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Sensitivity to the EDM with added acceptance effects

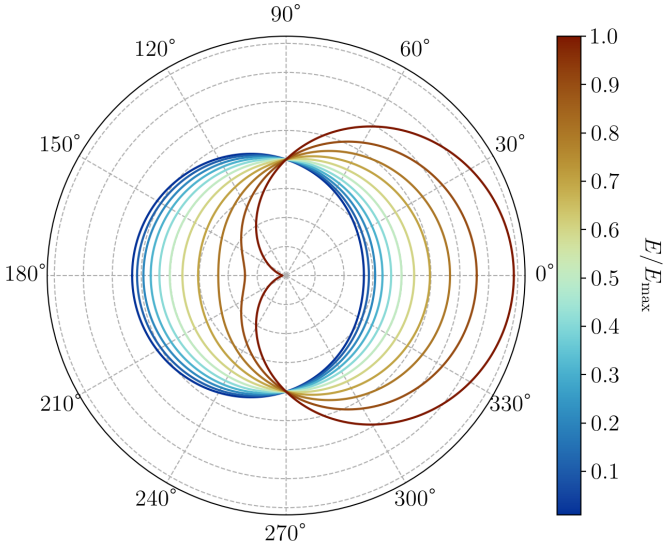
muEDM collaboration meeting – April 2024, Pisa (remote)

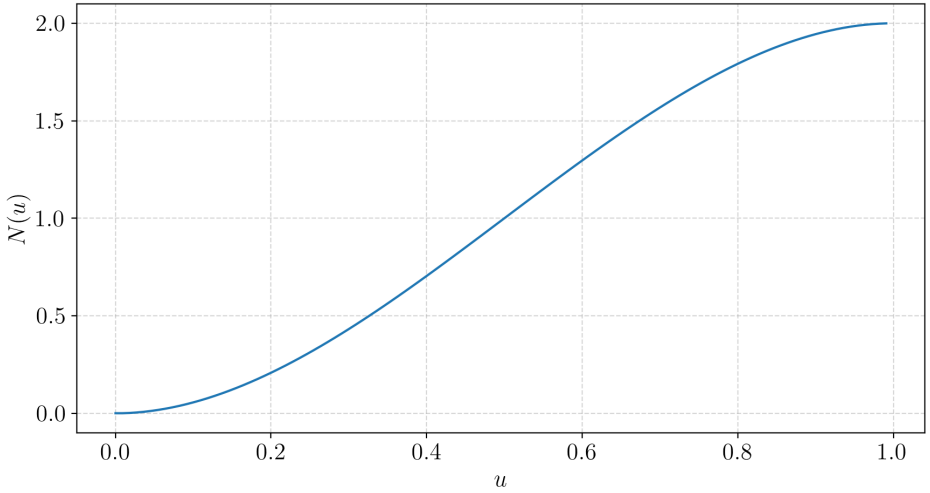
Angular distribution of the e^+ decay

Differential probability in the muon rest frame:

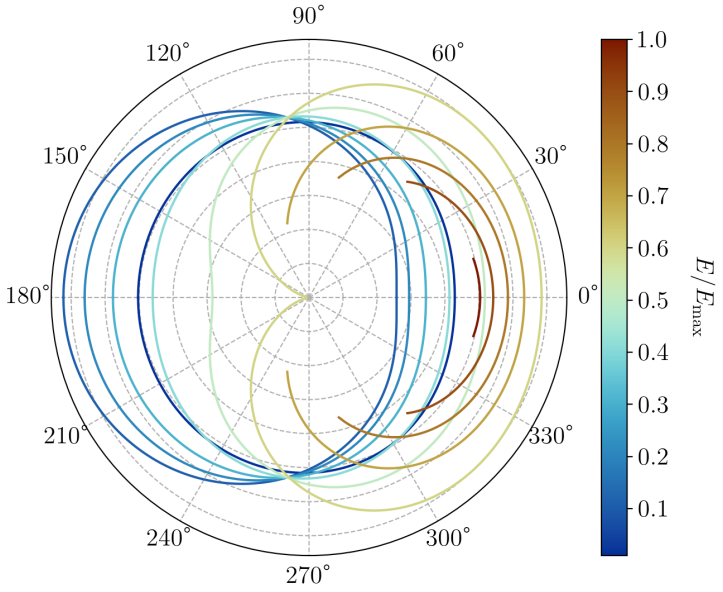
$$W(x, \cos\alpha)dx\ d\cos\alpha = x^2\ ((3-2x) + (2x-1)\cos\alpha)\ dx\ d\cos\alpha$$

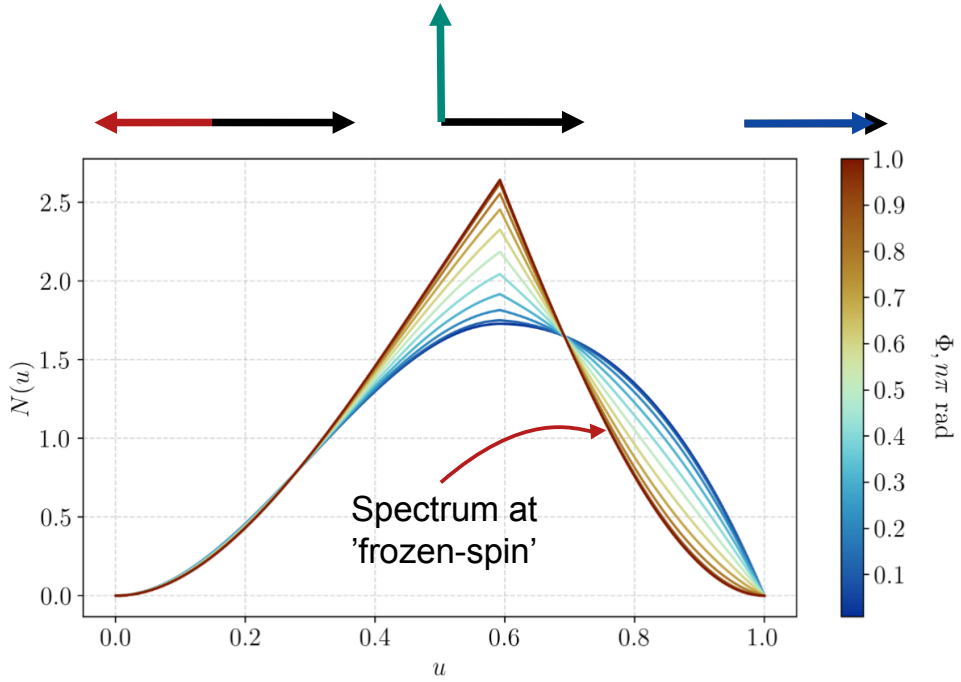
$$x = \frac{E}{E_{\max}}, \quad y = \cos\alpha, \text{ where } \alpha = \arctan\frac{E_x}{E_z}$$



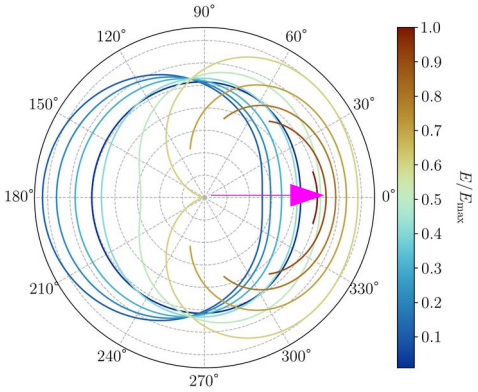


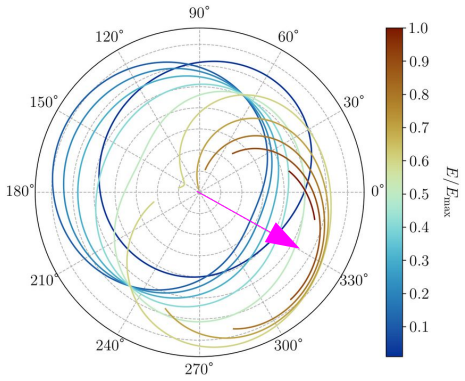
Boosted spectrum as a function of spin direction

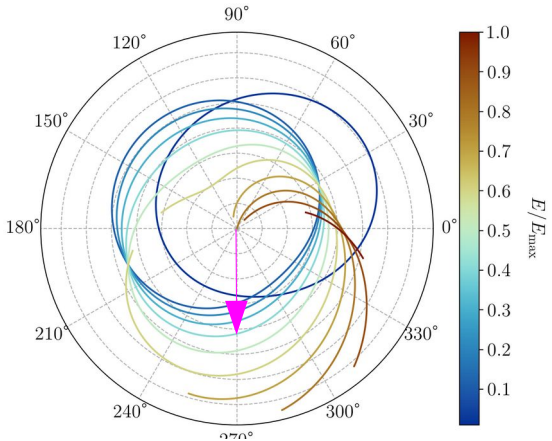


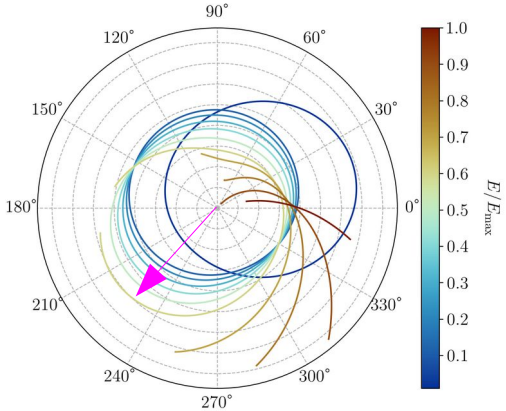


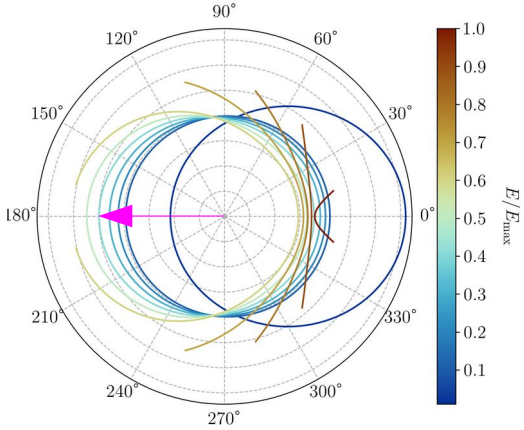
Boosted spectrum as a function of spin direction



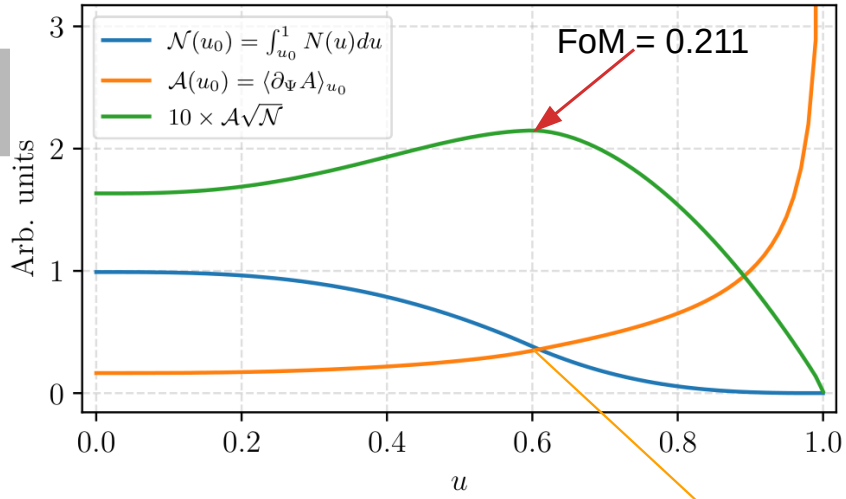




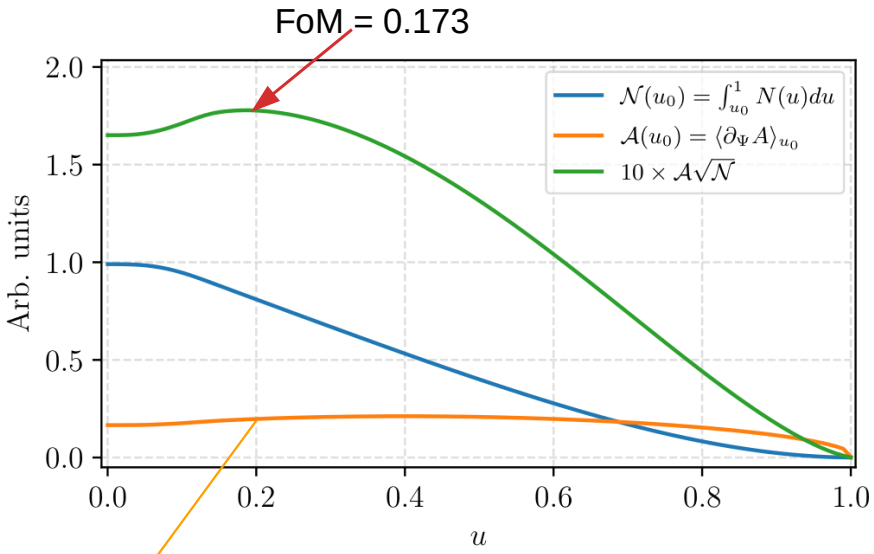




EDM Figure of Merit – Phase I and II



(a) Phase I, $p = 28\,\mathrm{MeV}/c$

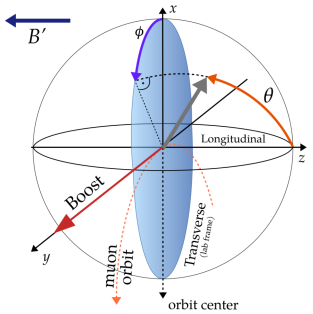


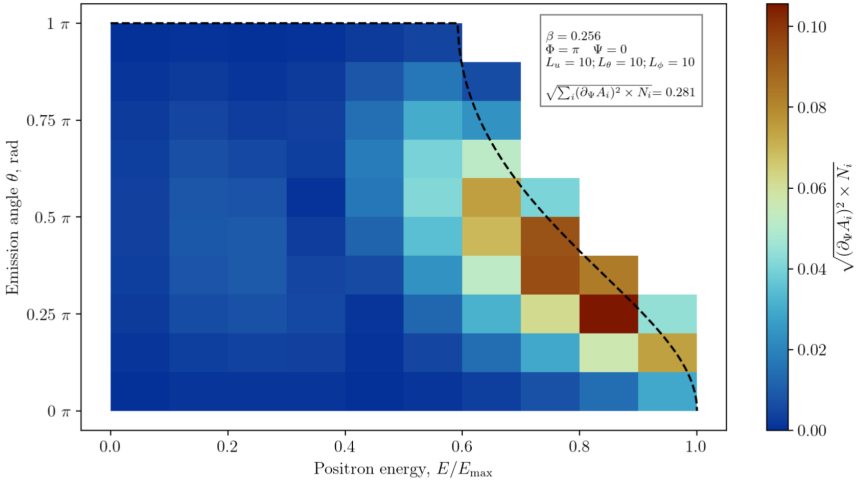
(b) Phase II, $p = 125\,\mathrm{MeV}/c$

$$\sigma_{d_\mu} = \frac{\hbar}{2c\beta B\alpha P}\frac{1}{\gamma\tau\sqrt{N}} \qquad \dot{A}_m = \frac{2c}{\hbar}\beta B\alpha P_0 d_\mu$$

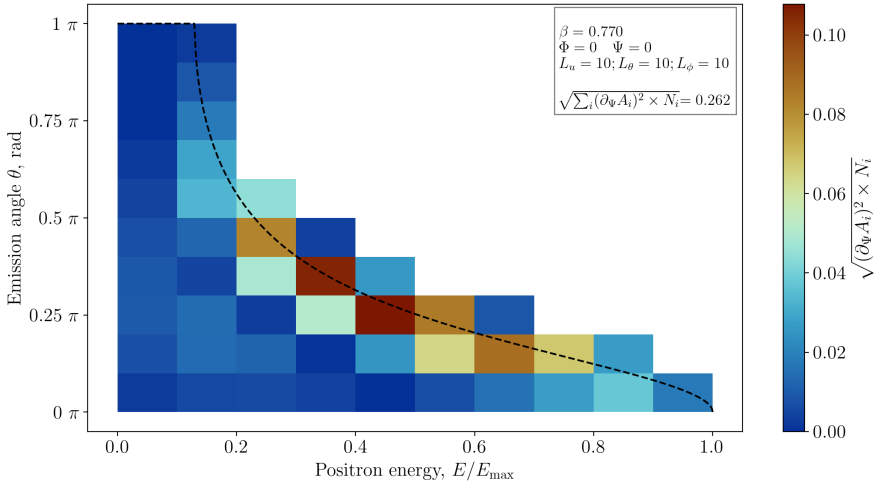
FoM is used to calculate the uncertainy and ***A*** to get d_μ from the measured signal

Binned analysis for Phase I and II





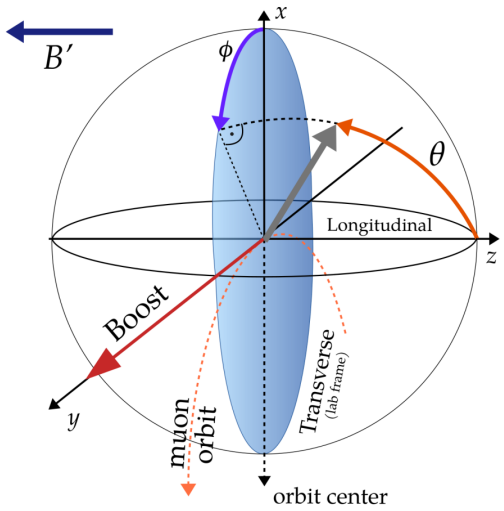
Simple: 0.167 → T-method: 0.211 → W-method: 0.281

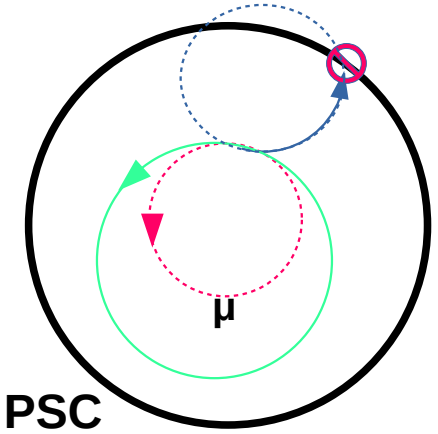


Simple: 0.167 → T-method: 0.173 → W-method: 0.262

Considering the magnet bore

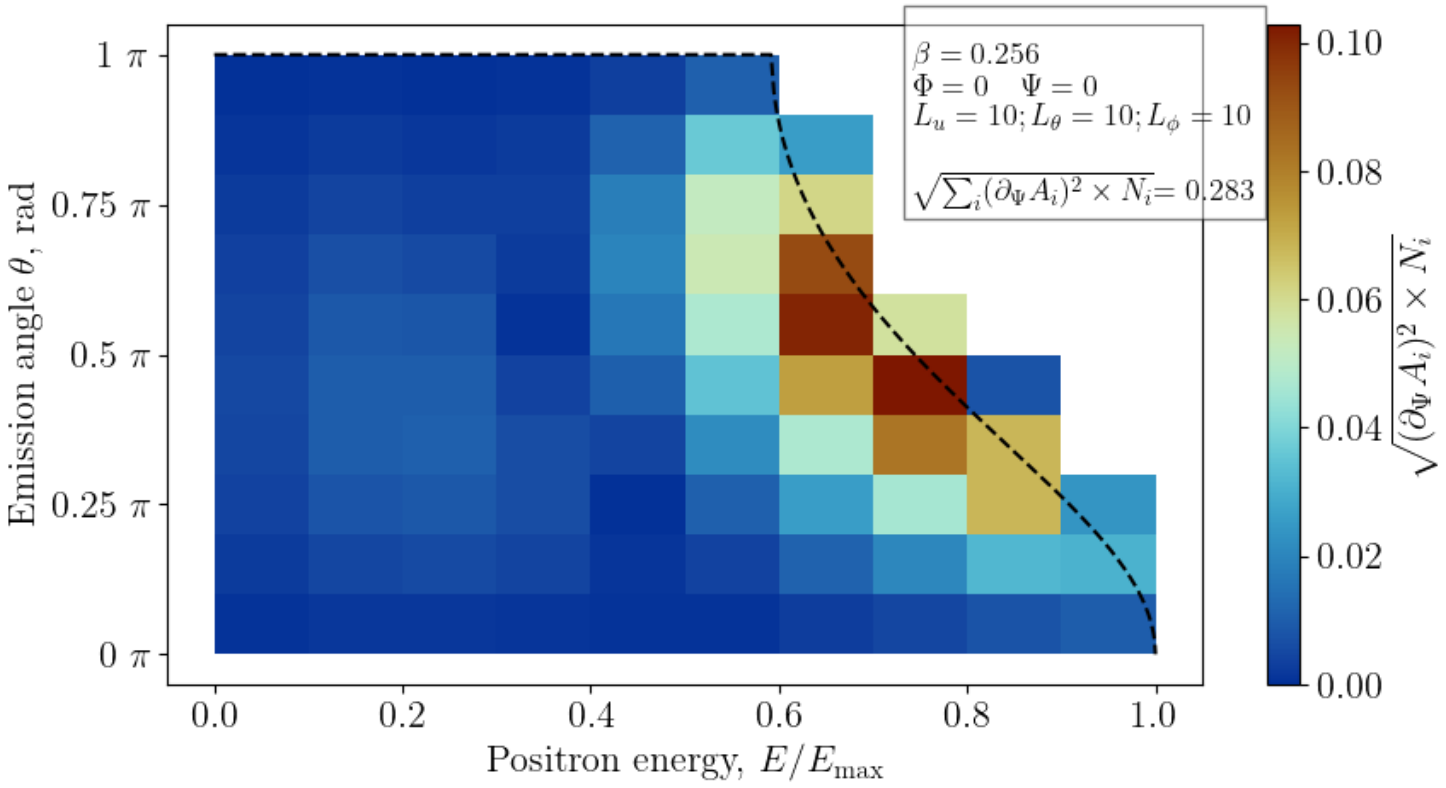
- The acceptance is included as a function of positron energy and emission direction that multiplies the angular distribution.
- If the positron orbit radius (transverse momentum) + muon orbit radius > magnet bore, then the positron is lost.
- Transverse emission angle also considered:
  - Forward emission leads to orbit that is on the inside of the muon one, backward emission to orbit that is outside.





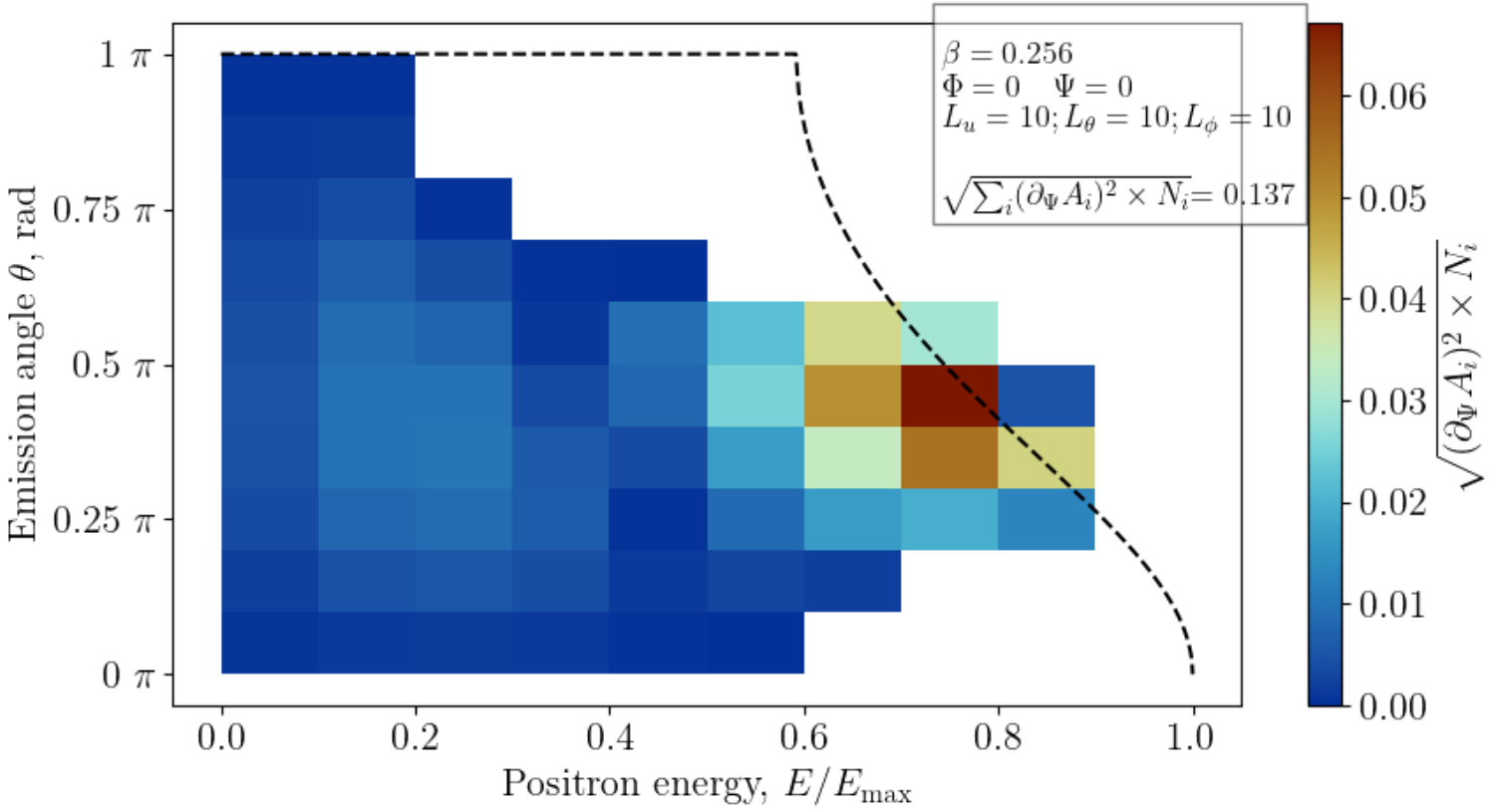
Large bore (no acceptance effects)

FoM = 0.283



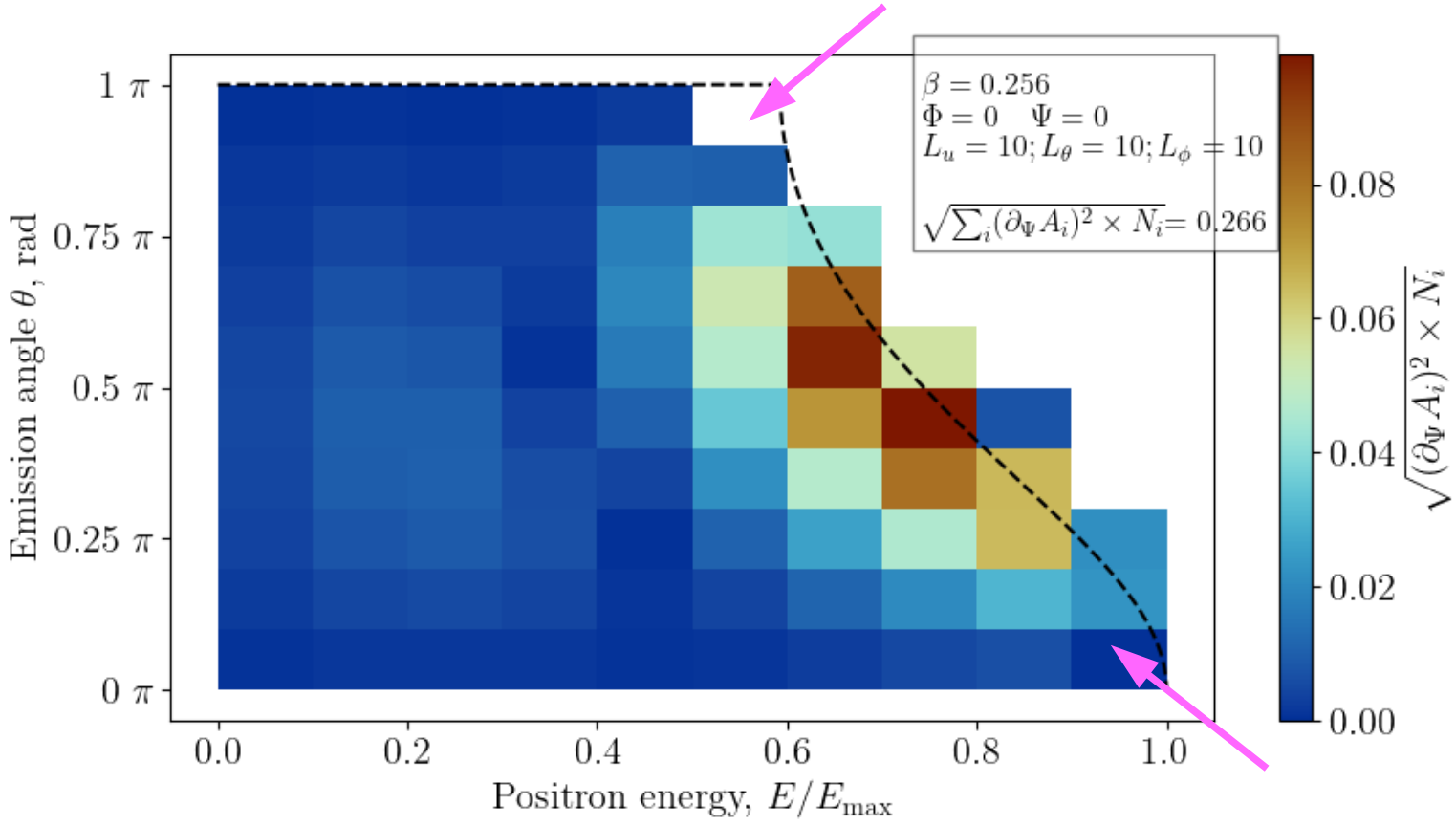
5 cm radius bore (for illustration)

FoM = 0.137

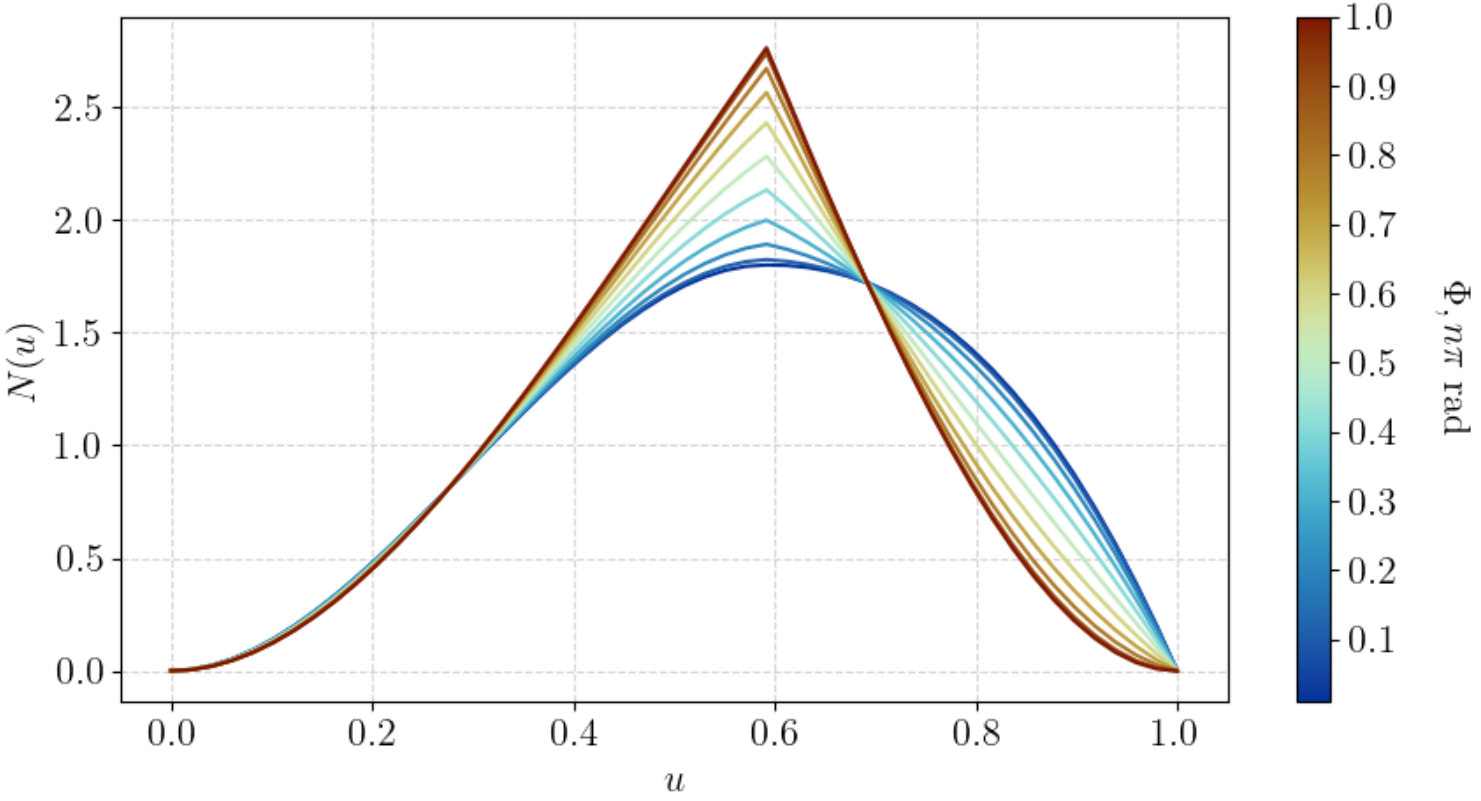


10 cm radius bore (acceptance effects)

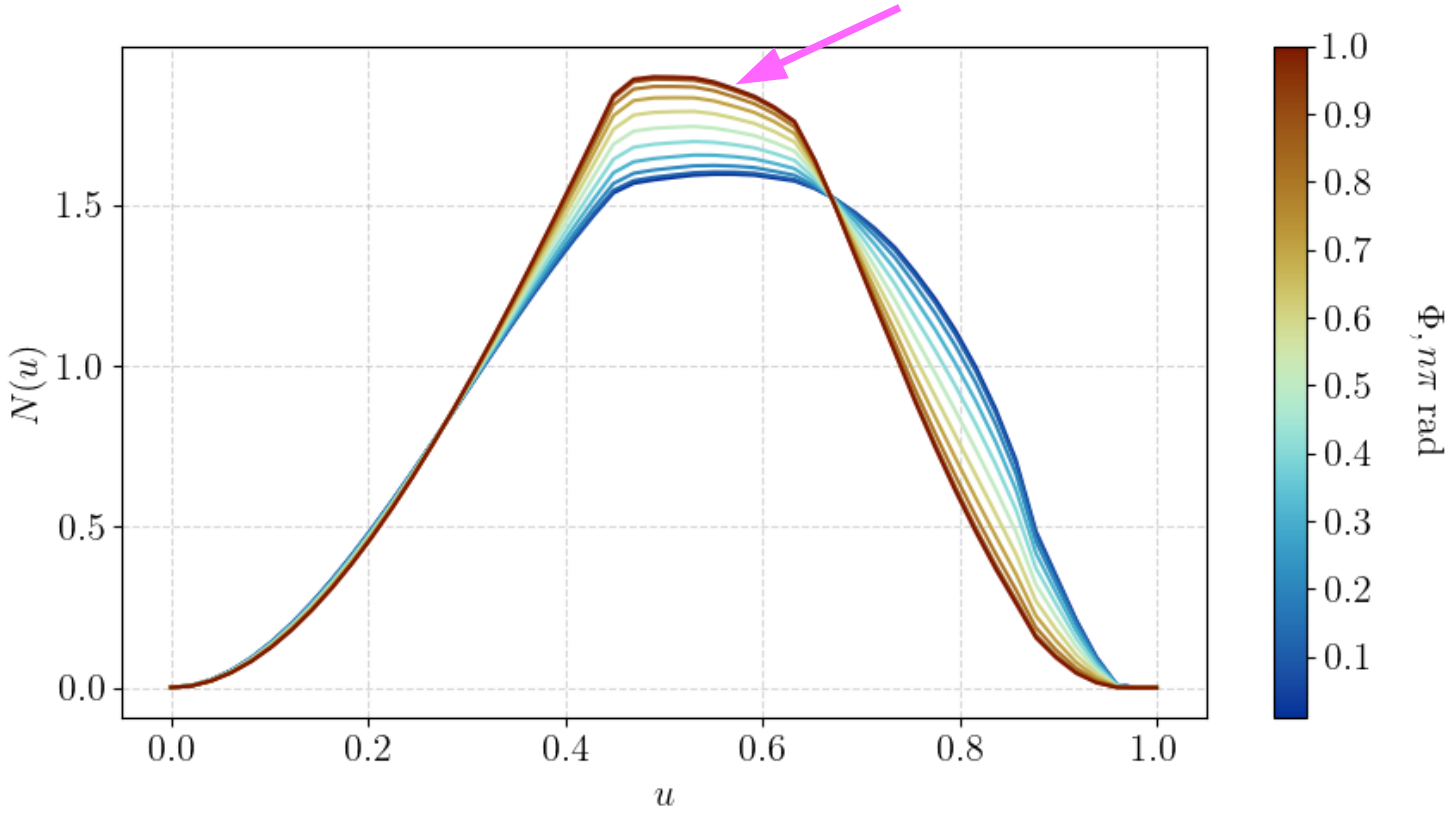
FoM = 0.266



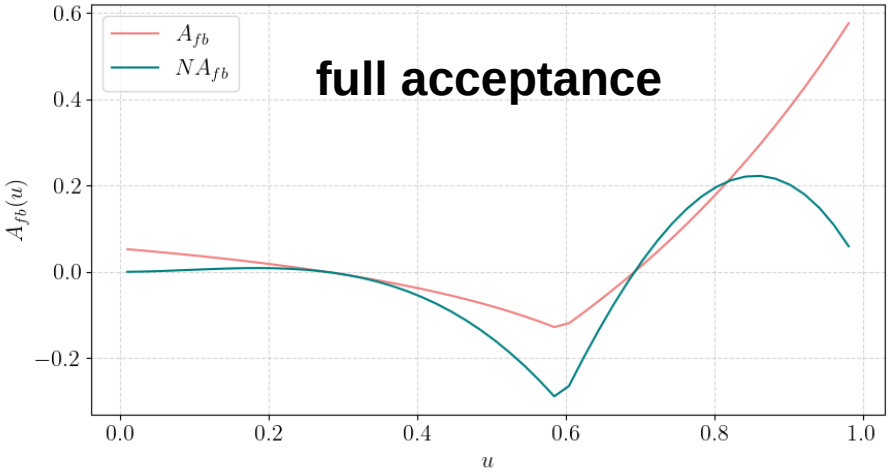
Positron spectrum (no acceptance effects)

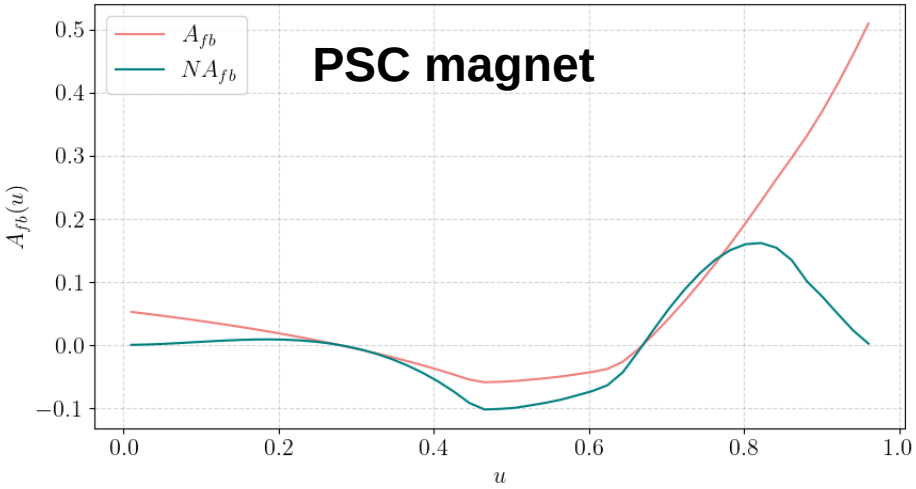


Positron spectrum (PSC magnet)

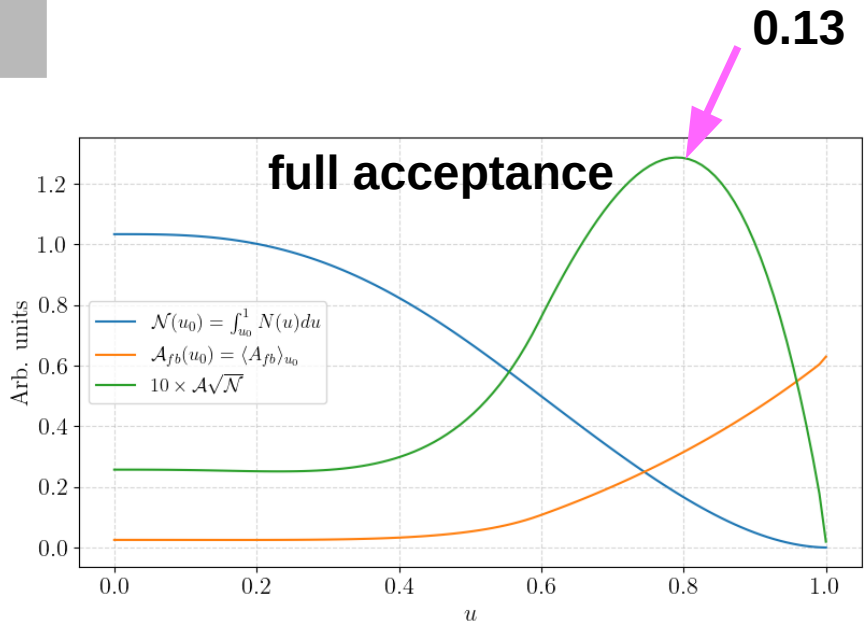


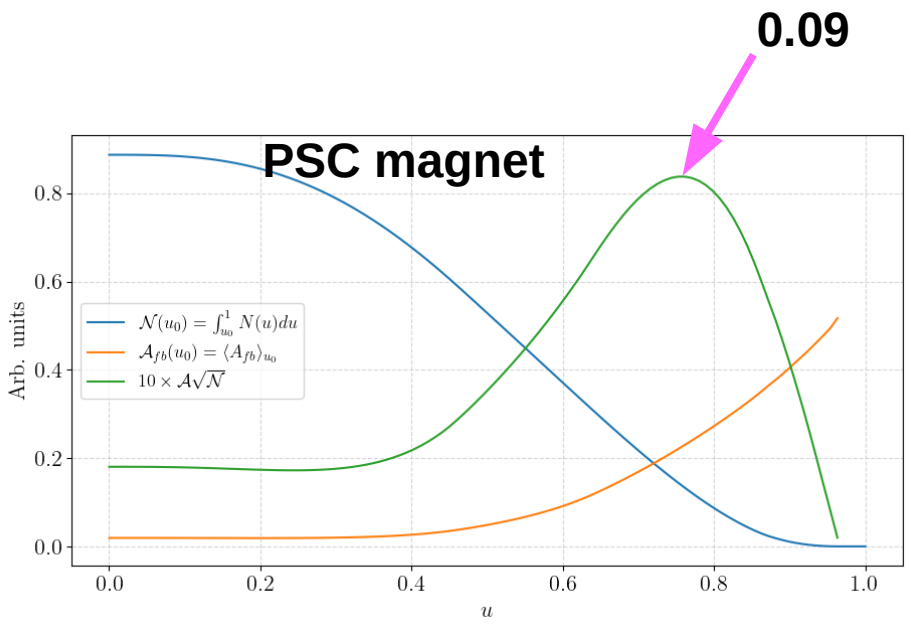
Forward-backward asymmetry (g-2)





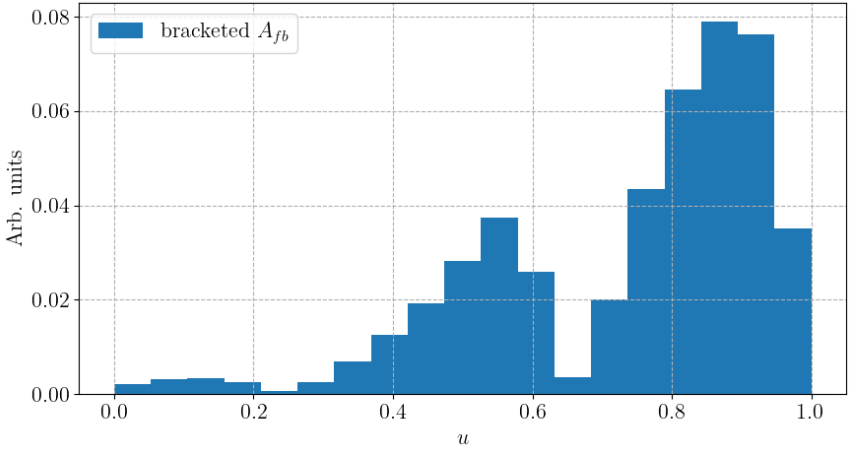
(g-2) Figure of merit



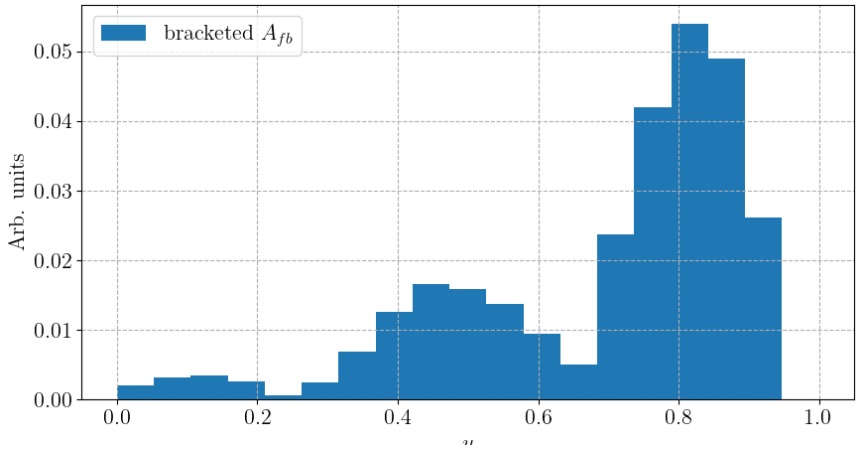


(g-2) Figure of merit with energy brackets

FoM = 0.152



FoM = 0.097



Conclusions

- Added reduced acceptance effects due to the bore of the PSC magnet.
- The FoM for the EDM reduces slightly when considering the positron loss
  - 0.283 to 0.266 for the W-method with 10x10x10 bins.
  - For the T-method the reduction is from 0.206 to 0.196
- The FoM for the *g-2* reduces from around 0.13 to 0.09 using the threshold method with threshold at 55 MeV (positrons).
- Going to energy brackets brings very little improvement.