



Science and  
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Facilities Council

# Beam stacking experiment at KURNS 04/11/22

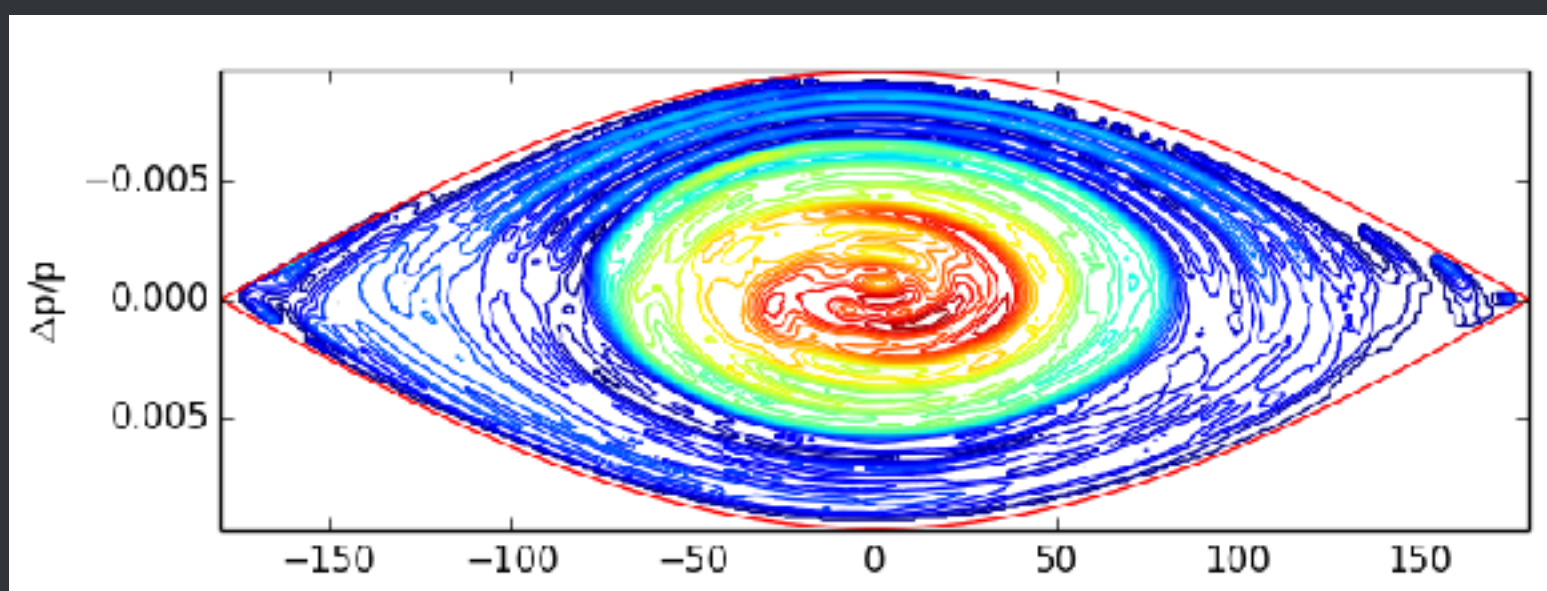
J.B. Lagrange  
ISIS, RAL, STFC

# Beam size estimate

Beam Size	
Kinetic Energy	Beam Size
21 MeV	$5.49 \pm 0.65$ mm
24 MeV	$5.40 \pm 0.81$ mm
25 MeV	$5.34 \pm 0.51$ mm
26 MeV	$5.11 \pm 0.40$ mm

(J. Devoille, Master thesis, 2022)

➔ Beam size  $\sim \pm 5$  mm



(D. Kelliher, IPAC19)

Beam size from momentum spread:  $\sim 3$  mm  
Beam size from transverse size  
( $10 \pi$  mm.mrad,  $\beta=0.9$  m):  $\sim 3$  mm

# Error of measurement

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

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

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

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

$$\left(\frac{\Delta P}{P}\right)_0 = \pm 0.007 \quad \frac{d\left(\frac{\Delta P}{P}\right)}{\left(\frac{\Delta P}{P}\right)_0} = 1 \times \left|\frac{dD}{D_0}\right| + 1.56 \times \left|\frac{d\sigma}{\sigma_0}\right| + 0.28 \times \left|\frac{d\epsilon}{\epsilon_0}\right| + 0.28 \times \left|\frac{d\beta}{\beta_0}\right|$$

11% (J. Devoille) → 18% error

# Conclusion

- Confirmation error numbers
- Large error from beam size measurement uncertainty