Assessment performance tests of Basler optical digital system vs. the standard BTV system at CLEAR/CERN

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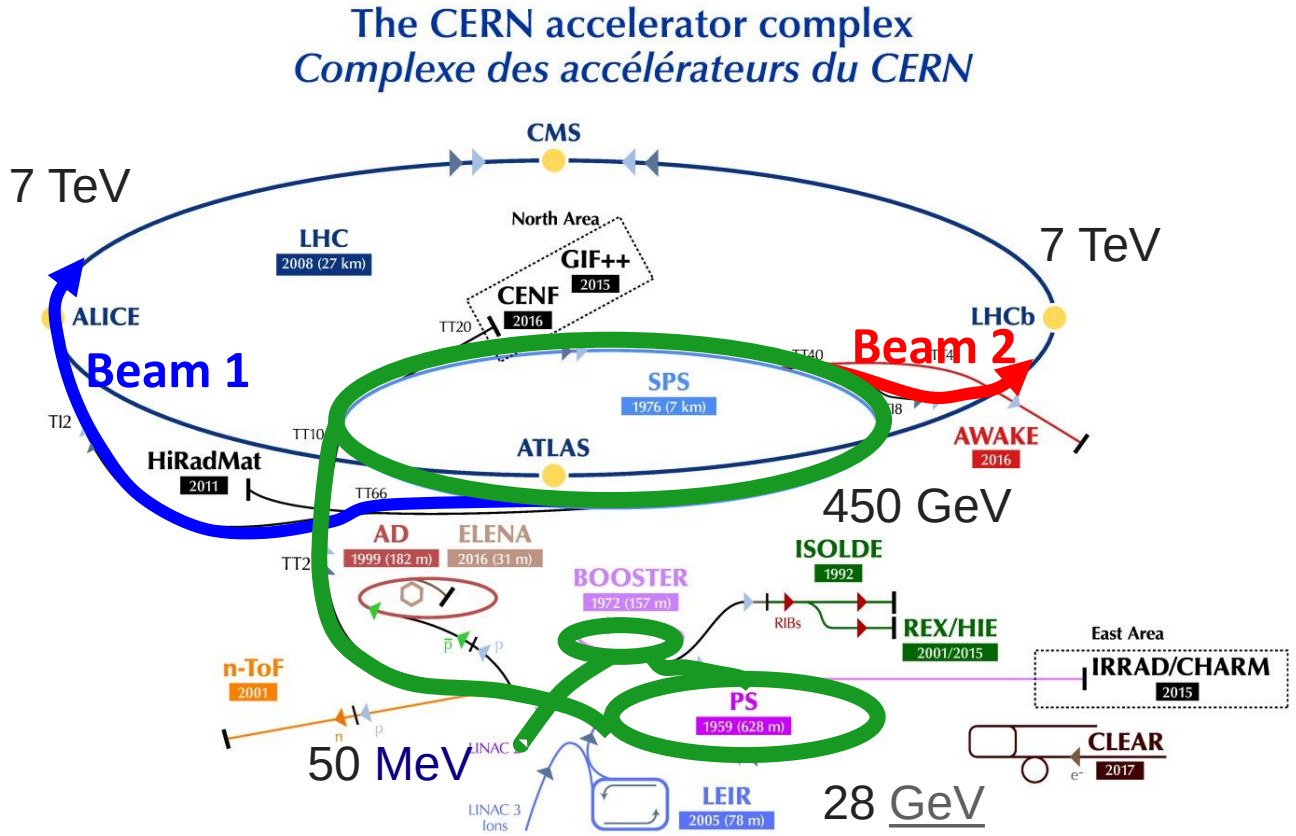
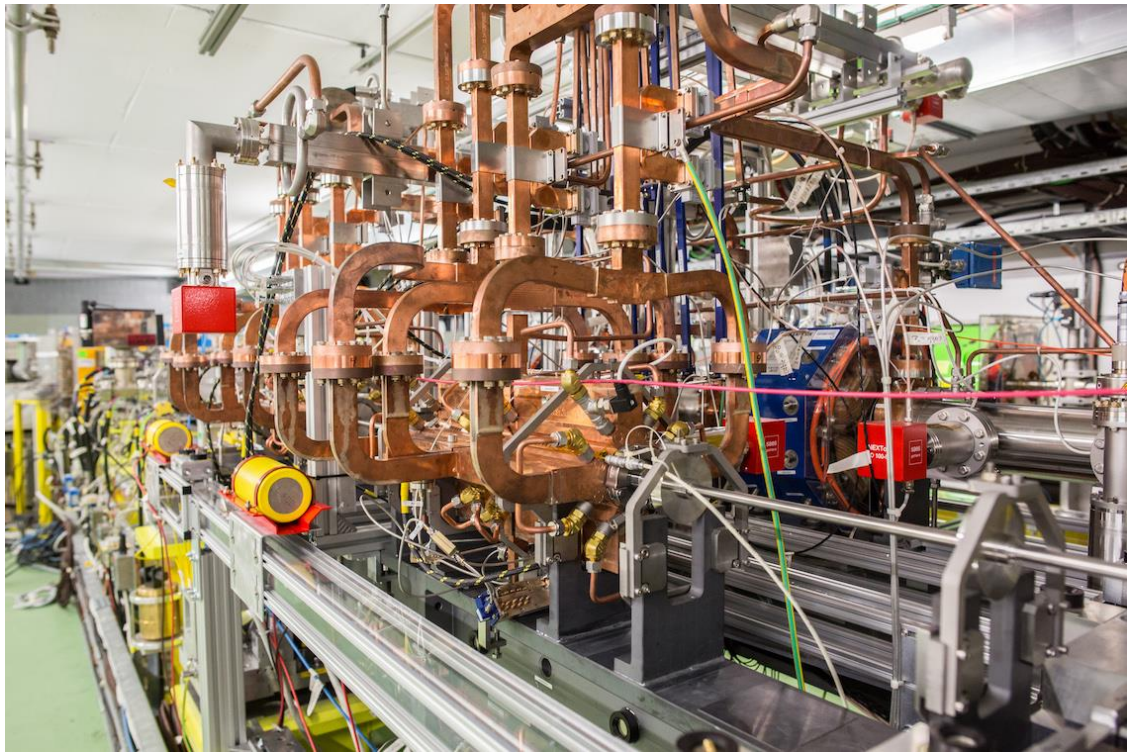
LHC and CLEAR

Protons on the way to LHC



The higher the particle‘s energy the larger the circumference.



CLEAR (CERN Linear Electron Accelerator for Research) increases the energy of the beam at 200 MeV

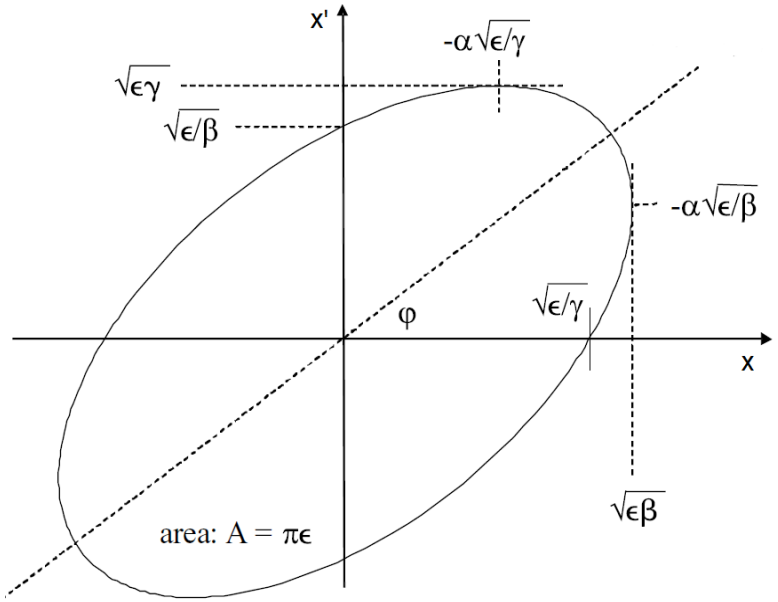
Motivation

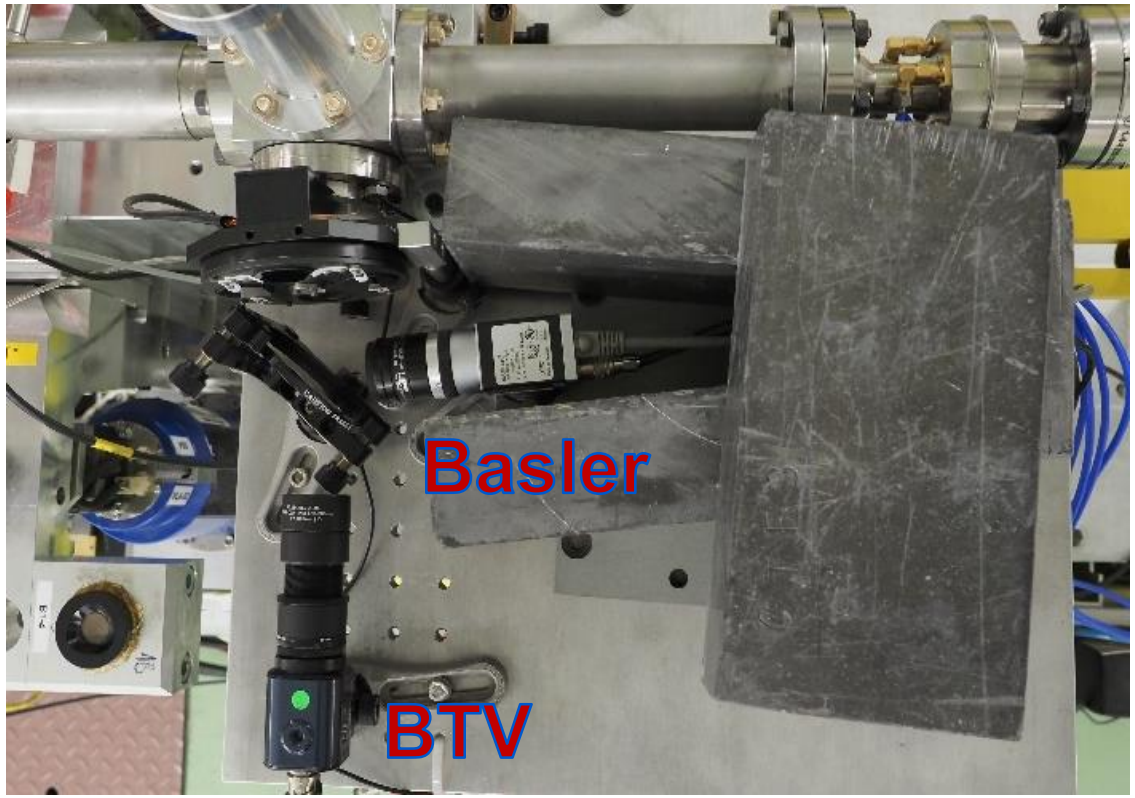
Emittance measurenment:

Phase Space $x(s) = \sqrt{\epsilon\beta(s)}cos(\varphi(s))$

$$\gamma x^2 + 2\alpha x x' + \beta x'^2 = \epsilon$$

Twiss Paramete $\beta(s) \quad \alpha(s) = -\frac{1}{2}\beta'(s) \quad \gamma = \frac{1+\alpha^2}{\beta}$



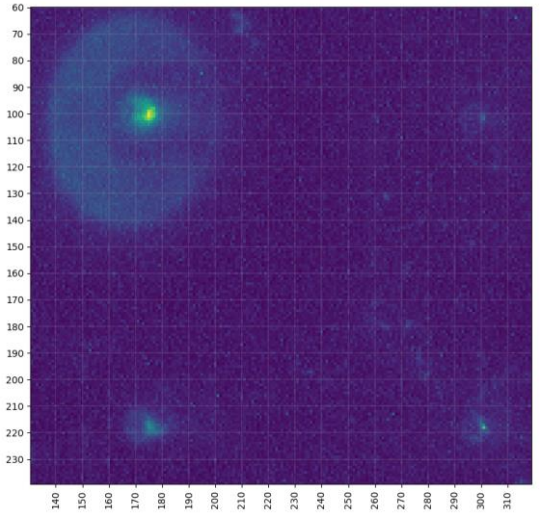


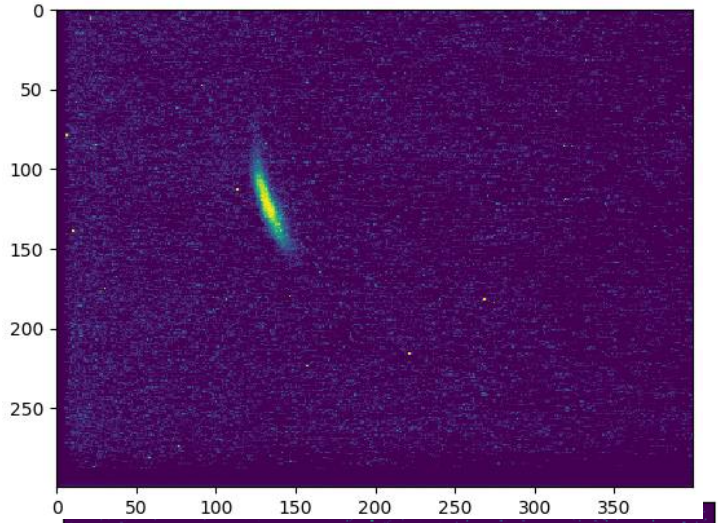
$$\sigma = \begin{bmatrix} \sigma_x^2 & \sigma_{xx'} \\ \sigma_{xx'} & \sigma_{x'}^2 \end{bmatrix} = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix} = \epsilon \begin{bmatrix} \beta & -\alpha \\ -\alpha & \gamma \end{bmatrix} \longrightarrow \begin{array}{l} det(\sigma) = \epsilon_{rms}^2 \\ \epsilon_N = \beta_{rel}\gamma_{rel}\epsilon_{rms} \end{array}$$

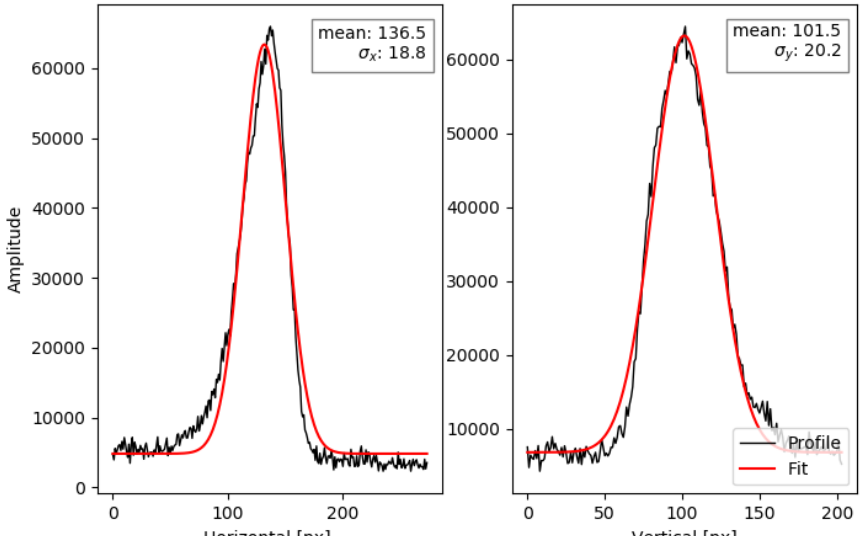
Keeping the emittance small means that the likelihood of particle interactions will be greater resulting in higher luminosity.

BTV camera vs. Basler camera

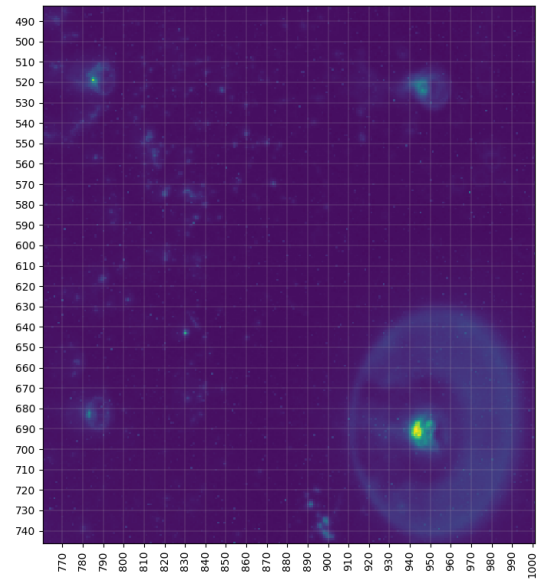
BTV

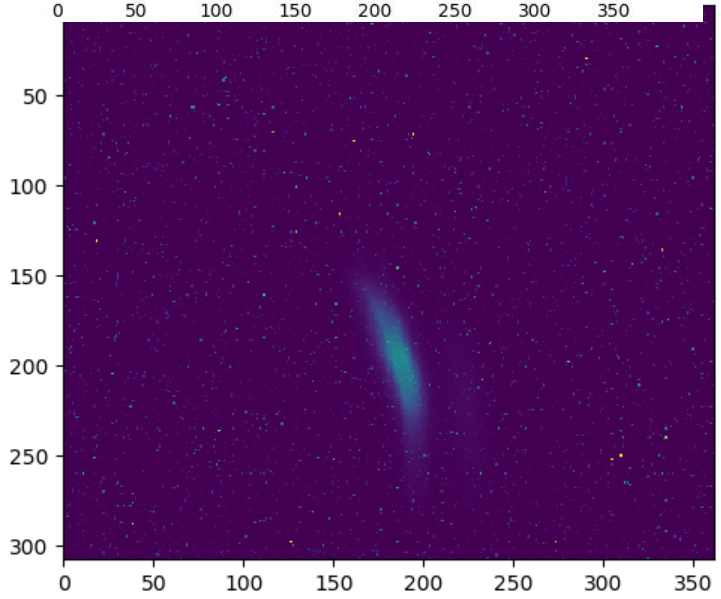


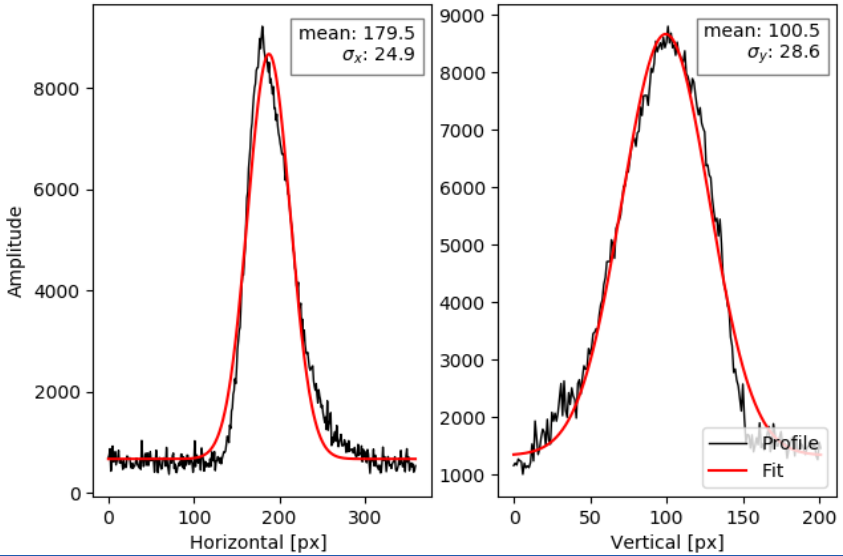




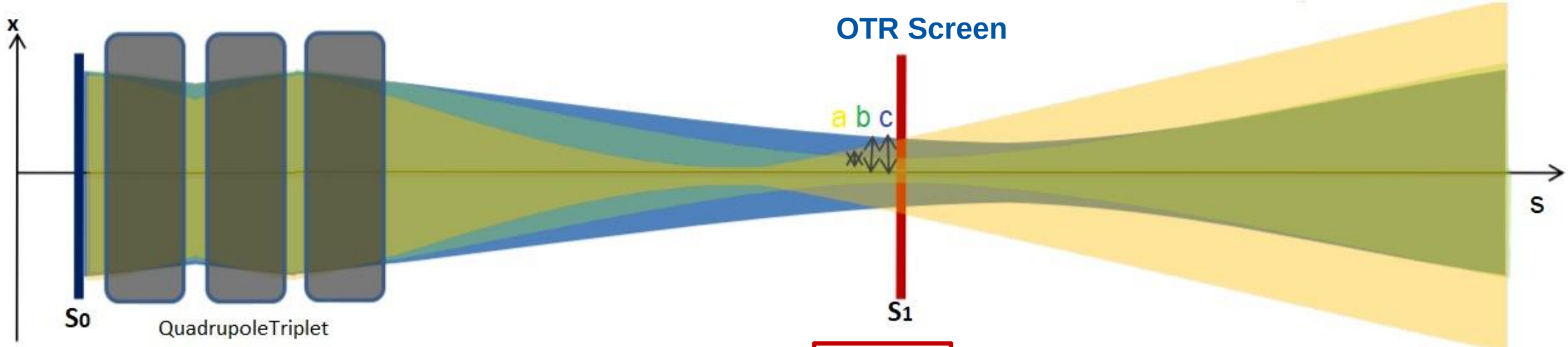
Basler







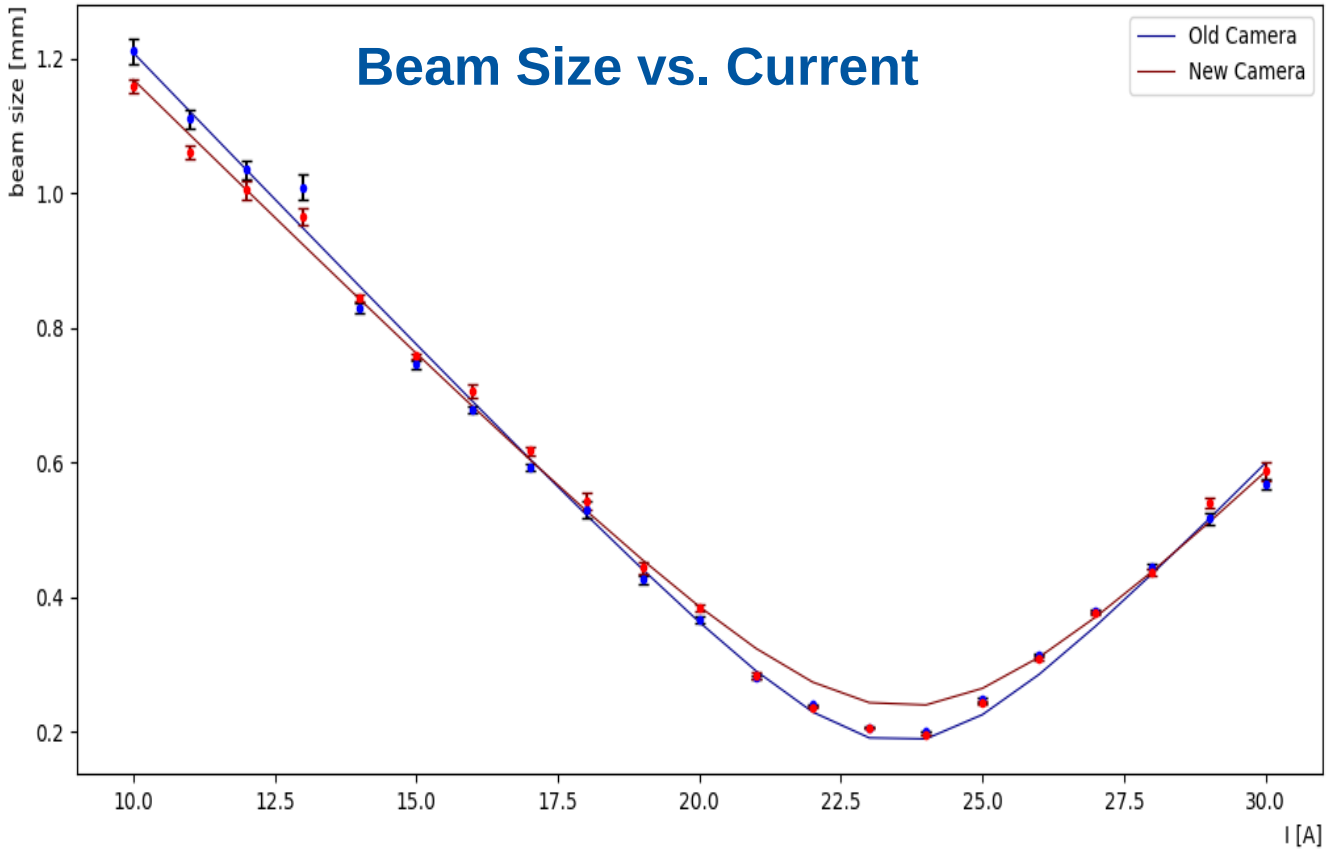
METHODOLOGY



$$M_{foc} = \begin{pmatrix} \cos(\sqrt{K}s) & \frac{1}{\sqrt{K}}\sin(\sqrt{K}s) \\ -\sqrt{K}\sin(\sqrt{K}s) & \cos(\sqrt{K}s) \end{pmatrix} \longrightarrow \begin{pmatrix} \sigma_{0,11} \\ \sigma_{0,12} \\ \sigma_{0,22} \end{pmatrix} = (M_{\sigma,n}^T M_{\sigma,n})^{-1} M_{\sigma,n}^T \begin{pmatrix} \sigma_{1,11} \\ \sigma_{2,11} \\ \vdots \\ \sigma_{n,11} \end{pmatrix}$$

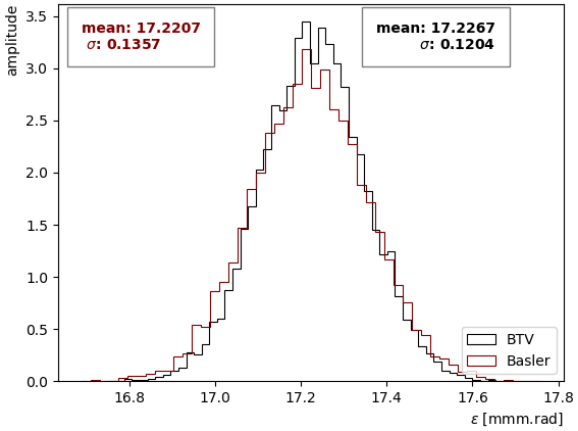
$$\sigma_{1,11}(k) = (d^2 l_q^2 \sigma_{0,11})k^2 - 2(d l_q \sigma_{0,11} + d^2 l_q \sigma_{0,12})k + (\sigma_{0,11} + 2d\sigma_{0,12} + d^2\sigma_{0,22})$$

RESULTS

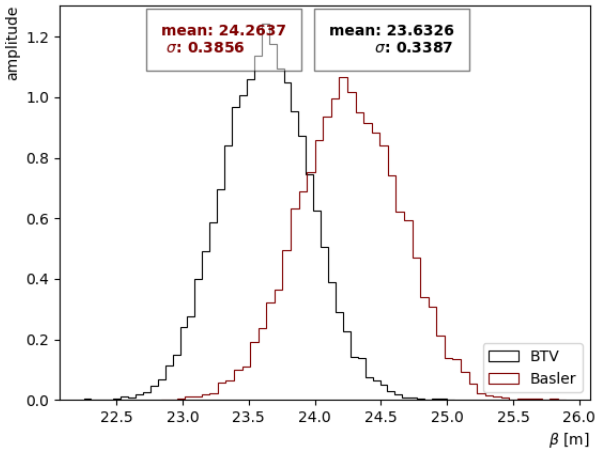


	ϵ_N mm.mrad	$\delta\epsilon_N$ mm.mrad	β m	$\delta\beta$ m	α	$\delta\alpha$	γ 1/m	$\delta\gamma$ 1/m
BTV	17.1670	0.1229	23.5344	1.1178	-0.1232	0.0243	0.0432	0.0022
Basler	17.1633	0.1418	25.2564	1.0871	-0.1719	0.0176	0.0408	0.0018

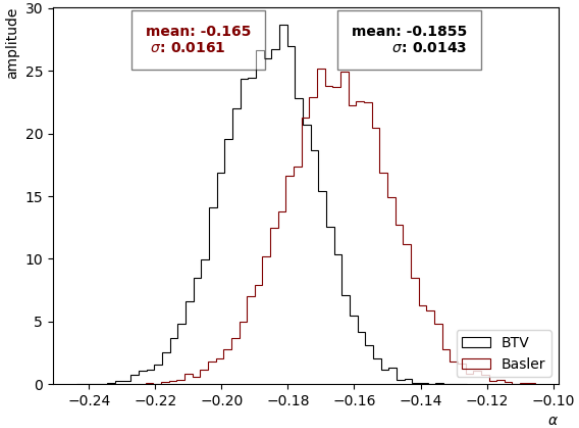
N. Emittance



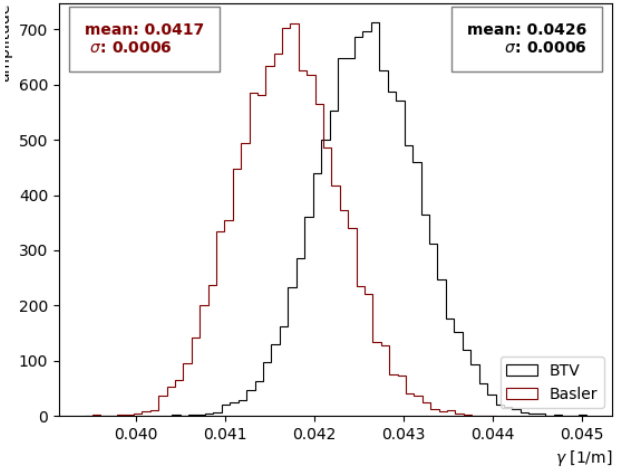
Beta



Alpha



Gamma



Thanks for your attention !