Tuning ATF2 at lower IP betas, goals and troubles

R. Tomás, S. Bai P. Bambade and Y. Renier

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Motivation I: The proposal

A R&D proposal has been recently submitted to ATF:

"Exploring ultra-low β^* values in ATF2"

P. Bambade, Y. Renier, *LAL (France)*
S. Bai, *IHEP (China) and LAL (France)*
H. Braun, J.P. Delahaye, D. Schulte, R. Tomás,
F. Zimmermann, *CERN (Switzerland)*
J. Gao, D. Wang, X.W. Zhu, *IHEP (China)*
Y. Honda, S. Kuroda, T. Okugi, T. Tauchi, J. Urakawa,
KEK (Japan)
A. Seryi, M. Woodley, *SLAC (USA)*
D. Angal-Kalinin, J. Jones, A. Scarfe, *CI (UK)*

Motivation II: Tuning difficulty

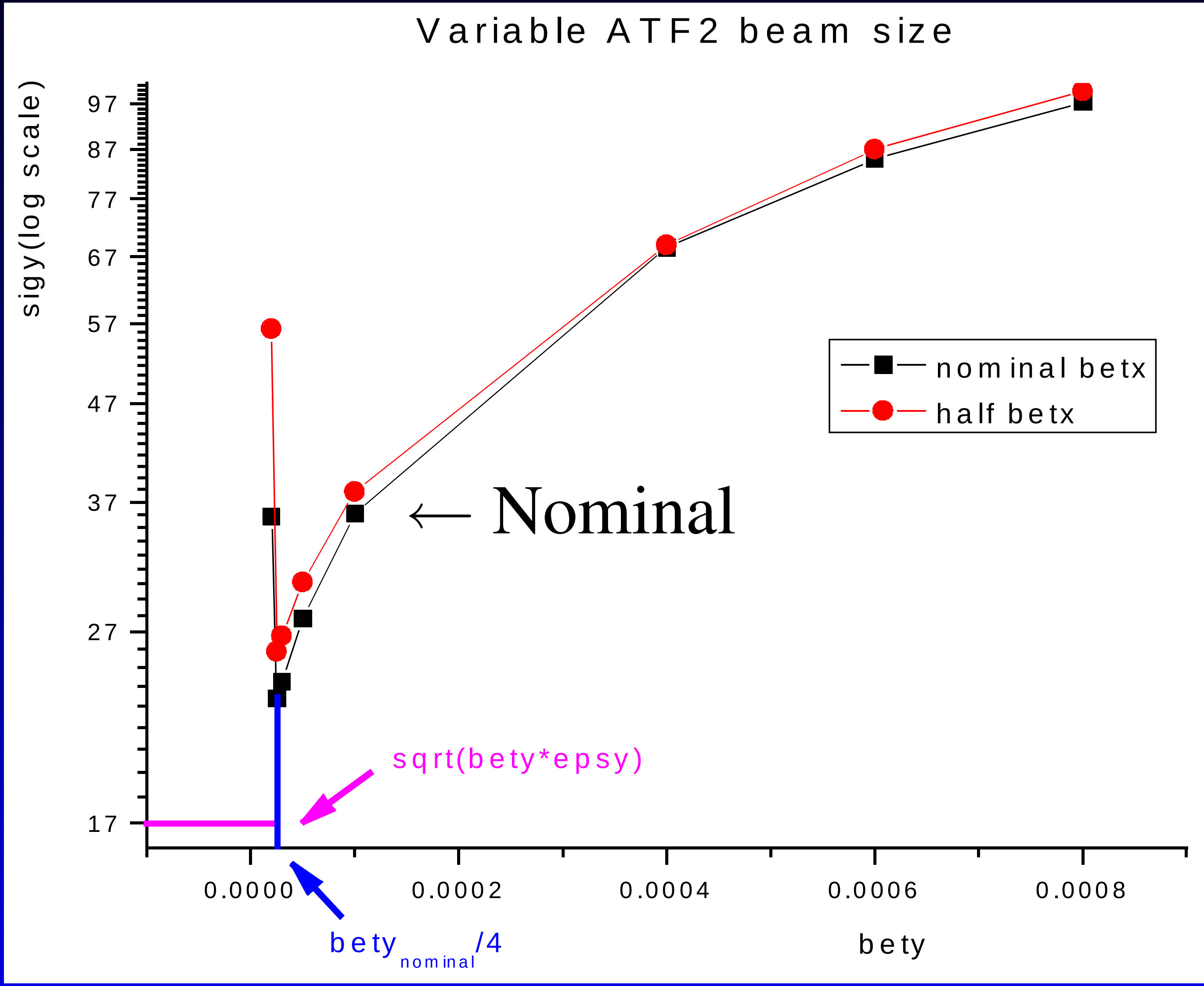
Project	Status	σ_y^* [nm]
FFTB	Measured	70
ATF2	Design	37
ATF2 pushed	Proposed	<26
ILC	Design	6
CLIC 500GeV	Design	3

Does tuning difficulty scale as ${\sigma_y^*}^{-1}$?

Both ILC and CLIC need as low ATF2 σ_y^* as possible.

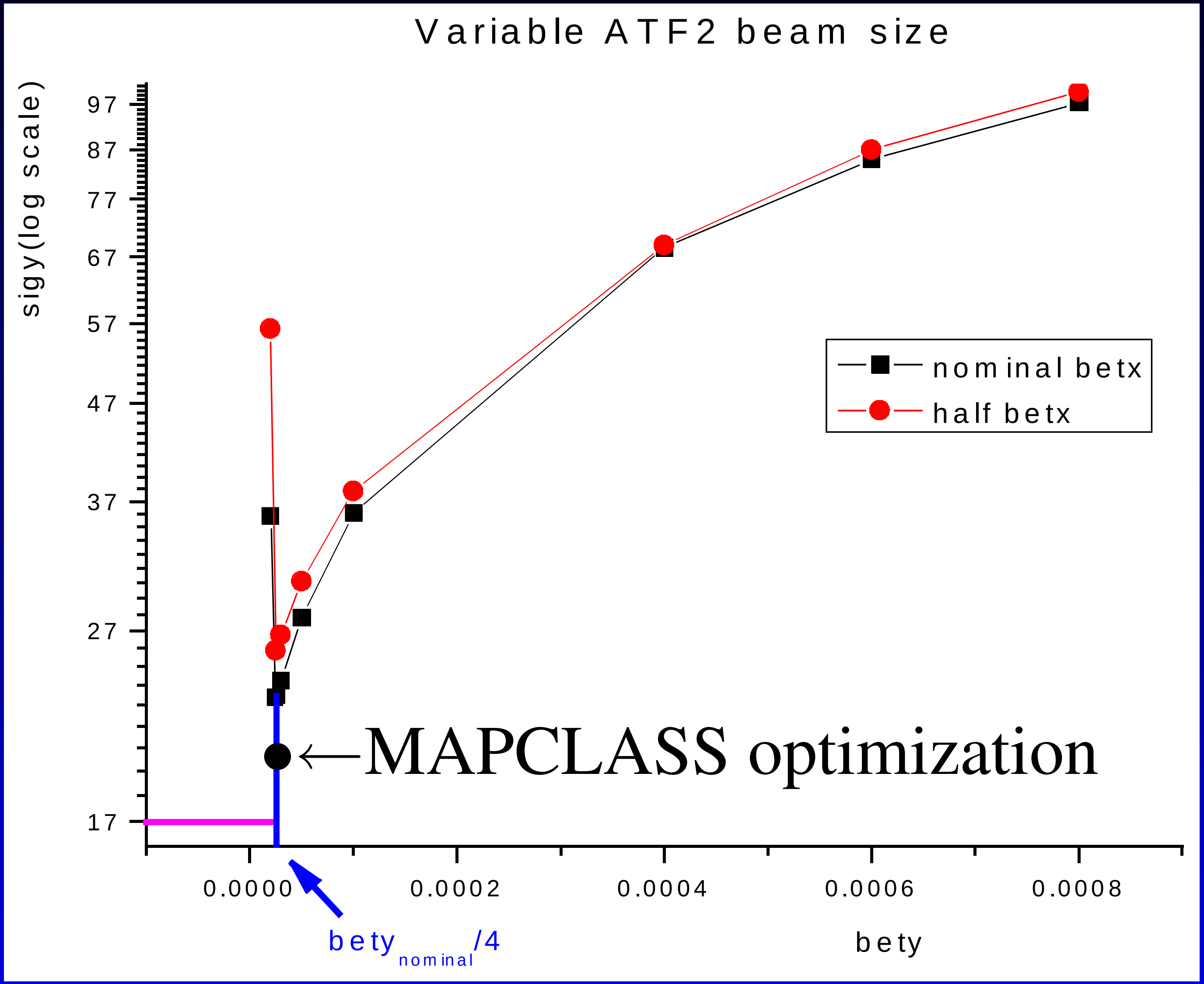
What is the minimum achievable σ_y^* in ATF2?

Sha and Philip's first β_y scan



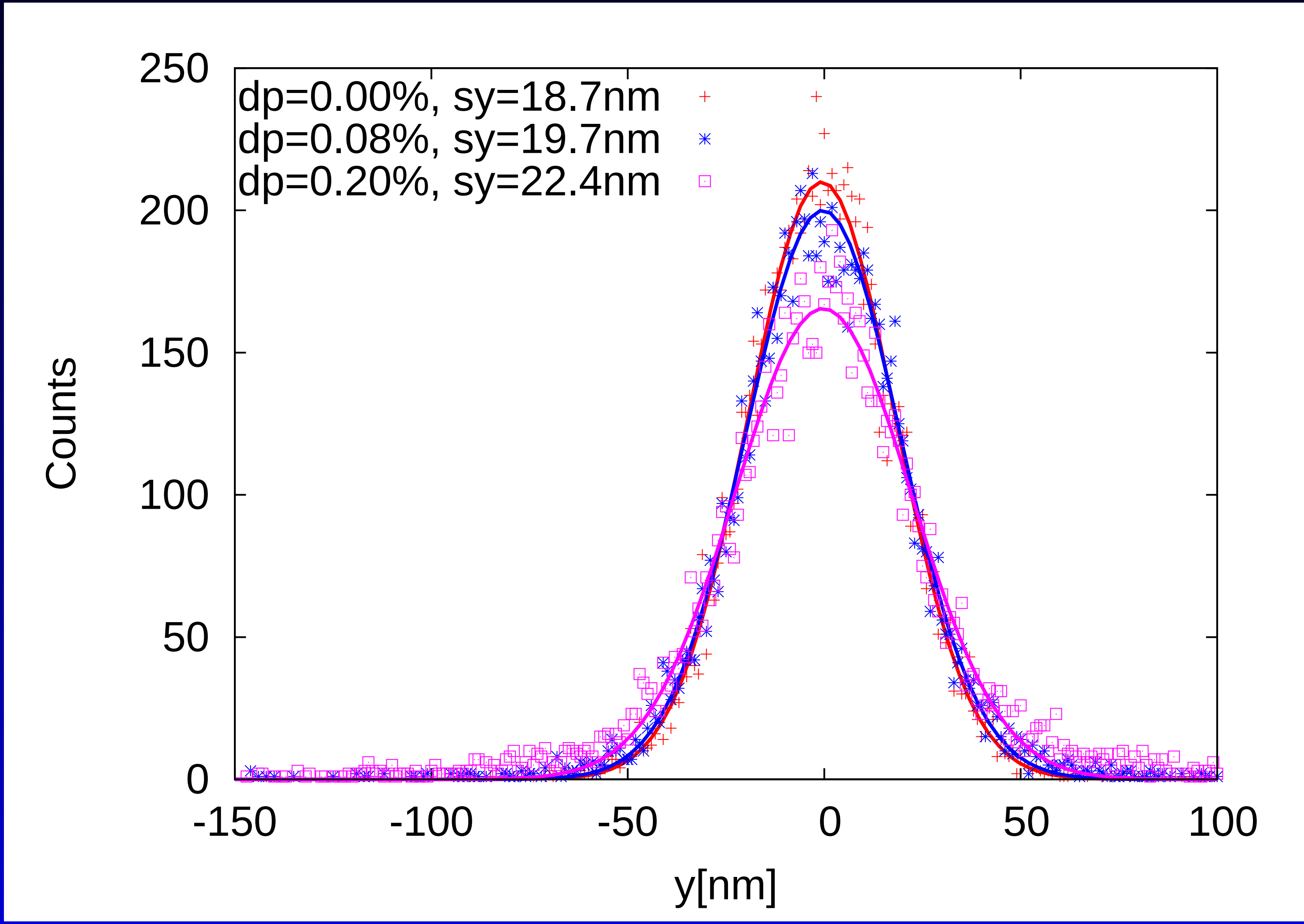
Could we push a bit more?

On-going optimization with MAPCLASS



Sha is still looking into further improvements...

Some tracking for β_y=0.025mm



Tuning versus β_y

A 0-th order tuning algorithm based on the Simplex:

- Observables: σ_x and σ_y at IP.
- Variables: Magnet strengths, x, y and tilt displacements.
- Code: PLACET-Octave
- Ingredients:
  - realistic errors
  - ground motion
  - convergence reached when σ_y <X for 3 measurements, or maximum number of iterations.
- We try this on the Nominal and $\beta_y/2$ cases.

Simulation ingredients

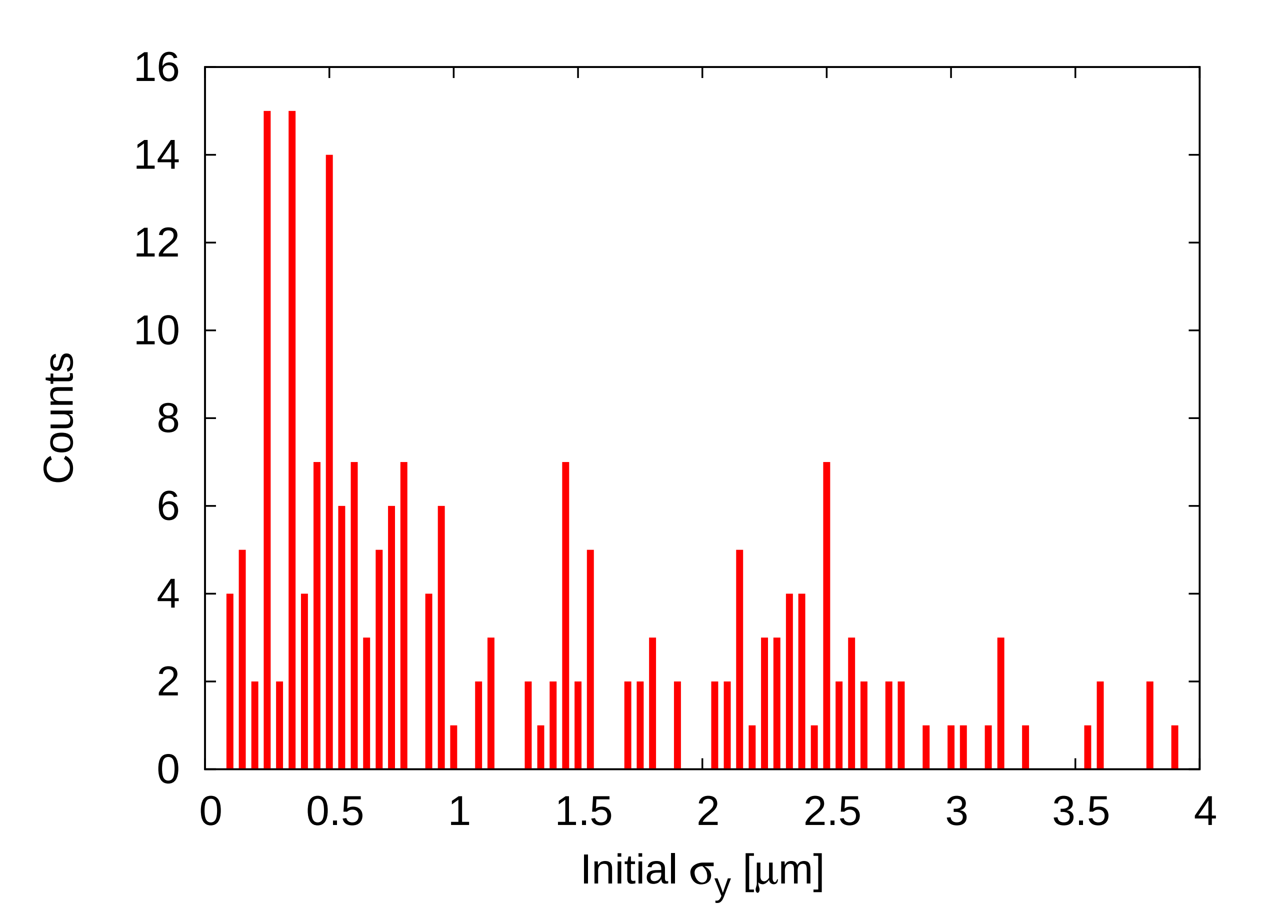
Errors:

- H & V misalignments with $\sigma = 30\mu$m.
- Transverse roll with $\sigma = 30\mu$rad (too low, sorry)
- Relative strength error with $\sigma = 10^{-4}$.
- Measurement error of σ_y, σ=2nm.

Missing ingredients:

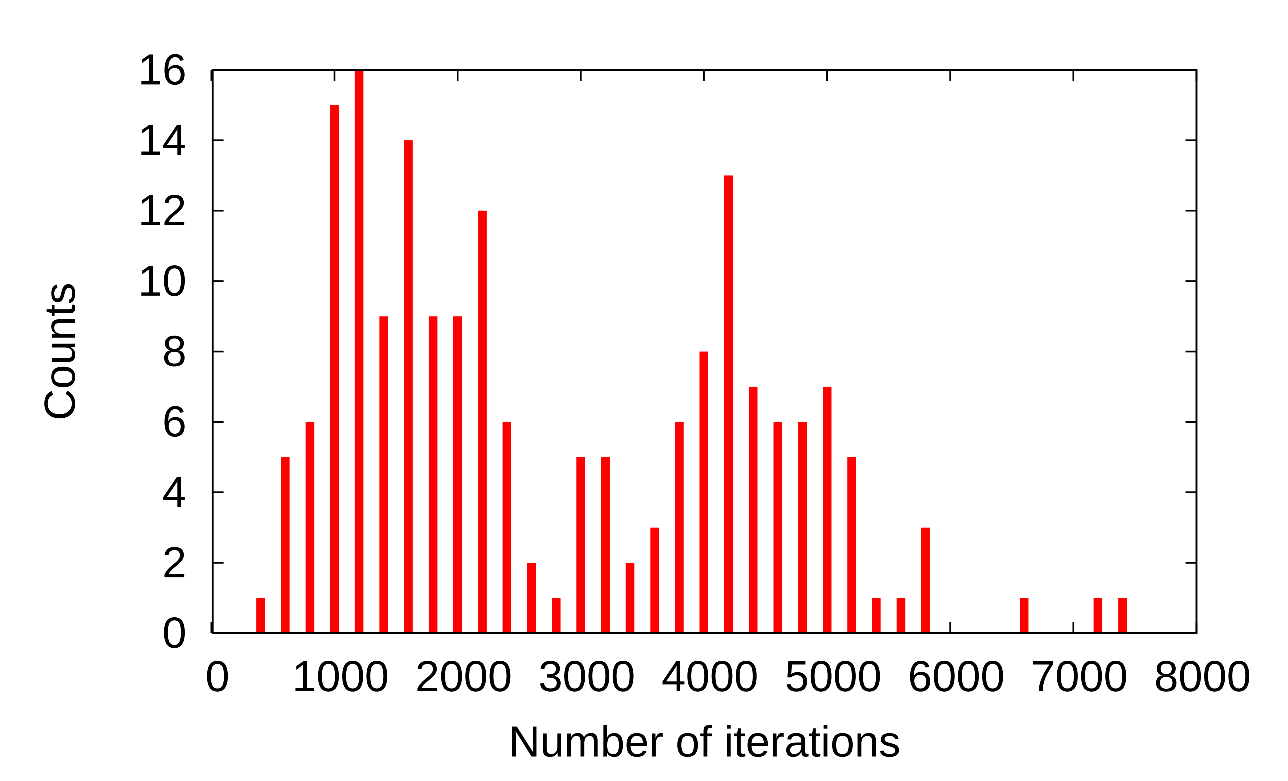
- Beam jitter
- Mover step size
- (which could become the limiting factors!)

Initial σ_y for 150 seeds



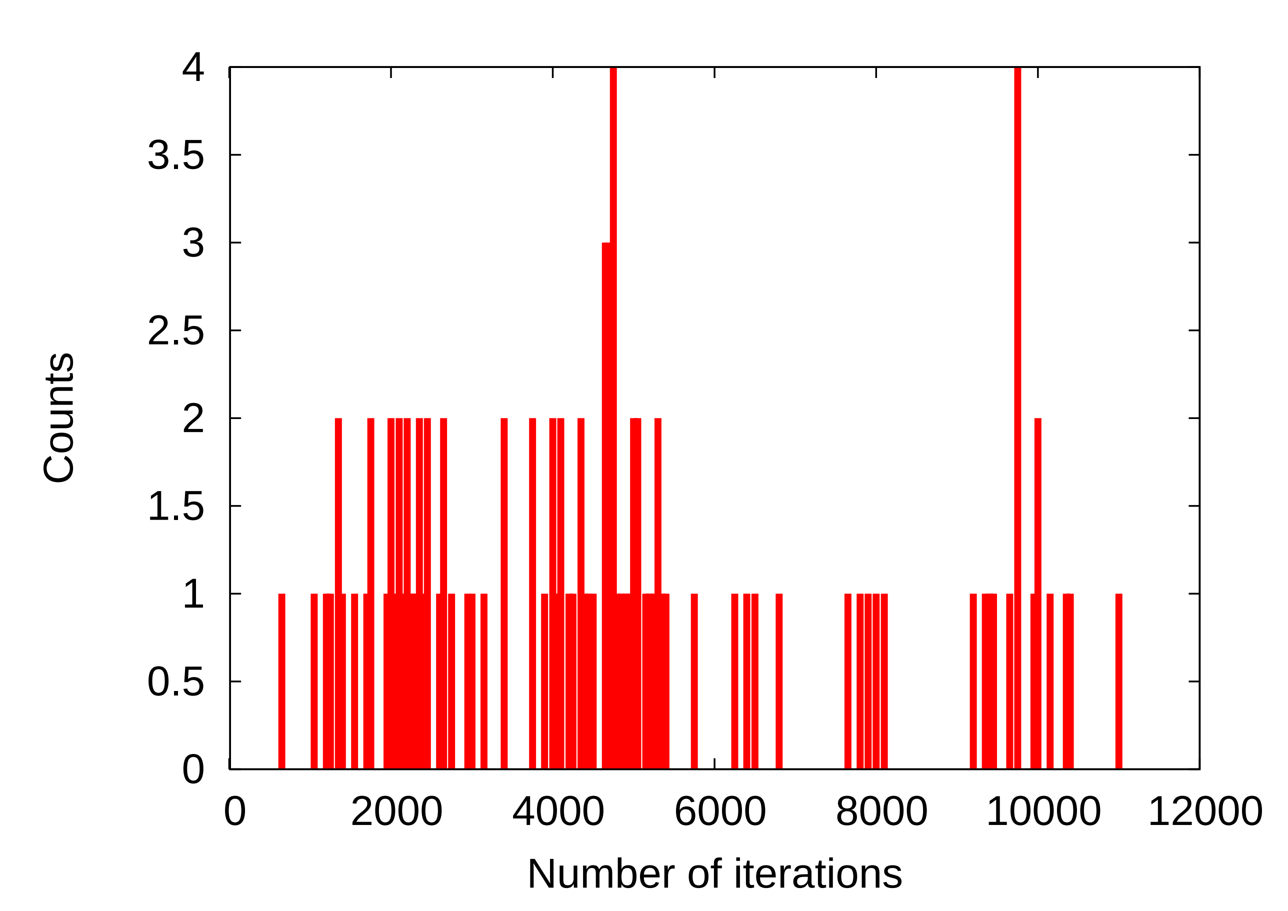
Up to 4μm of initial σ_y.

Number of iterations for β_y=0.1mm



Below 8000 iterations required.

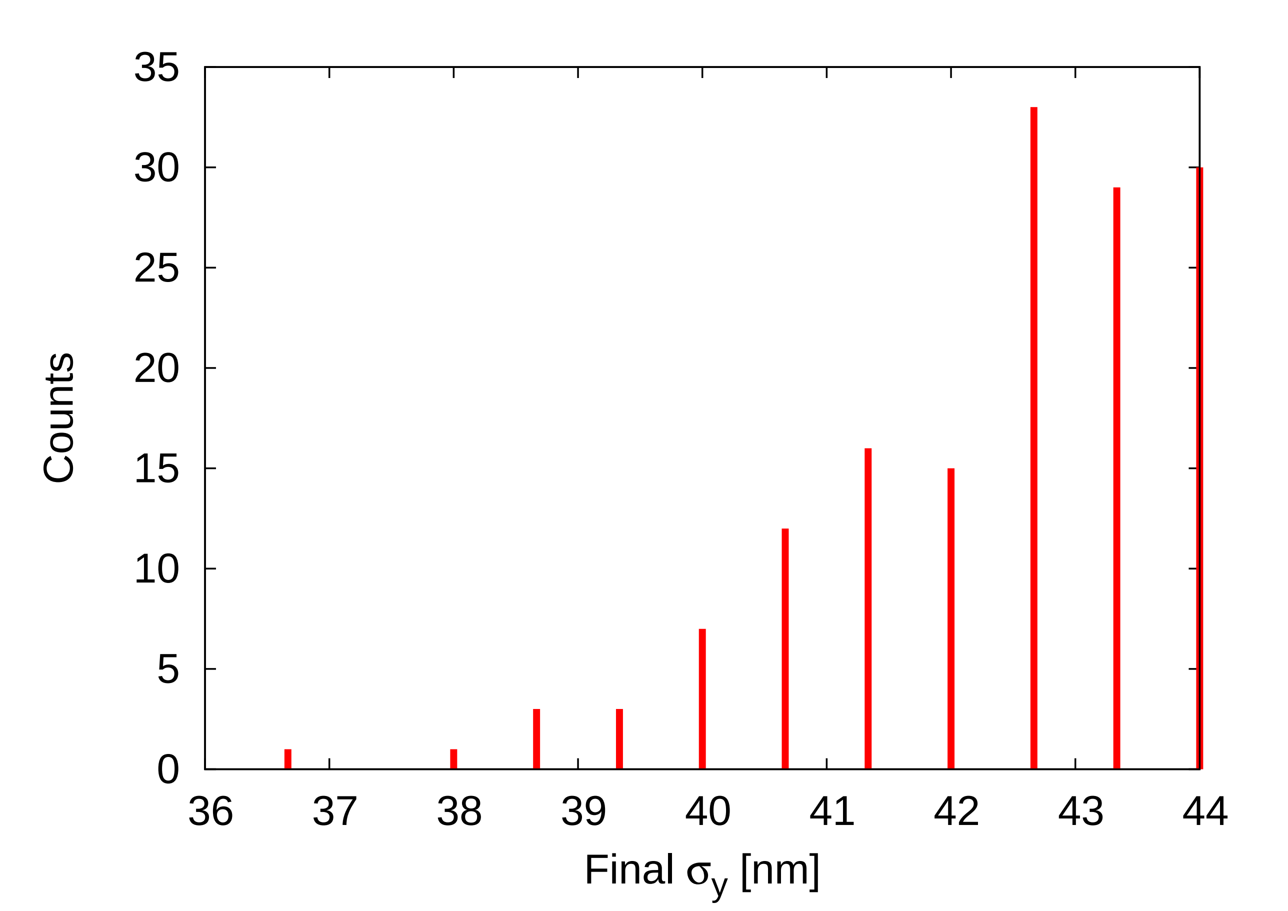
Number of iterations for β_y=0.05mm



Below 12000 iterations required but maximum is hit.

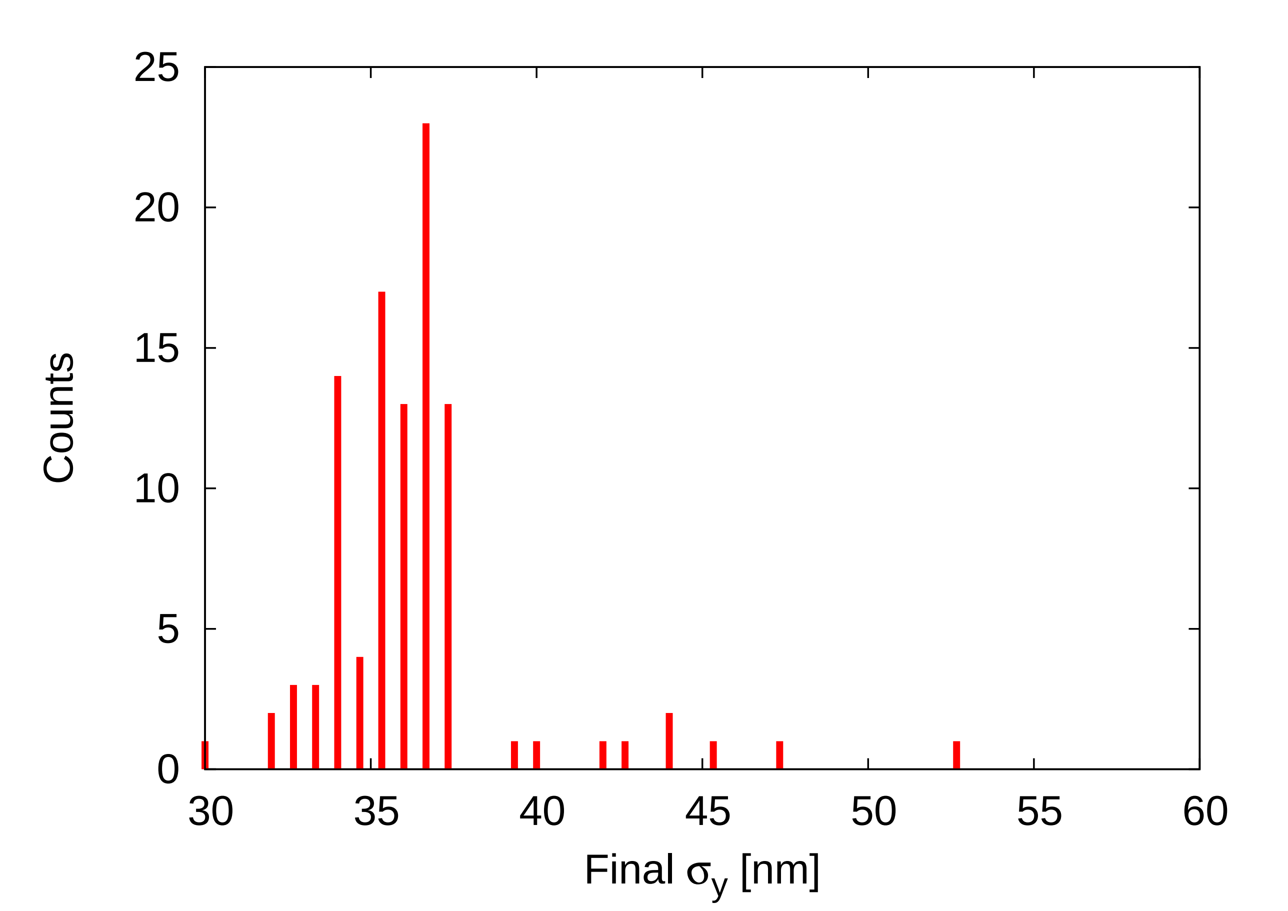
More iterations are required for lower β.

Final σ_y for β_y=0.1mm



Final σ_y between 37 and 44nm.

Final σ_y for β_y=0.05mm



Some seeds fail to finish between 30 and 37nm and one seed even stops at 53nm!!

More sophisticated tuning algorithms are required for lower β (which Glen or Yves might already have).

Remarks

- $\sigma_y \approx 20$nm has been reached in design respecting magnet powering and aperture constrains in ATF2.
- Shintake monitor has a measuring range between 25nm and 5μm, just a bit offside.
- However reducing β_x might increase halo at Shintake monitor.
- New larger superconducting quadrupoles could fix this problem,
- or beam could be collimated.
- Further studies are required.

Summary

- Lower β^* increases tuning difficulty
- ATF2 is the unique chance to learn how difficulty scales with σ_y in a real machine
- Tuning simulations are required: more realistic and sophisticated algorithms.
- Hope that within the framework of the new open collaboration a wealth of simulations is produced.
- A web page is being set-up to ease communication

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