Beam stacking experiment at KURNS 13/10/22

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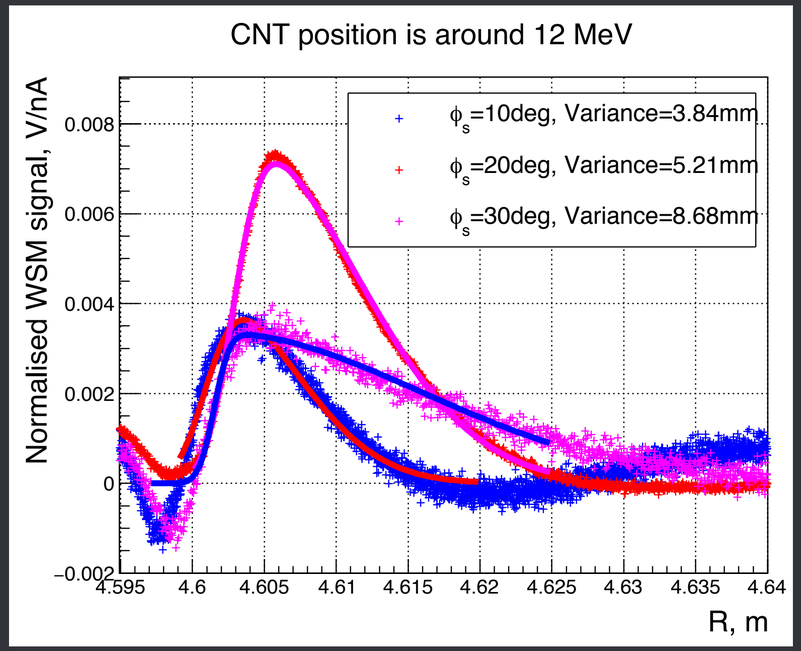
Beam size estimate

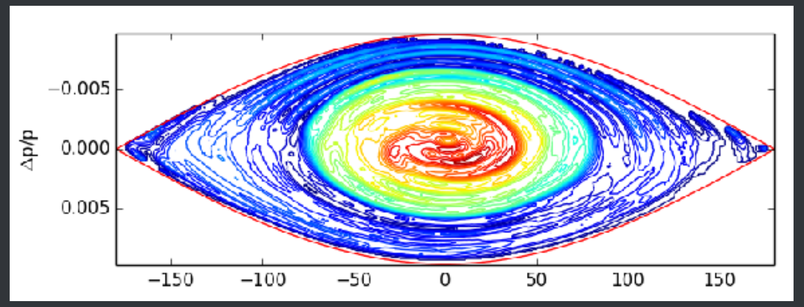
Beam Size	
Kinetic Energy	**Beam Size**
21 MeV	5.49 ± 0.65 mm
24 MeV	5.40 ± 0.81 mm
25 MeV	5.34 ± 0.51 mm
26 MeV	5.11 ± 0.40 mm

(J. Devoille, Master thesis, 2022)



(E. Yamakawa , 21/07/22)

➡ Beam size ~±5 mm



(D. Kelliher, IPAC19)

Beam size from momentum spread: ~3 mm

Beam size from transverse size

(10 π mm.mrad, β=0.9 m): ~3 mm

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Error of measurement

$$\sigma_{\mathrm{beam}} = \sqrt{D^2 \left(\frac{\Delta P}{P}\right)^2 + \epsilon\beta}$$

$$\left(\frac{\Delta P}{P}\right) = \frac{1}{D}\sqrt{\sigma_{\mathrm{beam}}^2 - \epsilon\beta} \quad \Rightarrow \quad d\left(\frac{\Delta P}{P}\right) = \left|\frac{\partial\left(\frac{\Delta P}{P}\right)}{\partial D}\right| dD + \left|\frac{\partial\left(\frac{\Delta P}{P}\right)}{\partial \sigma}\right| d\sigma + \left|\frac{\partial\left(\frac{\Delta P}{P}\right)}{\partial \epsilon}\right| d\epsilon + \left|\frac{\partial\left(\frac{\Delta P}{P}\right)}{\partial \beta}\right| d\beta$$

$$\frac{d\left(\frac{\Delta P}{P}\right)}{\left(\frac{\Delta P}{P}\right)_0} = \left|\frac{dD}{D_0}\right| + \left|\frac{\sigma_0^2}{\sigma_0^2 - \epsilon_0\beta_0}\frac{d\sigma}{\sigma_0}\right| + \left|\frac{\epsilon_0\beta_0}{2\left(\sigma_0^2 - \epsilon_0\beta_0\right)}\frac{d\epsilon}{\epsilon_0}\right| + \left|\frac{\epsilon_0\beta_0}{2\left(\sigma_0^2 - \epsilon_0\beta_0\right)}\frac{d\beta}{\beta_0}\right|$$

$(D_0, \sigma_0, \epsilon_0, \beta_0) = (0.54\,\mathrm{m}, \pm 5\,\mathrm{mm}, 10\,\pi\mathrm{mm.mrad}, 0.9\,\mathrm{m})$

$$\left(\frac{\Delta P}{P}\right)_0 = \pm 0.007$$

$$\frac{d\left(\frac{\Delta P}{P}\right)}{\left(\frac{\Delta P}{P}\right)_0} = 1 \times \left|\frac{dD}{D_0}\right| + 1.56 \times \left|\frac{d\sigma}{\sigma_0}\right| + 0.28 \times \left|\frac{d\epsilon}{\epsilon_0}\right| + 0.28 \times \left|\frac{d\beta}{\beta_0}\right|$$

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Next steps

- Confirmation error numbers
- Data with bunched beam will give momentum spread with tomography, check the results with the present method for comparison