Slice Emittance Measurement on CeC Diagnostic Beamline

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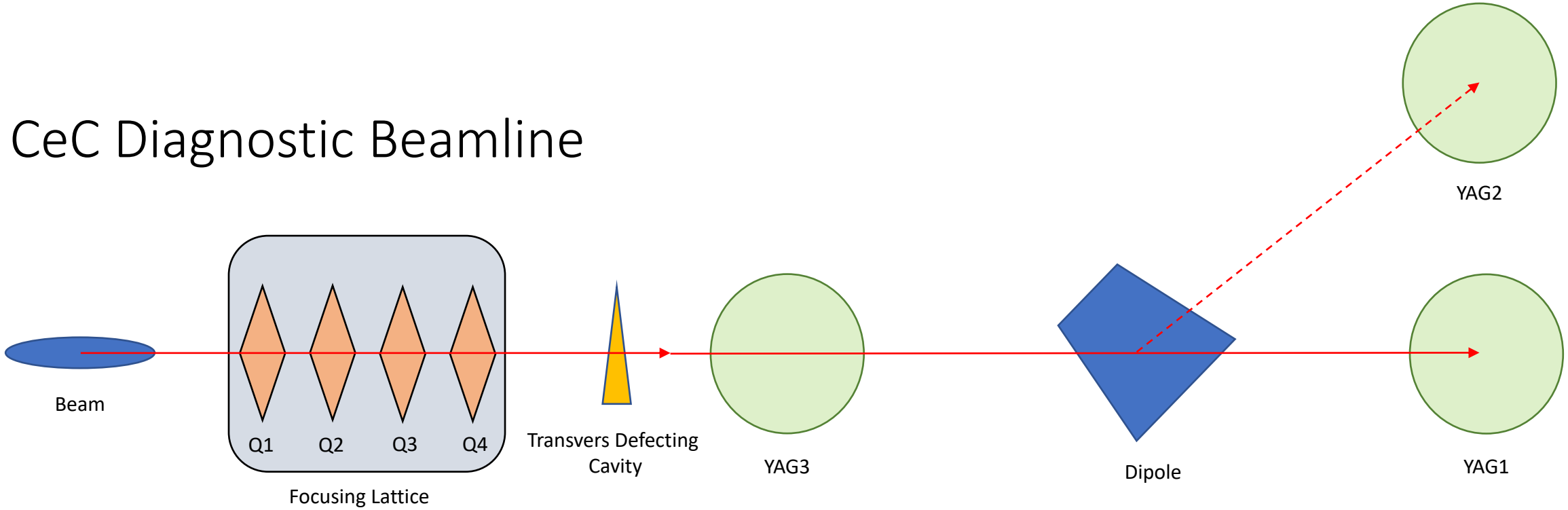
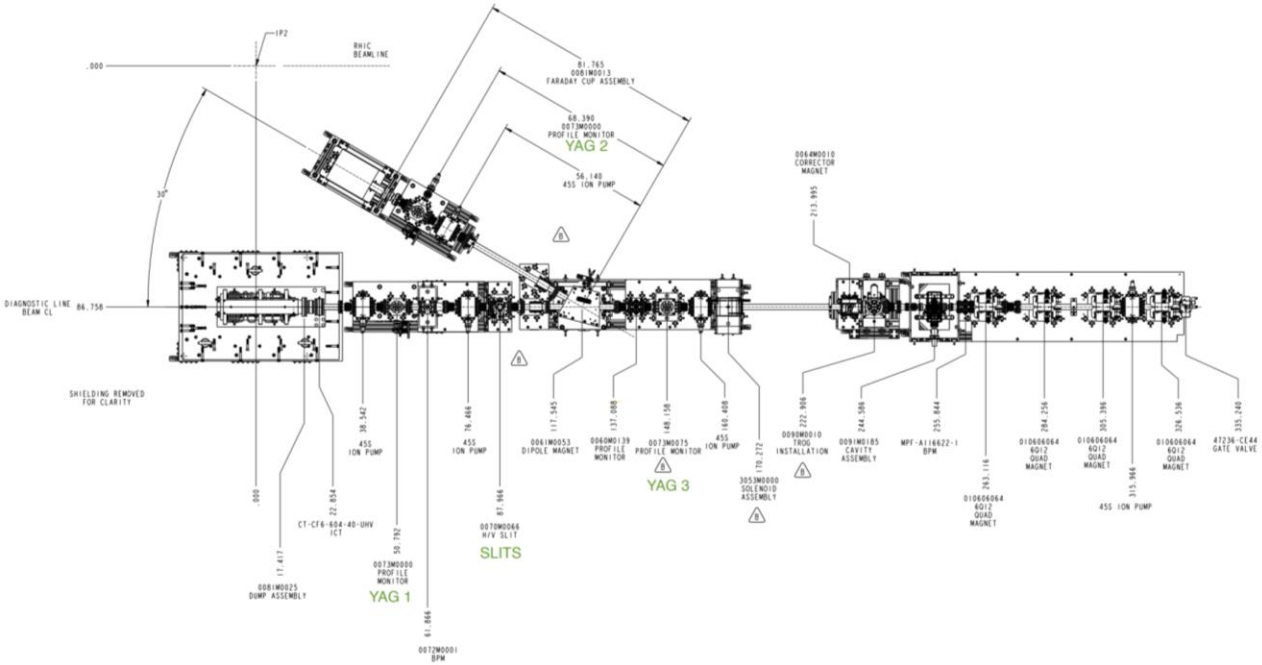
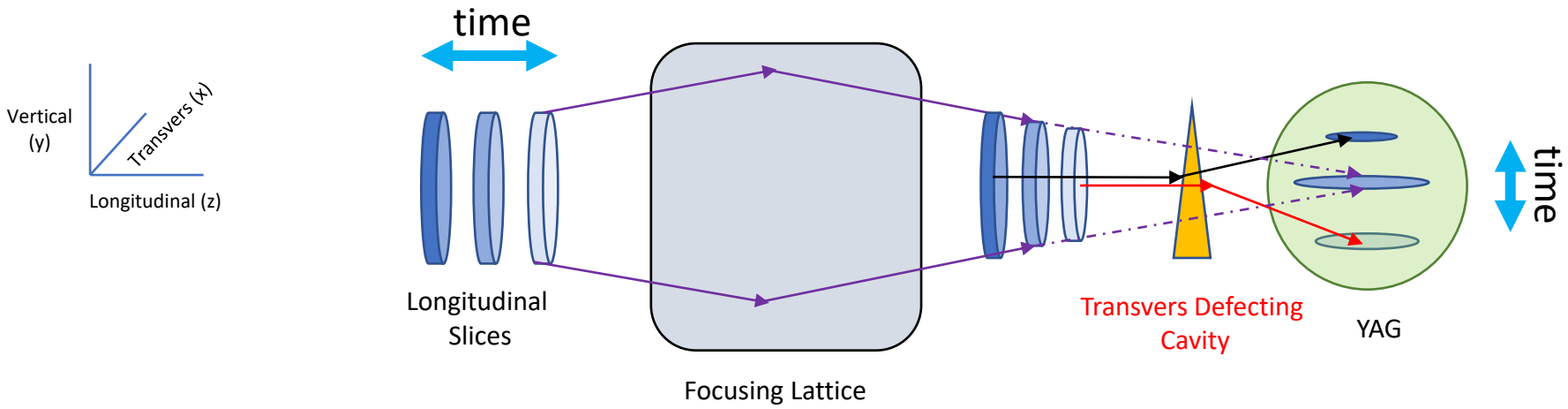
CeC Diagnostic Beamline



- Beam from Linacc carry KE 14.05MeV
- There are 4 Quadrupoles forming our focusing lattice
- Slice emittance measurement is mainly preformed on YAG 3
- Defecting Cavity is used for resolving longitudinal structure

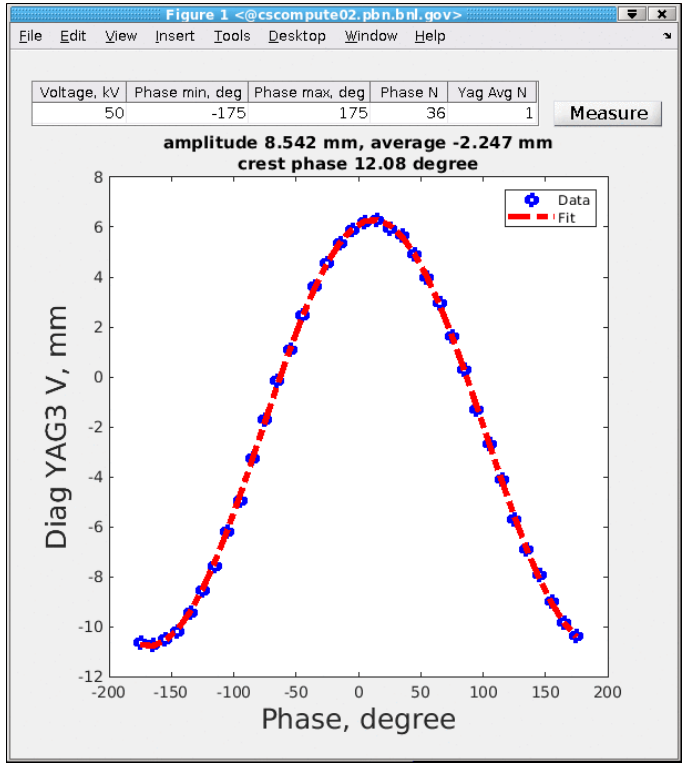


Defecting Cavity (TDC)

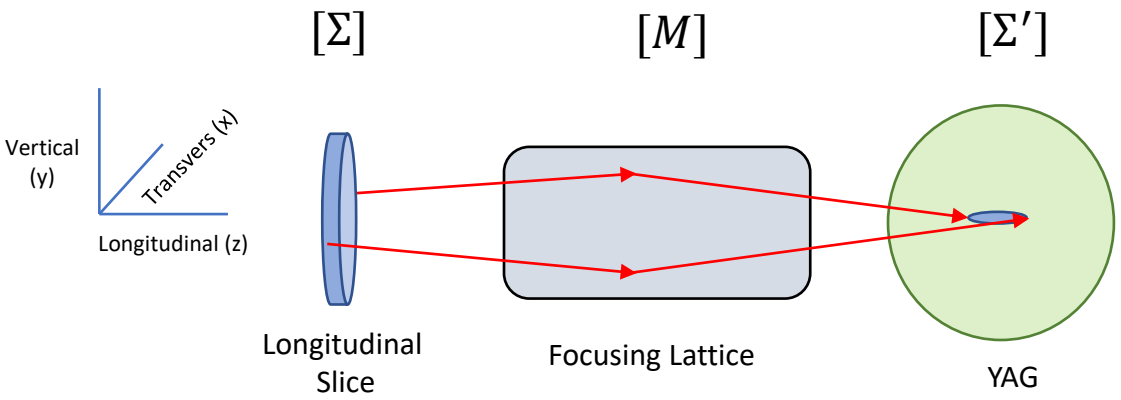


- The frequency of our TDC is 1.3GHz
- Typical beam length ~ 70 ps
- focusing Lattice focus slices veristically on YAG
- Different longitudinal slices experience different TDC phase
- Resulting in a different vertical kick
- Longitudinal slices projected on same YAG location in different vertical position (time)

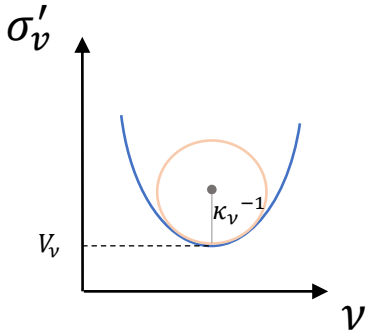
Kick vs phase



Emittance measurement



- By changing transvers focusing (ν or μ)
- A parabola (σ'_ν or σ'_μ) can be obtained
- Emittance ε at the focusing lattice entrance can be calculated from the parabola parameters (κ and V)
- Where κ is the curvature and V is the height of parabola at the vertex



Emittance $\varepsilon = \sqrt{\sigma_{11}\sigma_{22} - \sigma_{12}^2}$

$$[\Sigma] = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{bmatrix} \qquad [M] = \begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix}$$

$$\because\ [\Sigma'] = [M][\Sigma][M]^T \qquad \sigma_{11} = \langle x \rangle^2$$

$$\therefore \sigma'_{11} = m_{11}^2\sigma_{11} + m_{11}m_{12}2\sigma_{12} + m_{12}^2\sigma_{22}$$

$$\nu = \frac{m_{11}}{m_{12}} \qquad \sigma'_\nu = \frac{\sigma'_{11}}{m_{12}}$$

$$\sigma'_\nu(\nu) = \sigma_{11}\nu^2 + 2\sigma_{12}\nu + \sigma_{22}$$

$$\varepsilon = \sqrt{\kappa_\nu \times V_\nu}$$

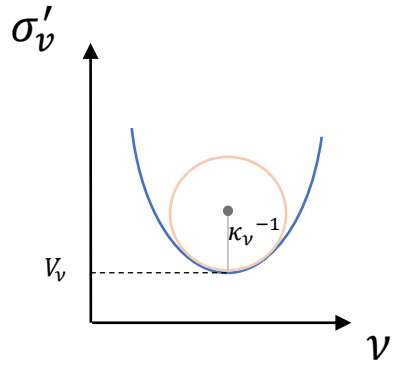
$$\mu = \frac{m_{12}}{m_{11}} \qquad \sigma'_\mu = \frac{\sigma'_{11}}{m_{11}}$$

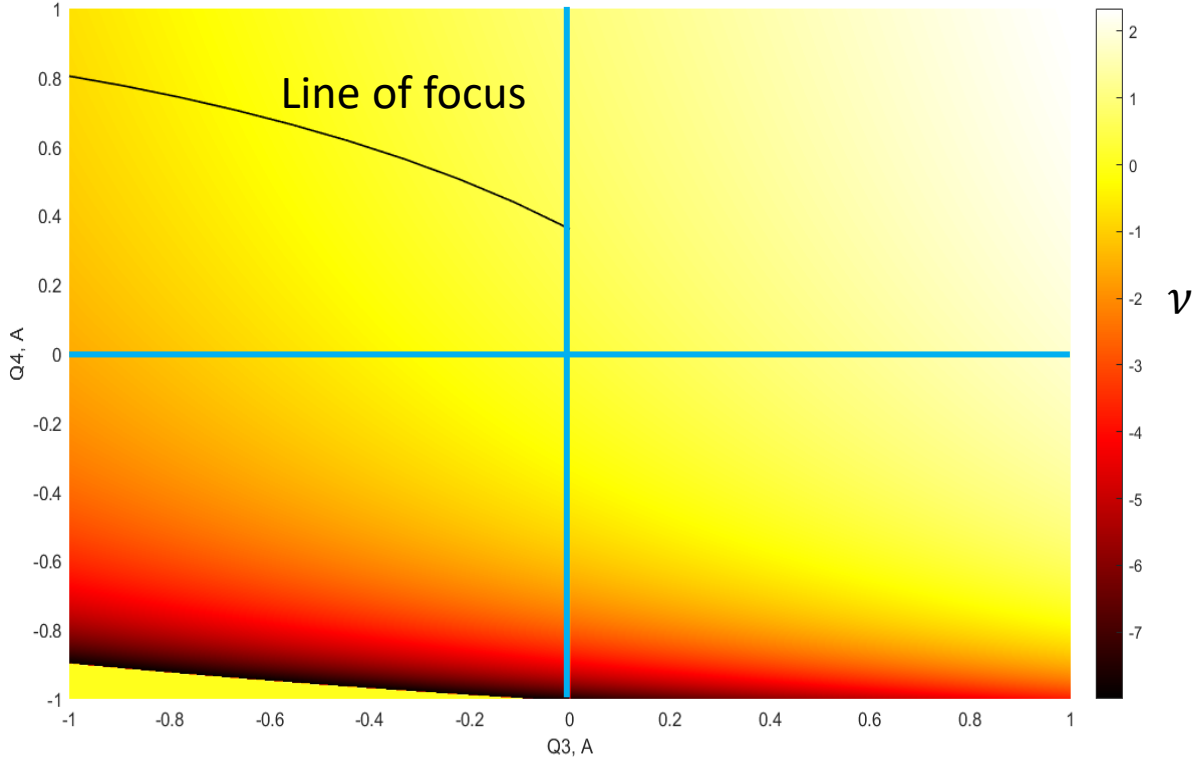
$$\sigma'_\mu(\mu) = \sigma_{22}\mu^2 + 2\sigma_{12}\mu + \sigma_{11}$$

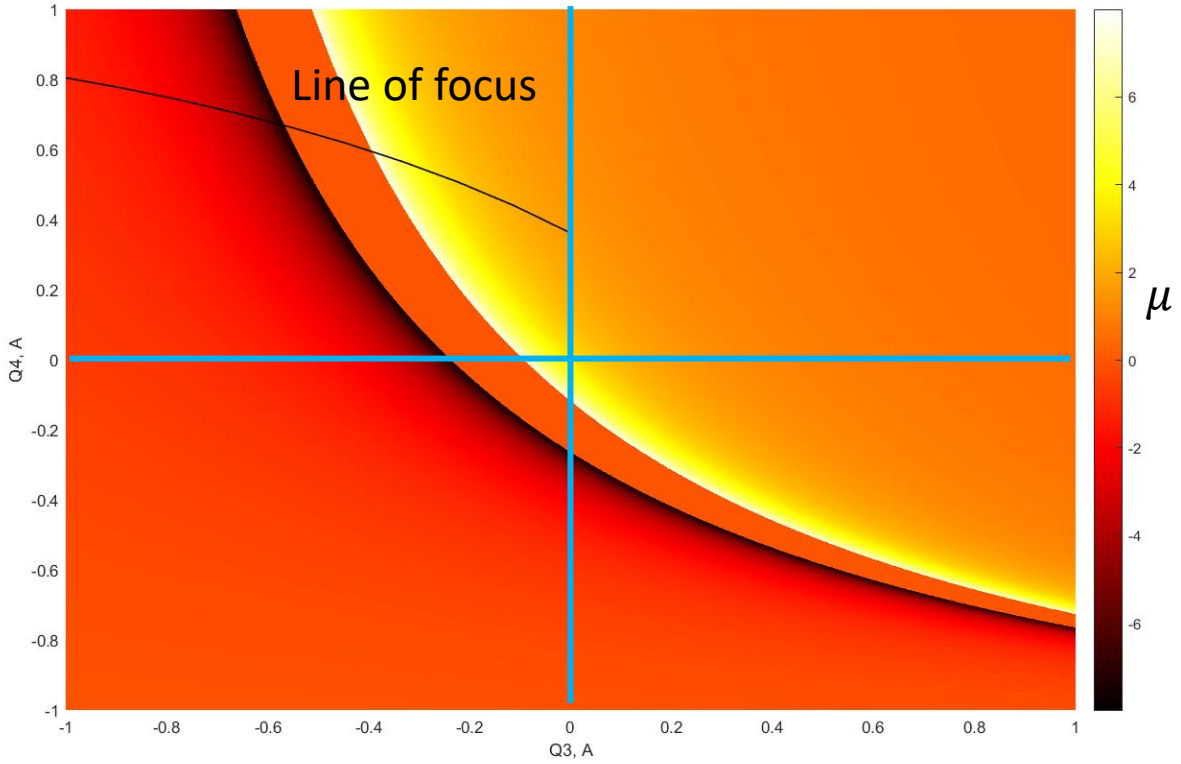
$$\varepsilon = \sqrt{\kappa_\mu \times V_\mu}$$

Beam focusing

- For our beam lattice, focusing fall on quadrant II of map μ, ν
- parabola (σ_ν' or σ_μ') will seat on the line of focus
- For the map of μ, σ_μ' is easy to cross the ridge ($-\infty$ to ∞)
- Also low values μ are not exist in quadrant II
- Therefore, the focusing parameter ν was selected for emittance measurement



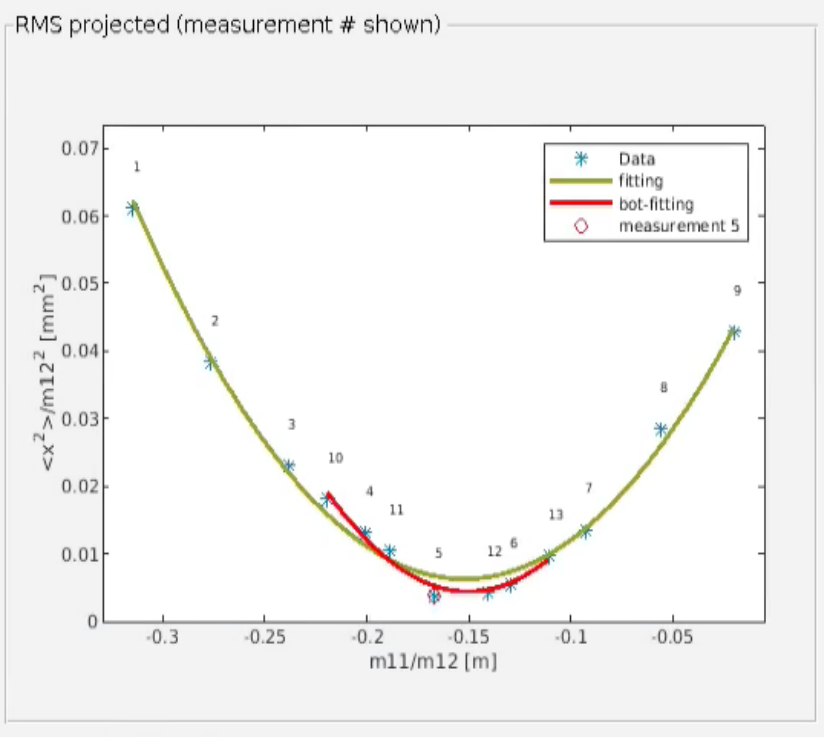




Data fitting

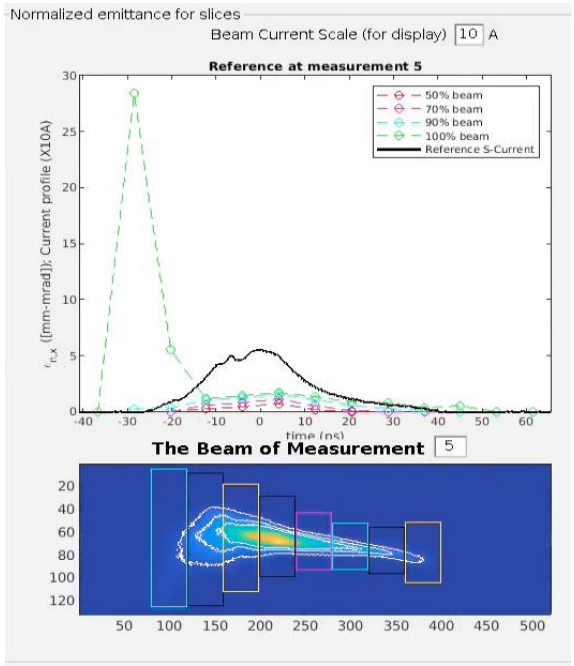
$$\varepsilon = \sqrt{\kappa_\nu \times V_\nu}$$

- Curvature κ was fitted by using all the measurement
- Vertix V was fitted by using bottom range
- This can prevent V from < 0 , giving false emittance result can be calculated from the parabola parameters (κ and V)

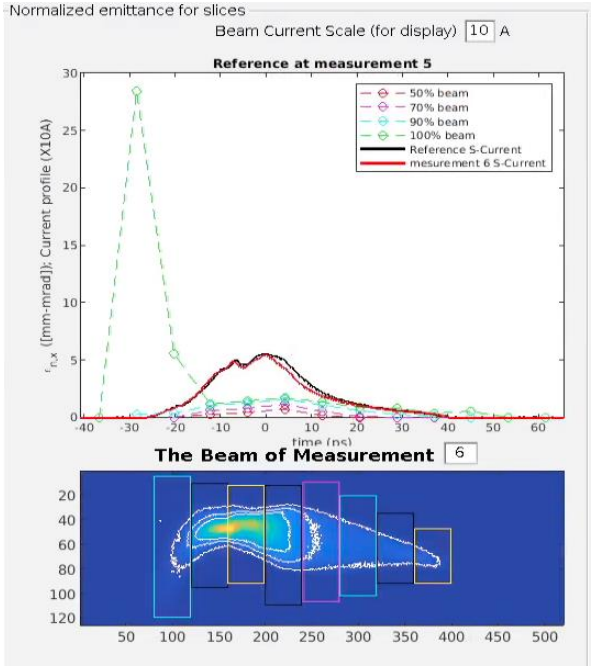


Beam Slicing

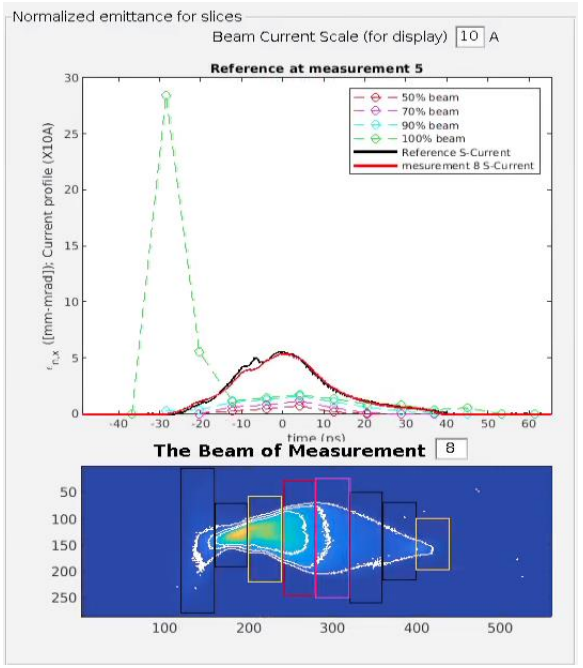
$\nu = -0.17$



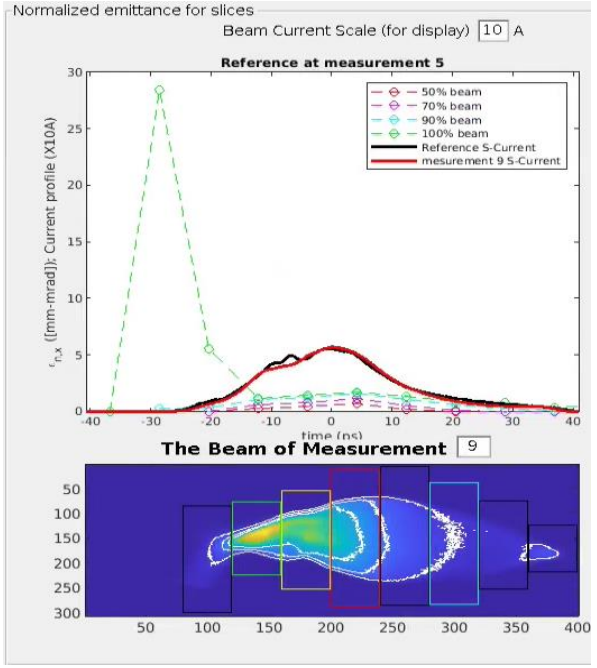
$\nu = -0.13$



$\nu = -0.06$



$\nu = -0.02$



time

Measurement Result