Measuring Fusion (ER) under reverse kinematics conditions

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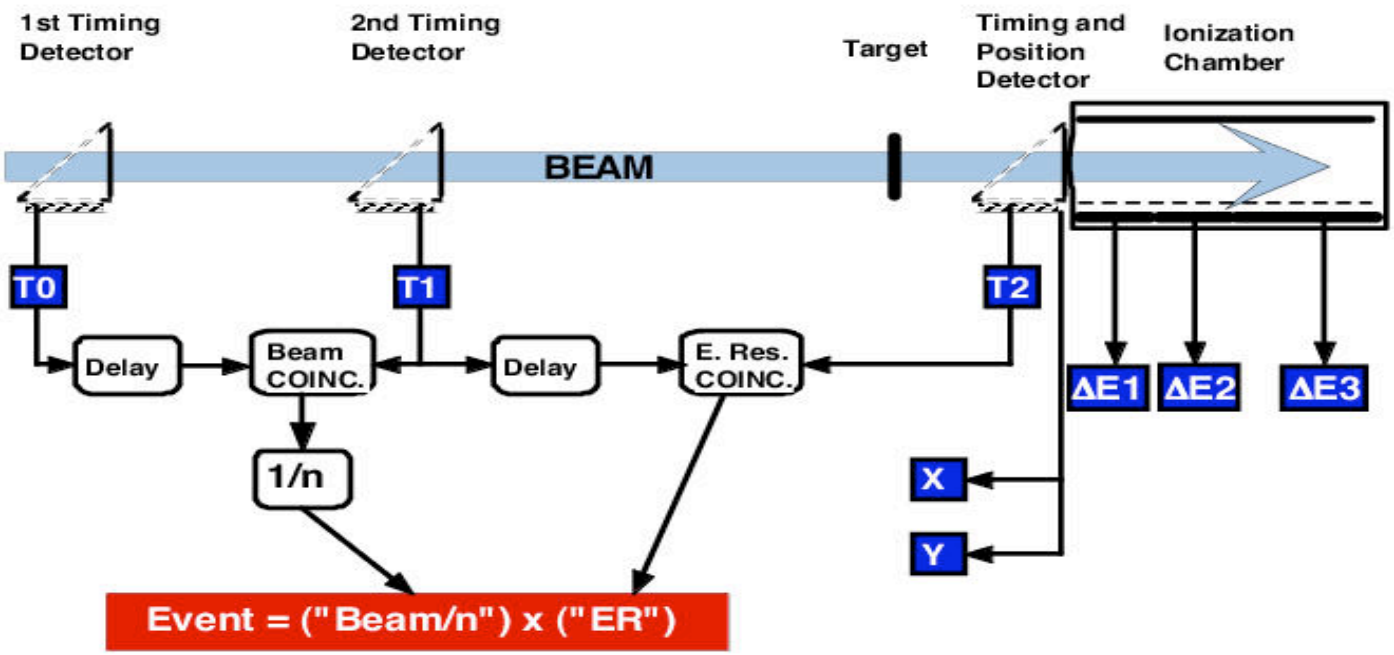
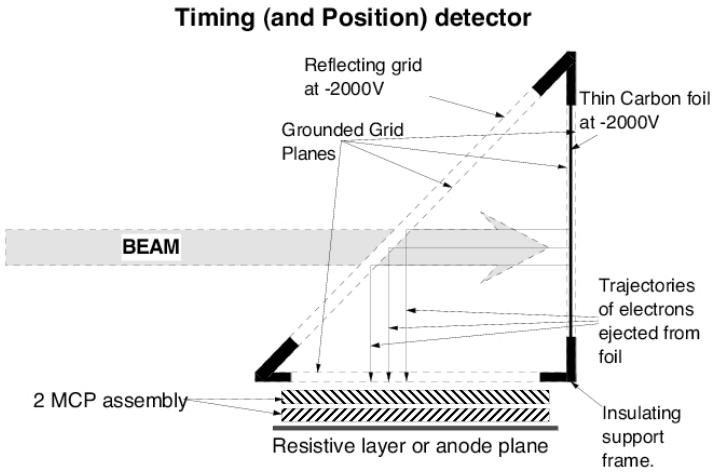
HRIBF Workshop - Near and Sub-barrier Fusion of Radioactive Ions with Medium and Heavy Targets
December 2-3, 2005

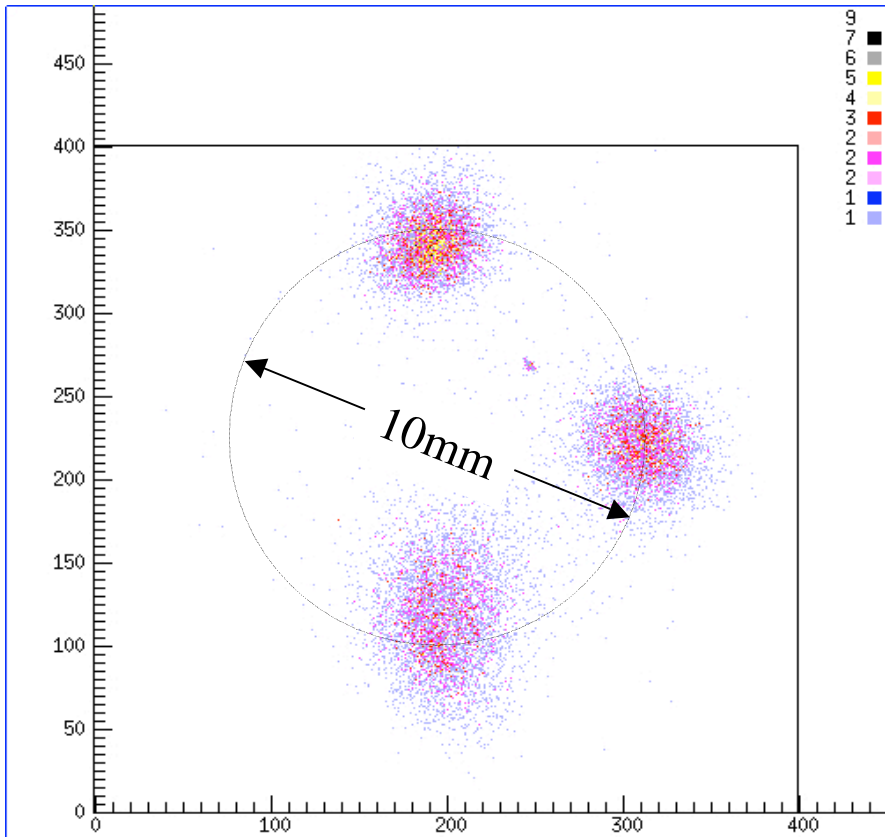
The present system

- With Inverse Kinematics efficiency ~100%.
- Normalization is simple and accurate.

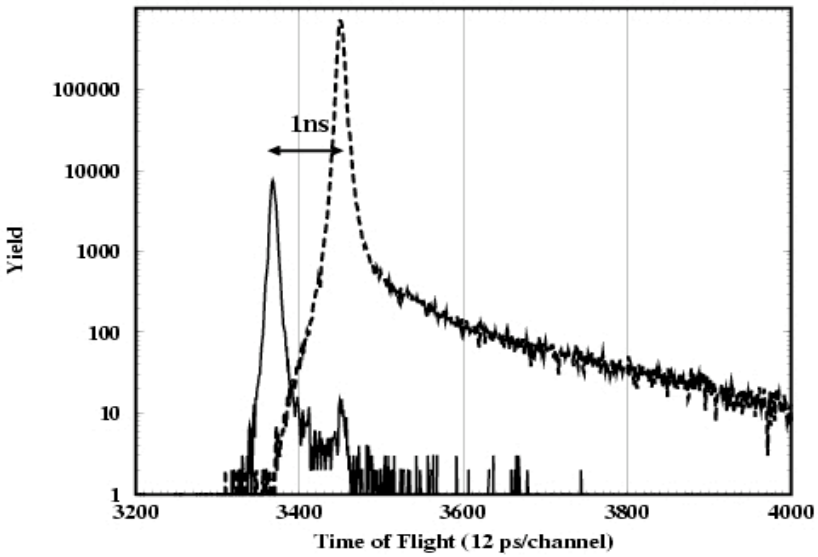


The position and timing detector



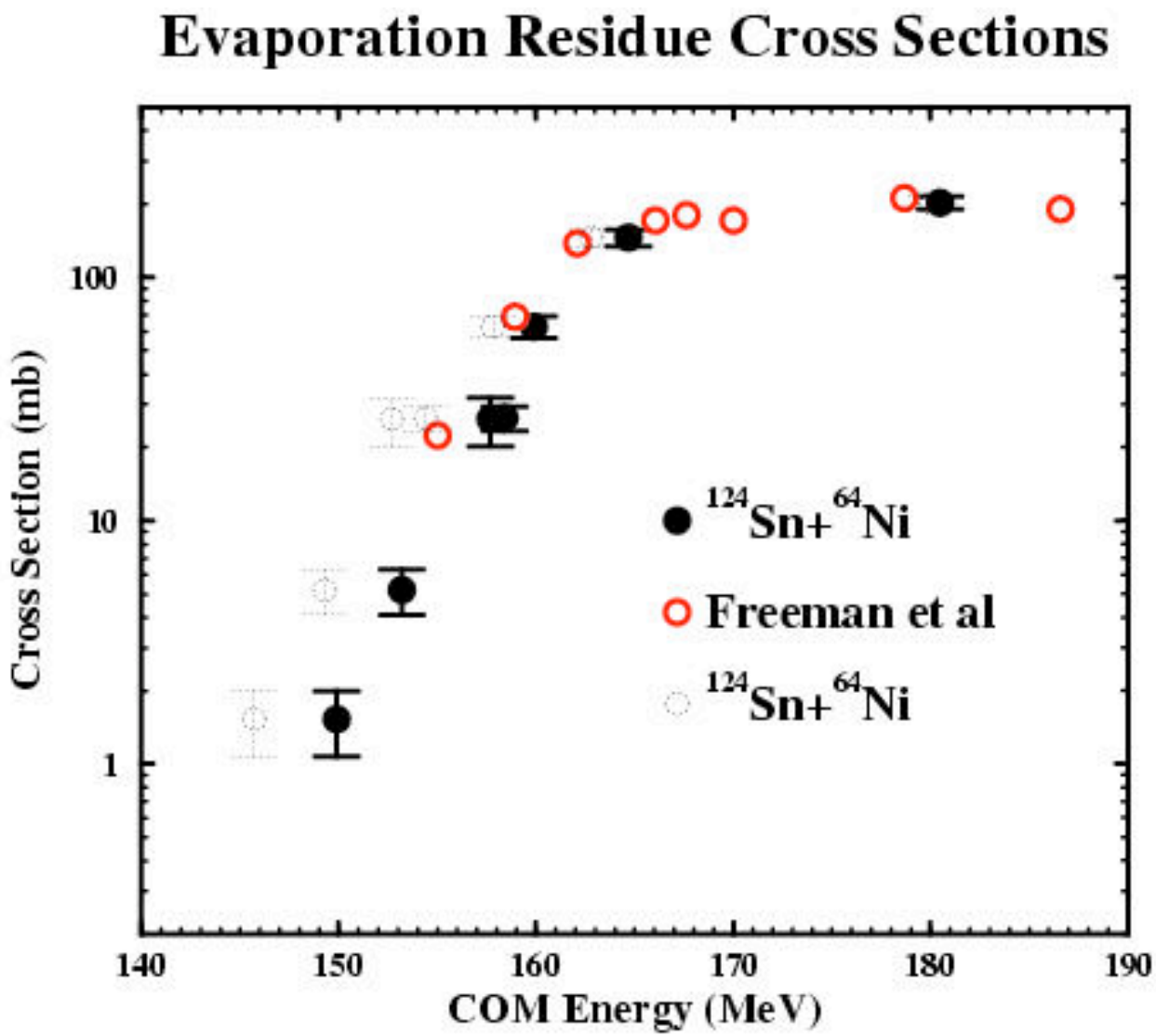


Position

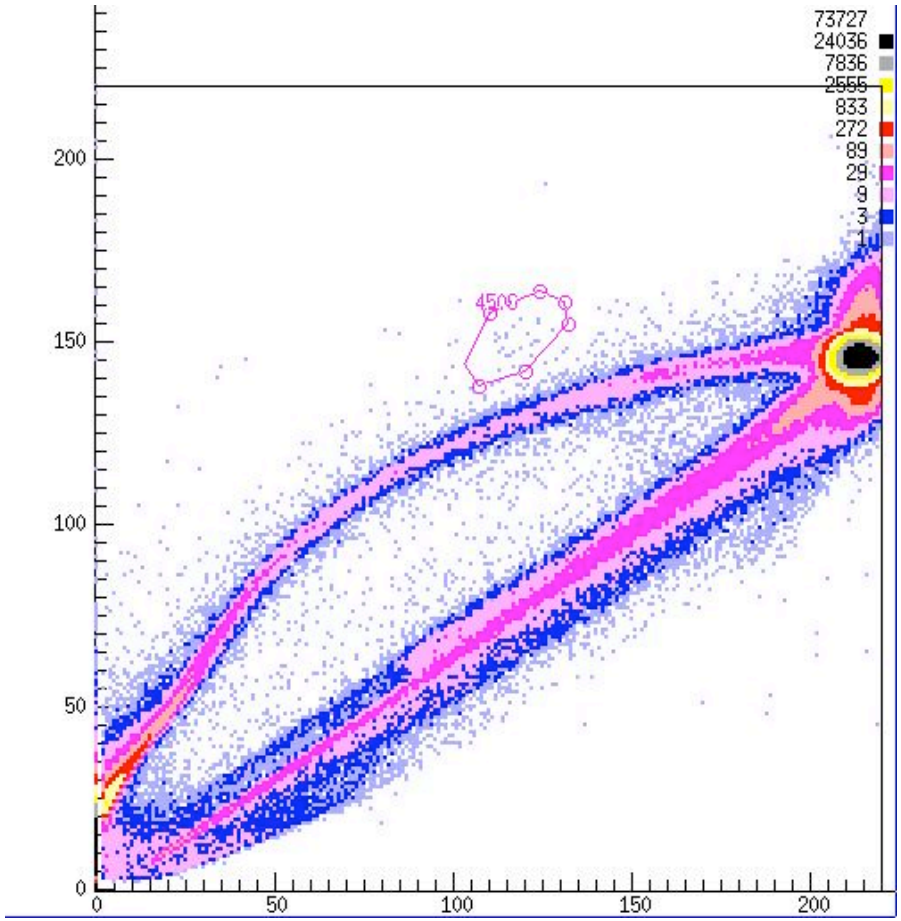


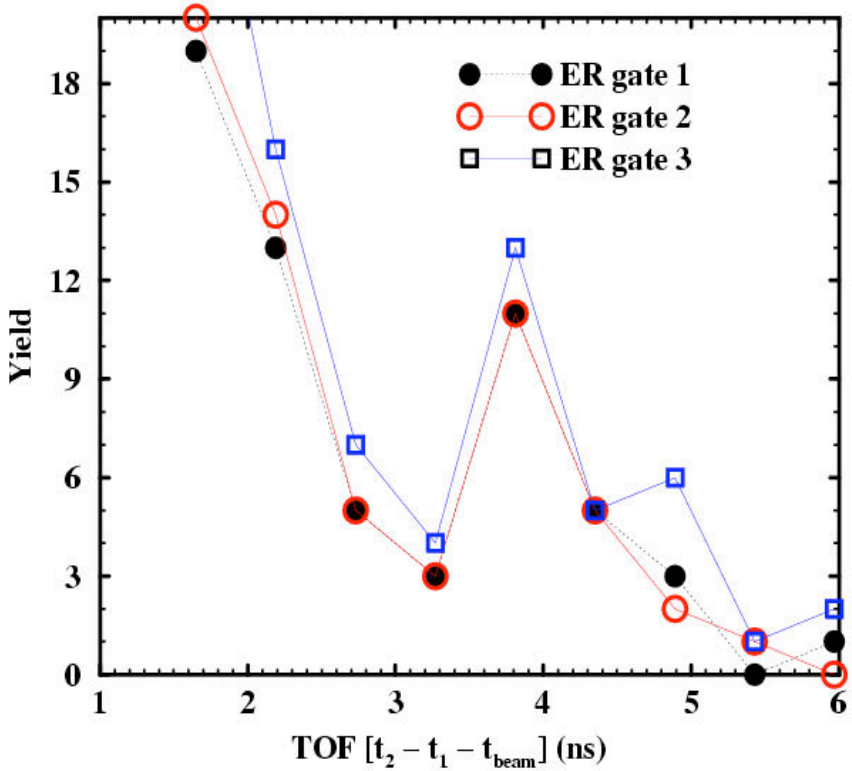
Timing

Testing….

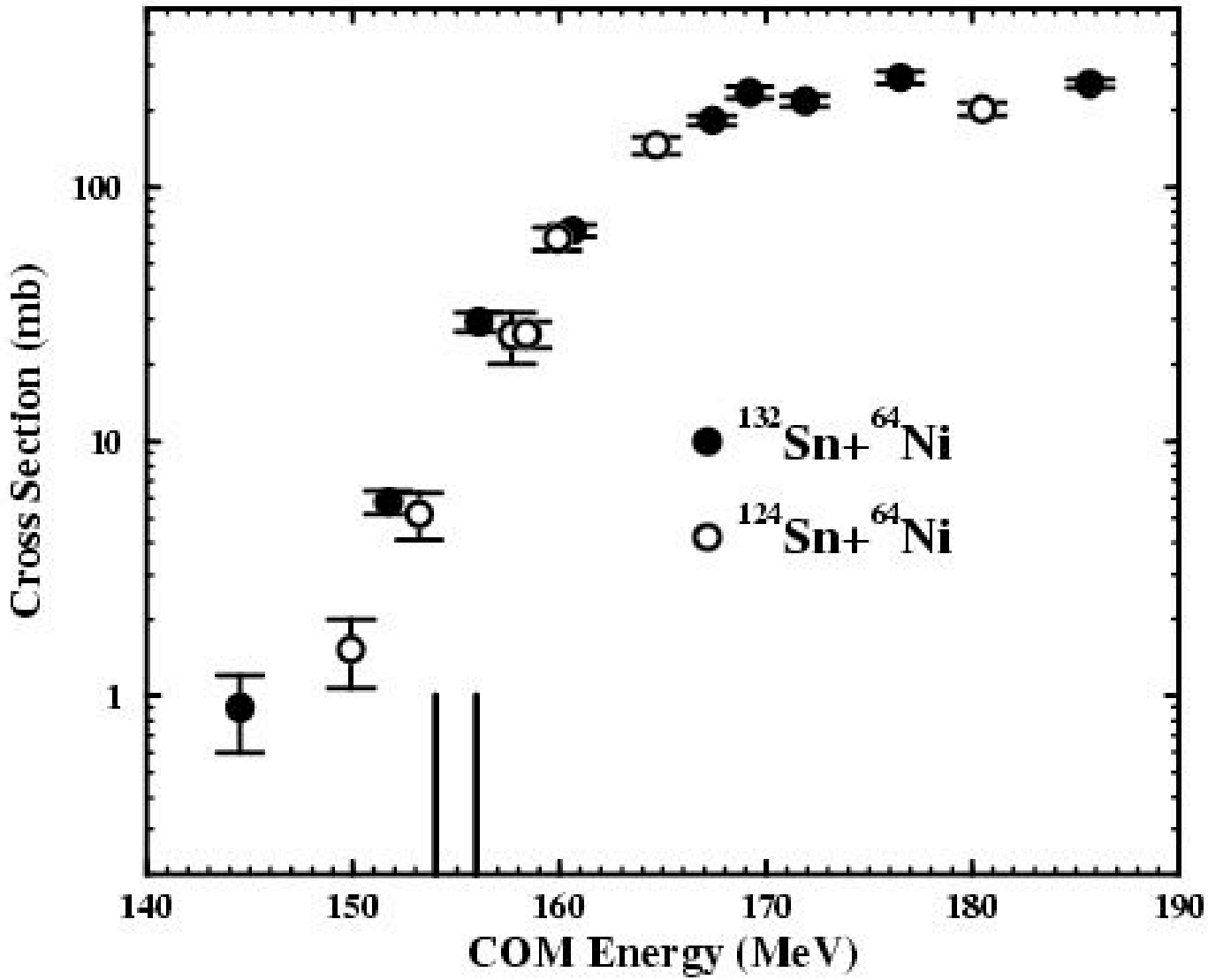

Evaporation Residue Cross Sections
Cross Section (mb)
100
10
1
140
150
160
170
180
190
COM Energy (MeV)
124Sn+64Ni
Freeman et al
124Sn+64Ni

Using TOF info to reduce random background count

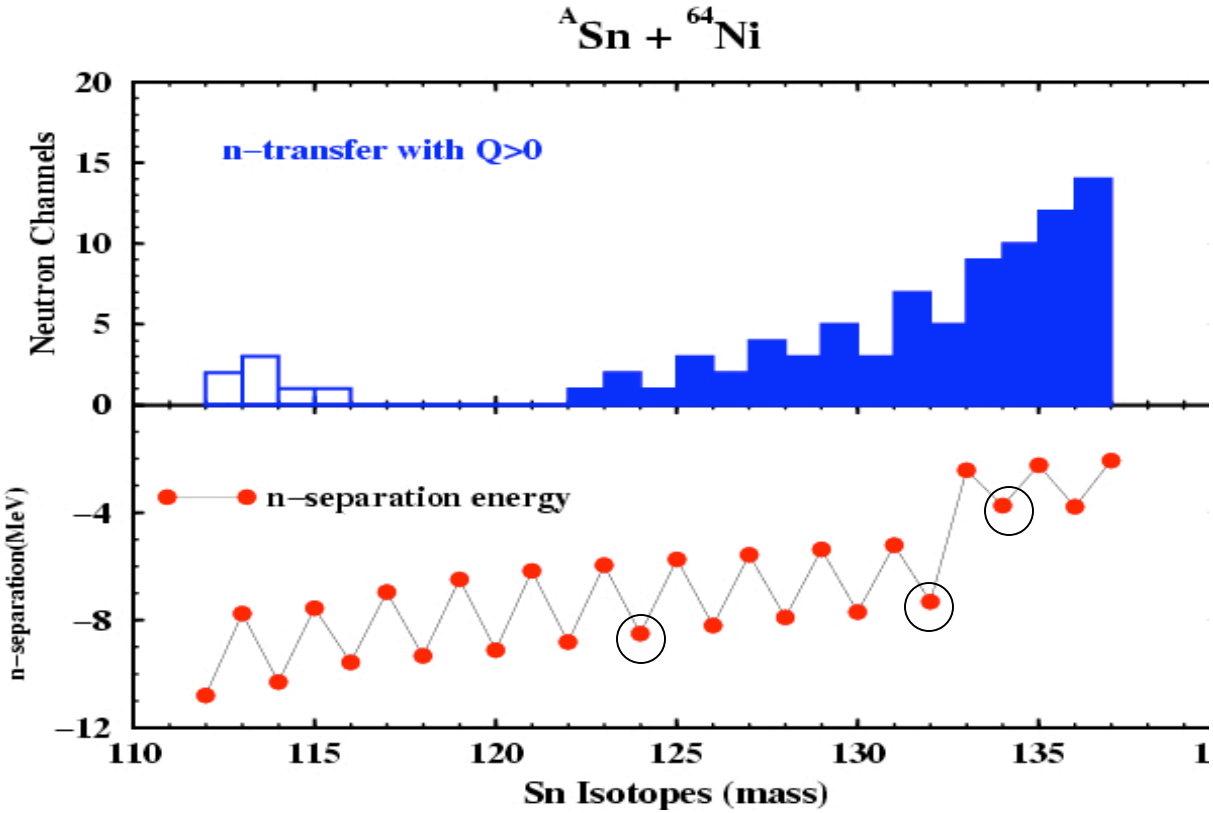




Evap. Residue Cross Sections

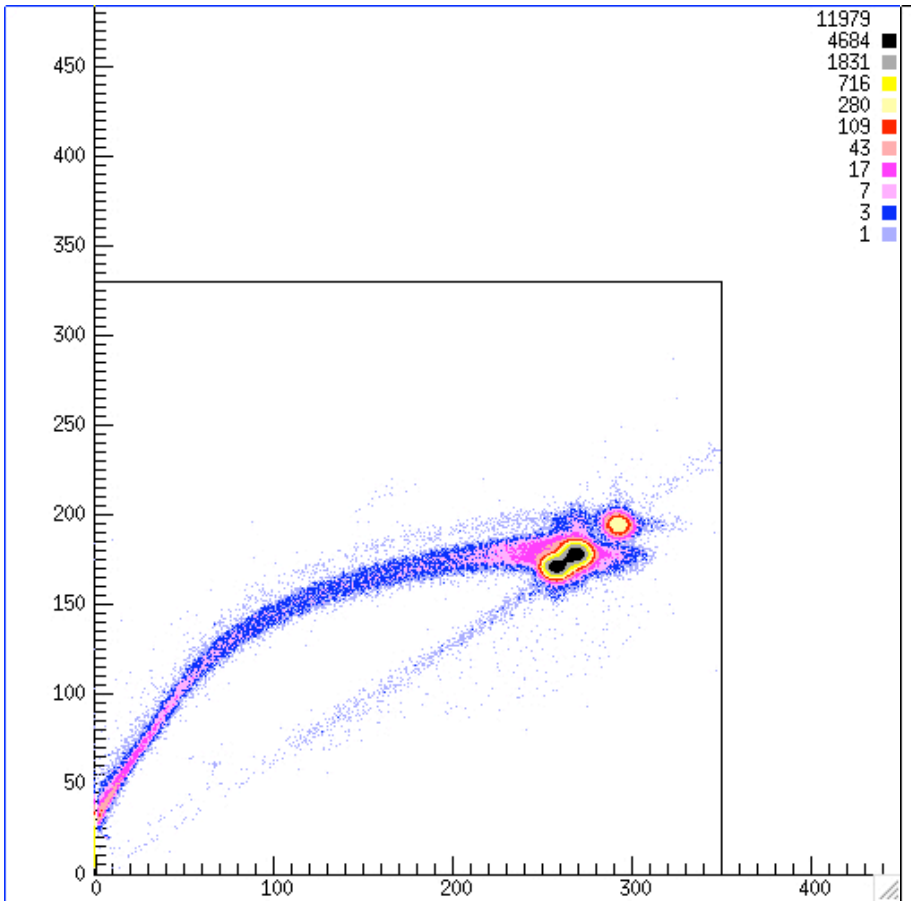


Neutron Binding energies for Z=50 chain

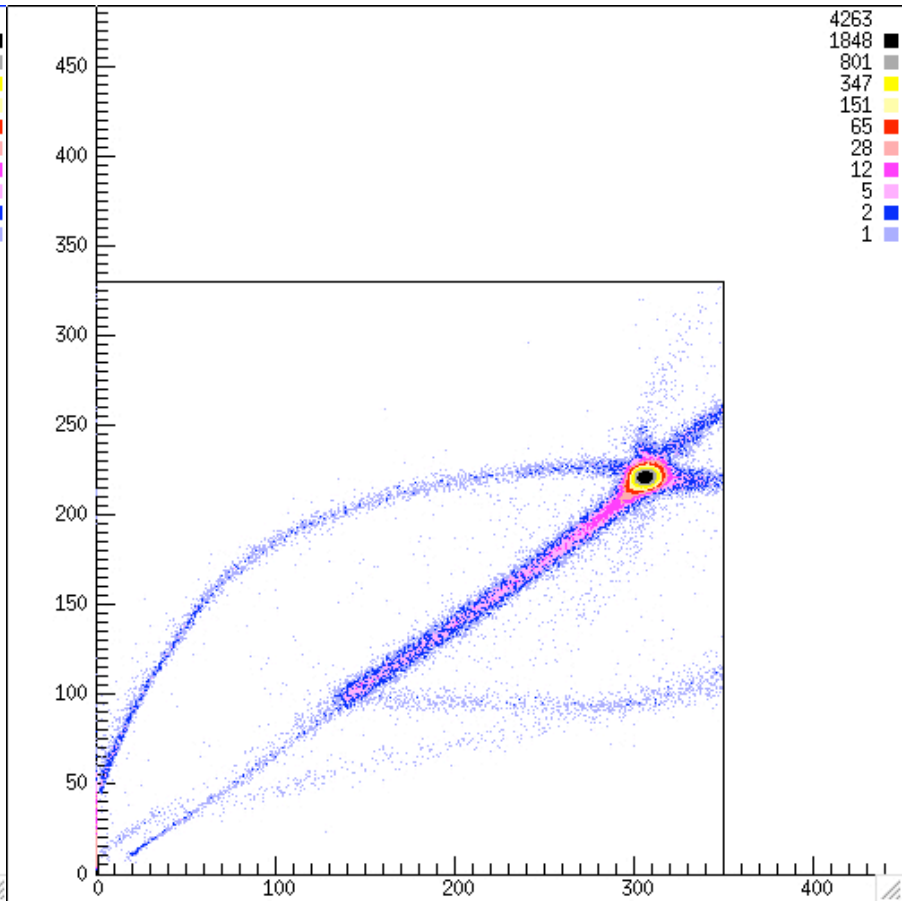


- ^{134}Sn experiment initially motivated by neutron flow model - expect larger cross section.
- Cross section could be smaller if neutron emitted prior to fusion.

Beam Triggered Events for mass A=134 analyzed from extracted sulfides (A=166)

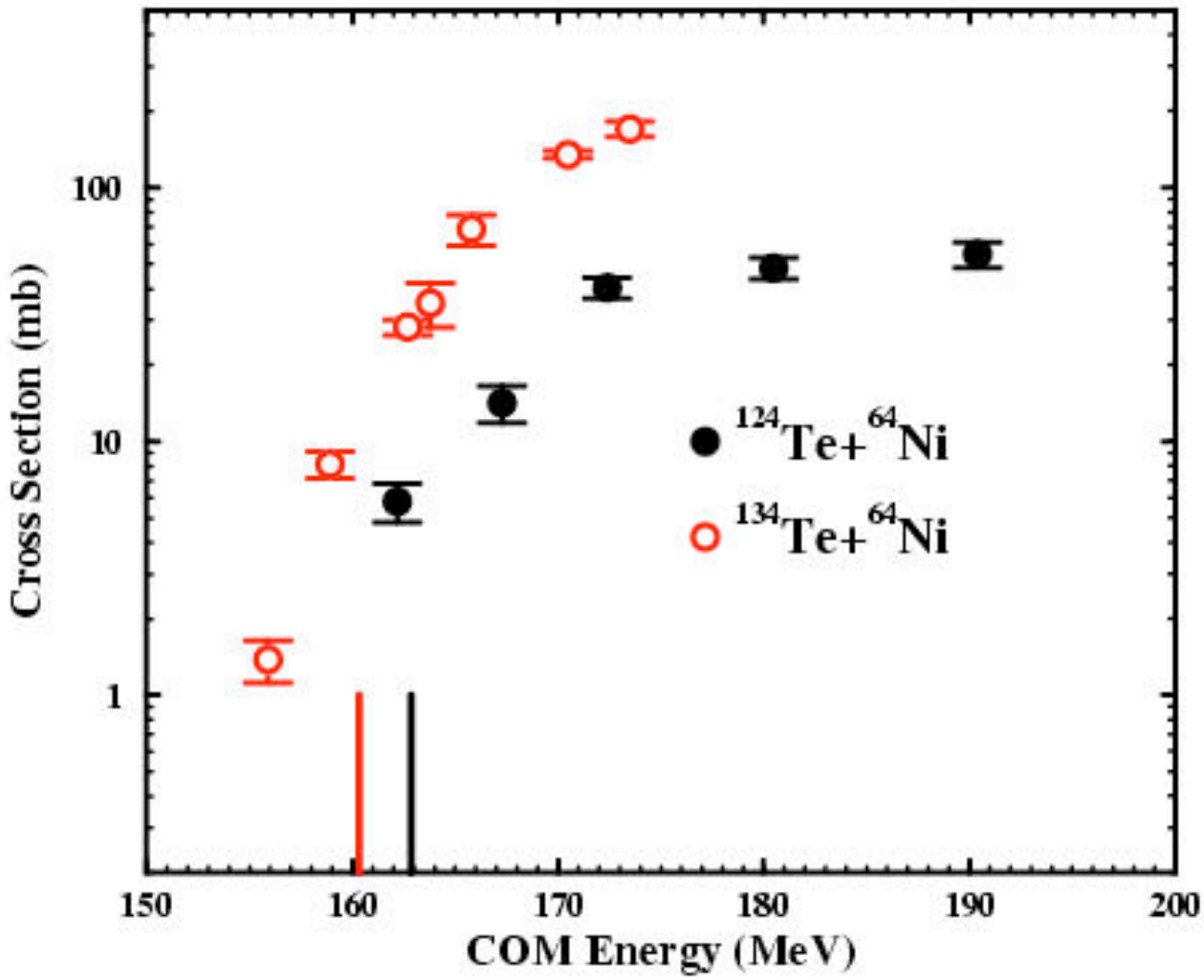


A=166 / A=134 cocktail

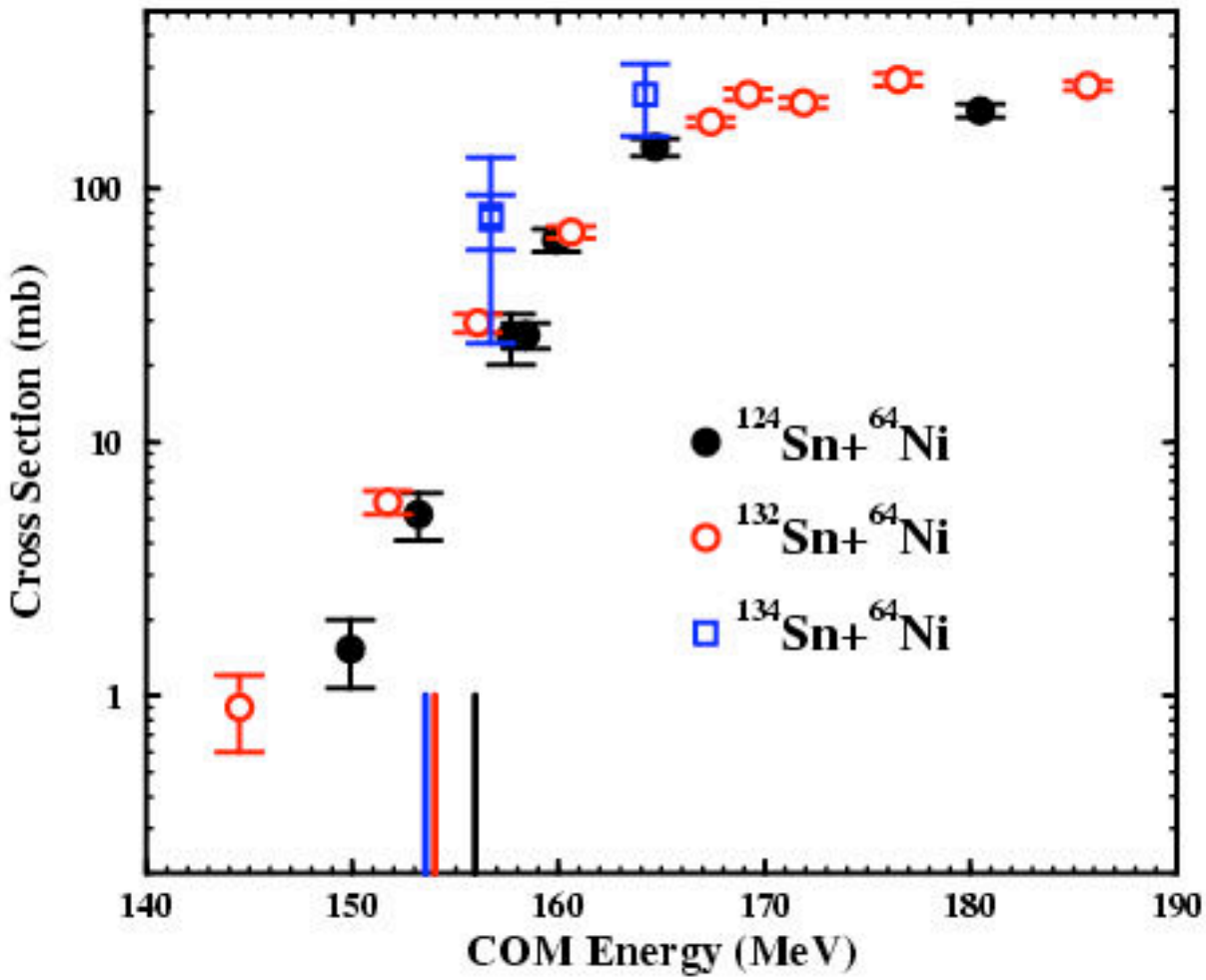


A=134 / Mostly ^{134}Te

Evaporation Residue Cross Sections

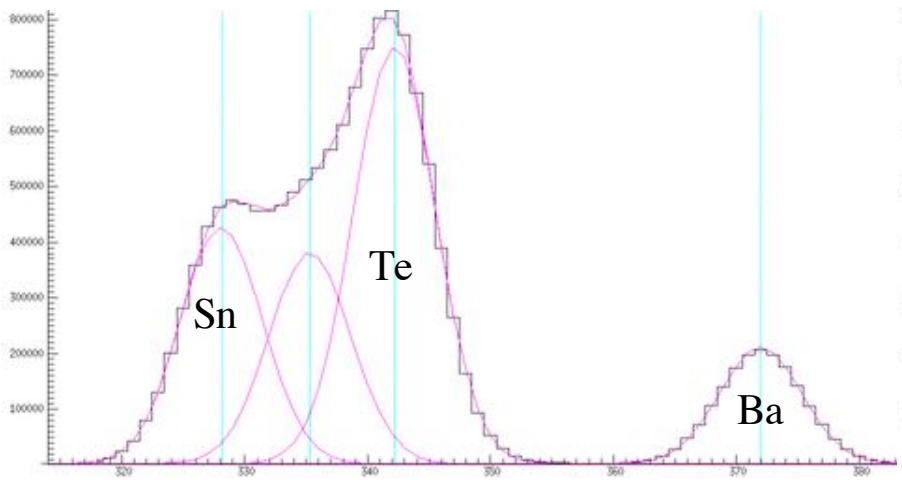


Evaporation Residue Cross Sections

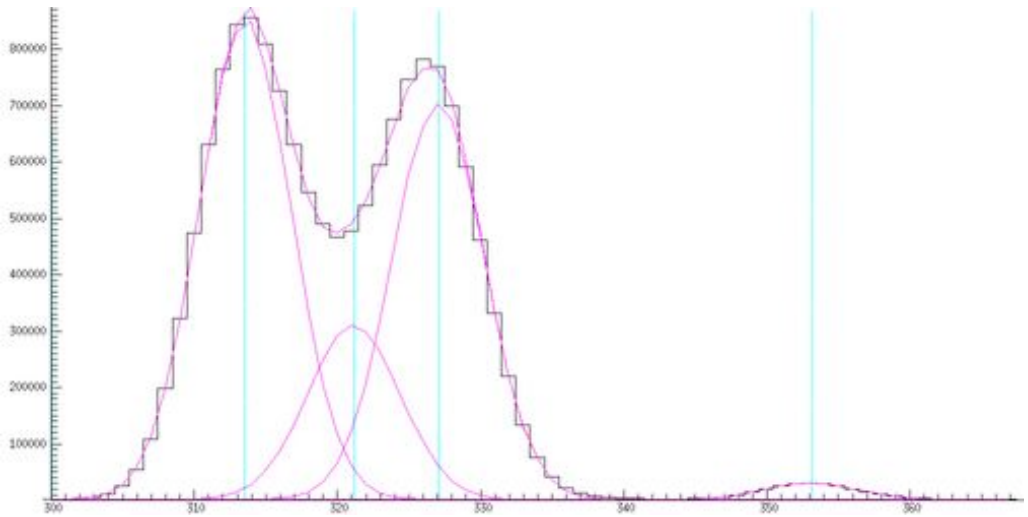


The A=134 cocktail - a closer look

2005



2004

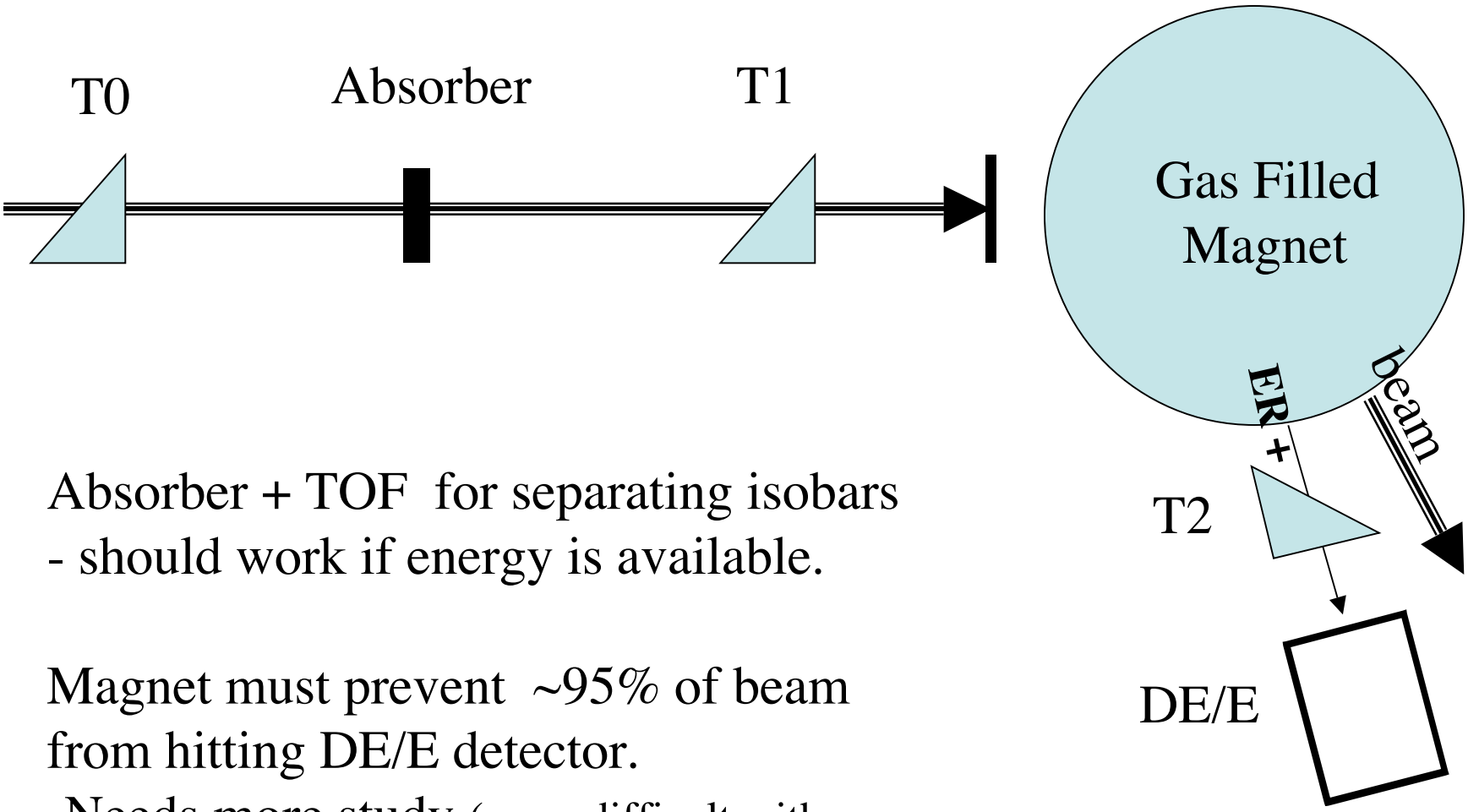


- Ratio of Sn/Sb/Te/Ba is not constant.
- Sn/Sb induced ER must be disentangled by repeating runs with different ratios of Sn/Sb in beam.
- Presently must pursue this solution.

A better system to perform ER measurements

- Must be able to tag beam (mixed beams).
- Must physically separate beam from residues (better sensitivity - reduce random counts).
- Keep the high efficiency for residue detection.

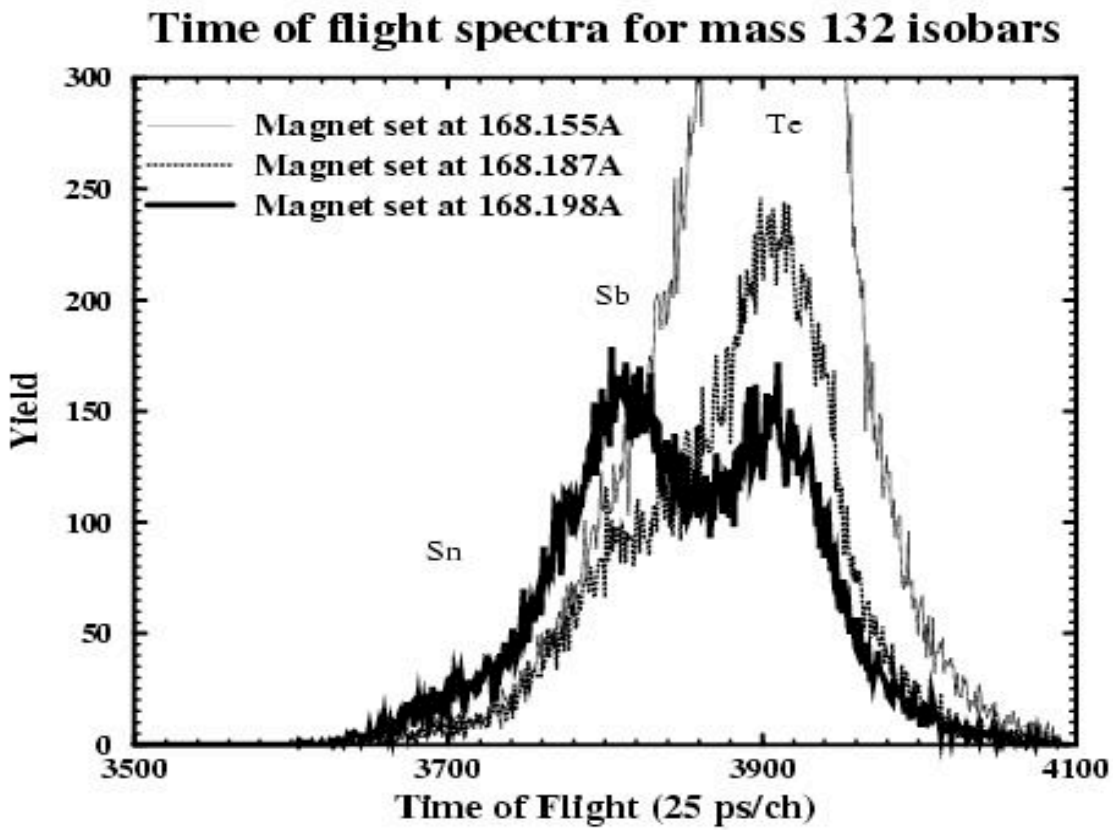
Straw man



Absorber + TOF for separating isobars
- should work if energy is available.

Magnet must prevent ~95% of beam from hitting DE/E detector.
-Needs more study (more difficult with inverse kinematics reactions).

Beam Tagging works

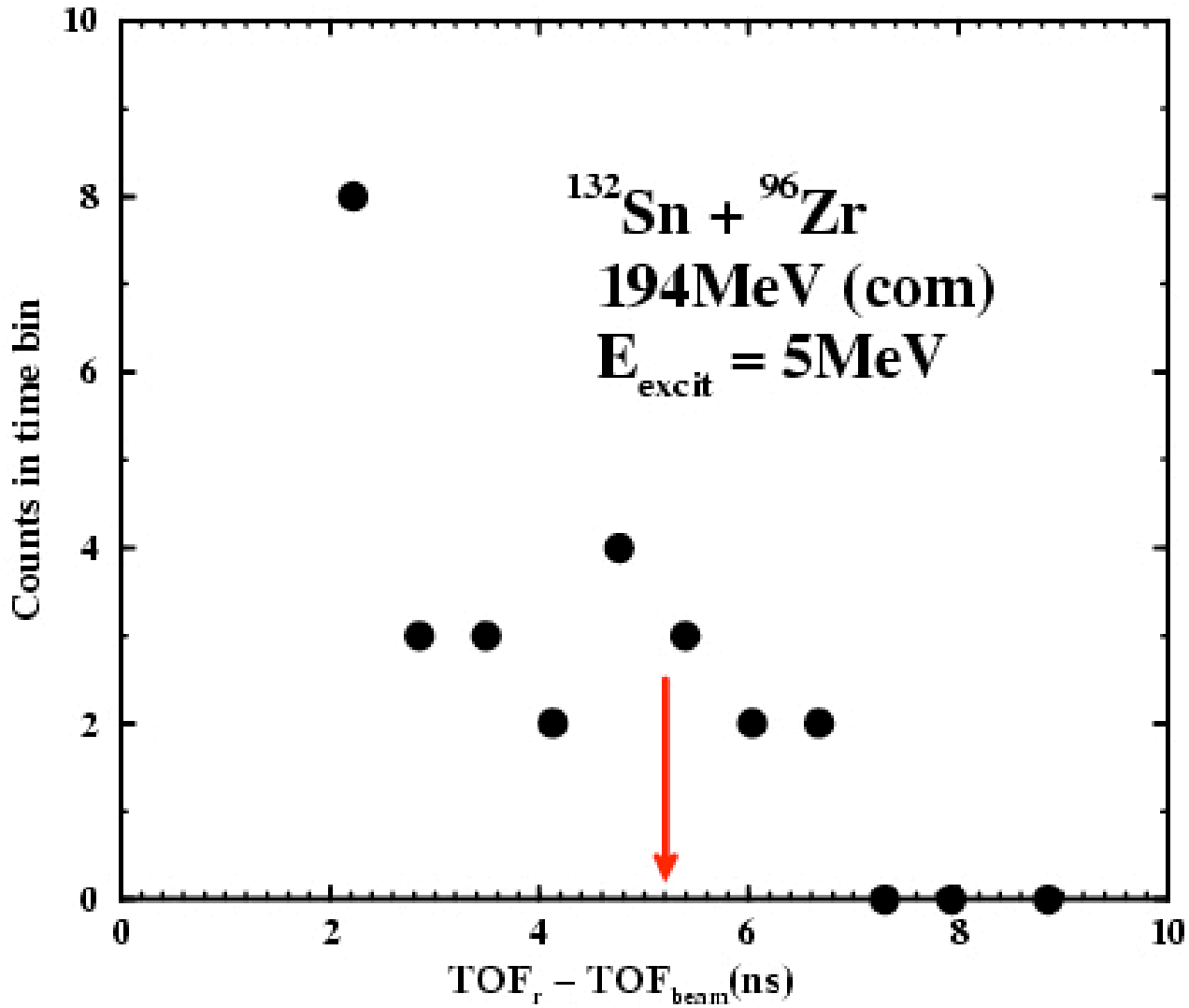


- Must have a uniform absorber <<1% variation.
- Separation improves with energy loss !
- Problem - not enough energy. If we had 8MeV/A available separation would be complete - for experiments needing 5MeV/A.

Measuring Evaporation Residues

- ER - a definite signal for CN formation at excitation energy determined by beam energy.
- RIB intensities necessitate high efficiency.
- Straight forward “generic” beam tagging is possible if accelerator has extra energy capability built in.
- Gas filled magnet is a first try at keeping most of the beam off the detector.

Some more on Th (prelim. Data)



>10^9 beam particles ~1.5mb

Study of Evaporation Residues from Reaction Induced by Radioactive Ion Beams

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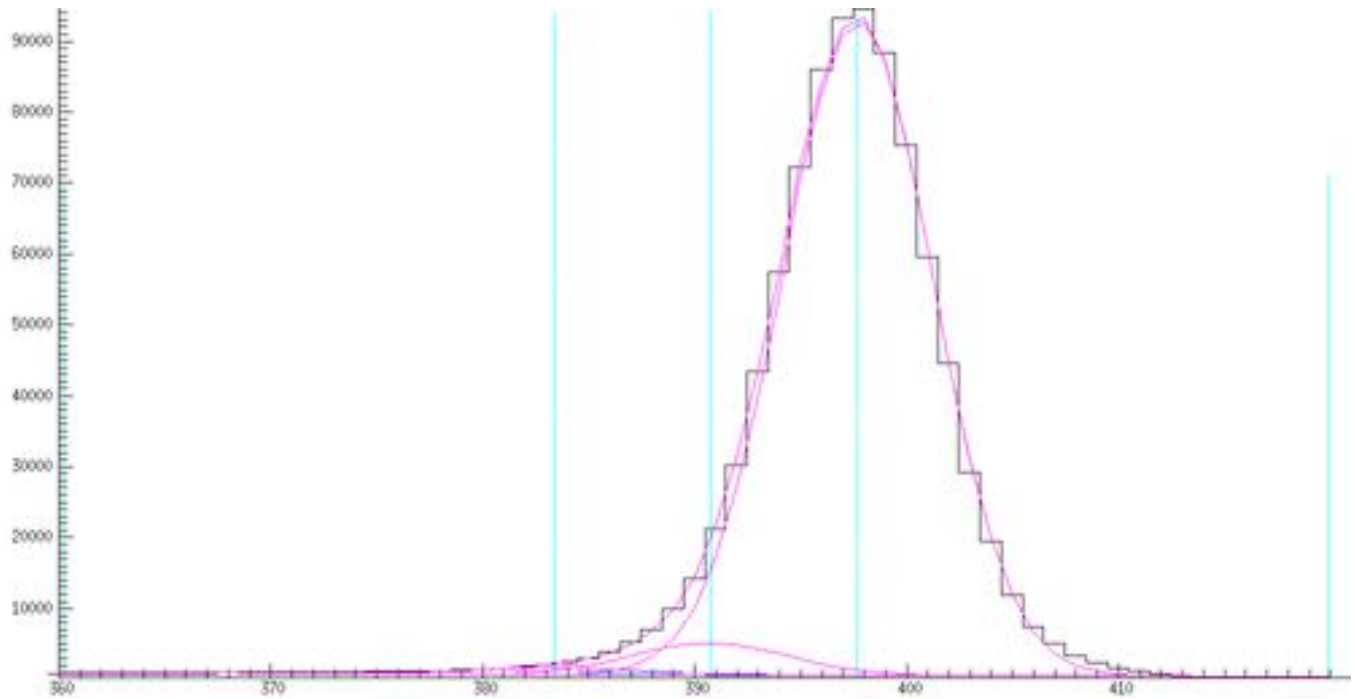
EXTRAS

The ^{134}Te - a closer look



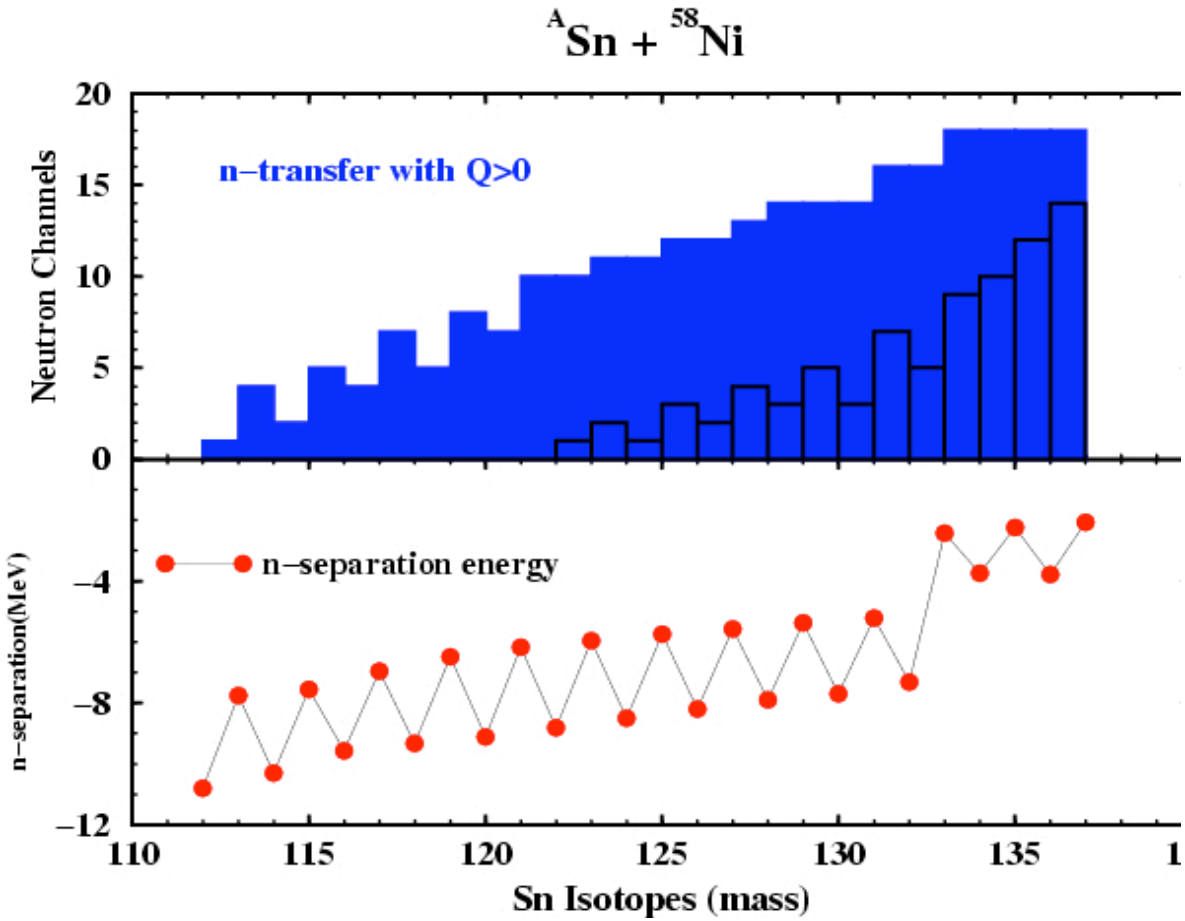
There is a ~4% contaminant of ^{134}Sb and <1% ^{134}Sn.

Problem only at low sub-barrier energies.

Turn off driver (proton) beam to get rid of Sb/Sn

Still must disentangle Sb and Sn contributions.

$^{132}Sn+^{58}Ni$ - One more easy experiment



- If Transfer reactions are an important factor this is better then $^{132}Sn+^{64}Ni$