Beam halo study using YAG/OTR monitor

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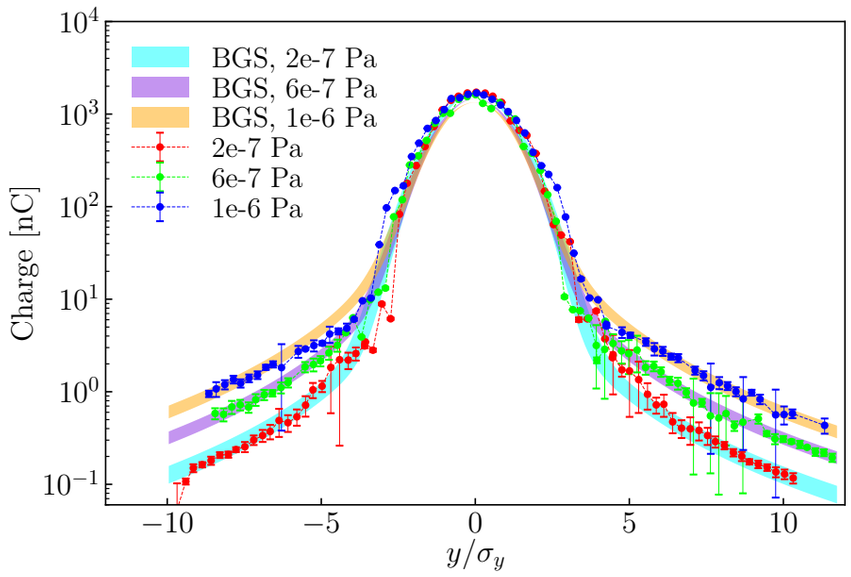
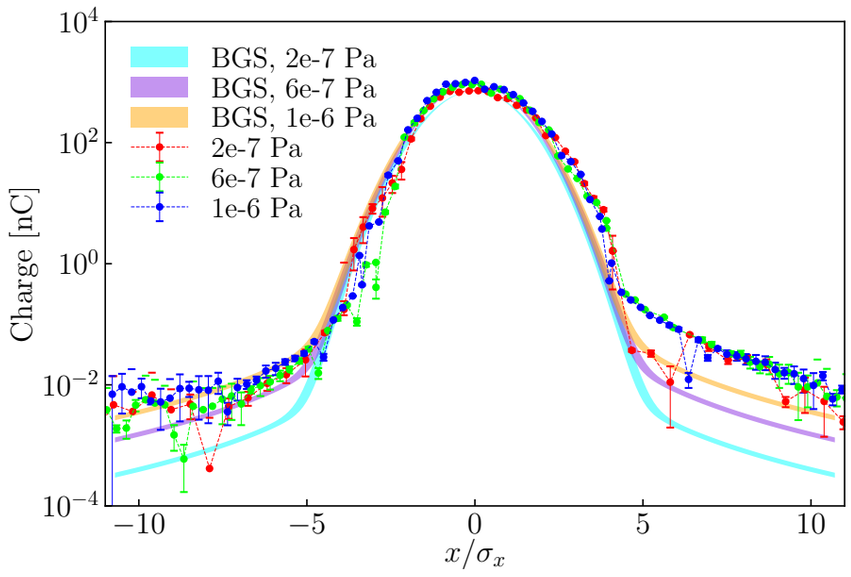
Vertical beam halo study with DS

- Vertical beam halo: elastic BGS in the DR
  Good agreement between simulation and DS data + vacuum dependence
- Hor. beam halo: under investigation
  Not BGS processes, chromaticity & aberration in FF or secondary particles





Evaluation of Beam Halo from Beam-Gas Scattering at the KEK-ATF*

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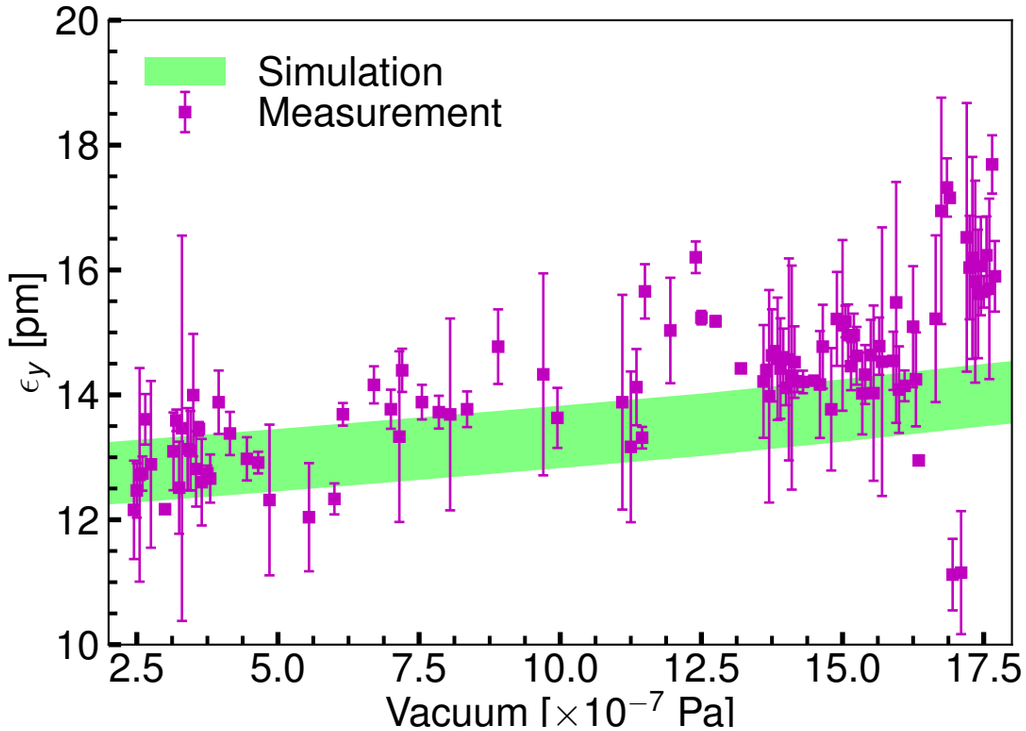
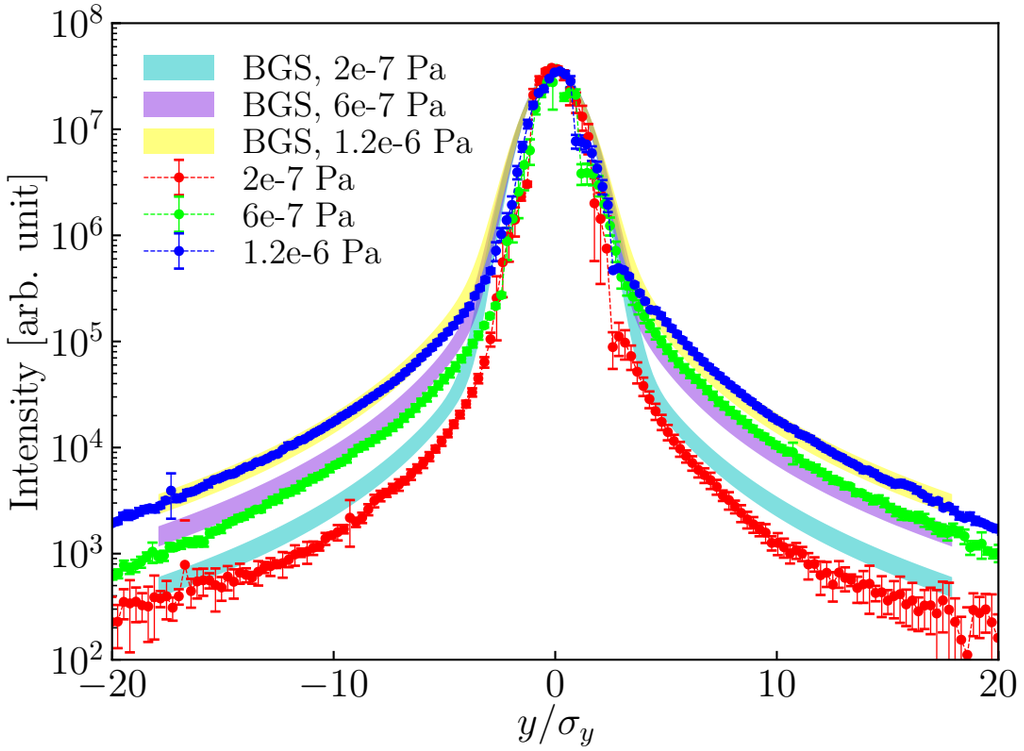
- Result submitted to PRAB

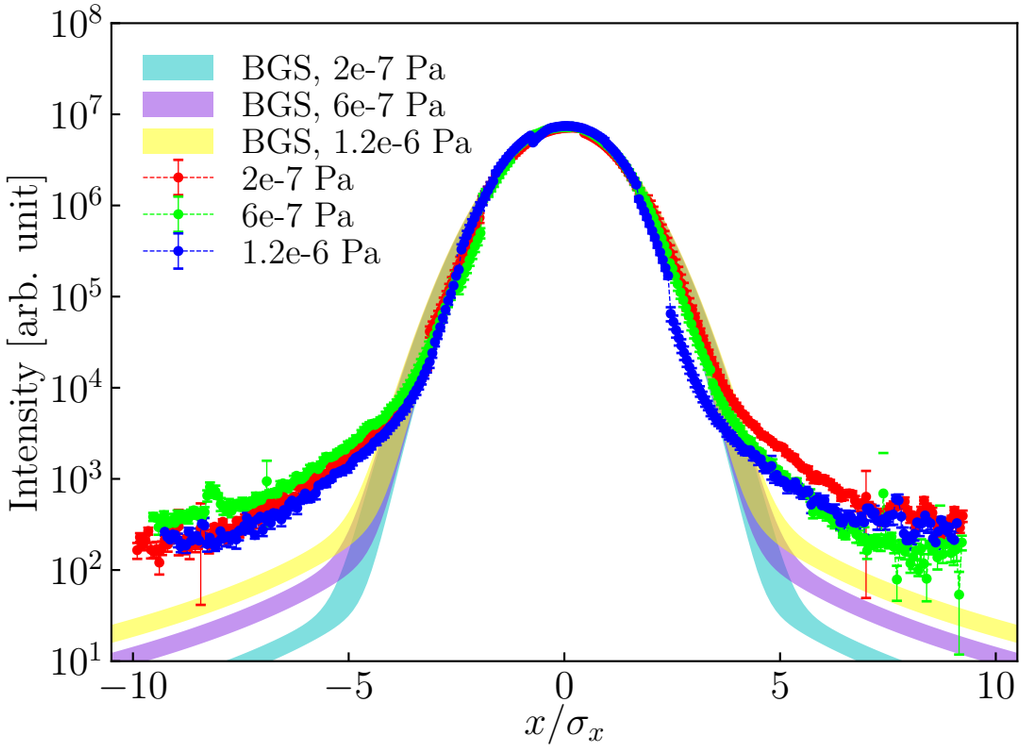
1. Visualisation of transverse beam halo

Transverse beam profile by YAG

- DR vacuum: adjusted by on/off SIP
- Ver. halo
  - increases for the worsened vacuum
- Ver. emittance
  - diluted for bad vacuum (BGS)
- Hor. halo
  - higher than BGS prediction
  - insignificant vacuum dependence
- Consistent with DS measurements!



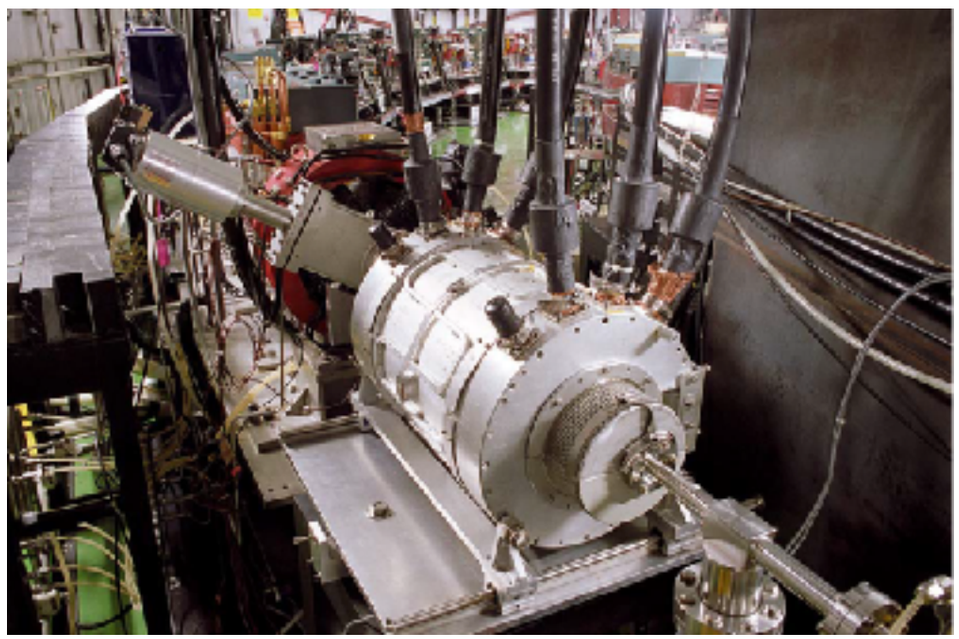


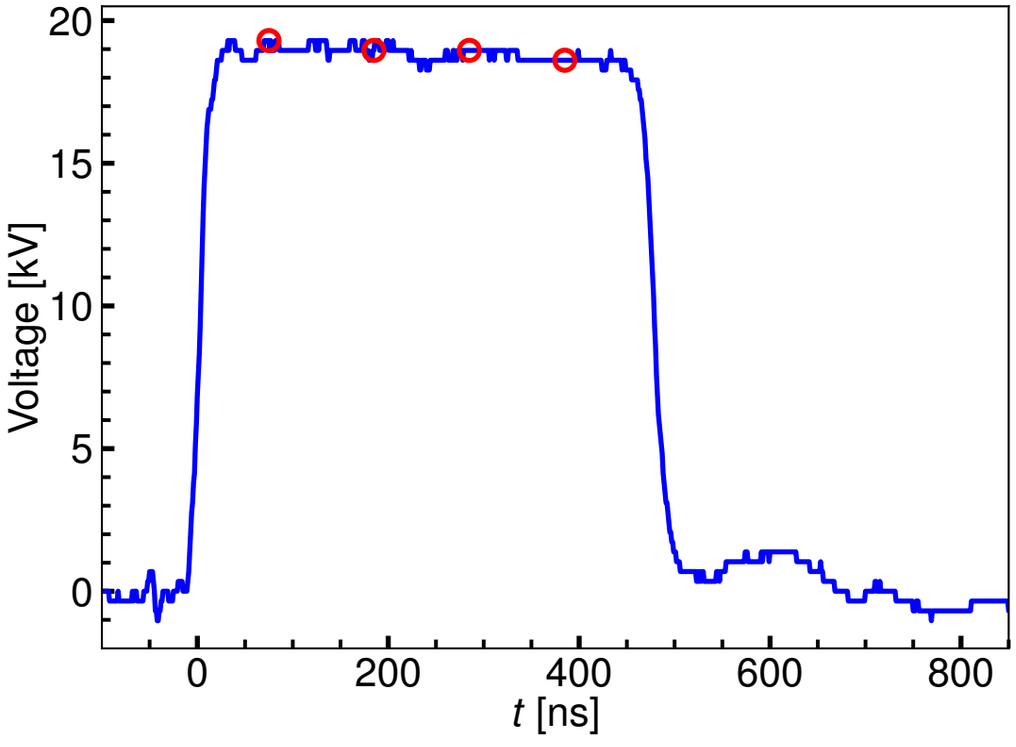


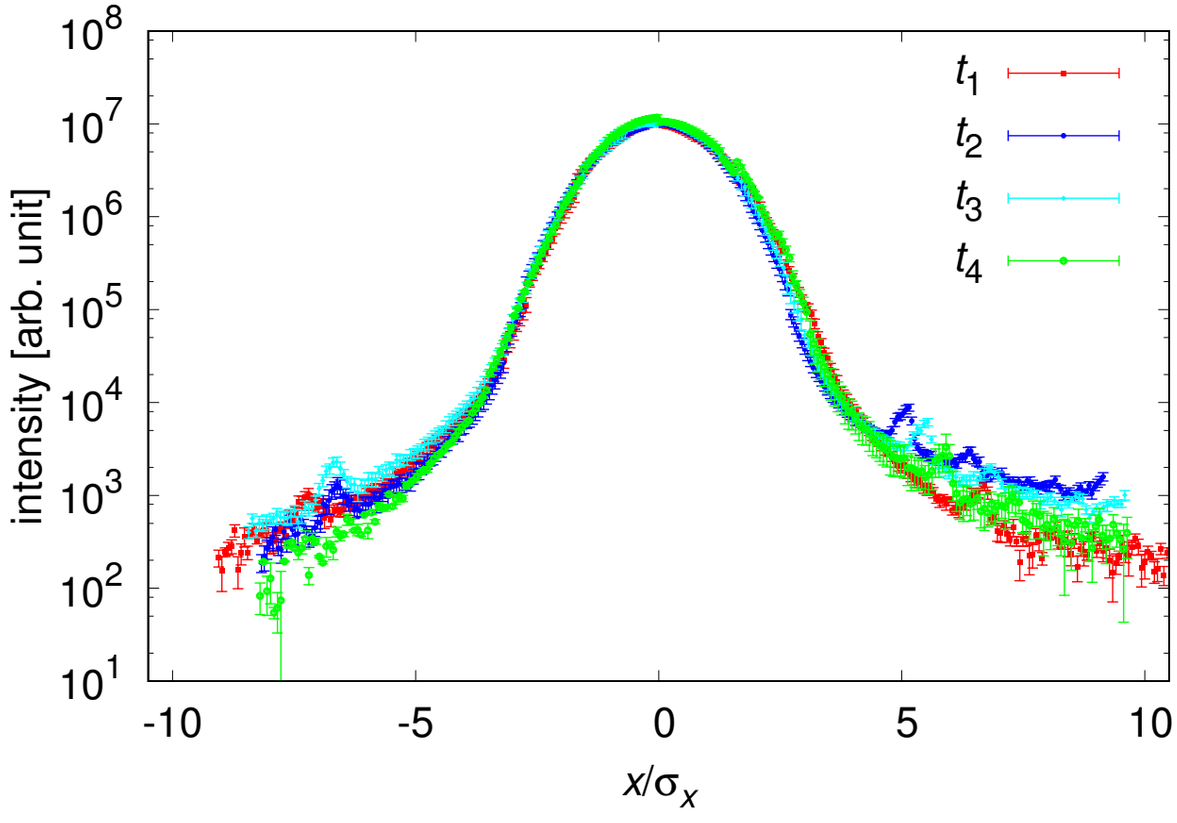
Horizontal halo vs. EXT kicker timing

- Field of EXT kicker might not be imperfect!
- 4 EXT timings, $\triangle t > 50$ ns
- Ver. and hor. dispersion have been corrected

- Hor. halo level doesn't change too much!
- EXT kicker timing —> Asymmetry hor. profile



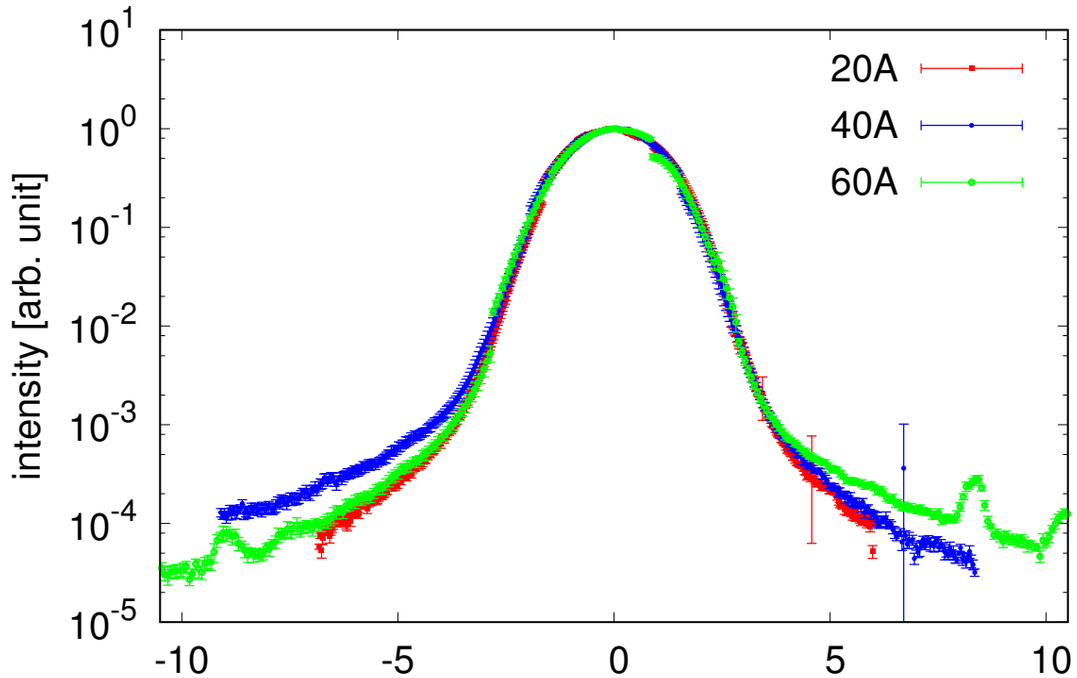


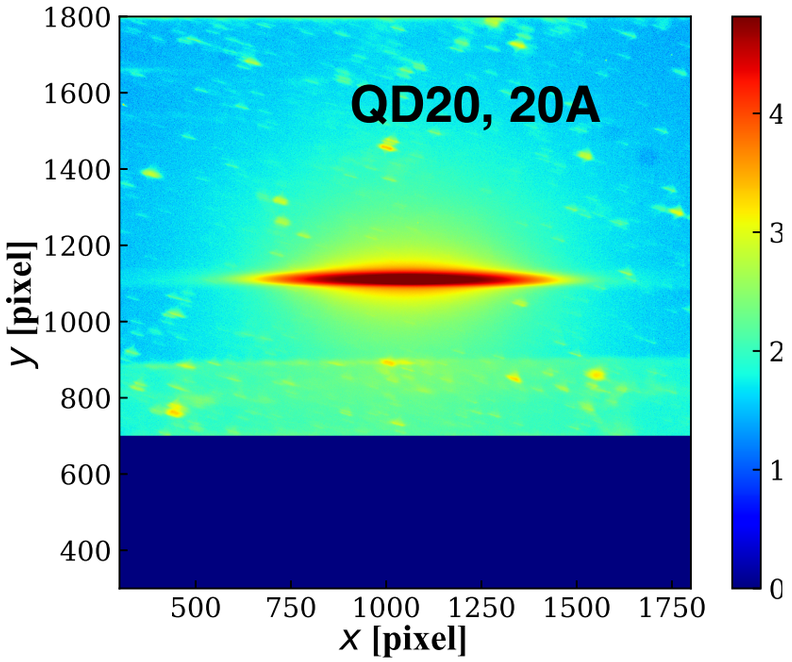


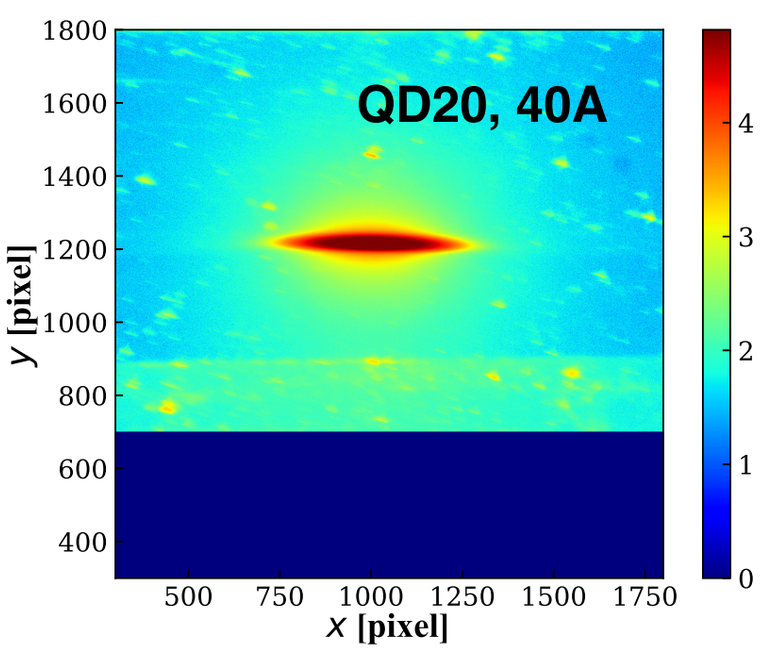
Horizontal halo vs. QF21 current

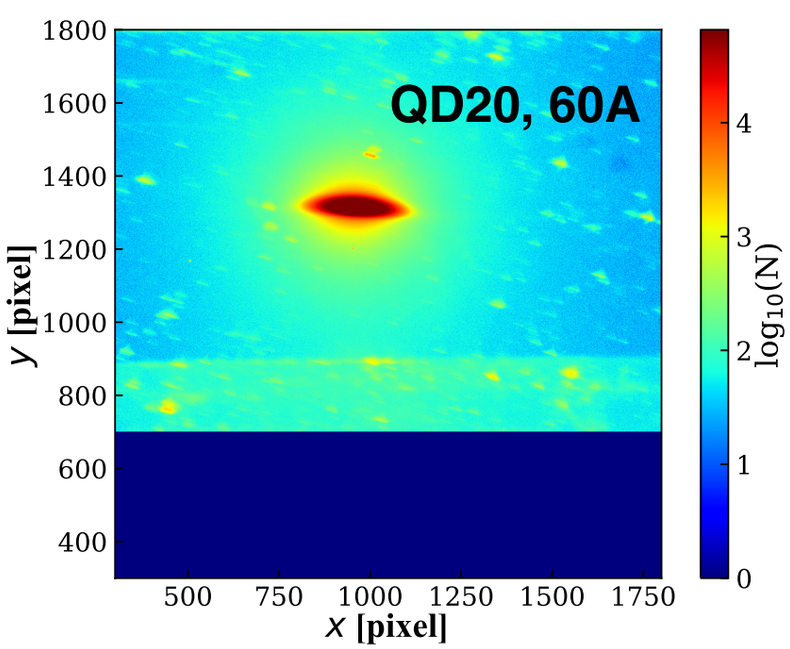
- Varying QF21 current, QD20 = 26 A
- $\eta_x < 10$ mm
- Beam sharp is modulated by QF21
- Horizontal halo and its asymmetry are also related to optical focusing!

- Asymmetric hor. profile might be induced by EXT kicker field and optical focusing!







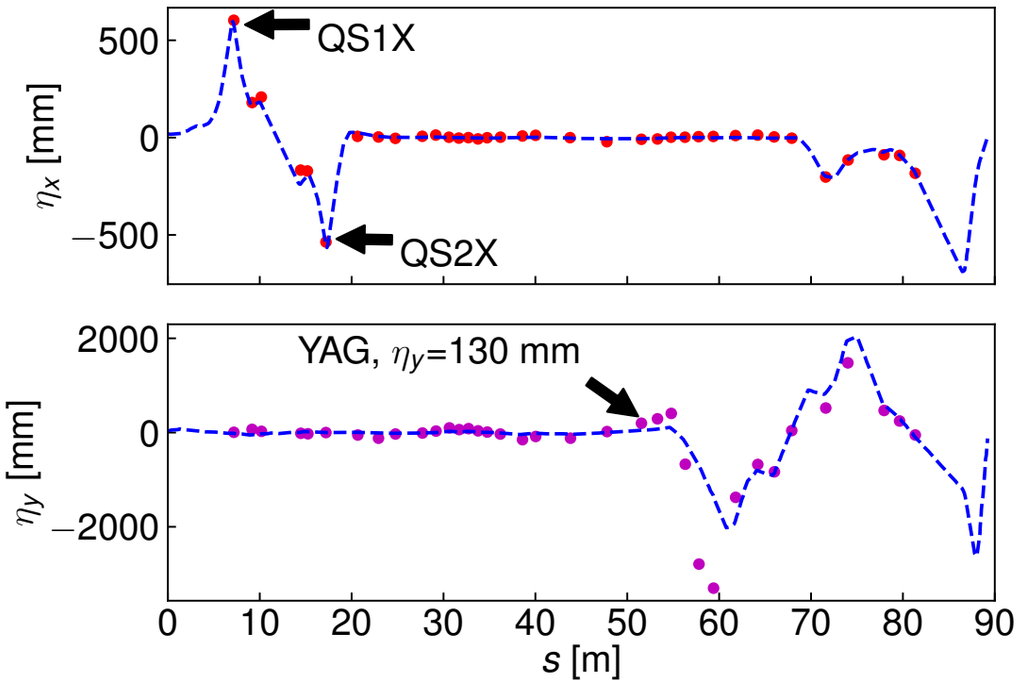


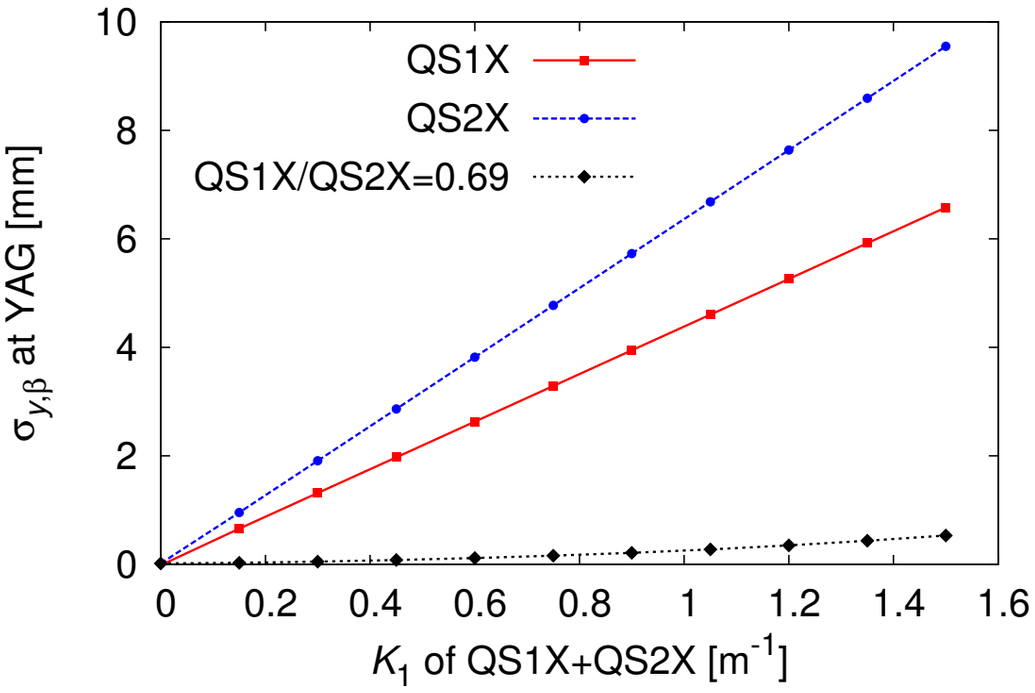
[1] Initial currents of QF21/QD20 are 55.6A/46.7 A

2. Visualisation of momentum tail

Momentum distribution visualisation

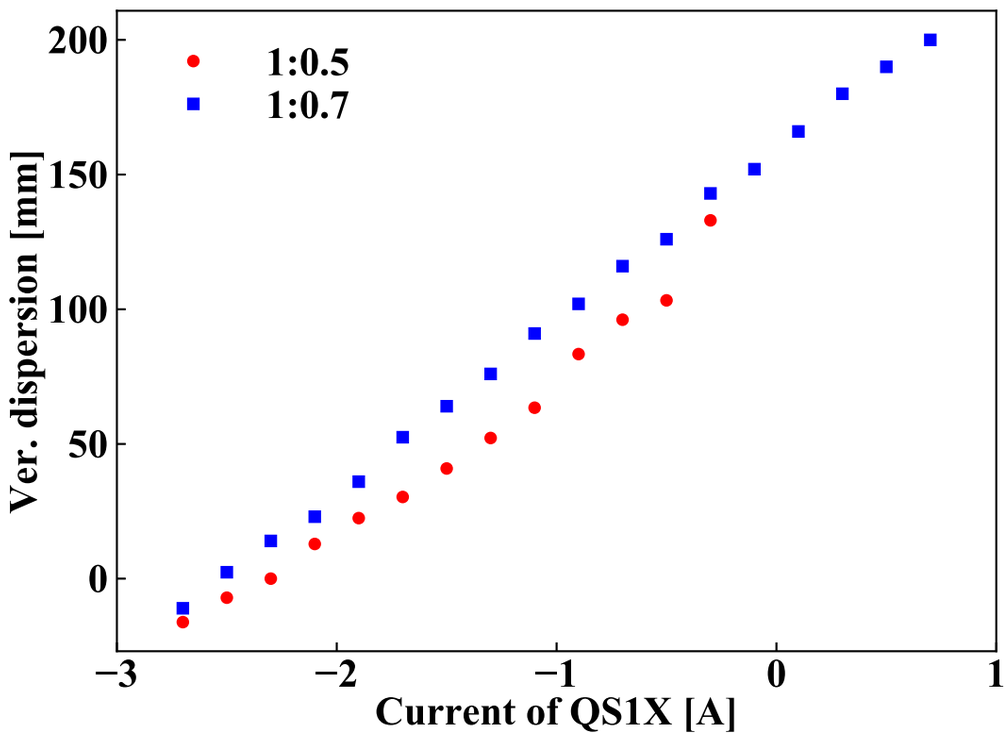
- Motivation:
  - Momentum tail is unknown (at ATF or other ring)
  - Hor. halo might be enhanced due to momentum tail via η_x in the DR
- Method:
  - Adjust η_y by tuning QS1X/QS2X with specific ratio (to minimum βy growth)
  - Ver. profile <— momentum distribution if η_y is large enough (>150 mm)
- Ratio between QS1X/QS2X is determined by the increment of βy when tuning QS1X or QS2X solely

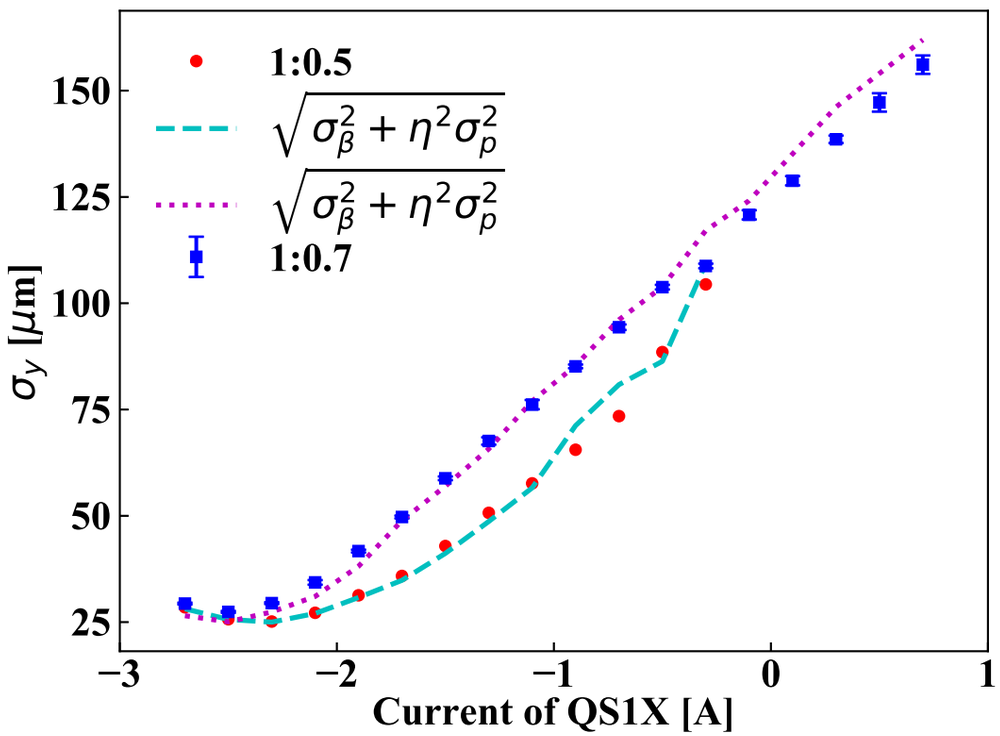




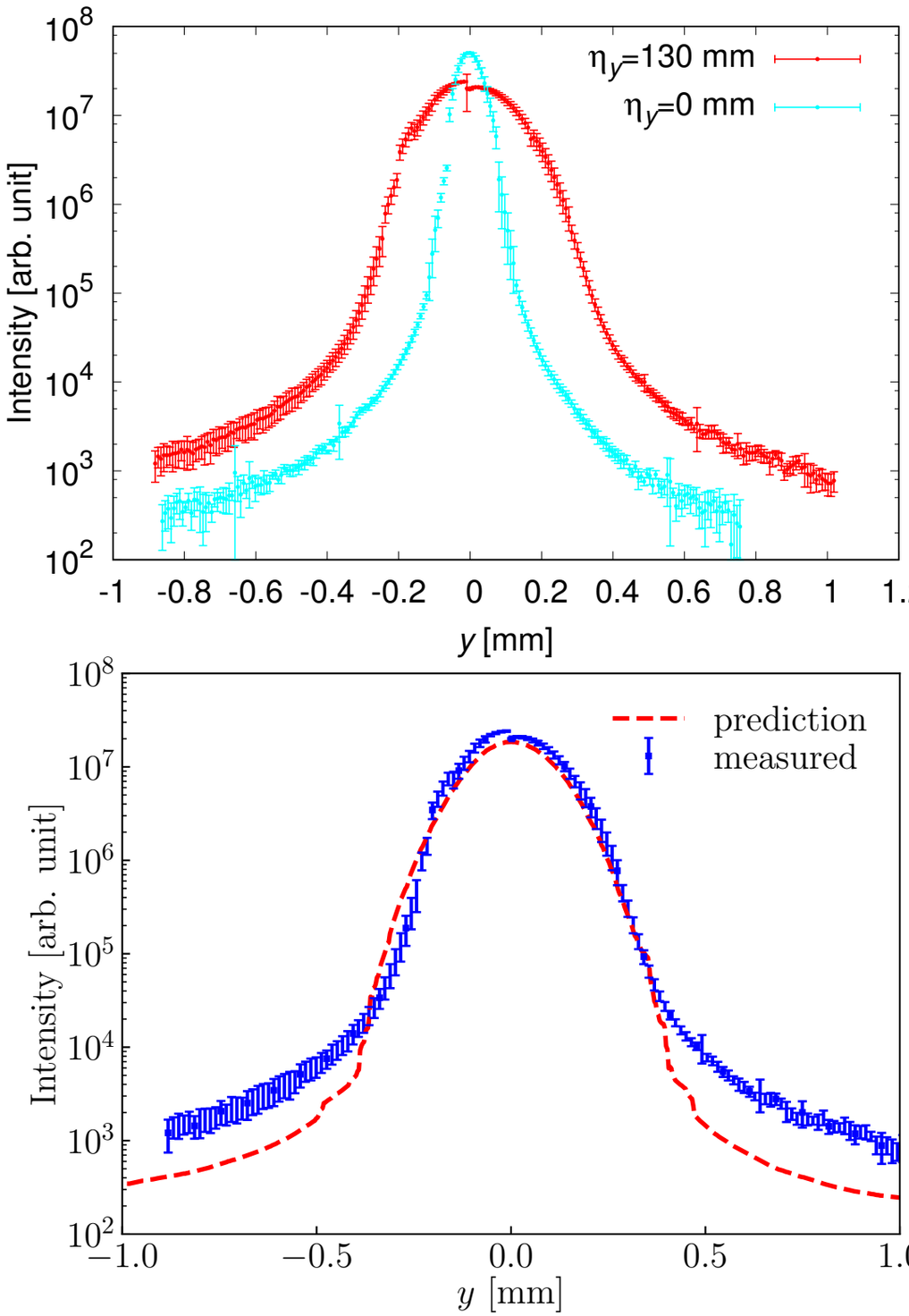
Momentum distribution visualisation

- QS1X/QS2X ratio = 1:0.5 (1:0.7)
- *xy* coupling (tilted beam) is suppressed (QK2X/QK4X knob)
- η_y raises up to 200 mm
- Vertical beam size is determined by dispersion/energy spread when(η_y >100 mm)
- Tail part is determined by energy spread for η_y > ??

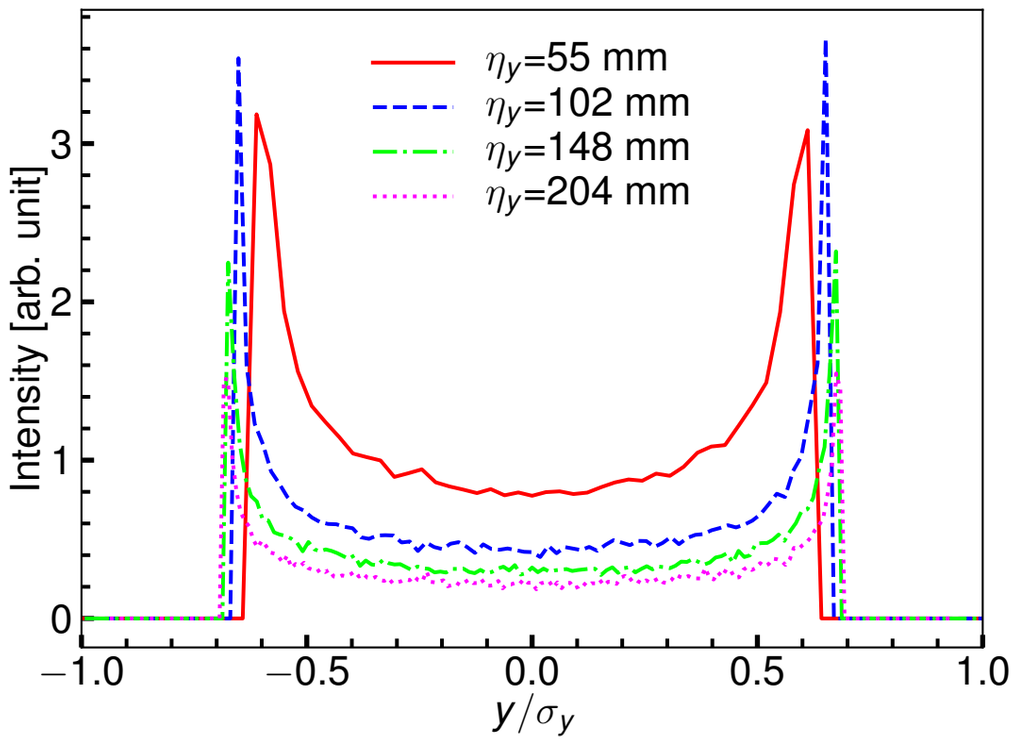




Momentum distribution visualisation

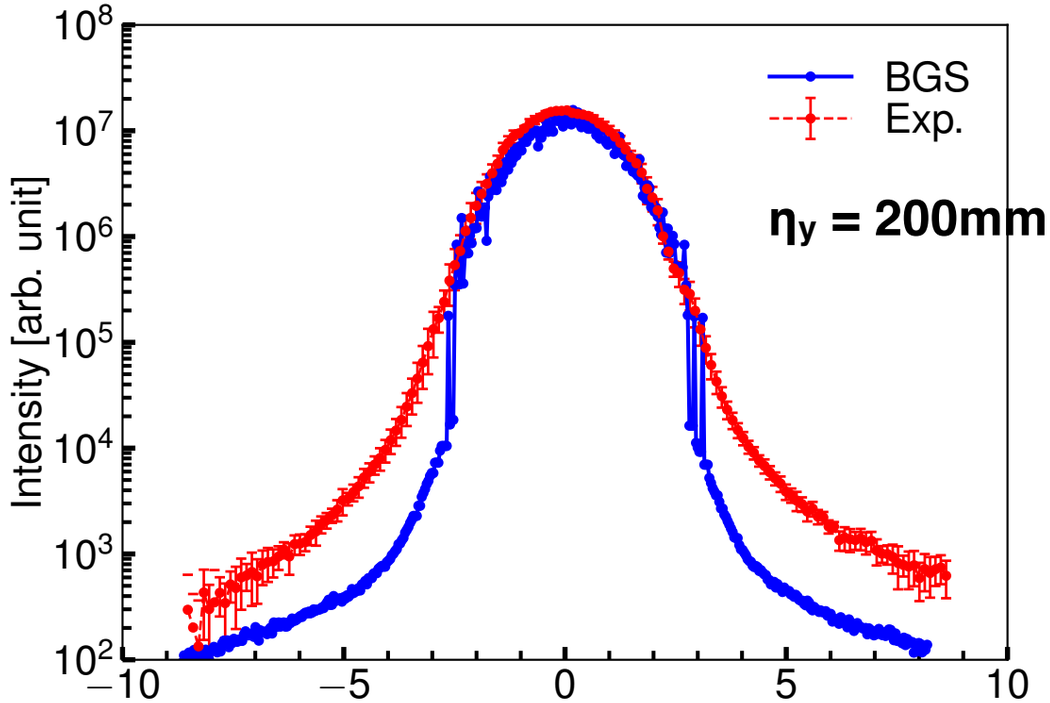


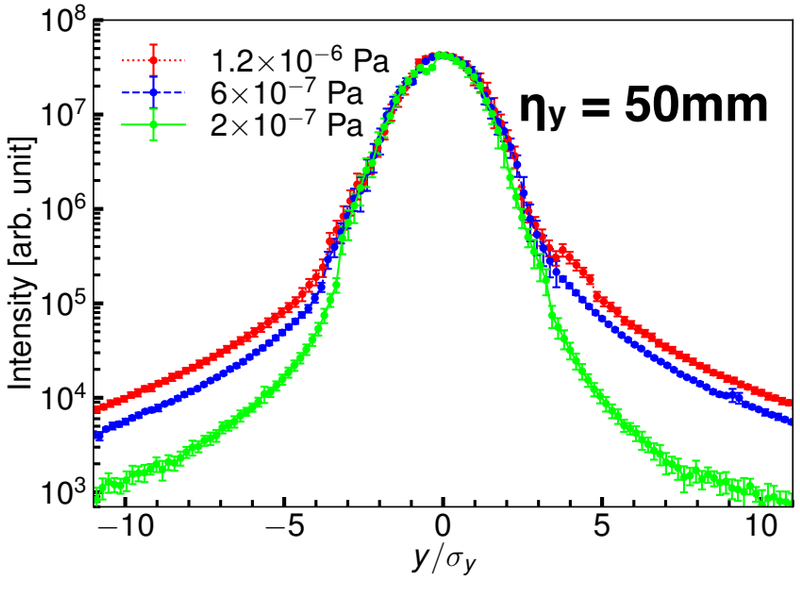
- Prediction of vertical profile (η_y = 130 mm)
  - Measured ver. betatron distribution
  - Gaussian distributed momentum deviation (σ_p = 0.07%)
- Measured vertical profile
  - Tail part is 4 times higher than prediction
- Hor. halo -> ver. tail by xy coupling (R31, R32) is negligible!
  —> hint of momentum tail?

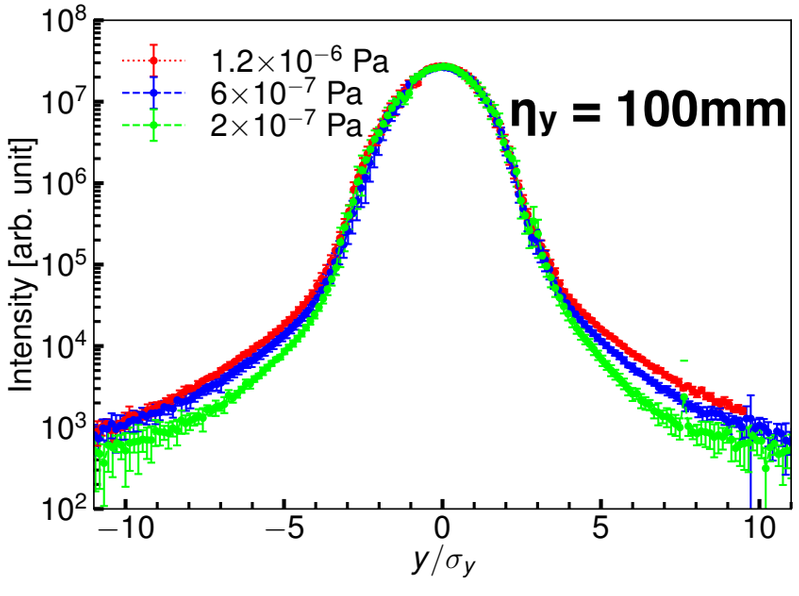


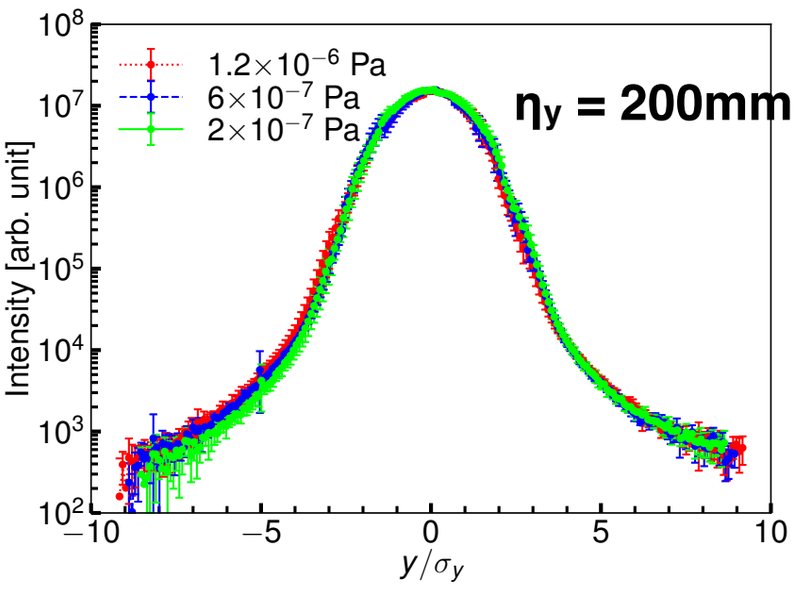
Vacuum dependence of momentum distribution

- For η_y = 200 mm:
  - Ver. halo is higher than BGS prediction by factor ~ 10
  - No significant vacuum dependence for ver. profile (momentum distribution)
- First observation of momentum distribution!
- Mechanism of momentum tail:
  Touschek scattering + Brems.??







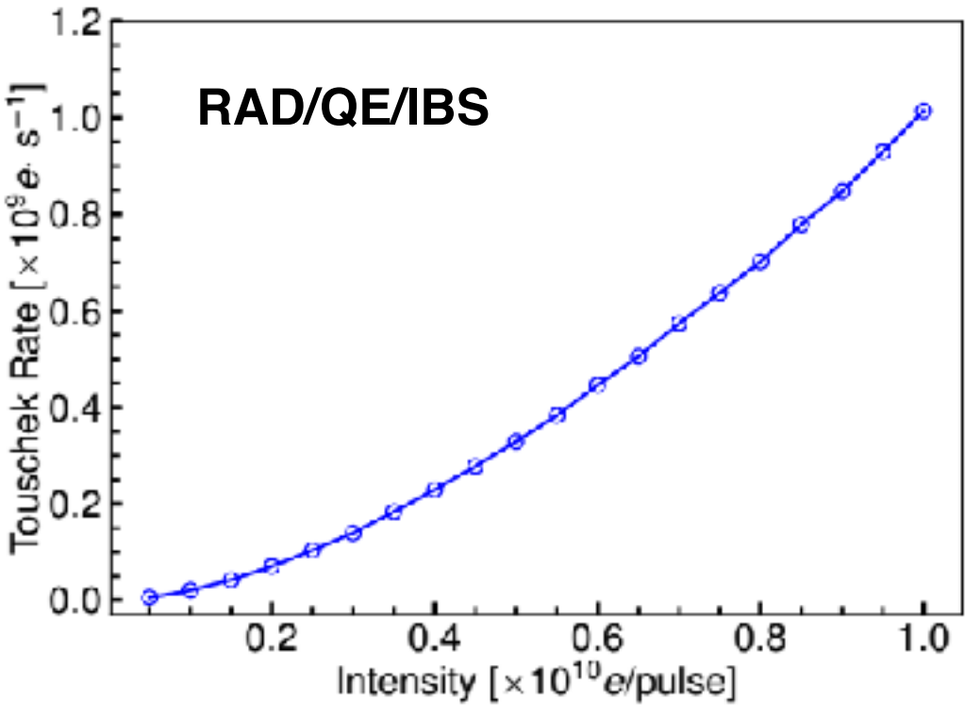


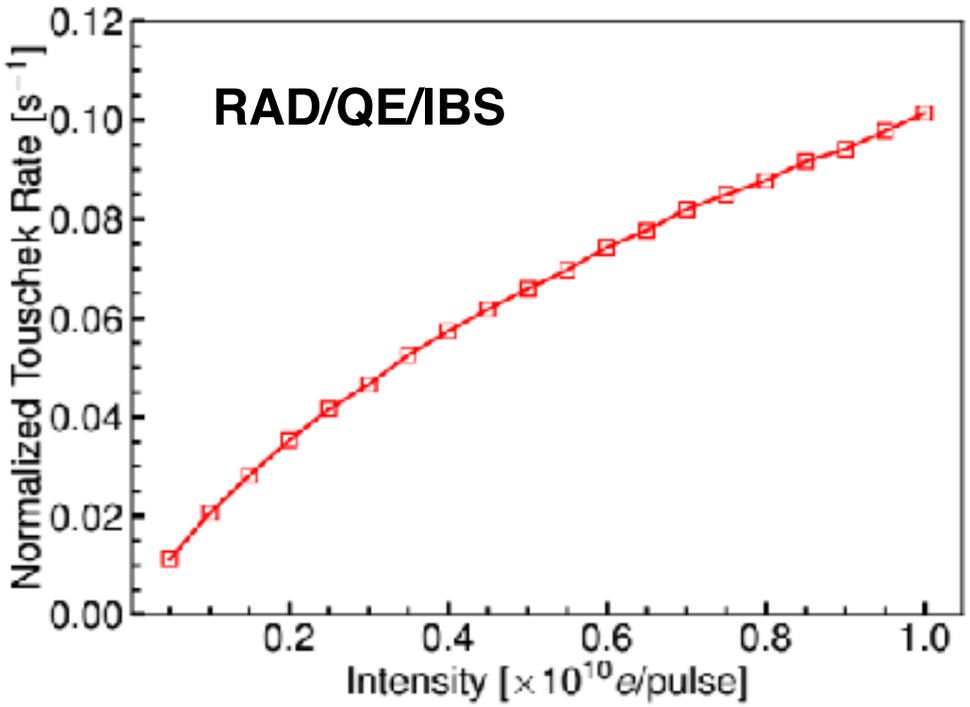
Momentum tail from Touschek scattering?

- The scattering rate is estimated using Piwinski formulas

$$R \propto \left\langle \frac{N_e^2}{\sigma_s \sqrt{\sigma_x^2 \sigma_y^2 - \sigma_\delta^4 \eta_x^3 \eta_y^2 \beta \delta_m}} \mathscr{F}(\beta\delta_m, B_1, B_2) \right\rangle$$

- Momentum deviation in the tail region (assuming 0.35% to 1.2%)

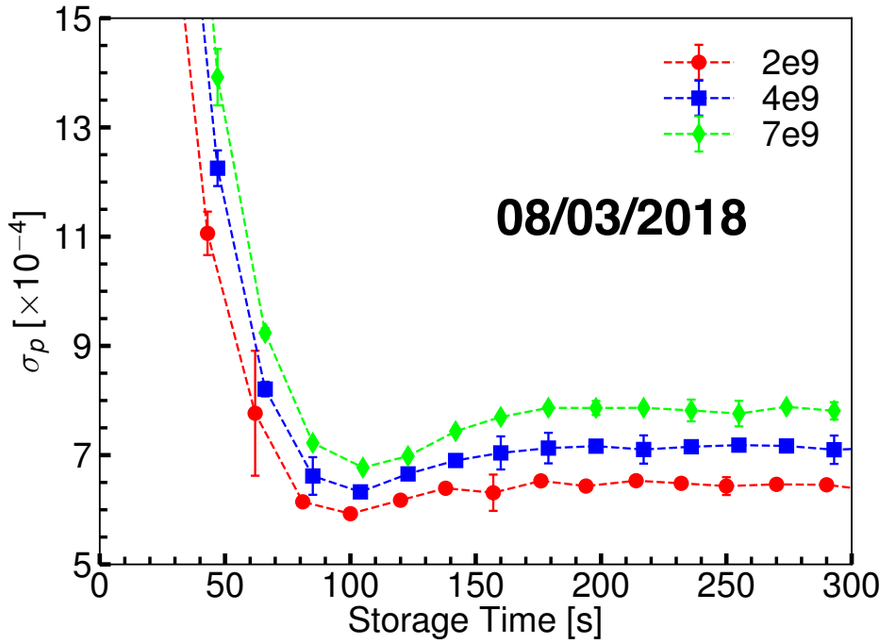




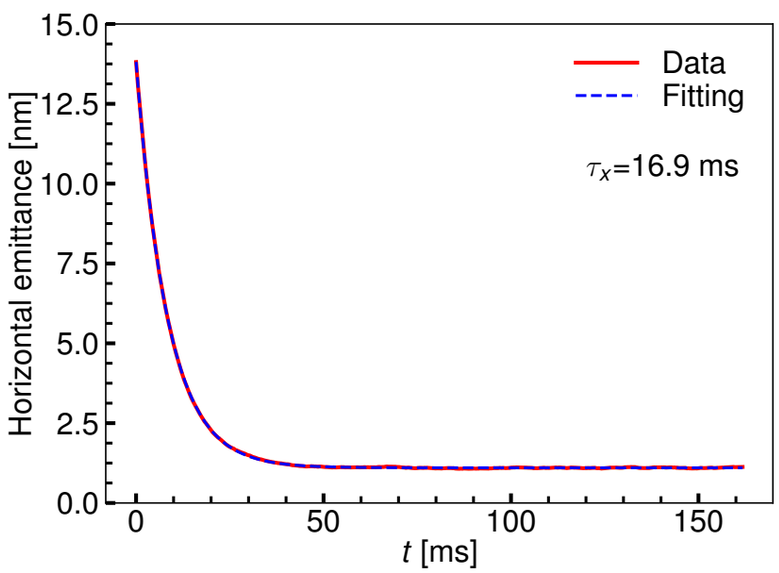
- Population of particles scattered into tail region increase with respect to beam intensity

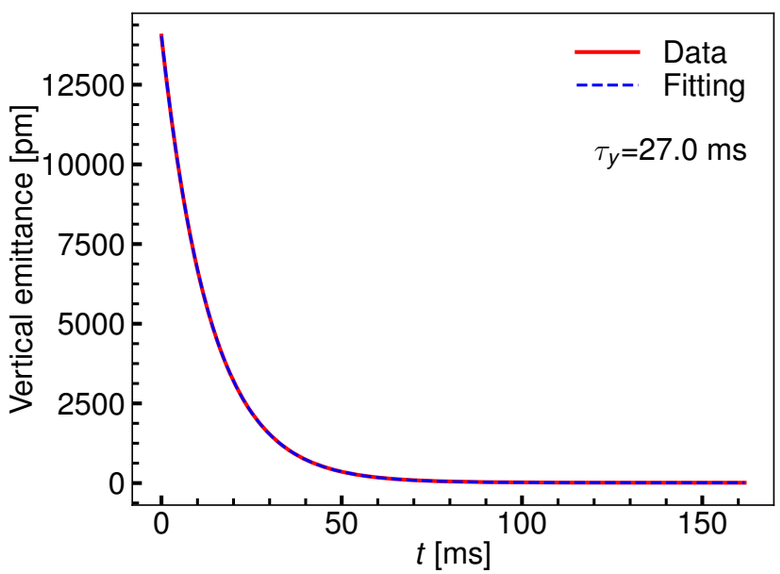
Momentum tail from Touschek scattering?

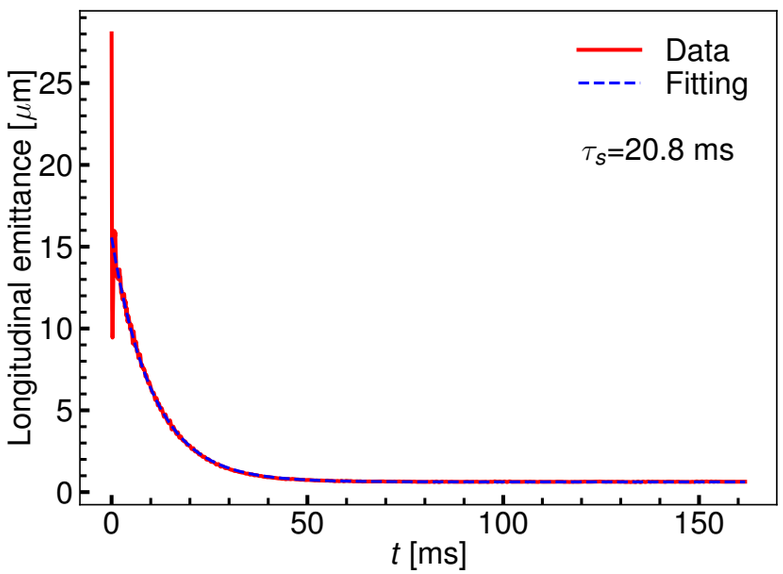
- Hor. and Ver. emittance reachs equilibrium after 100 ms and 160 ms
- Long. emittance decreases to the min. and then increases again due to IBS
- Small scattering rate at 120 ms and higher scattering rate at 200 ms and 300 ms?



Experiments in March; data analysis is on going!







Summary

- Transverse beam halo and the momentum tail have been measured using YAG monitor
  - Trans. beam halo is consistent with DS data
  - Asymmetric hor. distribution can be due to EXT kicker or focusing

- The first observation of the momentum tail has been achieved
  - Formation of momentum tail has been studied experimentally
  - Monte Carlo simulation of IBS and Touschek scattering is also underway

- Intensity dependence and the correlation with storage time of momentum tail have been measured
  - Data analysis is on going!

Thank you for your attention!

Many thanks to ATF collaboration and support from KEK!