Recent results from the AGATA Demonstrator Array at LNL

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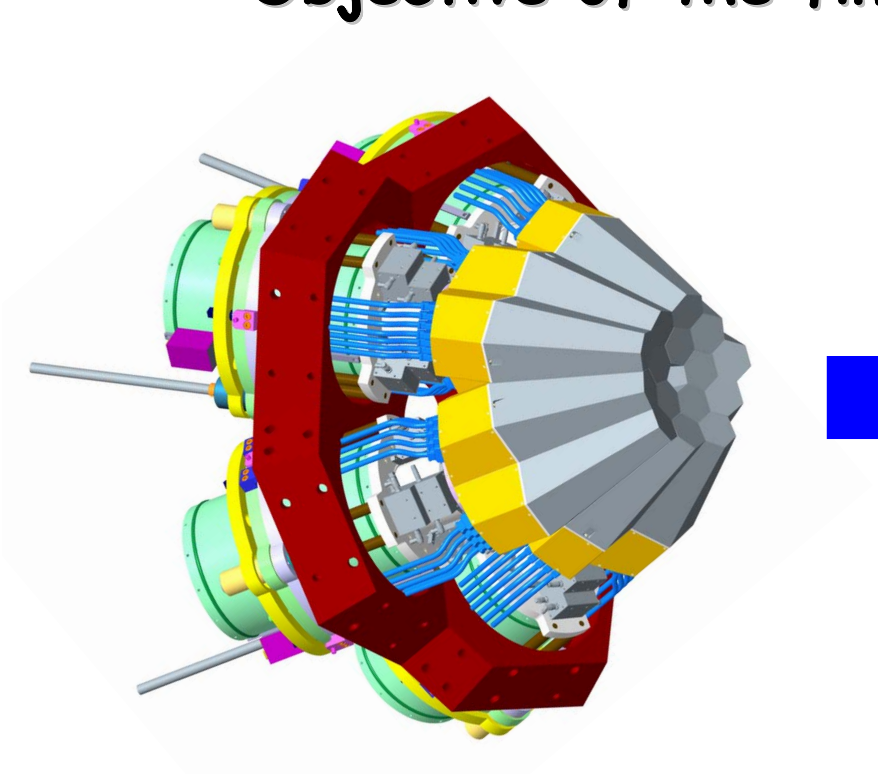
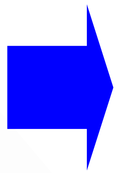
On behalf of the AGATA Collaboration

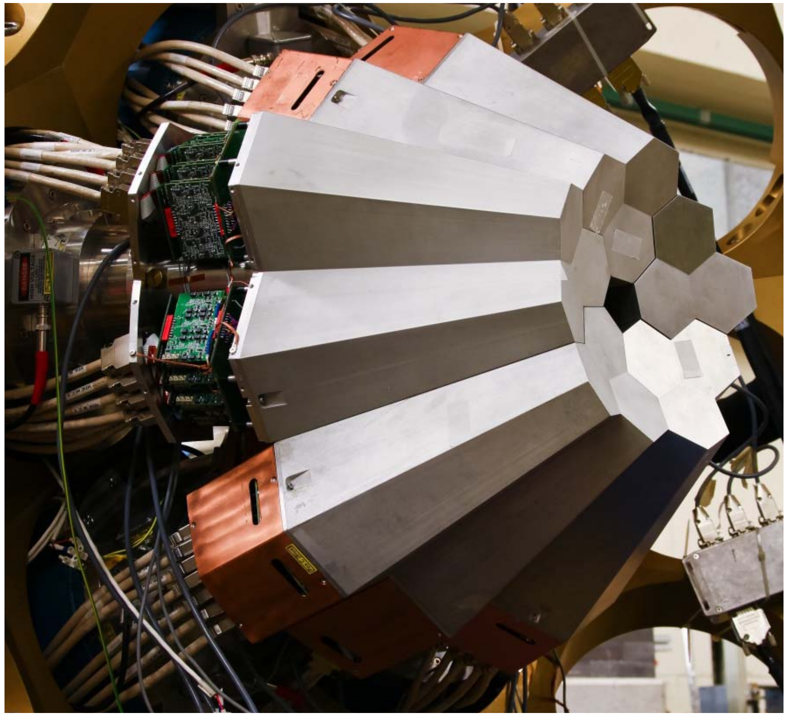
1. The AGATA Demonstrator at Legnaro
2. Highlights from the performed experiments

The AGATA Demonstrator

Objective of the final R&D phase 2003-2008



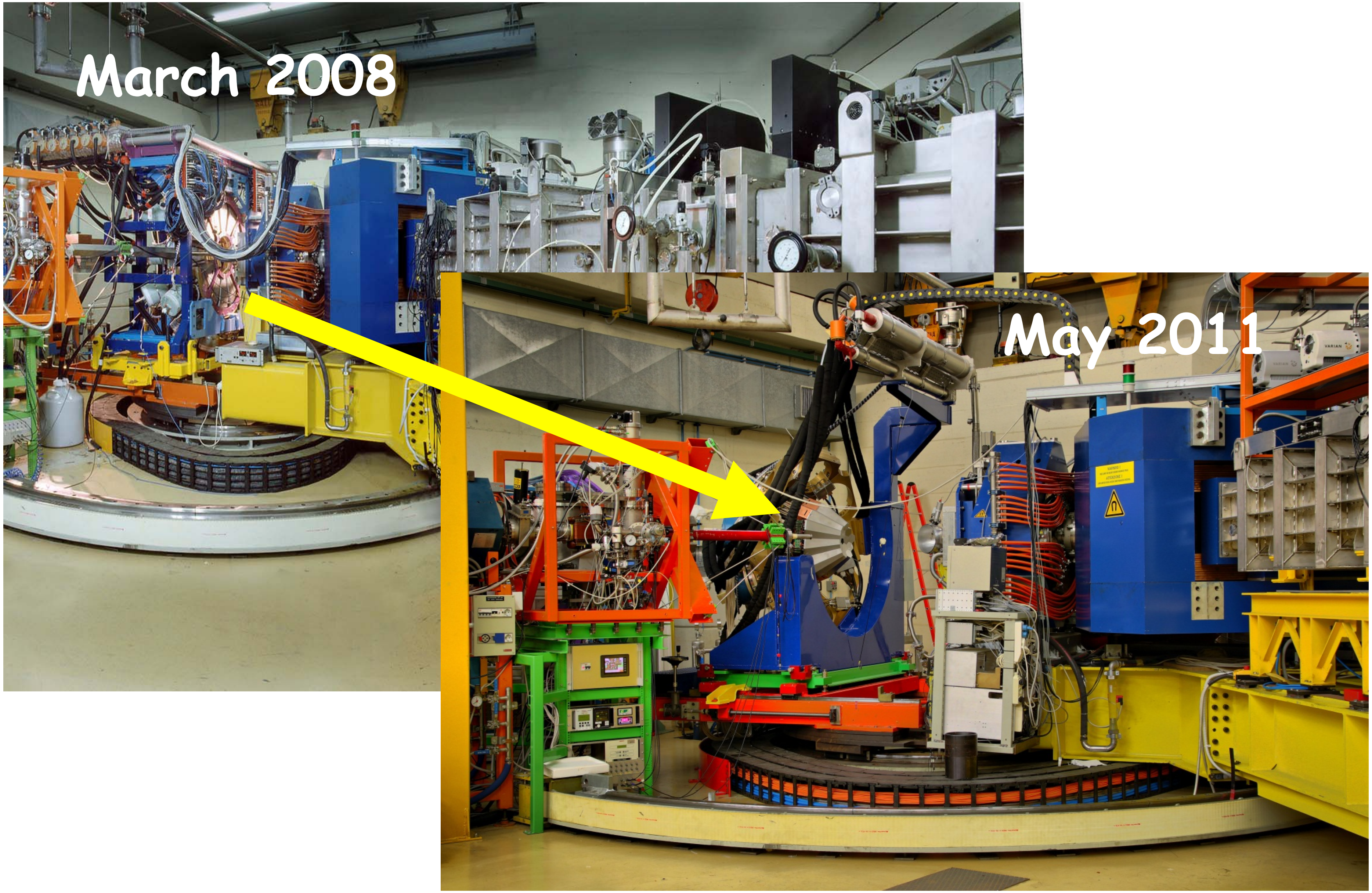




5 asymmetric triple-clusters
36-fold segmented crystals
555 digital-channels
Eff. 3 – 8 % @ M_γ = 1
Eff. 2 – 4 % @ M_γ = 30
Full EDAQ with on line PSA and γ-ray tracking
In beam Commissioning
First installation site: LNL

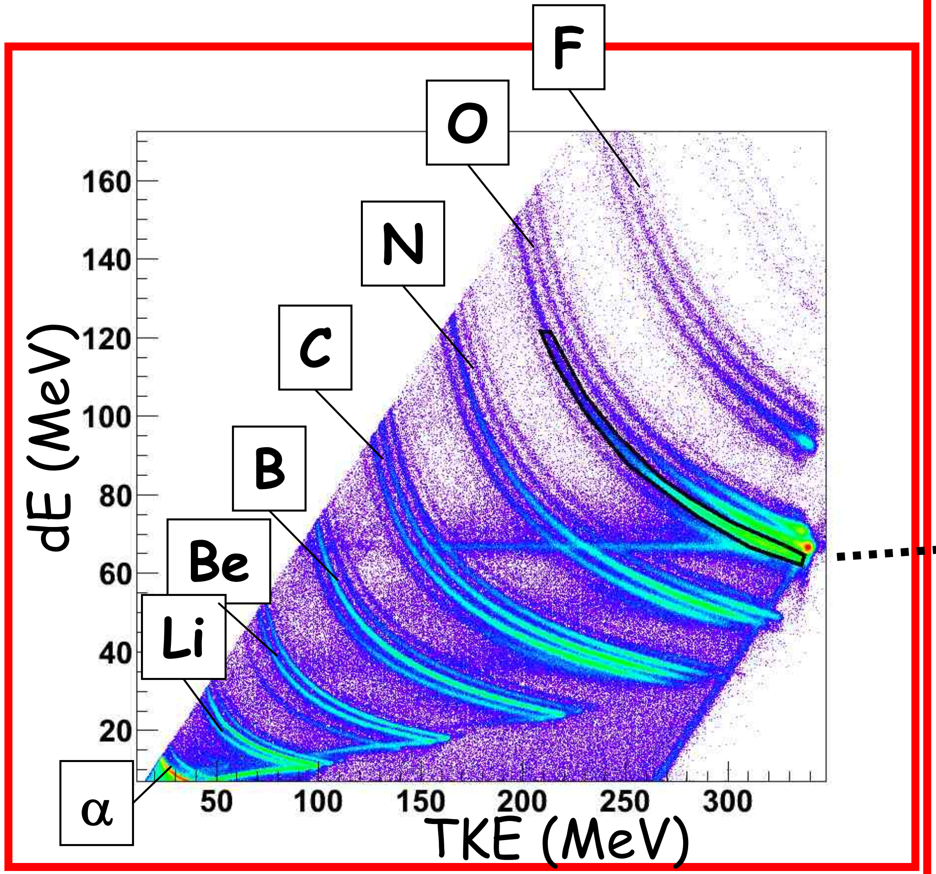
Main issue is Doppler correction capability → coupling to beam and recoil tracking devices

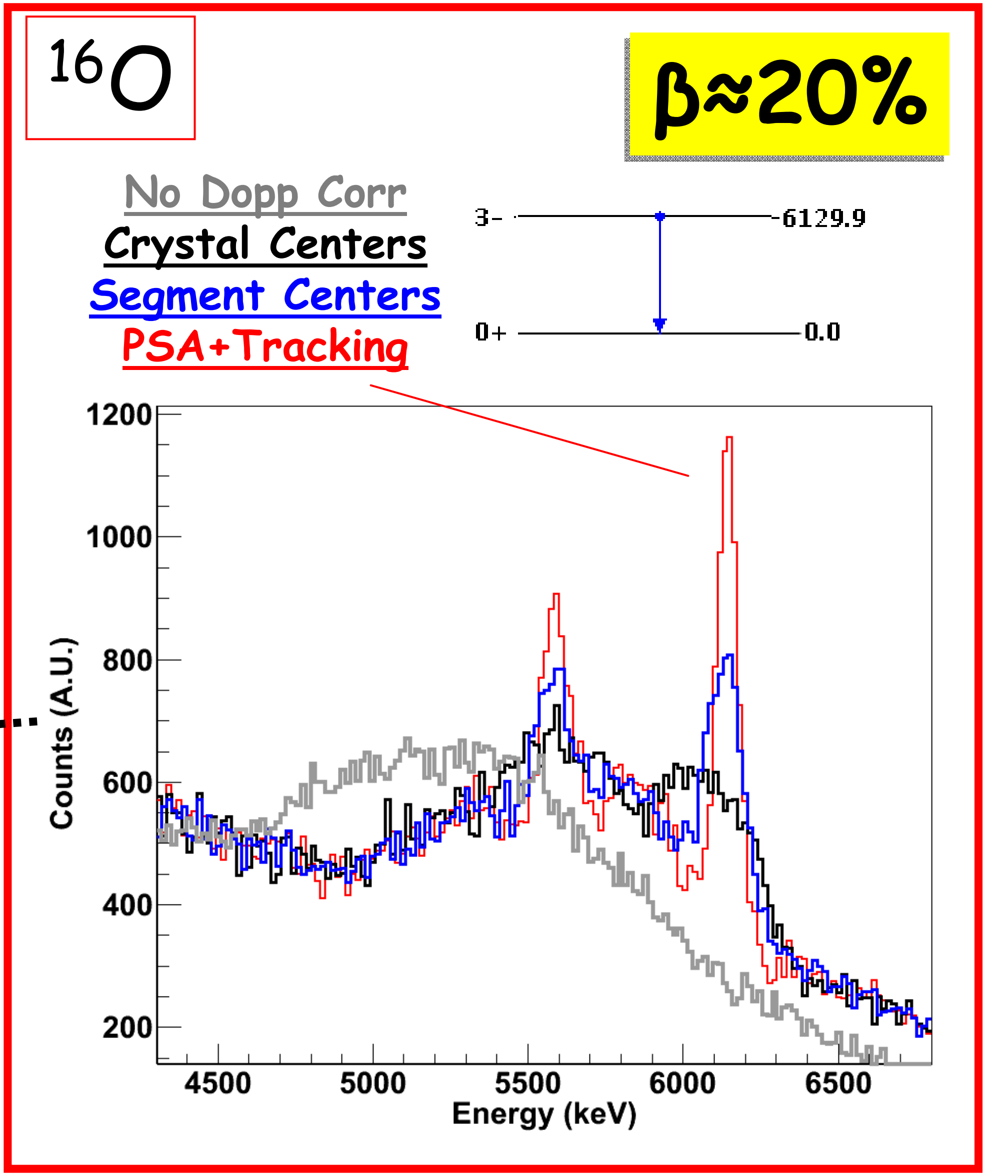
From CLARA to AGATA



Doppler correction capabilities

Inelastic scattering
^{17}O @ 20 MeV/u on ^{208}Pb

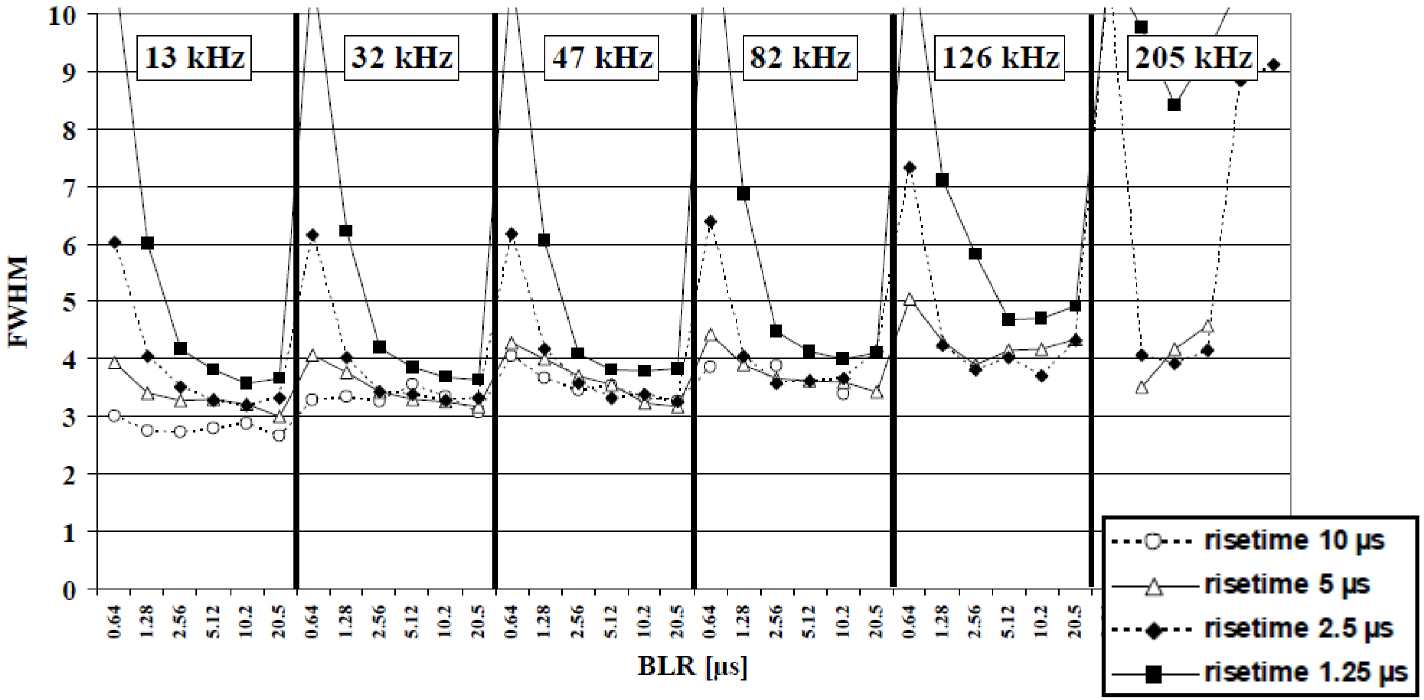




D.Mengoni, R.Nicolini, F.Crespi

Resolution vs rate

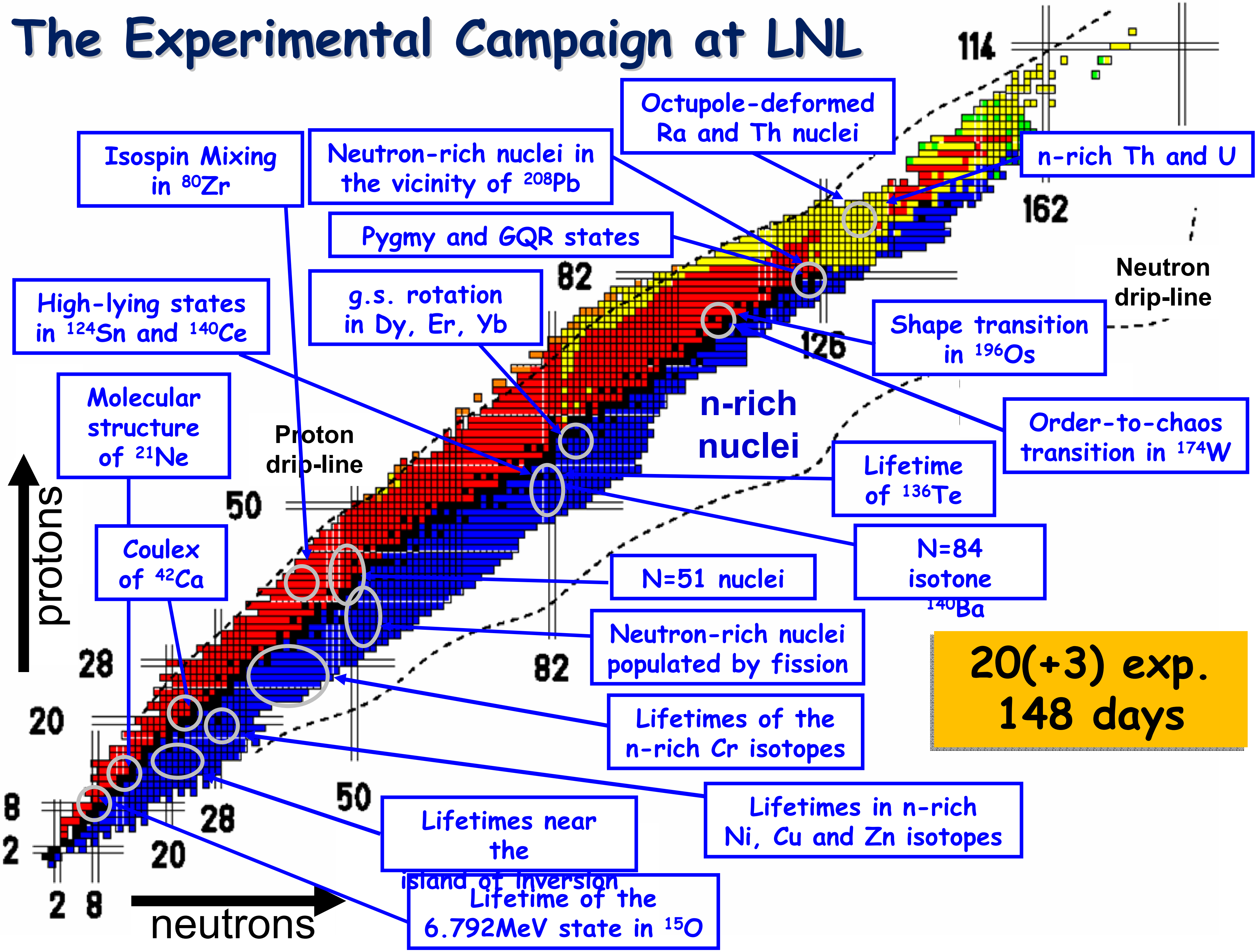
6 different rates x 4 trapezoid risetime x 6 blr length



Two independent sources of dead-time: pile-up rejector and GTS

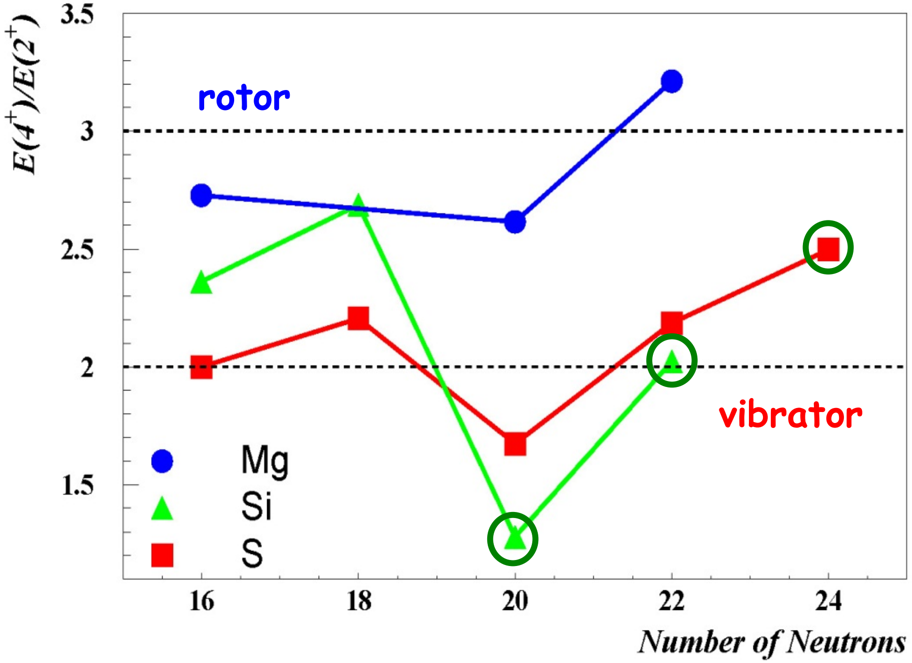
F.Recchia

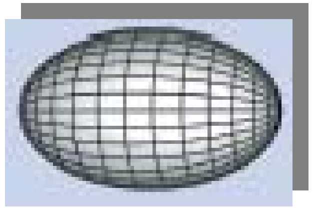
The Experimental Campaign at LNL

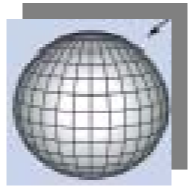


20(+3) exp.
148 days

Around the island of inversion

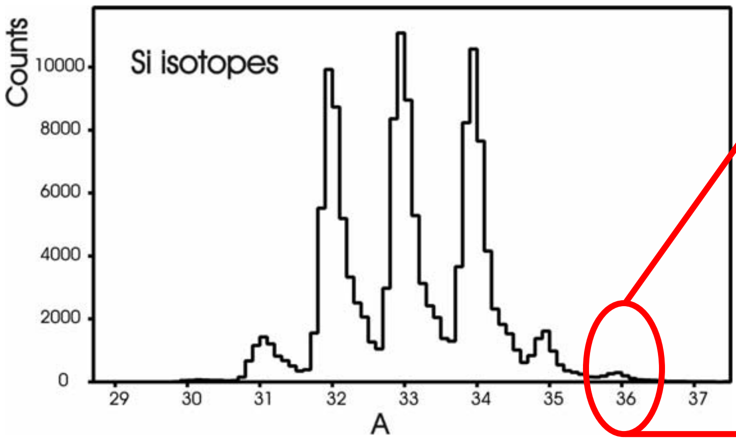


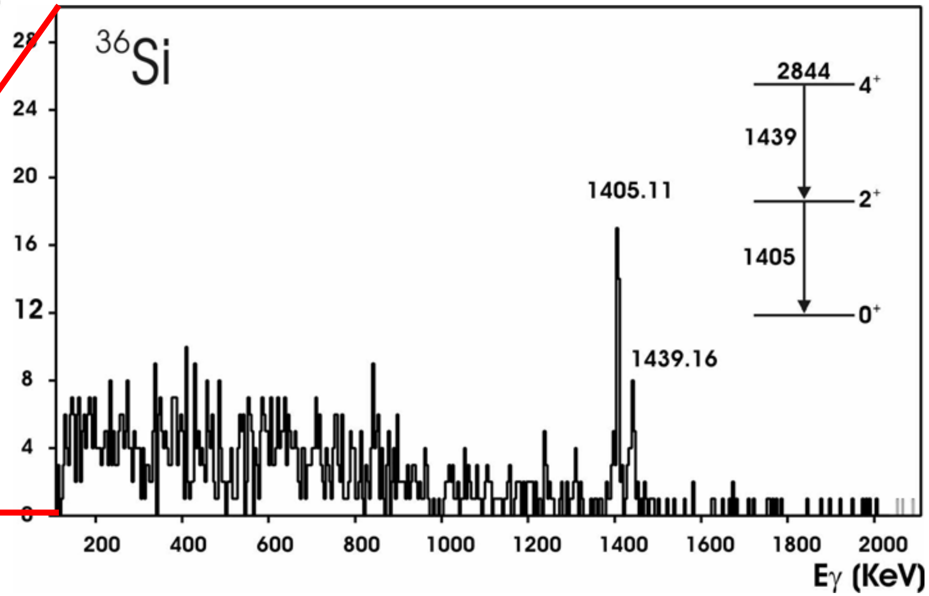




Transition from harmonic vibrator to rotor between Si and Mg at N=22?

X. Liang et al., PRC 74, 014311 (2006)

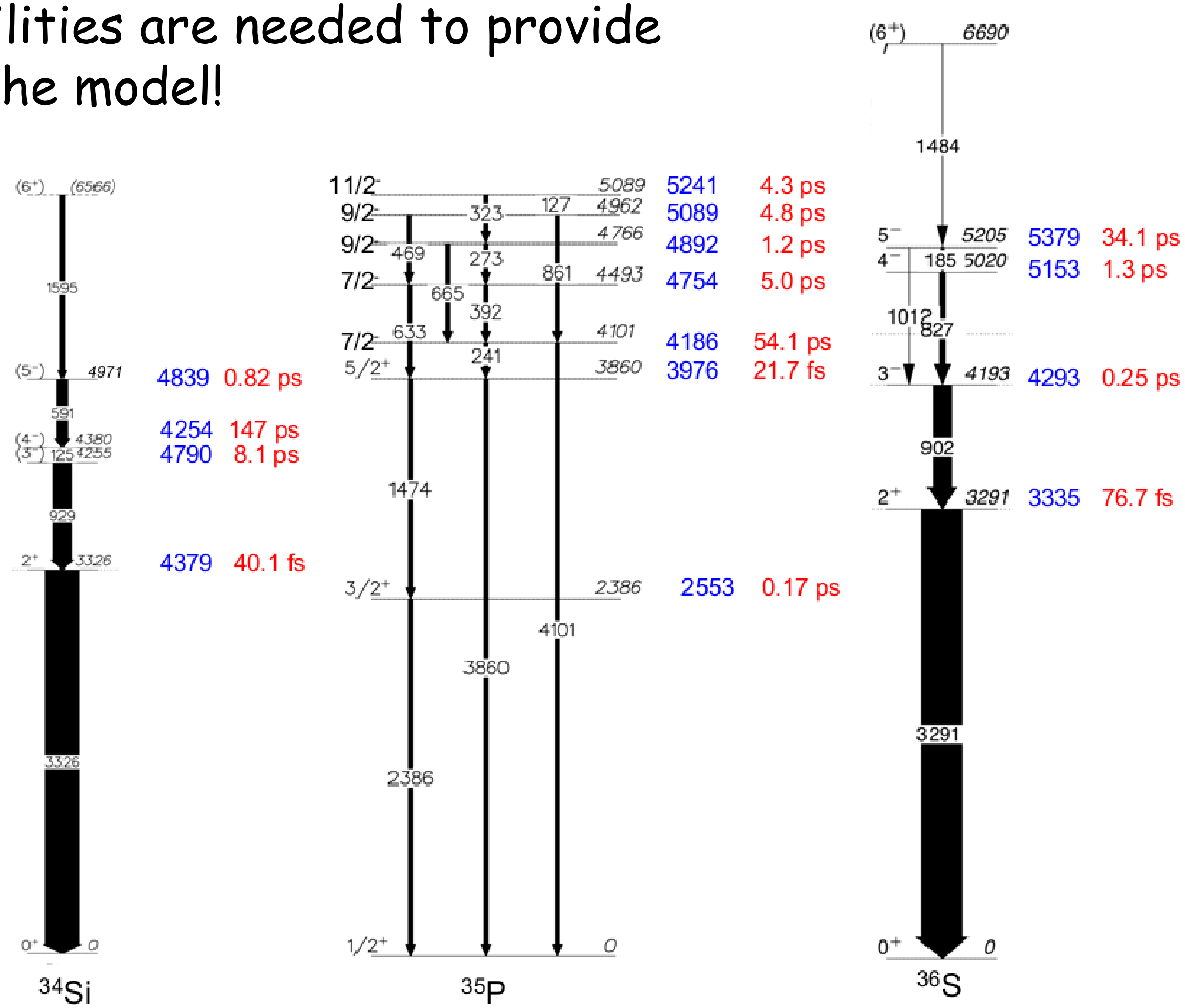




Around the island of inversion

Shell model calculations (Antoine+PSDPF) reproduce fairly the observed level energies (CLARA-PRISMA data), transition probabilities are needed to provide more stringent test of the model!

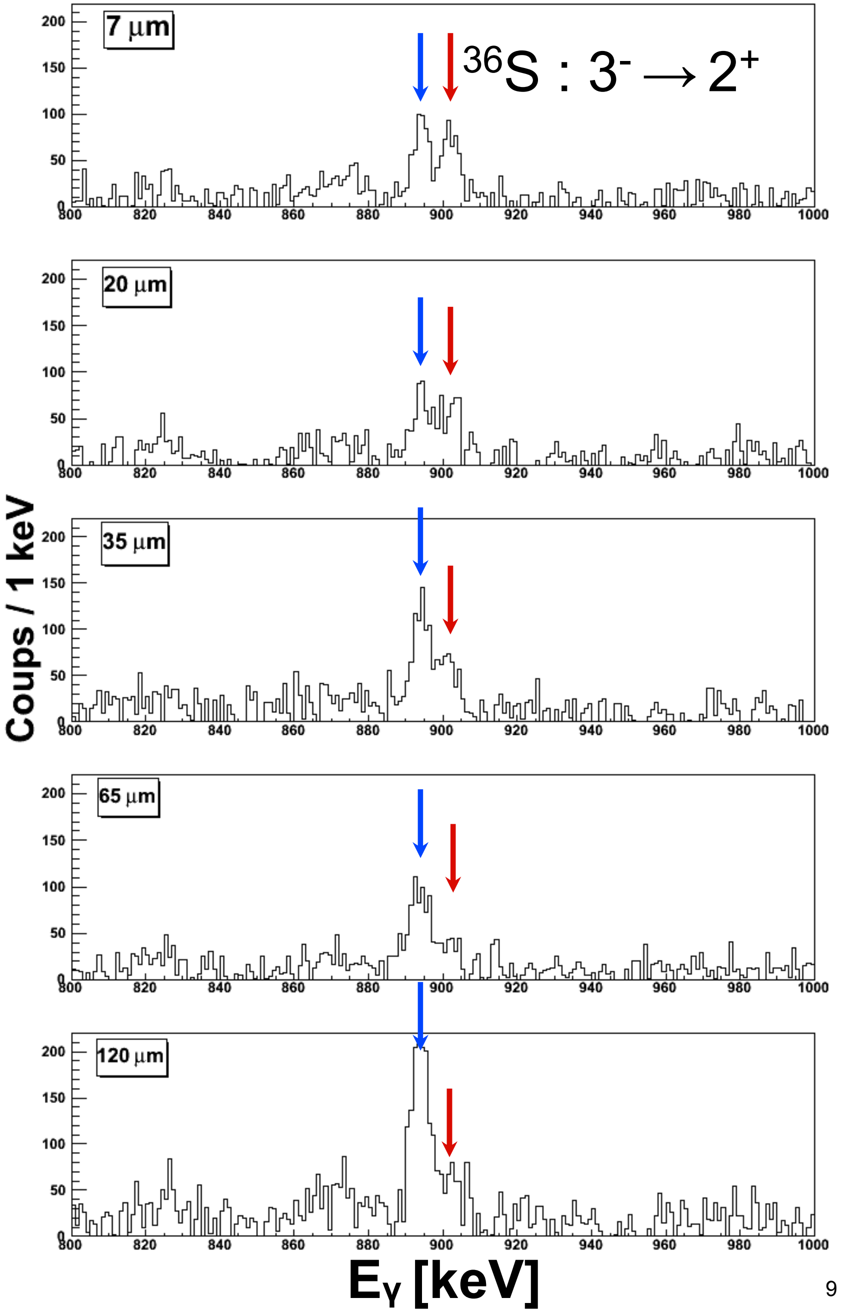
AGATA+PRISMA
+plunger experiment
$^{36}S+^{208}Pb$



Preliminary γ spectra

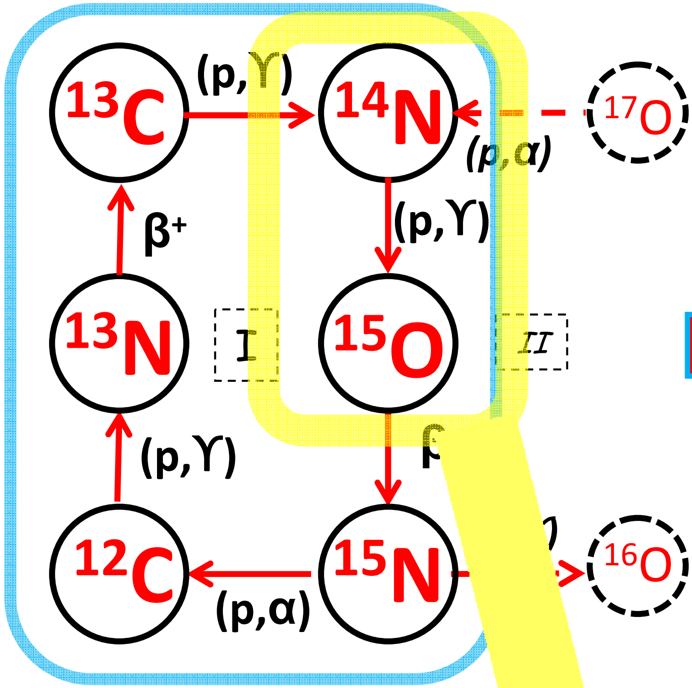
^{36}S

$3^- \rightarrow 2^+$ 902 keV transition
Predicted lifetime: 0.25 ps



A.Goasduff

Stellar burning rates and $^{14}N(p,\gamma)^{15}O$ reaction



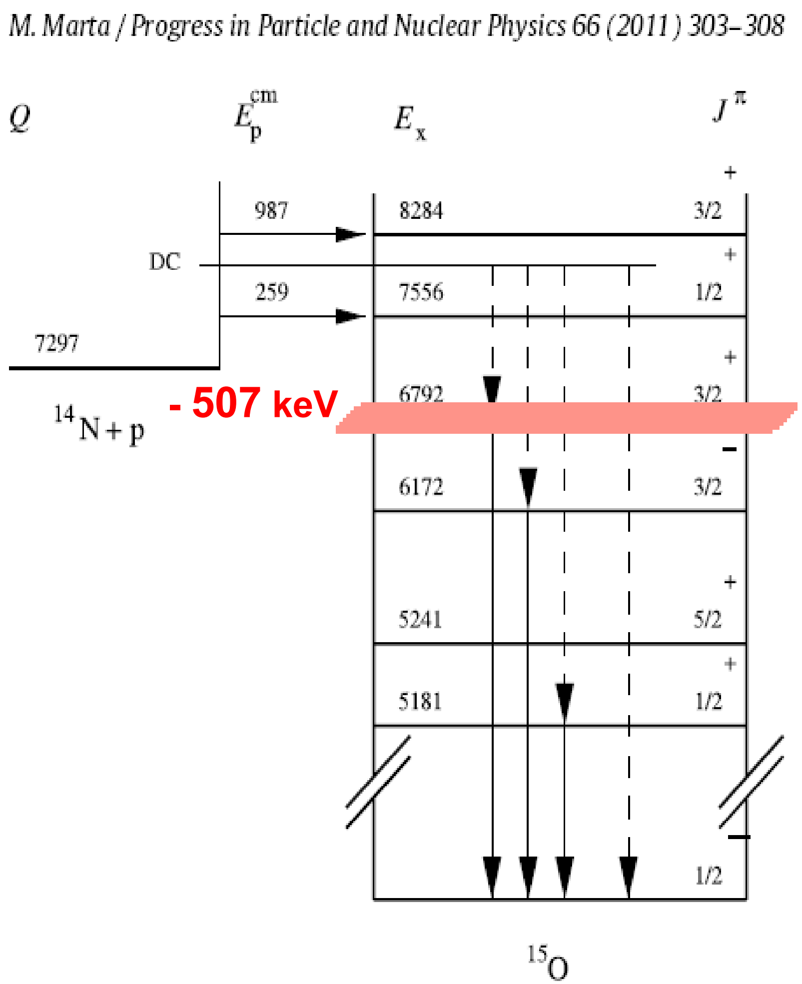
$^{14}N(p,\gamma)^{15}O$ is the "bottle neck" determining the overall rate

Precise knowledge of nuclear x-sections

C,N abundances in the solar core can be obtained by measuring the neutrino fluxes [W.C.Haxton et al., As.J.687(2008)678]

possible solution for the "solar composition problem" [A.M.Serenelli et al., As.J.Lett. 705, L123-L127 (2009)]

$^{14}N(p,\gamma)^{15}O$ reaction cross section



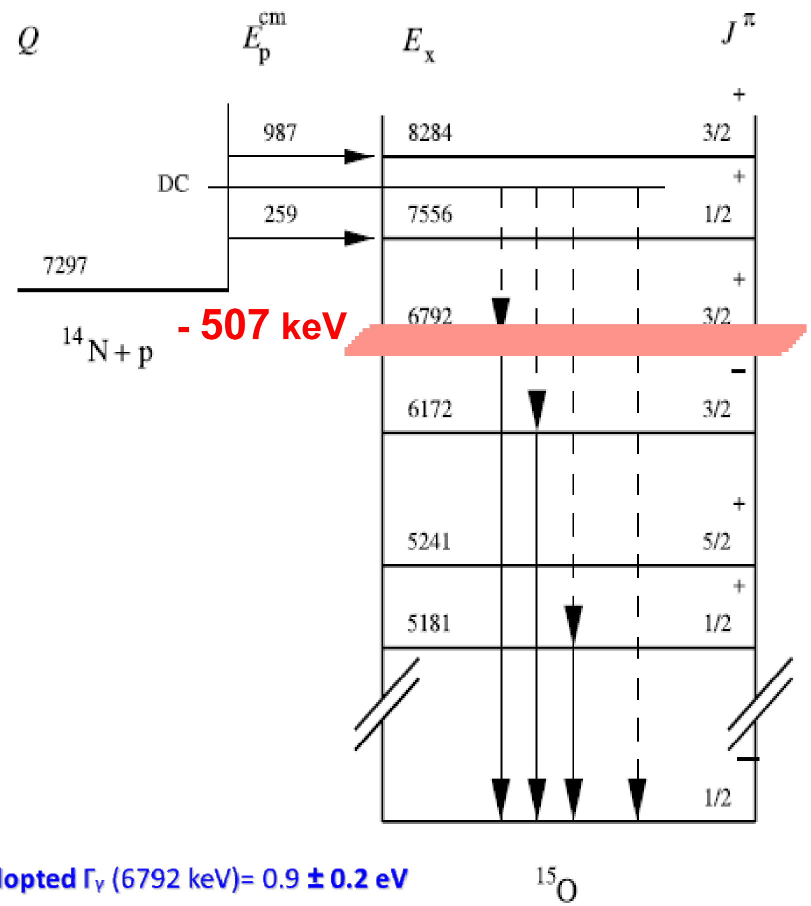
Captures to different excited states in ^{15}O contribute to the x-section. The one to the gs in ^{15}O is dominated by the tail of the sub-threshold resonance at -507 keV

(6.79 MeV state in ^{15}O)

[C.Angulo et al., NP A690 (2001) 755, M.Marta et al., PR C78 (2008) 022802(R), ….]

$^{14}N(p,\gamma)^{15}O$ reaction cross section

M. Marta / Progress in Particle and Nuclear Physics 66 (2011) 303–308

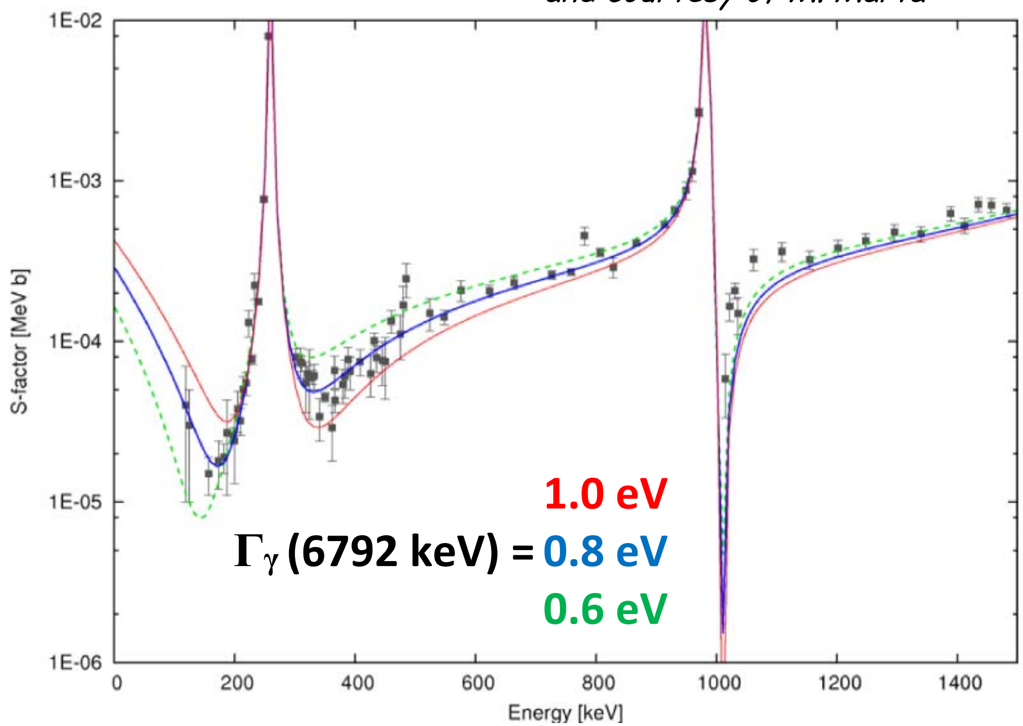


Adopted Γ_γ (6792 keV)= 0.9 ± 0.2 eV

$S_{GS}(0)$ = 0.20 ± 0.05 keV·b

M. Marta et al., Phys. Rev. C 78, 022802(R) (2008)

H.P. Trautvetter et al., JPG 35 (2008) 014019
and courtesy of M. Marta

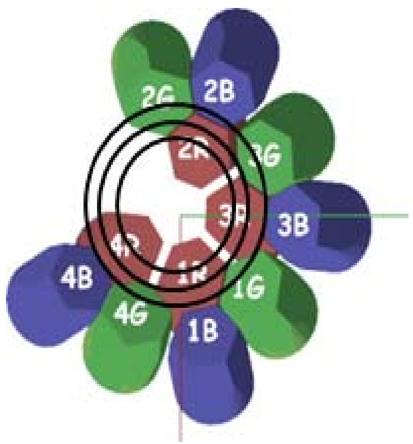


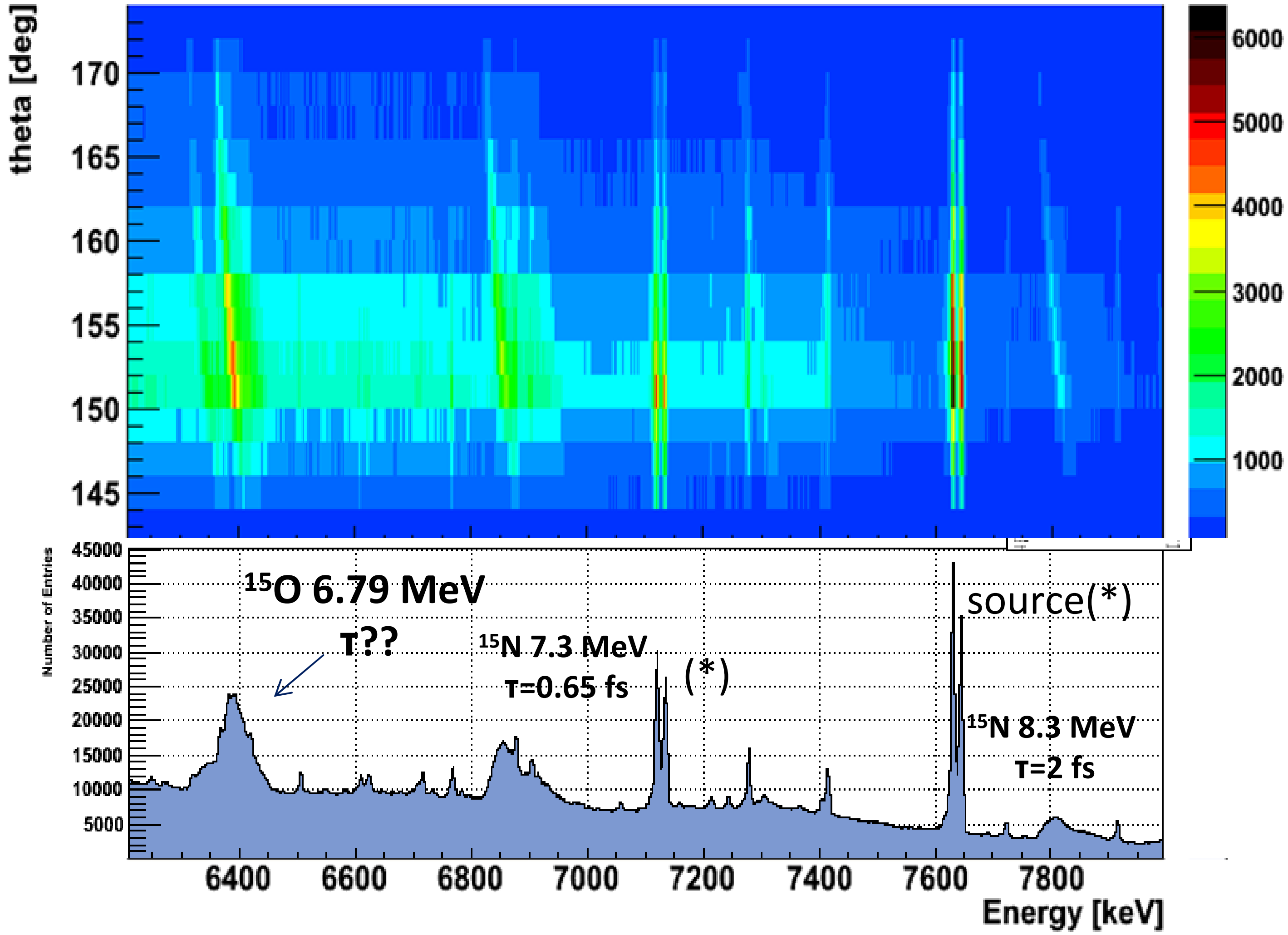
change of ≈20% in $\Gamma=\hbar/\tau$ → change of ≈30% in $S_{gs}(0)$

Lifetime measurement of the 6.79 MeV state in ^{15}O

$^{14}N(^{2}H,n)^{15}O$ and $^{14}N(^{2}H,p)^{15}N$ reactions @ 32 MeV (XTU LNL Tandem)

Direct lifetime measurement with 4 ATCs at backward angles (close to the beam-line)





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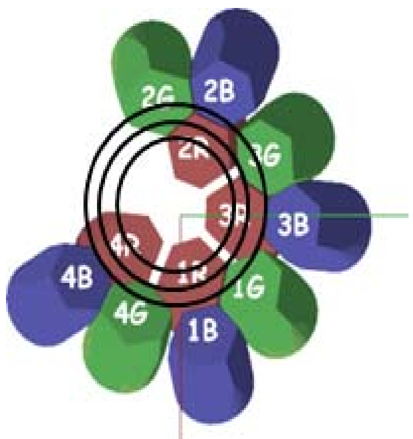
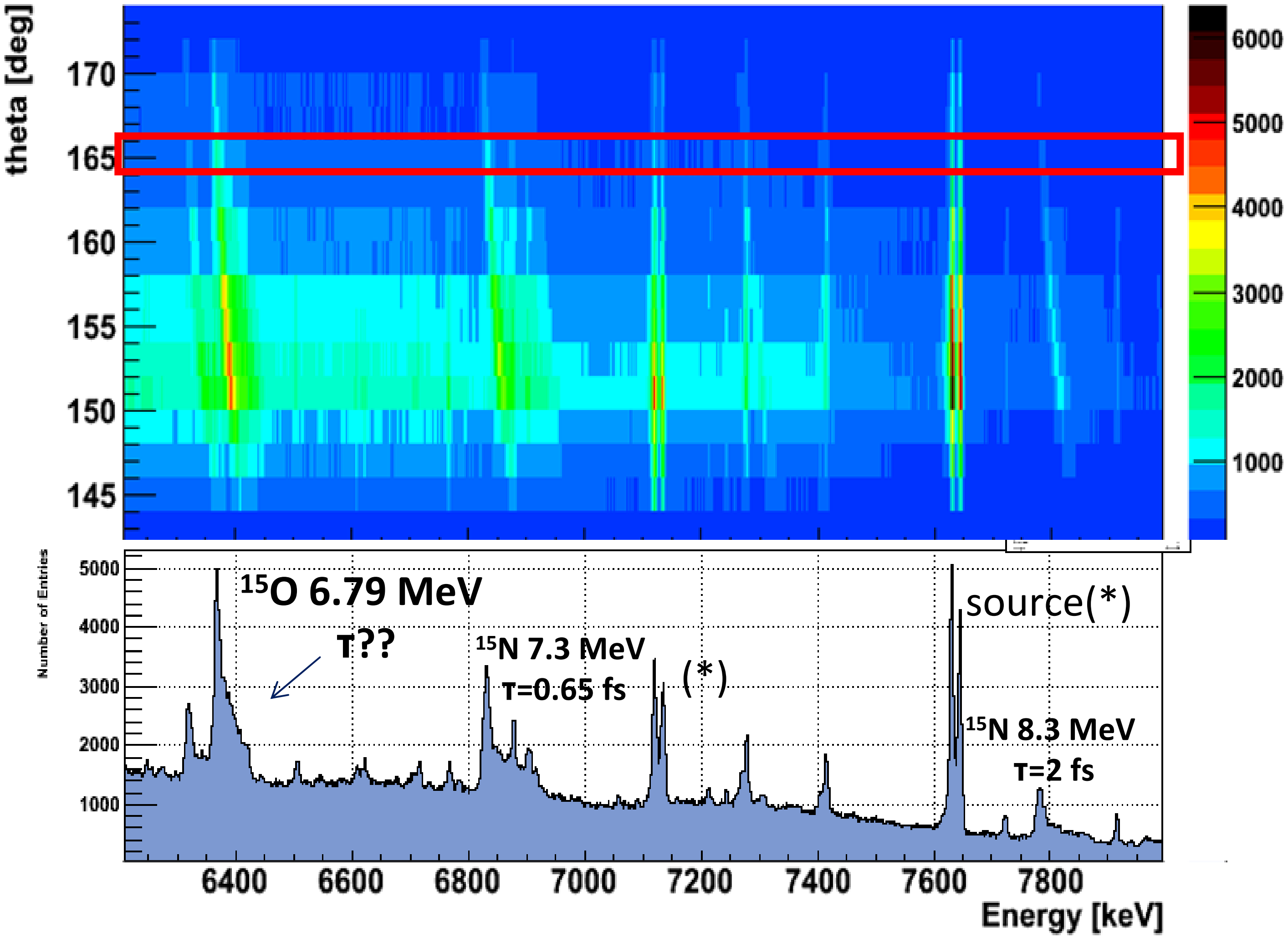


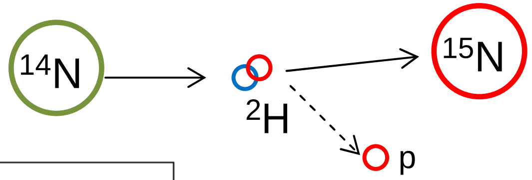
Detected gamma-rays can be sorted in few degrees θ "slices" with a continuous distribution



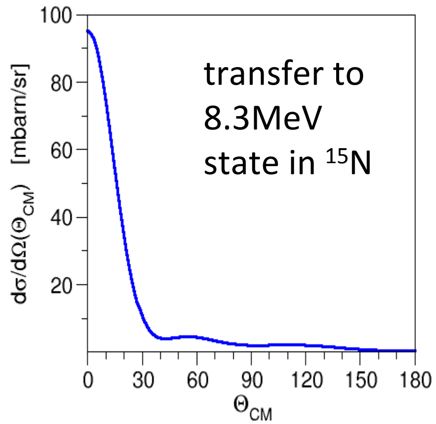
C.Michelagnoli

Reaction kinematics

Due to the short lifetimes, the lineshapes strongly reflect the reaction kinematics. Both ^{15}O and ^{15}N excited levels are mainly populated *via* nucleon (proton and neutron, respectively) transfer reactions

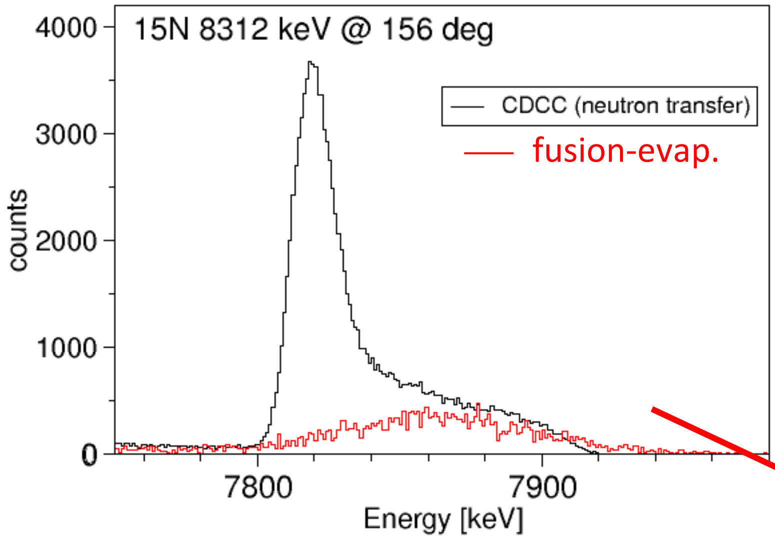


center of mass x-section

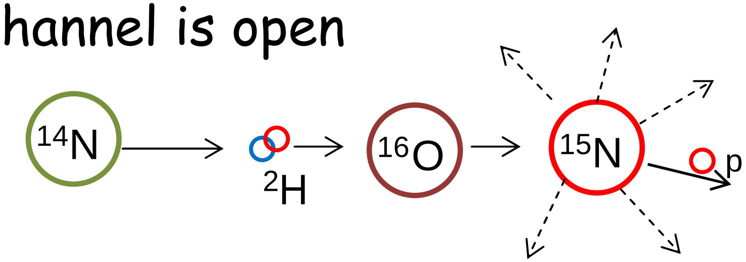


CDCC calculations of the nucleon transfer process by N. Keeley**

***Continuum-Discretized Coupled Channels*



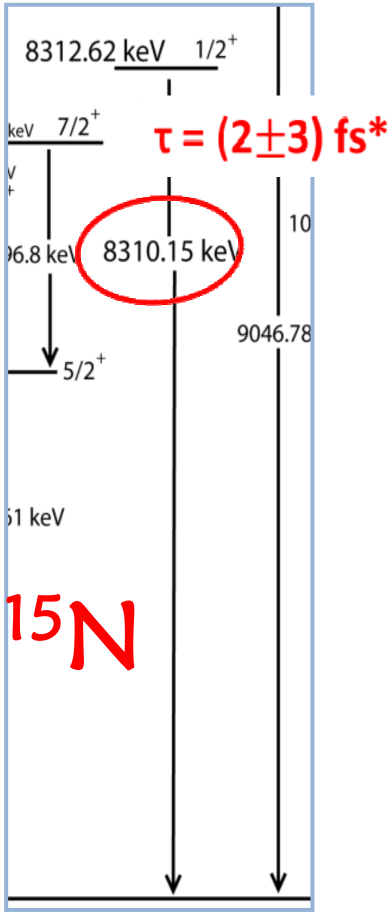
but also the fusion-evaporation channel is open

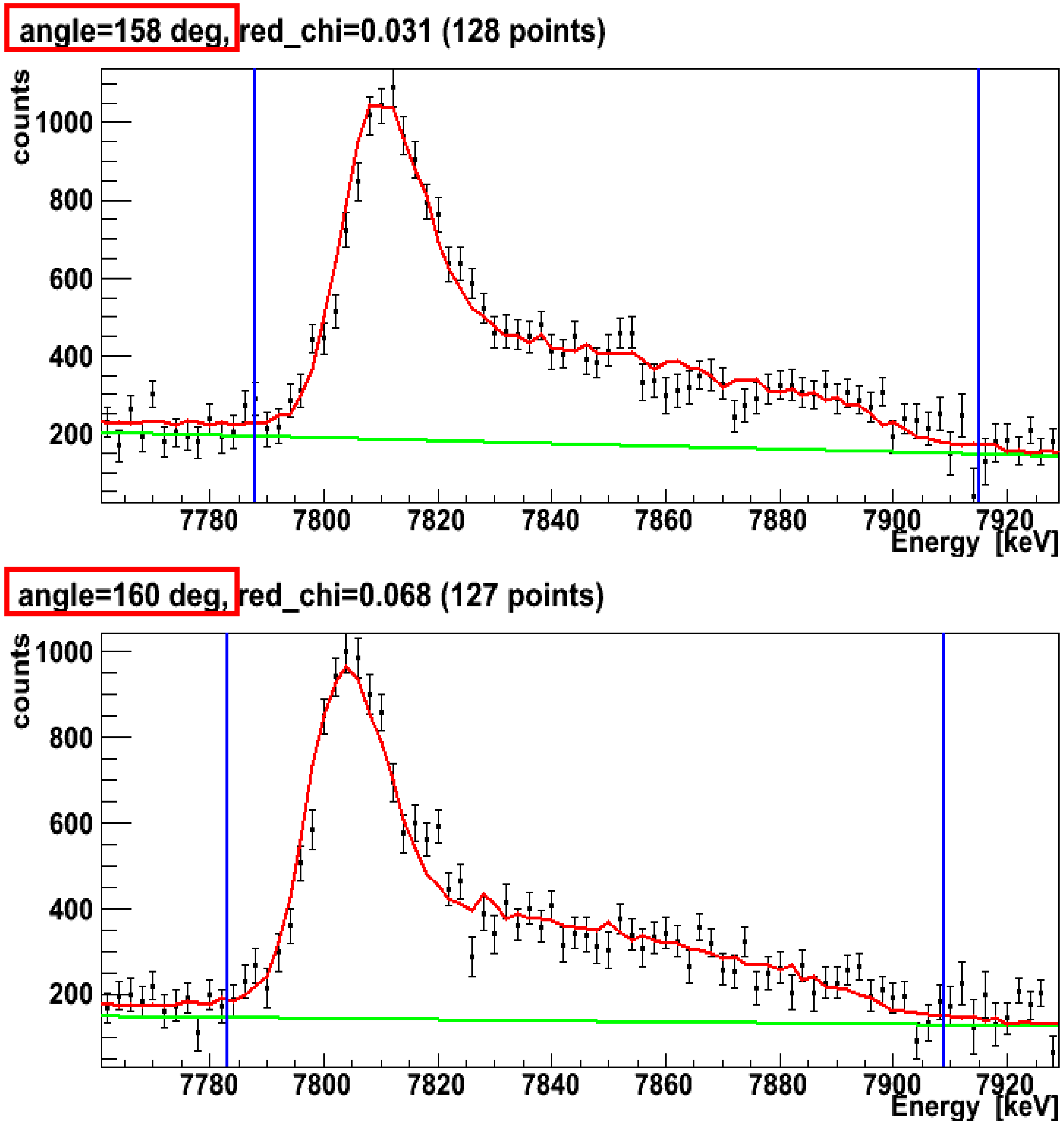


ratio between the two different mechanism and (energy) spectrum of the evaporated particle

not much help in the literature....

The 8.31MeV level in ^{15}N

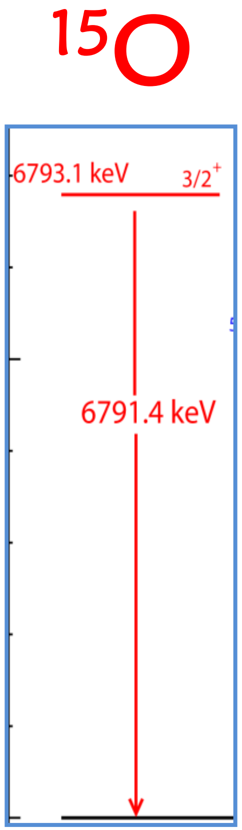


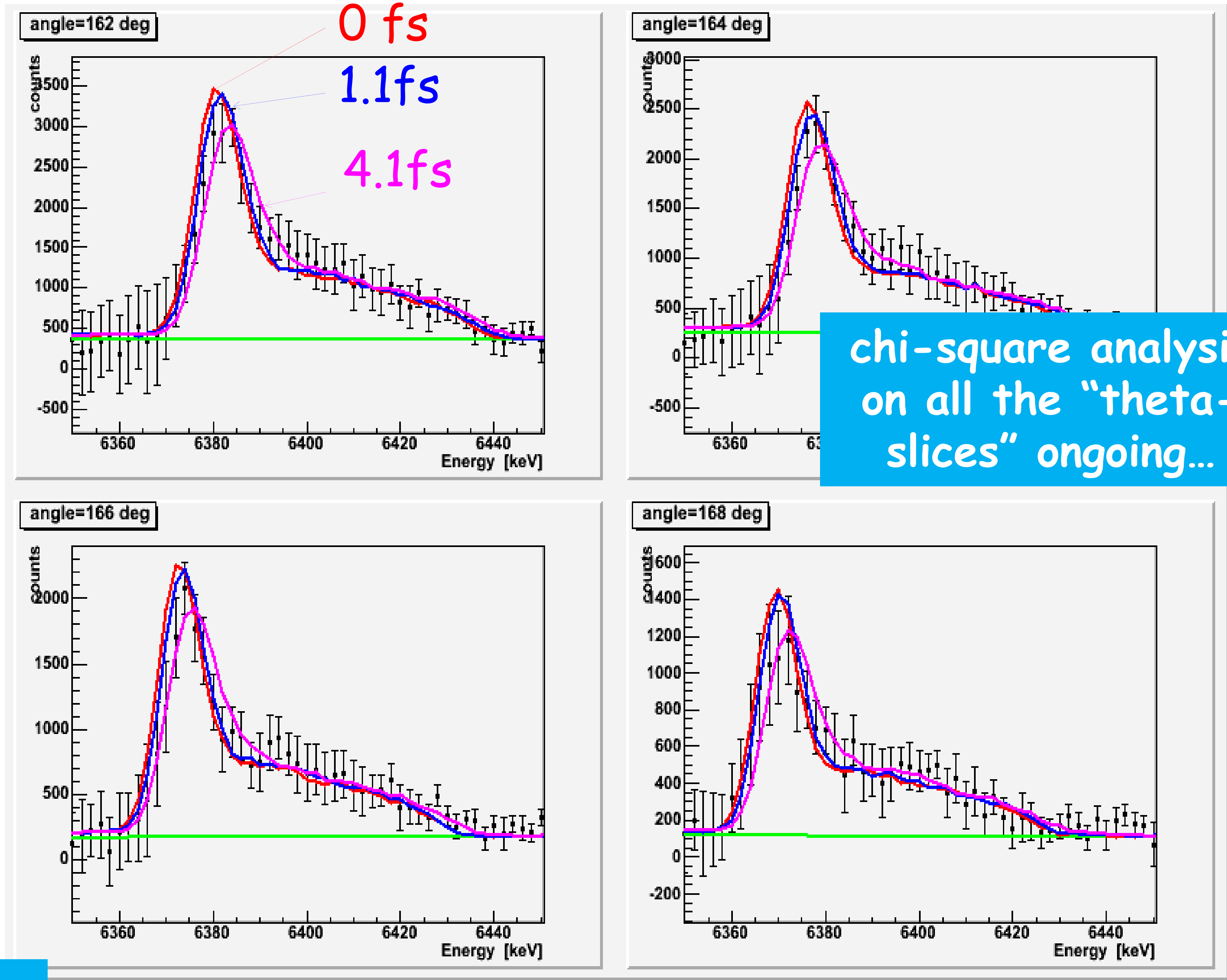


(*from Γ=(0.3±0.2) eV

[R. Moreh et al., PRC 23 (1981) 988])

The 6.79MeV level in ^{15}O





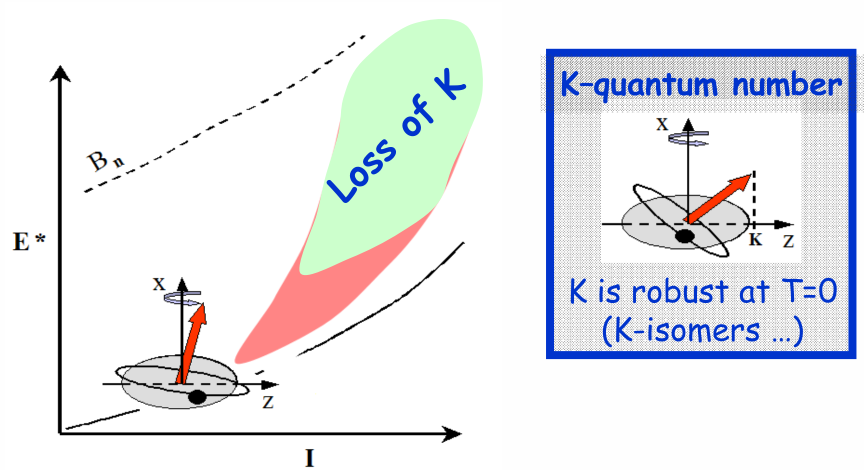
chi-square analysis on all the "theta-slices" ongoing…

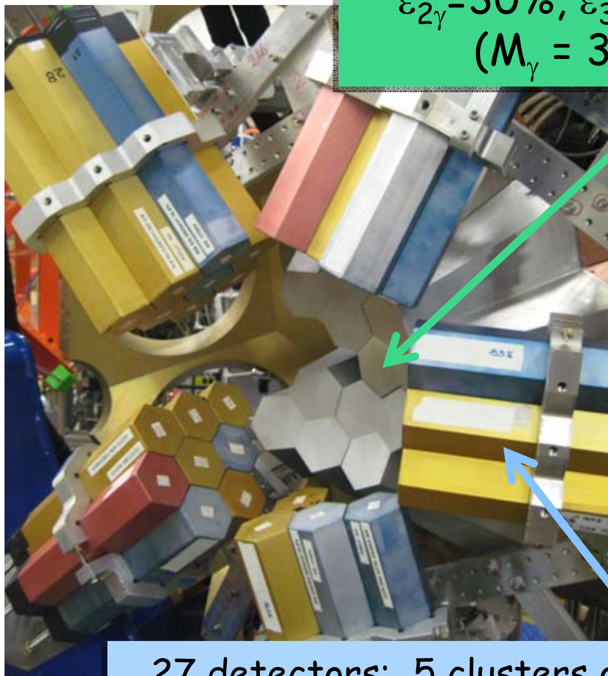
C.Michelagnoli

Order-to-chaos in ^{174}W

High-Spin Fusion Evaporation
^{50}Ti on ^{128}Te @ 217 MeV, $I \geq 60\hbar$

Loss of selection rules on K with temperature





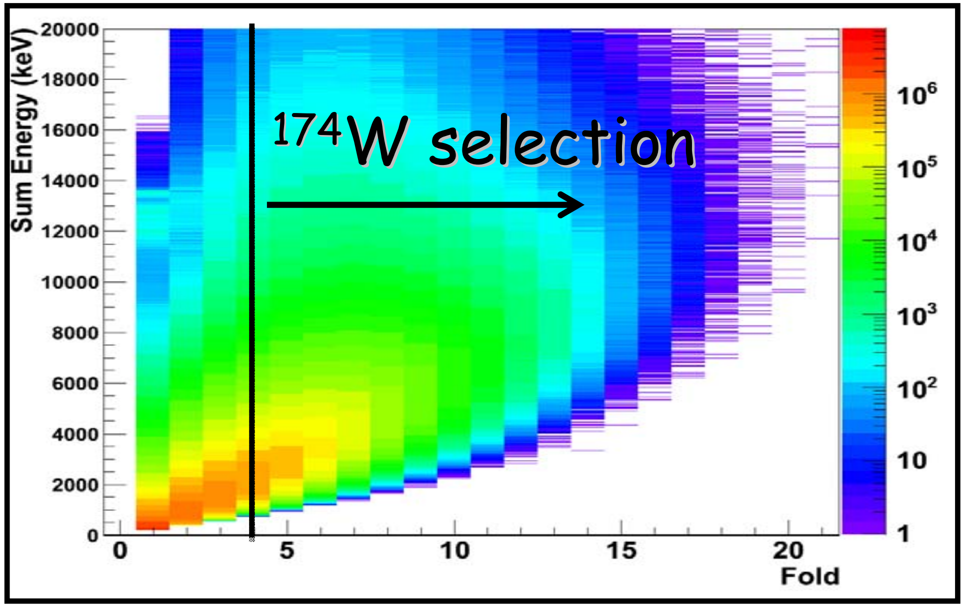
4 Triple Clusters
2 and 3 folds:
$\varepsilon_{2\gamma}$=30%, $\varepsilon_{3\gamma}$=10%
(M_γ = 30)

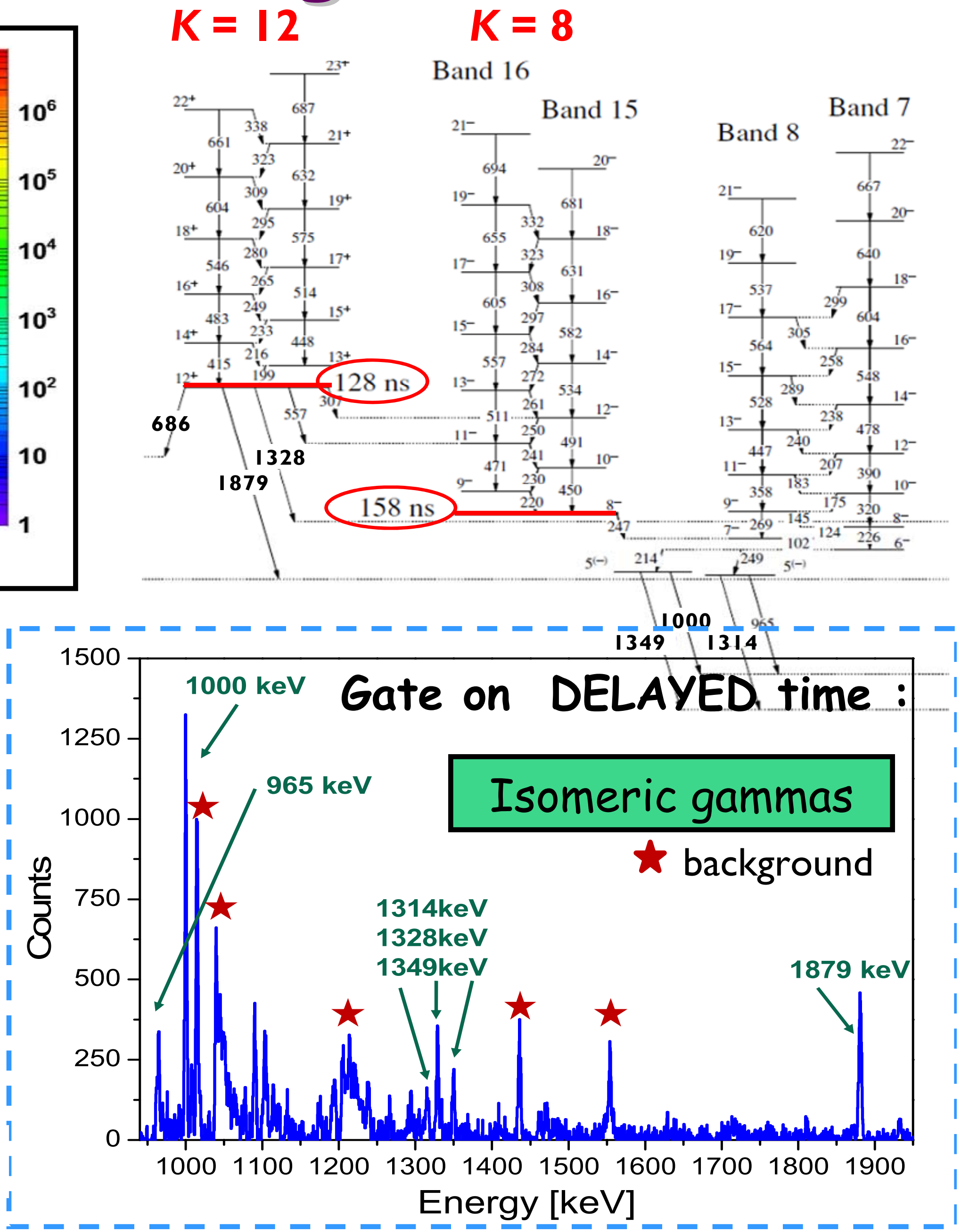
27 detectors: 5 clusters of BaF_2
(3"×3", exagonal)
Total solid angle: 25% of 4π
Total efficiency: 16% @ 500keV

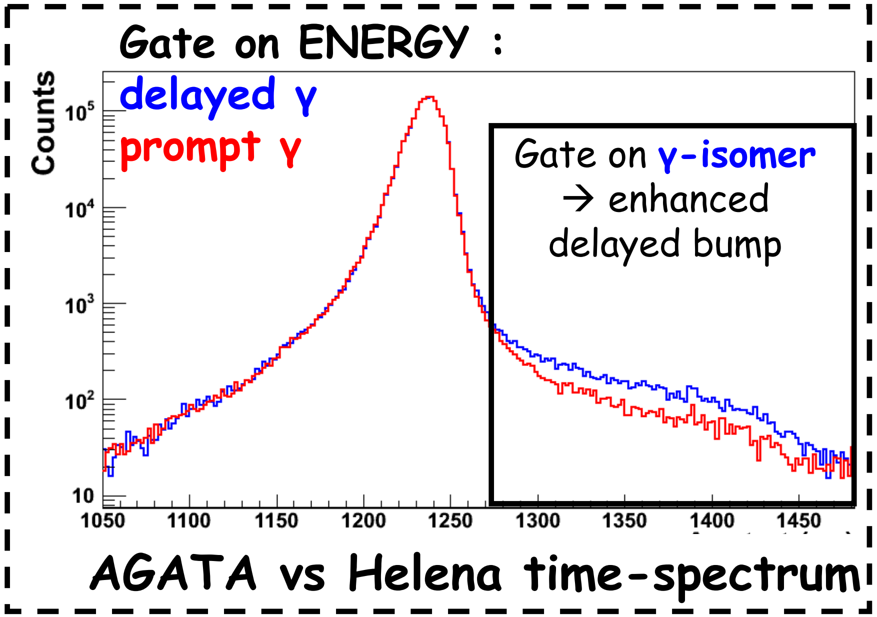
Goal: populate ^{174}W at the **highest possible spins** (≥60ħ), in order to make the **statistical fluctuation analysis of the ridge-valley structures in the γ-γ matrices**, to estimate the number of low-*K* and high-*K* bands and their correlation

V.Vandone

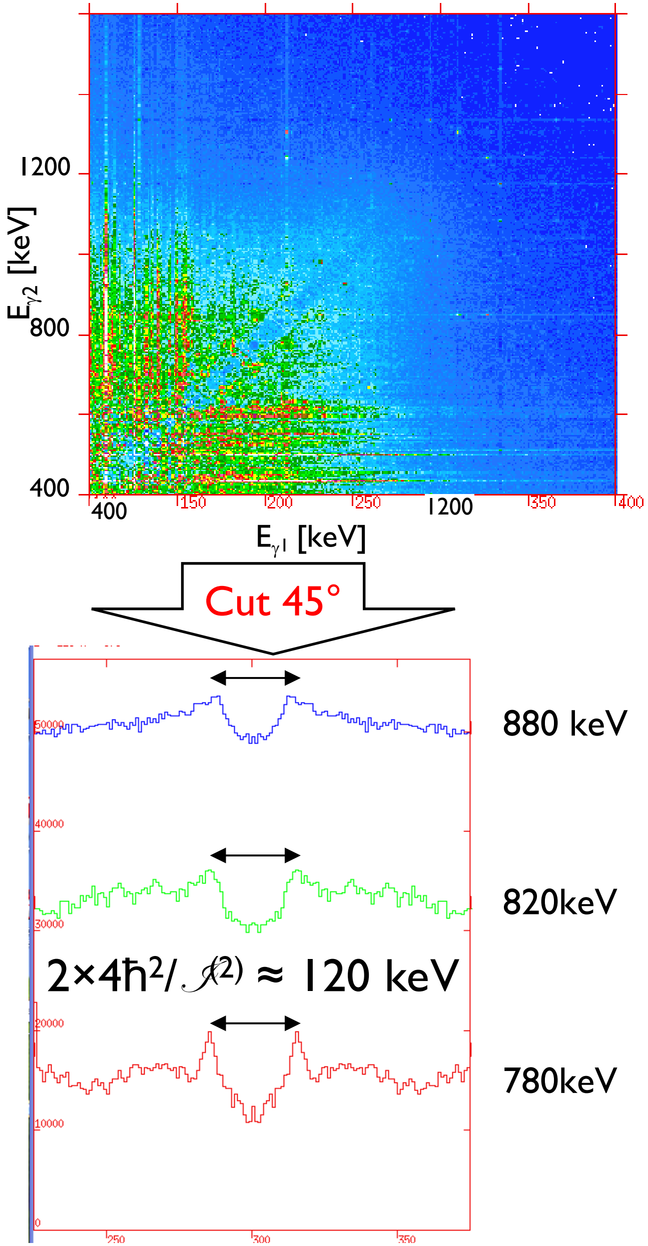
Helena: selection of high-K bands





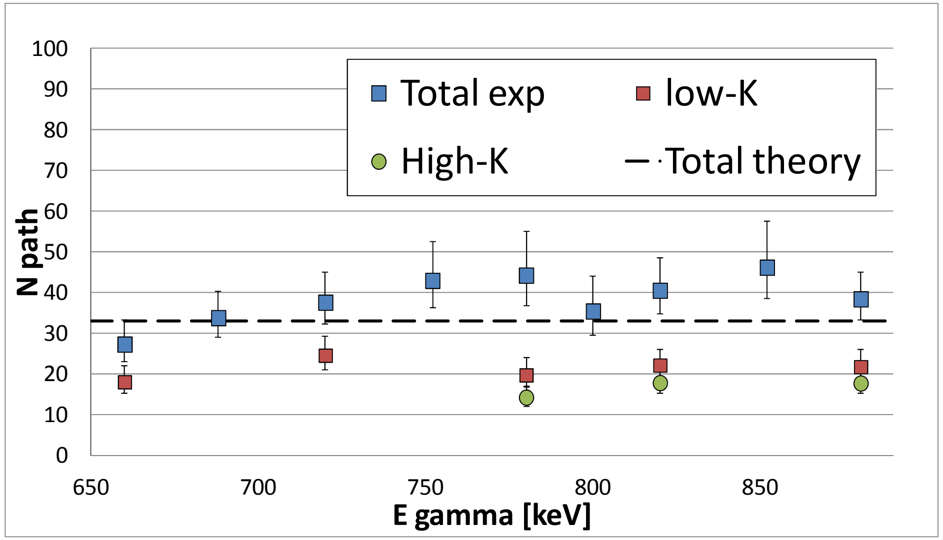


Quasi-Continuum γ-γ matrices



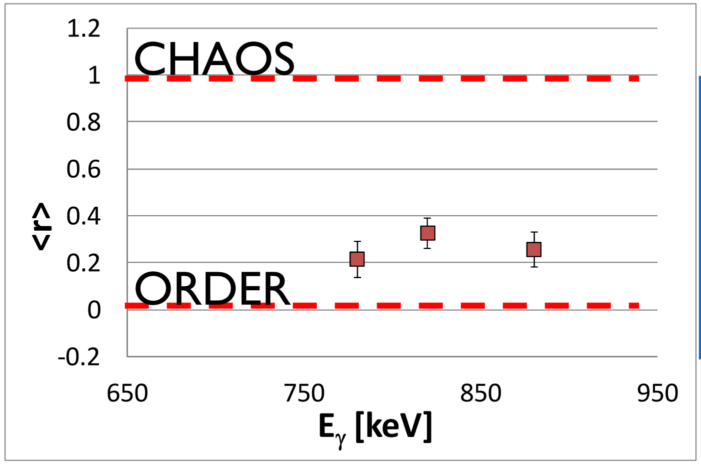
Statistical fluctuaction analysis of ridges:

Number of bands below 1 MeV



Covariance analysis of ridges

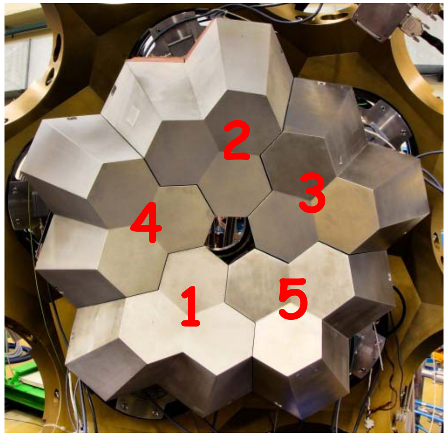
Covariance = similarity of different cascades & test of the **selection** rules

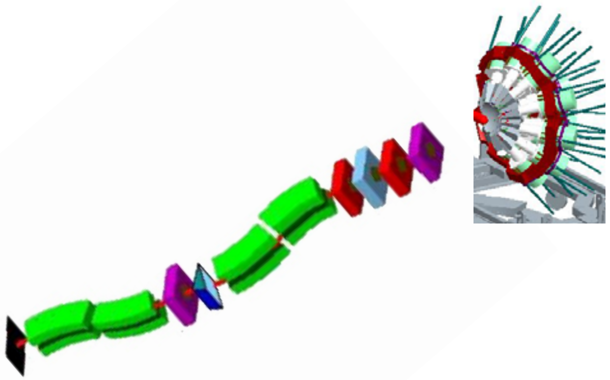


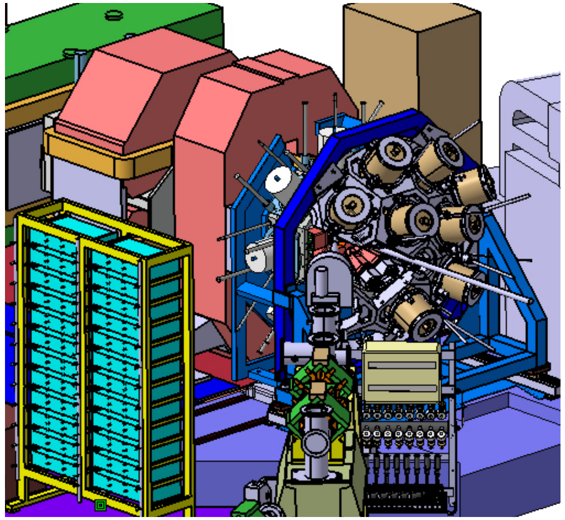
K quantum number is conserved up to 1 MeV

AGATA Demonstrator/1π Experimental Program

2010-2011 → LNL 5TC	2012 → GSI/FRS ≥5DC+5TC	2014 → GANIL/SPIRAL2 ~15TC

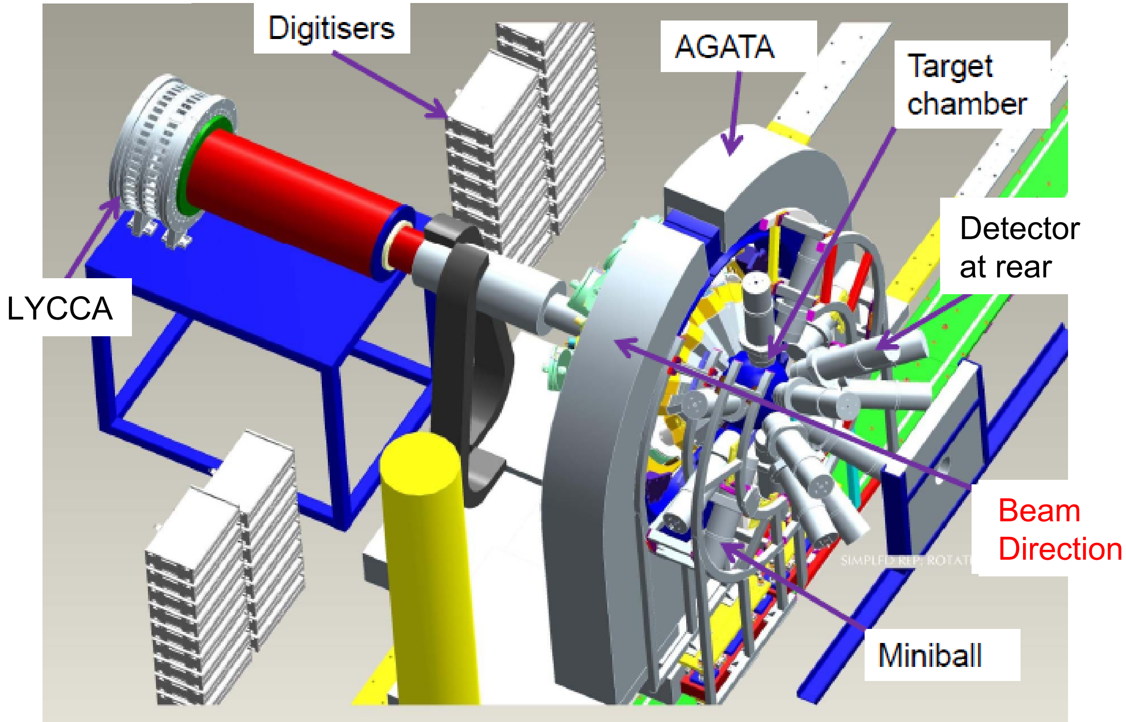






AGATA D.+PRISMA	AGATA @ FRS	AGATA + VAMOS + EXOGAM
Total Eff. ~6%	Total Eff. > 10%	Total Eff. > 20%

AGATA at PreSPEC



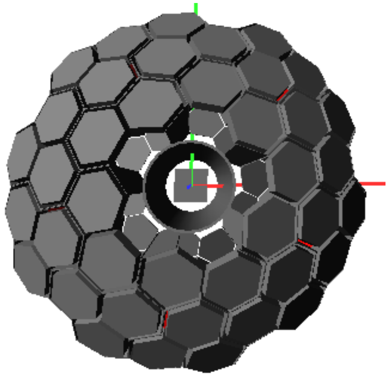
γ-efficiency = 17.5%
$\gamma\gamma$-efficiency = 2.5%

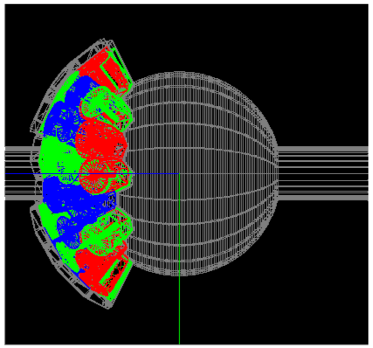
resolution (FWHM)	intrinsic spatial resolution
8.5 keV	5 mm
4 keV	2 mm

Aim for AGATA@GSI:

- **5 double Cluster**
  10 triple Cluster
- ***AGATA + Miniball***

start spring 2013





beam pipe diameter = 12cm
chamber diameter = 46 cm

Outlook

- Following the commissioning campaign, the physics campaign has started in February 2010
- Performance of the array is satisfactory, in close coupling with several ancillary devices
- Analysis of the experiments performed so far is ongoing, more results soon
- Good luck to the GSI colleagues with the upcoming AGATA@PreSPEC campaign!