TNA04 Highlight:

Recoil β- decay tagging of N=Z nuclei:

First observation of The A = 66, T = 1 triplet up to 6^+:

Coulomb and isospin non-conservation effects

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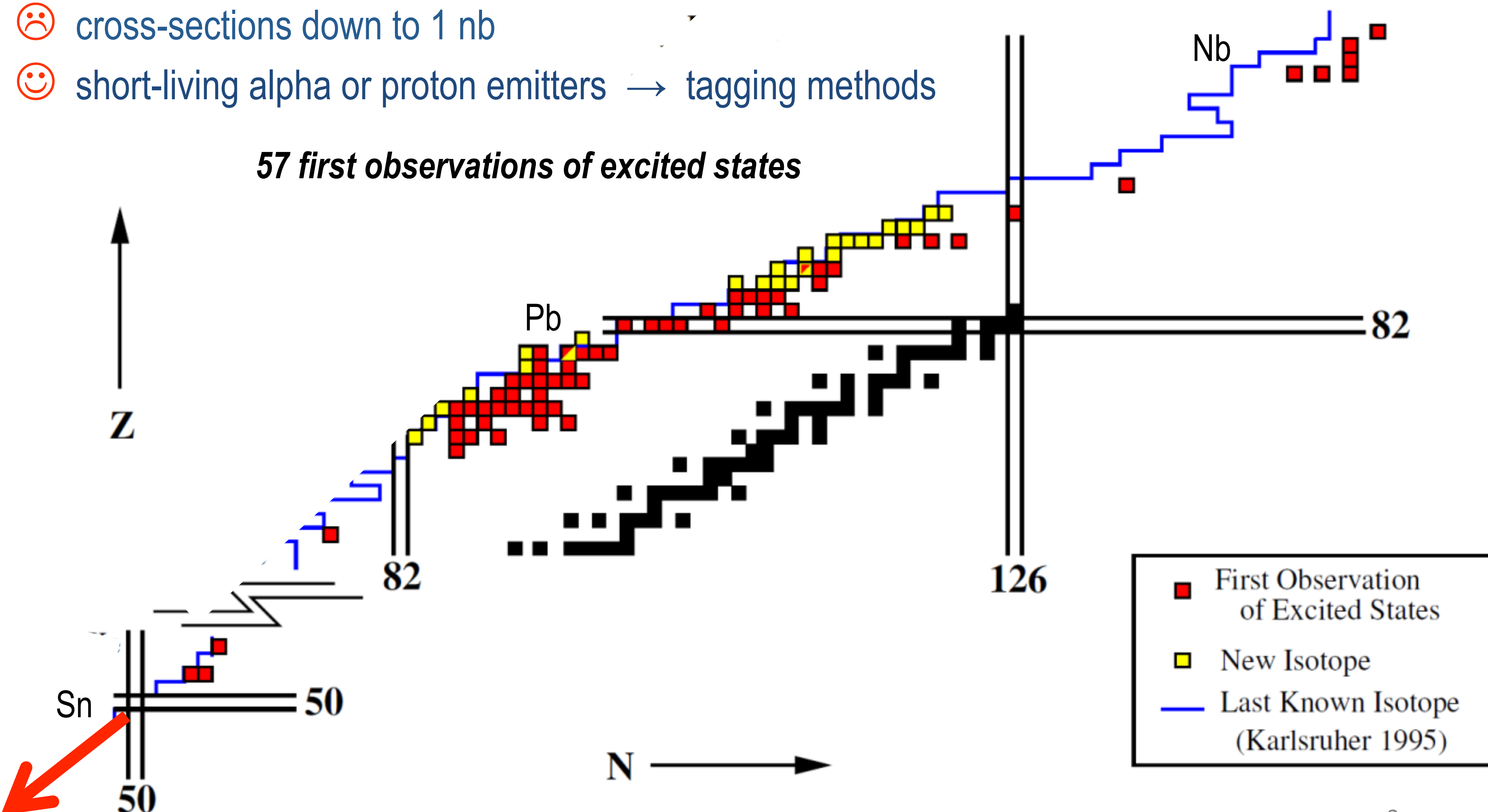
Probing proton-rich and heavy nuclei with Recoil - Decay - Tagging (RDT)

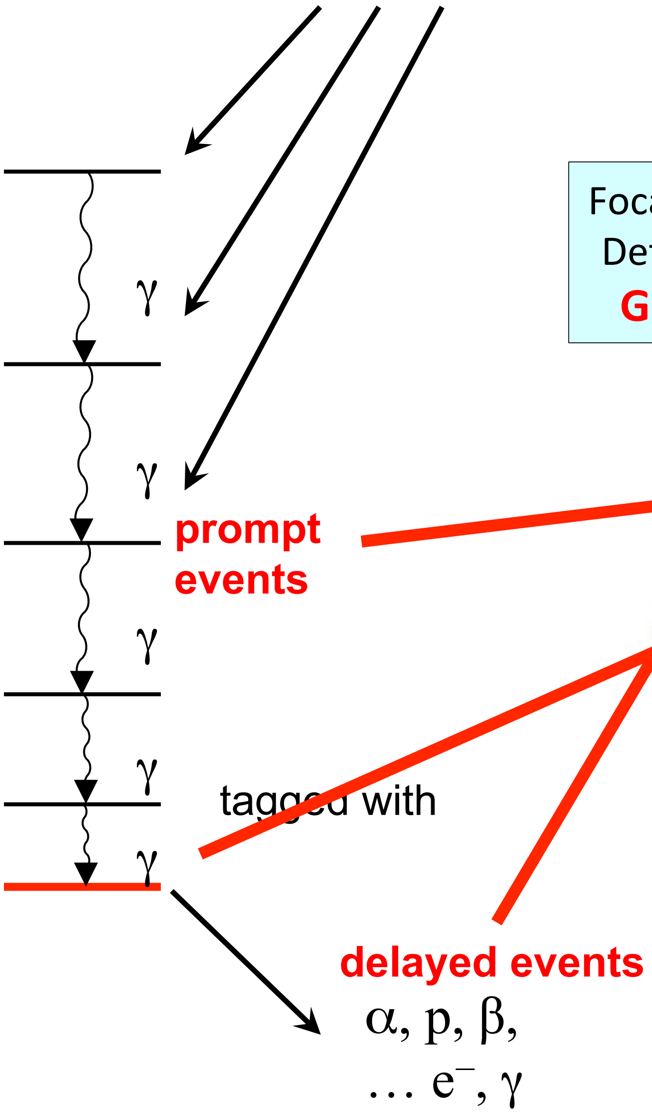
very neutron deficient heavy nuclei

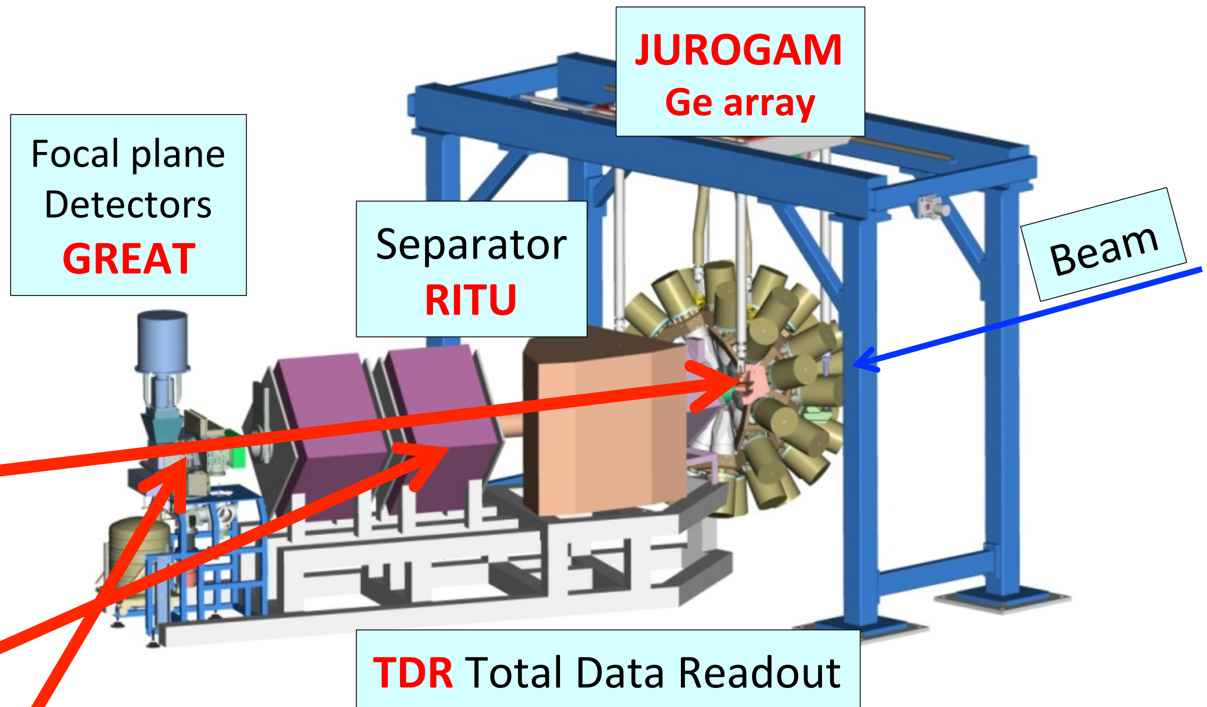
- ☺ can be produced via fusion evaporation with stable-ion beams and stable targets
- ☹ cross-sections down to 1 nb
- ☺ short-living alpha or proton emitters → tagging methods

57 first observations of excited states



Recoil - Decay - Tagging (RDT) with JUROGAM + RITU + GREAT





JUROGAM II (6.1 %)
15 EUROGAM Phase 1 + 24 EUROBALL Clover units from Gammapool
TDR (320 Lyrtech digital channels)
(free running mode with high rates)

Towards lighter proton-rich nuclei

Recoil β- decay Tagging

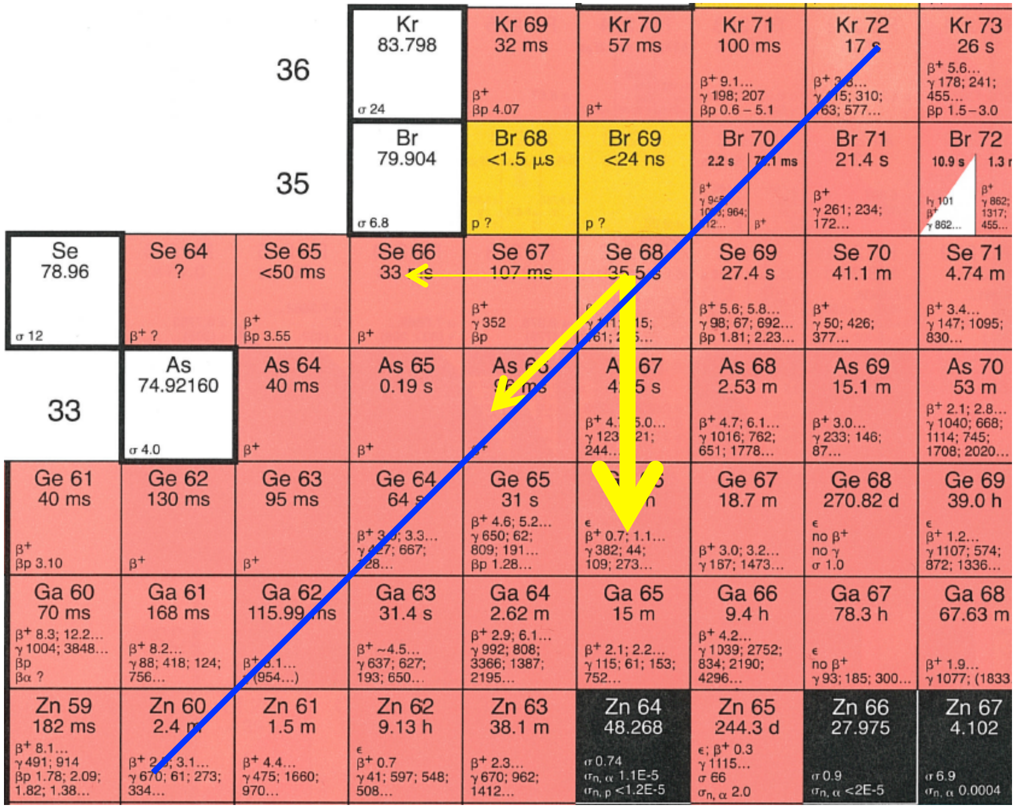
Spectroscopy of N = Z nuclei

Challenge:

- ✓ Large number of fusion-evaporation channels open
  - → high rate at the focal plane of the separator
- ✓ No discrete lines from α- nor p-decay for tagging

Methods used so far:

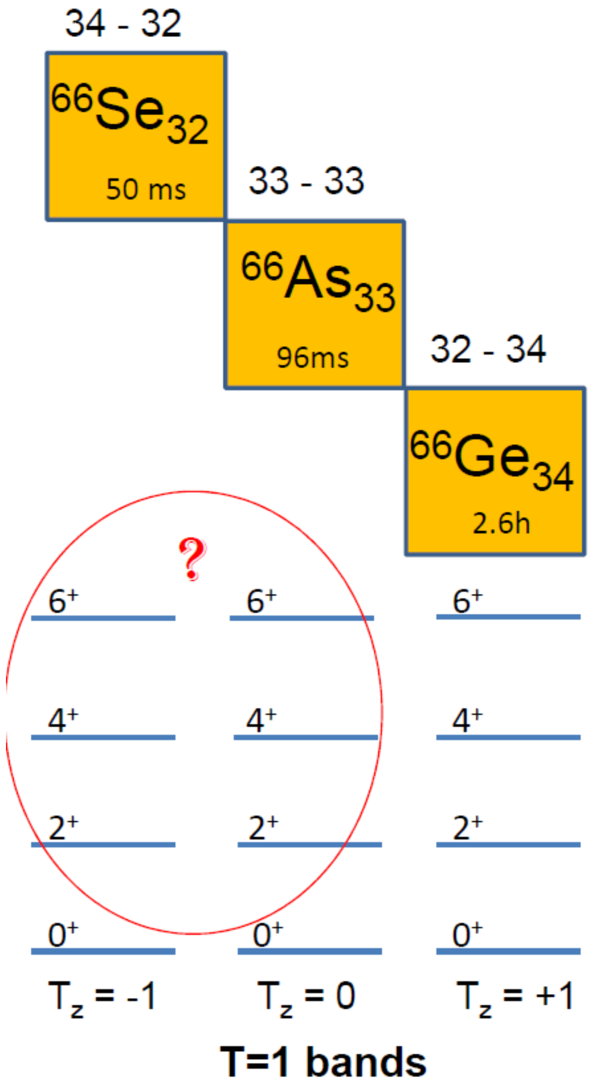
- Channel selection by particle-detector array around the target
- RIB: decay studies or knock-out



New: Recoil – β – Tagging

Recoil – β – Tagging

Application: Energy Differences
between Isobaric Analog States of T=1 bands in A = 66 nuclei



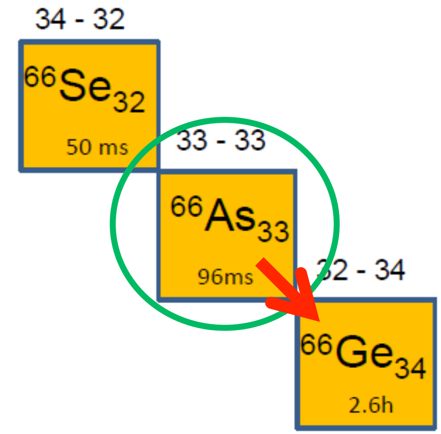
MED = Mirror Energy Differences
TED = Triple Energy Differences

- *High-energy β decays (compared to other reaction products)*
- *Relatively fast super-allowed Fermi β decays*:

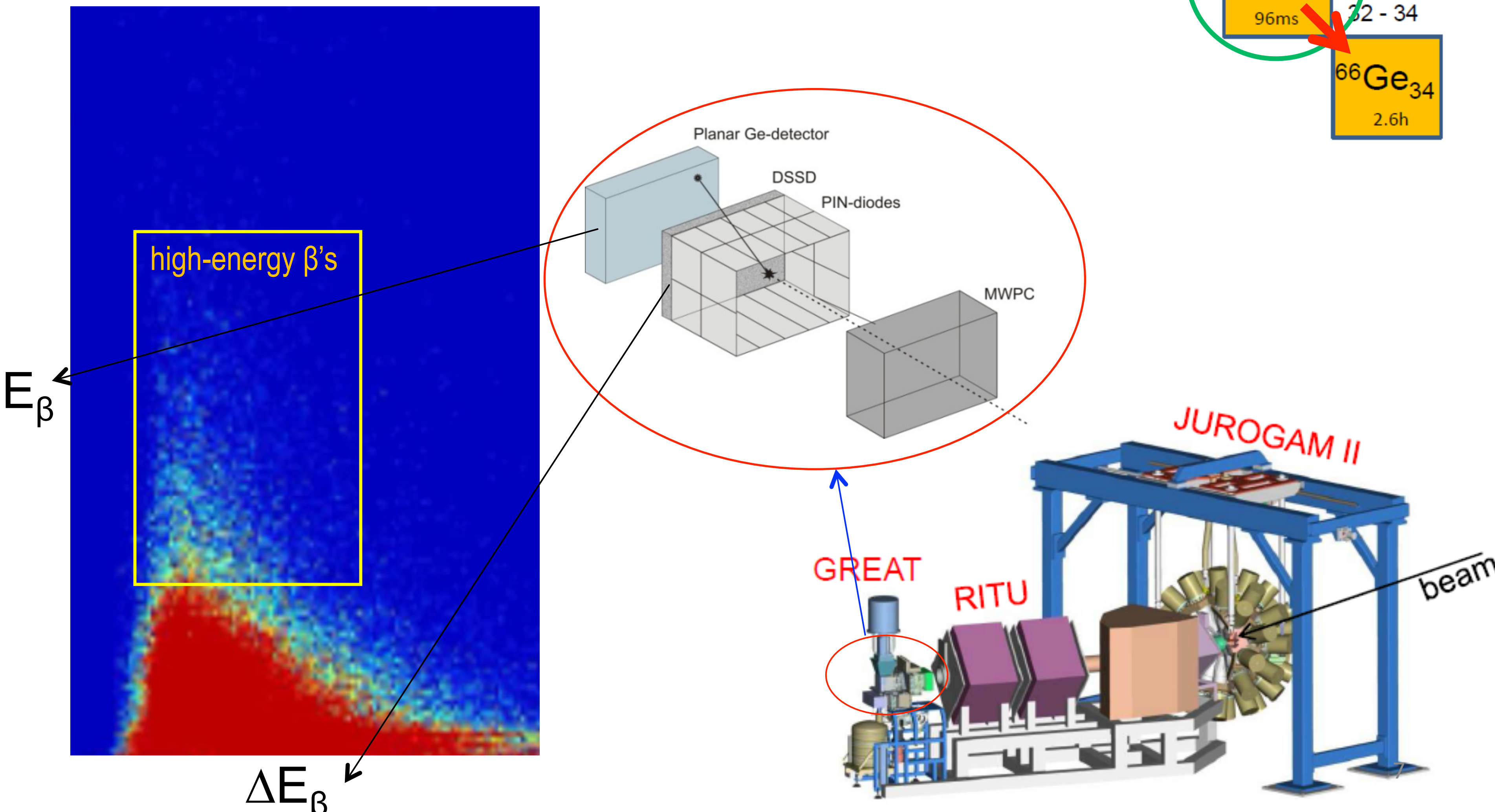
- *Continuous β- spectrum overlapping with those from uninteresting evaporation channels*

^{66}As (Z = N = 33)

γ-rays from $^{66}As_{33}$ tagged with its 96ms β decay

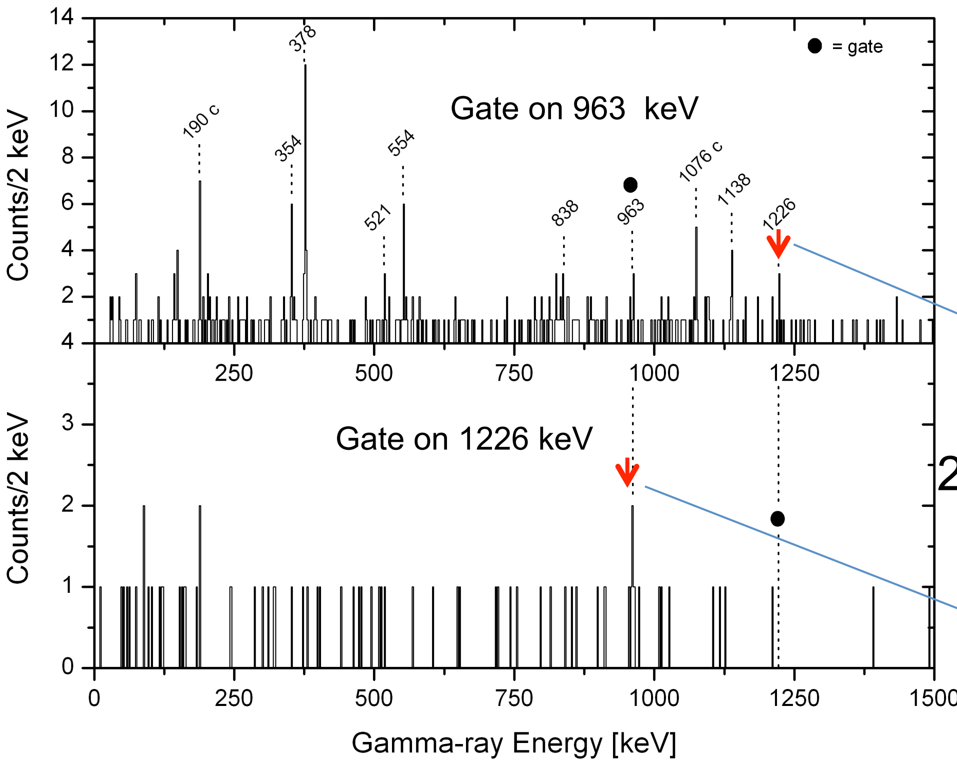


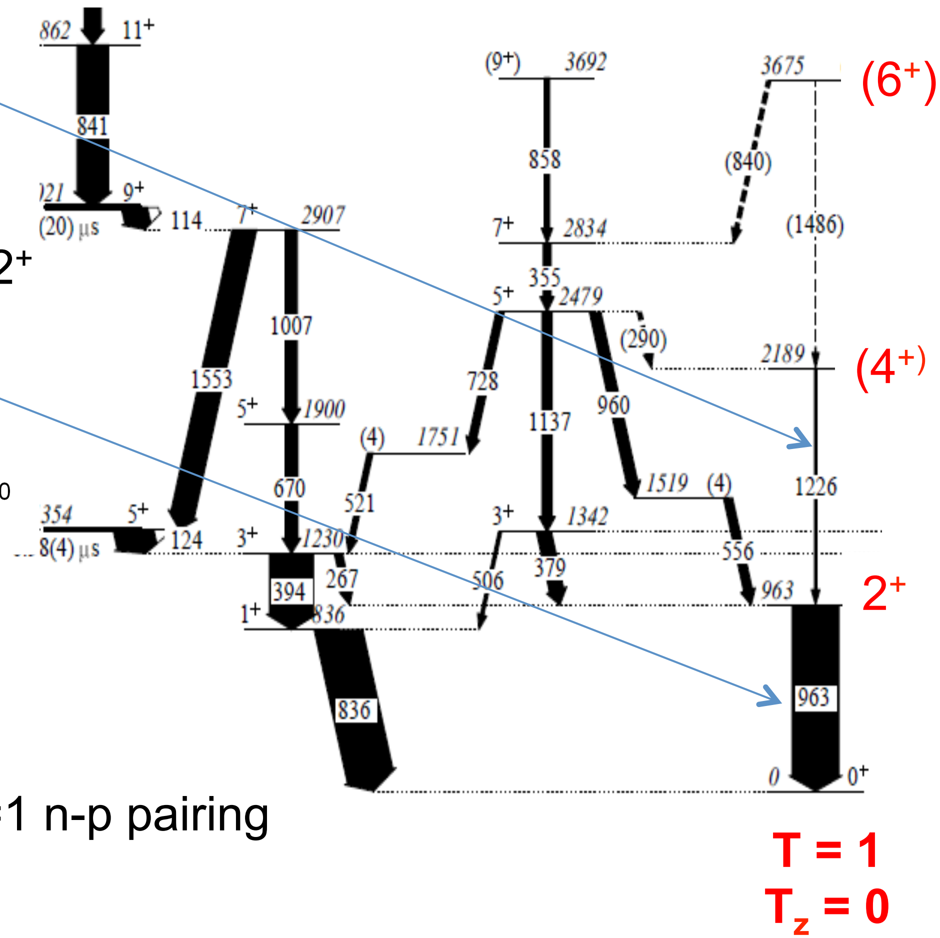
$^{40}Ca(^{28}Si,pn)^{66}As$ Z=N=33



^{66}As (Z = N = 33)

γ-rays from $^{66}As_{33}$ tagged with its 96ms β decay

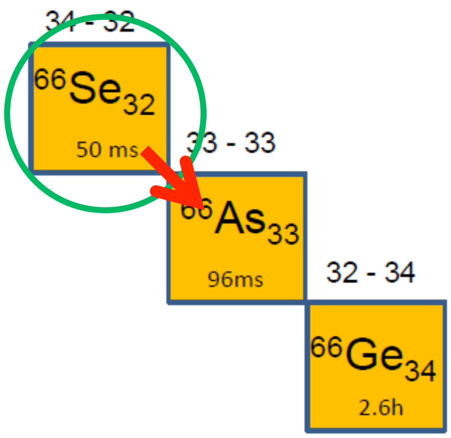




^{66}As is an odd-odd nucleus but still the 0^+ ground state is far below the first excited states, obviously due to the T=1 n-p pairing

^{66}Se(Z = 34, N = 32)

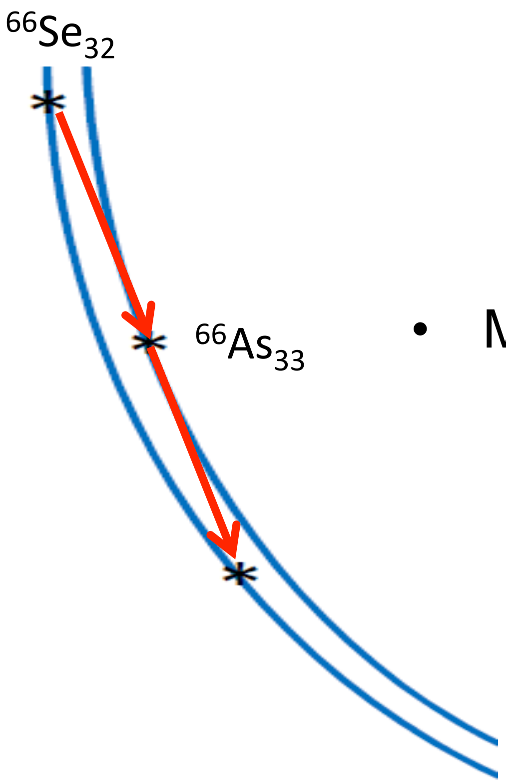
γ-rays from $^{66}Se_{32}$ tagged with its 50ms β decay



$^{40}Ca(^{28}Si,2n)\ ^{66}Se$

☺

- ^{66}Se is an even-even nucleus
  → the T= 1 band is the yrast band



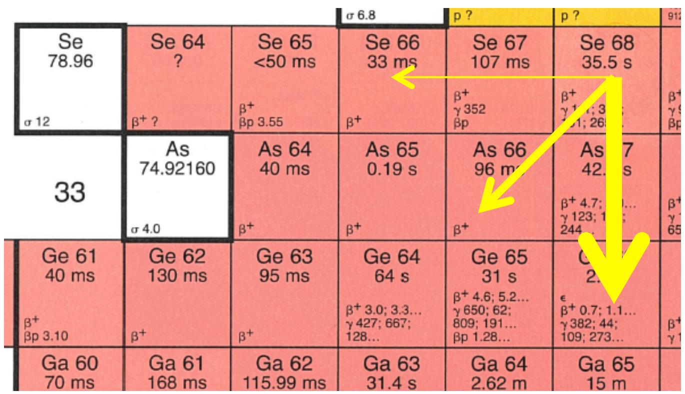
☹

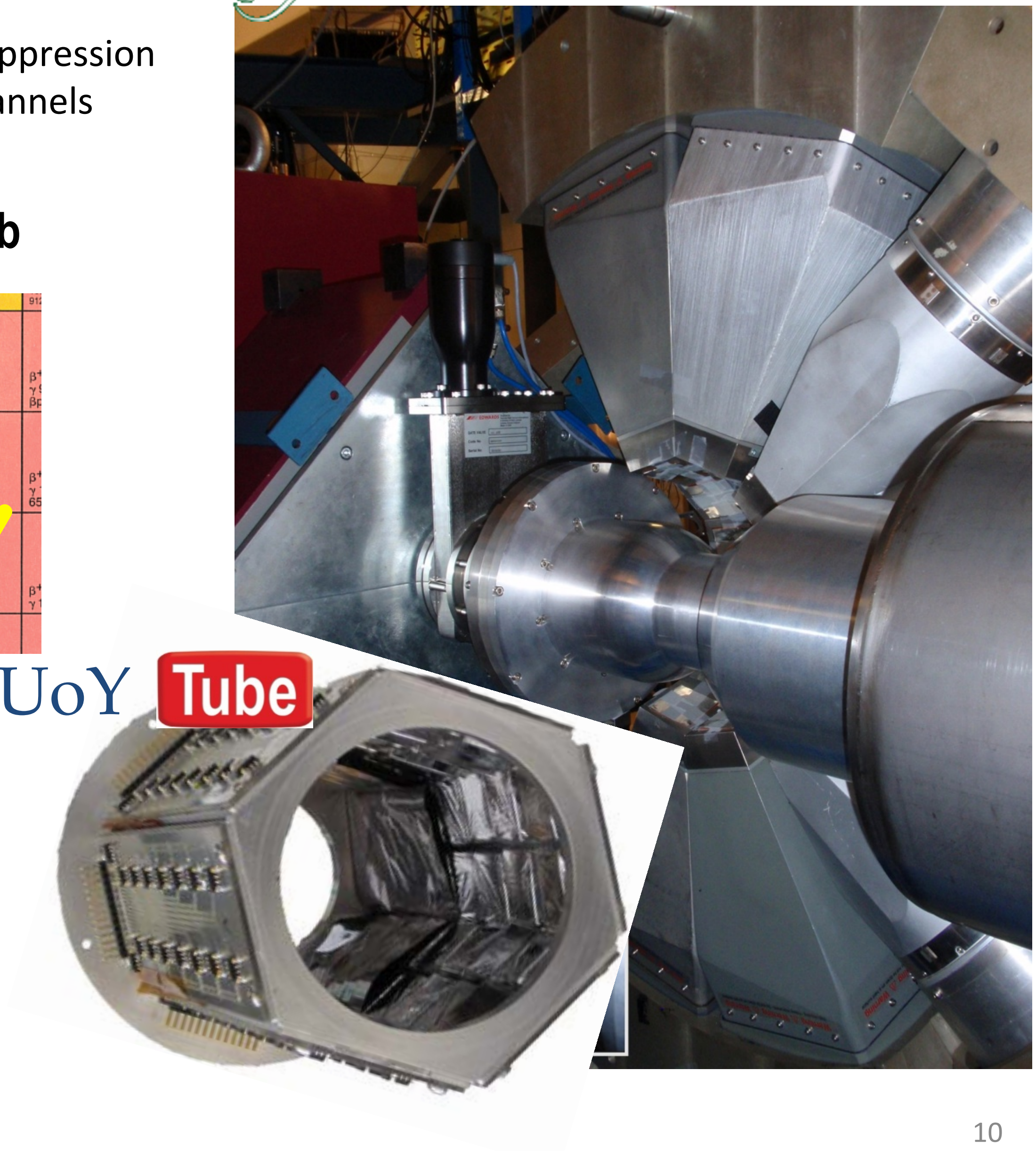
- Mass parabola → $^{66}Se_{32}$ and $^{66}As_{33}$ got similar β- decay energies and lifetimes

UoY Tube THE UNIVERSITY of York

Charged particle veto → efficient suppression of disturbing proton-evaporation channels

^{40}Ca(^{28}Si,2n) ^{66}Se ~ 200nb





UoY Tube

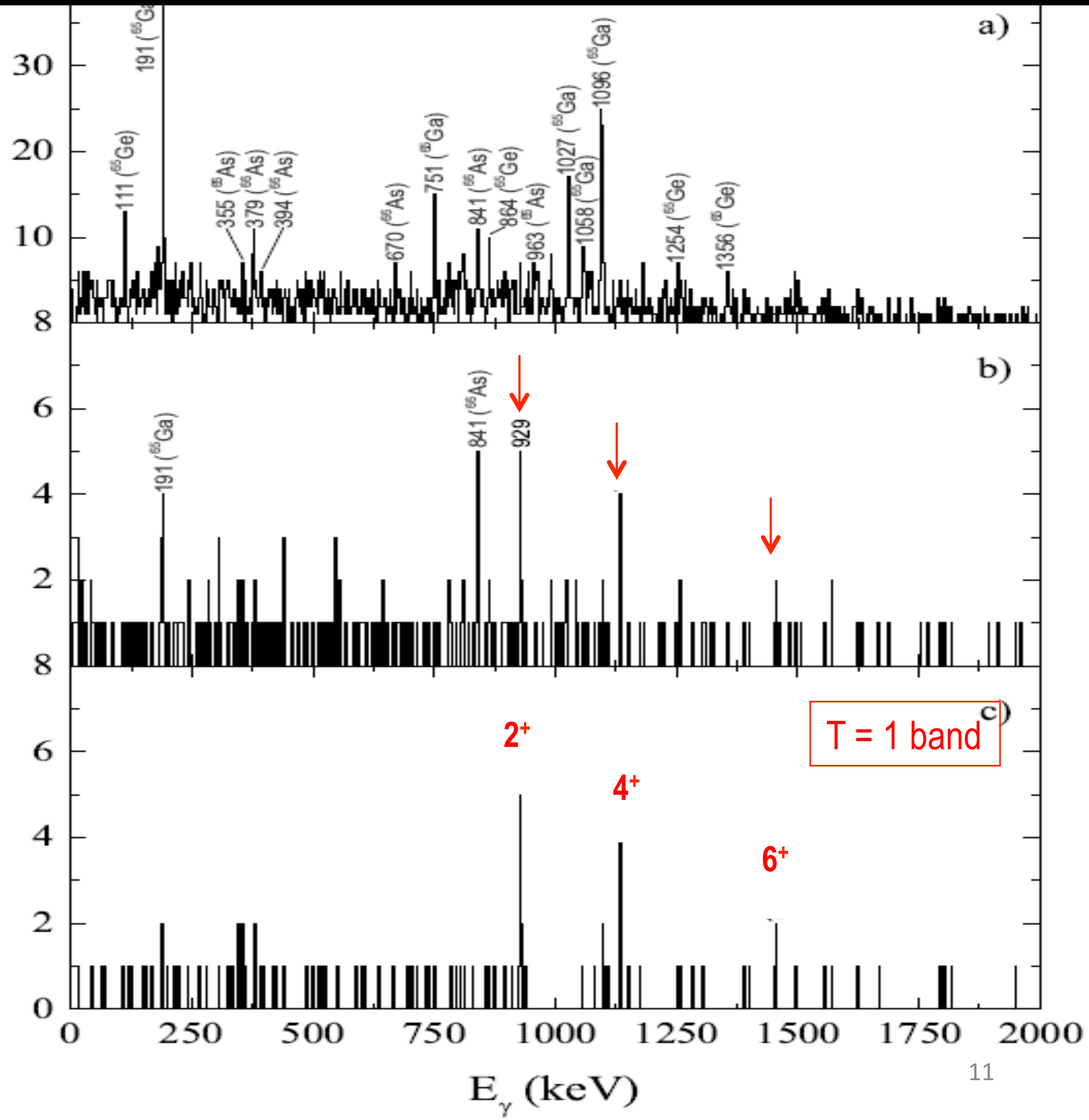
96 20 x 20 mm CsI crystals

^{66}Se (Z = 32, N = 34)

γ-rays from $^{66}Se_{32}$ tagged with its 50ms β decay

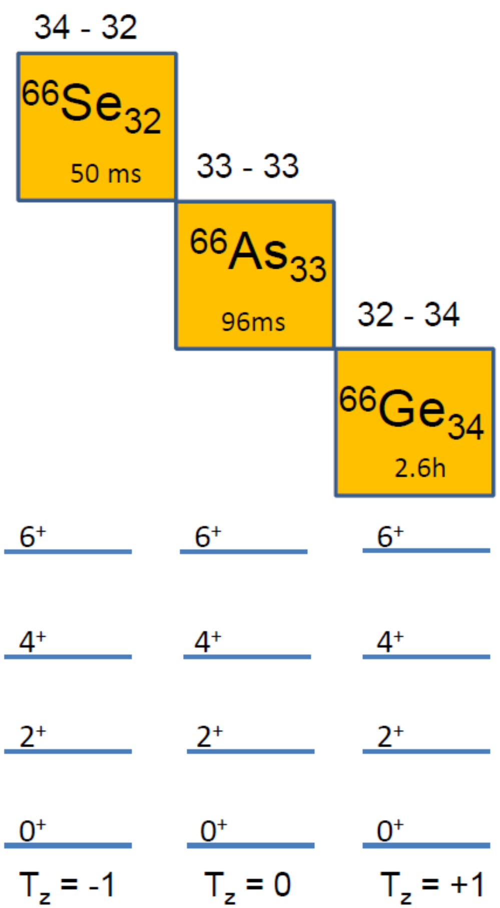
+ UoY Tube veto

+ ^{66}As isomer veto-tagging



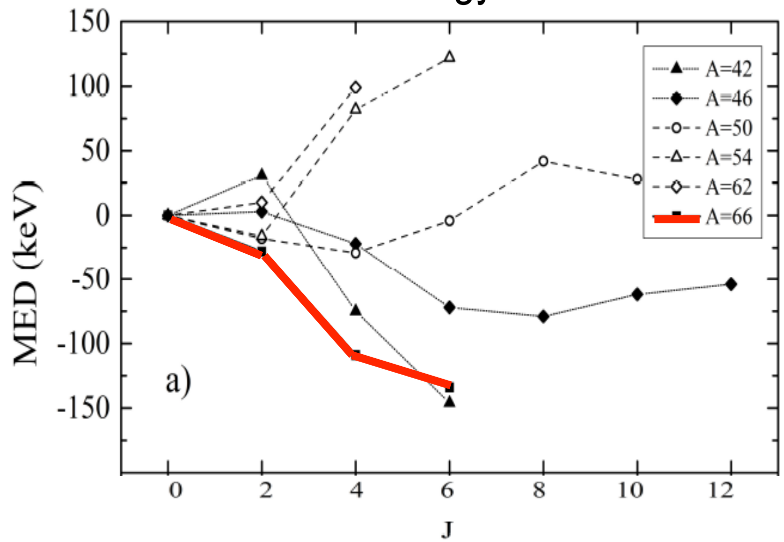
MED AND TED

A=66 is the heaviest
triplet of T = 1 bands up to 6+



T=1 bands

MED=Mirror Energy Differences

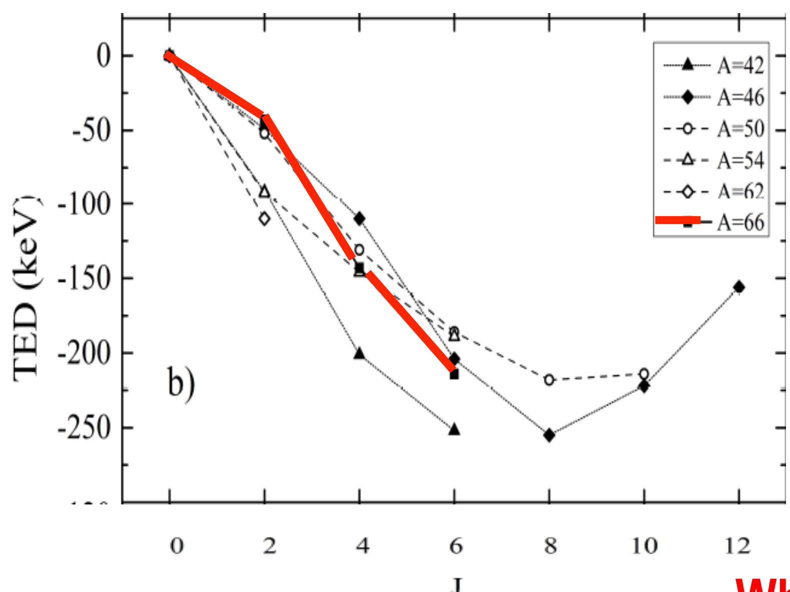


MED=
$E_x(T_z= -1) – E_x(T_z= +1)$

$V = v_{pp} – v_{nn}$

Charge symmetry

TED=Triple Energy Differences



TED=
$E_x(T_z= -1) + E_x(T_z= +1) - 2 E_x(T_z= 0)$

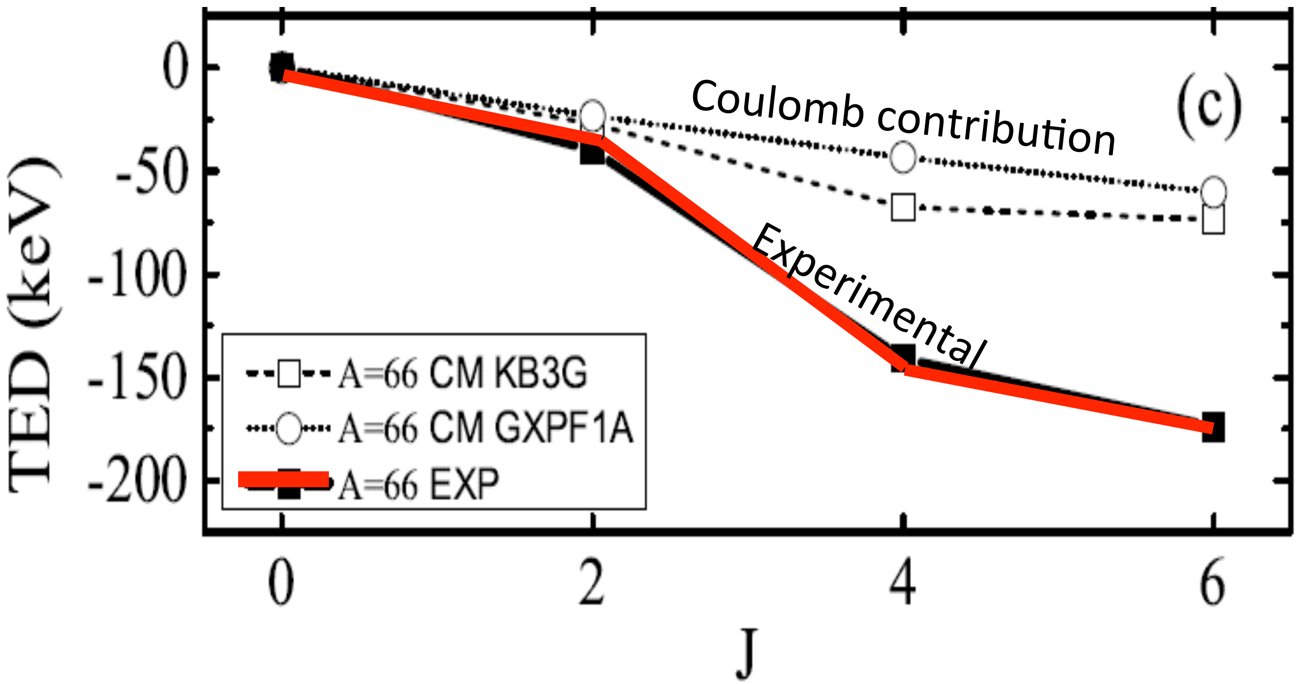
$V = v_{pp} + v_{nn} - 2v_{pn}$

Charge independence

One-body terms cancel out

Why similar TED behaviour ?

TED=Triple Energy Differences for the A = 66 T=1 triplet

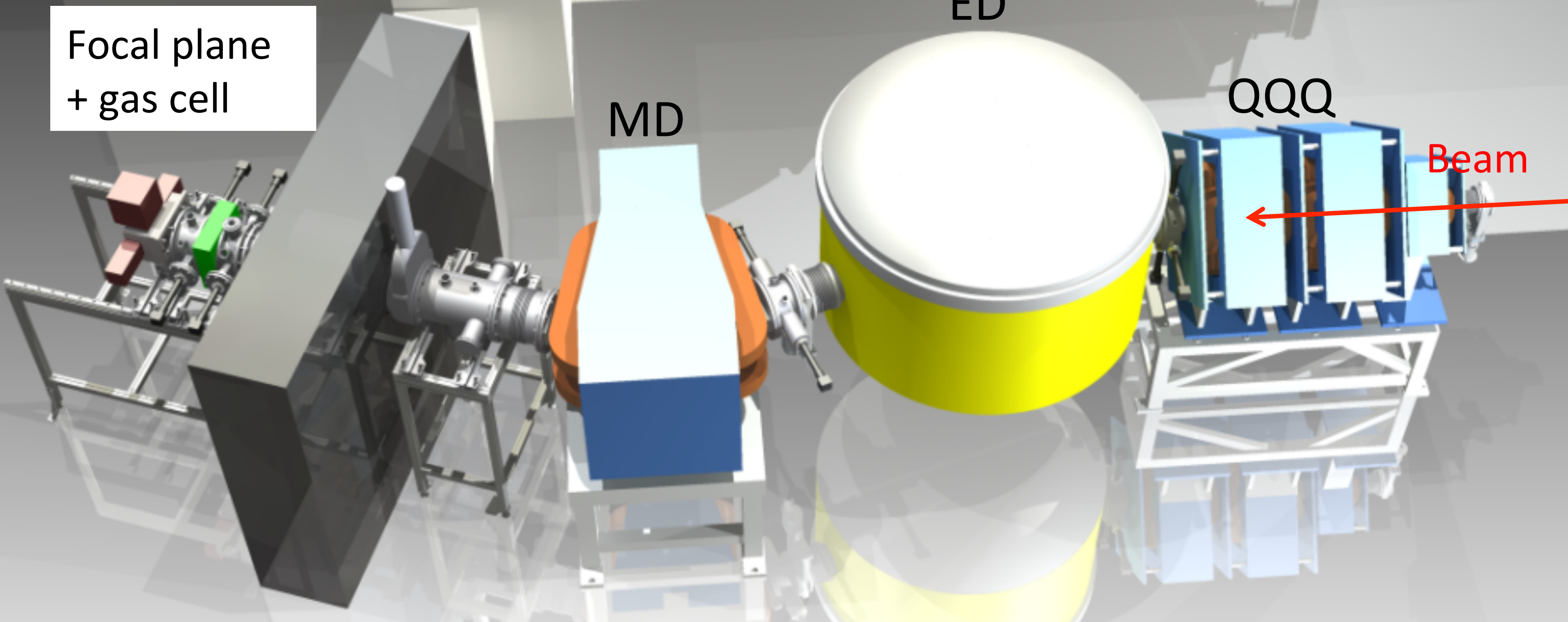


Isospin non-conserving contribution is needed !

TED=
$E_x(T_z= -1) + E_x(T_z= +1) - 2\,E_x(T_z= 0)$
$V = v_{pp} + v_{nn} - 2v_{pn}$
Charge independence

FUTURE

A new vacuum-mode separator – MARA
→ better mass selection in RDT experiments



- Solid angle acceptance (central m/q and energy) 10 msr
- Typical transmission ~12% per charge state


Thank You
ENSAR