Close Collisions Between Heavy Neutron-Rich Nuclei

Central question:
Is Nucleus-Nucleus Capture Probability Enahnced
in Collisions between Heavy Neutron Rich Nuclei
- and if so WHY.

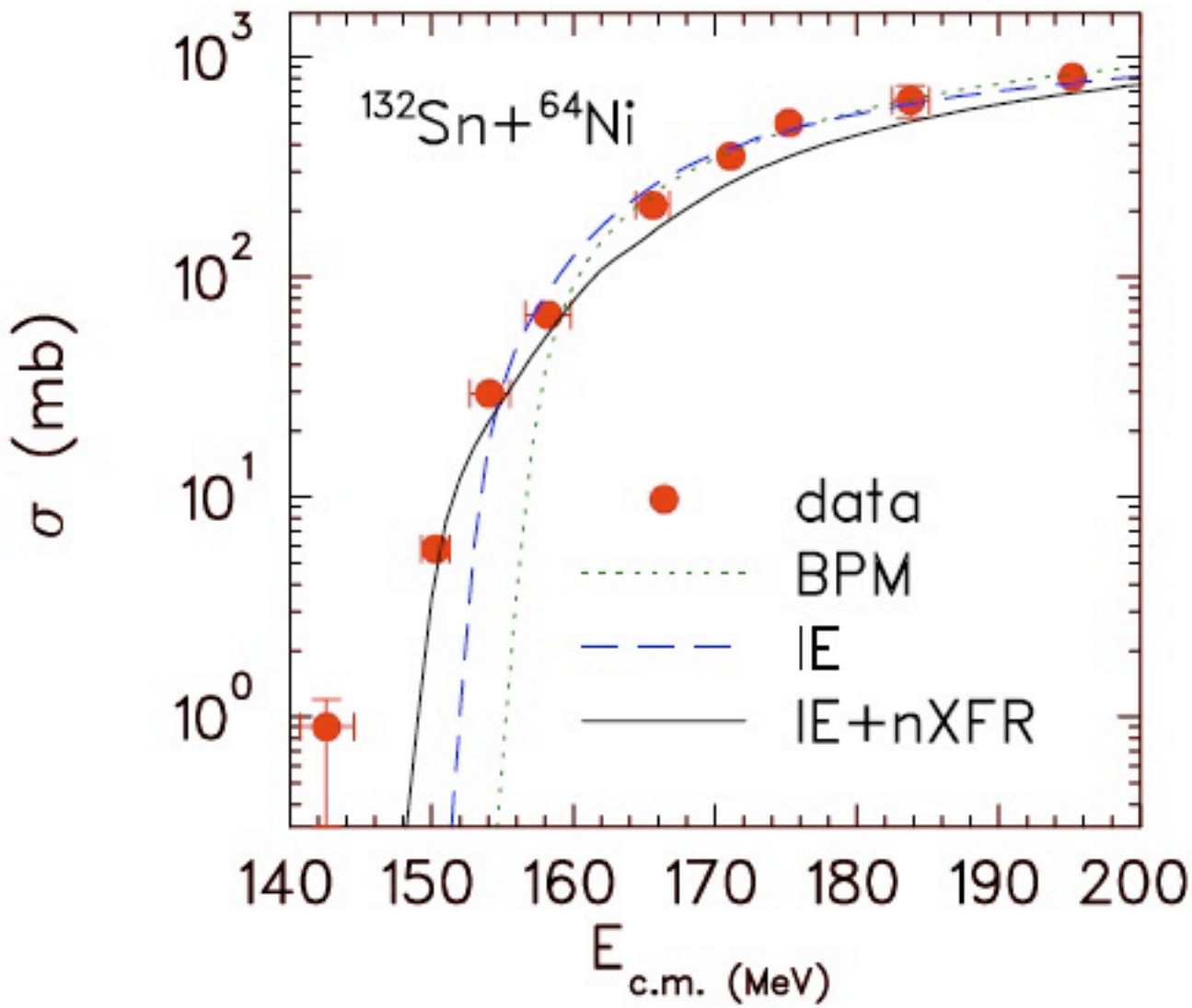
J. R. Beene
A. Galindo-Uribarri
J. Gomez del Campo
C. J. Gross
F. J. Liang
P. E. Mueller
D. W. Stracener
D. Shapira
D. Stracener
R. L. Varner

K.L . Jones (Rutgers)

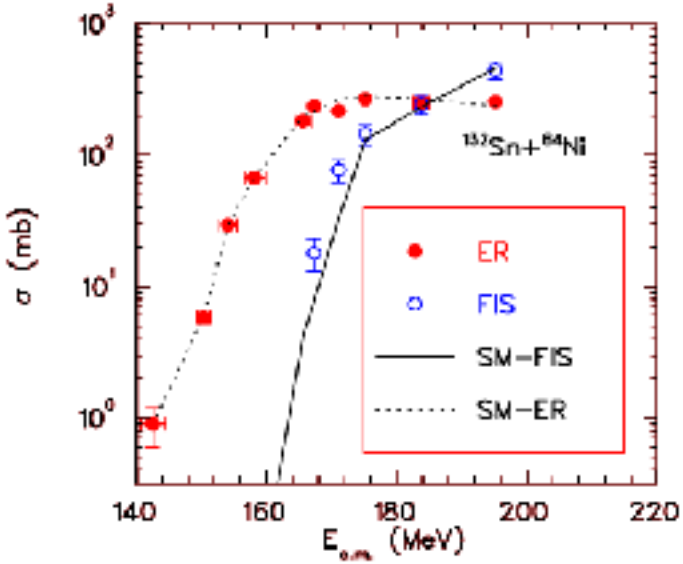
H. Amro (UND)
J. J. Kolata (UND)

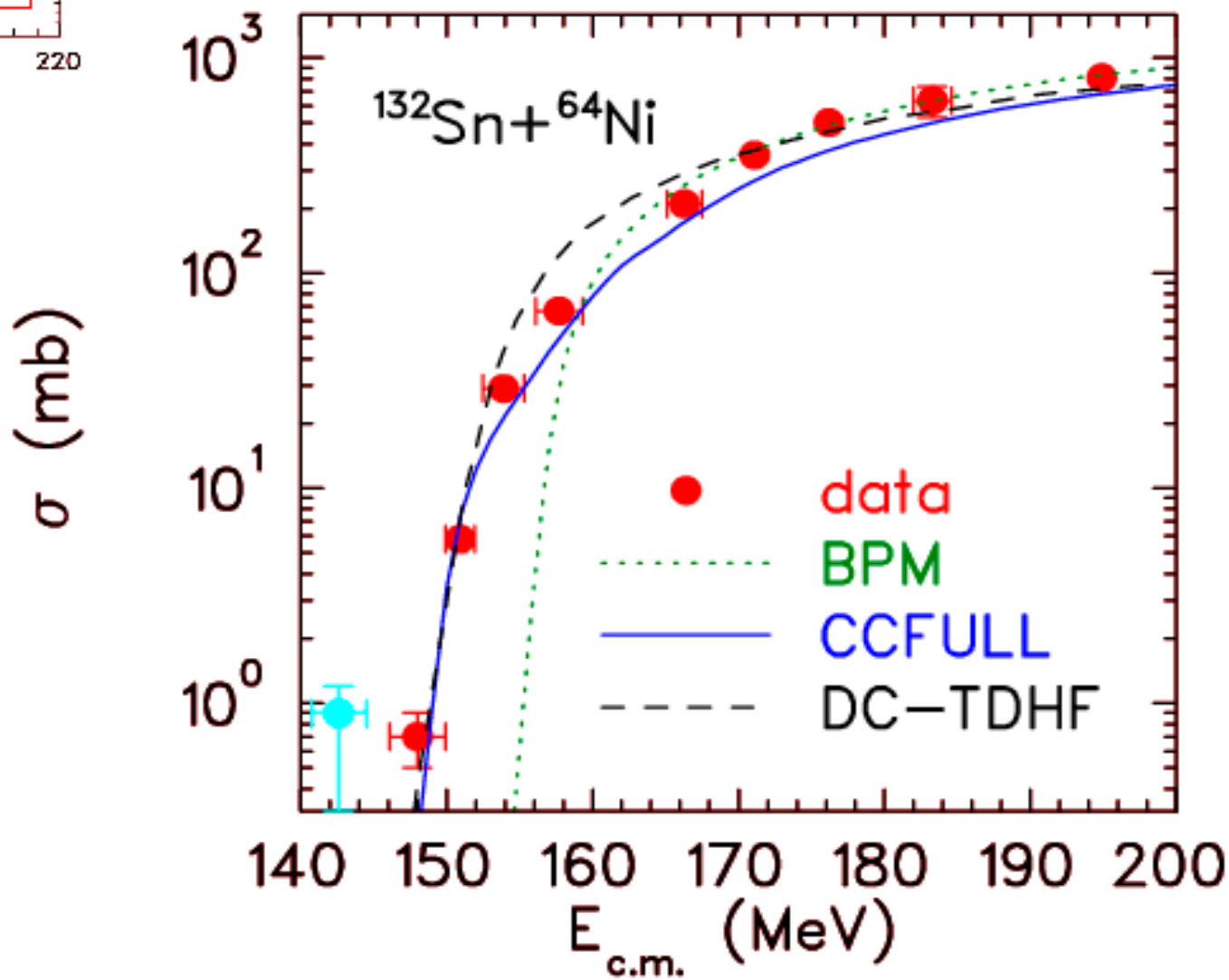
R. Loveland (OSU)
R. Vinodkumar (OSU)
P. H. Sprunger (OSU)
D. Peterson (ANL)

A. Caraley (NYSU Oswego)
J. Bierman (Gonzaga Univ.)

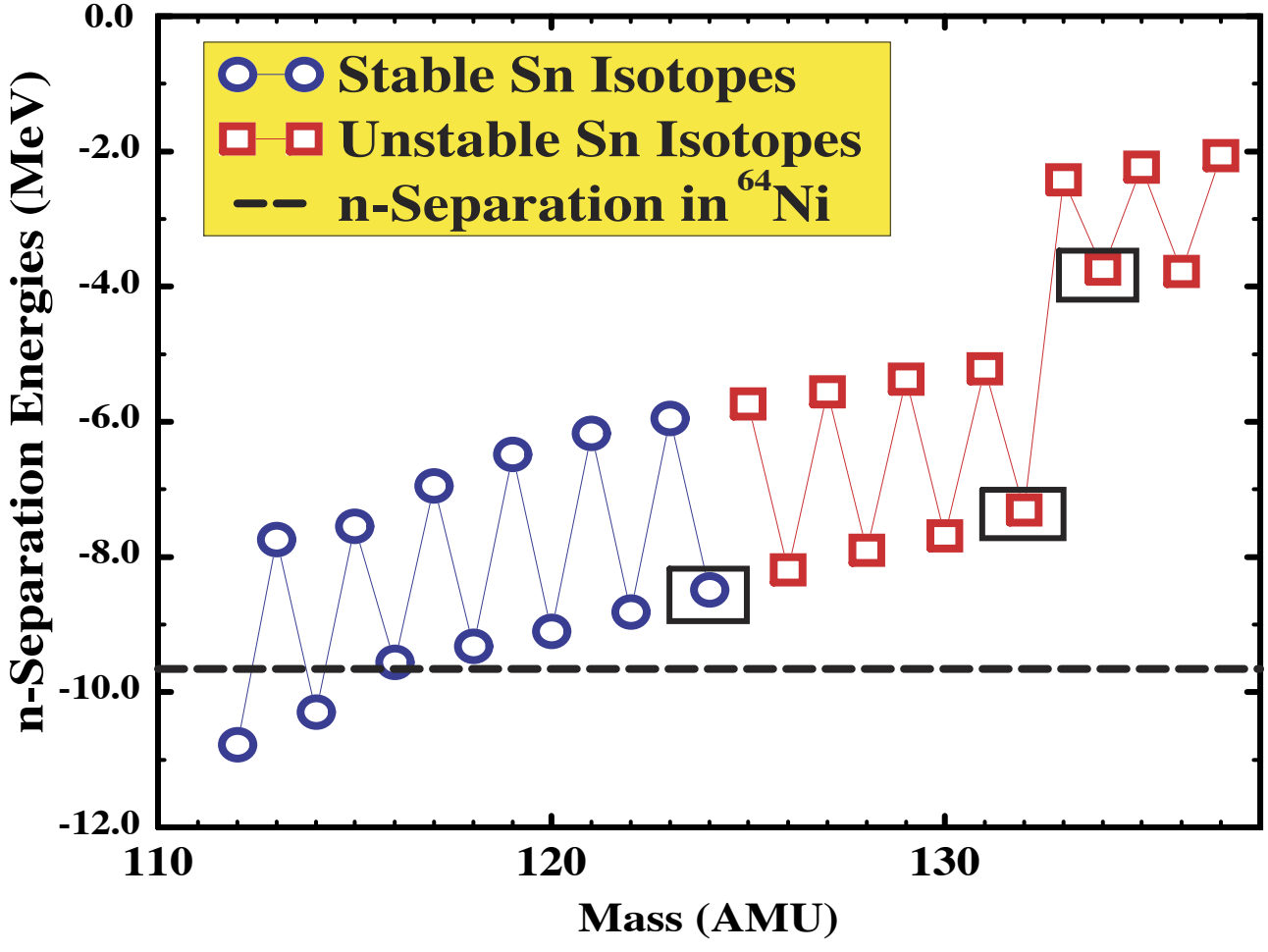


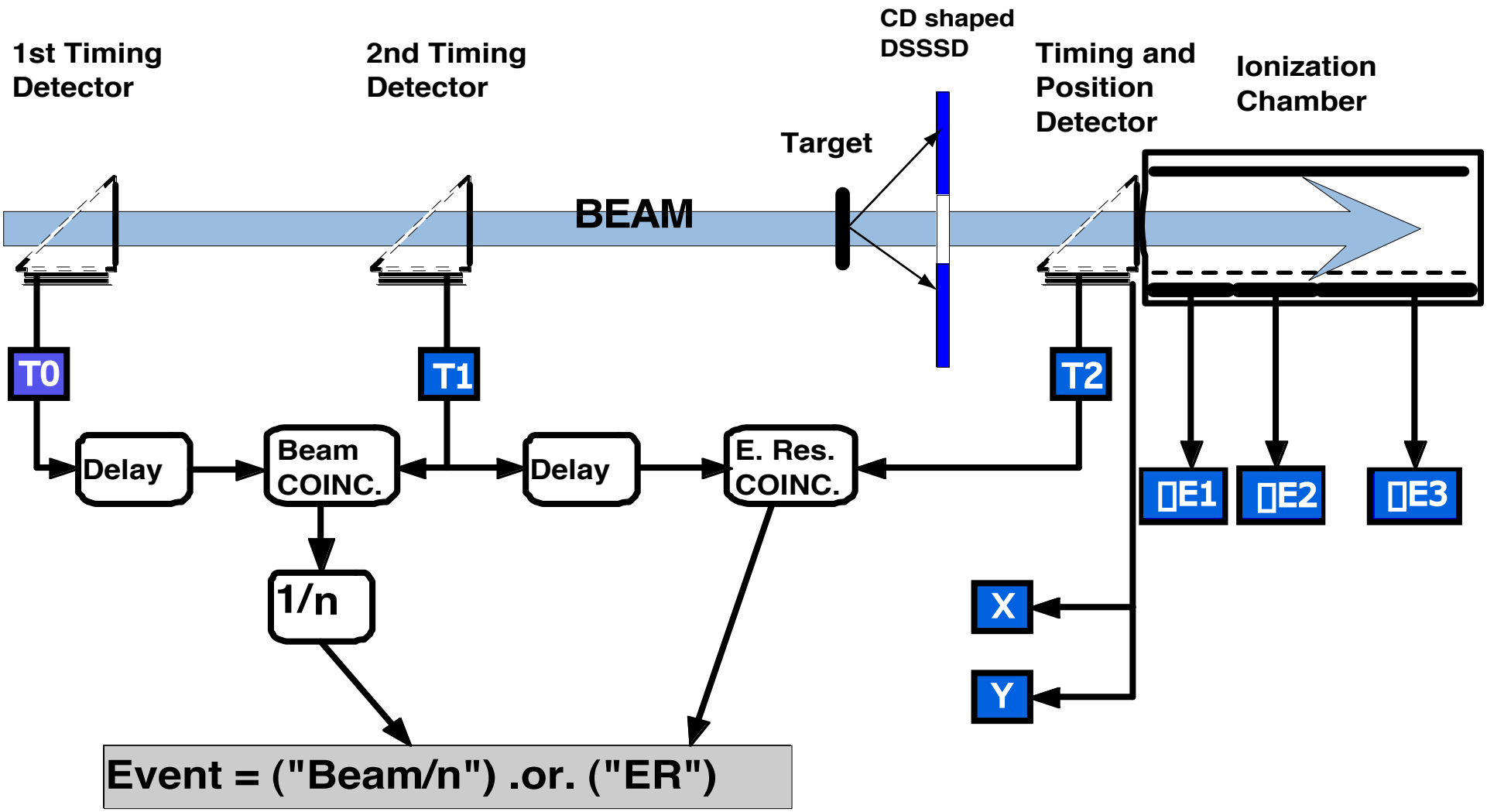
CC Calculations with Hagino's CCFULL code (Liang et. al.)


^{132}Sn+^{64}Ni
ER
FIS
SM−FIS
SM−ER
σ (mb)
E$_{c.m.}$ (MeV)


^{132}Sn+^{64}Ni
data
BPM
CCFULL
DC−TDHF
σ (mb)
E$_{c.m.}$ (MeV)

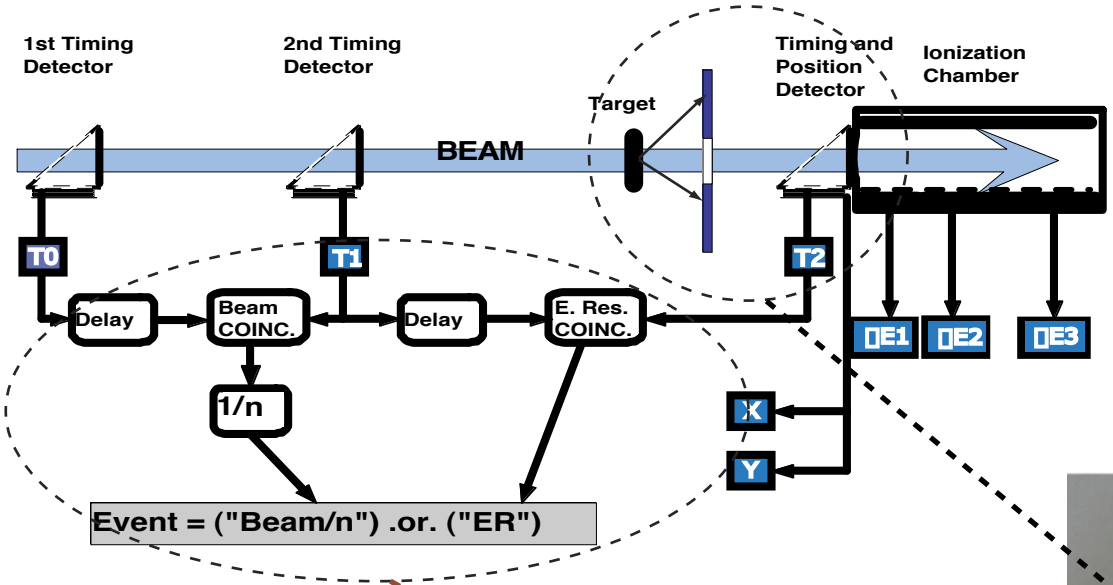
Valence Neutron Separation Energy

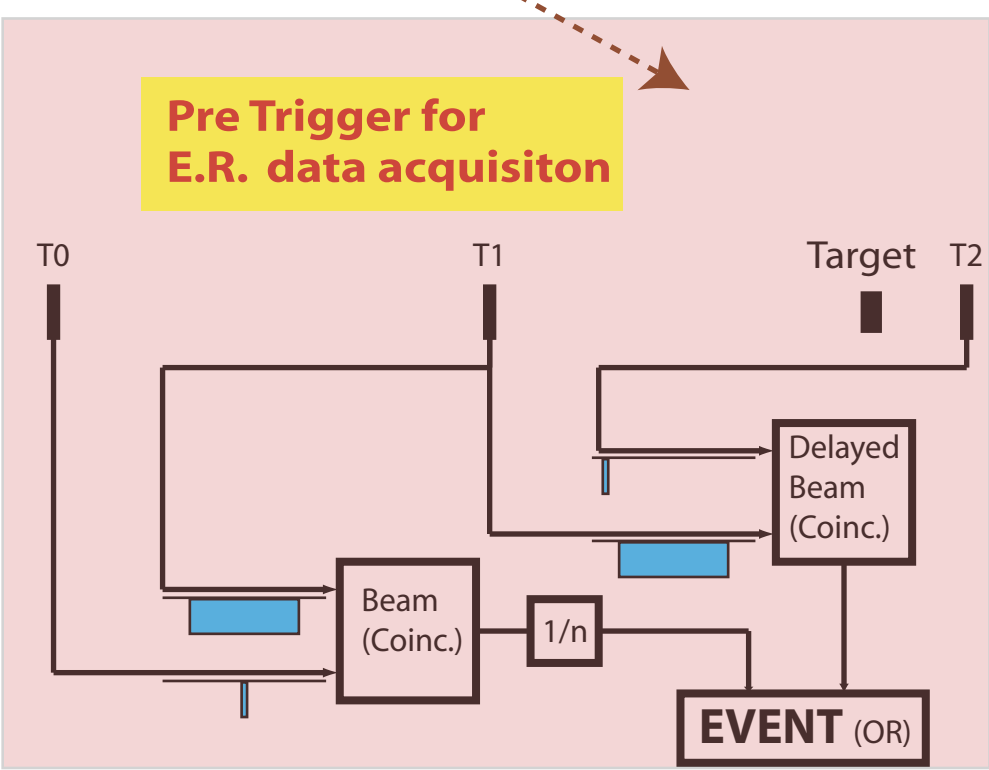


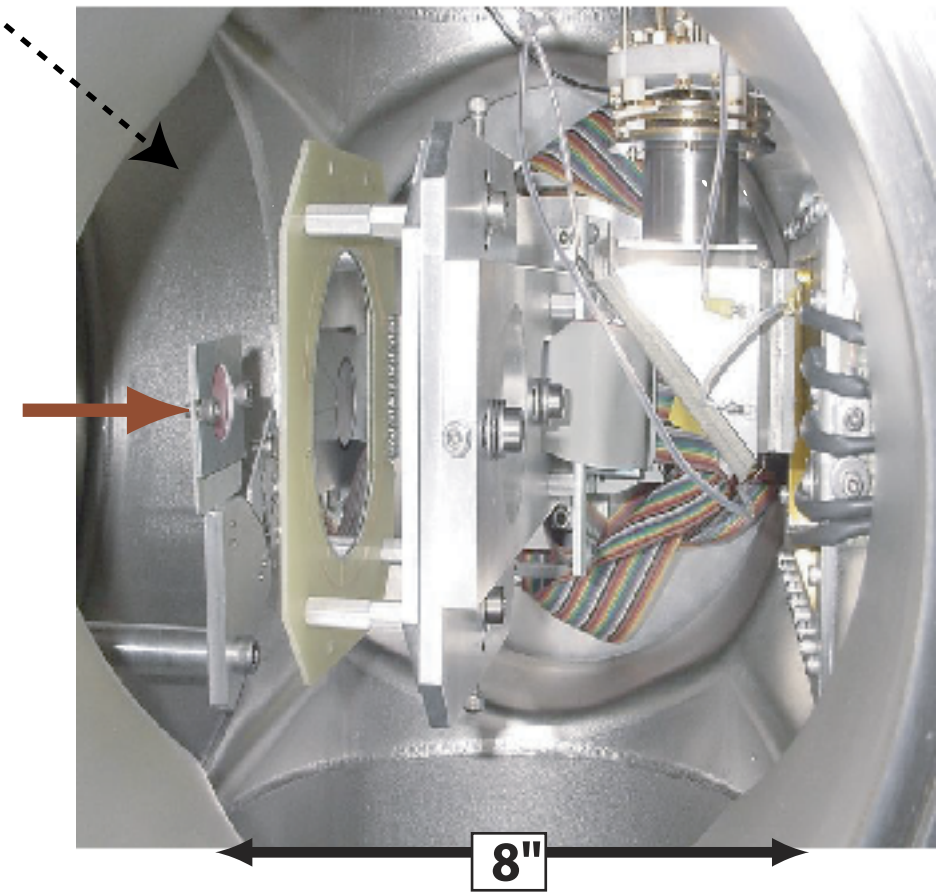


1) Ionization Chamber at 0 deg. (ER)
2) CD shaped DSSD close to target. (FF)
3) Pre Trigger based on TOF.
4) Beam counting and sampling.

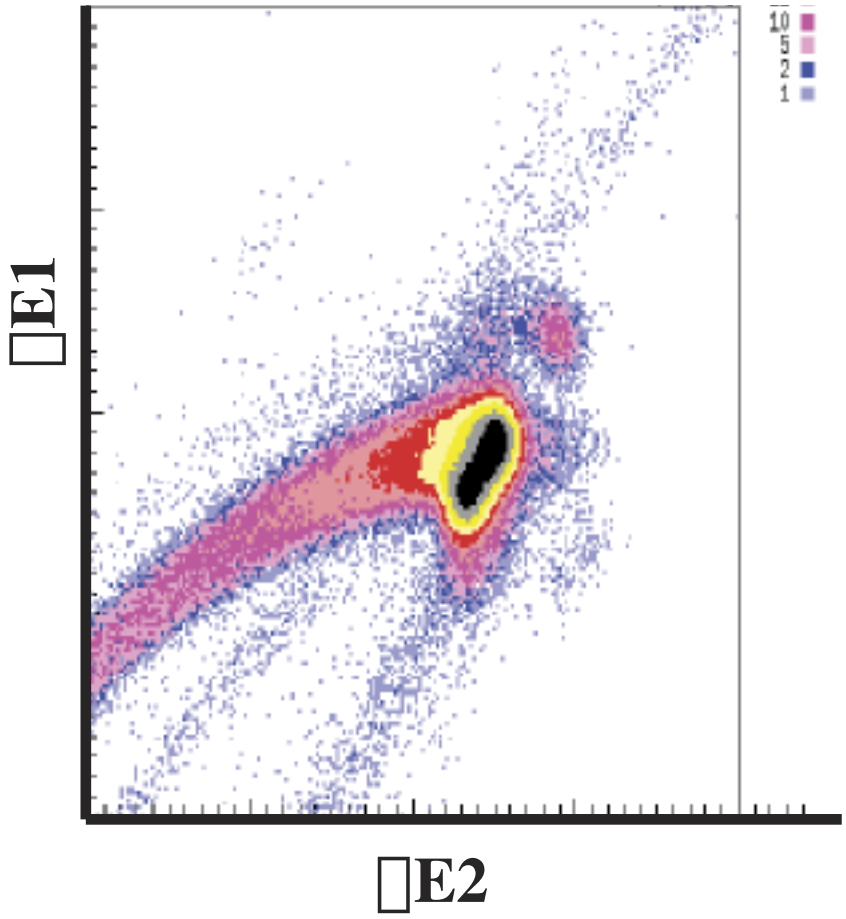
Beam Intensity <100,000/sec
For Reverse Kinematics
Efficiencies reached are:
ER ~ 100% FF~5%

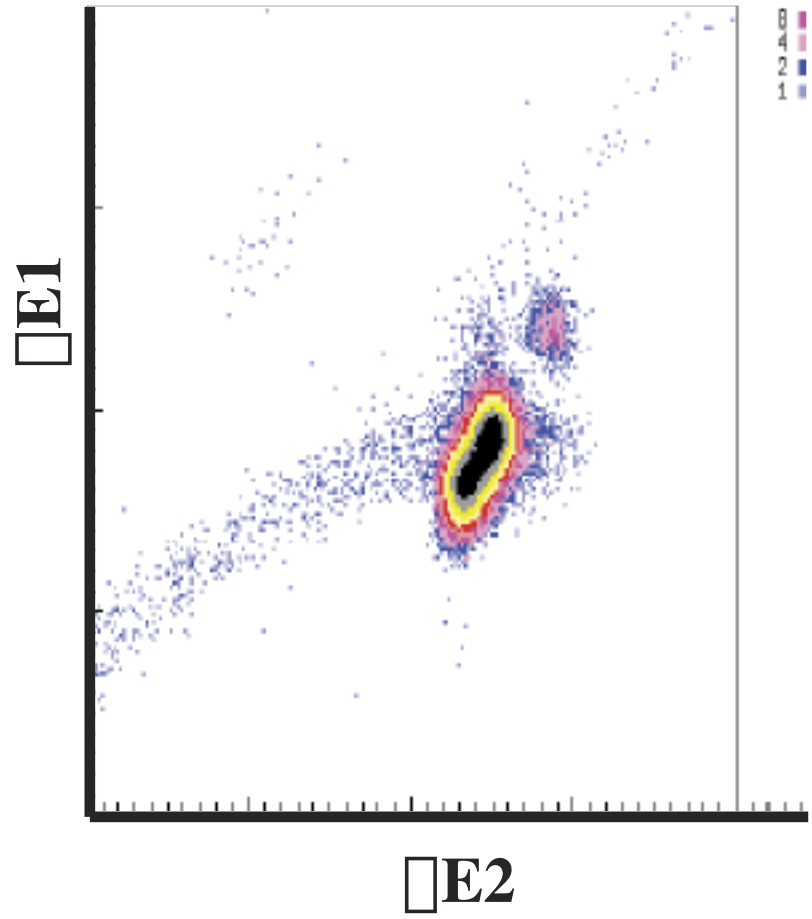

1st Timing Detector
2nd Timing Detector
Target
Timing and Position Detector
Ionization Chamber
BEAM
T0
T1
T2
Delay
Beam COINC.
Delay
E. Res. COINC.
1/n
X
Y
E1
E2
E3
Event = ("Beam/n") .or. ("ER")


Pre Trigger for
E.R. data acquisiton
T0
T1
Target
T2
Delayed Beam (Coinc.)
Beam (Coinc.)
1/n
EVENT (OR)

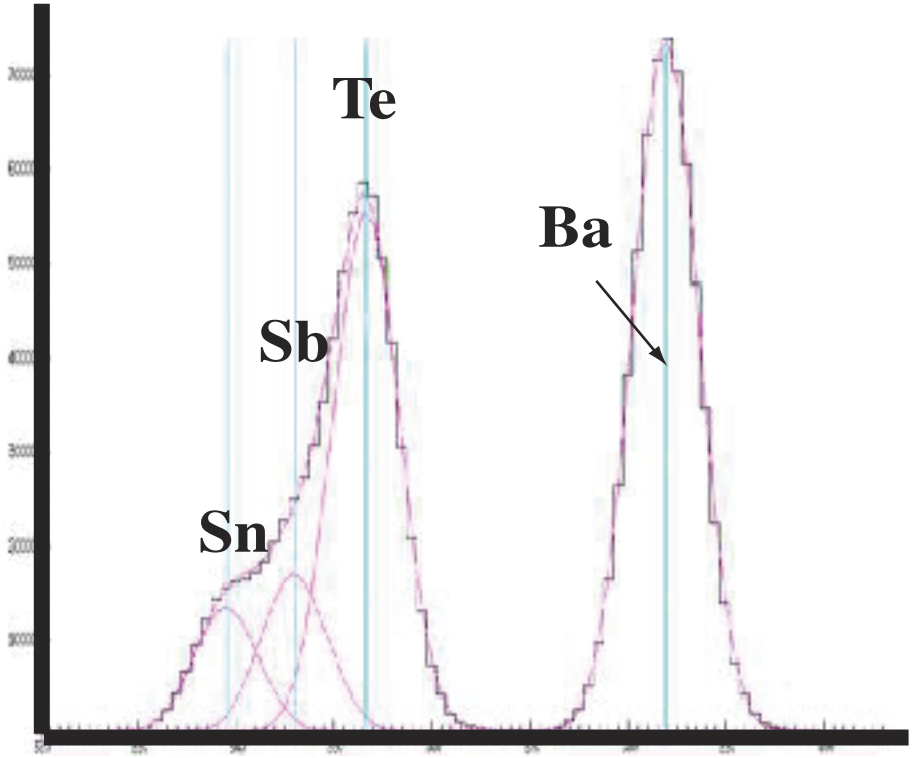

8"

500MeV $^{134}A + ^{64}Ni$ -> ER (~15mb)

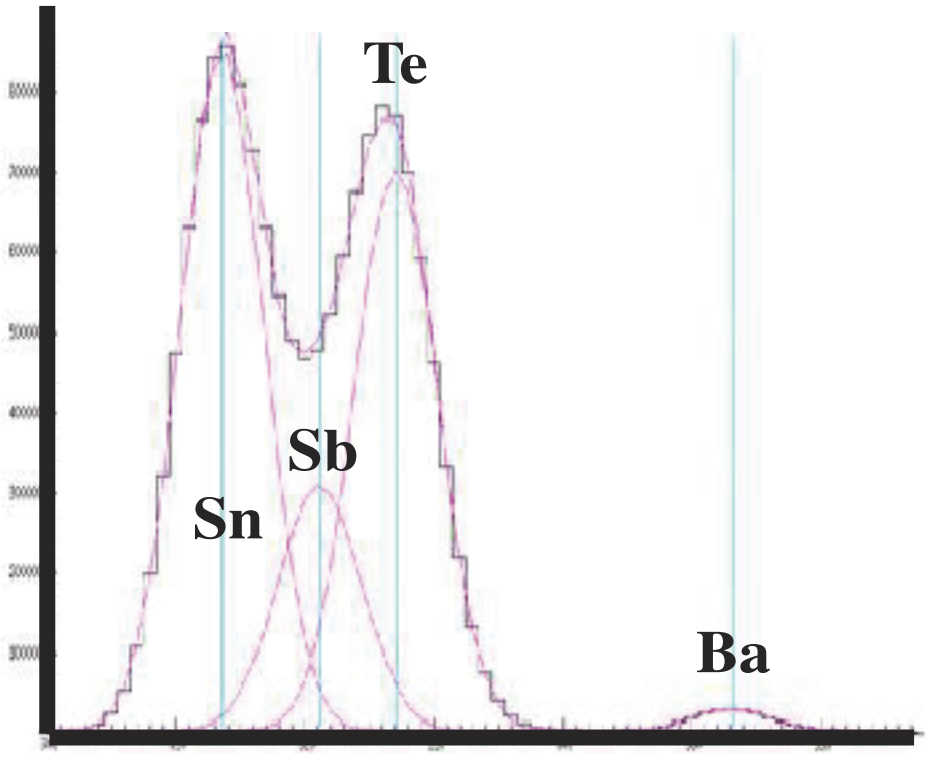




500MeV $^{134}A + ^{64}Ni$



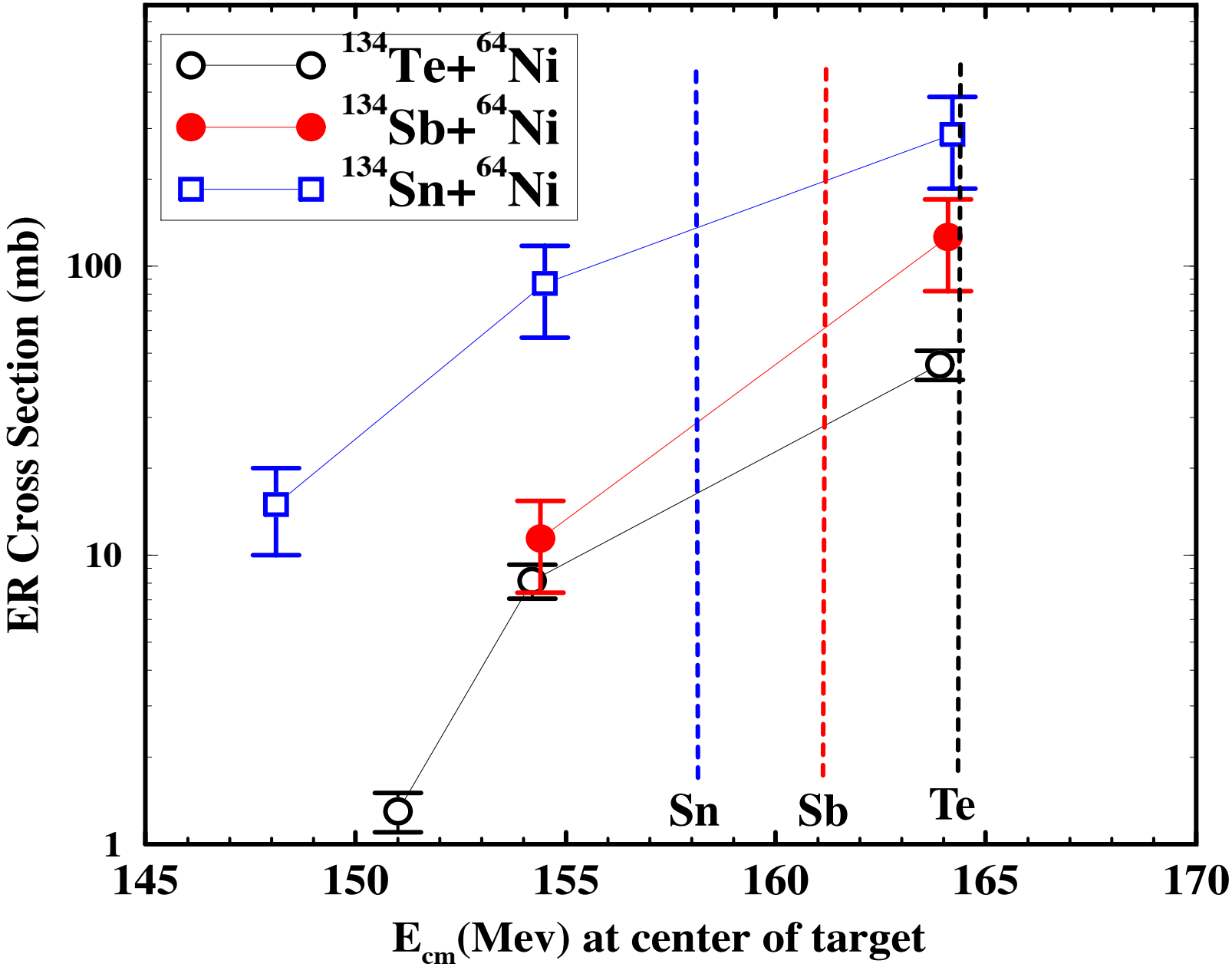
Energy Loss



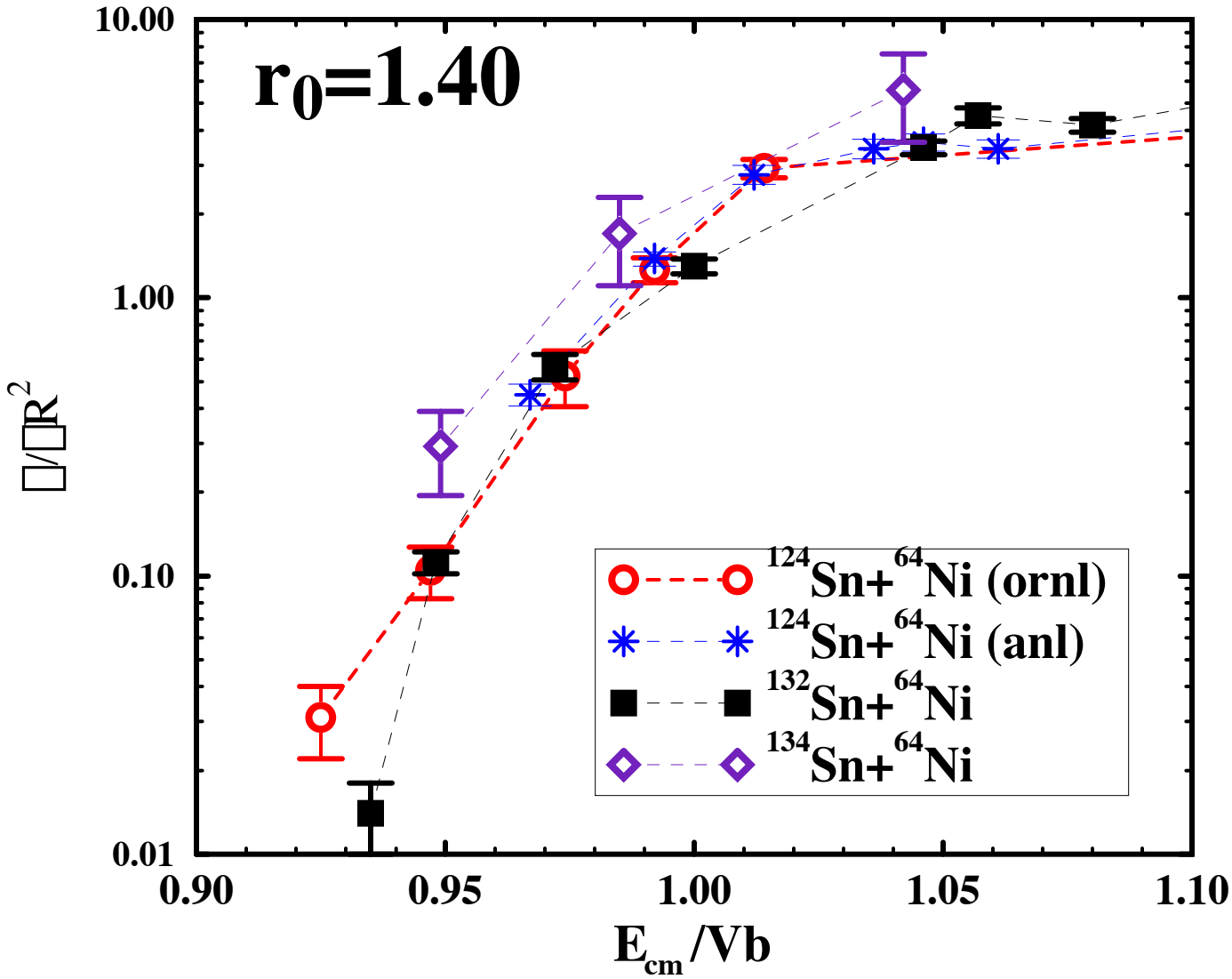
Energy Loss

Conduct several measurements with different relative yields of isobars and solve to obtain several cross sections.

Measured Evaporation Residue Cross Sections



n- Binding (^{134}, ^{132}, ^{124}Sn)



Plans to measure the following:

$^{40}Ca + ^{124}Sn \rightarrow ER$

$^{48}Ca + ^{124}Sn \rightarrow ER$

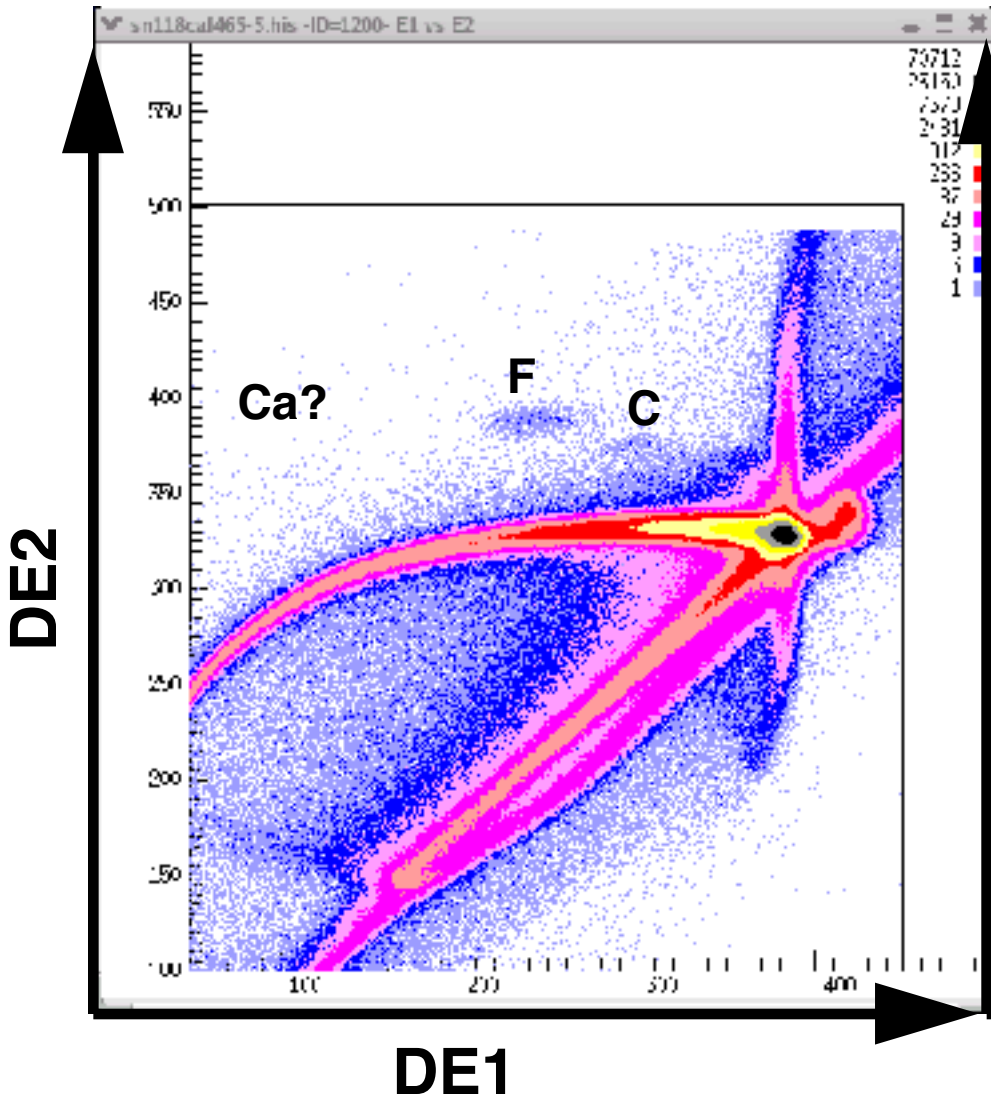
$^{40}Ca + ^{132}Sn \rightarrow ER$

$^{48}Ca + ^{132}Sn \rightarrow ER$

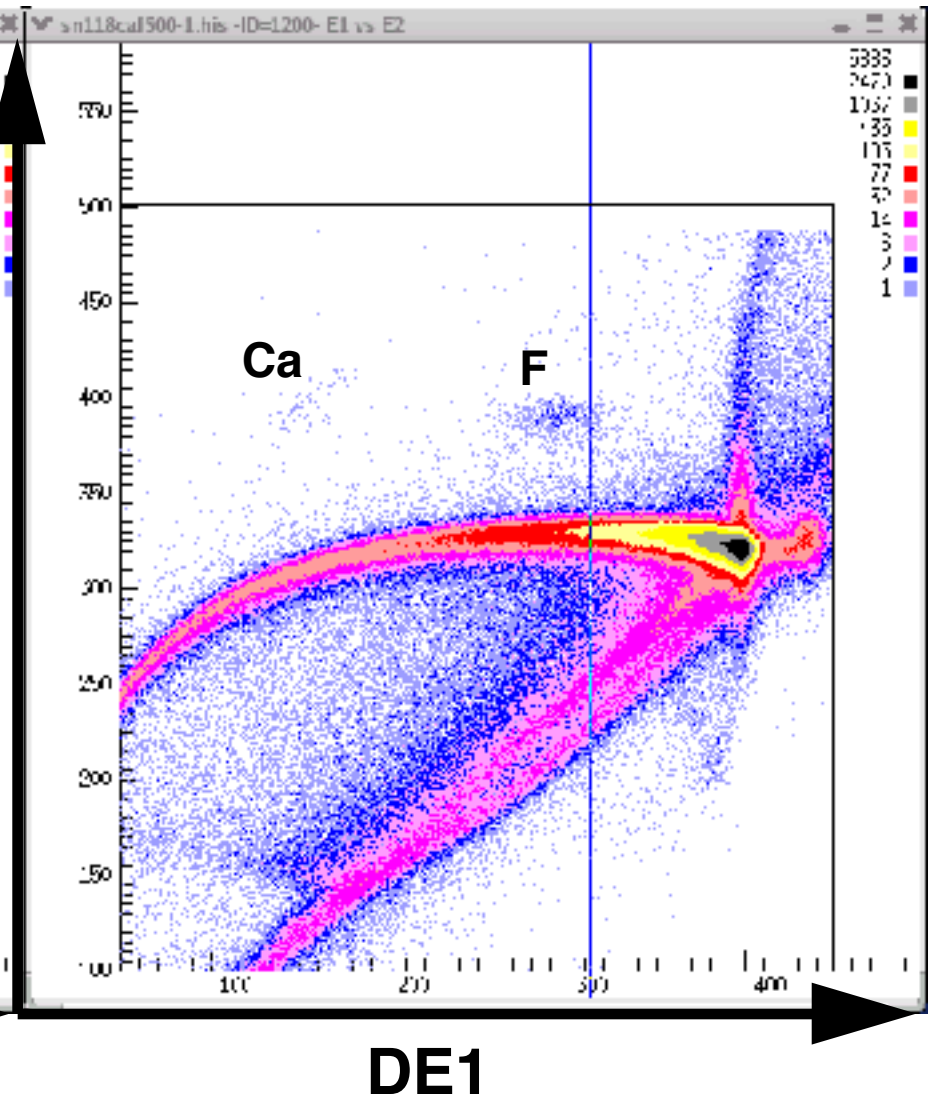
$1.34 < (N/Z)_{CN} < 1.57$

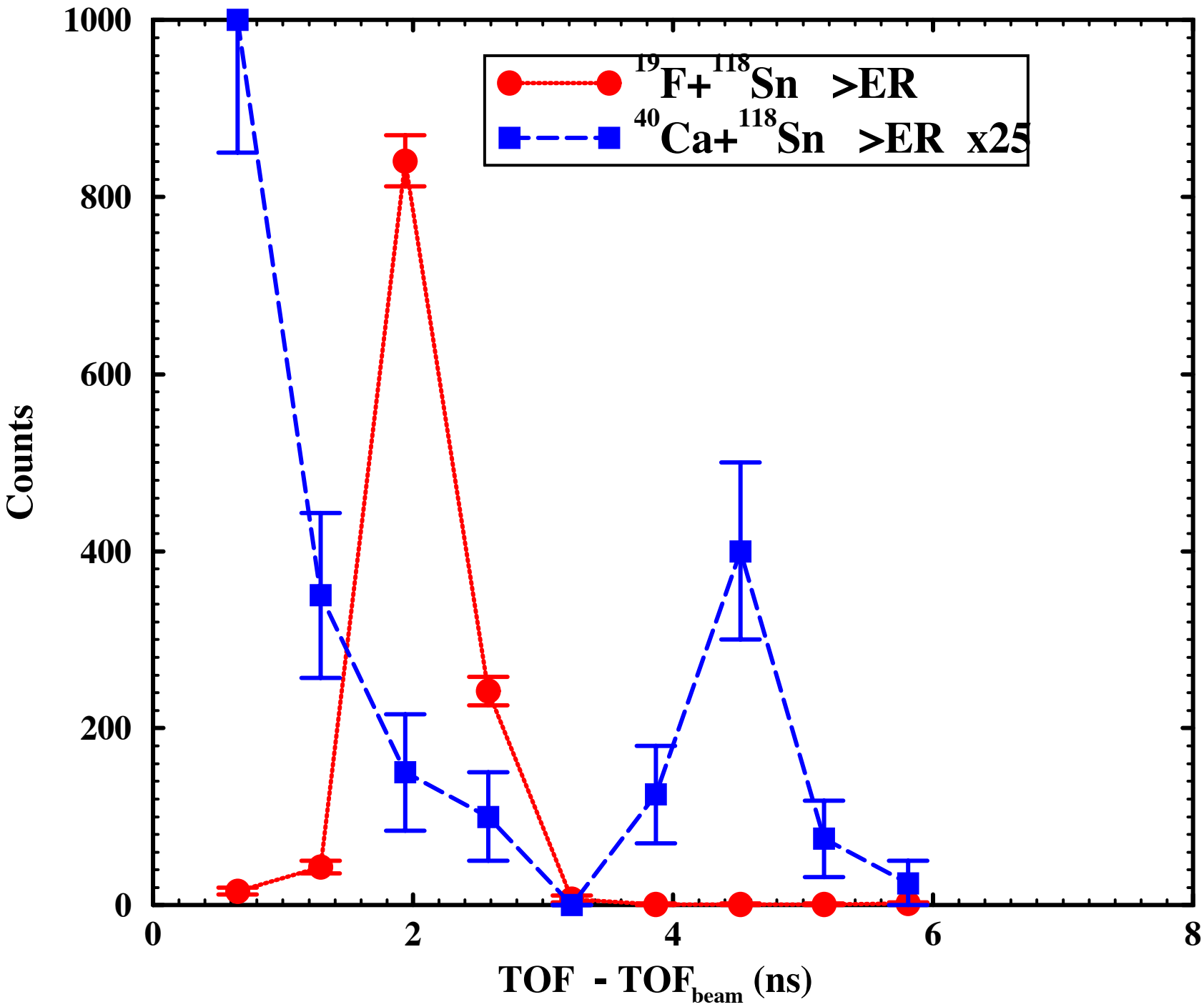
Carbon backed CaF_2 + ^{118}Sn -> ER

E=465MeV



E=500MeV




^{19}F+^{118}Sn >ER
^{40}Ca+^{118}Sn >ER x25
Counts
TOF - TOF$_{beam}$ (ns)
0
200
400
600
800
1000
0
2
4
6
8

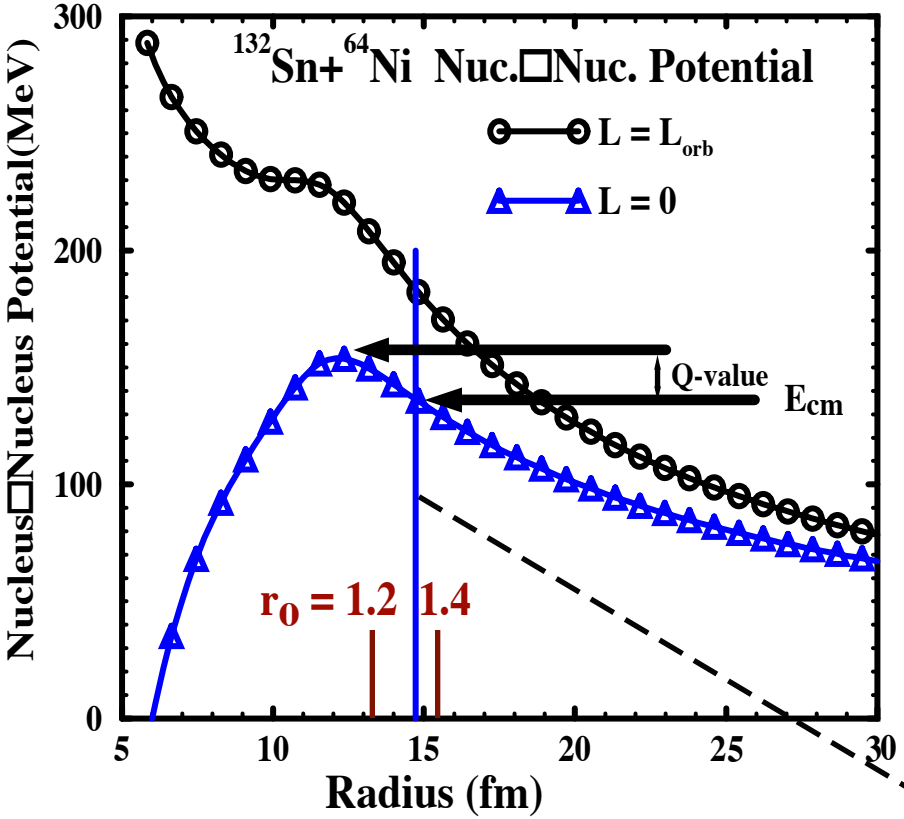
Developed system to measure ER residues.

Suitable for low intensity RIBs.
Nearly 100% efficient.
Measure accurate cross sections down to ~1mb.
Can handle situation of impure beam.
Can handle compound targets.

Low Cost.

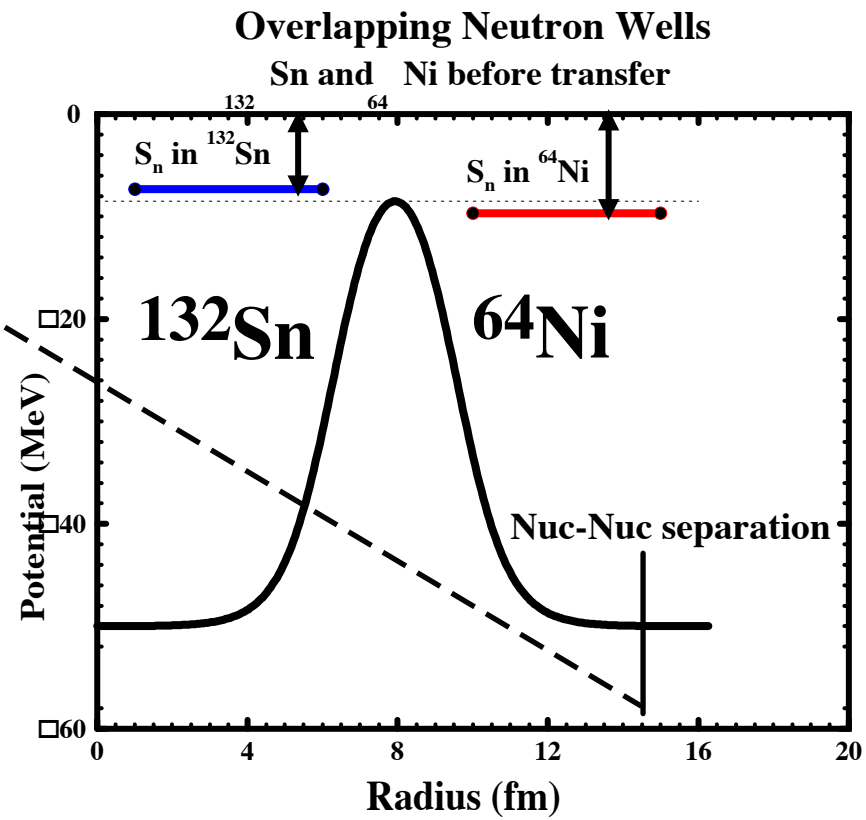
First look at the data

Enhanced capture with n-rich nuclei?



n-Transfer channels with Q>0.

(~2000) Y. Denisov
V. Zagrebaev



Neutron Flow

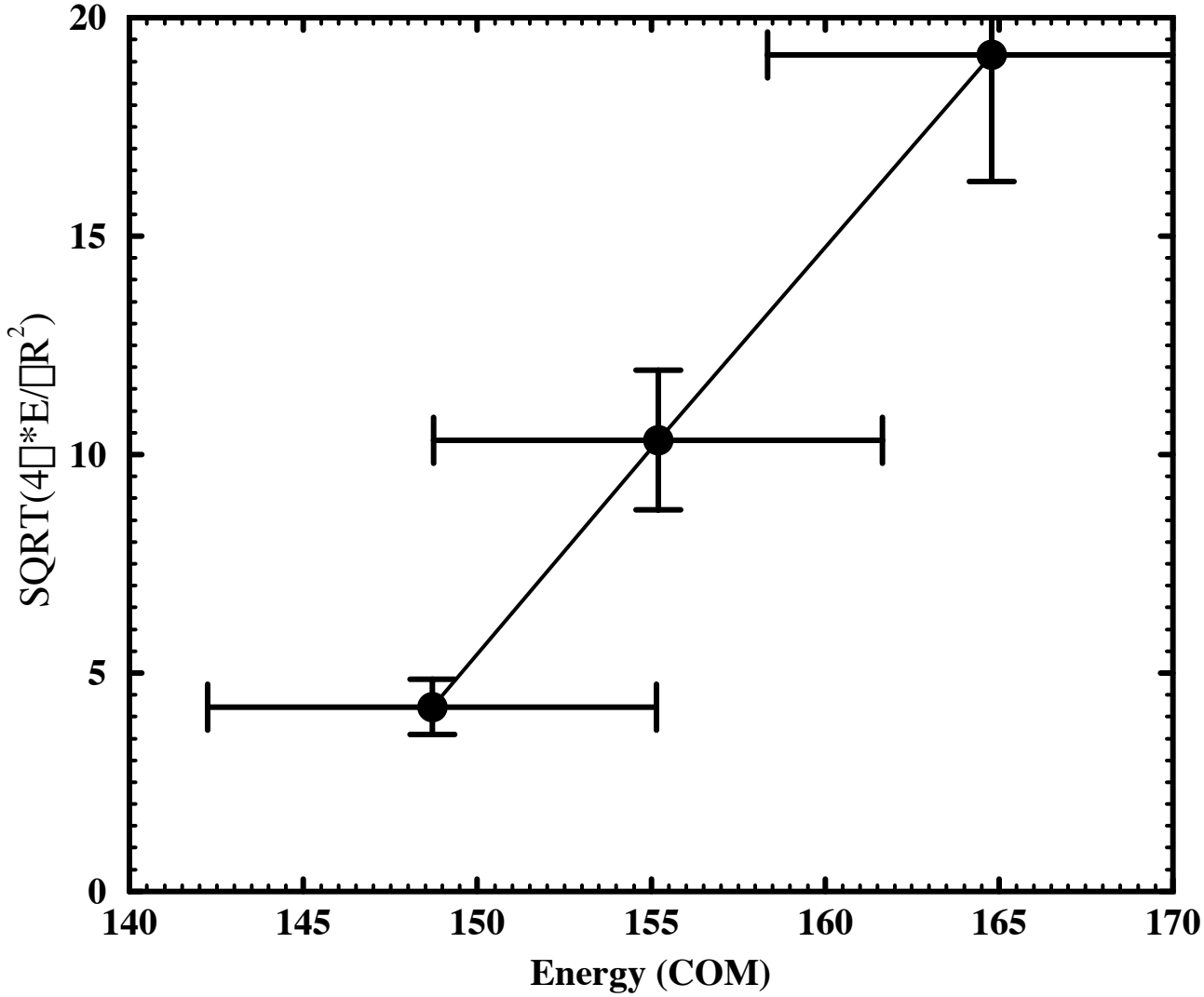
P. Stelson
N. Rowley (~1990)

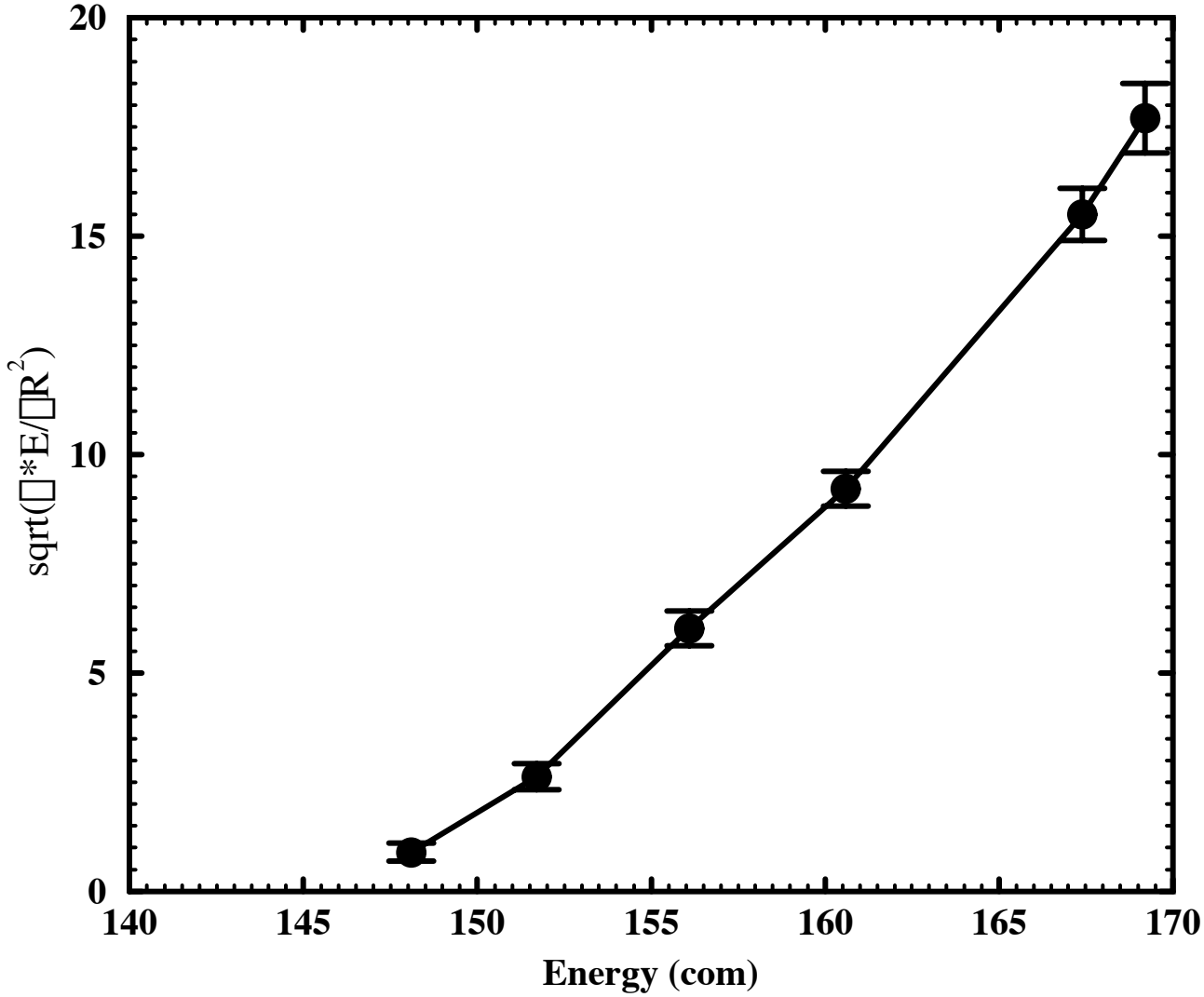
$$\sigma(E) = \pi R^2 \times (1 - \frac{B}{E}). \tag{1}$$

$$\sigma(E) = \int_T^E \sigma(E, B) D(B) dB$$

$$= \pi R^2 \times \frac{1}{2(B_0 - T)} \int_T^E (1 - \frac{B}{E}) dB$$

$$= \pi R^2 \frac{(E - T)^2}{4(B_0 - T)E} \tag{2}$$


20
15
10
5
0
140
145
150
155
160
165
170
Energy (COM)
SQRT(4□*E/□R^2)


20
15
10
5
0
140
145
150
155
160
165
170
Energy (com)
sqrt(□*E/□R^2)