Experiment 03045:
Two particle correlation functions and isospin effects in nuclear reactions

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for HiRA collaboration
Motivation I

- investigation of density dependence of the symmetry energy, \( E_{\text{sym}}(\rho) \) in the equation of state

  two-proton correlation functions

  greatest sensitivity to \( E_{\text{sym}}(\rho) \) at low relative particle momenta \( q<15\text{MeV}/c \)

- stiff \( E_{\text{sym}}(\rho) \):
  => earlier, more correlated pre-eq. emission
  => emitting source less expanded in space
  => larger radii of neutron stars
Experimental idea

- 4pi detector provides impact parameter selection and reaction plane reconstruction

- Light charge particle correlations detected by HiRA are sensitive to $N/Z$ content of the initial systems.

- Reaction systems:
  
  $^{40}$Ca + $^{40}$Ca at 80 $\text{A MeV}$
  $^{48}$Ca + $^{48}$Ca at 80 $\text{A MeV}$
Experimental challenge (op.I)

How to combine HiRA and 4pi detector?
Experimental challenge \textit{(op.II)}

How to combine HiRA and 4pi detector?

1\textsuperscript{st} attempt =>
Experimental challenge *(op.III)*

**How to combine HiRA and 4pi detector?**

- 17 HiRA telescopes
- 63 cm from the 4pi center (i.e. target)
- 7.5-8° apart
- ang. Coverage 20-60°

*Design by Len Morris*
Experimental challenge (*op.* IV)

**HiRA ready for 4pi**

Fabrication: Doug Miller, Jay Pline, Bob Weldon, ...

4pi resurrection: Skip Vander Molen, Daniela Henzlova
Experimental challenge (*op.*V)

*HiRA inside 4pi:*
Experimental challenge (op. VI)

**Calcium targets:**

⇒ Calcium quickly oxidizes in air atmosphere (~ minutes)

⇒ All $^{40}$Ca and $^{48}$Ca targets rolled and assembled in argon atmosphere inside the glove box *(Sergei Lukyanov and Micha Kilburn)*
Preliminary results - multiplicities

Event multiplicity in 4π gated by mult ≥2 in CsI

Micha Kilburn, Betty Tsang
Preliminary results - PID

Energy loss in Si detector (1.5 mm) vs. energy in CsI (40 mm)

Betty Tsang
Preliminary results - PIDs

Detail of PID plot (energy in thick Si vs. energy in CsI)

Betty Tsang
Preliminary results – recoil p calib.

Calibration of CsI with recoil protons from $^{40}$Ca + CH$_2$ reaction