LNL-Experiment 09.08, October 2011

Coulomb excitation of ^{136}Xe and α-transfer to ^{140}Ba for precision lifetime measurements

J. Leske, C. Stahl, C. Bauer, L. Coquard, P. R. John,
Th. Kröll, O. Möller, Th. Möller, N. Pietralla, M. Reese

IKP, TU Darmstadt, Germany

P. Singh

GSI, Darmstadt, Germany

G. Rainovski

Dept. of Physics, Univ. of Sofia, Bulgaria

D. Bazzacco, A. Gadea, A. Gottardo, E. Farnea, C. Michelagnoli, J.J. Valiente-Dobon

LNL, Legnaro & INFN, Padova, Italy

Motivation – Physics case(s)

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Threefold motivation for the experiment:

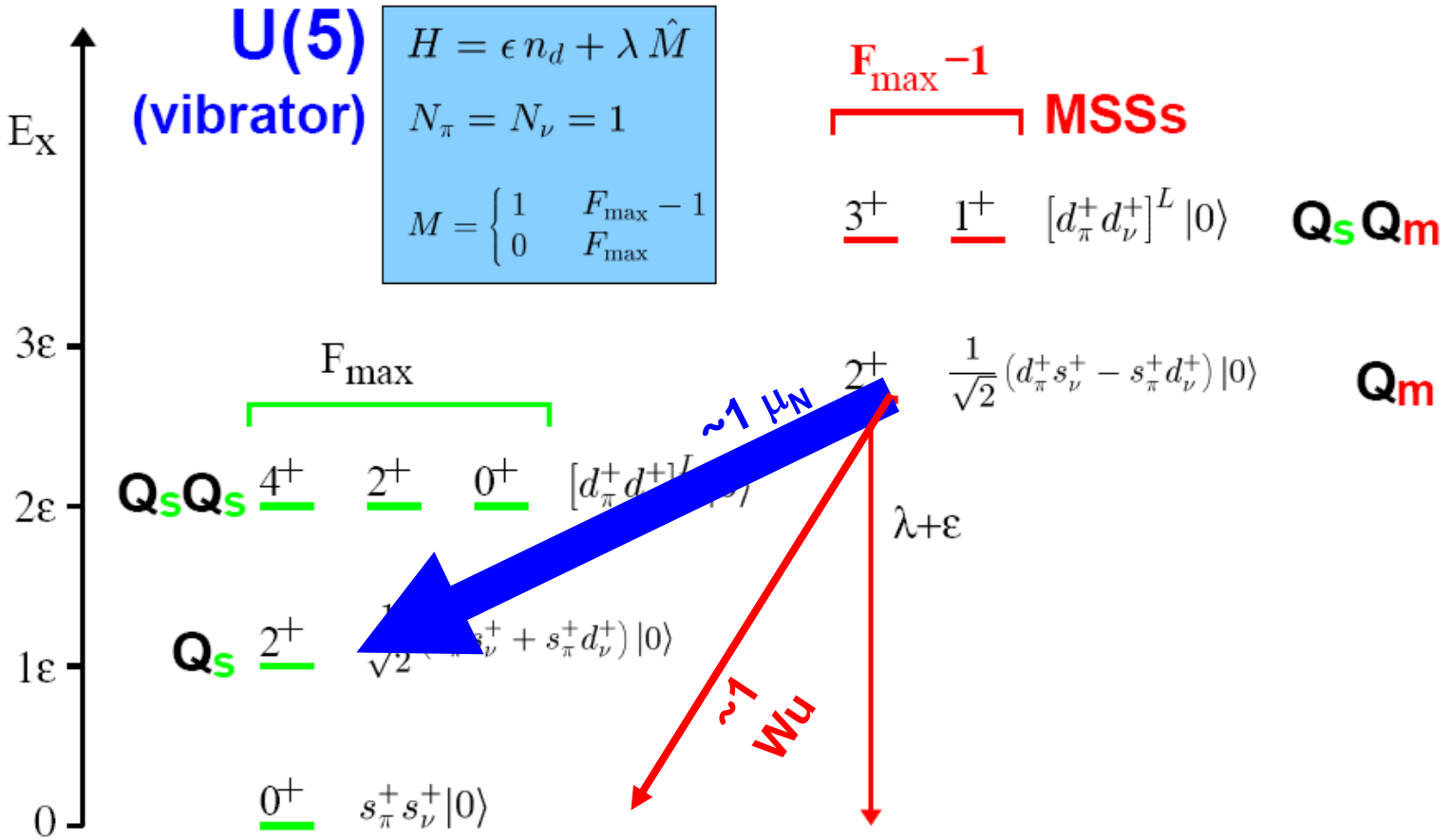
- **Population of the $2^+_{1,ms}$ Mixed-Symmetry State (MSS) in ^{140}Ba**
  → α-transfer intensity: New experimental signature for MSSs?

- **Testing a new approach for the Doppler-Shift Attenuation Method (DSAM)**
  → test case ^{136}Xe, take advantage of AGATAs abilities for DSAM measurements

- **Determine the level lifetime of the MSS in ^{140}Ba**

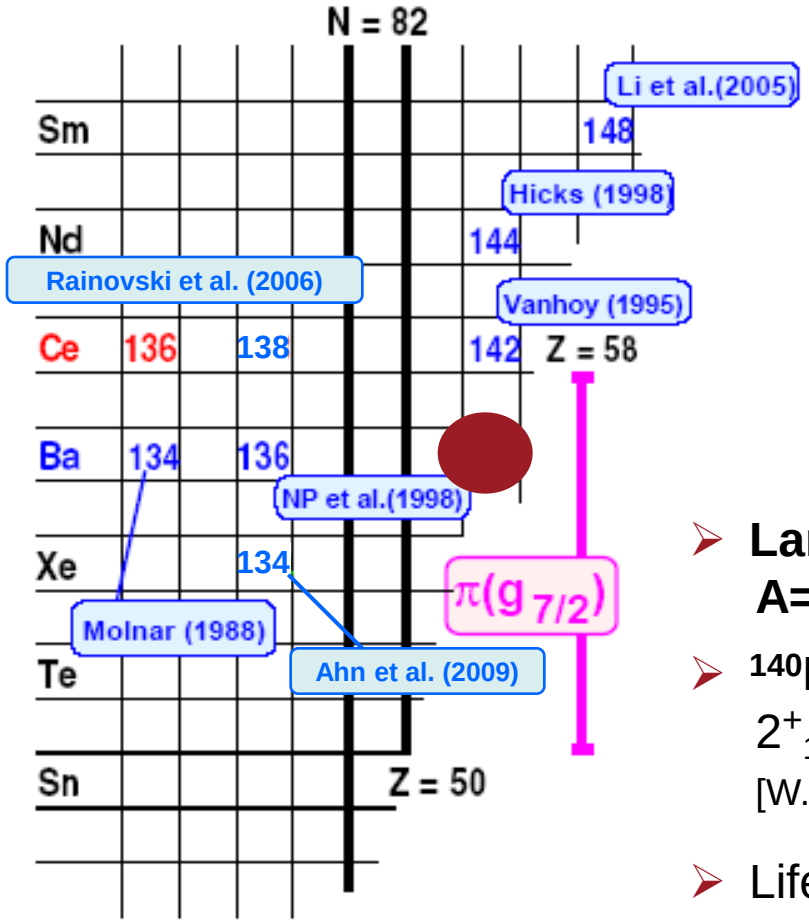
Motivation – MSS in ^{140}Ba

$2^+_{1,ms}$ - fundamental quadrupole collective isovector excitations in the valence shell

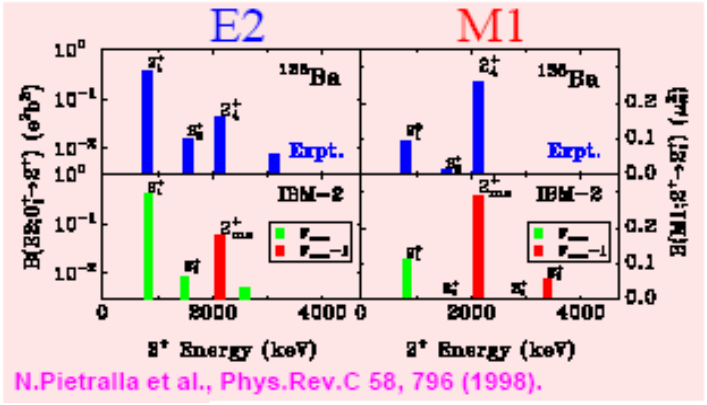


IBM-2, A. Arima, F. Iachello

Motivation – MSS in ^{140}Ba



^{136}Ba



N.Pietralla et al., Phys.Rev.C 58, 796 (1998).

- **Large number of MSSs** known in the **A=130 mass region**
- **^{140}Ba 2^+_3 level at 1994keV** suspected to be $2^+_{1,ms}$ state from **small E2/M1 mixing ratio**
  [W.D. Hamilton et al., PRL 53 (1984) 2469]
- Lifetime information missing for unambiguous assignment of mixed symmetric character

Motivation – population of MSSs

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„Population of mixed-symmetry states via *α* transfer reactions“
C. E. Alonso, J. M. Arias, L. Fortunato, N. Pietralla and A. Vitturi
PHYSICAL REVIEW C **78**, 017301 (2008)

- α-transfer reaction: $^{12}C(^{A}X, ^{8}Be)^{A+4}X$

- α-transfer intensities scale as $(N\pi - N\nu)^2/N$ for mixed-symmetry states

→
- population of MSS forbidden for $N\pi = N\nu$
- SU(3) [rotor]: population of $2^+_{1,ms}$ only **a few percent compared** to $2^+_{1,s}$
- U(5) [vibrator]: population of $2^+_{1,ms}$ can be **significantly larger**

→
Best test case : ^{140}Ba

$N\pi = 2$
$N\nu = 0$
$I(\alpha; 2^+_1) = I(\alpha; gs)$
$I(\alpha; 2^+_{1,ms}) = 1/3\ I(\alpha; 2^+_1)$

Motivation – DSAM with AGATA

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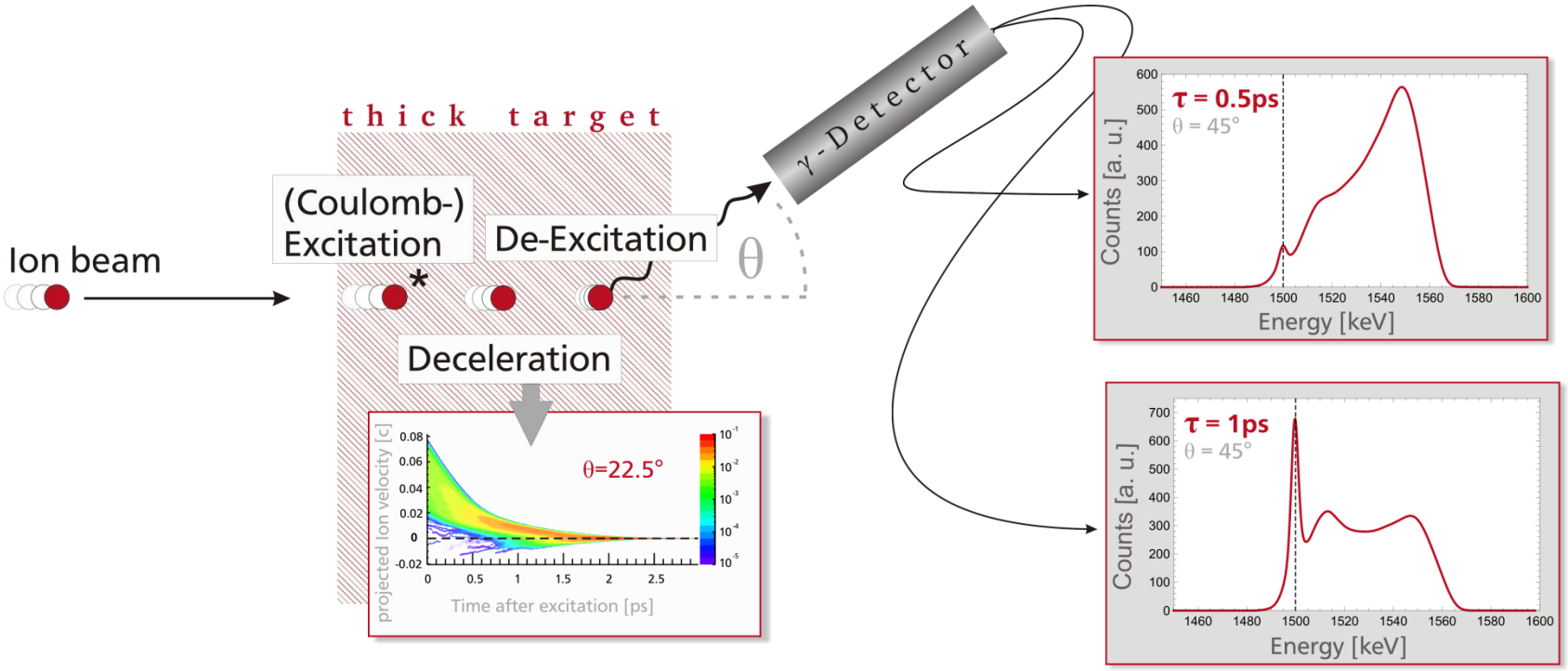
The Doppler-shift attenuation method



Deduce **level lifetimes** from the shape of **Doppler-broadened photo-peaks**

Motivation – DSAM with AGATA

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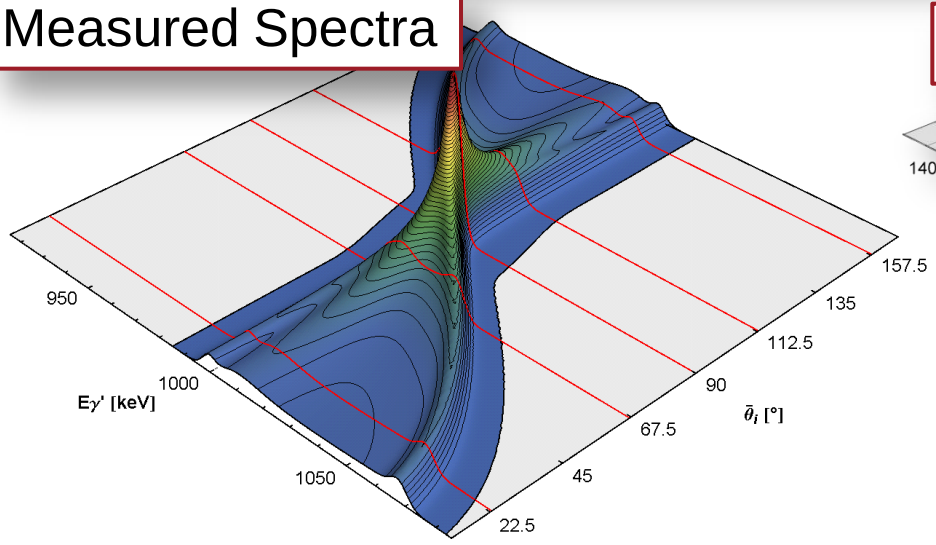
New analysis software developed:

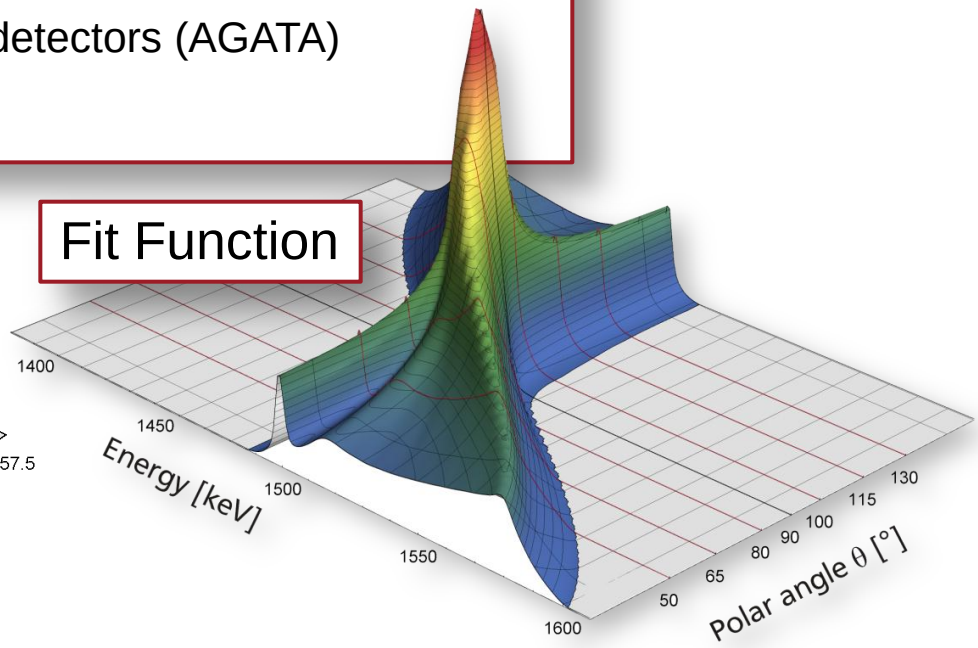
- Modeling the evolution of the lineshape over the polar angle
- Fit to spectra with **continuous polar angle information**

  as obtained from position sensitive detectors (AGATA)
- **Poster**

Measured Spectra



Fit Function



LNL Experiment 09.08, using the AGATA demonstrator

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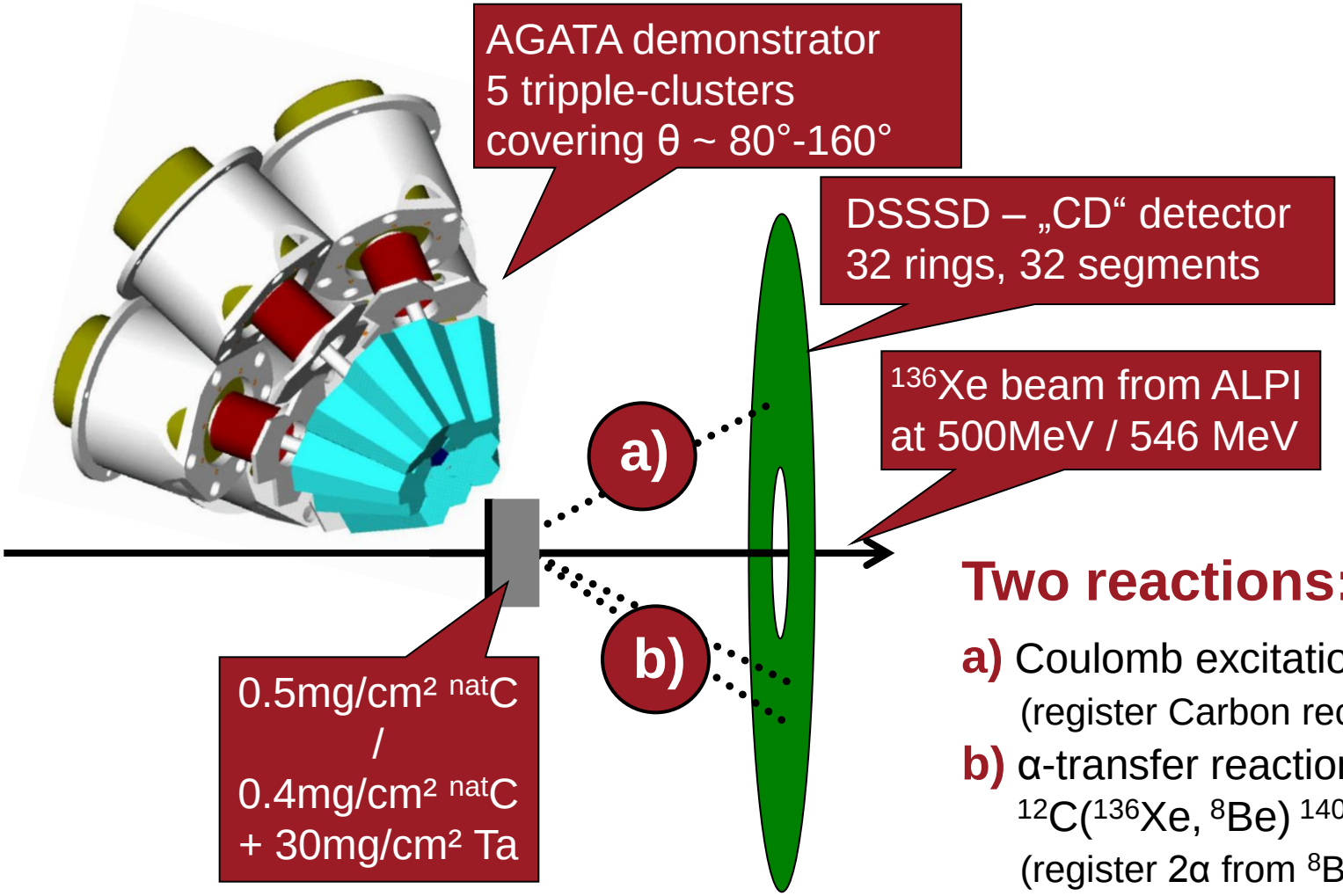

Two reactions:

a) Coulomb excitation of ^{136}Xe
(register Carbon recoil)

b) α-transfer reaction
^{12}C(^{136}Xe, ^{8}Be) ^{140}Ba*
(register 2α from ^{8}Be)

Preliminary („Online“-) Spectra

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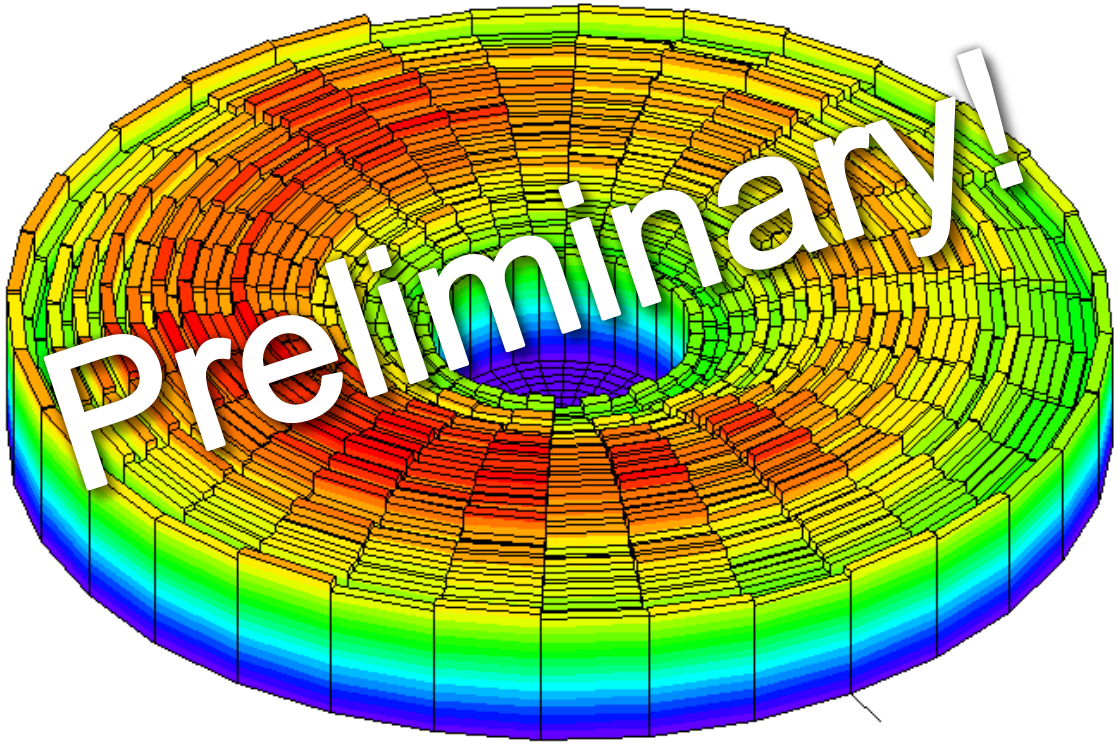
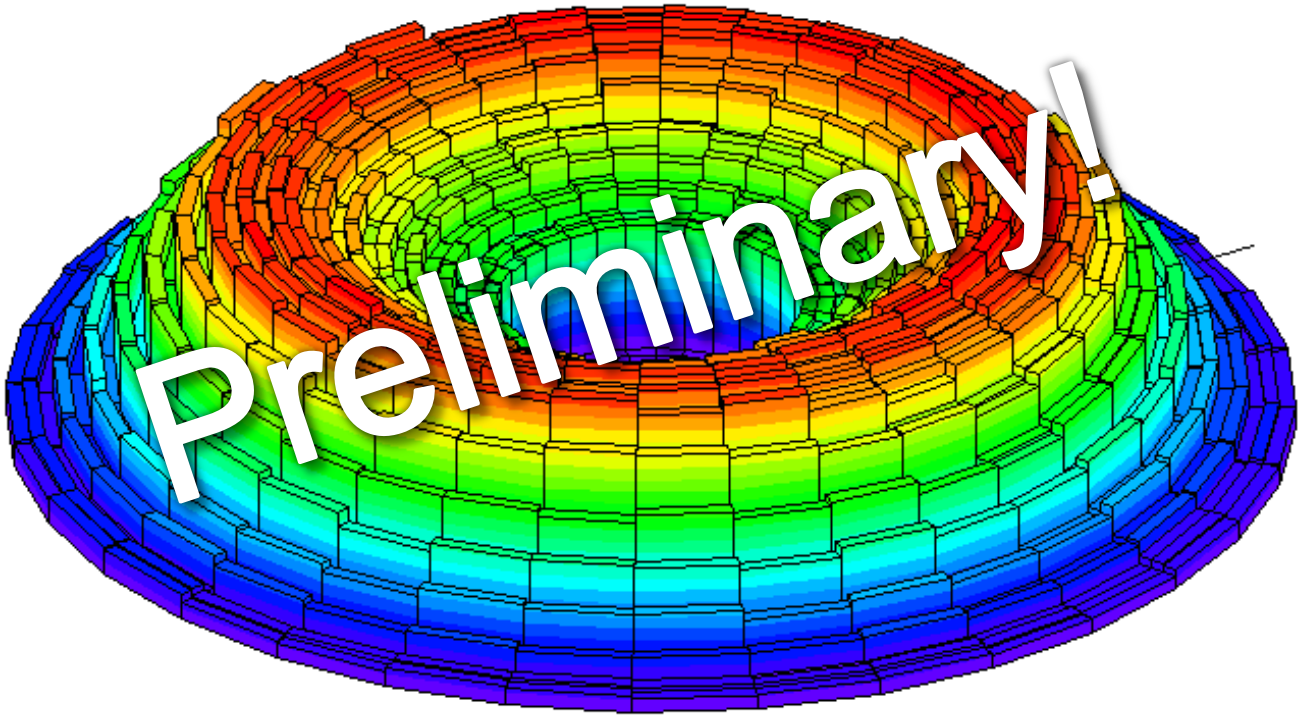
CD-Hitpattern, 546MeV, C-Target



Preliminary („Online“-) Spectra

TECHNISCHE UNIVERSITÄT DARMSTADT

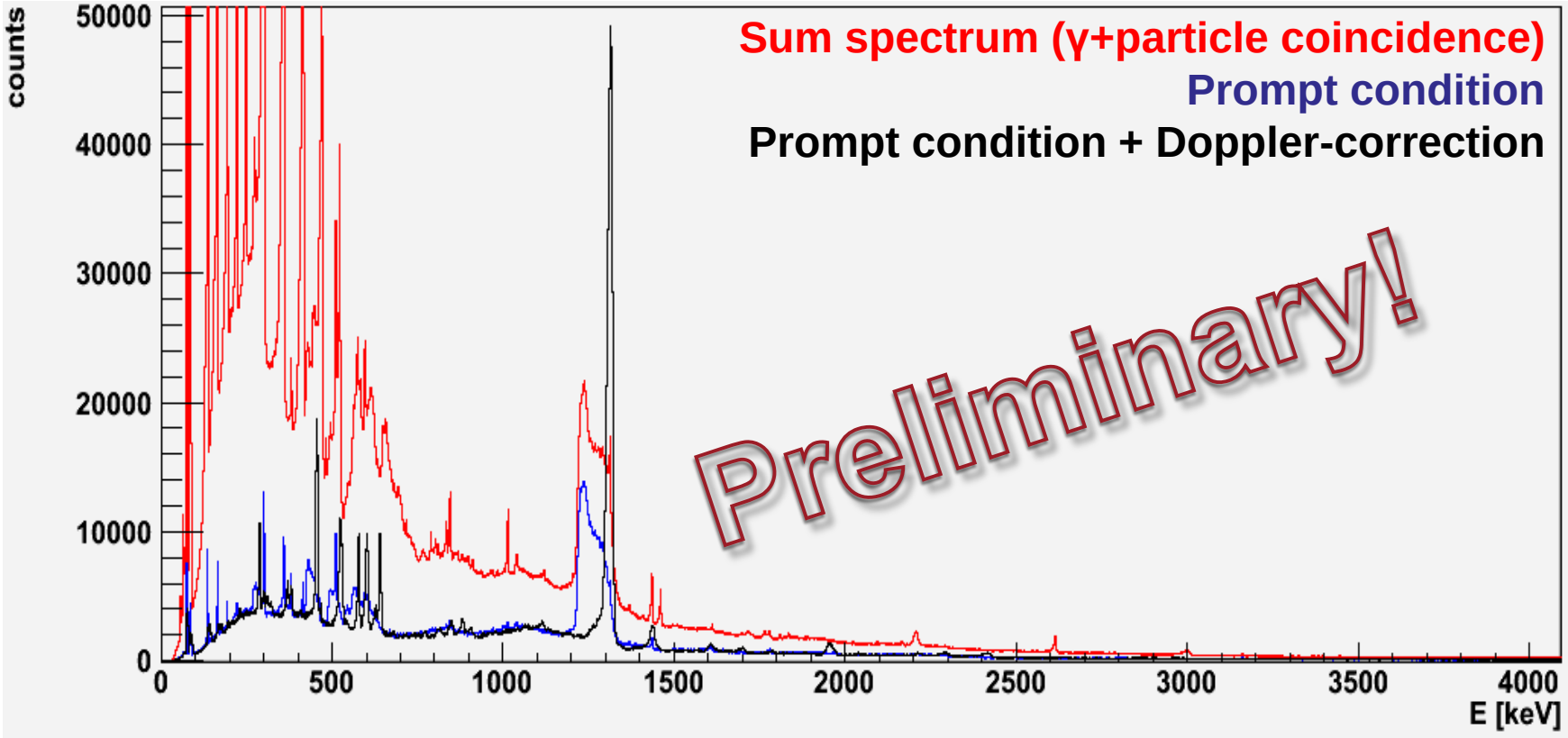
CD-Hitpattern, 546MeV, DSAM-Target



Preliminary („Online“-) Spectra

TECHNISCHE UNIVERSITÄT DARMSTADT

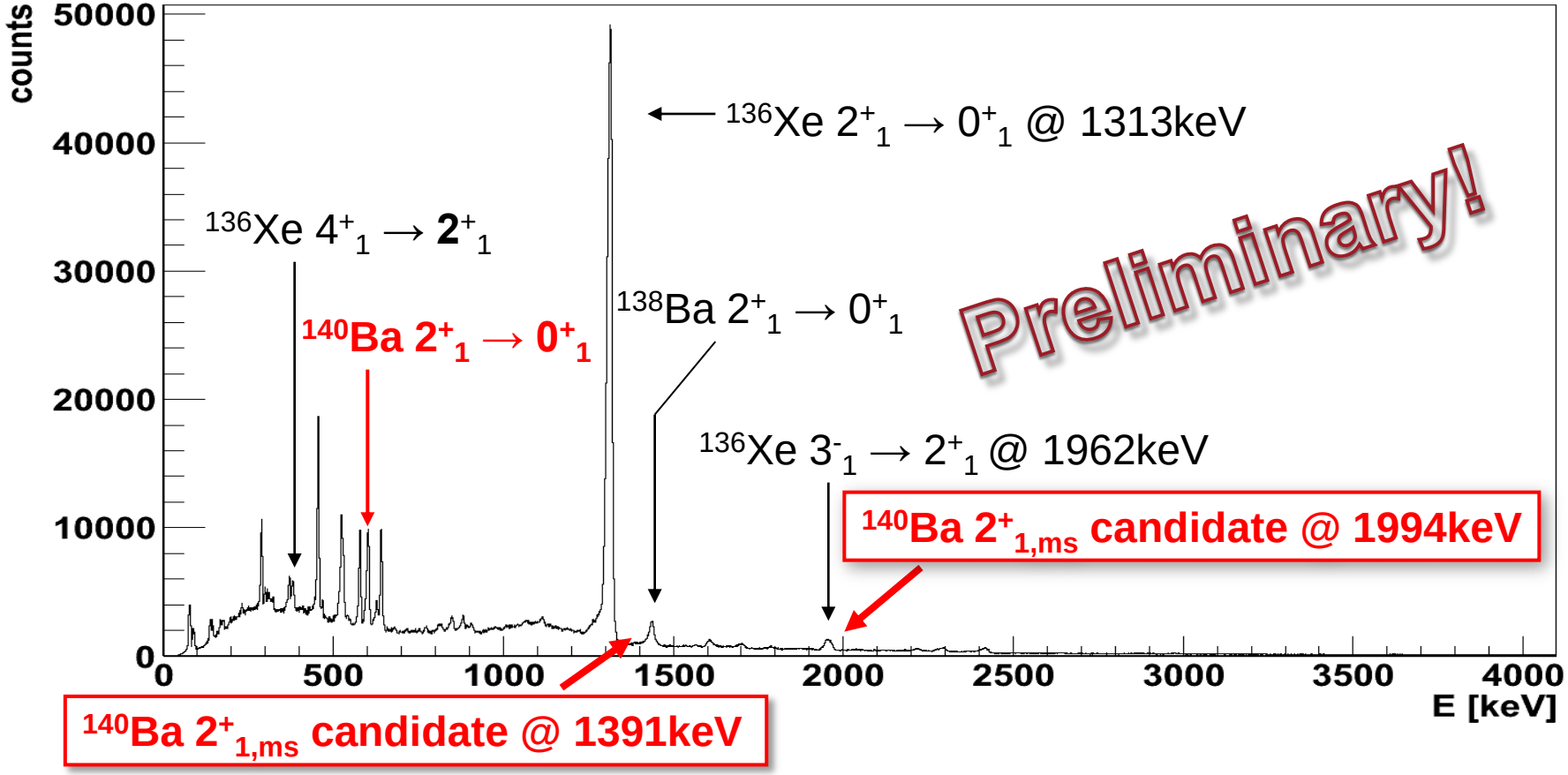
AGATA Energy – Spectrum: 546MeV, C-Target (run 84-95)



Preliminary („Online“-) Spectra

TECHNISCHE UNIVERSITÄT DARMSTADT

AGATA Energy – Spectrum: 546MeV, C-Target (run 84-95)



Preliminary („Online“-) Spectra

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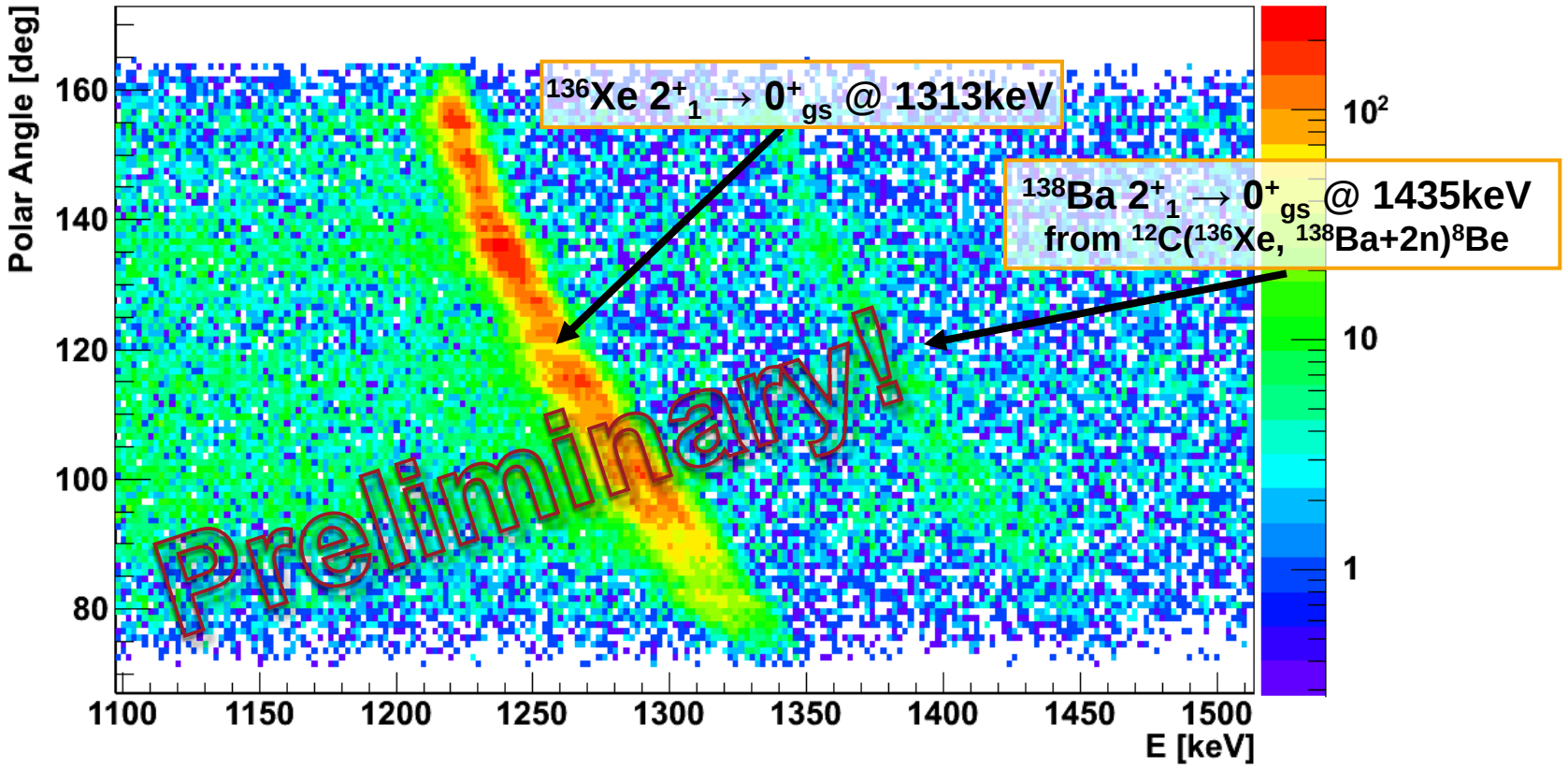
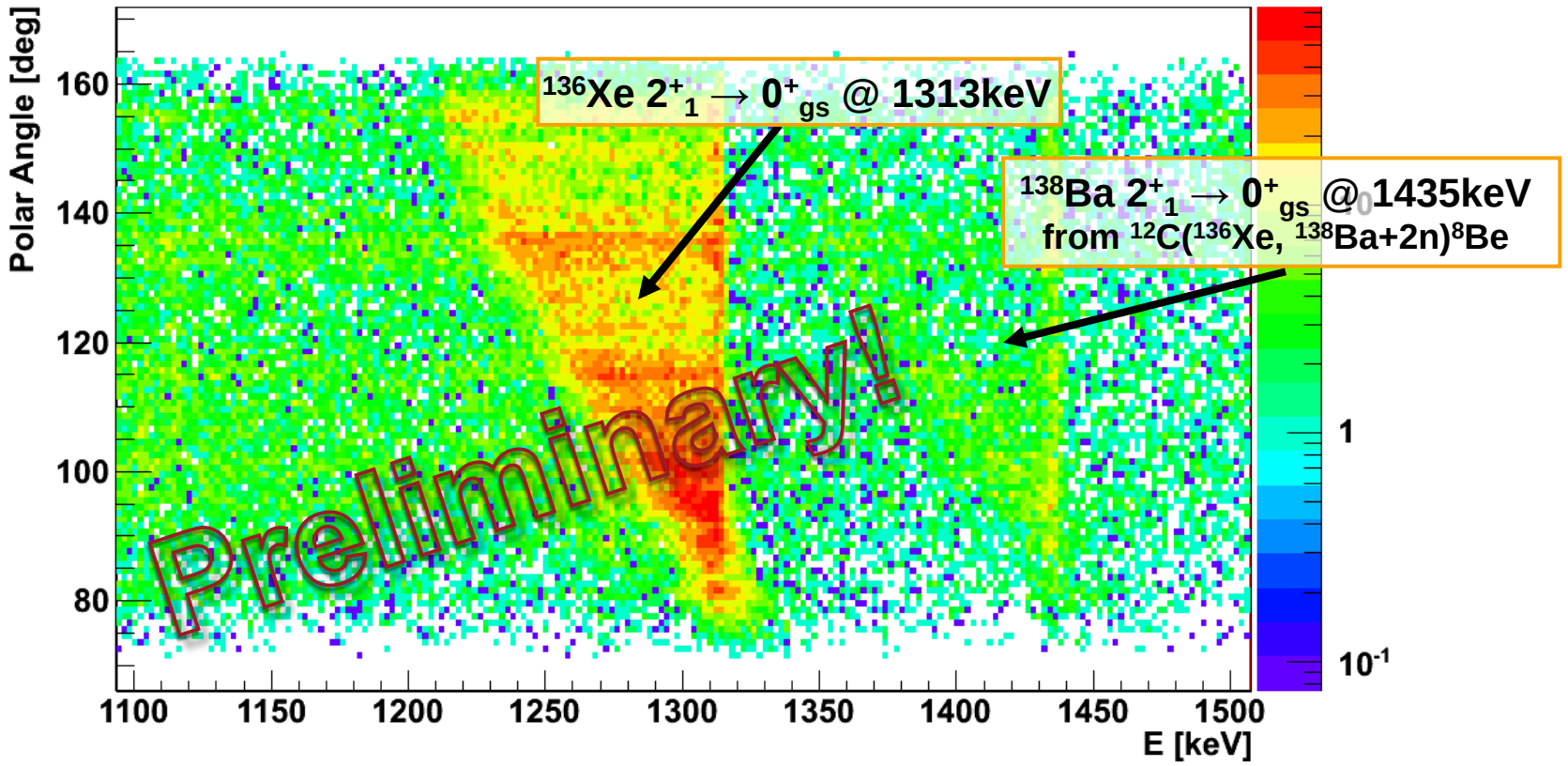
AGATA Energy/Polar-angle spectrum: 546MeV, C-Target (run91)



Preliminary („Online“-) Spectra

TECHNISCHE UNIVERSITÄT DARMSTADT

AGATA Energy/Polar-angle spectrum : 546MeV, DSAM-Target



Conclusions

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- Simultaneous measurement of 2 reactions
  - Coulomb excitation of 136Xe
  - α-transfer to 140Ba
- Prediction by Alonso et al.: Strong population of MSS by α-transfer in 140Ba

$$I(\alpha;\ 2^+_{1,ms}) = 1/3\ I(\alpha;\ 2^+_1)$$

→ Not observed, population much weaker than predicted

- Very nice 2D-spectra of several transitions in ^{136}Xe, ^{140}Ba, … obtained

  → Test and application of new DSAM – approach; see Poster
- Investigation of α-transfer cross section (angular dependence, 2 energies)
- Detailed analysis still to come (starts in this year)

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A **BIG** “thank you”!

to the local team in Legnaro who did a superb job!

Dino,
Caterina,
Enrico,
Andres,
Andrea,
Javier
and the LNL accelerator crew