Preliminary results on Z, N fission yields in inverse kinematics at VAMOS++

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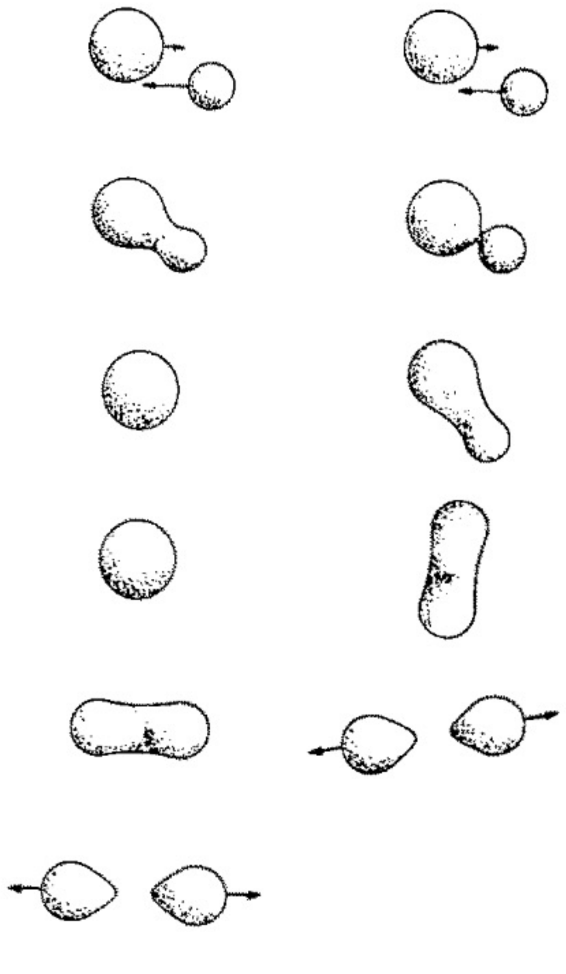
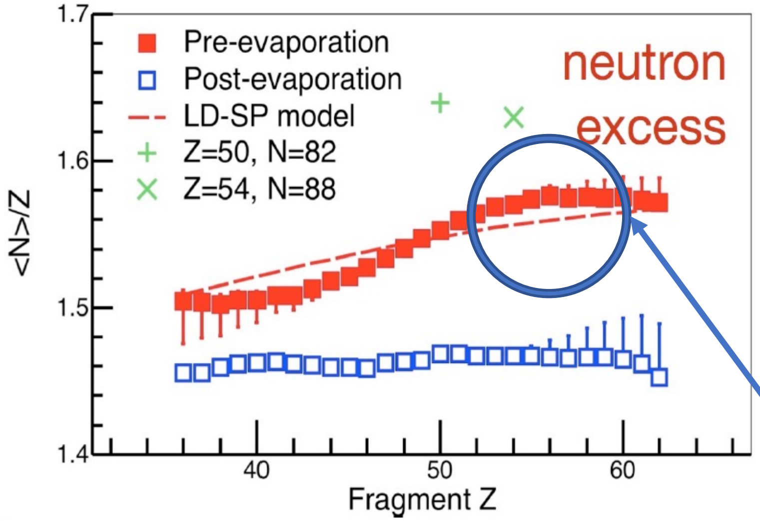
Study high E* fission and quasi-fission

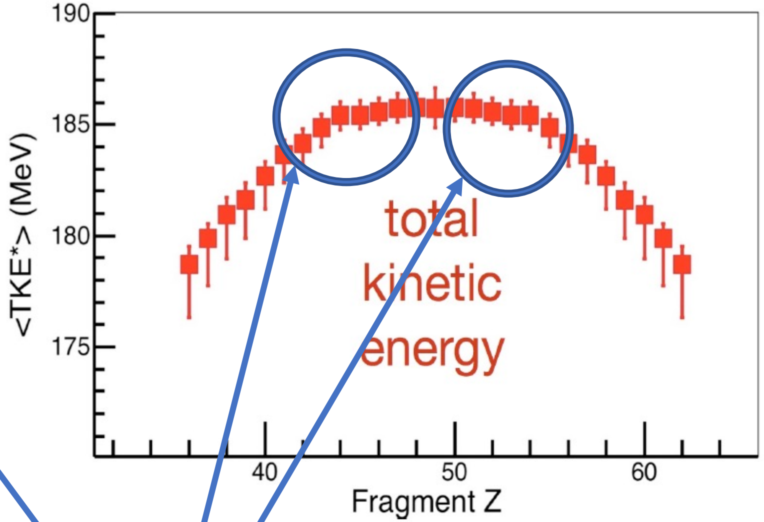


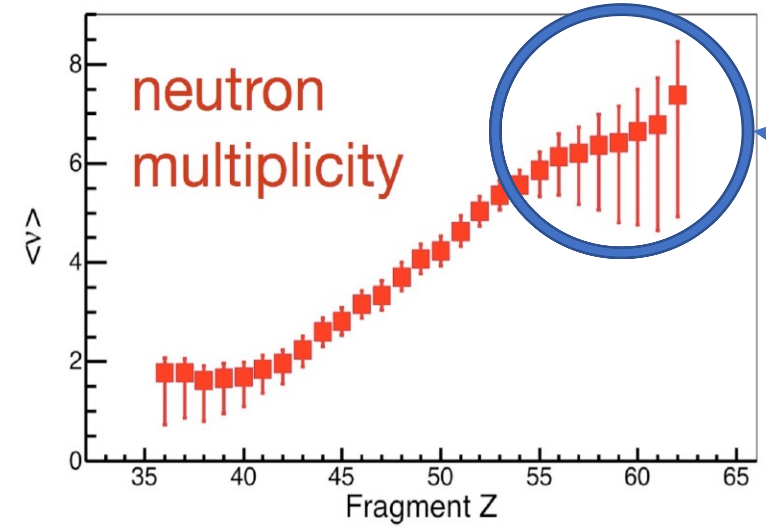
COMPOUND NUCL. FISSION

QUASI-FISSION

Observables at scission corresponding to 250Cf at E*=42 from 12C+238U fusion-fission reactions [1]





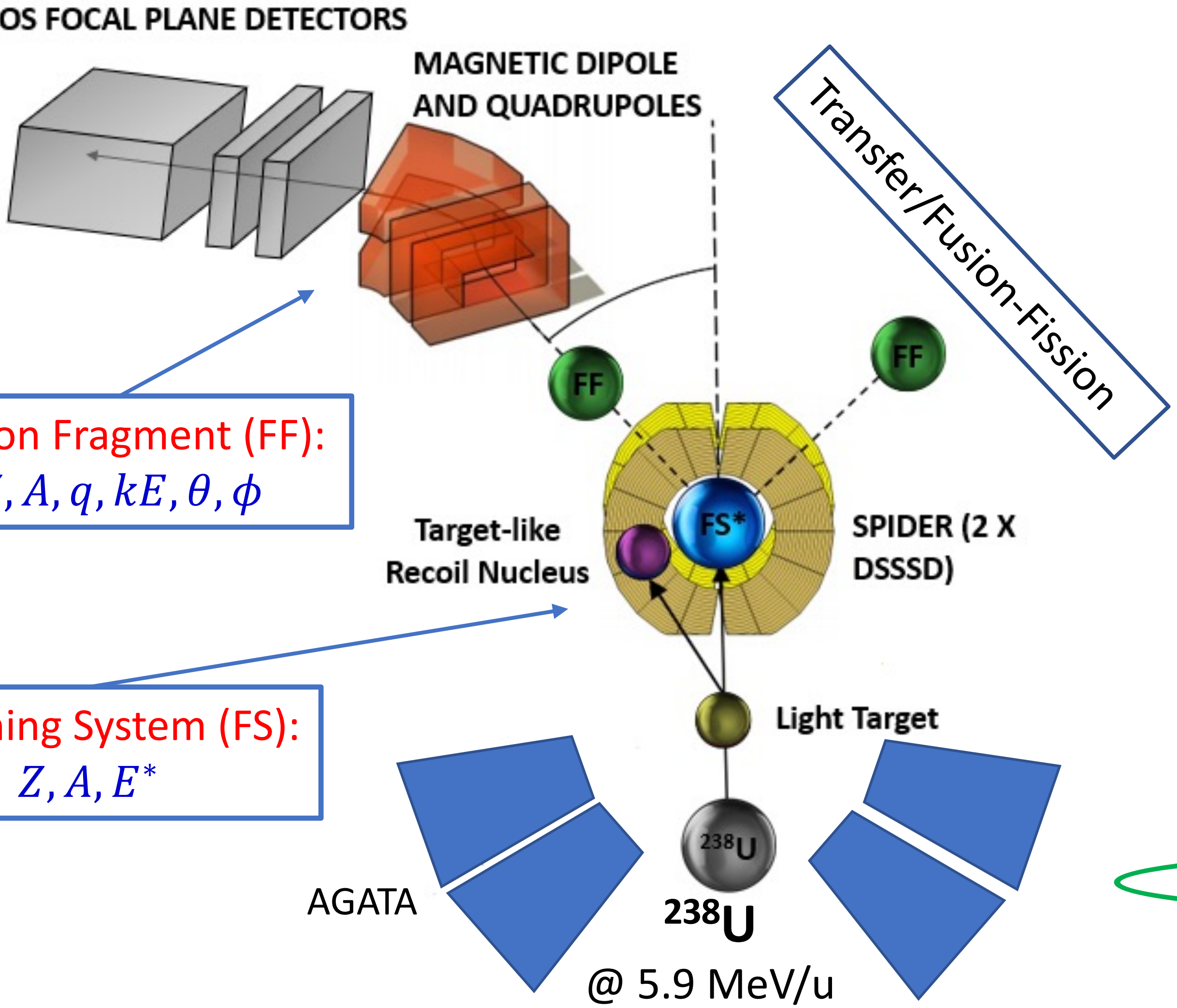


Nuclear structure effects???

[1] M. Caamaño et al., PRC 92, 034606 (2015)

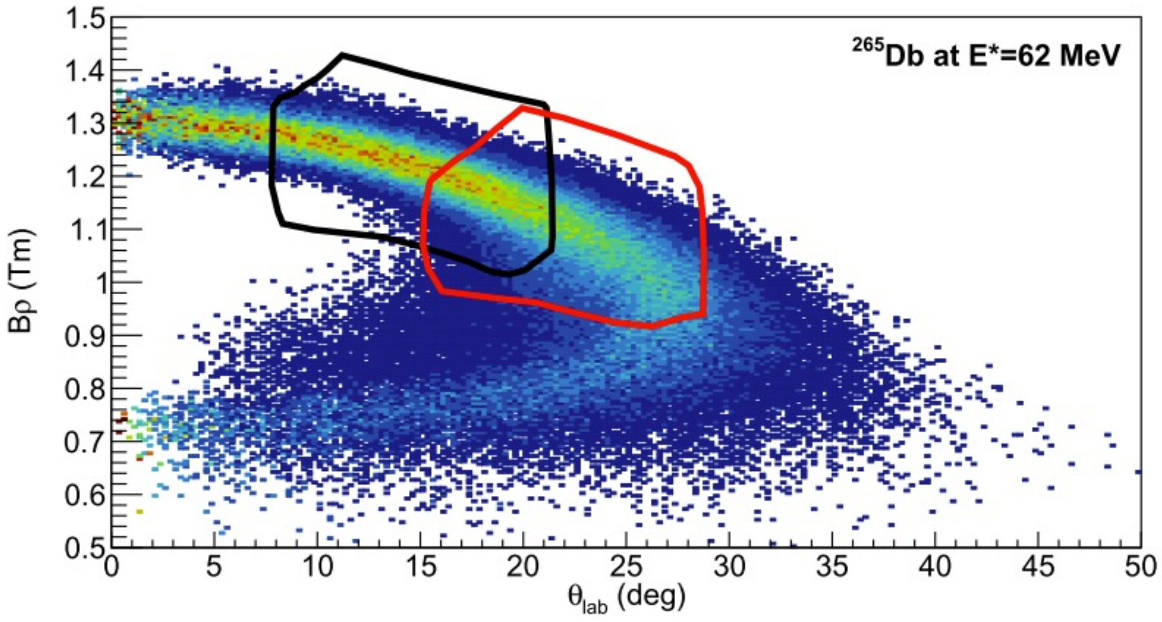
2 VAMOS Settings:
1) $B\rho_0$ = 1.24 Tm, θ = 14 deg
2) $B\rho_0$ = 1.1 Tm, θ = 21.5 deg

VAMOS++
Angular acceptance = Δϑ= ±7 deg Δϕ= ±10 deg



Fission Fragment (FF):
$Z, A, q, kE, \theta, \phi$

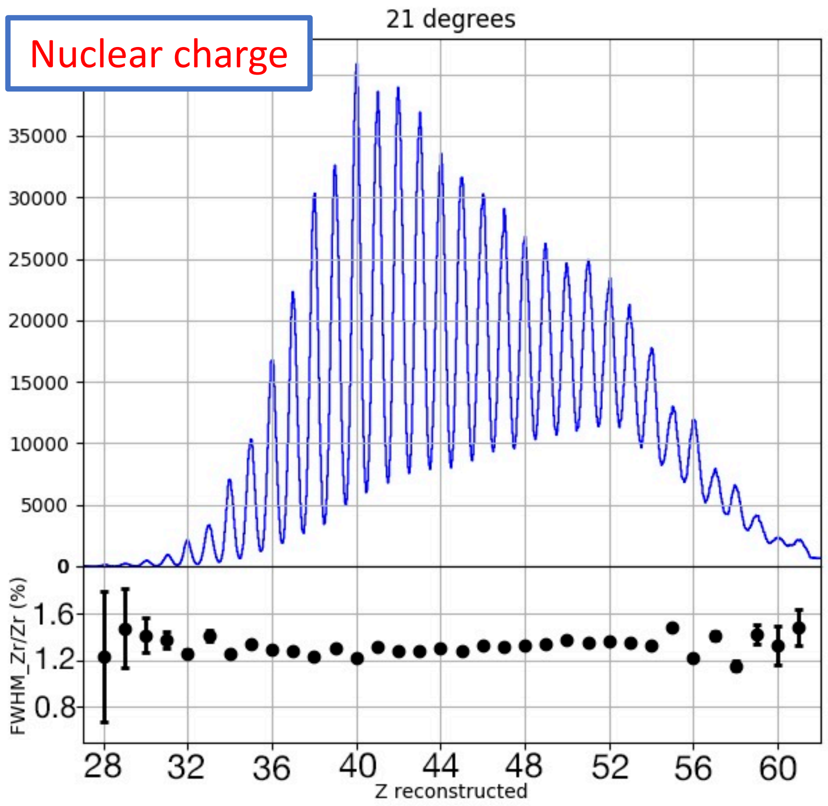
Fissioning System (FS):
Z, A, E^*



Target	Thickness	FS
^{9}Be	500 µg/cm^2	^{247}Cm
^{Natural}B	100 µg/cm^2	^{249}Bk
^{24}Mg	500 µg/cm^2	^{262}Rf
^{27}Al	200 µg/cm^2	^{265}Db

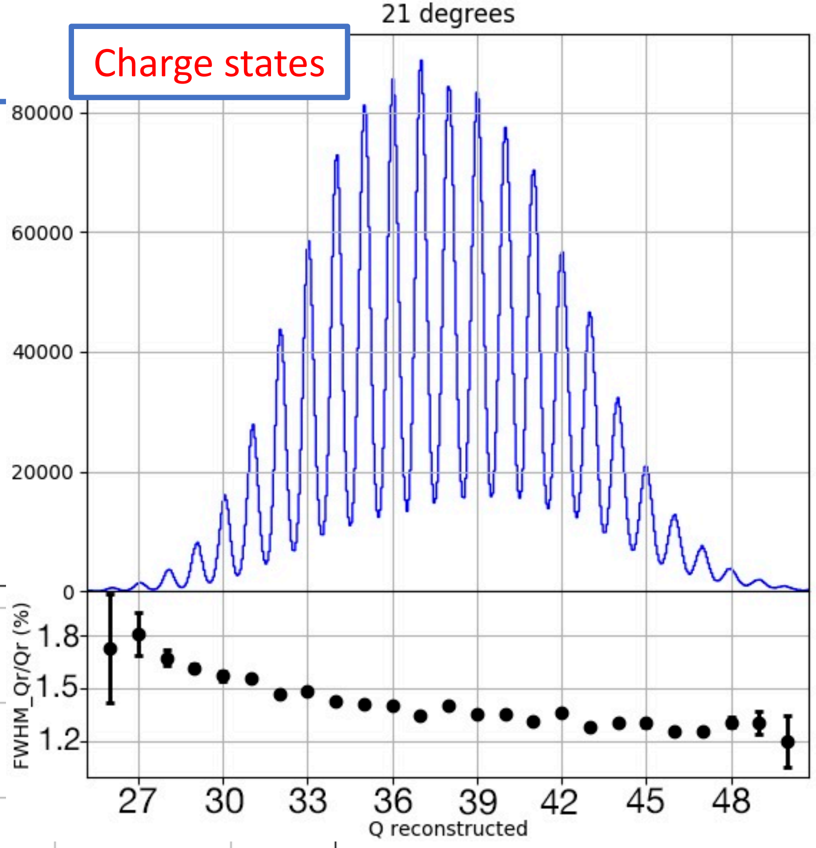
Today, preliminary results with this target

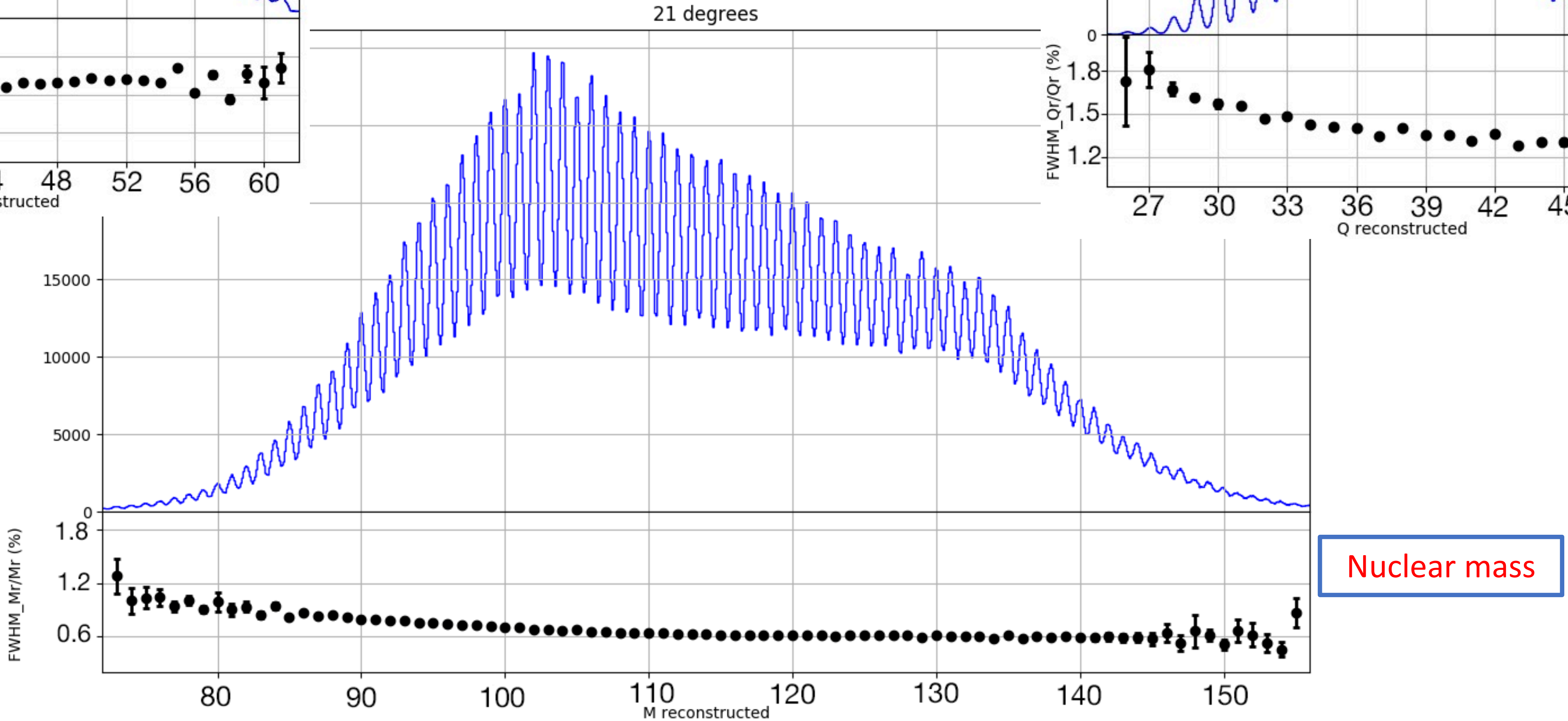
Fragment identification and resolution

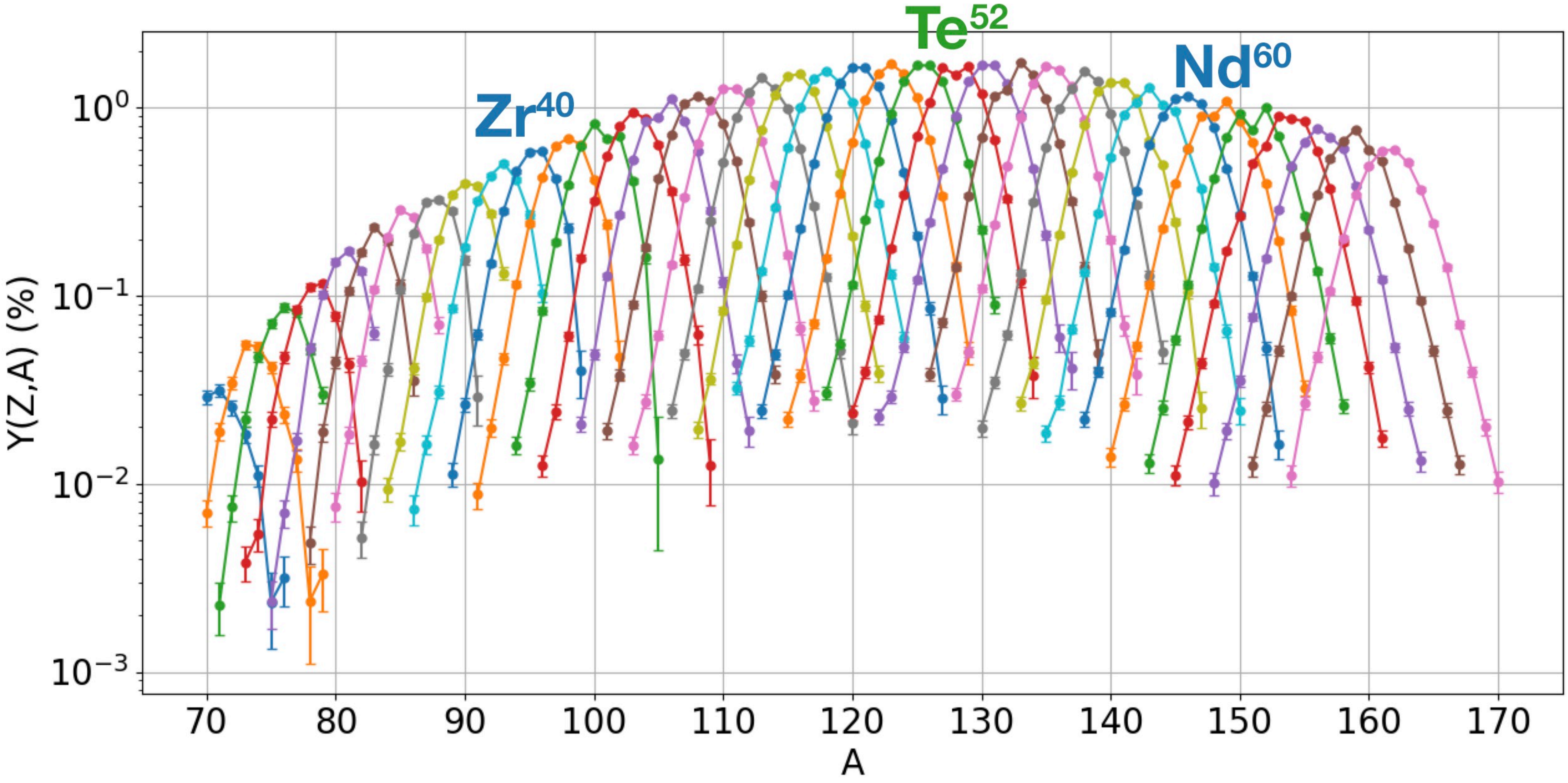


$Z \in [28,66]$
$A \in [70,177]$
$Q \in [26,53]$

$\Delta Z/Z \sim 1/70$
$\Delta A/A \sim 1/200$
$\Delta Q/Q \sim 1/70$

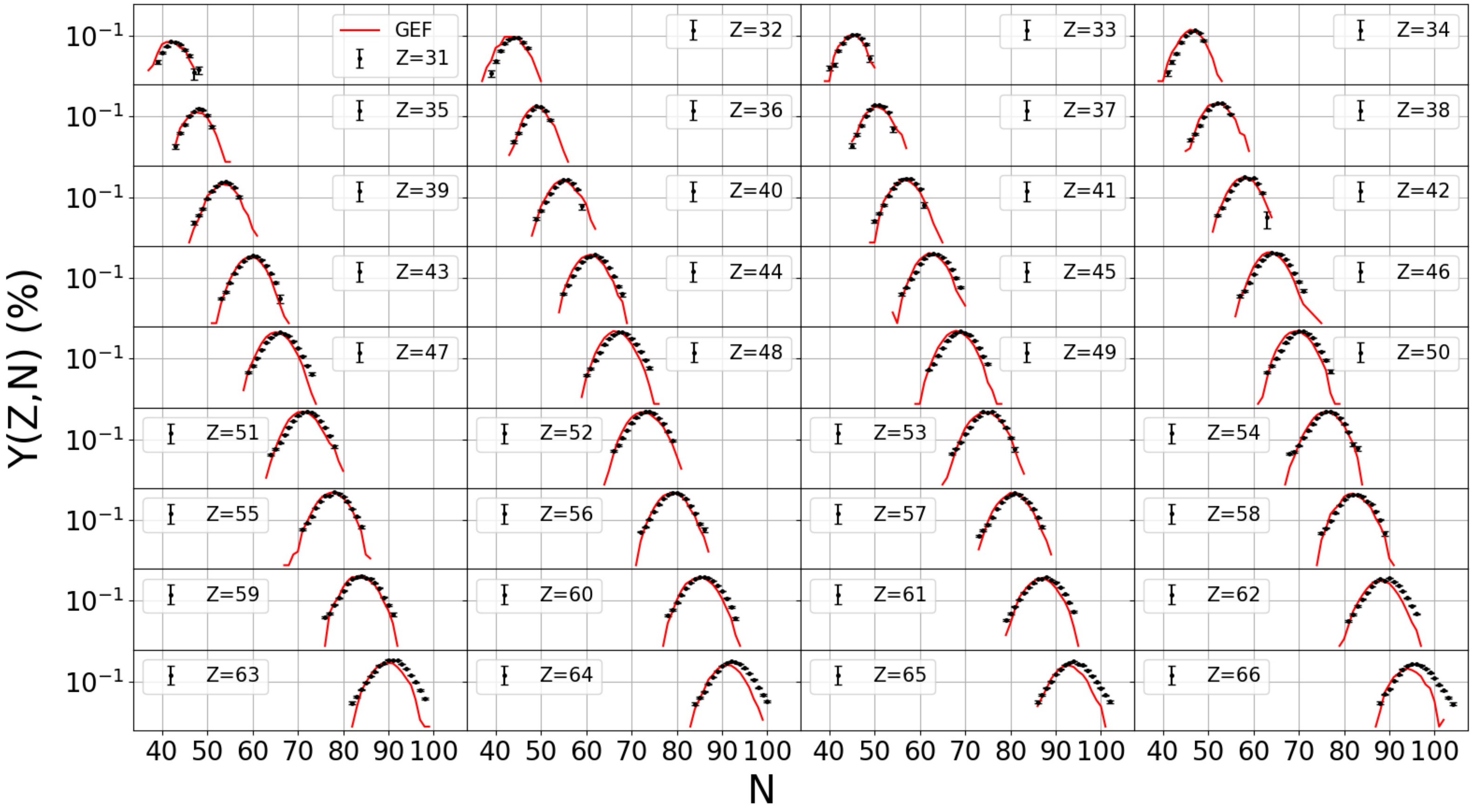






$Isotopic\ Fission\ Yields$: $Z \in [30,66]$ $A \in [70,170]$

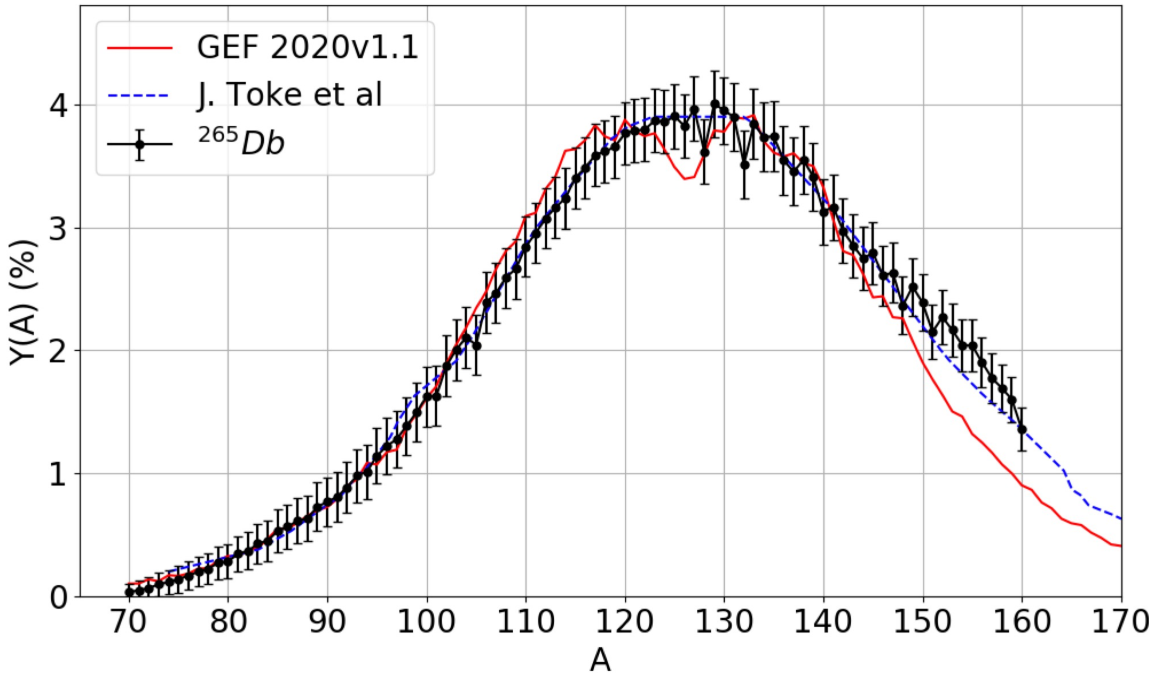
Aluminium target   Db265 Isotopic Fission Yields

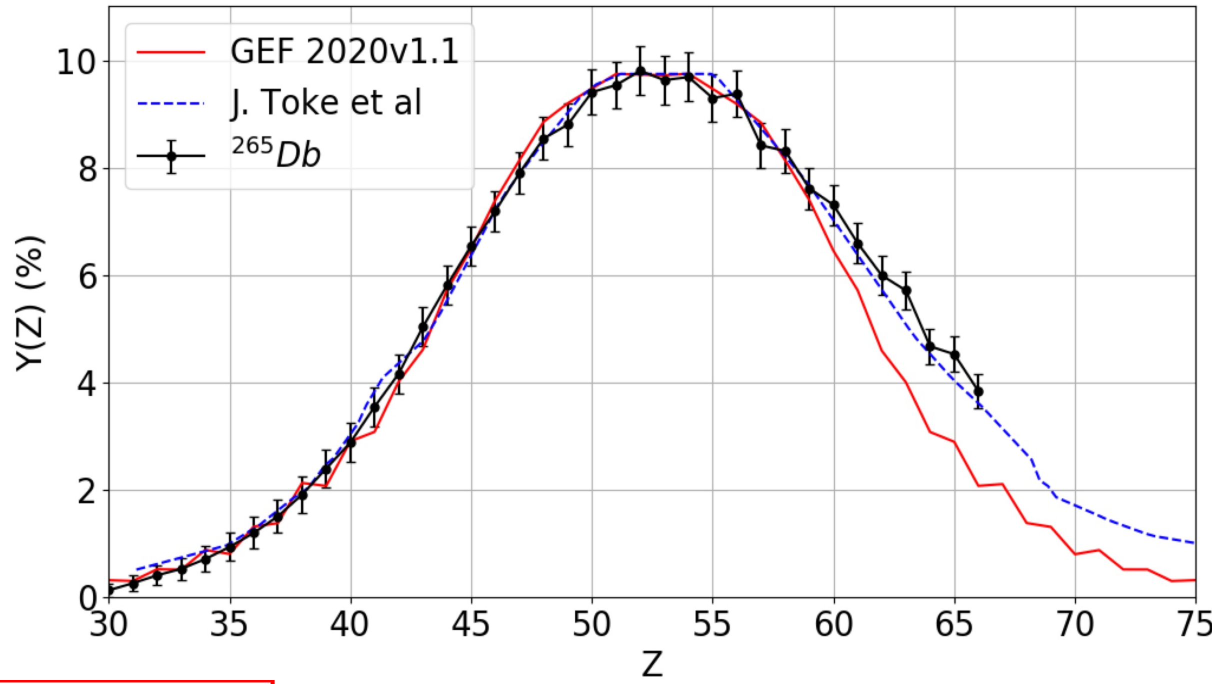


Discrepancies with GEF in the tails are due to quasi-fission

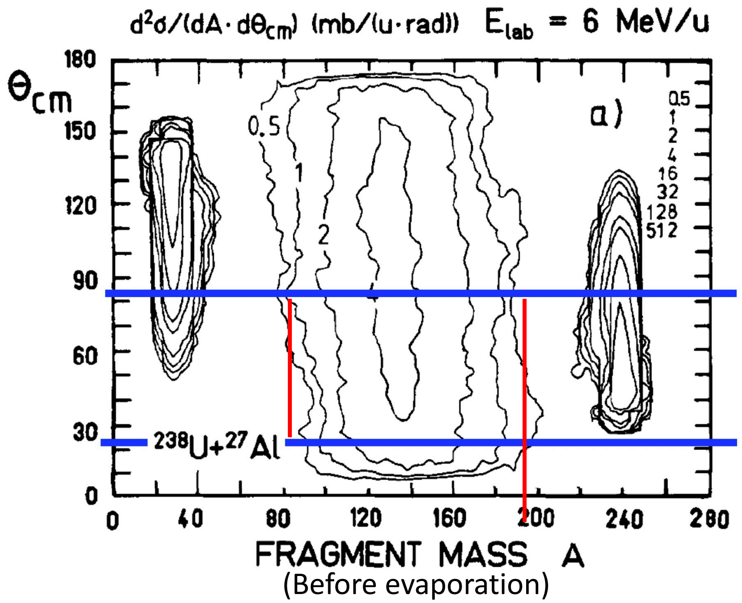
[GEF] K.-H. Schmidt, B. Jurado, 2020v1.1

Aluminium target   Db265 Y(A) and Y(Z) distributions





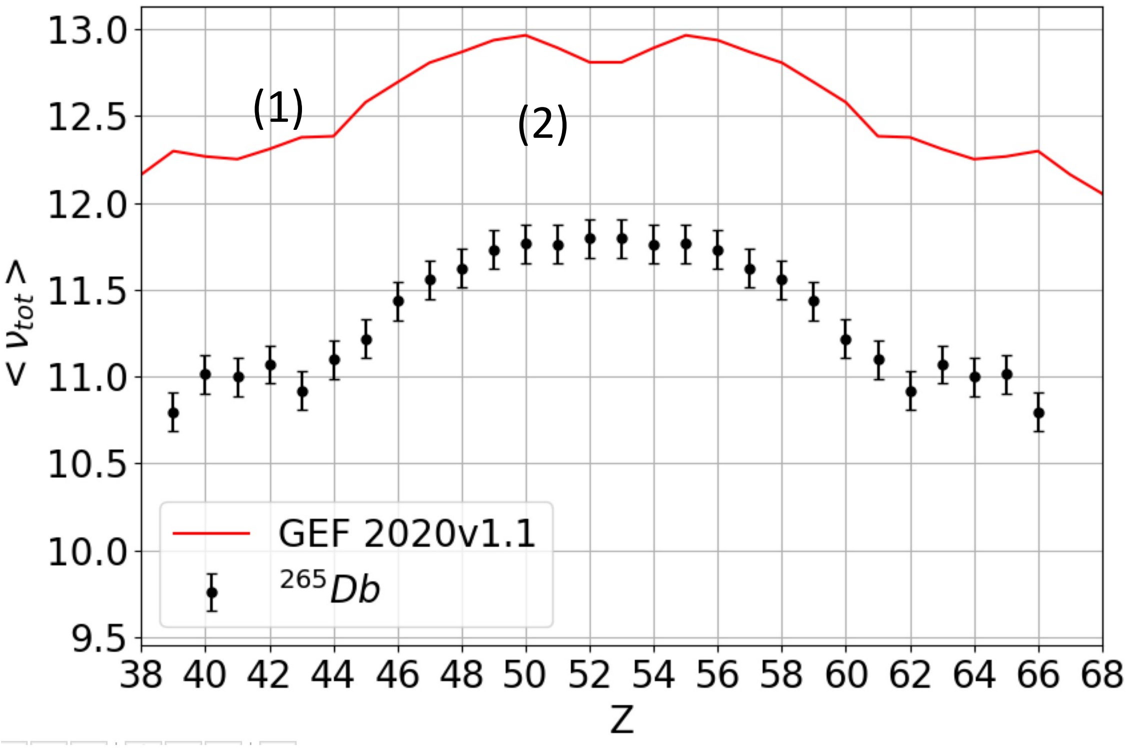
- We are restricted to an angular region and limited in A and Z
- Non symmetric distribution
- The difference in tail is due to quasi-fission
- The flat zone in the middle of A distribution compared to GEF is due to quasi-fission and neutron evaporation



[1]

[1] J. Toke et al., NPA 440 (1985) 327

Aluminium target   Db265 Neutron Evaporation and Standard Deviation of Y(Z,A)

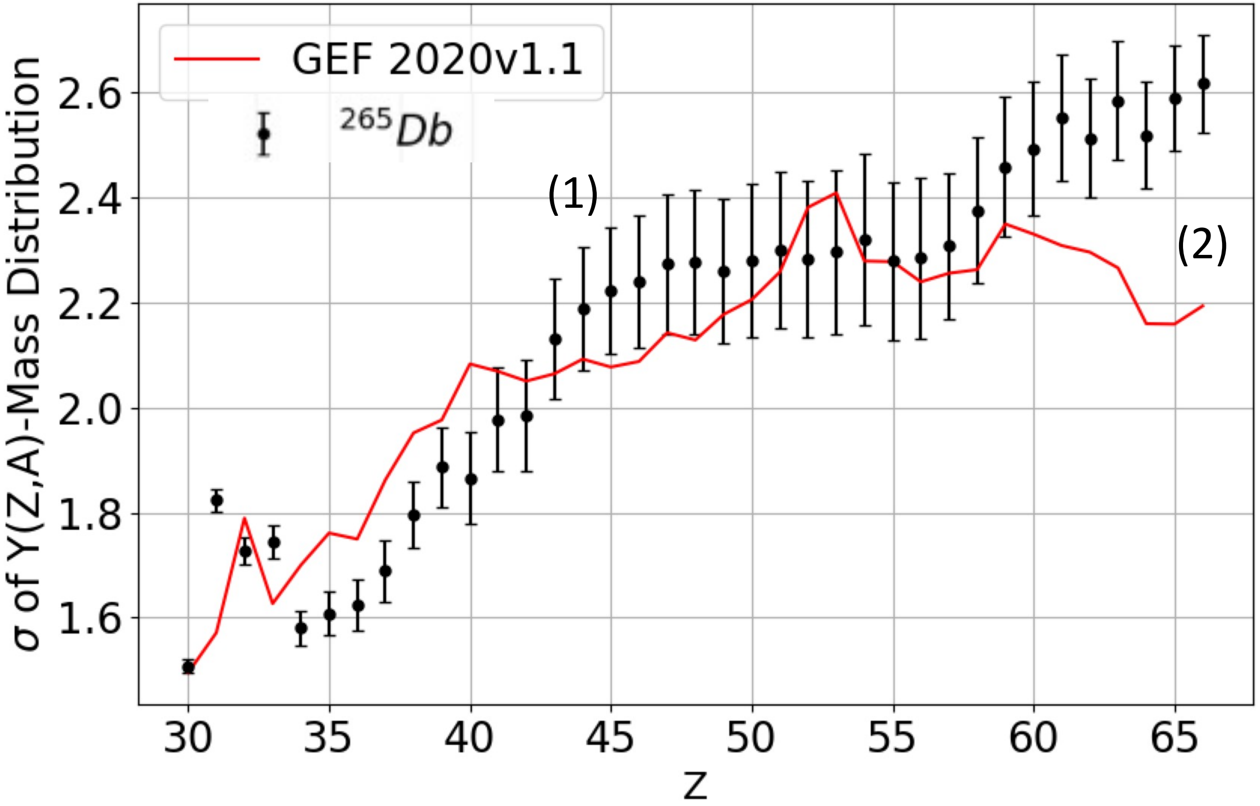


Total neutron evaporation:

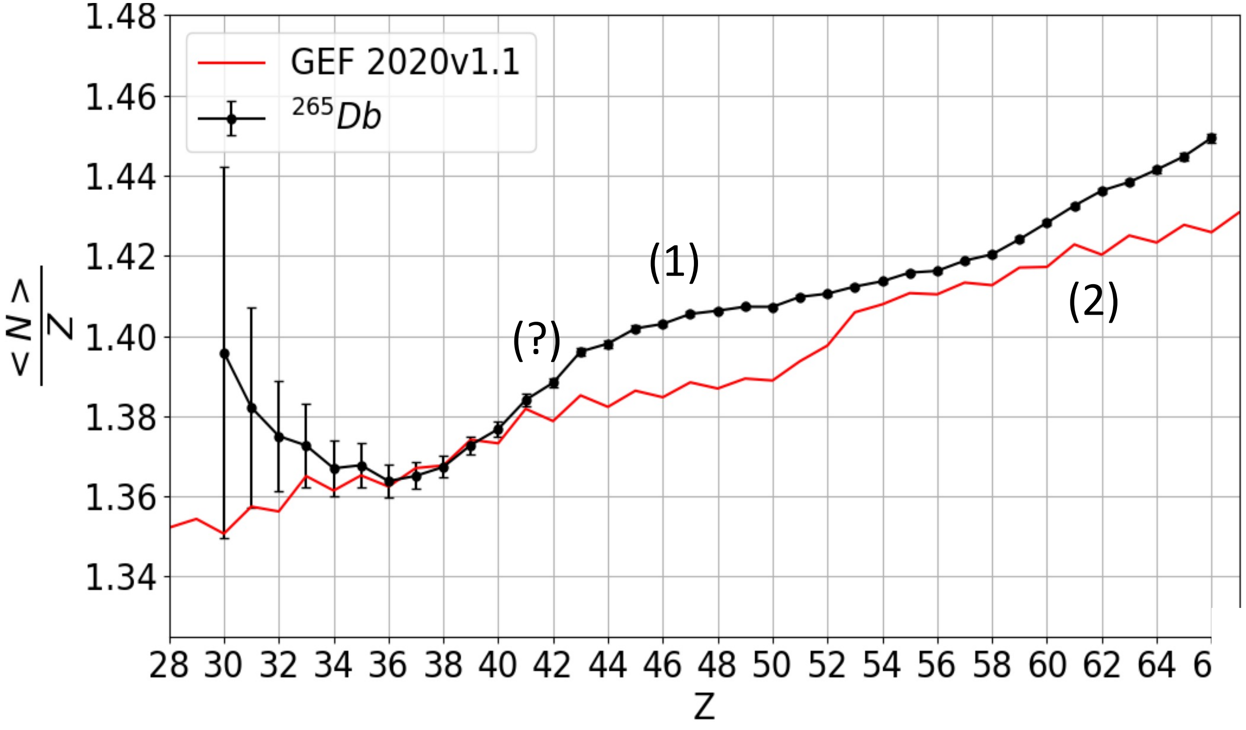
- (1) GEF gives higher neutron emission than our data.
- (2) The central zone is not flat for GEF.

Y(A) standard deviation:

- (1) More evaporation gives a higher σ, but the opposite effect is seen; probably due to quasi-fission.
- (2) Our σ increases due to quasi fission, which GEF doesn't include.



Aluminium target   Db265 Neutron Excess and Even-Odd Staggering



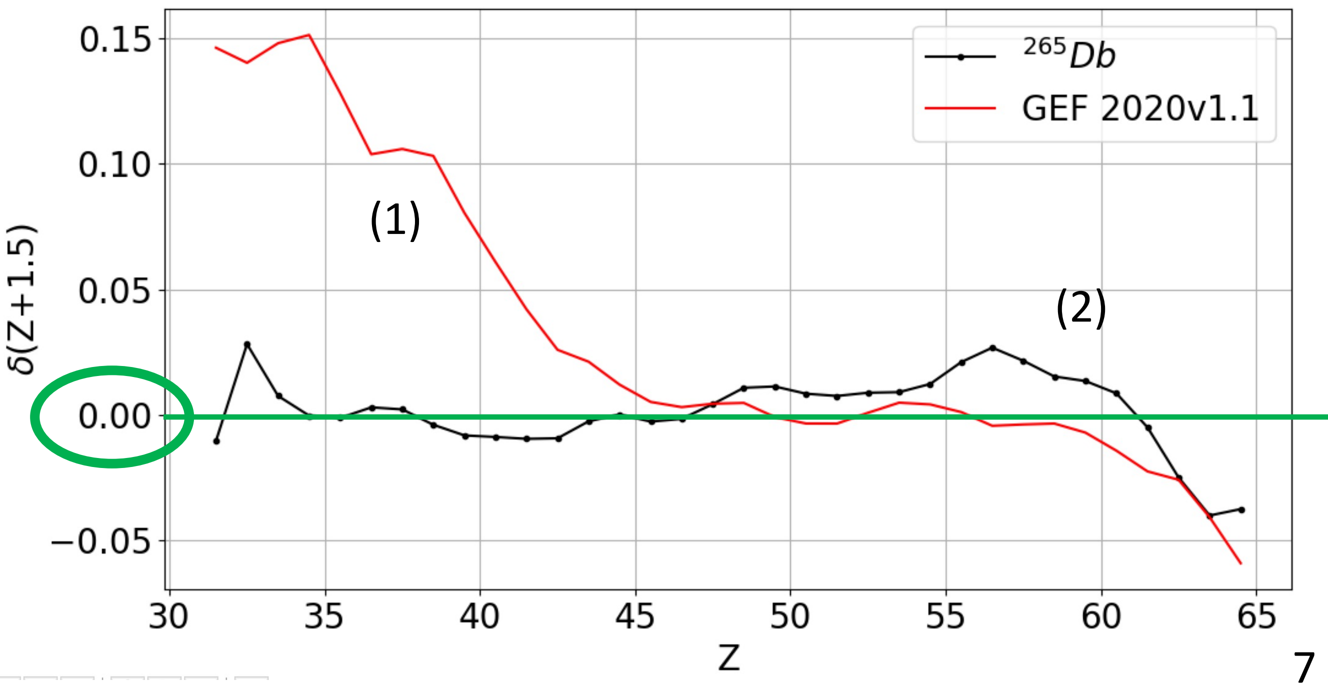
Neutron Excess:

Neutron excess is very sensitive to the structure effects, but we don't seem to have any (?) Z=44.

- (1) Low neutron evaporation provides higher neutron excess in the data than in GEF.
- (2) There is a strong deviation from GEF in the heavy fragment but not in the light one.

Even-Odd Staggering (Db^{265}_{105}):

- (1) GEF predicts higher neutron emission before scission and therefore less excitation energy, which increases the even-odd effect.
- (2) The Even-Odd effect is bigger in our data probably due to quasi-fission. It seems that $\delta_{QF} > 0$



Conclusions

- Observation of fission (265Db) and quasi-fission consistent with previous experiment.
- GEF is a powerful model but at these energies the neutron evaporation is overestimated. This justifies the need for new data in this region.
- In fission we see a behavior change (Z=44) in $\frac{<N>}{Z}$ which is very sensitive to the structure.
- VAMOS brings promising observables to disentangle fission and quasi-fission. These observables reveal features in quasi-fission that need a deeper analysis.

Future perspectives

- Analyze more observables: TKE and TXE
- Get the results of the other targets: B, Mg, Be for a more complete systematics on high E* fission and quasi-fission.

Thank you for your attention!