Recent results from VAMOS

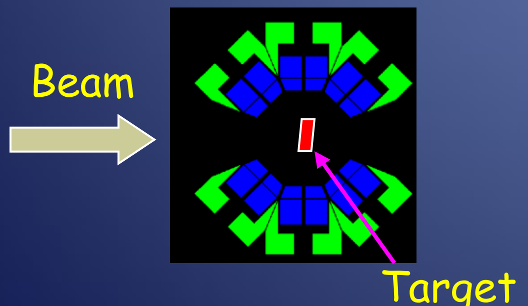
In this presentation:

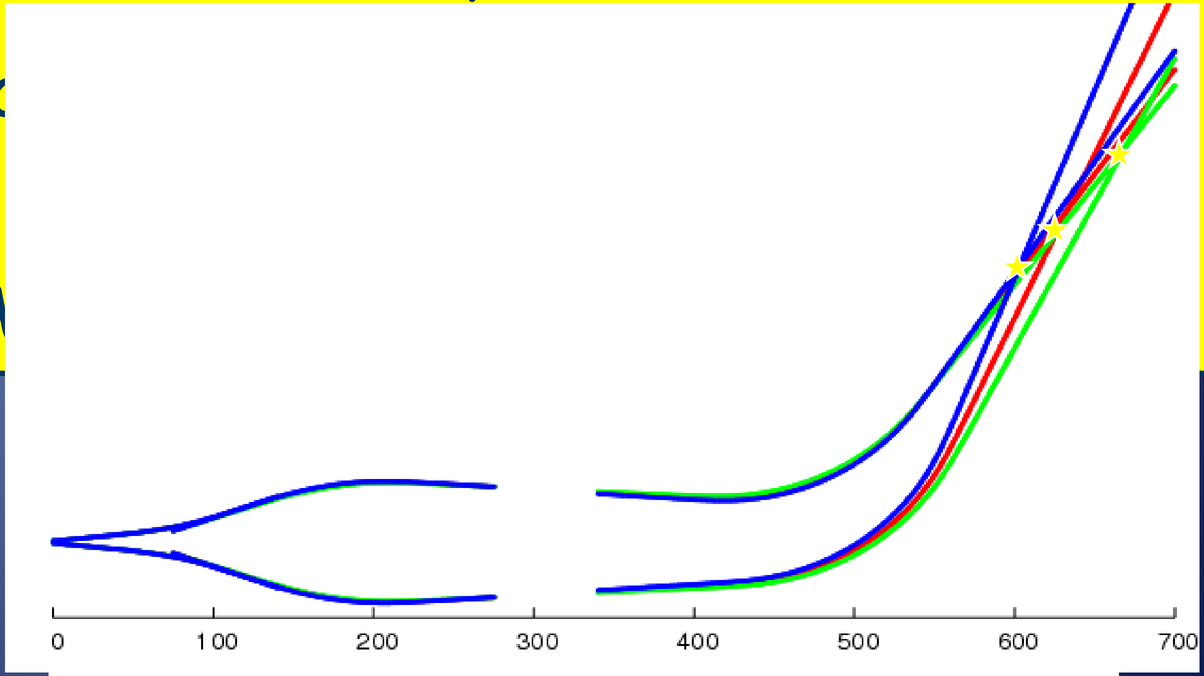
- VAMOS
- recent results using:
  - Low intensity radioactive beams
  - High intensity stable beams

VAMOS++

Essential for nuclear structure and reaction studies

- ✓ Identification of reaction products
- ✓ Large accept
- ✓ Coupling with
MUST2, TIARA





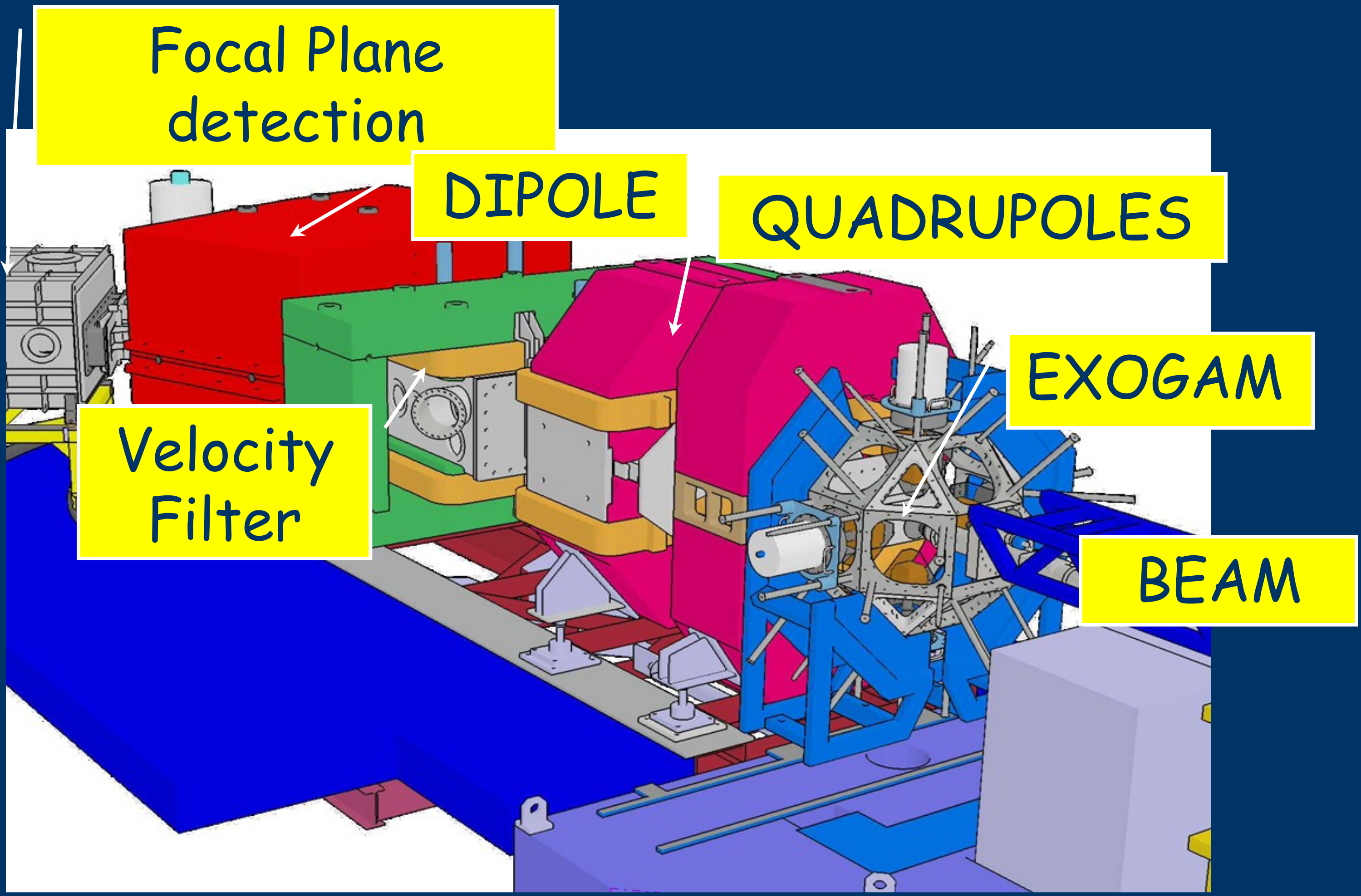
Variable Mode Operation

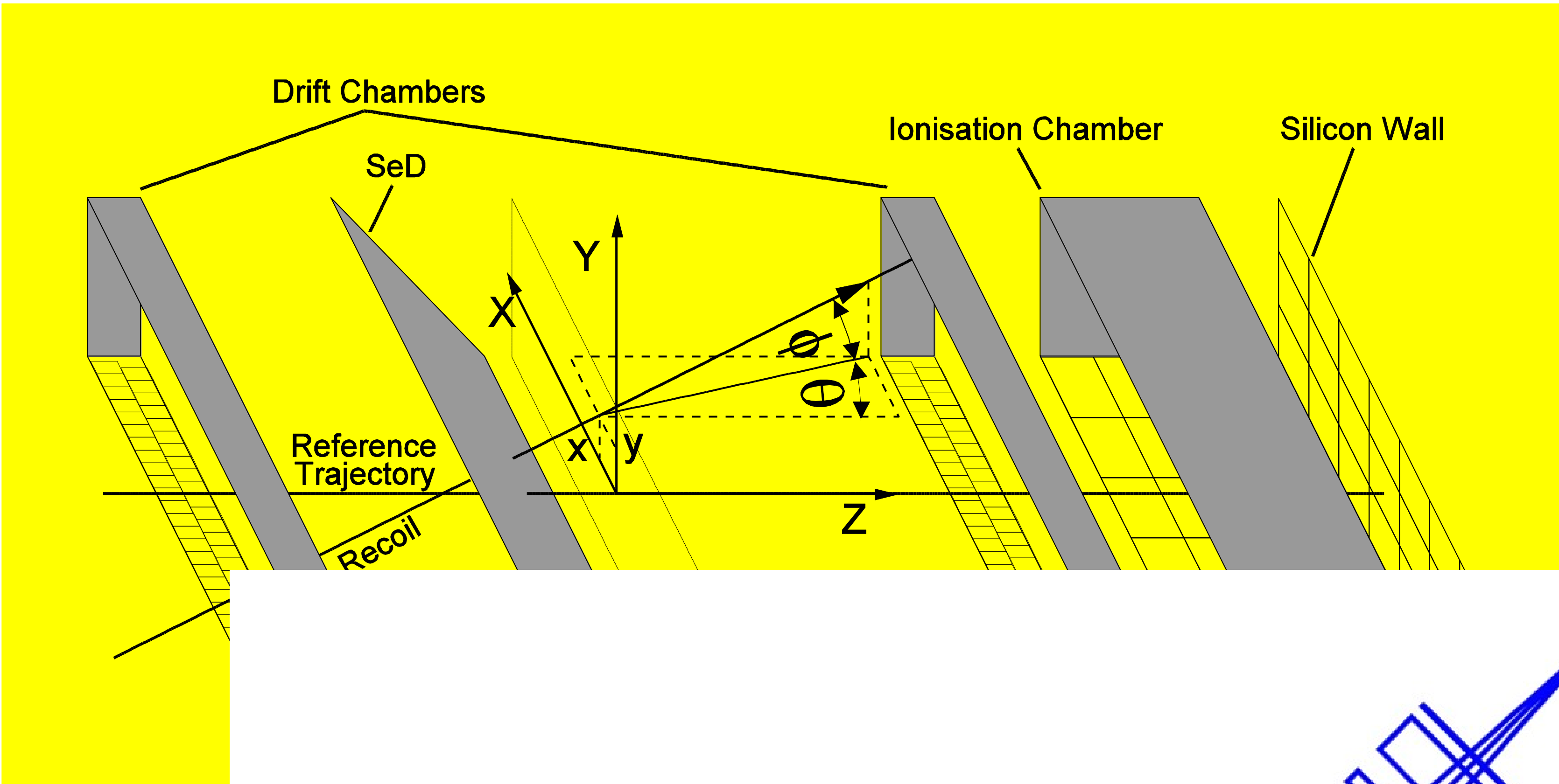
- ✓ QQ – Focusing Mode
- ✓ QQD – Spectrometer
  - ➢ Variable Dispersion
- ✓ Recoil Separator
  - ▪ QQF(D)
  - ▪ QQD (Gas filled)

S. Pullanhiotan et al, NIMA 593 (2008) 343

C. Schmitt et al, NIM A 621 (2010) 558

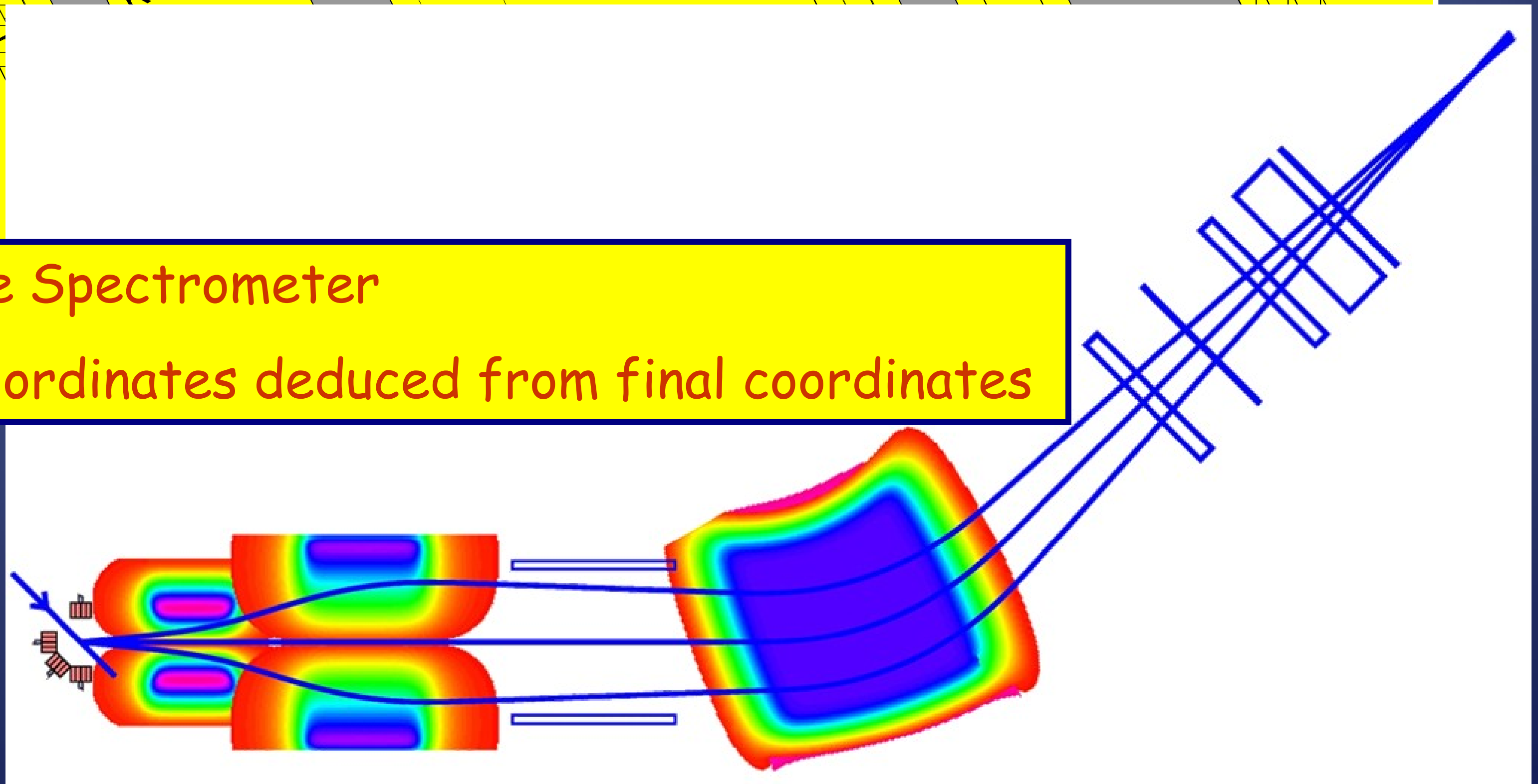
VAMOS Spectrometer Schematic View



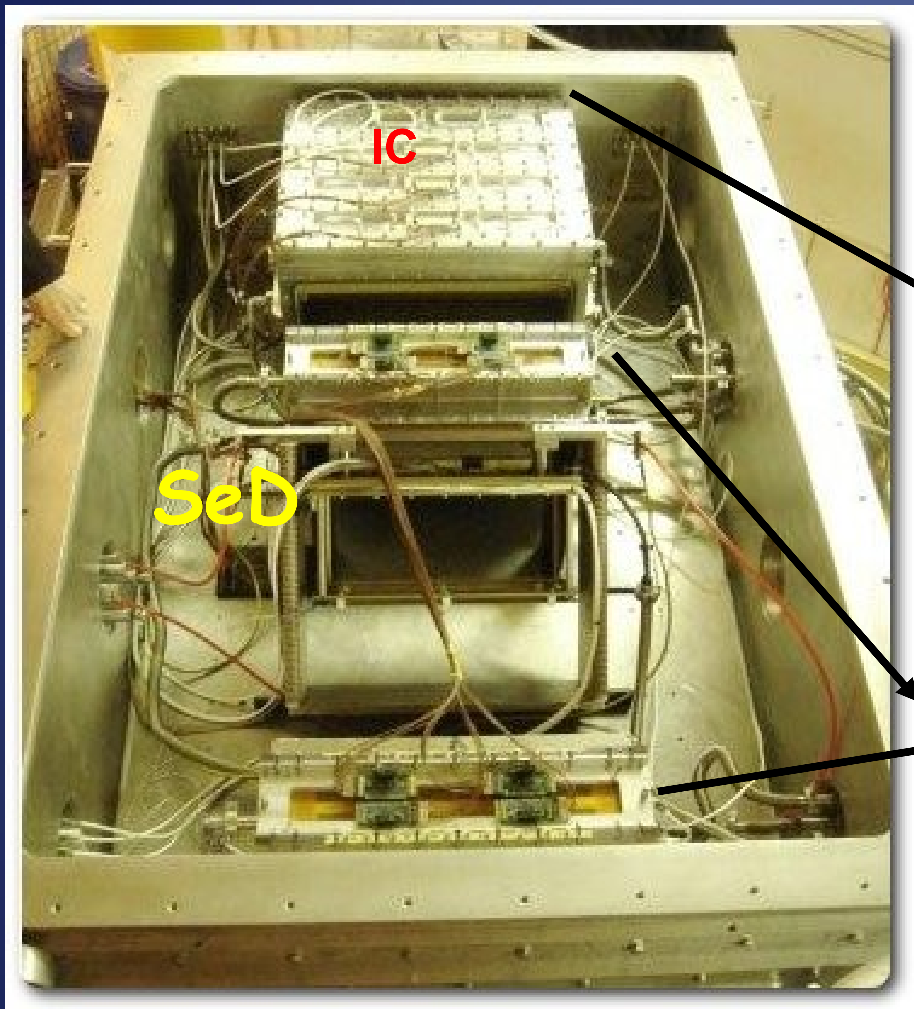


Software Spectrometer

Initial coordinates deduced from final coordinates

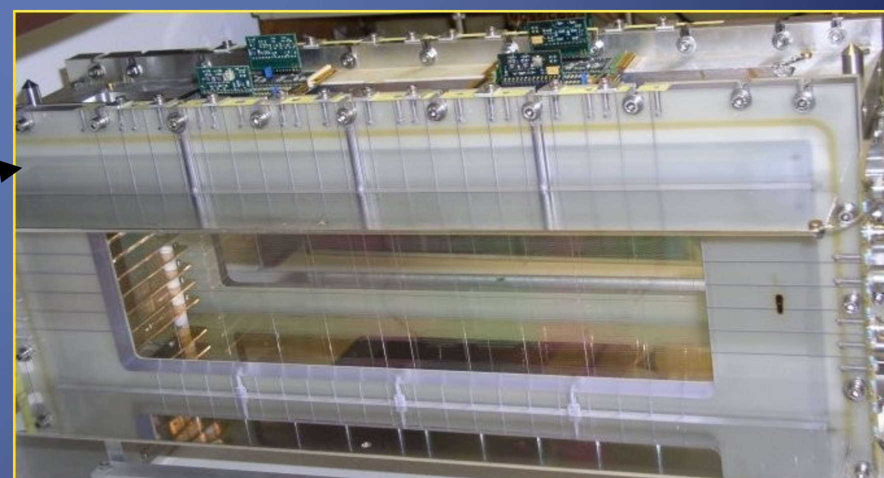


Focal Plane Setup



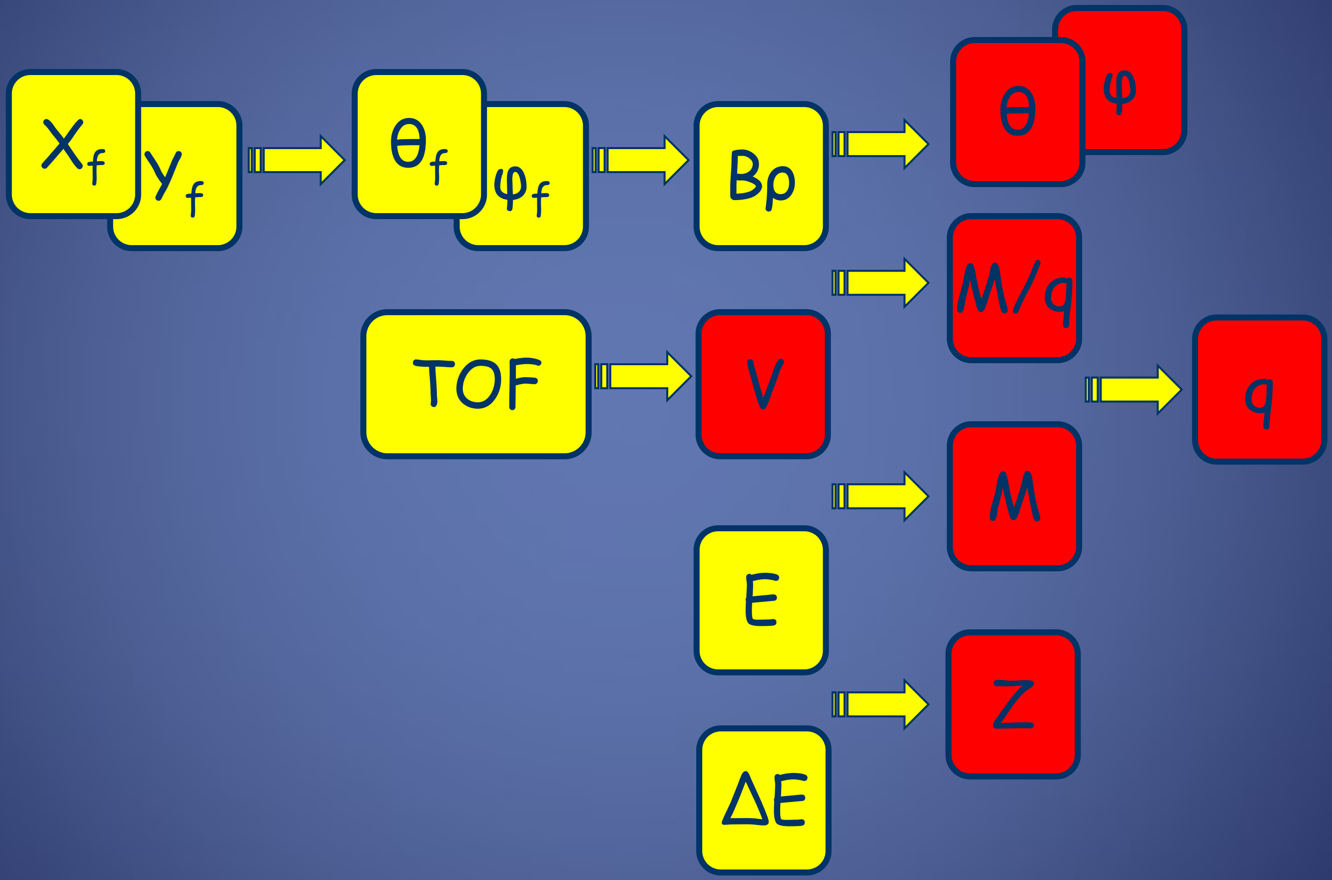
beam

Si Wall



Drift Chamber

VAMOS Measurement
(Software Spectrometer)

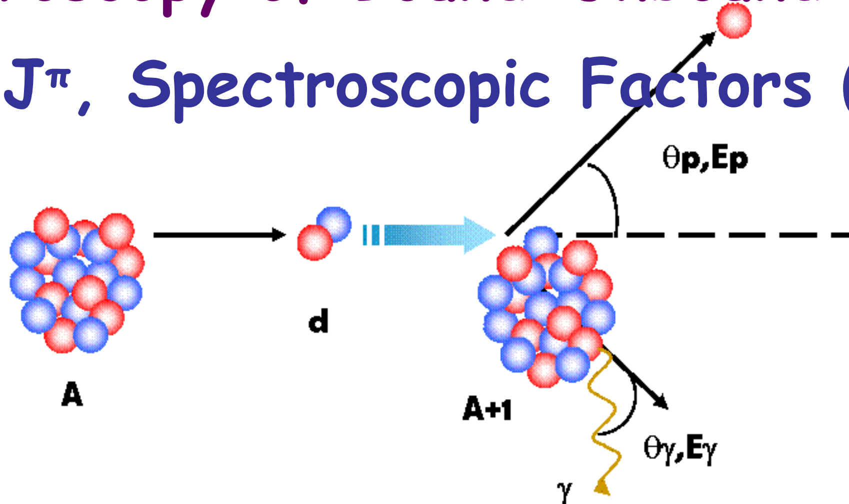


Experimental approach

-transfer reactions in inverse kinematics

Spectroscopy of Bound-Unbound states

Ex, J^{π}, Spectroscopic Factors (SF)



Measurements -> Observables

Ep and/or Eγ ->Ex

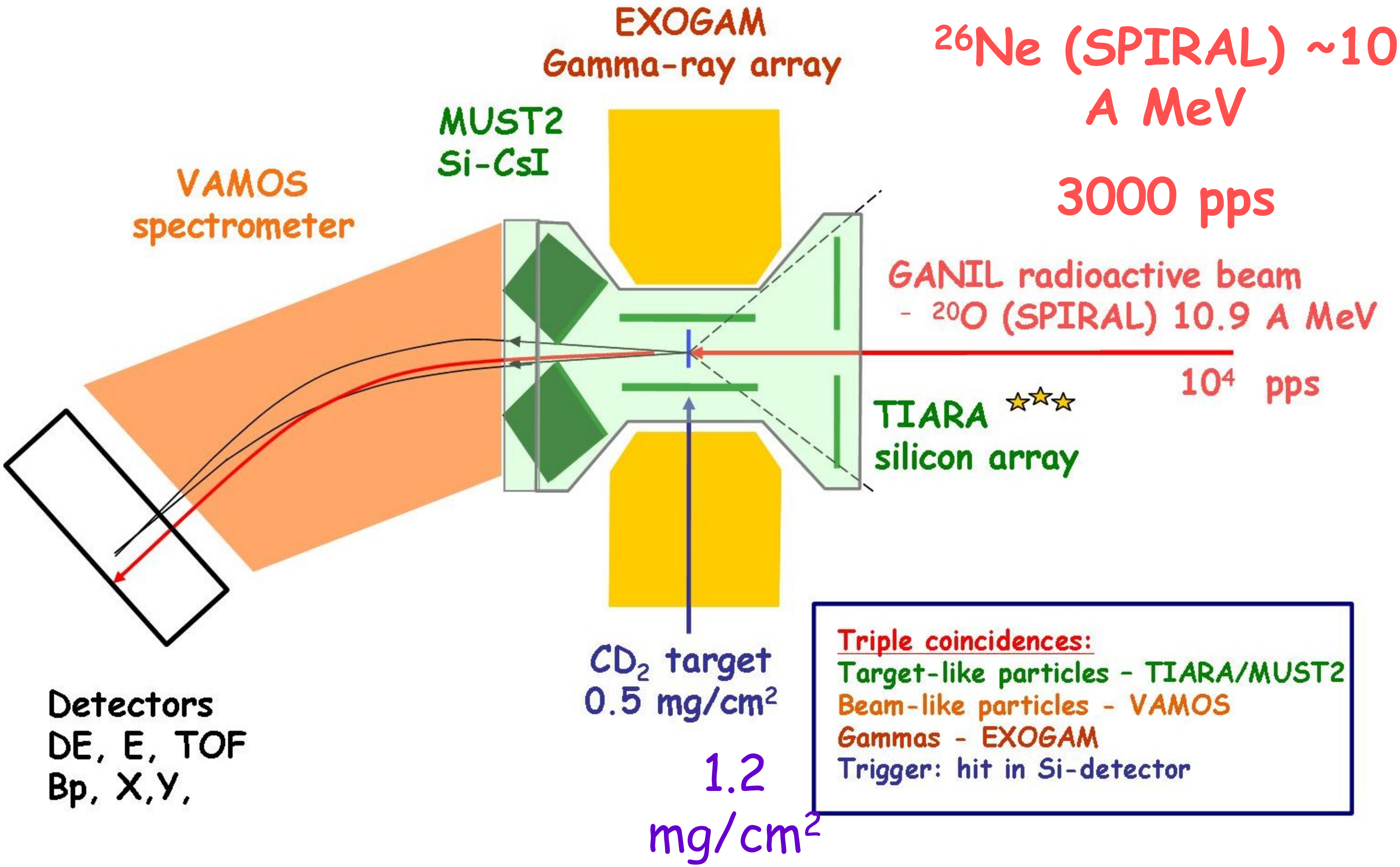
θp -> $d\sigma/d\Omega$ -> (ℓ , SF)

Inverse kinematics->(d,p),(d,t),(d,^{3}He),(d,d')

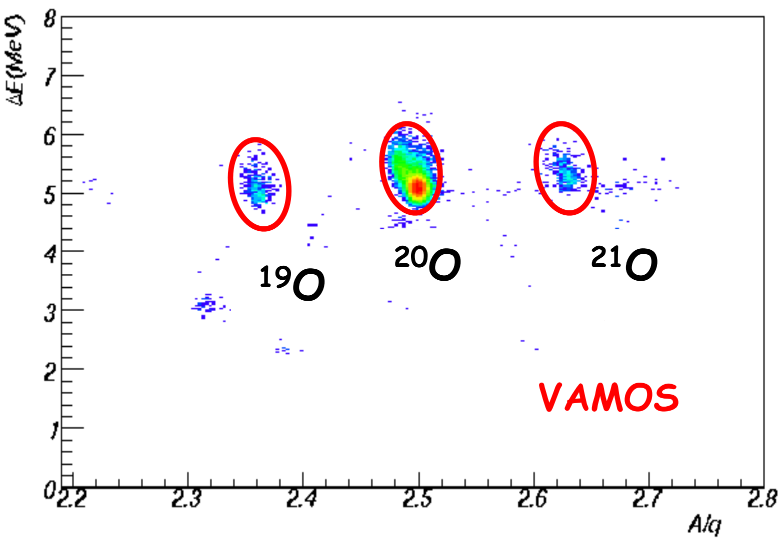
B. Fernandez-Dominguez et al, PRC 84, (2011), 011301

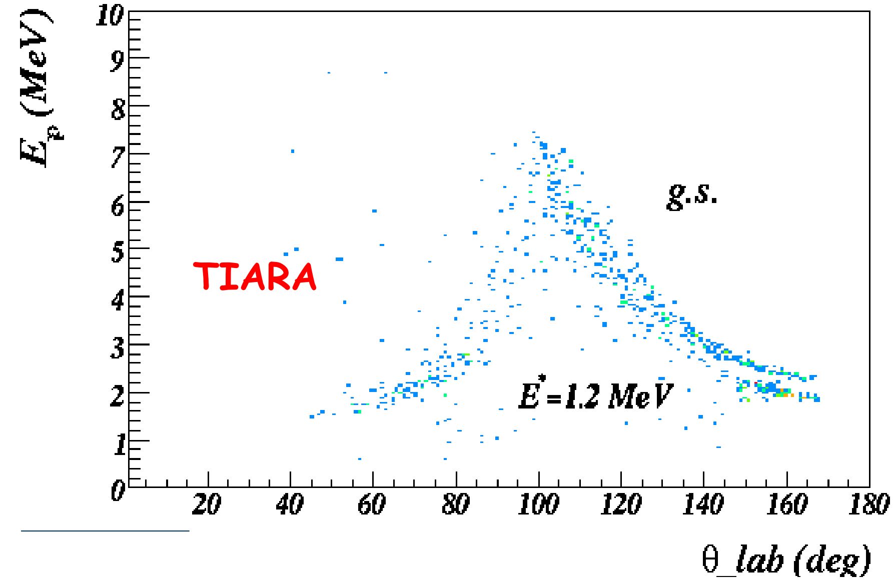
Experimental Set-Up

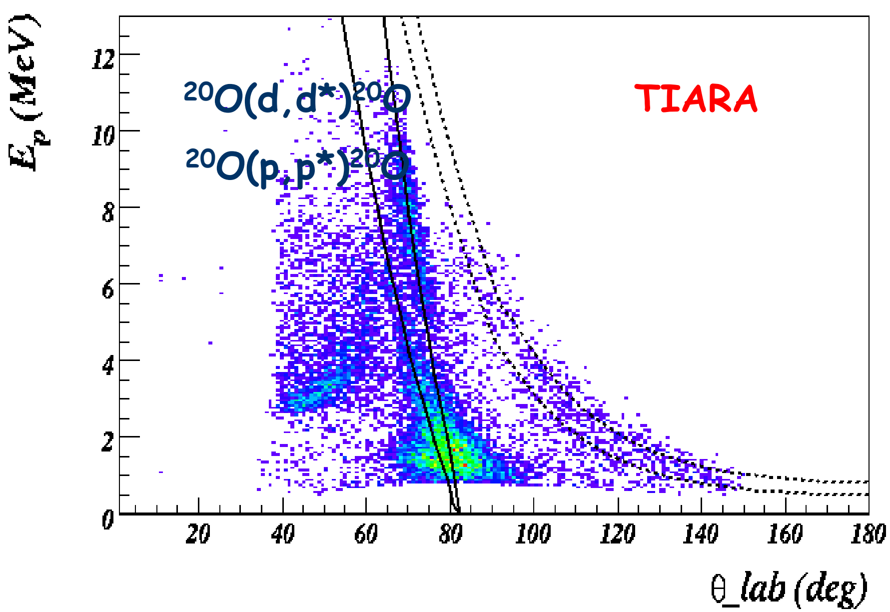
TIARA+MUST2+VAMOS+EXOGAM @ GANIL

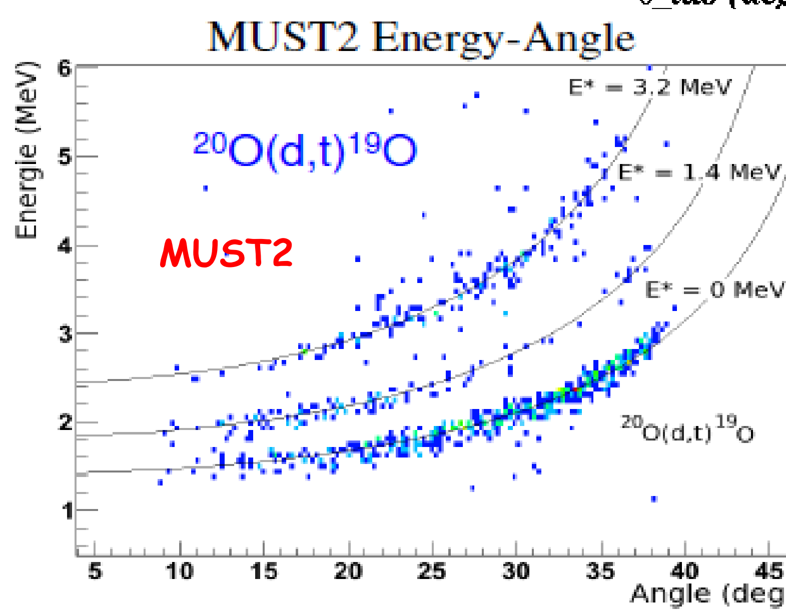


ANALYSIS : Example d(^{20}O,p)^{21}O

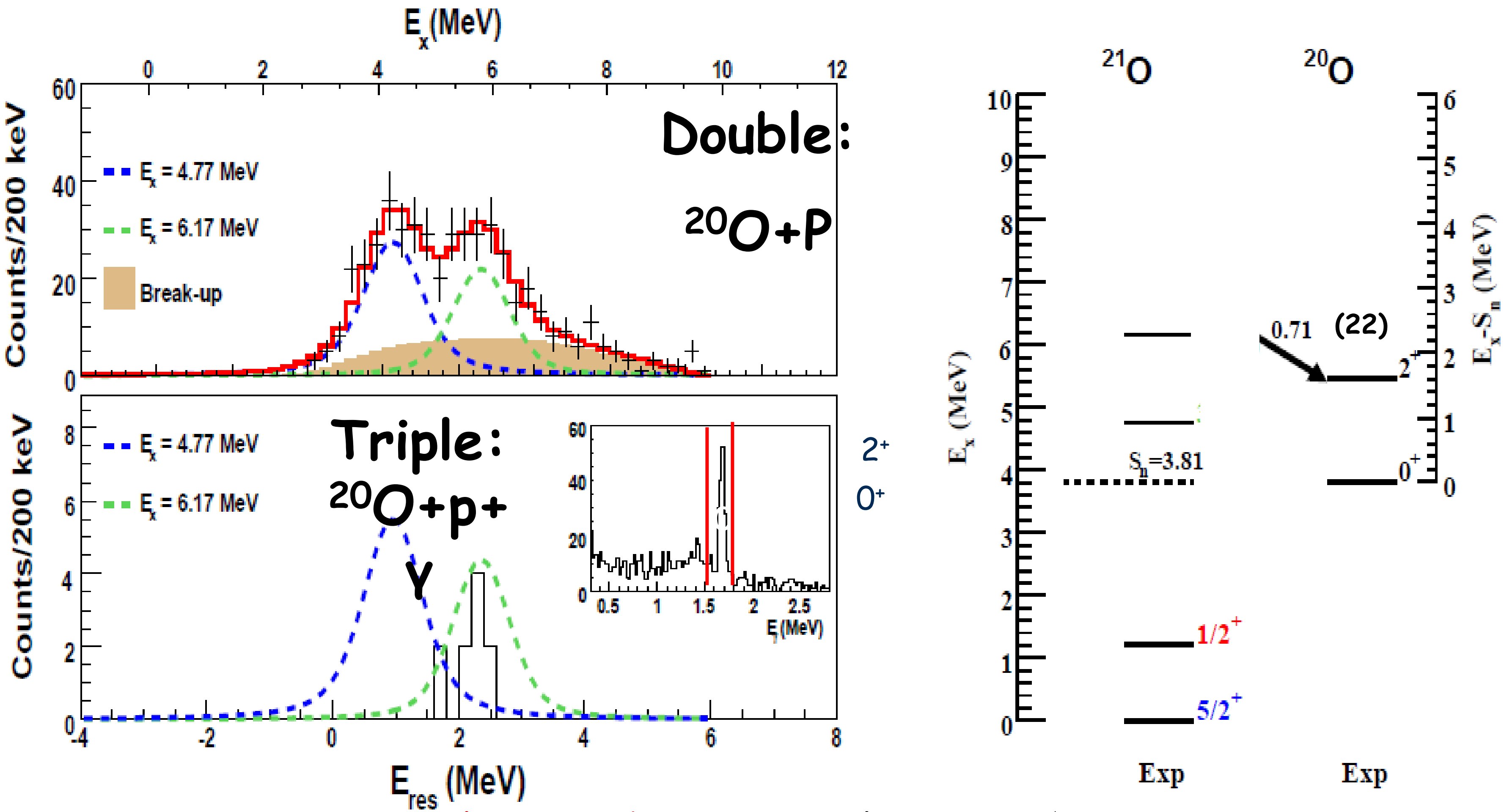








UNBOUND STATES: $d(^{20}O,p)^{21}O \rightarrow {}^{20}O + n$ (stripping)

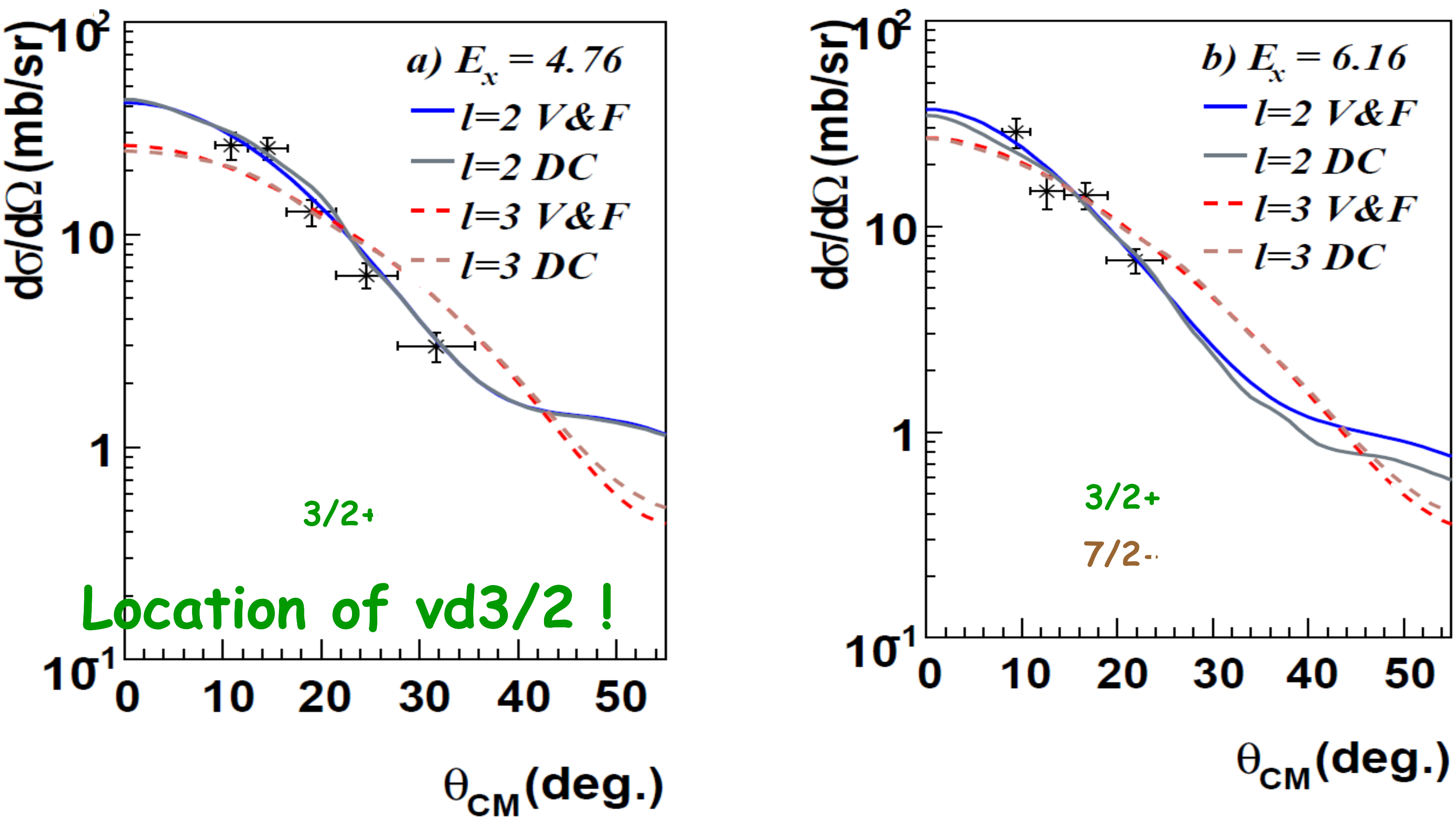


Triple coincidence: particle+γ+recoil

Measurement of core-excitations in unbound nuclei through its decay:

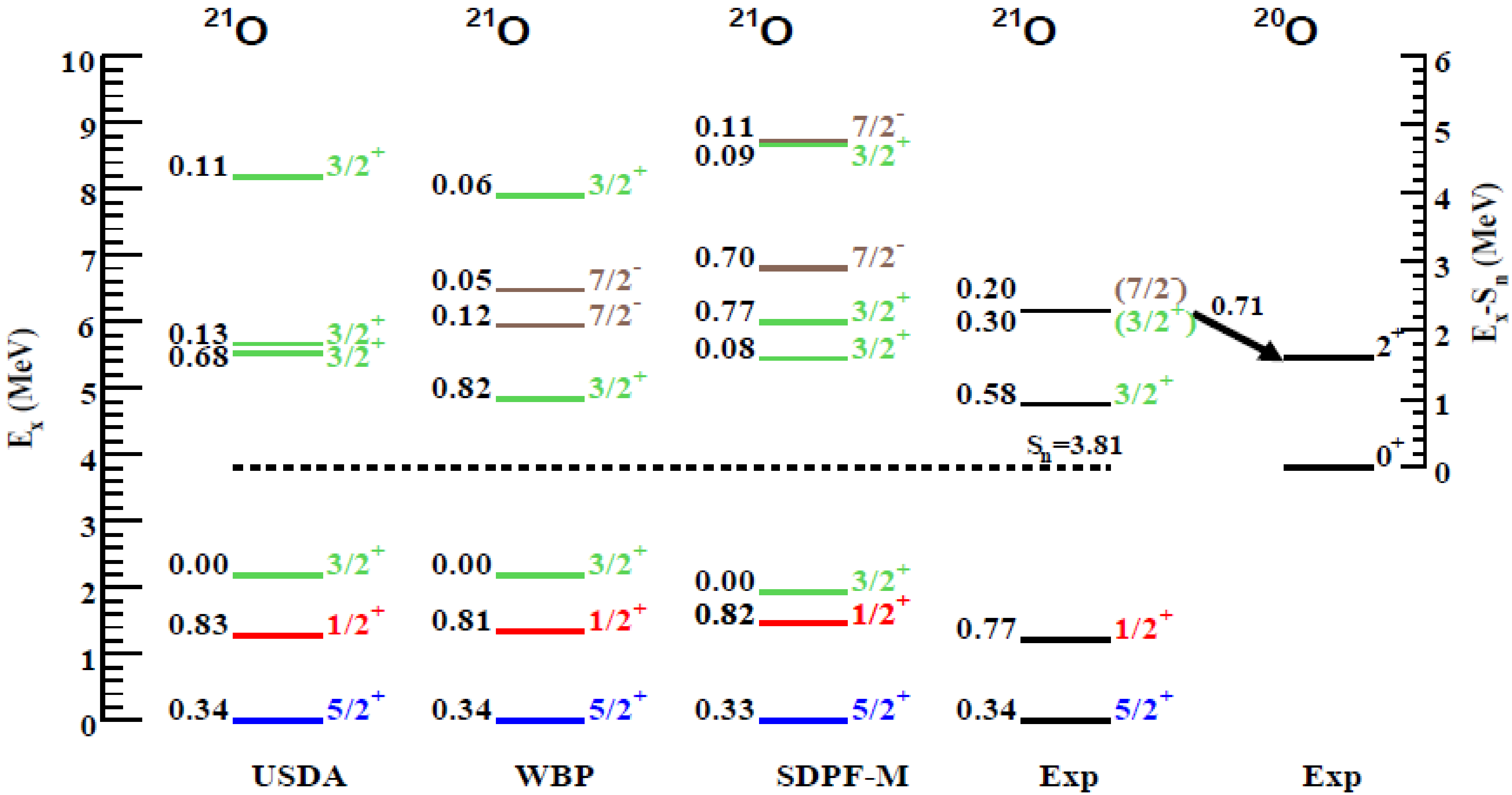
$$\Psi(^{21}O \text{ @ } 6.2 \text{ MeV}) = a\,|n \times {}^{20}O(0^+)\rangle + b\,|n \times {}^{20}O(2^+)\rangle$$

UNBOUND STATES: d(^{20}O,p)^{21}O → ^{20}O + n (stripping)



First 3/2+ state corresponds to the sought vd3/2

UNBOUND STATES: d(^{20}O,p)^{21}O → ^{20}O + n (stripping)

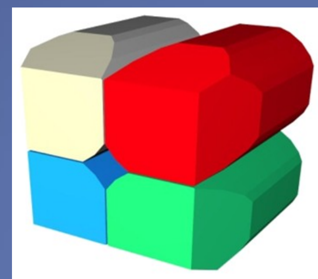


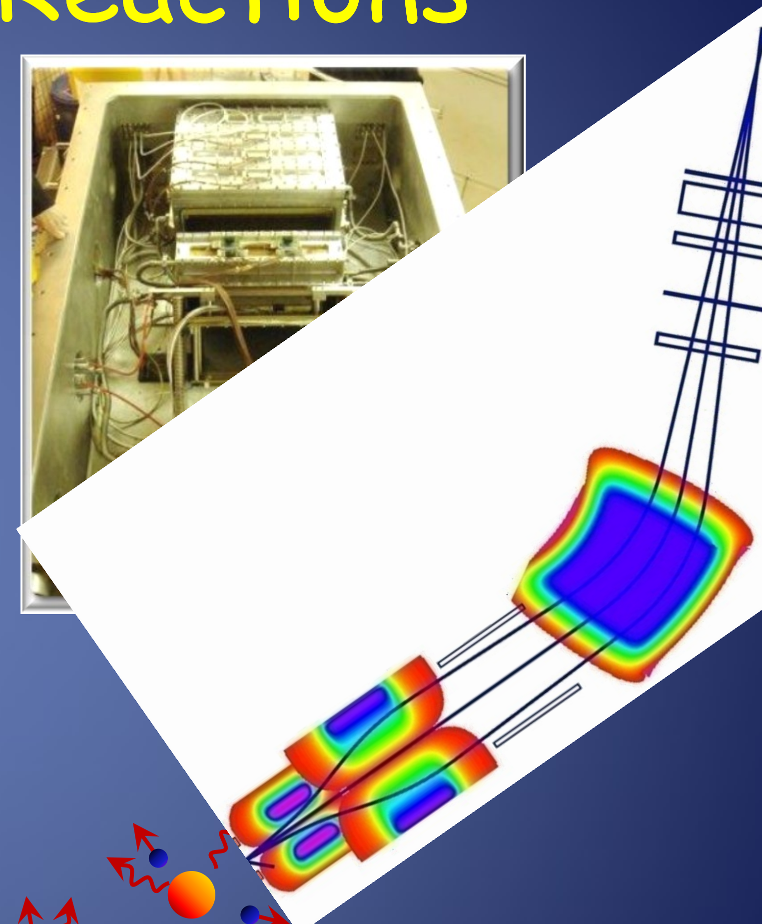
Difficult to interpret unbound states with the standard Shell Model:

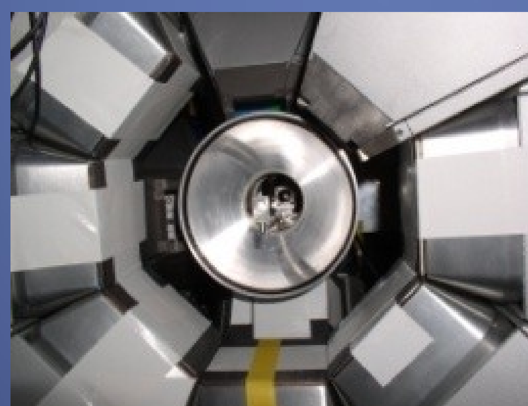
Relying on spectrocopic factors the 3/2+ state seems to favour USDA which predicts ^{26}O unbound

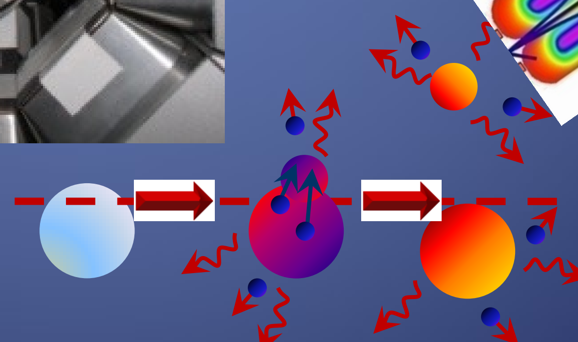
Multinucleon and Deep Inelastic Transfer Reactions

- Beam:
  - ^{238}U
  - 5.5 MeV/u
  - 2pnA
- Target
  - ^{48}Ca
  - 1 mg/cm^2



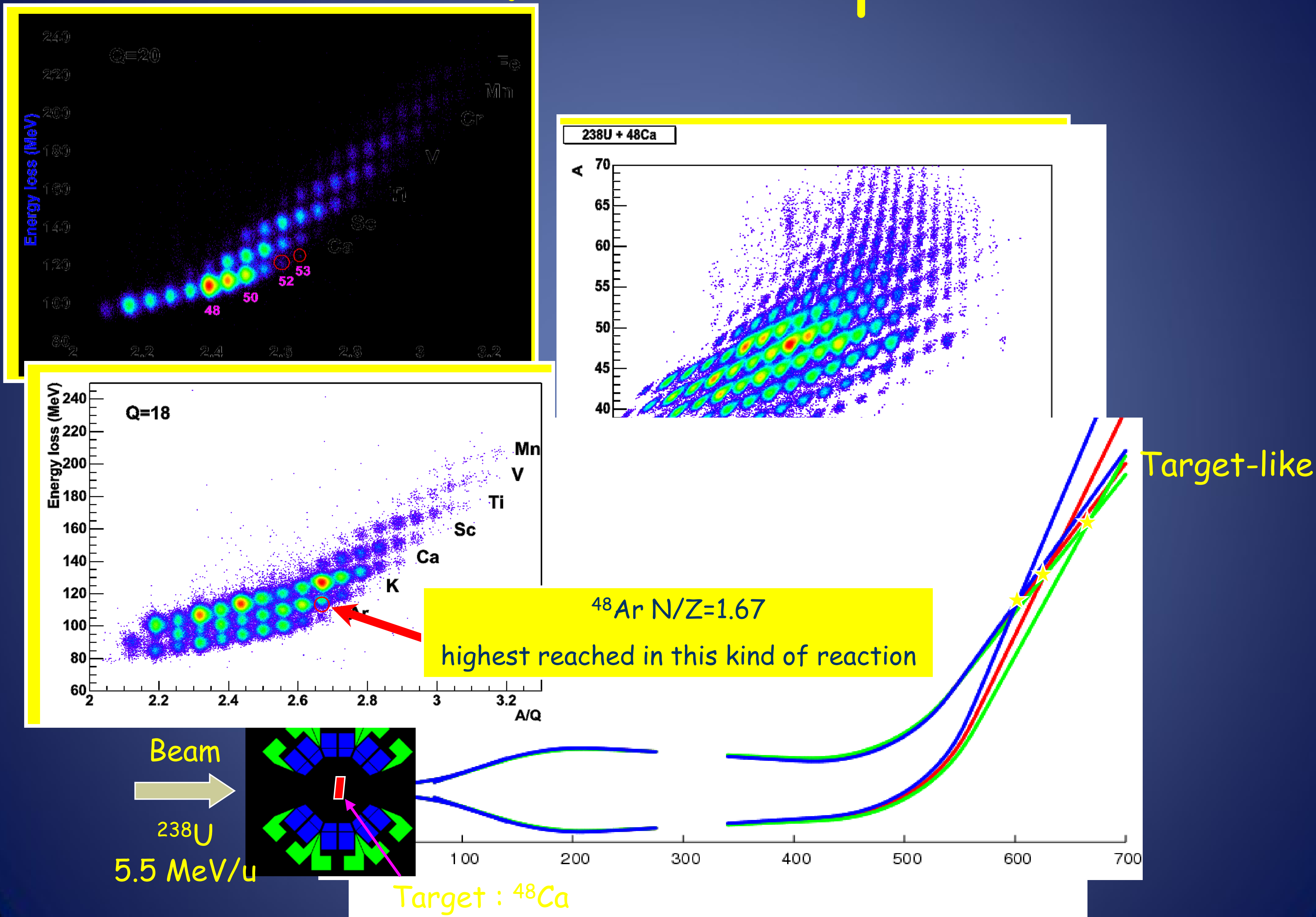




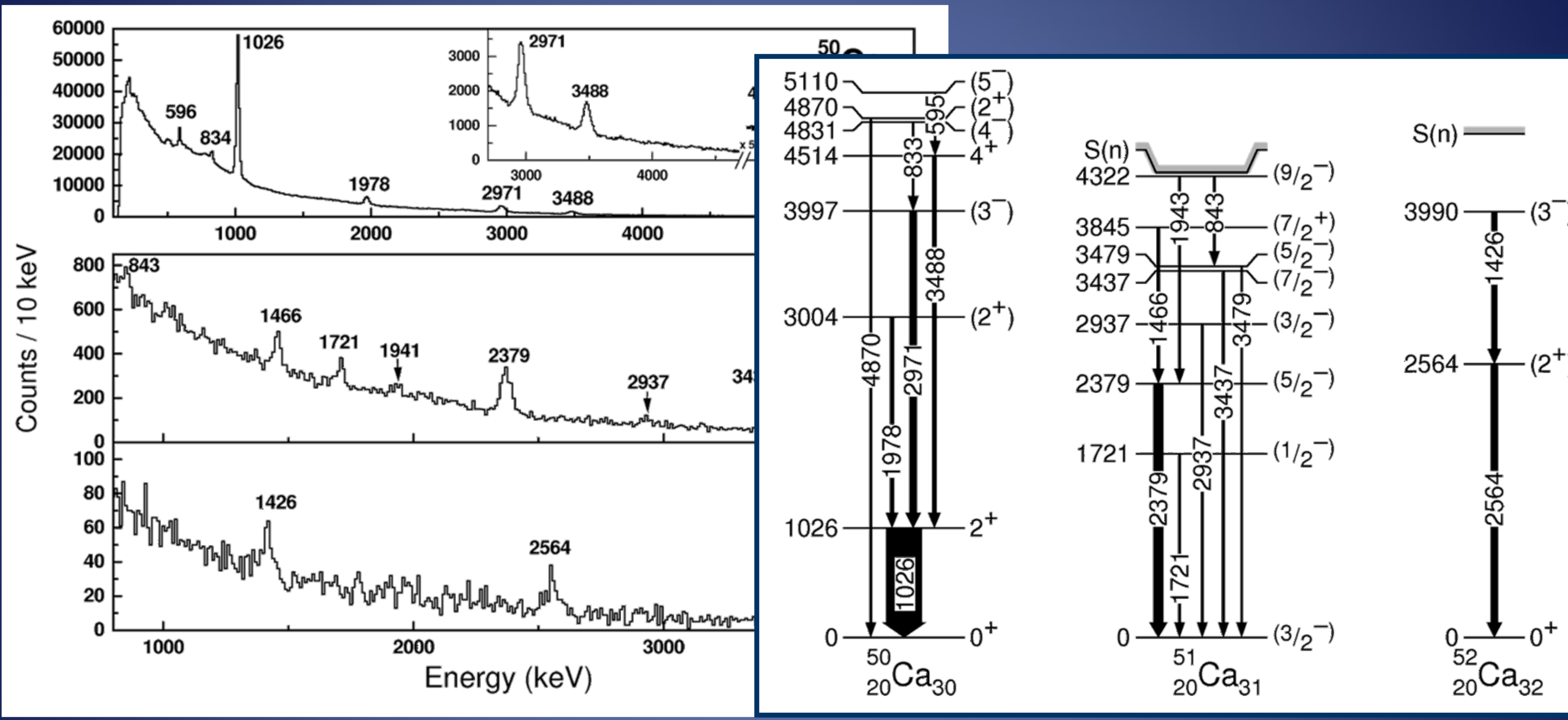


NIMA 593, 343 (2008)

Identification spectra



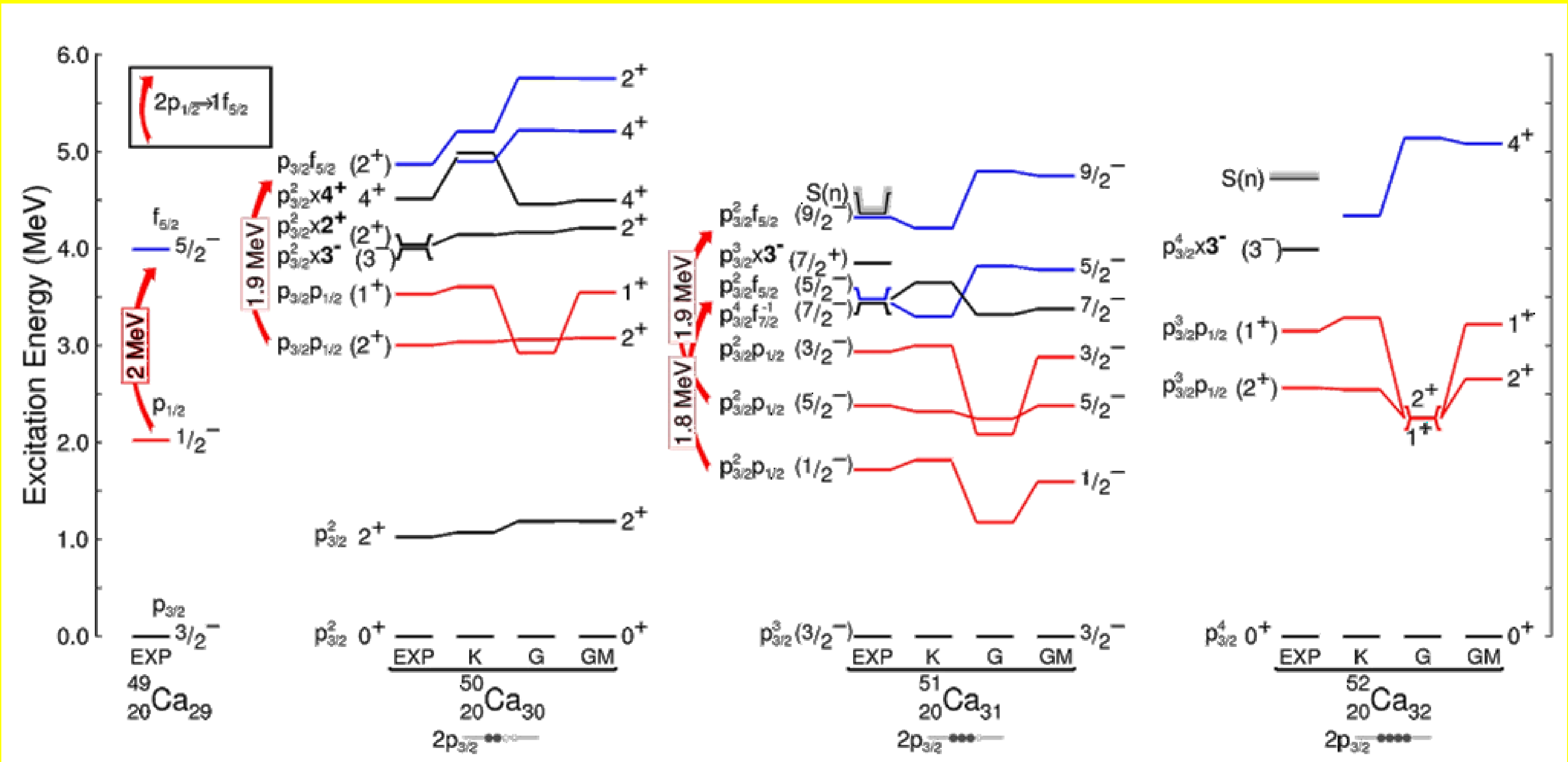
Neutron rich isotopes of Calcium



Doppler corrected using V from VAMOS

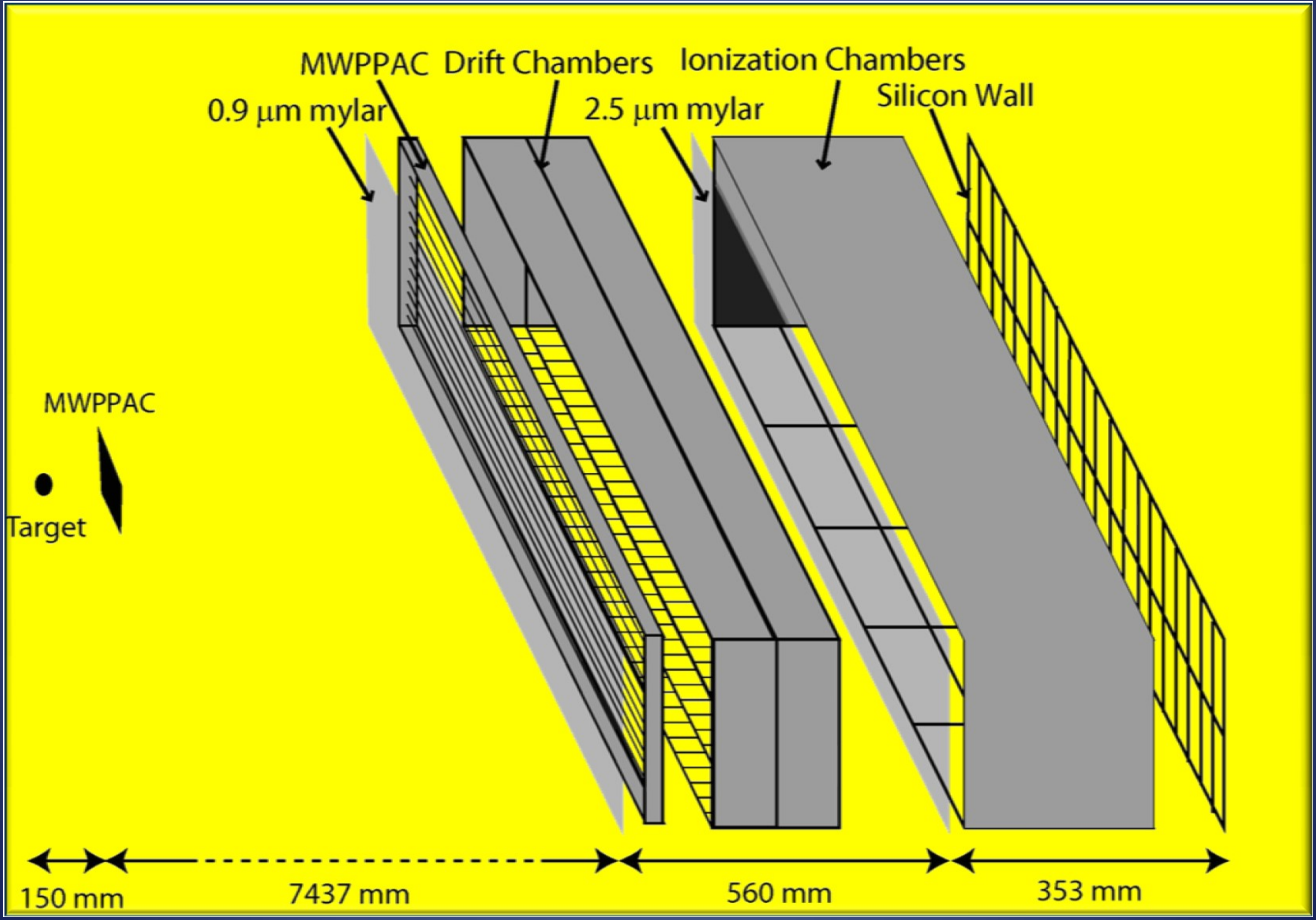
^{238}U (5.5 MeV/u) + ^{48}Ca

No new shell gap at N=34 in Calcium



M. Rejmund et al. PRC 76, 021304(R) (2007)

VAMOS++
New Detection System



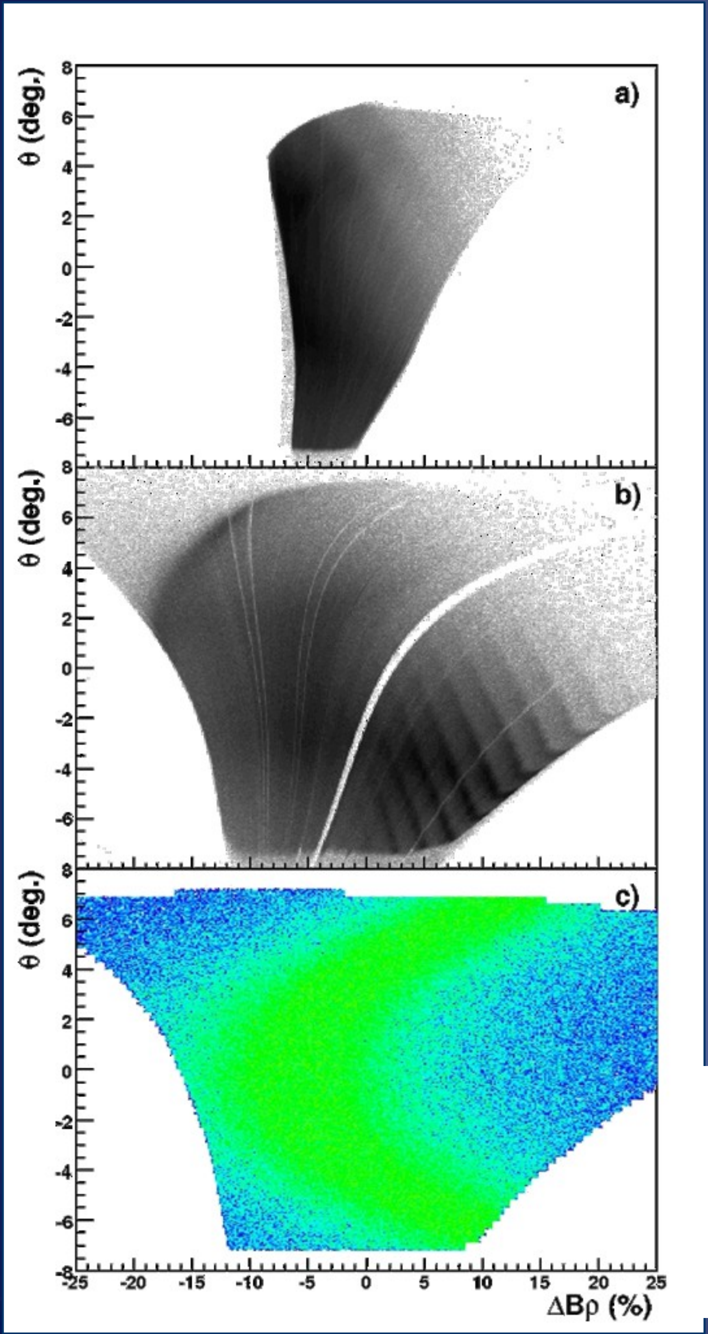
Detectors

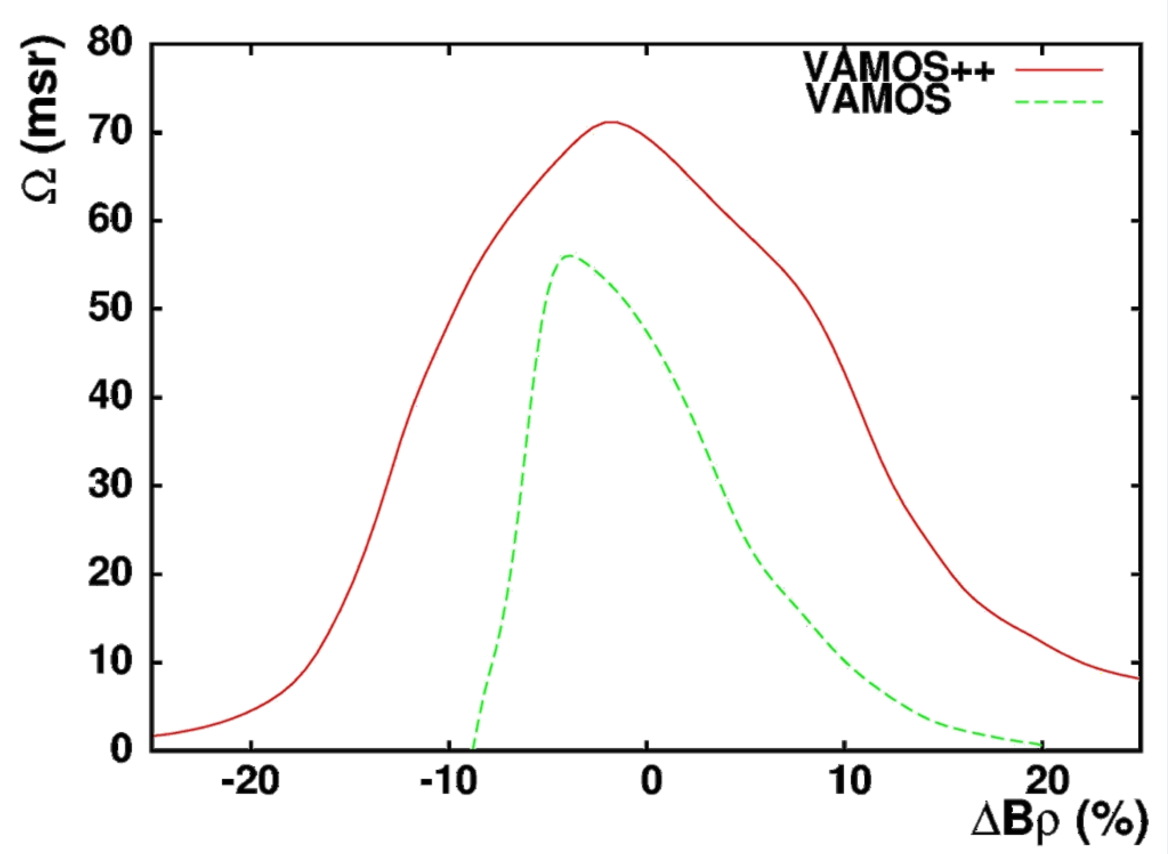
Drift Chambers

MWPPACs

Si-Wall

Acceptance



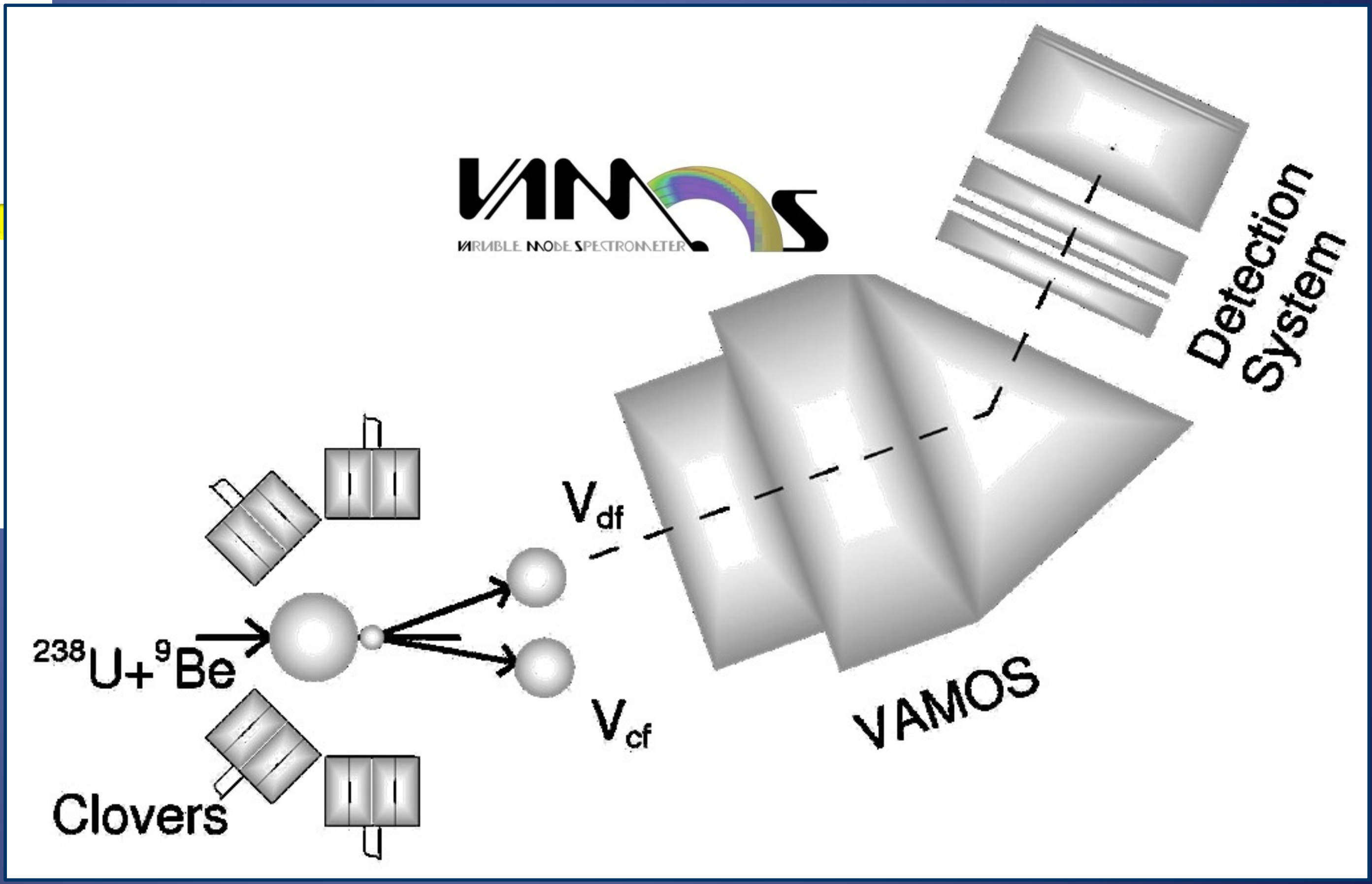


M. Rejmund et al,

NIM A 646 (2011) 184

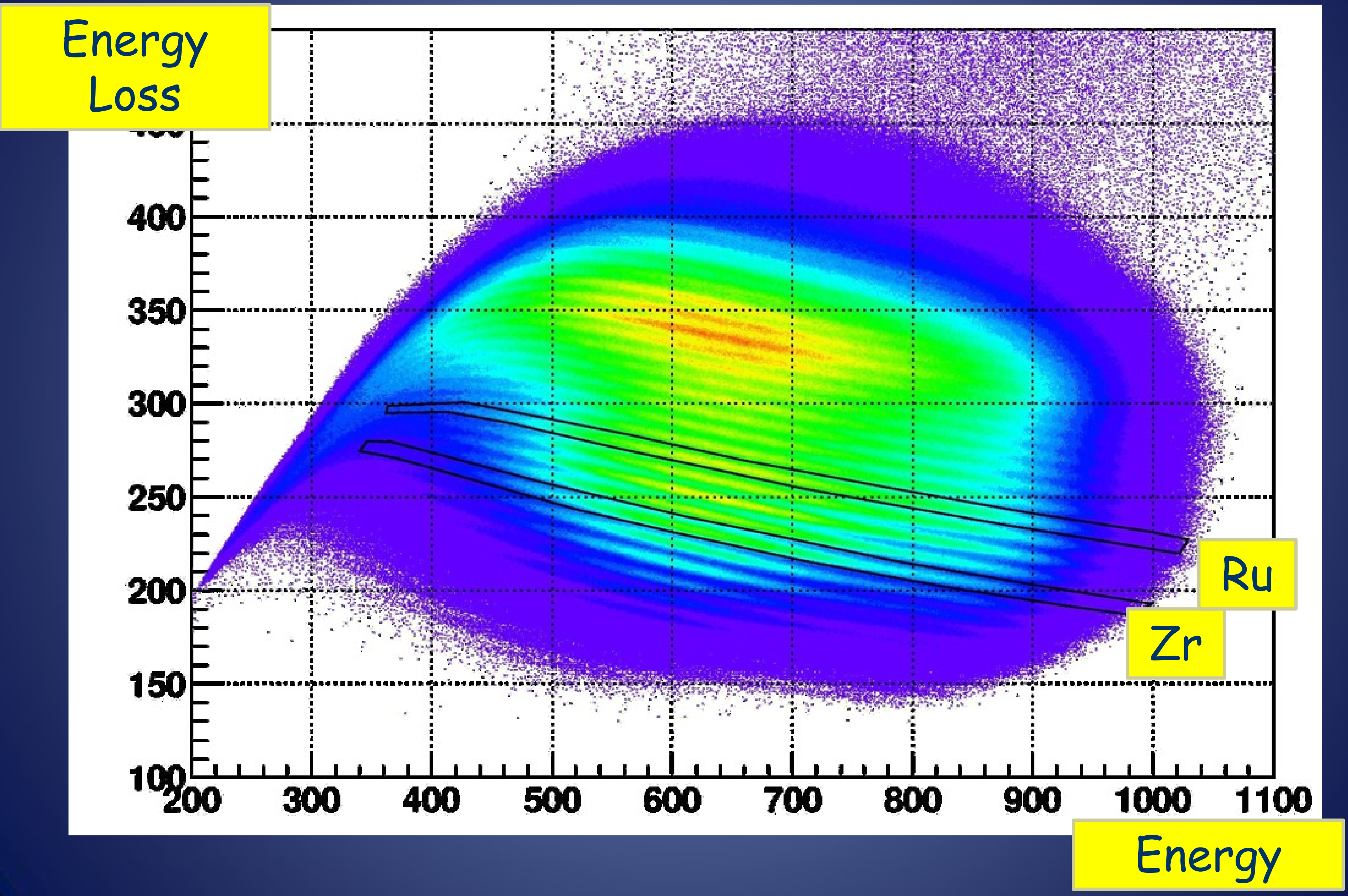
Prompt Gamma Spectroscopy of Fission Fragments

- Beam:
  - ^{238}U
  - 6.2 MeV/u
- Target
  - ^{9}Be
  - 2 mg/cm^2

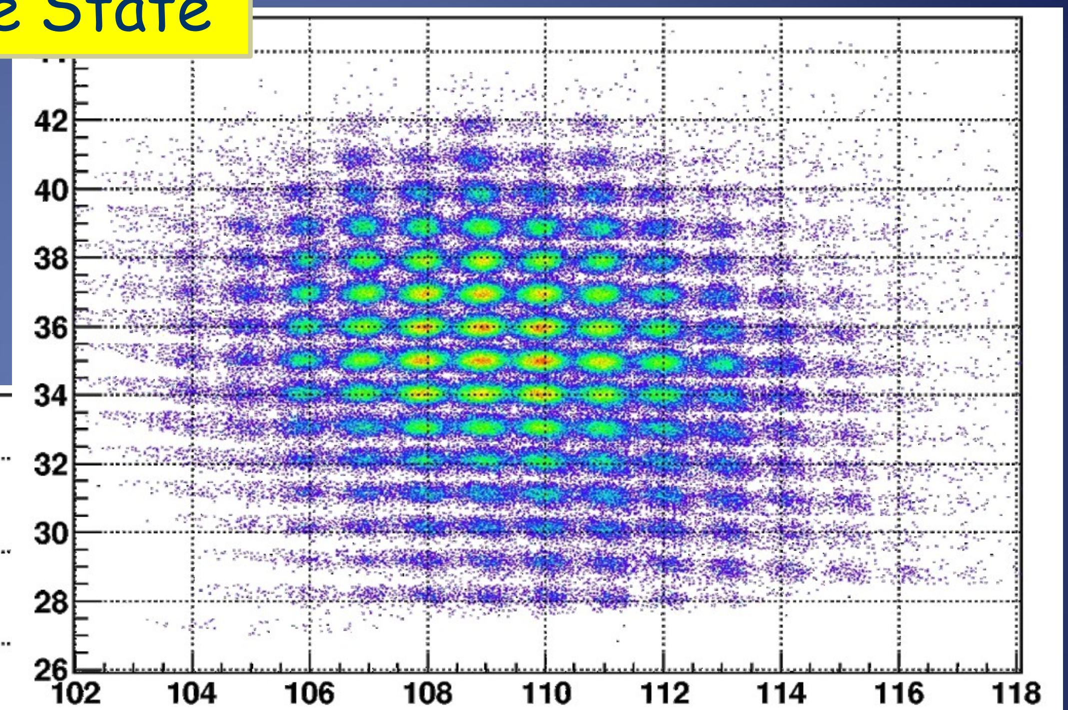


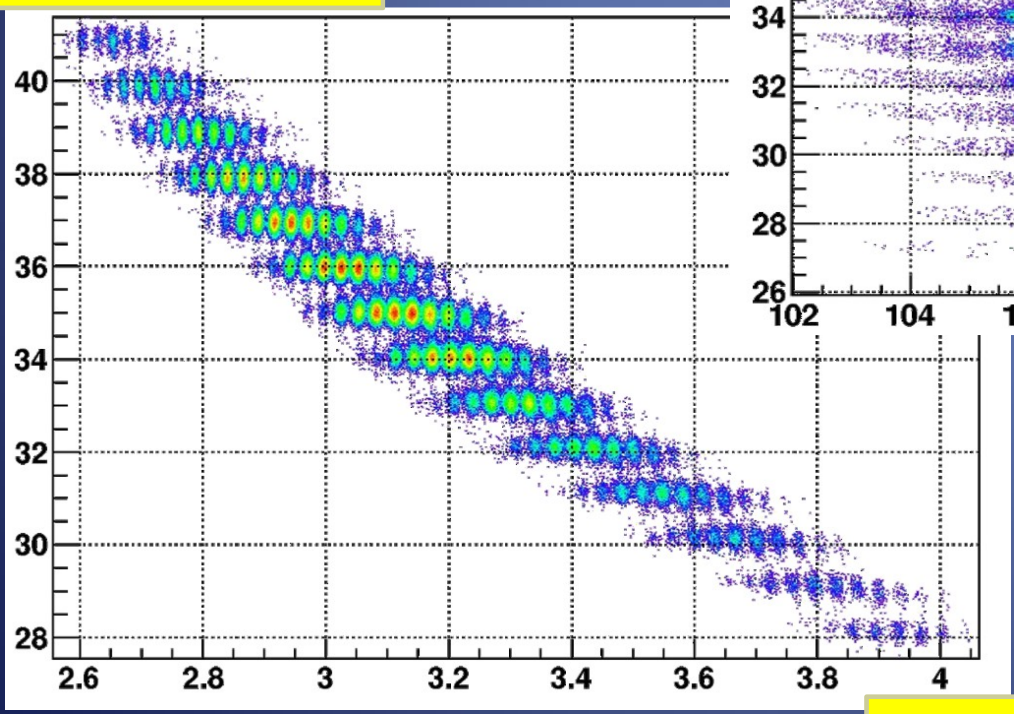
Preliminary Results Only

Identification of the Element

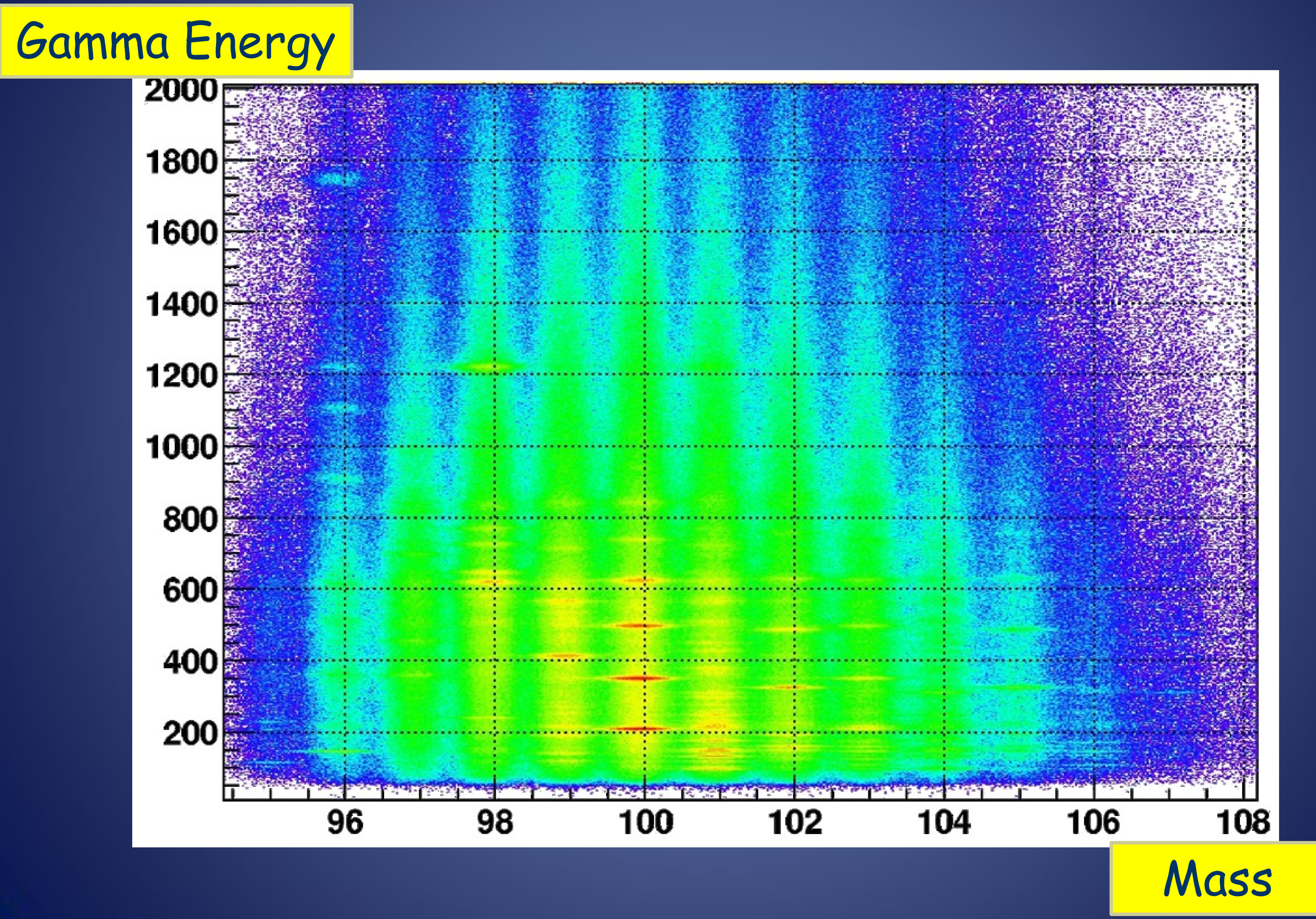


Identification of the Isotope

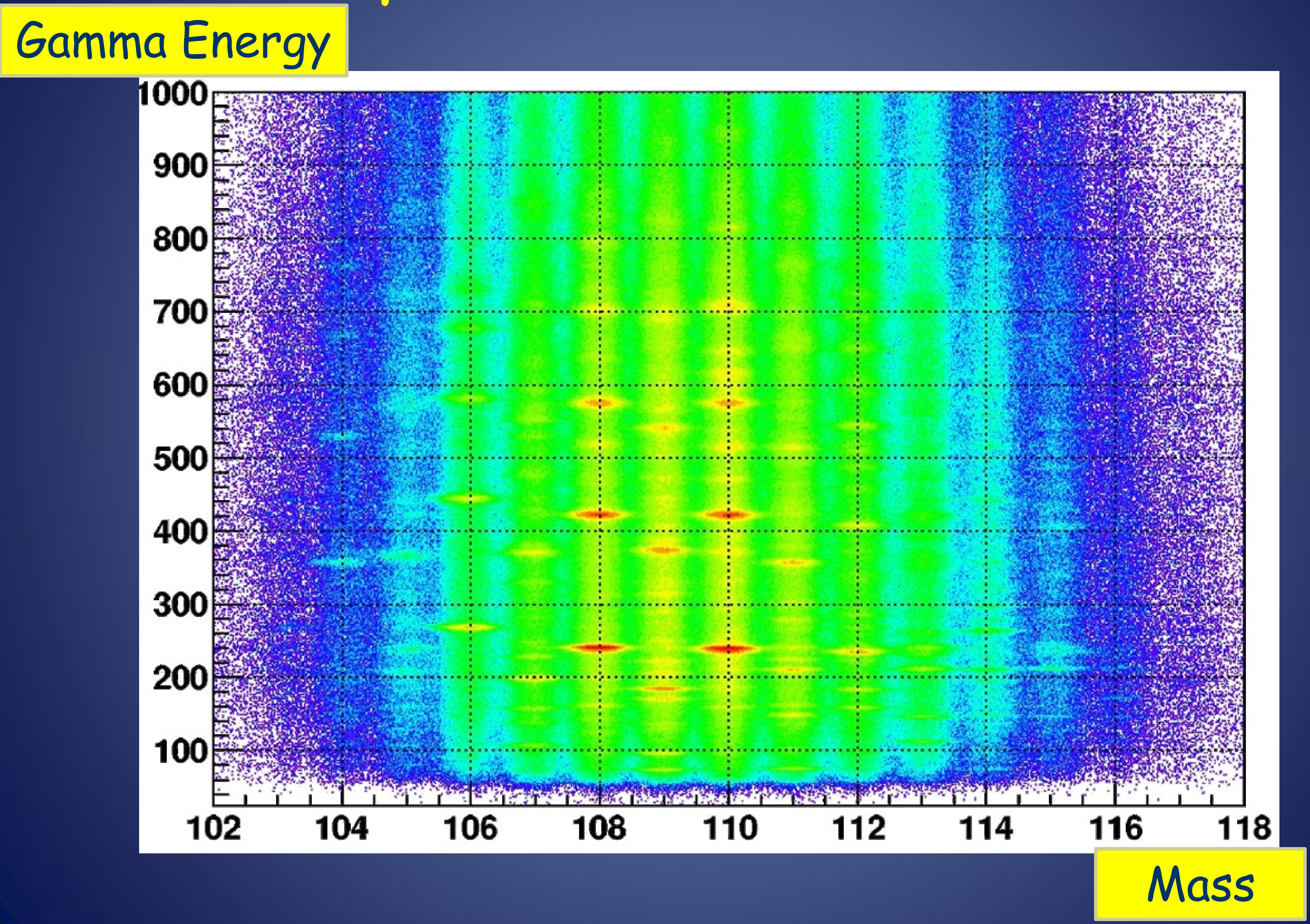




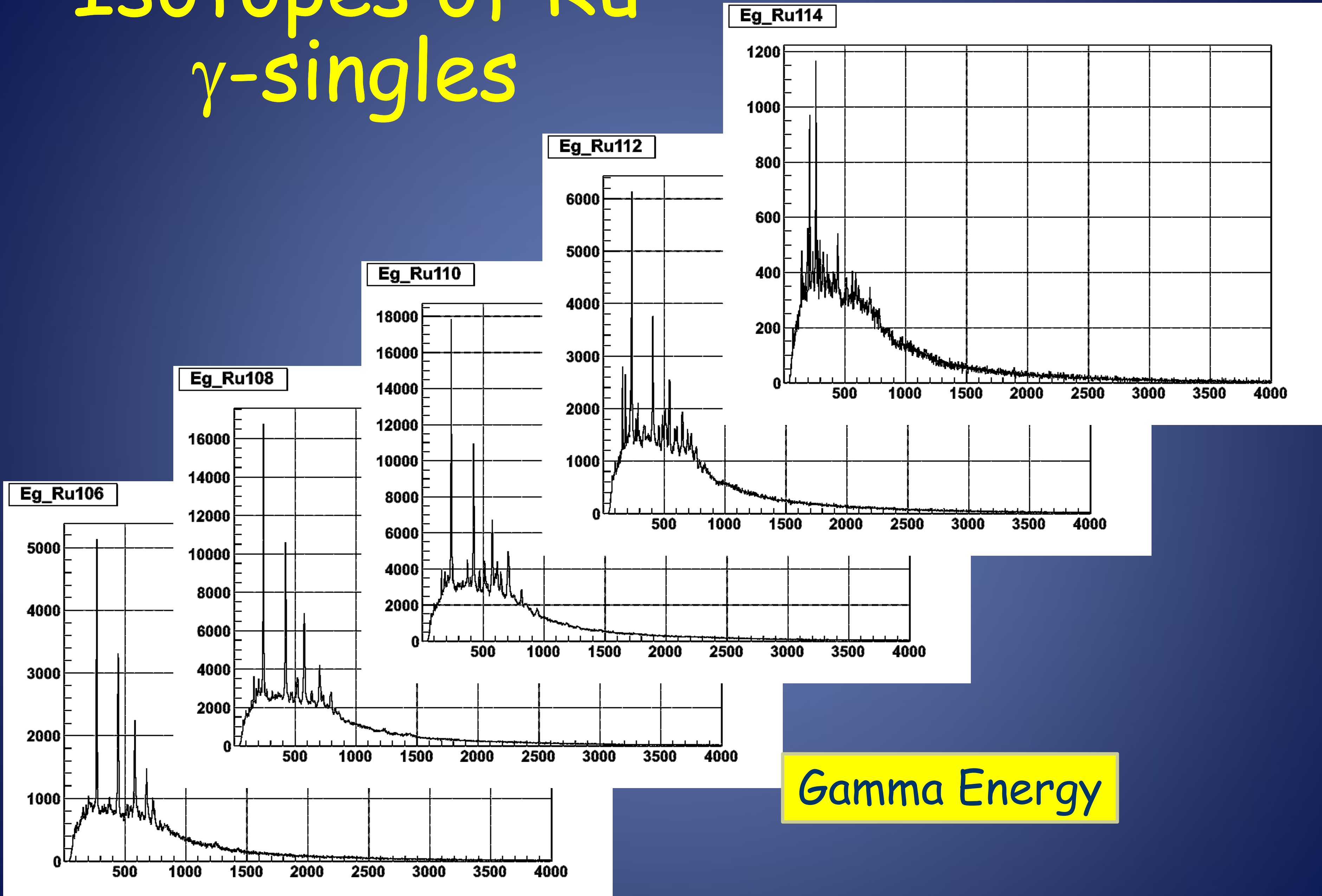
$E\gamma$ vs A for Zr Z=40



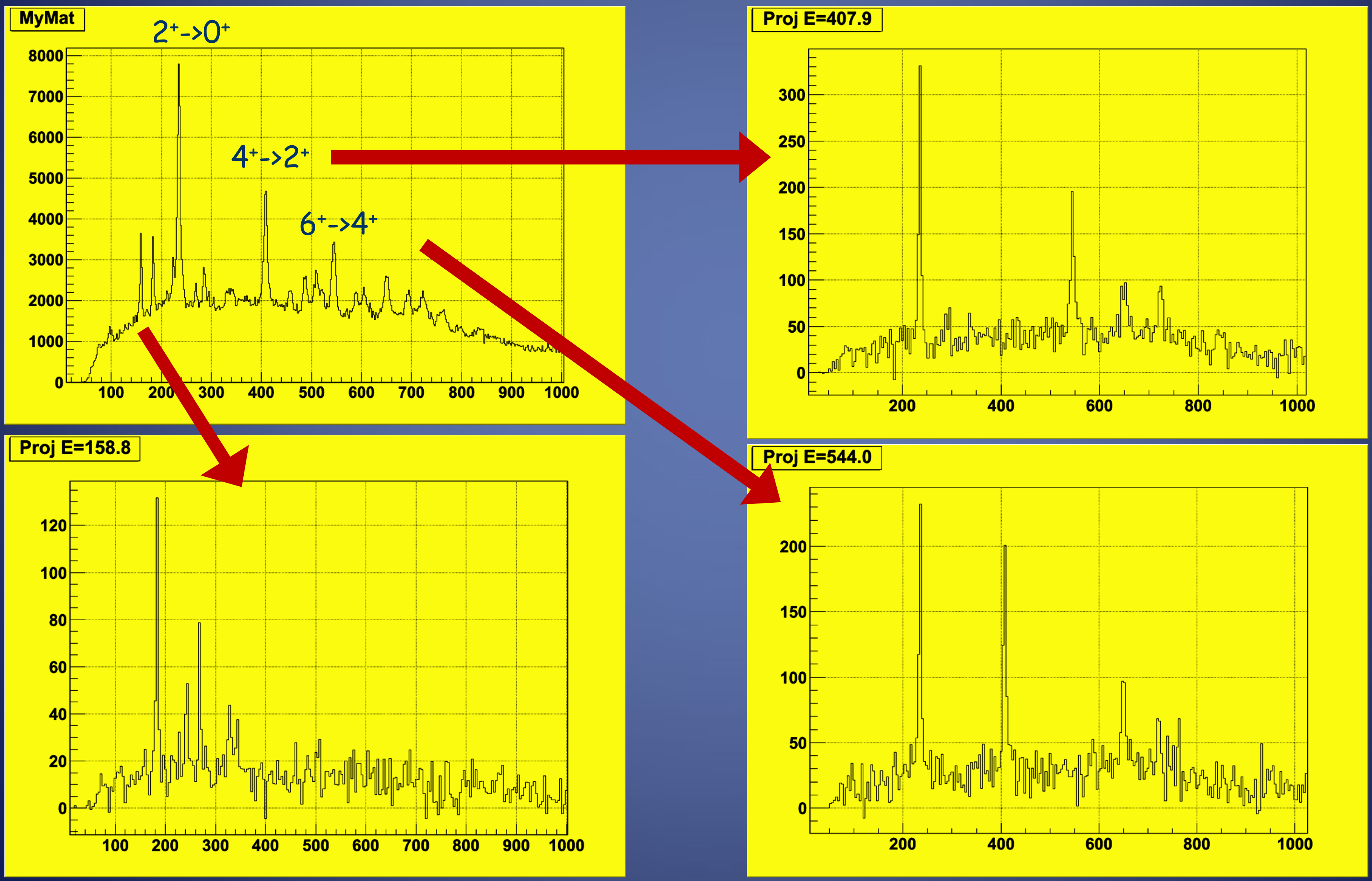
Eγ vs A for Ru Z=44



Isotopes of Ru
γ-singles



^{112}Ru
γ-γ coincidences



Tomorrow and the day after

- Old mechanisms with modern tools provide unique insights to the physics of nuclei towards drip line
  - Gamma spectroscopy of neutron rich exotic nuclei
    - Transfer Reactions
    - Fission
- Ensures fruitful endeavors with SPIRAL2