Collectivity at Maximum Nucleon Valency: Investigation of Ground-State Rotation in the Neutron-Rich Dy and Er Nuclei

AGATA + PRISMA / DANTE

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Collectivity at Maximum Nucleon Valency

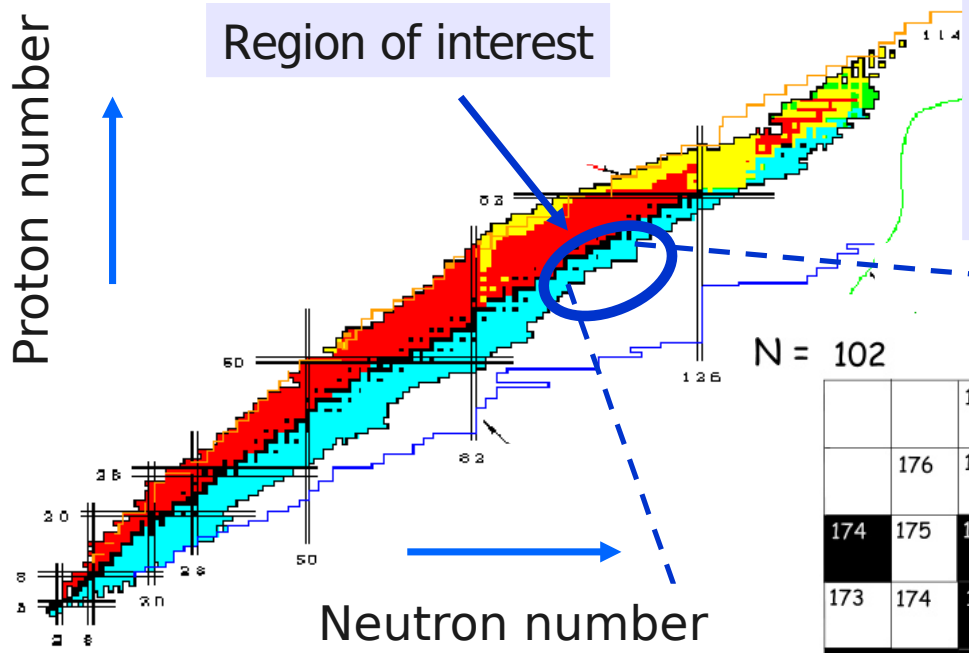
Main Aim of the Experiment

Study the structure of yrast bands in the neutron-rich rare-earth nuclei $^{170}_{66}Dy_{106}$ and $^{176}_{68}Er_{108}$ (no previously known excited states), which are located in the region of maximum collectivity, and search for high-K isomers in this region.

Physics

- Naively (excluding sub-shell closures), the doubly mid-shell nucleus $^{170}_{66}Dy_{104}$, which is located in the valence maximum, is the most collective of all nuclei with $A < 208$.
- ^{170}Dy might have a pure 6^+ isomeric state. Other long-lived high-K isomers are expected in this region.
- ^{170}Dy is the most promising candidate for an SU(3) prolate rotor in the IBA. Identification of the γ band is required.

Region of Interest in the Chart of Nuclides



Difficult to populate nuclei in this region; multi-nucleon transfer reactions

N =	102	104	106	108	110	112	
		178	179	180	181	182	183	184	185	186	W
	176	177	178	179	180	181	182	183	184	185	Ta
174	175	176	177	178	179	180	181	182	183	184	Hf
173	174	175	176	177	178	179	180	181	182		Lu
172	173	174	175	176	177	178	179	^{180}Yb			Yb
171	172	173	174	175	176	177	178	179			Tm
170	171	172	173	174	175	^{176}Er	177	178			Er
169	170	171	172	173	174	175	176	177			Ho
168	169	^{170}Dy	171	172	173	174	175				Dy

Current limits of γ-ray spectroscopy for neutron-rich rare-earth nuclei

AGATA + PRISMA / DANTE Experiment

Study the nuclei of interest using the complementary fragment technique

Beam, Target, Reaction

Beam: PIAVE + ALPI ^{136}Xe 850 MeV, 2 pnA, $q = 28^{+}$
Target: ^{170}Er 1.0 mg/cm^2 to populate

- ^{170}Dy (1.3 mb, -2p+2n transfer)
- ^{176}Er (1.8 mb, +6n transfer)

N/Z ratios
^{136}Xe: 1.52
^{170}Er: 1.50

Cross sections from GRAZING calculations

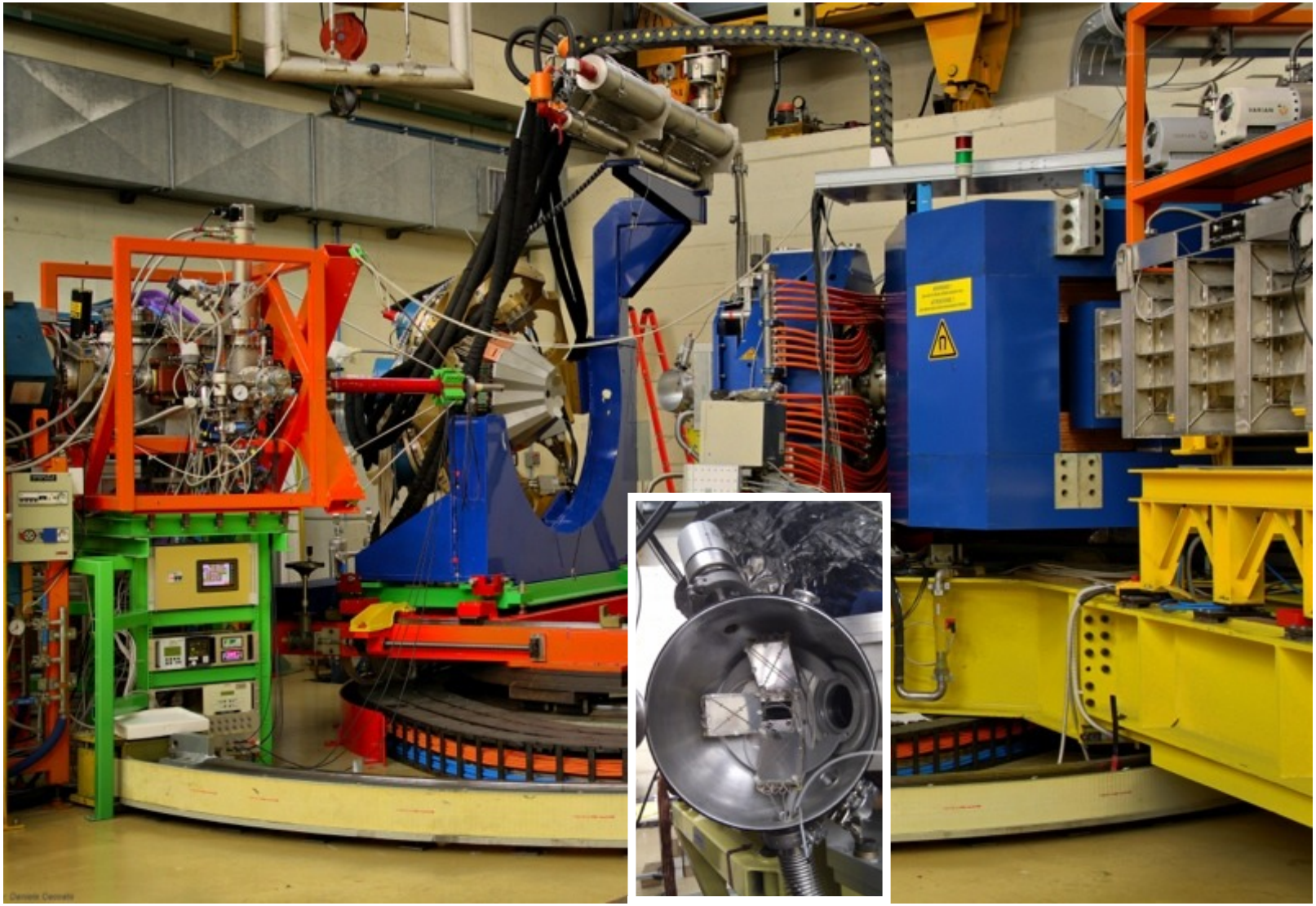
Trigger Condition

PRISMA OR ($\gamma\gamma$-AGATA AND DANTE)

Data

in total 6 TB of data taken

AGATA + PRISMA / DANTE Experimental Setup



AGATA + PRISMA / DANTE Experimental Setup

AGATA

Doppler corrected γ rays for both projectile-like (PLFs) and target-like fragments (TLFs)

No collimators $\rightarrow$ possibility to detect isomers

- in PLFs for tagging: ^{134}Ba, 10^+, 2.63 μs and ^{136}Ba, 10^+, 91 ns
- in TLFs for search of high-K isomers

PRISMA at 44°

Detect PLFs: Z identification, A/q, velocity, ...

or

DANTE 3 detectors on a 42° ring

Obtain angle of emission of TLFs for Doppler correction of isomer tagging events using average velocity of TLFs

Data Analysis

Data analysis is still in progress!

Nearline analysis during the campaign:
By gating on delayed γ rays we obtained a spectrum corresponding to the decay of the 10^+ isomer with $\tau_{1/2} = 91$ ns in ^{136}Ba

^{136}Ba is the beam-like partner of ^{170}Dy

Offline analysis using `gammaware` and `PRISMA Lib`

Data Analysis

Aila Gengelbach (Uppsala) and Peter Hampson (Liverpool)

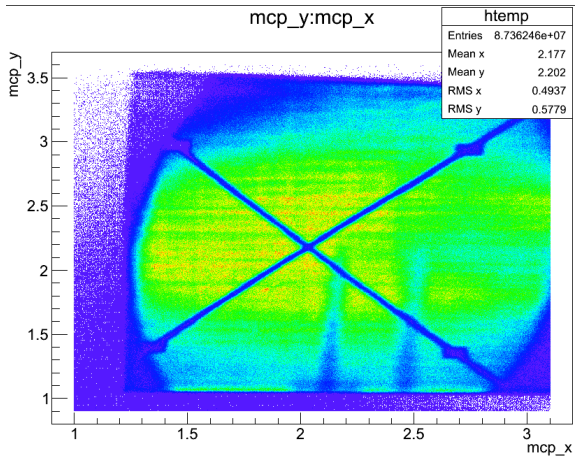
Started with the calibration of the PRISMA components

- MCP:
  1. determine the position of the calibration points x and y
  2. use a matrix method for a linear calibration containing both uncalibrated x and y

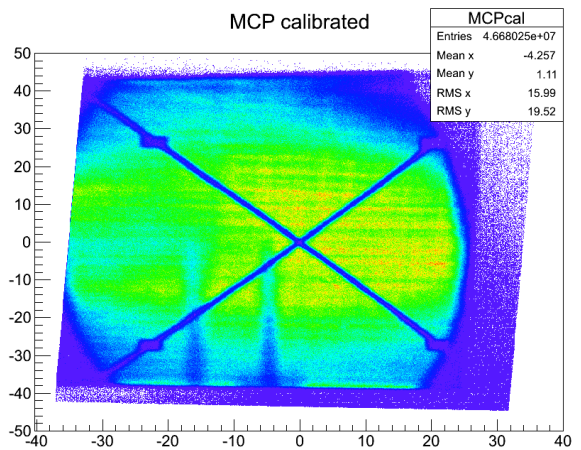
$$x' = a_x + b_x x + c_x y,$$
$$y' = a_y + b_y x + c_y y$$

  with the known calibration points x' and y'
- MWPPAC and
- IC currently under investigation

uncalibrated MCP histogram



calibrated MCP histogram



Collaboration

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and the AGATA and PRISMA collaboration at LNL.

Questions?