☆ (Diamond, thick converter)/1.6

✶ (Amorphous, thin converter)×1.25

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Convergence optimization helps by ~few %. Confirms that -16% cannot be all due to degraded beam spot size.

(See also F.O.M study in a few slides)

Photon beam Transmission

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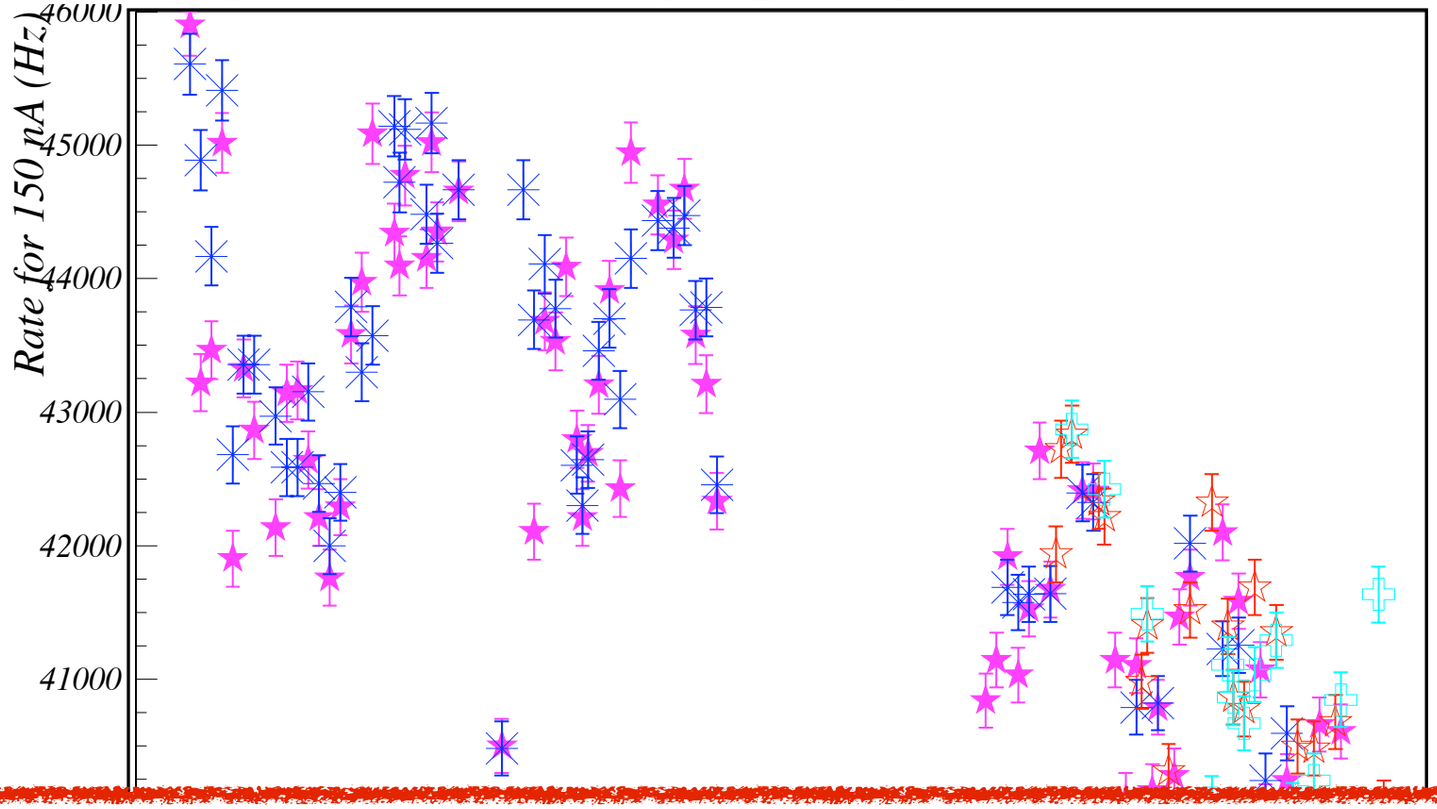

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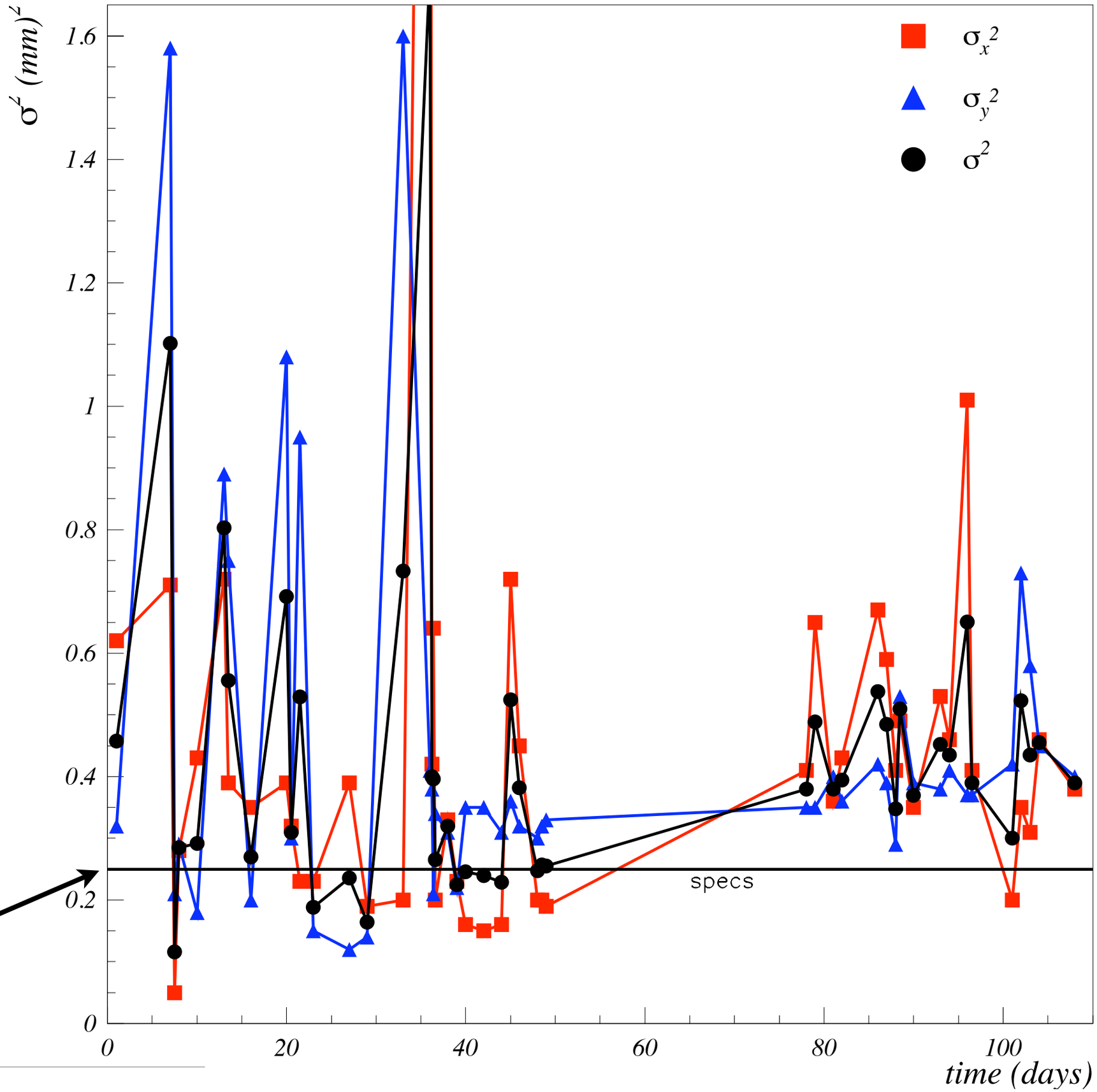
- Transmission evolve on timescale of a few days. Presumably the beam polarization does too.
- Consistent with daily measurements of beam spot size with harps.
- Suggest transmission correlated with beam quality in general and beam convergence in particular.
- Causes for beam convergence drift investigated. Attempts to improve it for next runs (See Todd Satogata's talk yesterday https://halldweb.jlab.org/doc-private/DocDB/ShowDocument?docid=3667).

Beam convergence

•Monitored daily with Harp scans (30 min).

Mined from logbook (Hovanes scan analyses posting).
Unstable: Large change within ~day.



(https://halldweb.jlab.org/wiki/index.php/Specification_for_12_GeV_electron_beam_and_associated_instrumentation)

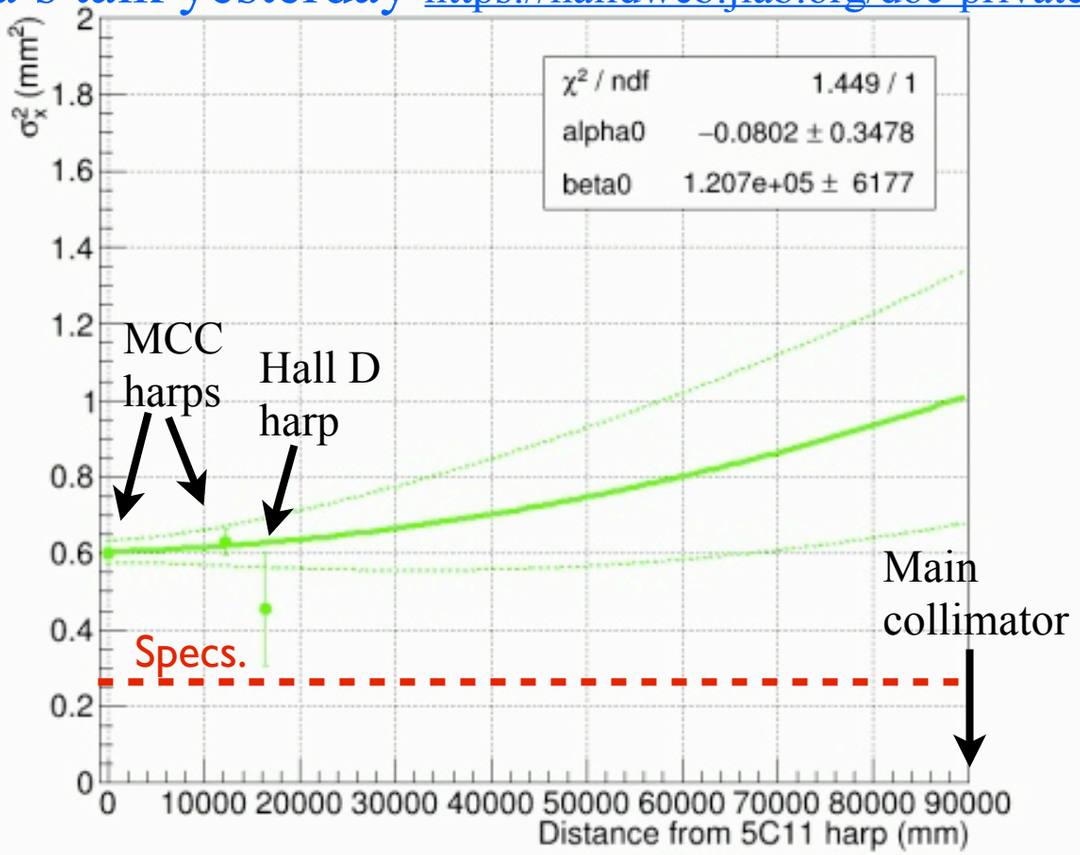
Beam convergence

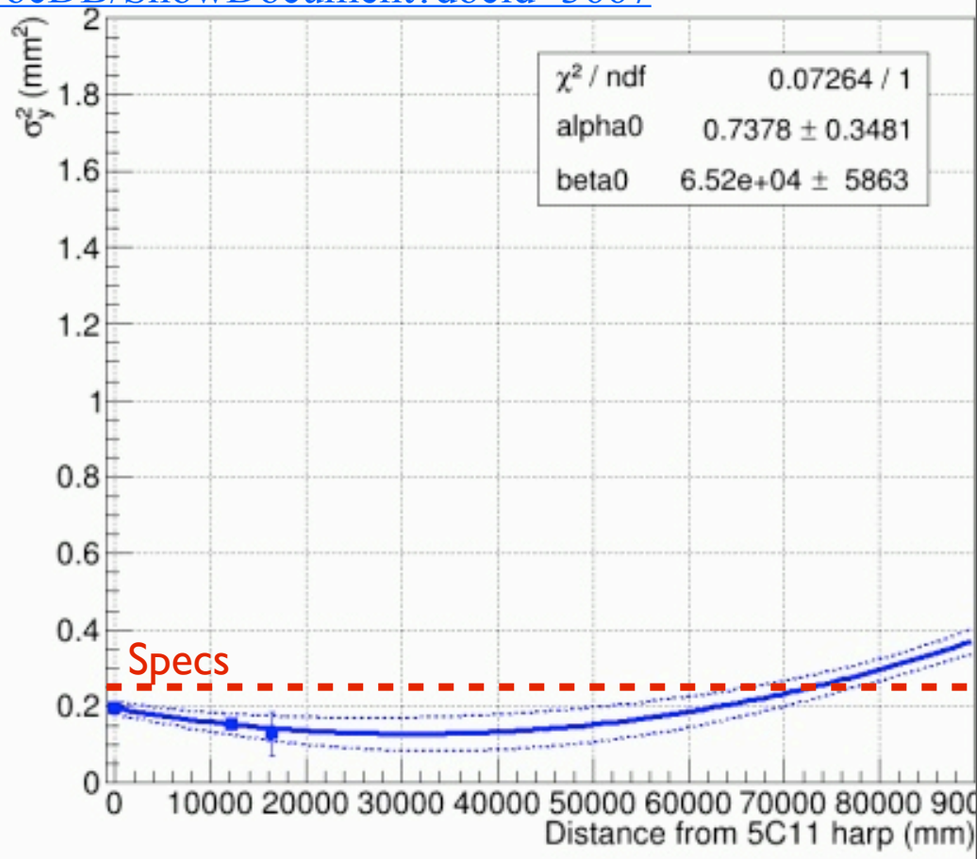
- Monitored daily with Harp scans (30 min).
- Can be optimize by MCC operators. 30 min in principle. Not always successful.

See Todd Satogata's talk yesterday https://halldweb.jlab.org/doc-private/DocDB/ShowDocument?docid=3667

Before convergence optimization:

Lognumber 3562928.
Submitted by hovanes
on Wed, 04/18/2018





After convergence optimization:

(Lognumber 3562938.
Submitted by hovanes
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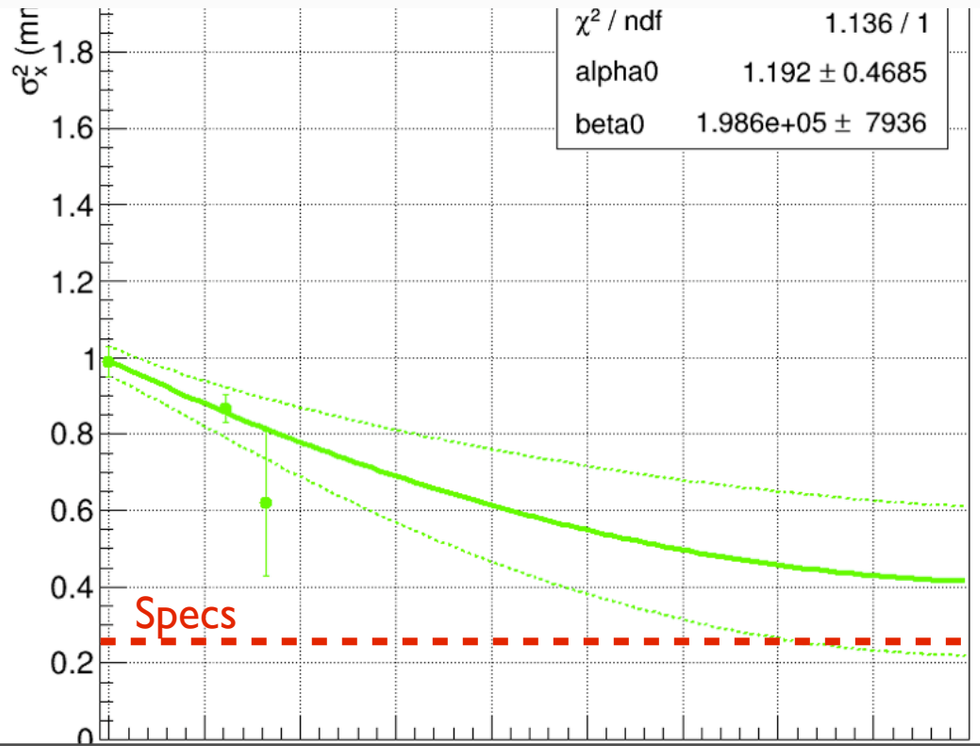

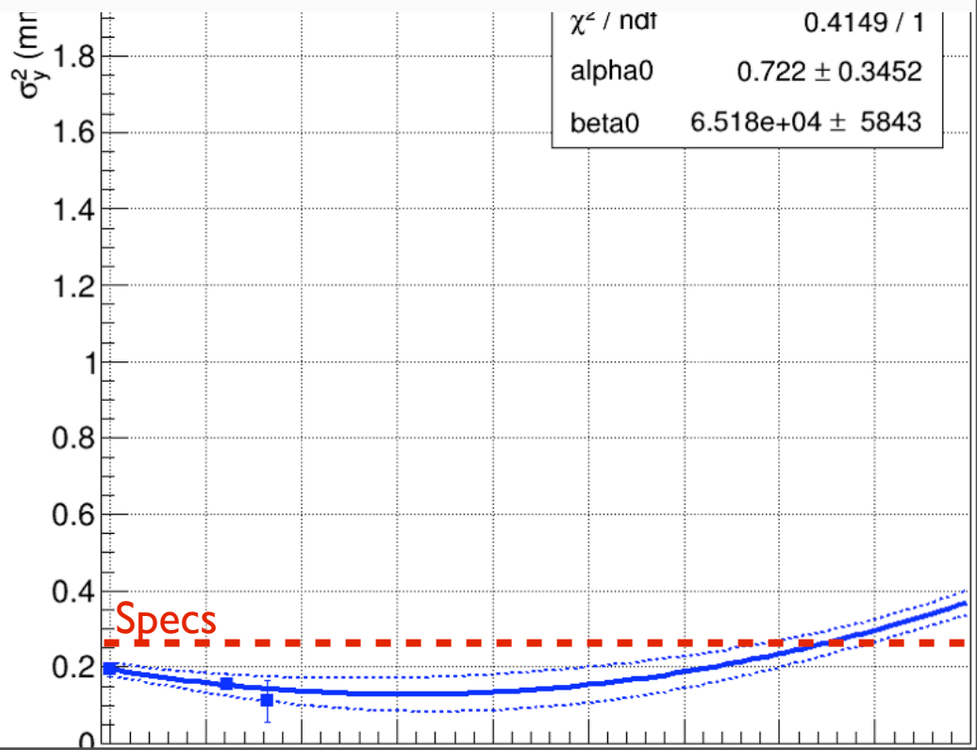

Jefferson Lab
Thomas Jefferson National Accelerator F
Exploring the Nature of Matter

Convergence Diagnostics

- Transmission monitoring
  - Parasitic
  - Offers continuous monitoring
  - Ambiguous (other effects may reduce transmission, e.g. beam centering and wobbling) ⇒ May not be an accurate diagnostic for beam convergence.

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- Harp scans
  - Best diagnostic presently at our disposal.
  - Invasive (30 min). Done once a day.
  - Extrapolation uncertainty
  - Consistency of MCC and Hall D harps
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Convergence Diagnostics

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  - Offers constant monitoring
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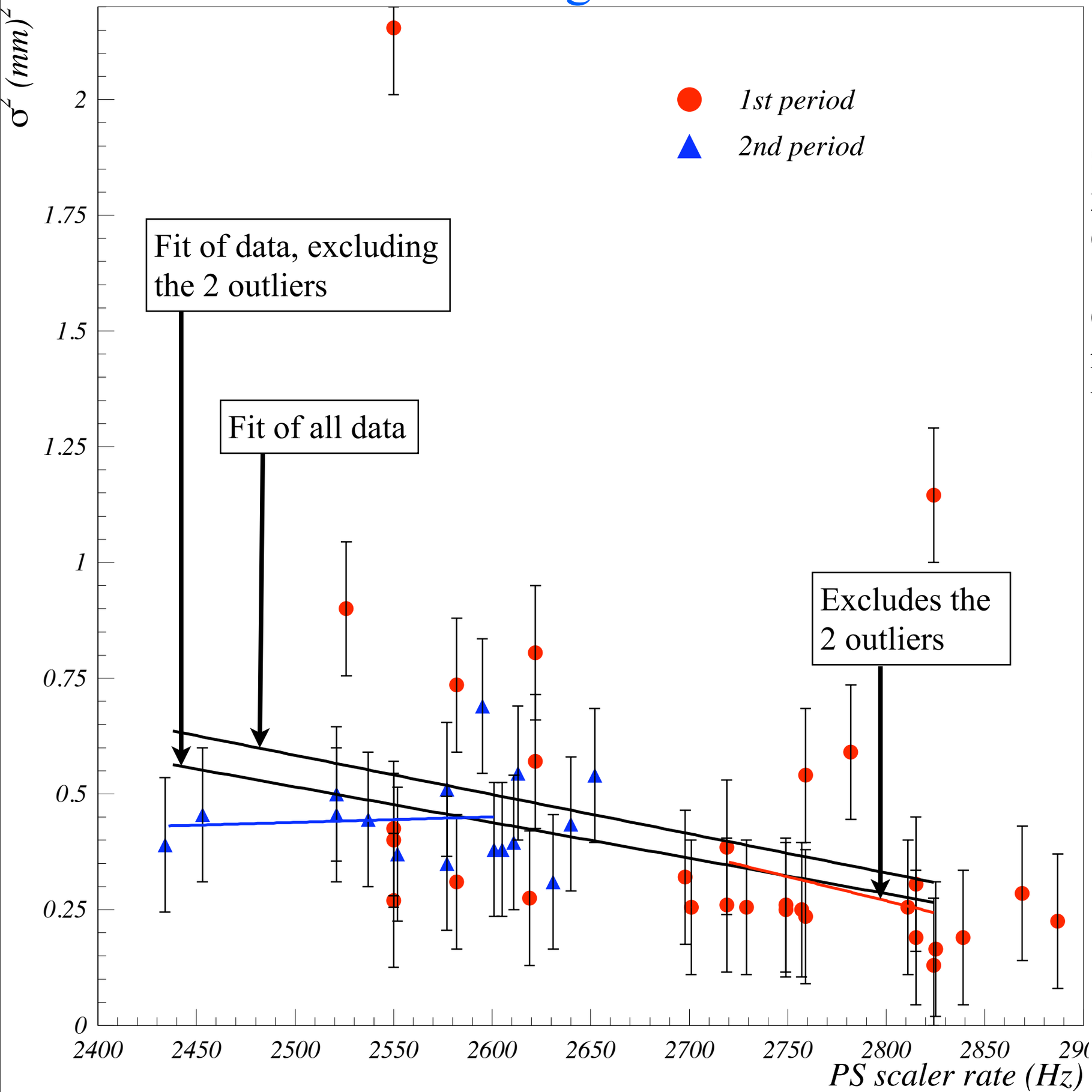
Convergence-rate correlation

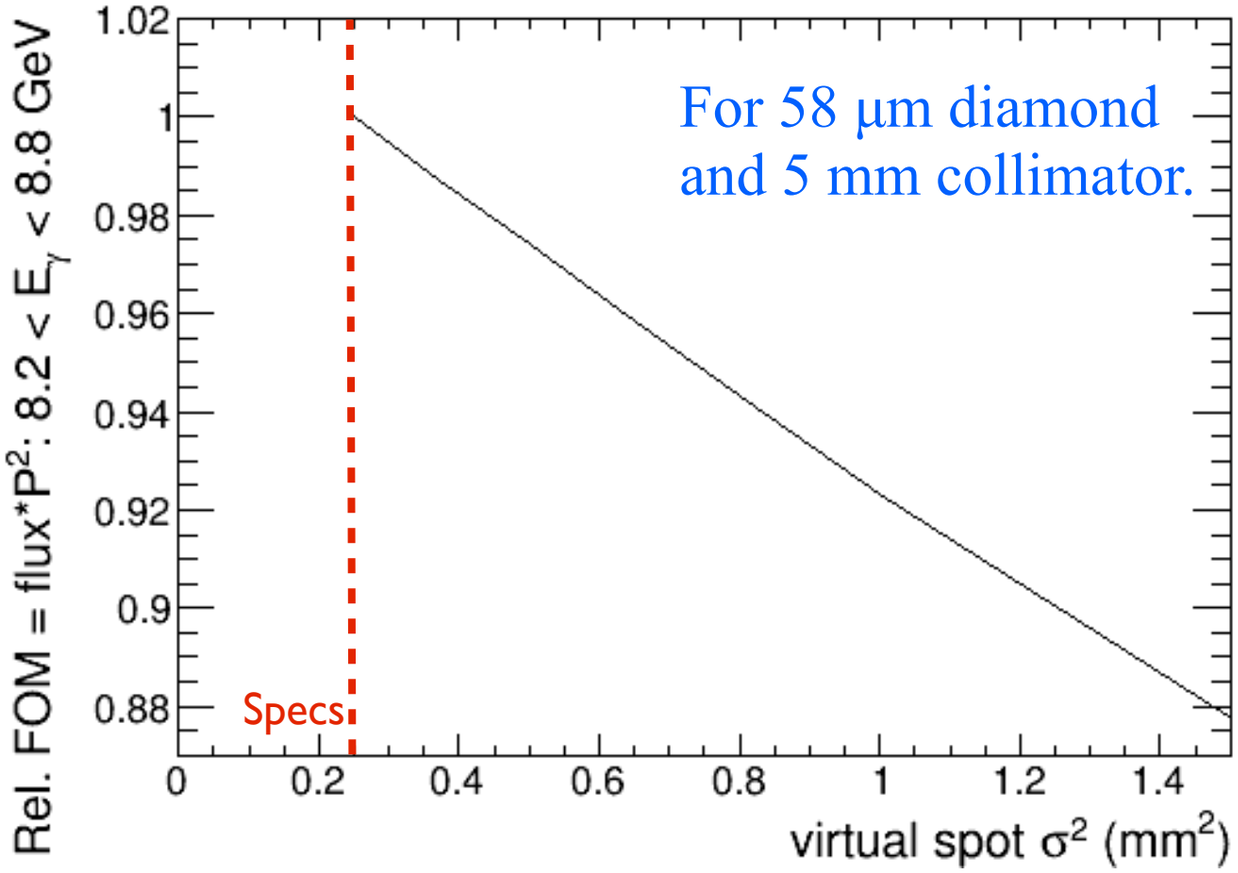


Some correlation, but for 2nd period only (after 3-week CHL-1 repair)

Quick analysis (Harp scans and rate measurements may not be very coincident)

Figure of merit study

Figure of Merit: flux×(polarization)^2 averaged over the coherent peak



F.O.M Produced by J. Stevens:
https://logbooks.jlab.org/entry/3558232
https://logbooks.jlab.org/entry/3560023
https://logbooks.jlab.org/entry/3560036
https://logbooks.jlab.org/entry/3561677

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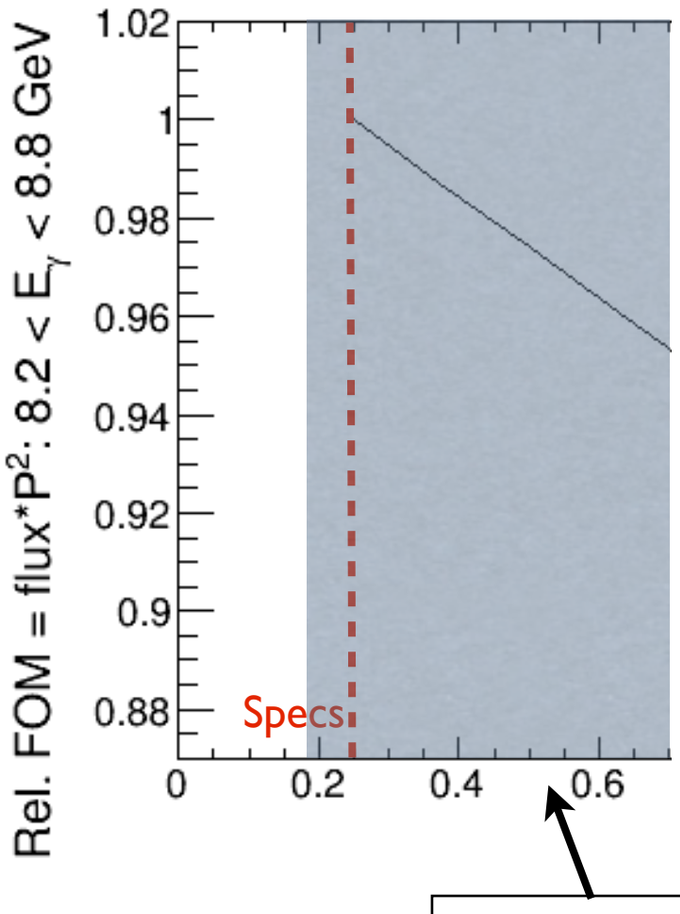
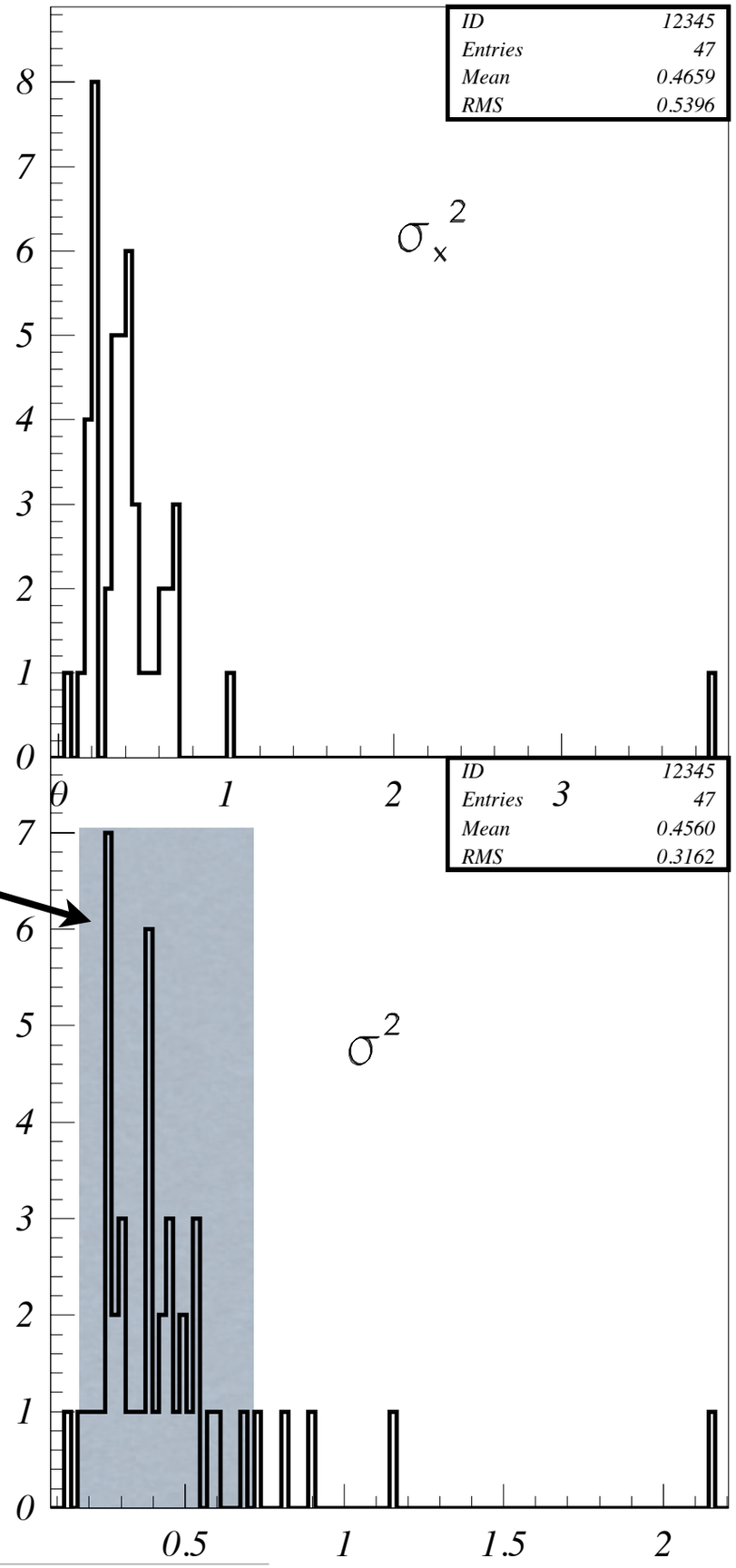
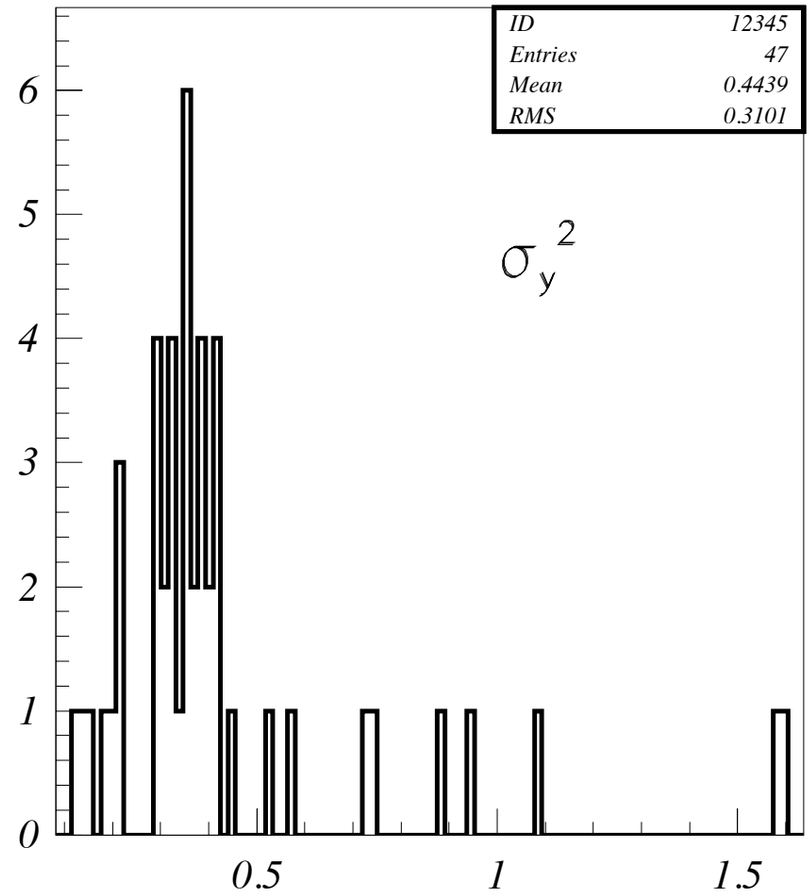


Typical running range





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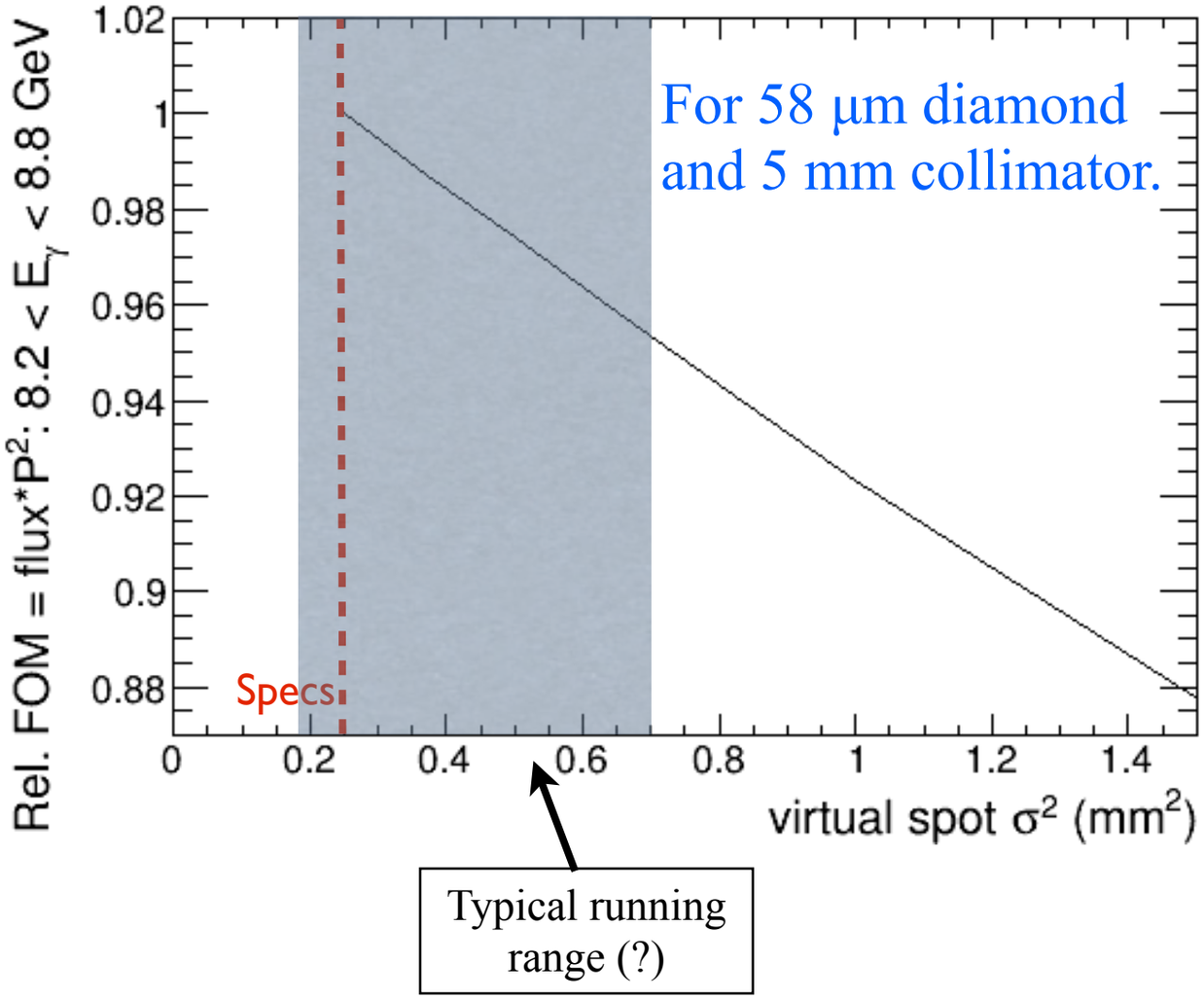
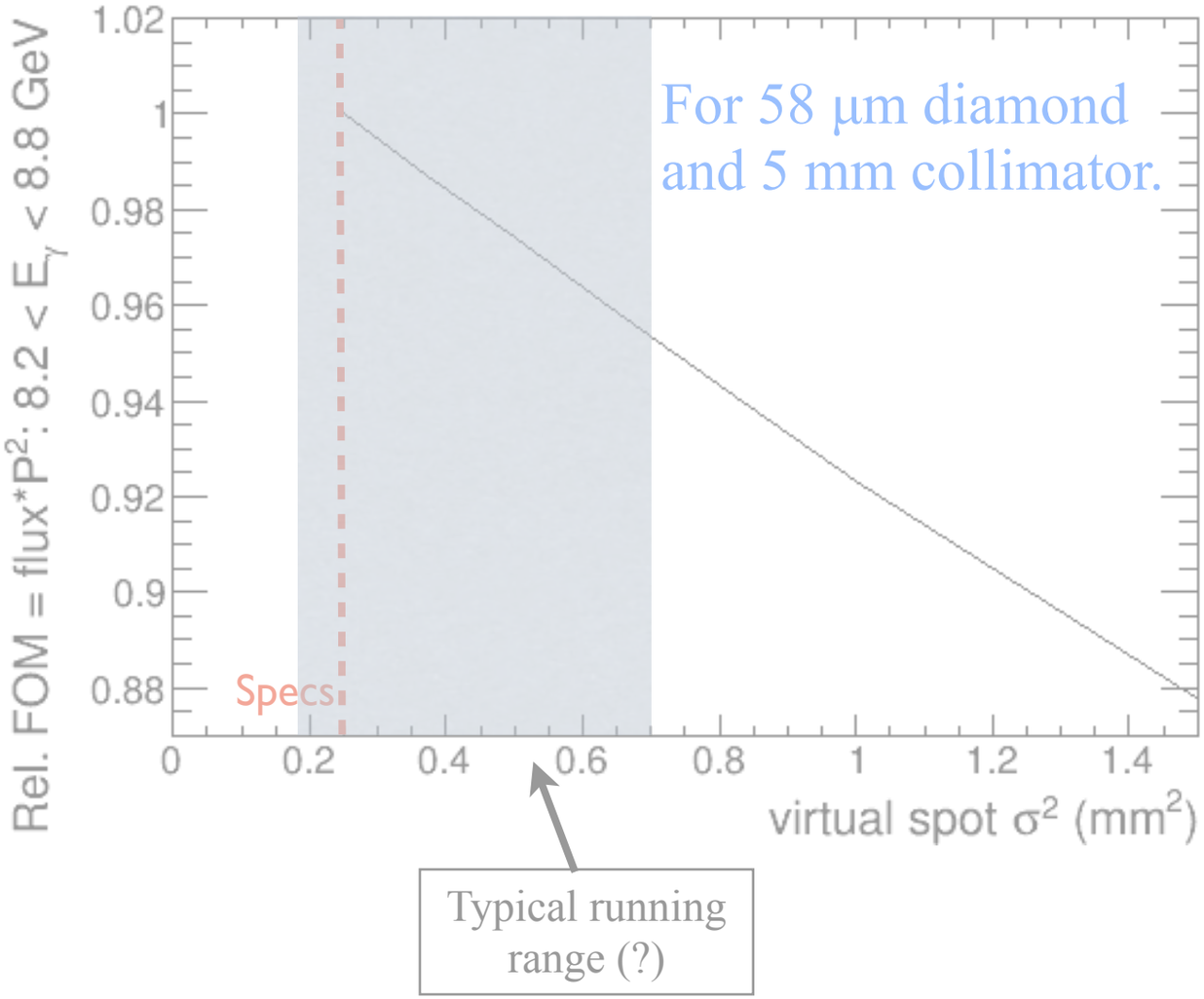
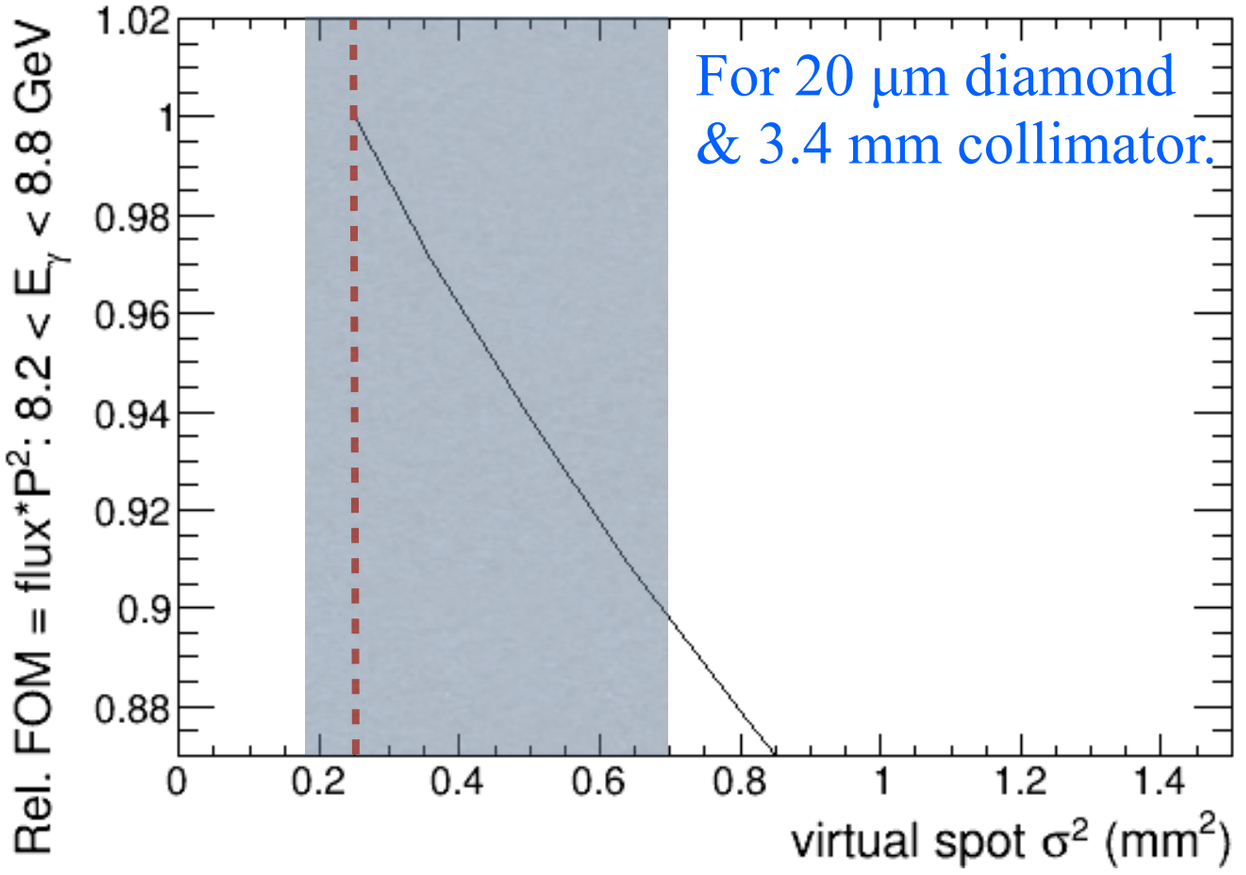


A typical 3% decrease ⇒ Start being worth re-optimizing every 2.5 days.

Assume 3% decrease linearly over 1 day (<1.5%>/day). 30 min optimization procedure+checks (harps,...) and 60% beam efficiency. Does not count routine daily harp scans

Figure of merit study

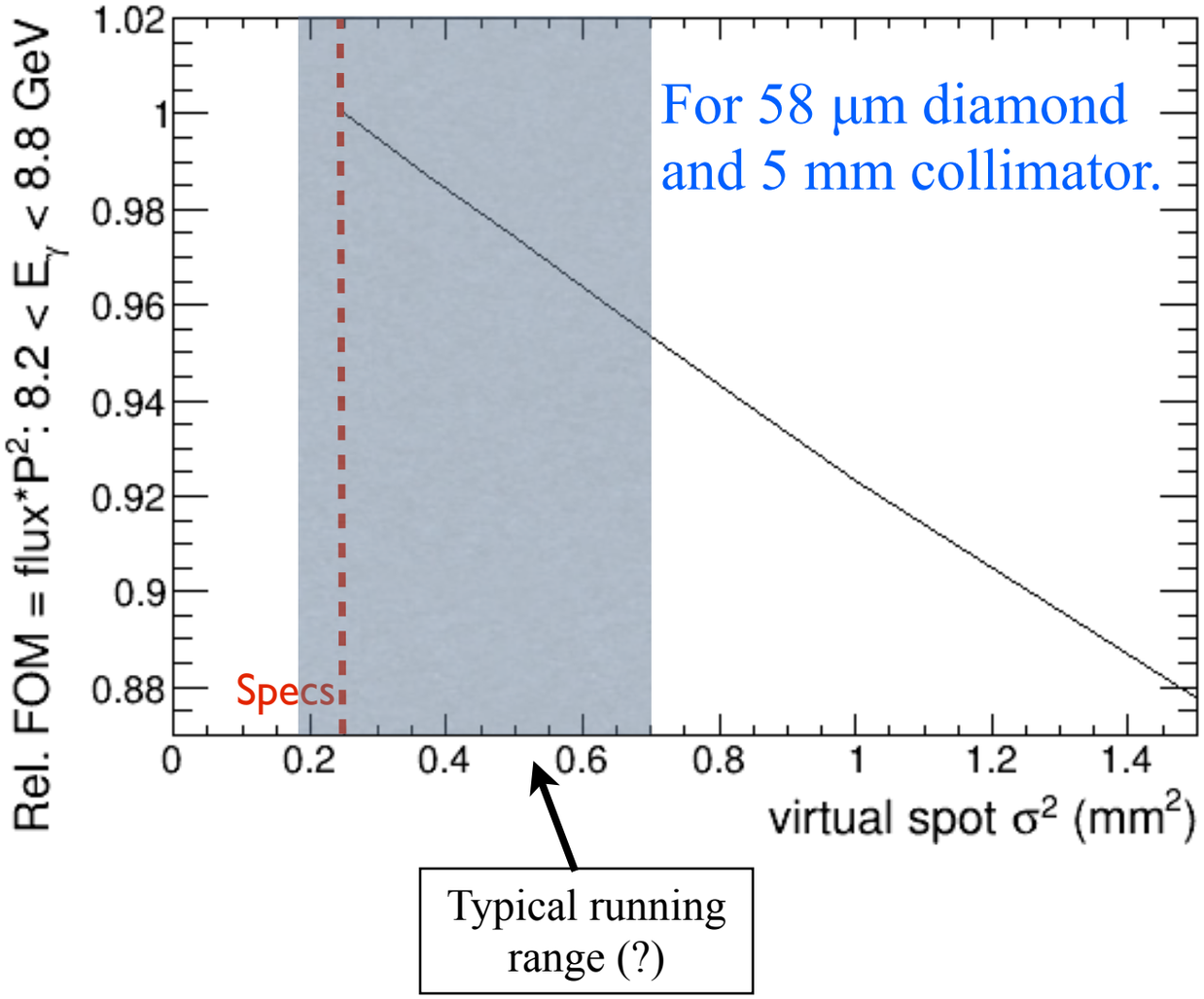


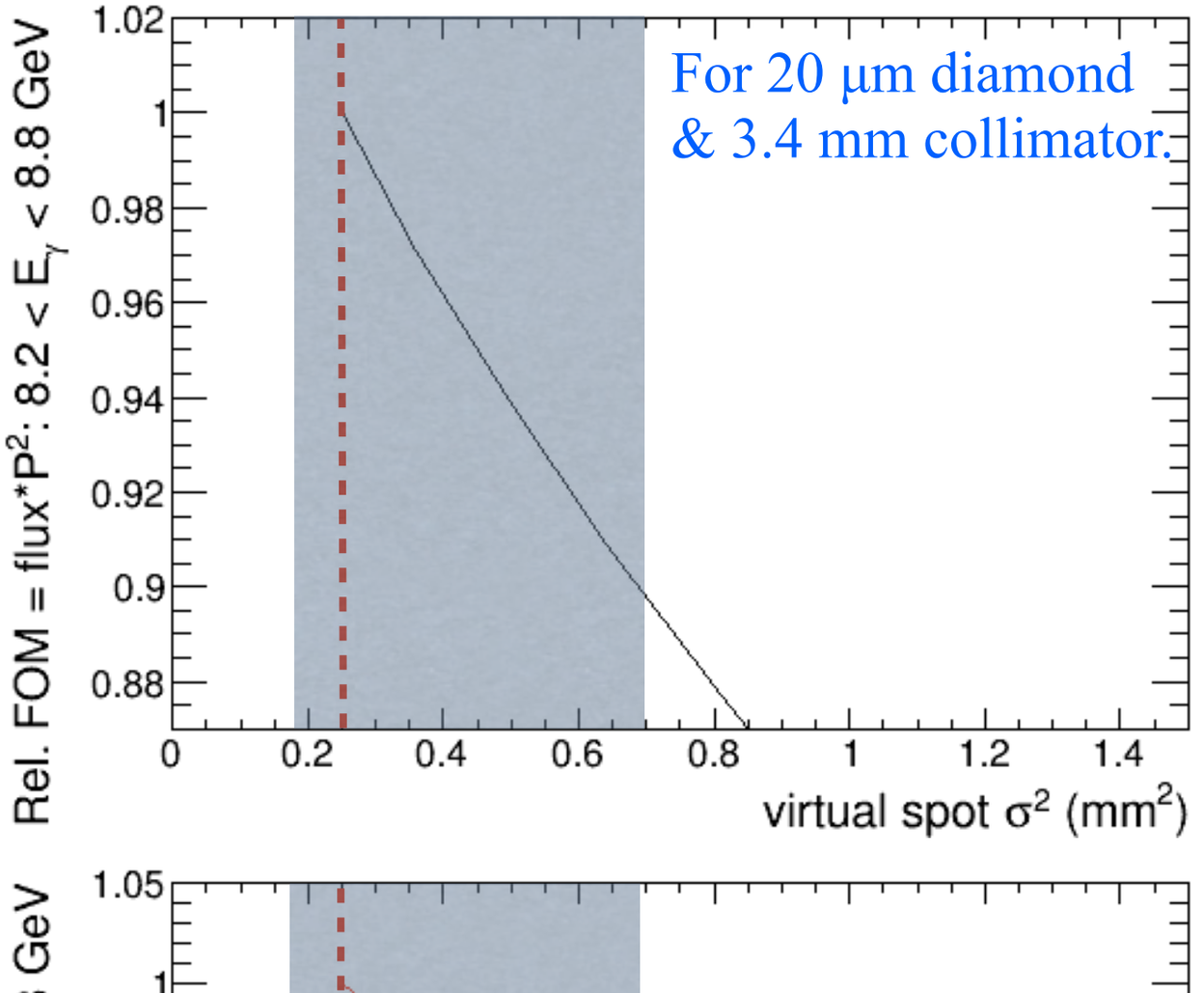


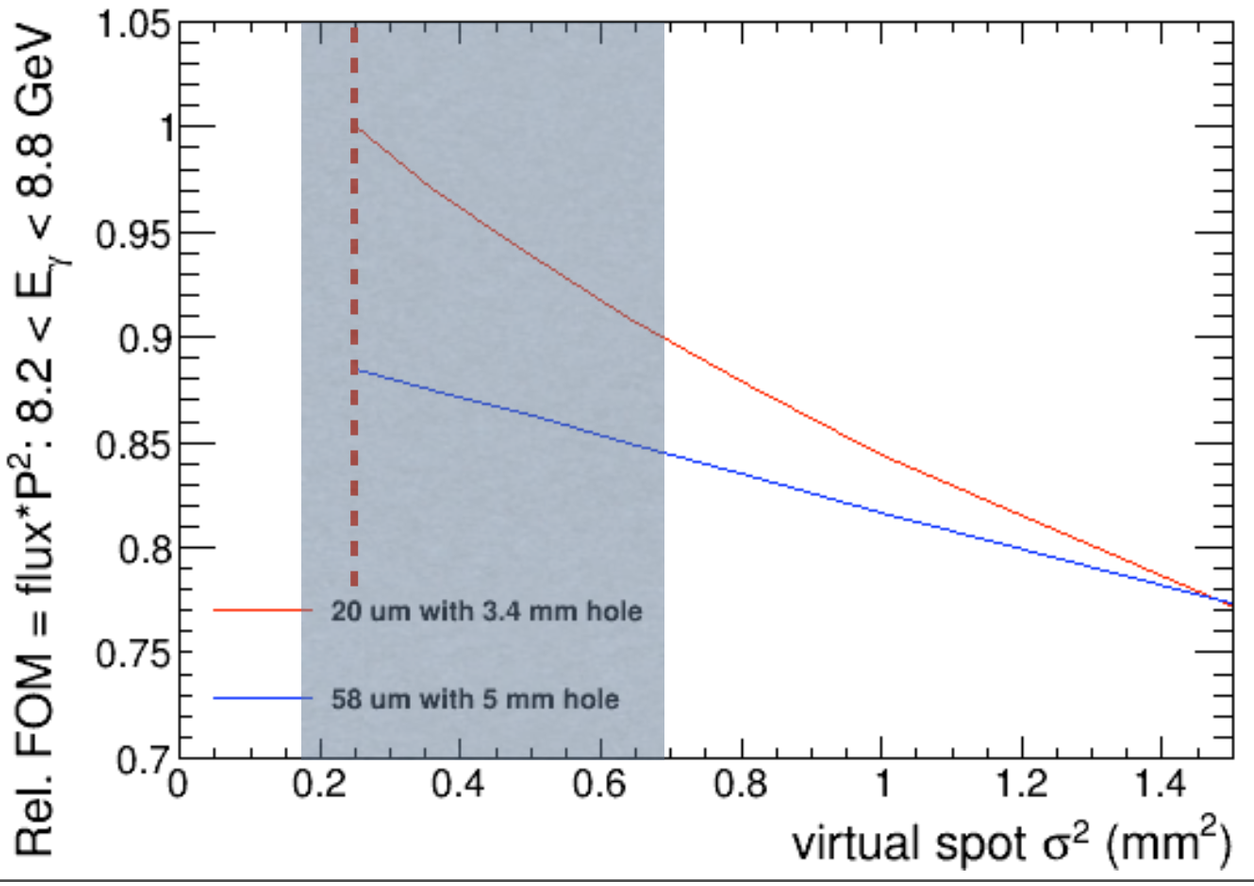
7% decrease ⇒ Start being worth re-optimizing every day.

Same assumption as previous slide.

Figure of merit study







Conclusions (open for discussions)

- Beam spot size on collimator degrades at a scale of ~day.
  - Possible causes investigated and will be act upon for next runs.
  - Presently no good (parasitic, fast and reliable) diagnostic to get beam spot size. Several methods are being explored.
  - Optimization procedure exists and is relatively fast. Did not work systematically (operator training, poor initial beam tune)
  - Daily monitoring with Harps justified and adequate.

- F.O.M study shows that, given Spring 2018 condition), optimizing every few days is beneficial.

- Transmission drop of ~15% seems too much to be explained by spot size degradation, although correlation is seen. Confirmed by optimization helping only partially.