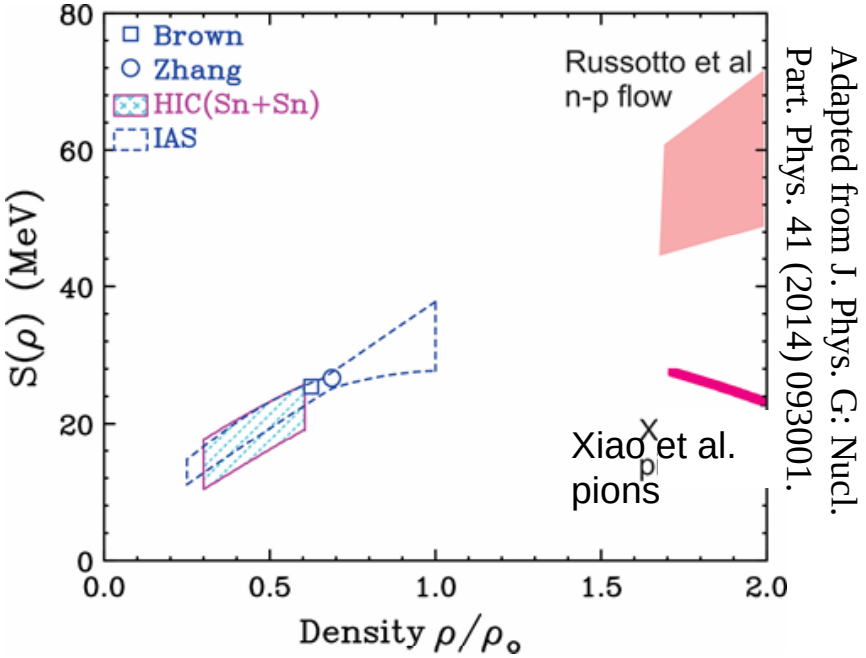
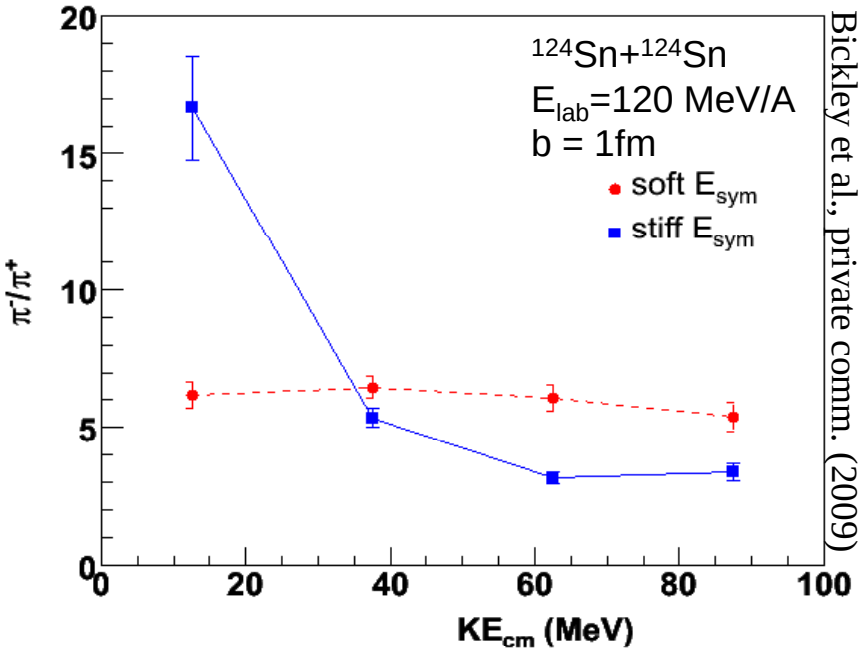
Probing the symmetry energy with fast n-rich beams

Constraints on S(ρ)



Adapted from J. Phys. G: Nucl. Part. Phys. 41 (2014) 093001.

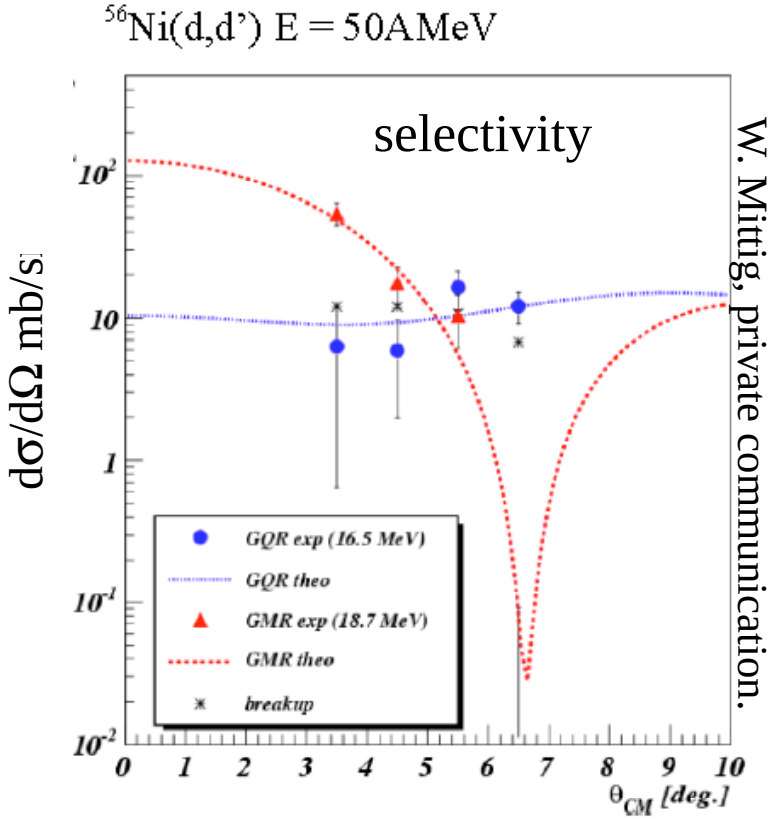
Example: using pions to probe $\rho>\rho_0$

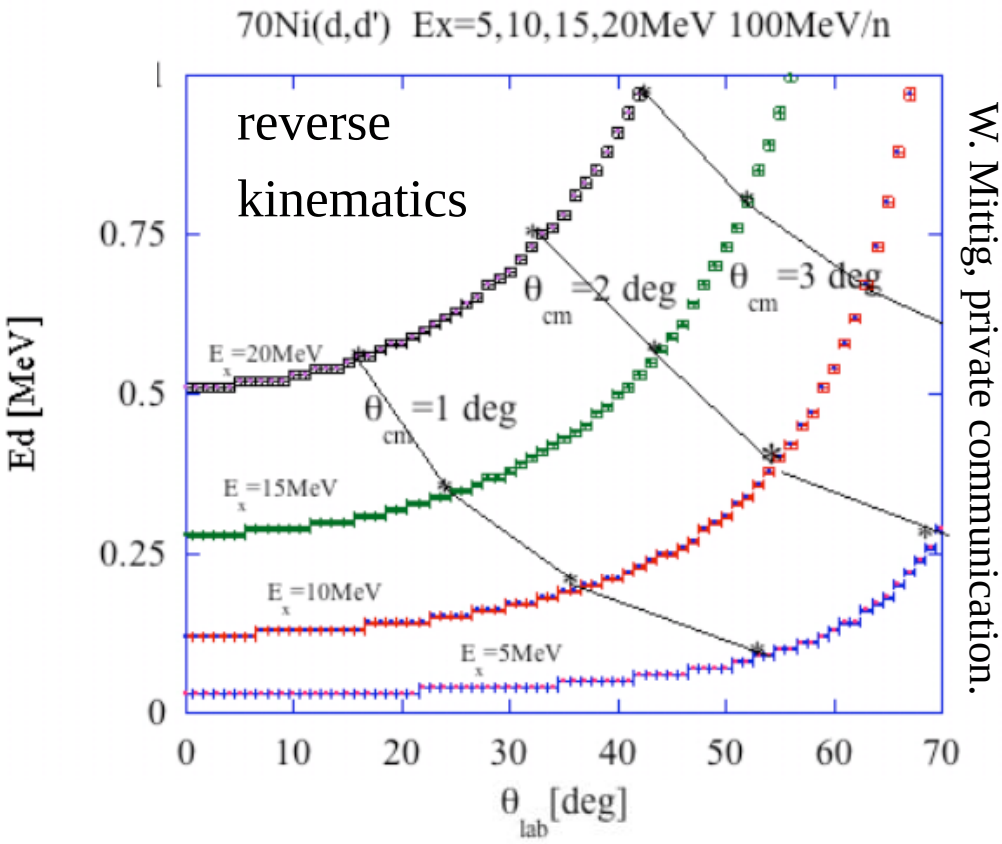


Bickley et al., private comm. (2009)

- Have some consistency in constraints at $\rho<\rho_0$, but much large uncertainties at $\rho>\rho_0$:
  - Goal is to increase the sensitivity of observables to the symmetry energy using RIB's and to assess and reduce the model dependence by requiring consistency with a "large" range of "reliable" observables.
- Highest sensitivity to symmetry energy obtained with the most neutron-rich systems.
- Best reaction rates are often obtained at the highest energy, requiring very rigid neutron rich beams as the justification for the High Rigidity Spectrometer (HRS).
- The right panel illustrates sensitivity at $\rho>\rho_0$ for pion production that could be explored with HRTPC on a high rigidity beam line. Sensitivity is greater for ^{132}Sn beam.

Another example, GMR in rare isotopes using Active Target-Time Projection Chamber AT-TPC

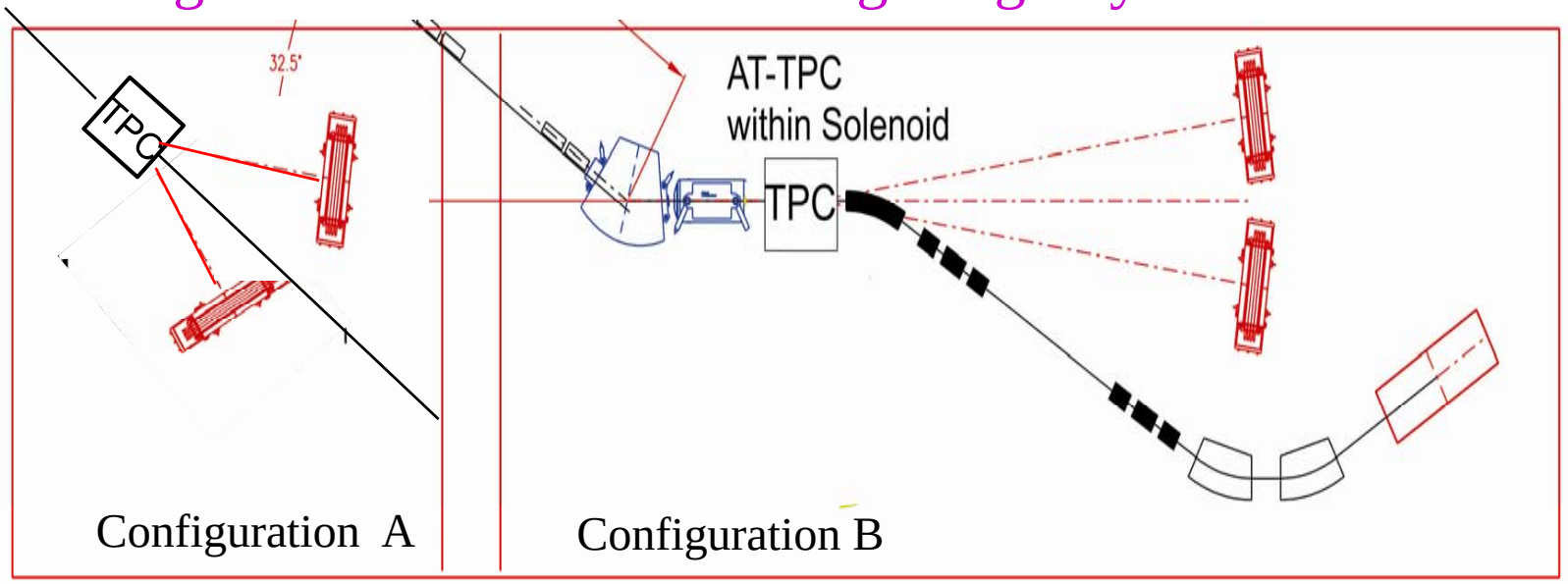




- Interesting to explore long isotope chains: e.g. Sn isotopes ^{104}Sn – ^{134}Sn
- Gives

$$K_\tau = K_{sym} - 6L - \frac{L}{K_\infty}\frac{27\rho_0^3\partial^3\left(\varepsilon_{SNM}/\rho\right)}{\partial\rho^3}$$

Two Configurations for HRTPC in High Rigidity Vaults at FRIB



- Configuration A
  - Allows standalone operation and more flexible arrangements and higher angular coverage.
  - pion production and flow
  - n-p, t, ^{3}He, fragment (IMF) spectra and flows
  - Fragmentation studies, very low density (neutrino-sphere EOS)
- Configuration B
  - Allow some of the studies of configuration A but with reduced efficiency.
  - Allows GMR studies in active target mode
  - Allows (d,^{2}He) excitations of Gamow-Teller and Spin Dipole resonances
  - five week typical switchover times between major configurations