EGAN 2012 Workshop

June 25th-27th, 2012 - Orsay France

Isospin Mixing in the N=Z Nucleus ^{80}Zr at Medium Temperature

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Isospin Mixing in ^{80}Zr

The Ground State of most of nuclei has Isospin $I=I_z=(N-Z)/2$

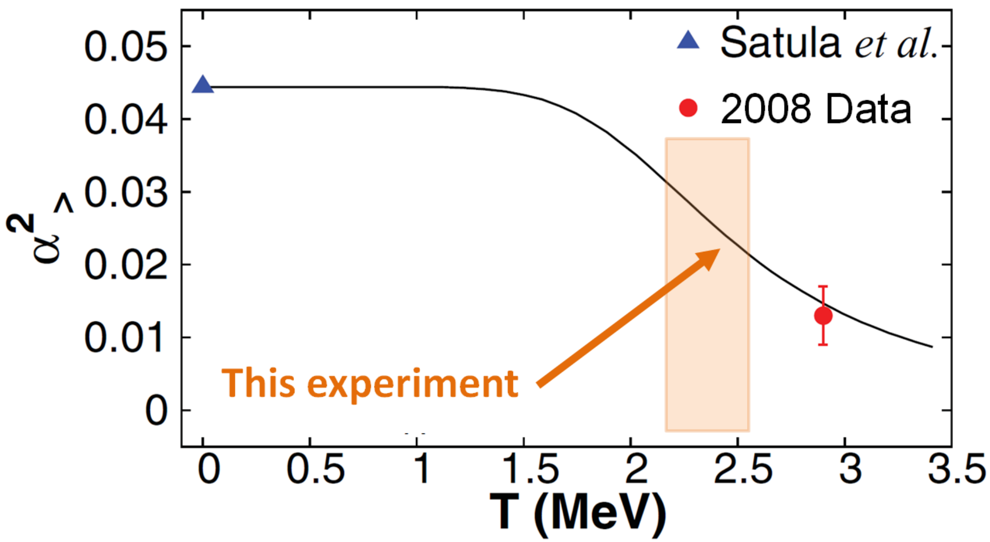
Isospin: **almost good quantum number**

Isospin symmetry in nuclei **is broken by Coulomb interaction**

GDR is a tool to measure the isospin mixing

Measure of the Isospin mixing in ^{80}Zr at T=2.4MeV

It is a follow up of a GARFIELD-HECTOR experiment (T = 3 MeV)



The measure of isospin mixing in the same system at two T will be a test of theoretical model.

Our objectives:

- measure the temperature dependence of isospin mixing in ^{80}Zr
- extract the value of Isospin mixing at zero temperature
- validate the theoretical calculations to extract the T=0 mixing value from the T≠0 one
- measure the Coulomb Spreading Width

H.L. Harney et al rev. Mod. Phys. 58(1986)607 - M.N. Harakeh et al. Phys. Lett. B 176(1986)297 - A.Behr et al. Phys. Rev. Lett. 70(1993)3201 – A. Corsi et al. Phys. Rev. C 84 (2011) 041304(R)

How we measure Isospin mixing

I=0 Compound Nucleus obtained by heavy ions fusion reaction

$^{40}Ca + ^{40}Ca \longrightarrow ^{80}Zr^*$ $E^* = 54$ MeV

γ-ray yield from the decay of the GDR built on the CN

I=0 to I=0 E1 transition are **forbidden**

I=0 to I=1 E1 transition are **allowed**

less I=1 state available by GDR decay in respect to I=0 states

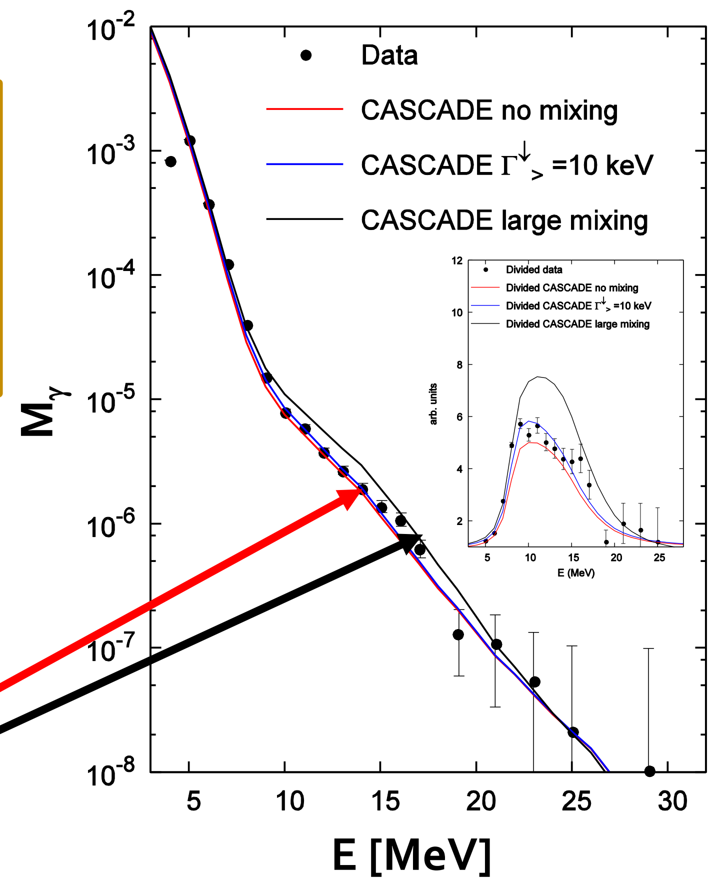
This results in a strong inhibition of the first step GDR γ-decay

Coulomb interaction mixes I=0 states with I=1 states

Two extreme scenarios

No Mixing → strong inhibition of the γ-decay

Full Mixing → no inhibition of the γ-decay



From the results of mixing at **finite T** we obtain the value of Isospin mixing a **T=0 MeV**

Experimental set up

Two symmetric fusion evaporation reactions: $^{40}Ca + ^{40}Ca = ^{80}Zr$ & $^{37}Cl + ^{44}Ca = ^{81}Rb$

projectile	target	CN	E_{beam}(MeV)	E*(MeV)	I_z
^{37}Cl	^{44}Ca	^{81}Rb	95	54	7/2
^{40}Ca	^{40}Ca	^{80}Zr	136	54	0

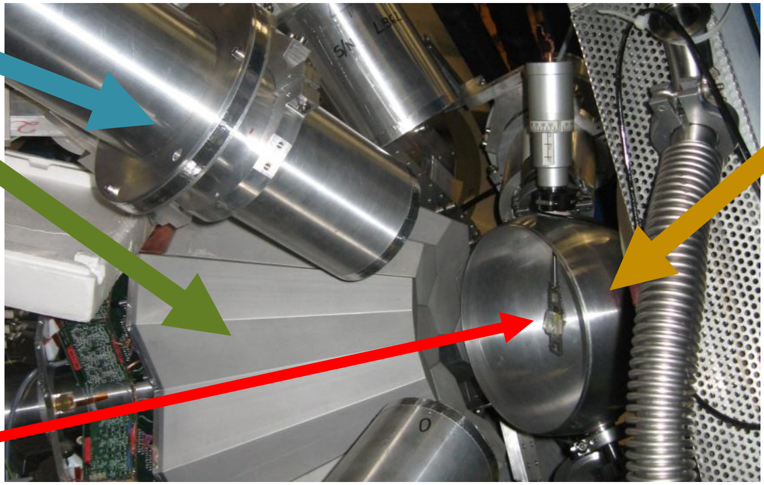
7 Large Volume $LaBr_3$:(Ce)

-High energy γ ray

-To select the evaporation residues

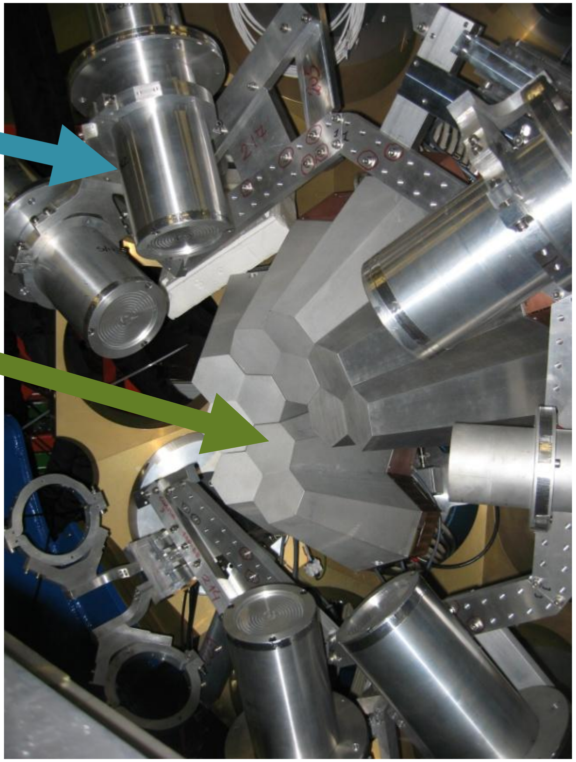
AGATA Demonstrator

-To select the evaporation residues



Reaction chamber

Beam line



Triggers and acquired events

$^{40}Ca + ^{40}Ca = ^{80}Zr$ (I = 0) Beam time: 110h
$^{37}Cl + ^{44}Ca = ^{81}Rb$ (I ≠ 0) Beam time: 70h
$^{11}B + D = ^{12}C + n + \gamma$ (Calibration) Beam time: 8h

$^{40}Ca + ^{40}Ca$ total events $7.3 \; 10^8$

Trigger	Events
AGATA & $LaBr_3$:Ce	84%
$LaBr_3$:Ce $M_\gamma \geq 2$	20%
Singles $LaBr_3$:Ce	2%
Singles AGATA	4%

$^{37}Cl + ^{44}Ca$ total events $7.5 \; 10^8$

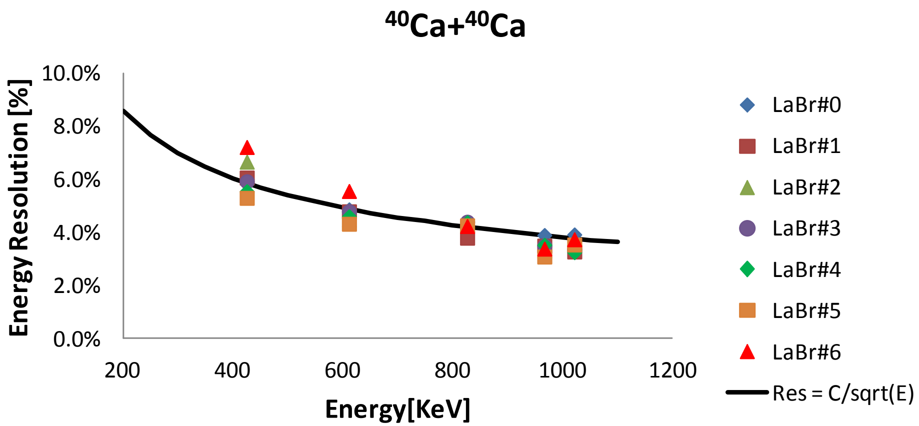
Trigger	Events
AGATA & $LaBr_3$:Ce	82%
$LaBr_3$:Ce $M_\gamma \geq 2$	21%
Singles $LaBr_3$:Ce	2%
Singles AGATA	5%

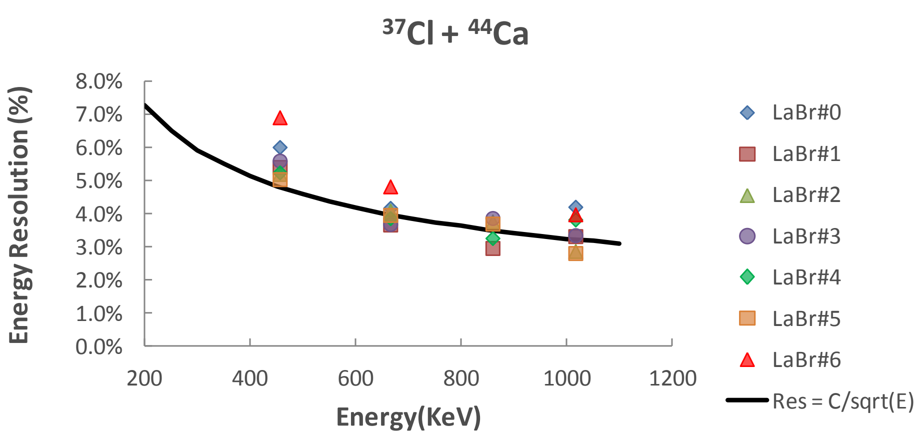
AGATA event: γ in AGATA & $LaBr_3$:Ce gated on time and energy, no single
$LaBr_3$:Ce event: two γ in $LaBr_3$:Ce gated on time and energy, no single
$LaBr_3$:Ce single event
AGATA single event

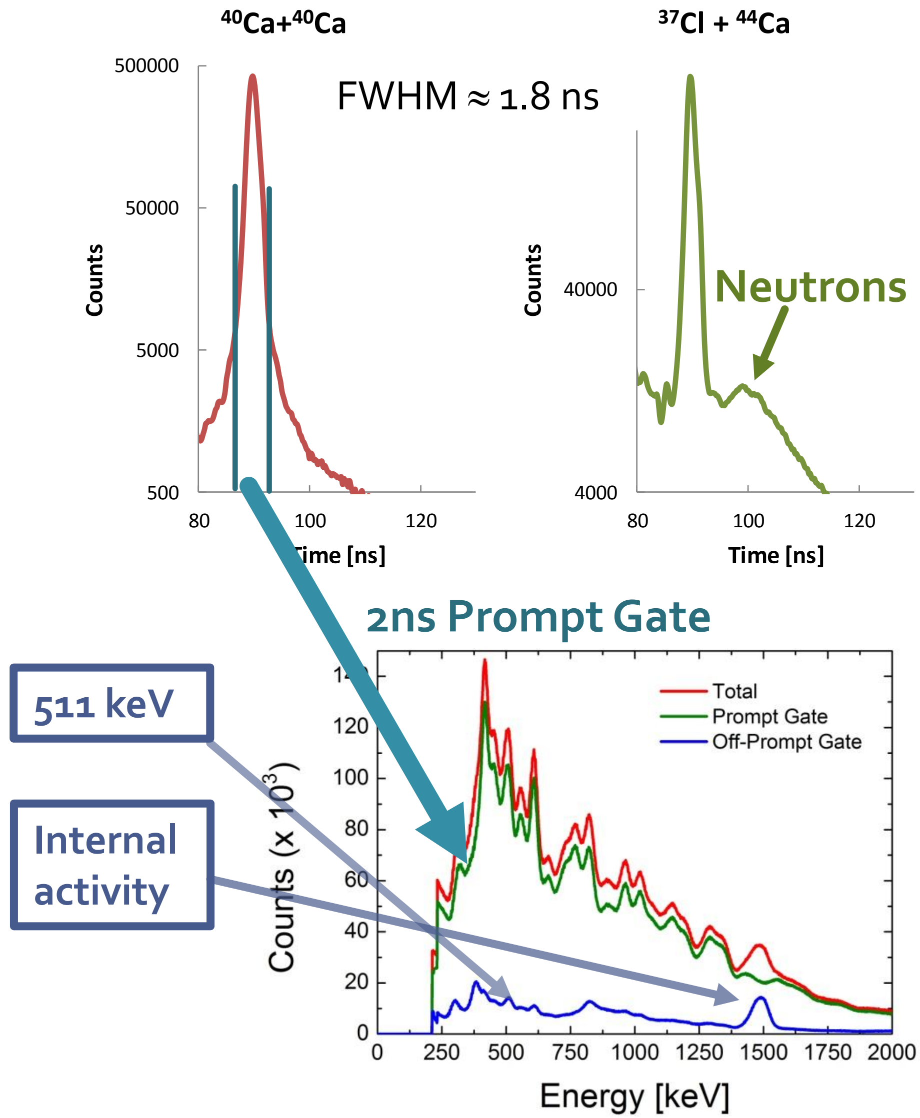
Gain of a factor 3 in statistic using AGATA coupled to $LaBr_3$:Ce, instead of AGATA stand alone

Preliminary Results: $LaBr_3$:Ce

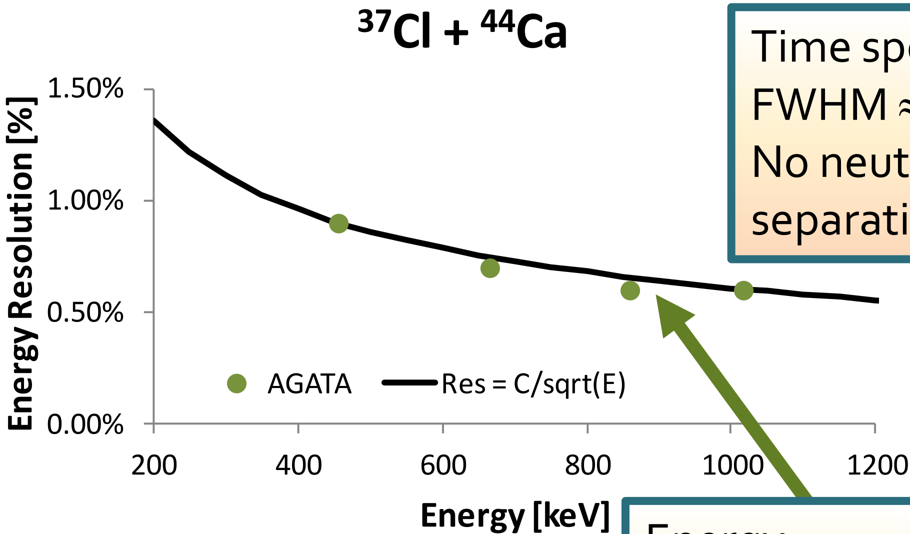
The energy resolution trend after the Doppler correction for the two reactions at low energy



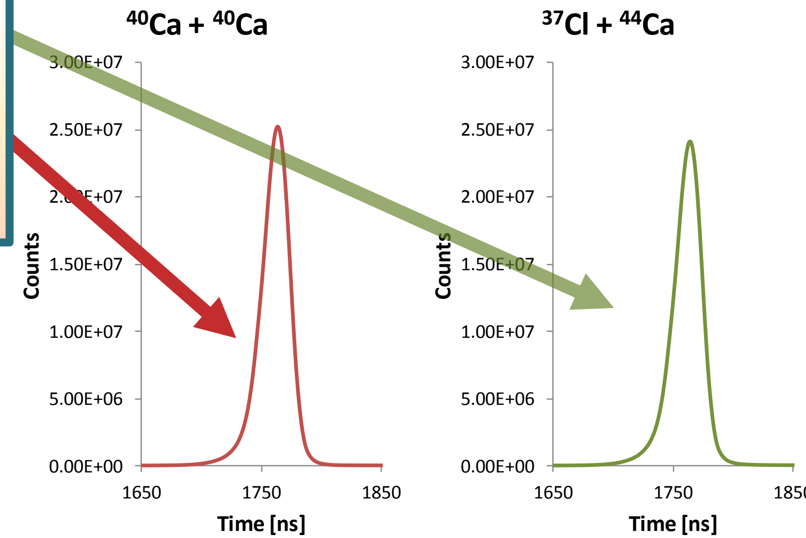




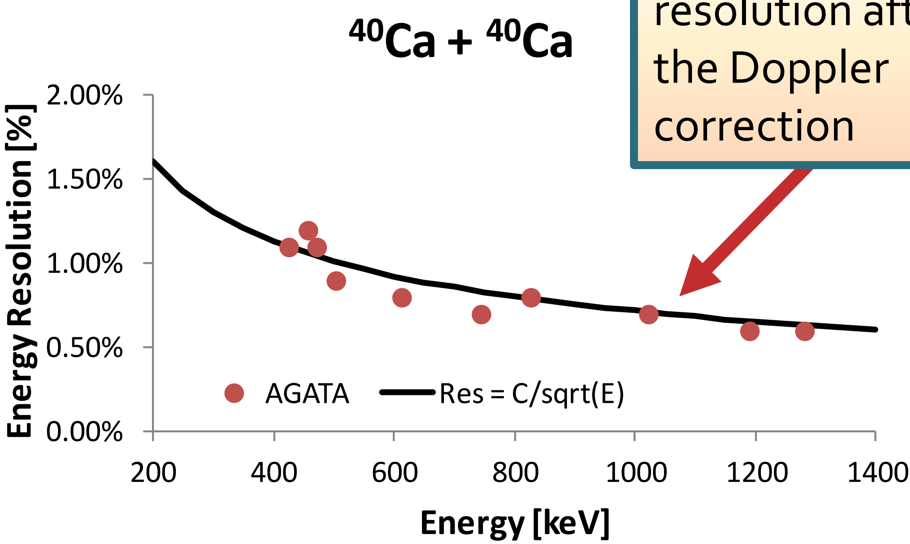
Preliminary Results: AGATA

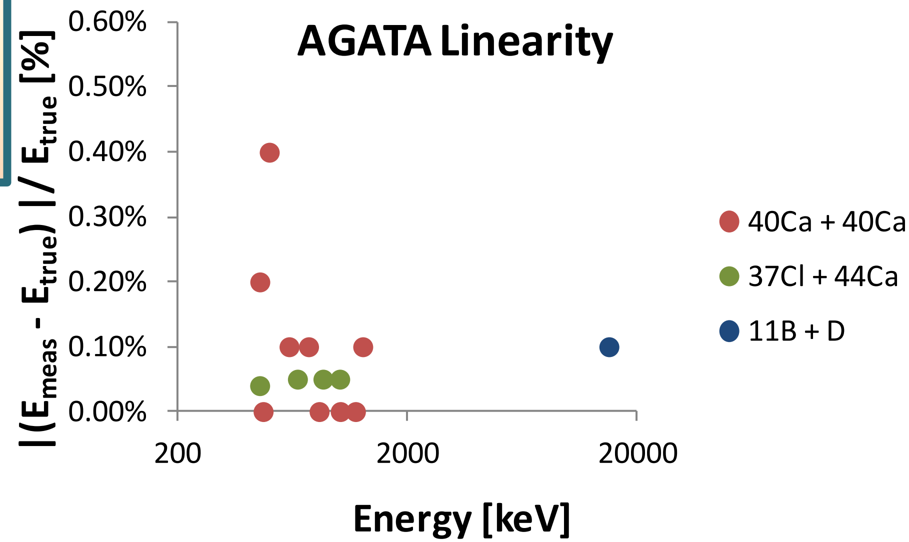


Time spectra:
FWHM ≈ 25 ns
No neutrons separation



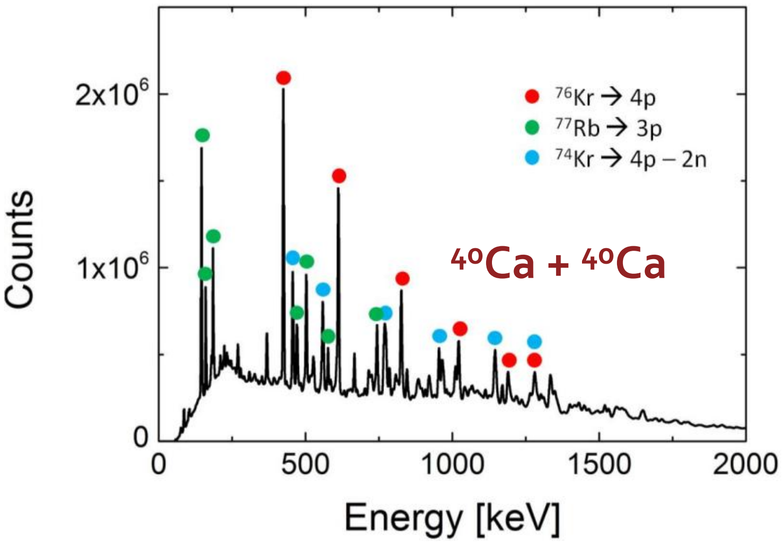
Energy resolution after the Doppler correction

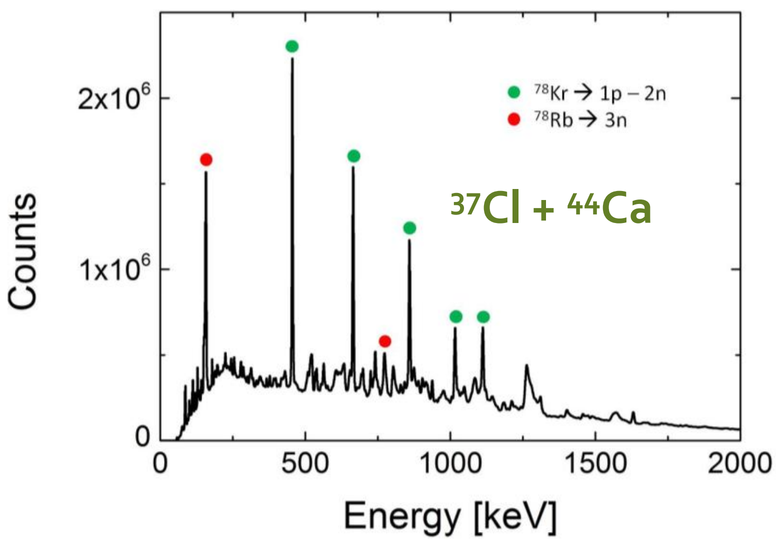




Evaporation residues in AGATA and in $LaBr_3$:Ce

AGATA





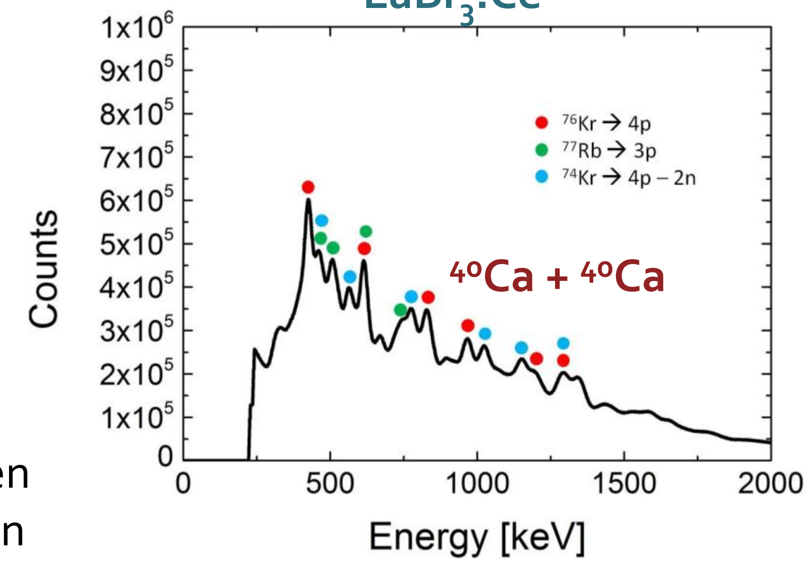
Previsions

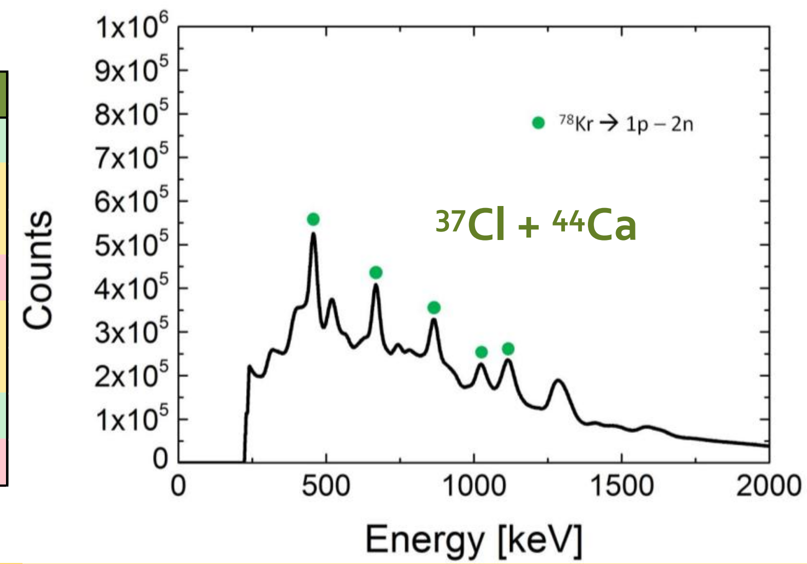
$^{40}Ca + ^{40}Ca$	
33.2%	^{76}Kr
19.1%	^{77}Rb
17.2%	^{74}Kr
13.1%	^{76}Rb
11.4%	^{73}Br
3.3%	^{70}Se
2.9%	^{77}Sr

Green: even-even
Yellow: odd-even
Pink : odd-odd

$^{37}Cl + ^{44}Ca$	
38.6%	^{78}Kr
17.2%	^{77}Kr
8.6%	^{75}Br
8.3%	^{78}Rb
7.3%	^{77}Br
6.1%	^{75}Se
4.5%	^{74}Se
4.3%	^{78}Br

$LaBr_3$:Ce

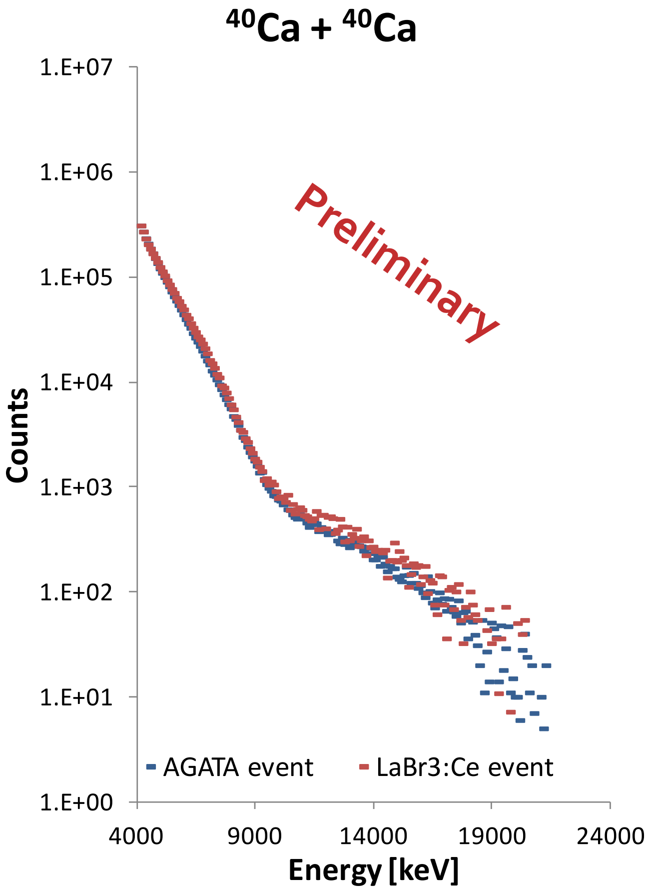




$^{40}Ca + ^{40}Ca$ high energy γ-spectra

$LaBr_3$:Ce detectors

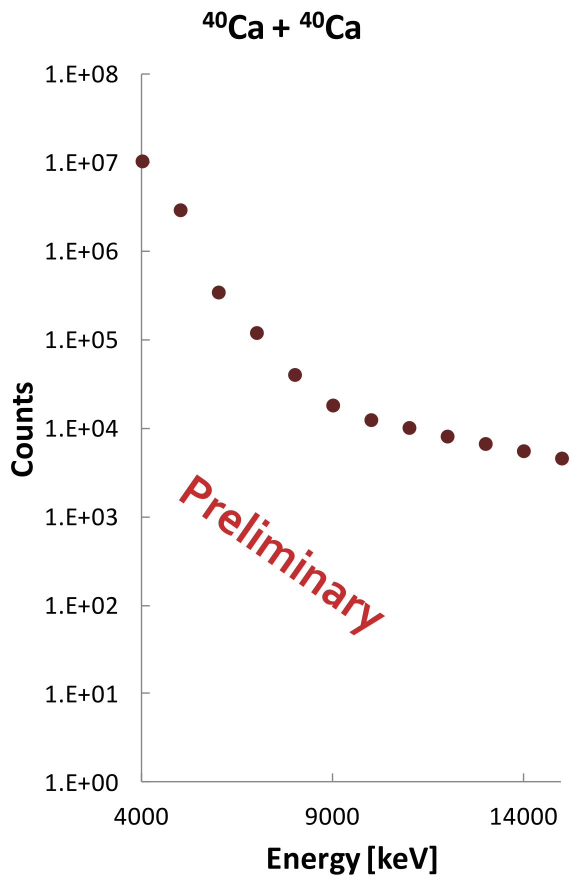
Comparison between high energy spectrum for $Labr_3$:Ce event gated on γ prompt peak (2 ns) and the same for AGATA event (gate about 30 ns)



The background subtracted spectra are obtained fitting with a constant between 20-22 MeV

AGATA demonstrator

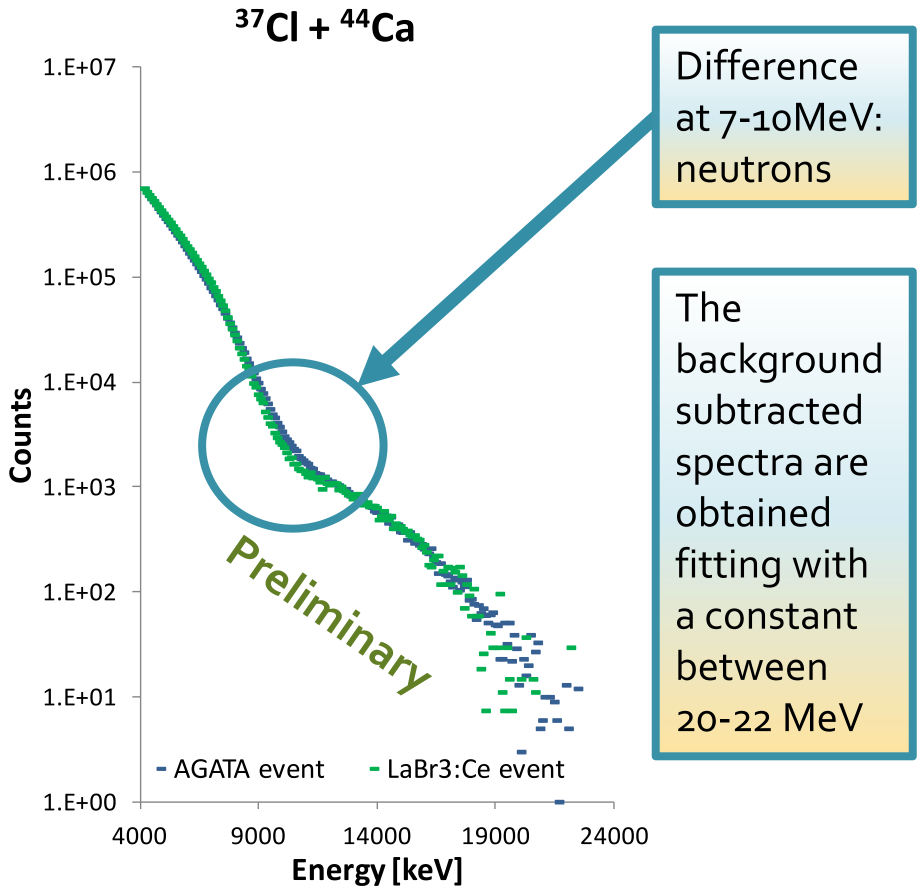
High energy spectrum for AGATA event (trigger AGATA and $LaBr_3$:Ce)
gate about 30 ns



^{37}Cl + ^{44}Ca high energy γ-spectra

$LaBr_3$:Ce detectors

Comparison between high energy spectrum for $Labr_3$:Ce event gated on γ prompt peak (2 ns) and the same for AGATA event (gate about 30 ns)



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High energy spectrum for AGATA event (trigger AGATA and $LaBr_3$:Ce)

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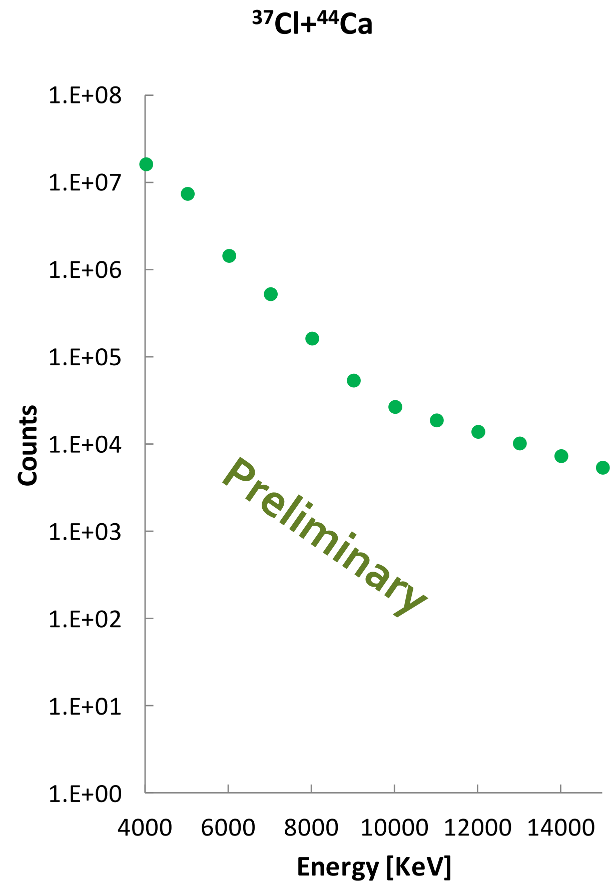

Conclusions and prespectives

- Data replay, data calibration and Doppler correction
- **Residues identification** – neutron channels identification (only in ^{37}Cl + ^{44}Ca)
- Preliminary **high-energy γ-rays spectra** – background reduction with gate

- **Cascade** calculations with isospin formalism for ^{40}Ca + ^{40}Ca (AGATA and LaBr3:Ce event)
- **Cascade** calculations with isospin formalism for ^{37}Cl + ^{44}Ca (LaBr3:Ce event)
- **Monte Carlo Cascade** calculations for ^{37}Cl + ^{44}Ca (AGATA event) → neutrons

- Cascade calculations in way to obtain **isospin mixing value** at finite temperature and at T=0 MeV

Collaboration

A.Giaz[1], S. Ceruti[1], F.Camera[1], R.Avigo[1], G.Benzoni[1], N.Blasi[1], A.Bracco[1], S.Brambilla[1], A.Corsi[1,8], F.Crespi[1], S.Leoni[1], A.I.Morales-Lopez[1], B.Million[1], L.Pellegri[1], R.Nicolini[1], S.Riboldi[1], V.Vandone[1], O.Wieland[1], M.Bellato[2], D.Bortolato[2], C.Fanin[2], A.Gottardo[2], F.Gramegna[2], V.Kravchuck[2], T.Marchi[2], V.Modamio[2], D.R.Napoli[2], E.Shain[2], J.J.Valiente-Dobon[2], D.Bazzacco[3], E.Farnea[3], D.Mengoni[3,7], C.Michelagnoli[3], D.Montanari[3], F.Recchia[3], C.Ur[3], M.Ciemala[4], M.Kmiecik[4], A.Maj[4], S.Myalski[4], J.Styczen[4], M.Zieblinski[4], M.Bruno[5], M.D'Agostino[5], G.Casini[6], R.De Palo[9]

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Thank you for the attention