Preliminary Simulation of beta matching in Extraction Line

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2008.10.22

Procedure

- Use perfect Extraction Line
- Set initial mismatch
  - At entrance of EXT, set beta and alpha
- Simulate emittance and beam (Twiss) parameter measurement
  - Multi-wire or
  - Quad scan
- Change quads in EXT line for matching at EXT exit
  - Look at B_mag
  - Look at beam size at IP (with perfect FF line).

Initial mismatch

- Two cases of B_mag
  - B_mag=1.2 and B_mag=2

$$2B_{mag} = \beta_0 \gamma + 2\alpha_0 \alpha + \gamma_0 \beta$$

$$= (\beta_0 < x'^2 > + 2\alpha_0 < xx' > + \gamma_0 < x^2 >)/\varepsilon$$

  - Three cases for each Bmag

$$\beta = \beta_0, \quad \beta = \beta_0(B_{mag} \pm \sqrt{B_{mag} - 1})$$

This may not be realistic. (?)

Simulation of multi-wire measurement

- Tracking using SAD. 40000 macro-particles
- 5 wires (MW0X ~ MW4X)
- Error of beam size measurement
  - Absolute + relative

  $$a_{x(y)} + r_{x(y)}\sigma_{x(y)}$$

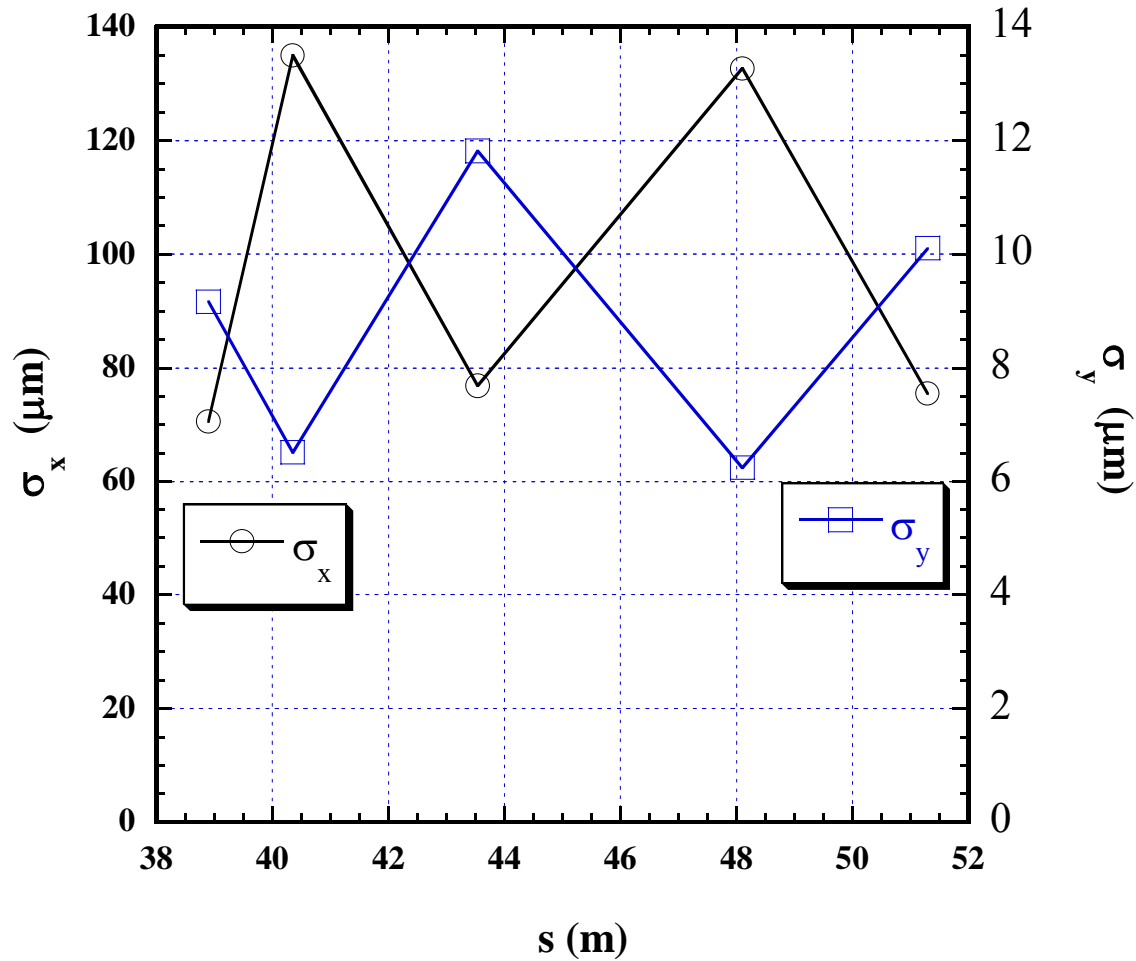 $$\text{standard}: a_{x(y)} = 1\,\mu\text{m}, \quad r_{x(y)} = 0.03$$

- Dispersion at each wire is set by hand

  $$\text{standard}: \eta_x = 10\,\text{mm}, \text{ error of } \eta_x = 3\,\text{mm}$$

  $$\eta_y = 3\,\text{mm}, \text{ error of } \eta_y = 1\,\text{mm},$$

- 100 random seeds for errors
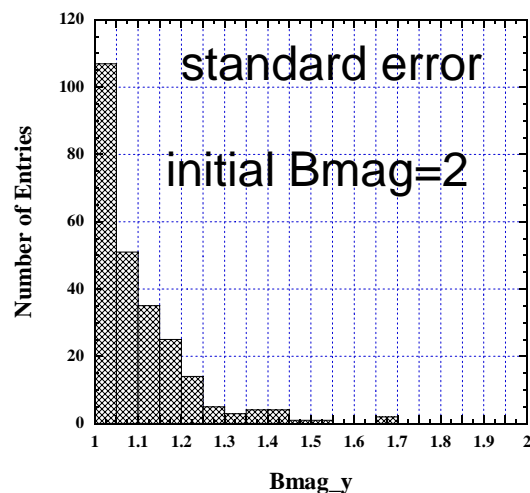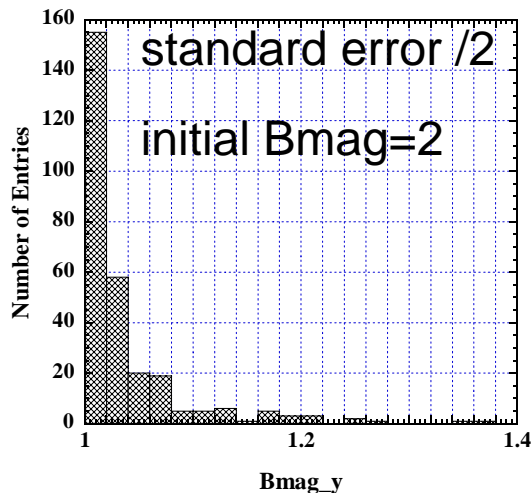- Emittance and Twiss-parameters are fitted.
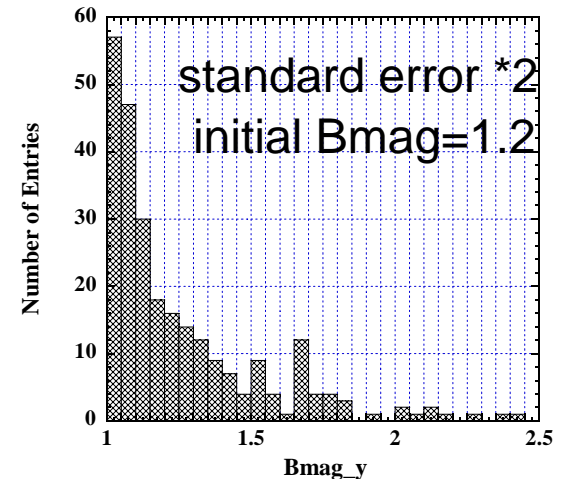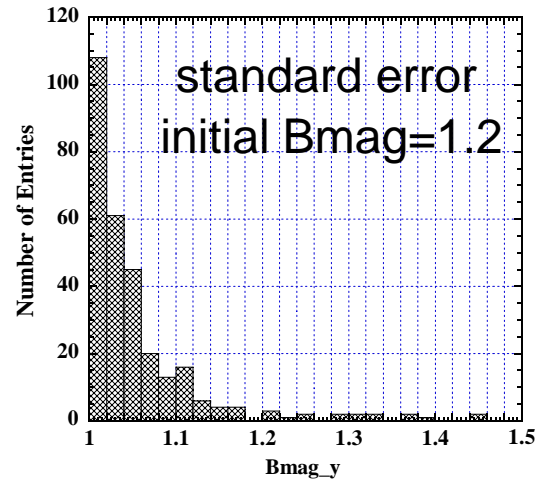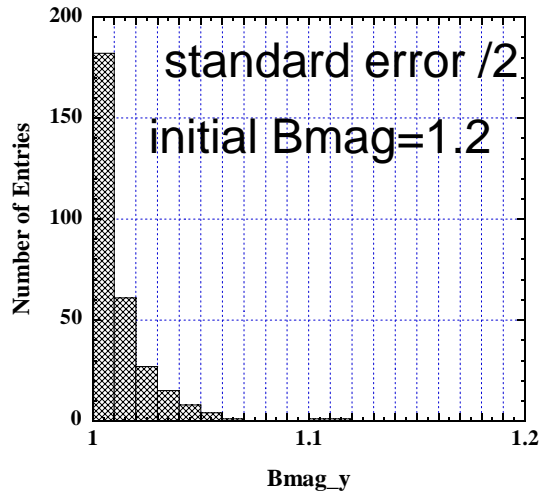
Beam size at wires, no error

Set Quads for matching

- From fitted beam parameters, calculate strengths of QF9X ~ QD14X for matching at the end of EXT line (entrance of FF line)
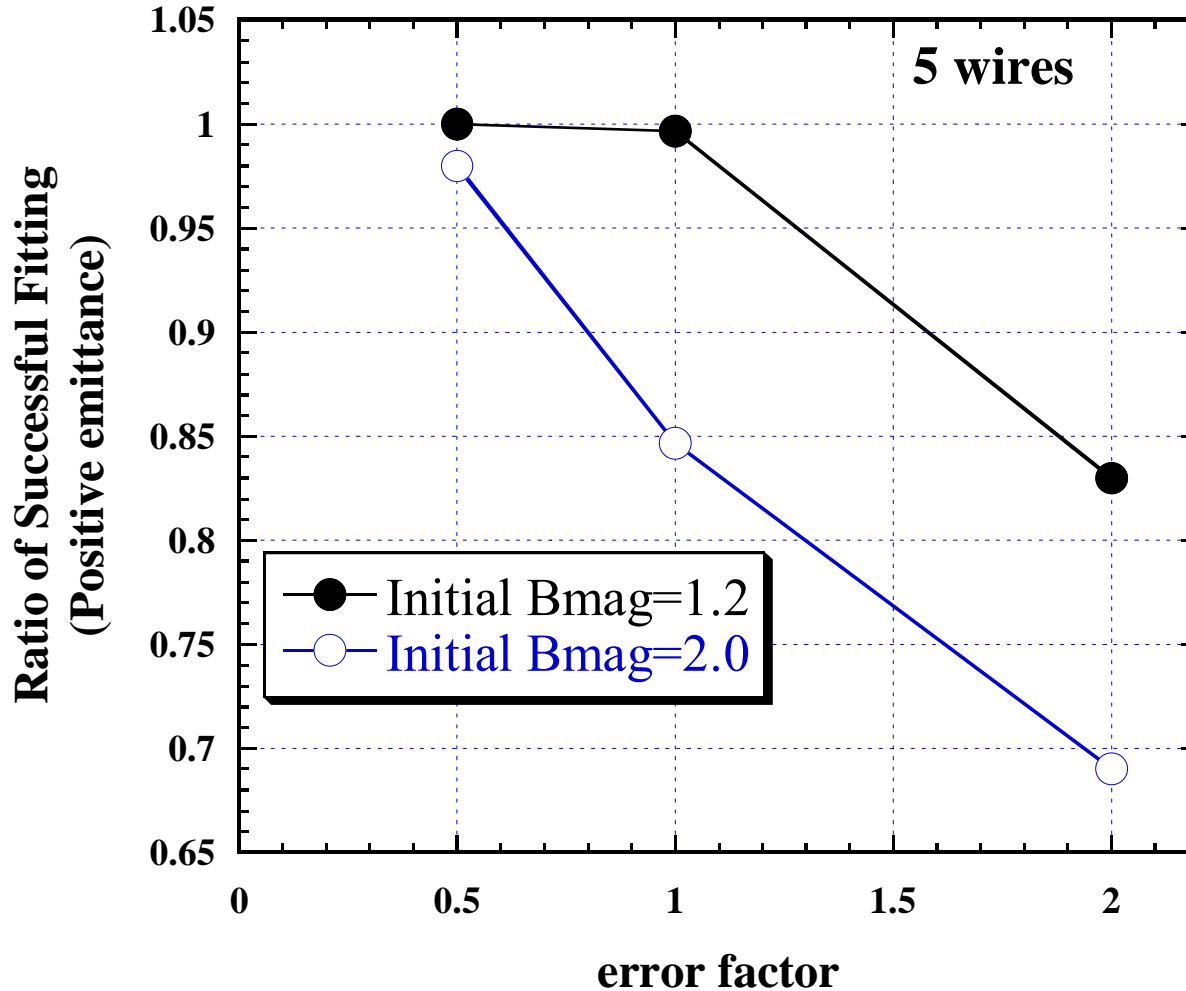- Command "fit" of SAD is used.

Result of multi-wire simulation
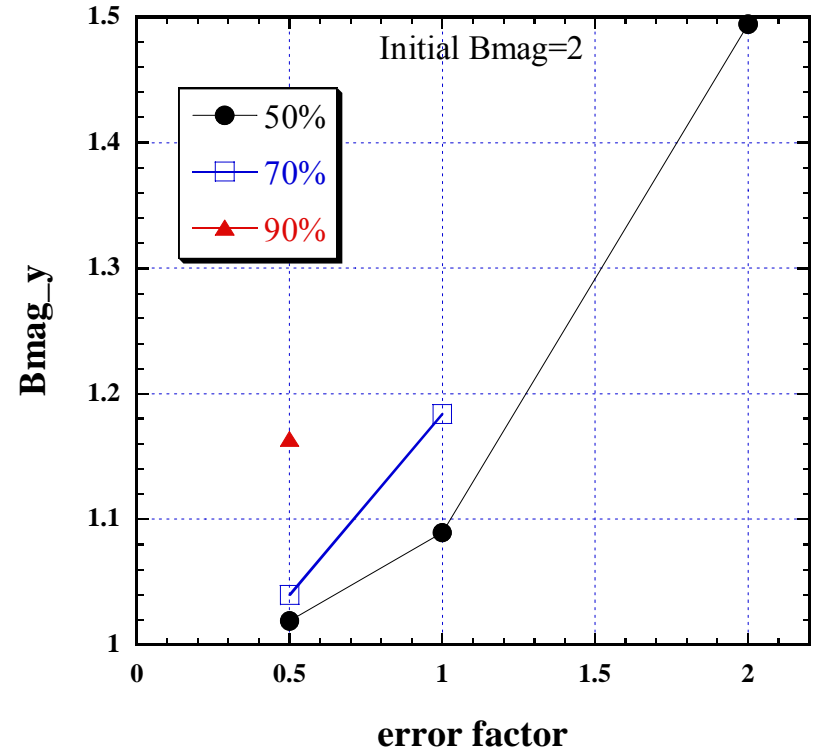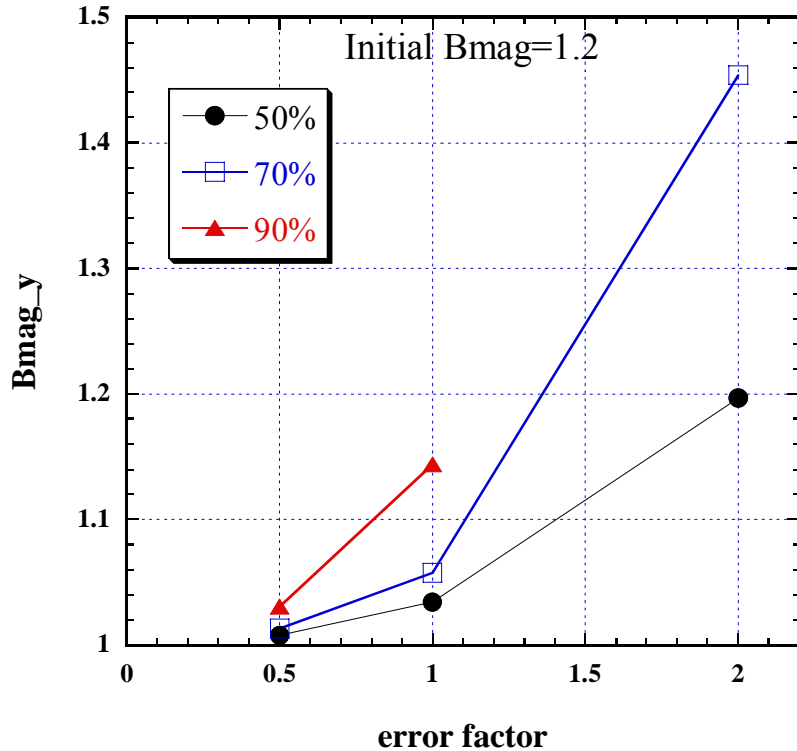## Distribution of Bmag after matching correction

Fitting deos not give
positive emittance
for some random seeds,
in the large error cases.
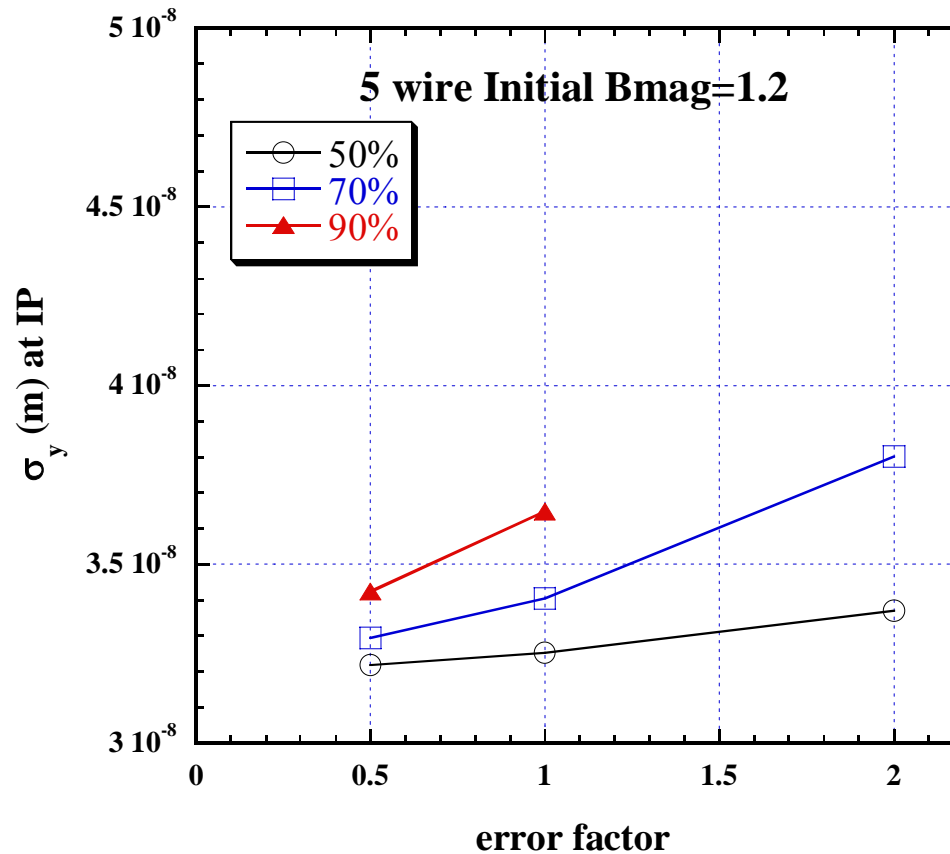
Ratio of successful fitting
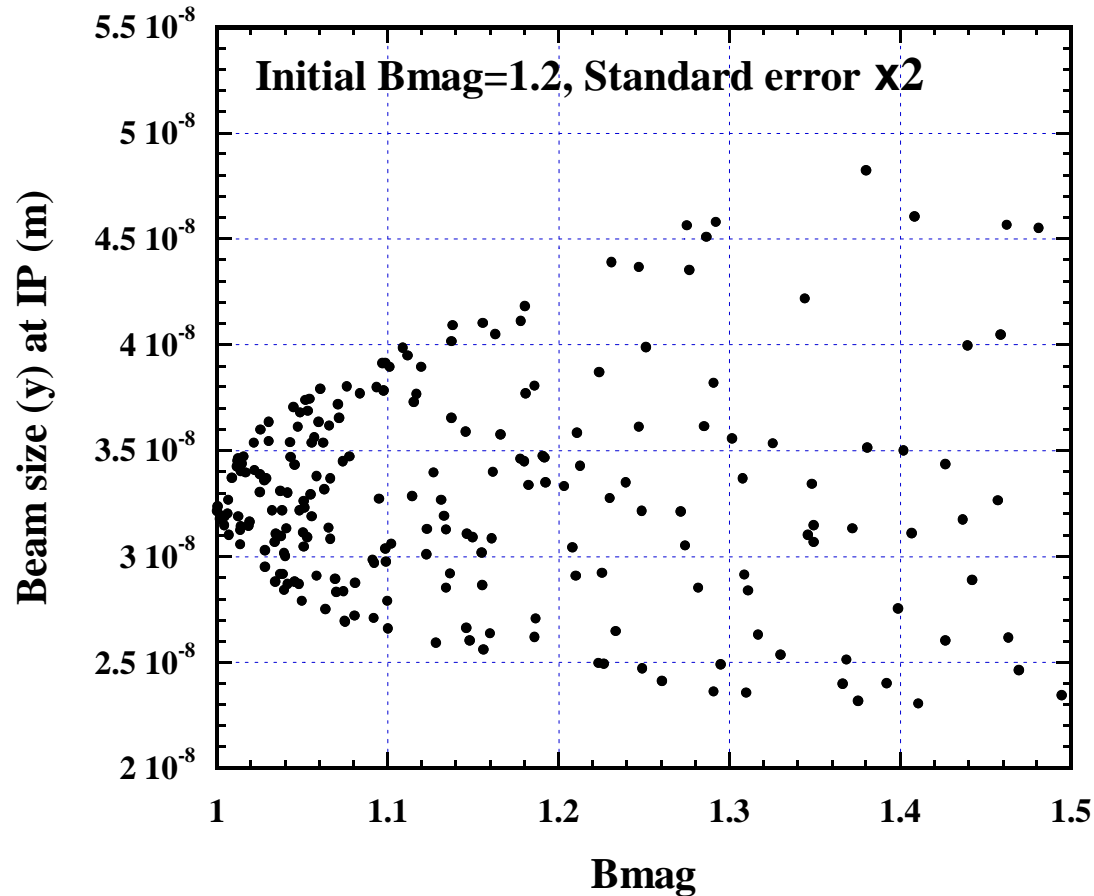
Bmag_y after matching correction (5-wires)

Standard error seems too large. 1/2 seems fine.

Beam size at IP
after matching correction (5-wires),
Perfect FF line

Bmag vs. Beam size at IP (perfect FF line)

Simulation of Quad scan measurement

- Tracking using SAD. 40000 macro-particles
- Scan Quad: QD20X, Wire: MW3X
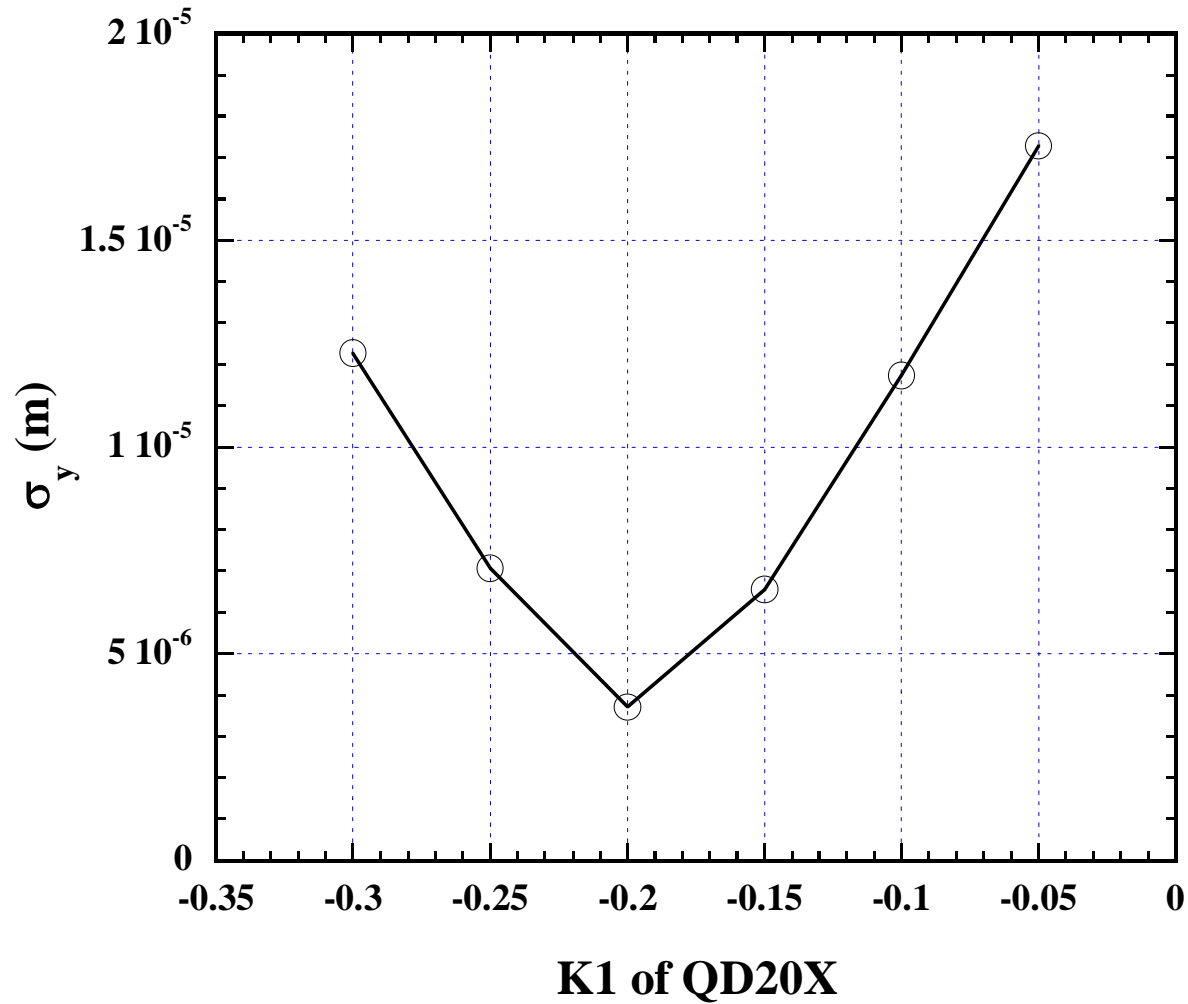- Error of beam size measurement (same as multi-wires)
  - Absolute + relative

$$a_{x(y)} + r_{x(y)}\sigma_{x(y)}$$

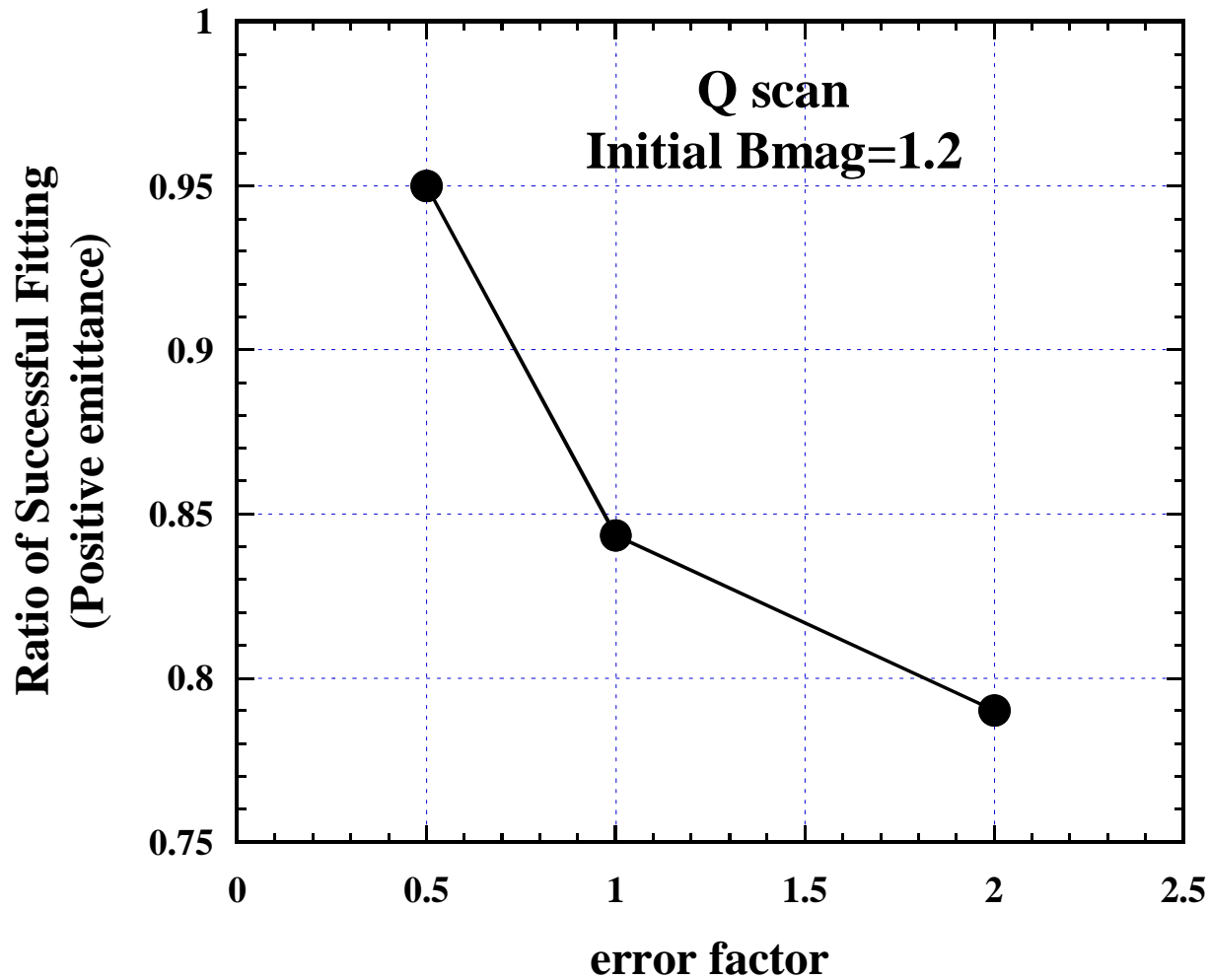$$\text{standard}: a_{x(y)} = 1\,\mu\text{m}, \quad r_{x(y)} = 0.03$$

- No dispersion at the wire
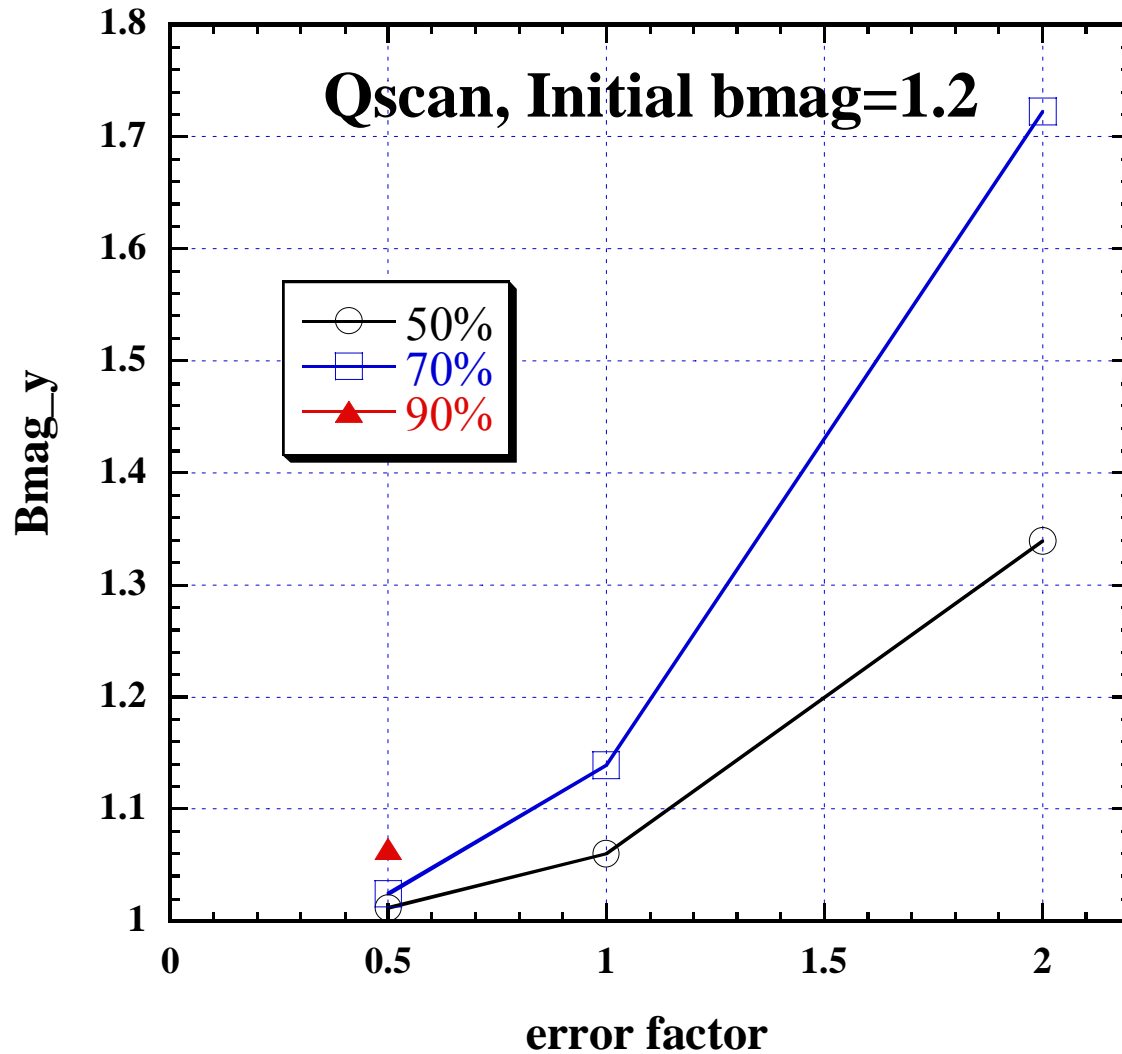- Emittance and Twiss-parameters are fitted.

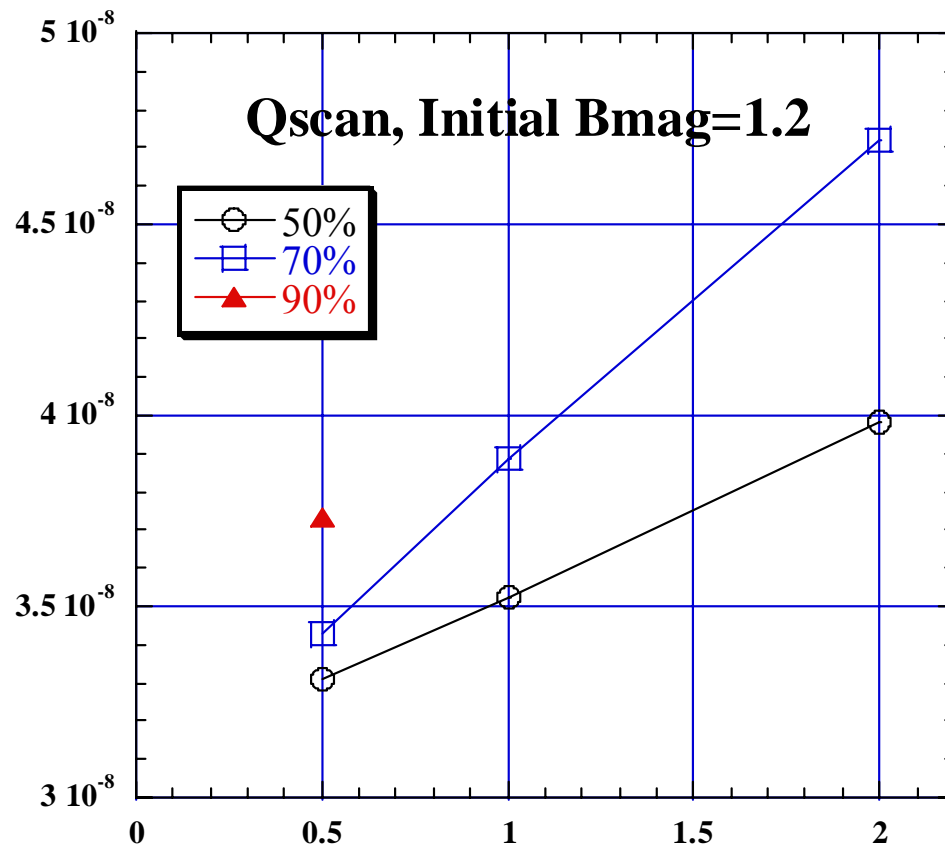# Quad scan measurement
Without errors

Ratio of successful fitting

Bmag_y after matching correction (Q scan)

Beam size at IP
after matching correction (5-wires), Perfect FF line

Summary

Simulation of beta-matching was performed:

- Multi-wire method (5 wire scanners)
- Quad scan method

- Dependence on beam size error was looked.

- Bema size resolution ~0.5 micron is desirable

- Both methods will be fine for good bema size measurement. But multi-wire method is less sensitive to beam size error.

- Results may depend on detailed parameters.

More works

Simulations: (We may learn from experiment first ???)

- Realistic (?) setting of initial (and induced in EXT) mismatch.

- Include misalignment, orbit, dispersion, field errors, etc..

For operation, beam test

- Prepare software for operation