In-beam fast-timing experiments using a mixed $LaBr_3$:Ce – HPGe array

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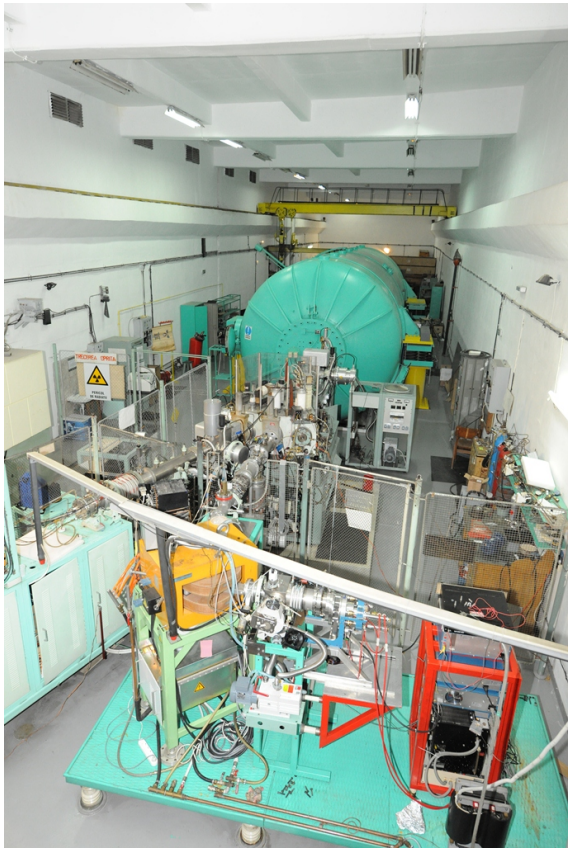
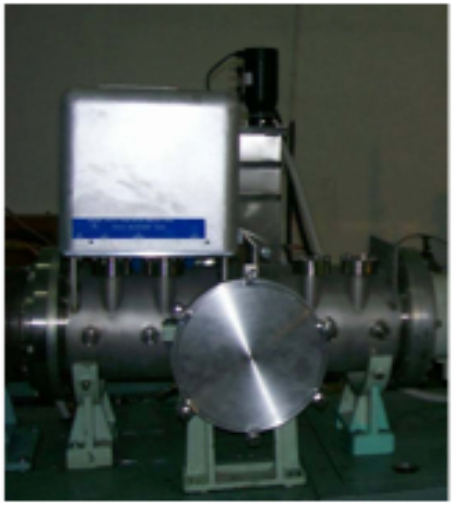
TANDEM Accelerator at IFIN-HH

- 9 MV TANDEM accelerator, completely modernized
- Duoplasmatron alpha particles source (Li-exchange)
- Sputtering source
- “Fast” (nanoseconds) pulsing system
- “Slow” (>millisecond) pulsing system
- Very good transmision (>98%)

Ions from protons to Si can be accelerated at energies above the Coulomb barrier





Detection systems

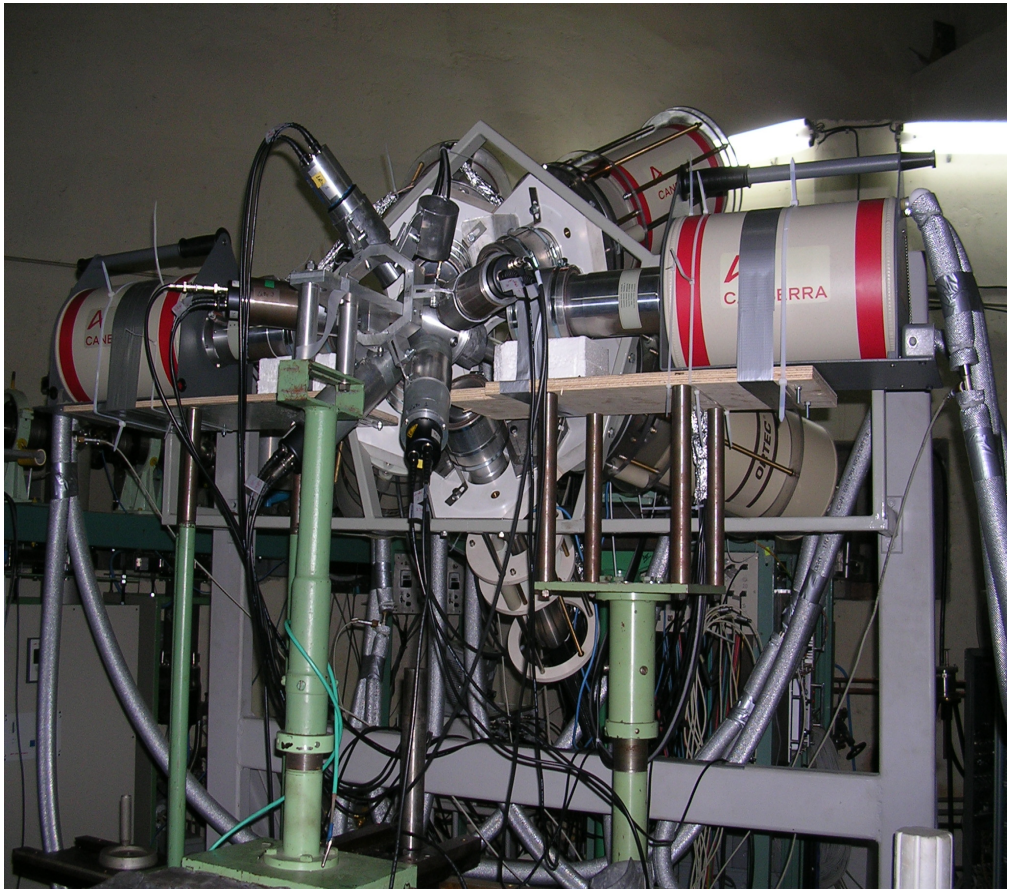
Present infrastructure:

- 18 HPGe detectors with 55% efficiency
- two clover detectors
- scintillation detectors: 8 $LaBr_3$:Ce,

  3 : 2”x2”

  3 : 1.5”x1.5”

  2 : 1.5” conical
- charged-particle detectors
- neutron detectors



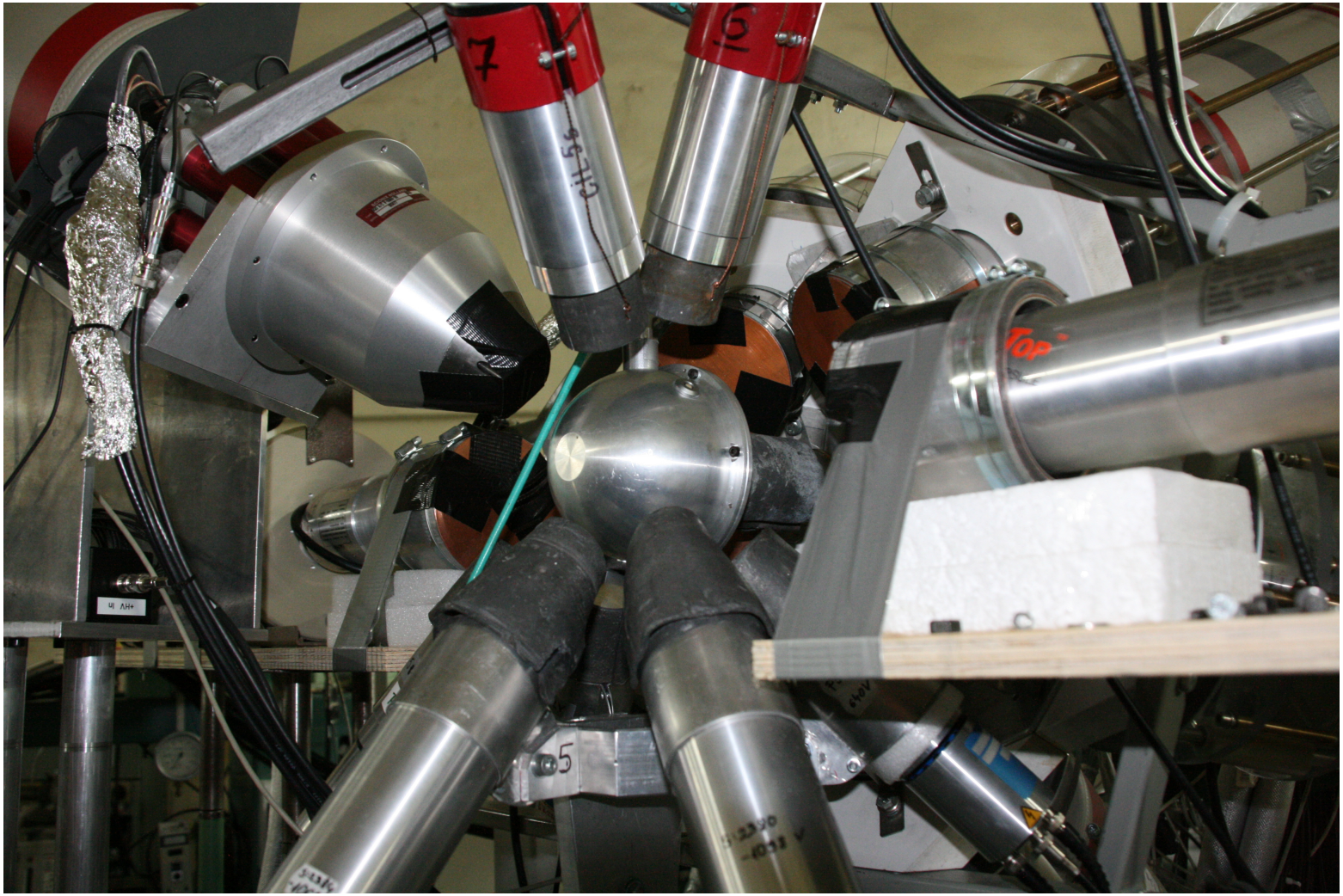
Permanent gamma detection array

7-8 55% HPGe detectors

8 $LaBr_3$:Ce detectors

+ 4 new 1.5” conical detectors ordered in Dec. 2010

Present “in-beam fast timing” setup

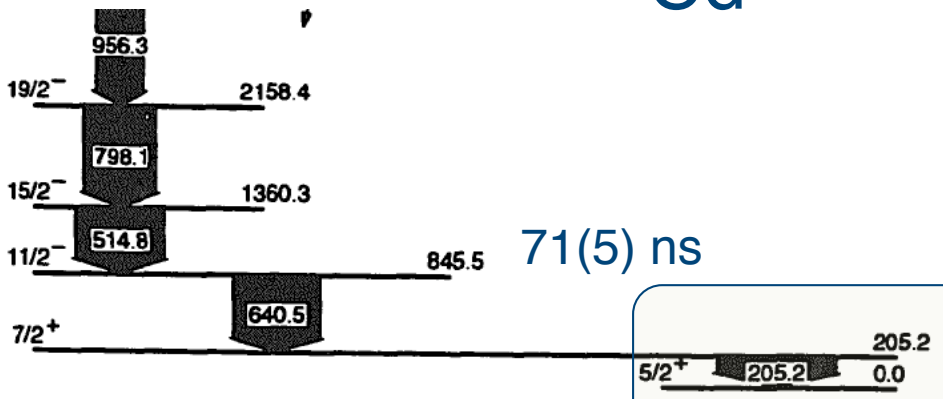


In-beam Fast-Timing : test experiment

Experiment proposed by D. Balabaski (INRNE-BAS Sofia)

$^{98}Mo(^{12}C,3n)^{107}Cd$
50 MeV incident energy

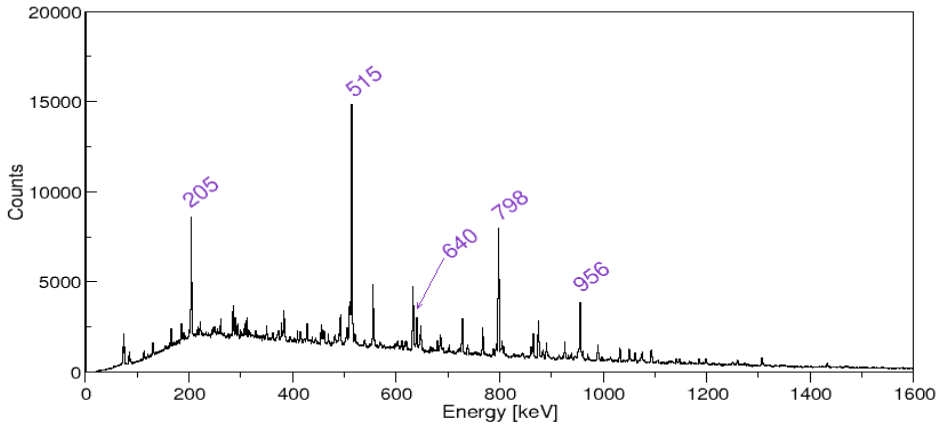
^{107}Cd



71(5) ns

0.71(4) ns

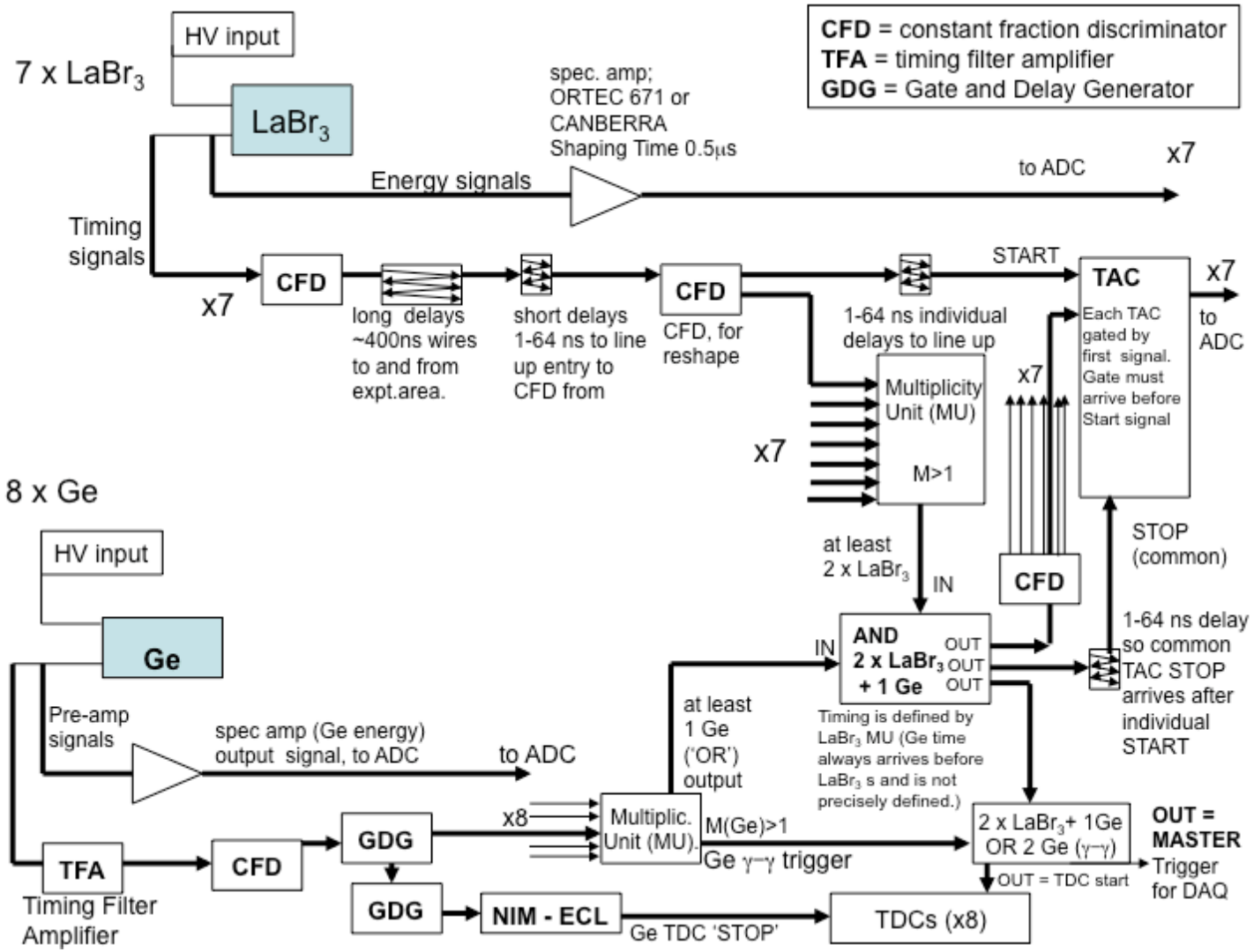
- 5 $LaBr_3$:Ce detectors (Sofia, Orsay)
- 7 HPGe detectors (Bucharest)



72 hours experiment, January 2009

Trigger condition
Ge ≥ 1 AND $LaBr_3$:Ce ≥ 2

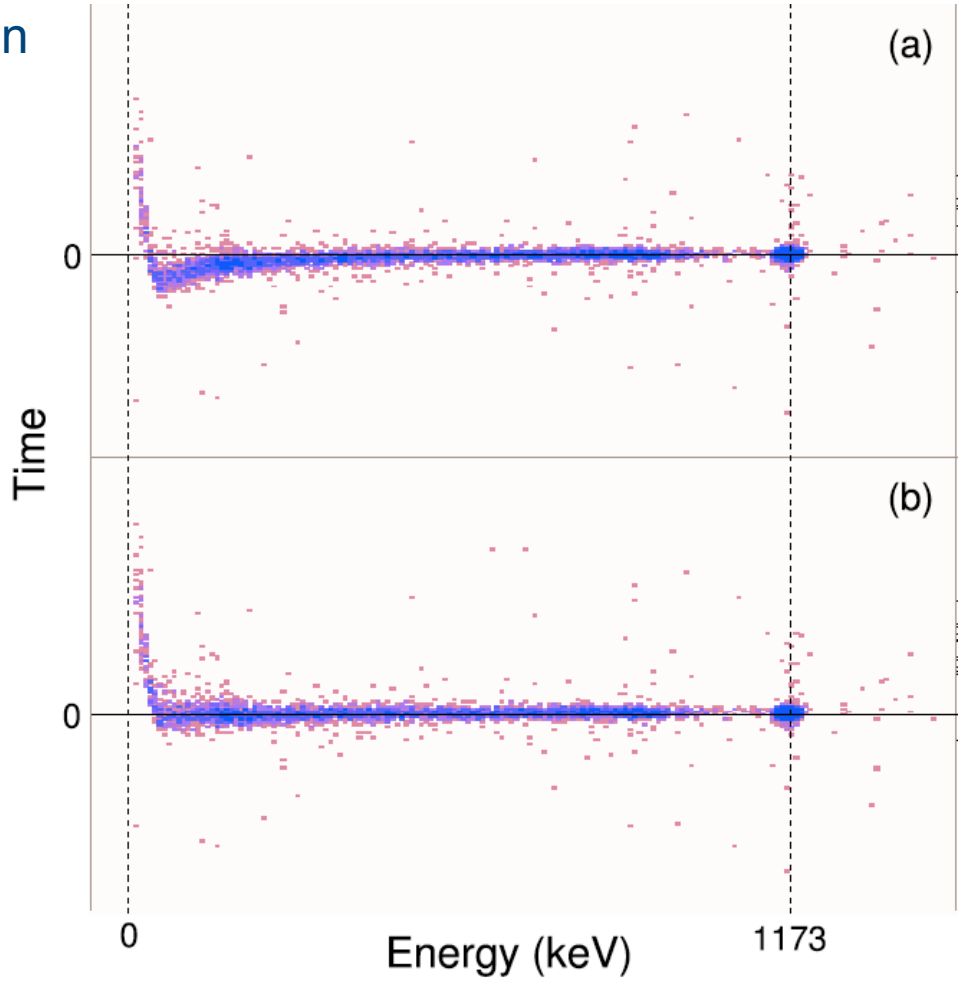
In-Beam Fast Timing Electronic Diagram



CFD walk correction

- ^{60}Co source placed in target position
- One $LaBr_3$:Ce detector taken as time reference
- Voltage close to the linear regime for energy
- Time reference detector gated on the 1332 keV full-energy peak

The CFD walk dependence on amplitude is removed using offline corrections, in order to insure similar time response for all elements of the detection system

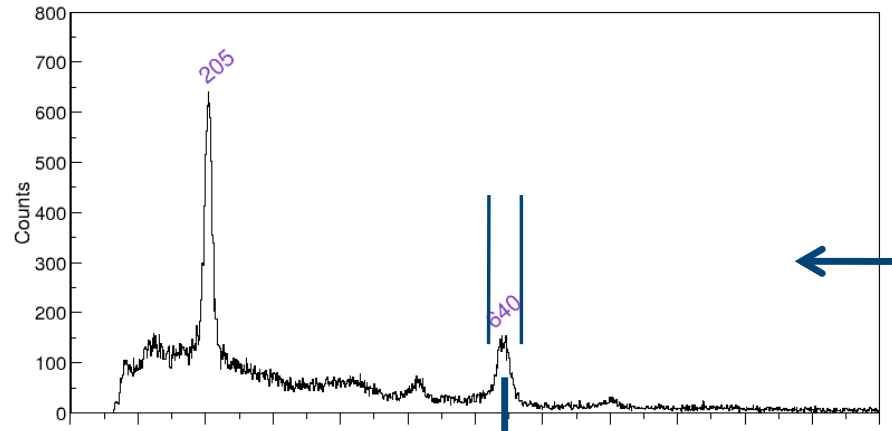


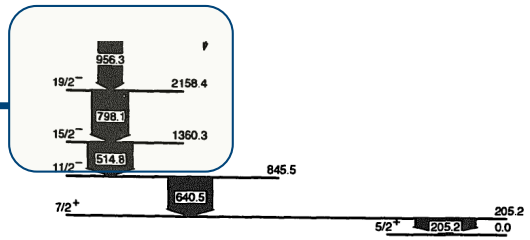
In-beam Fast-Timing : ^{107}Cd test case

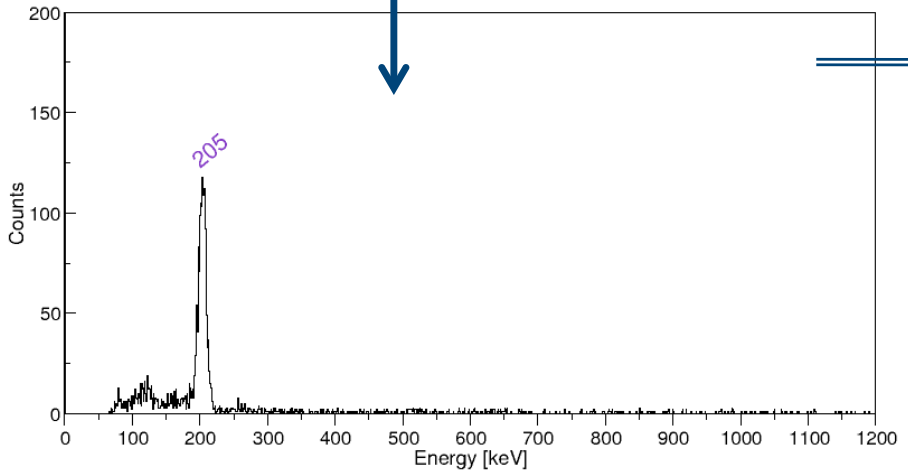
640-205 coincidence in $LaBr_3$:Ce detectors

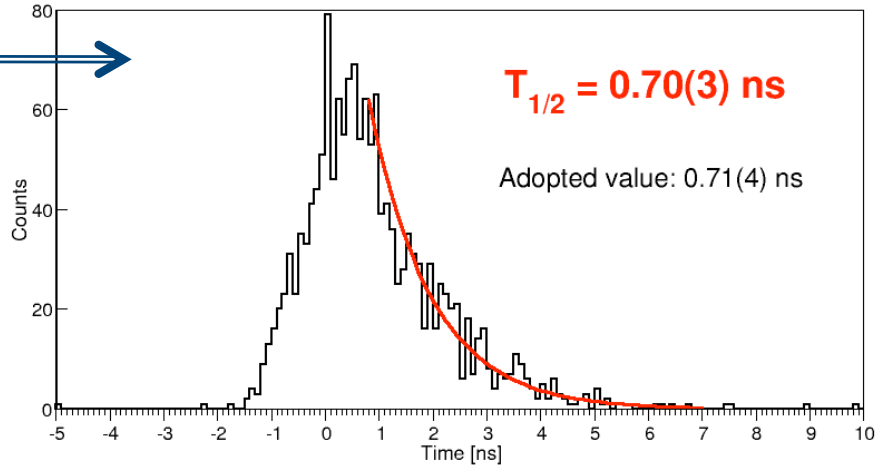
selected gating with HPGe detectors

on yrast transitions of ^{107}Cd







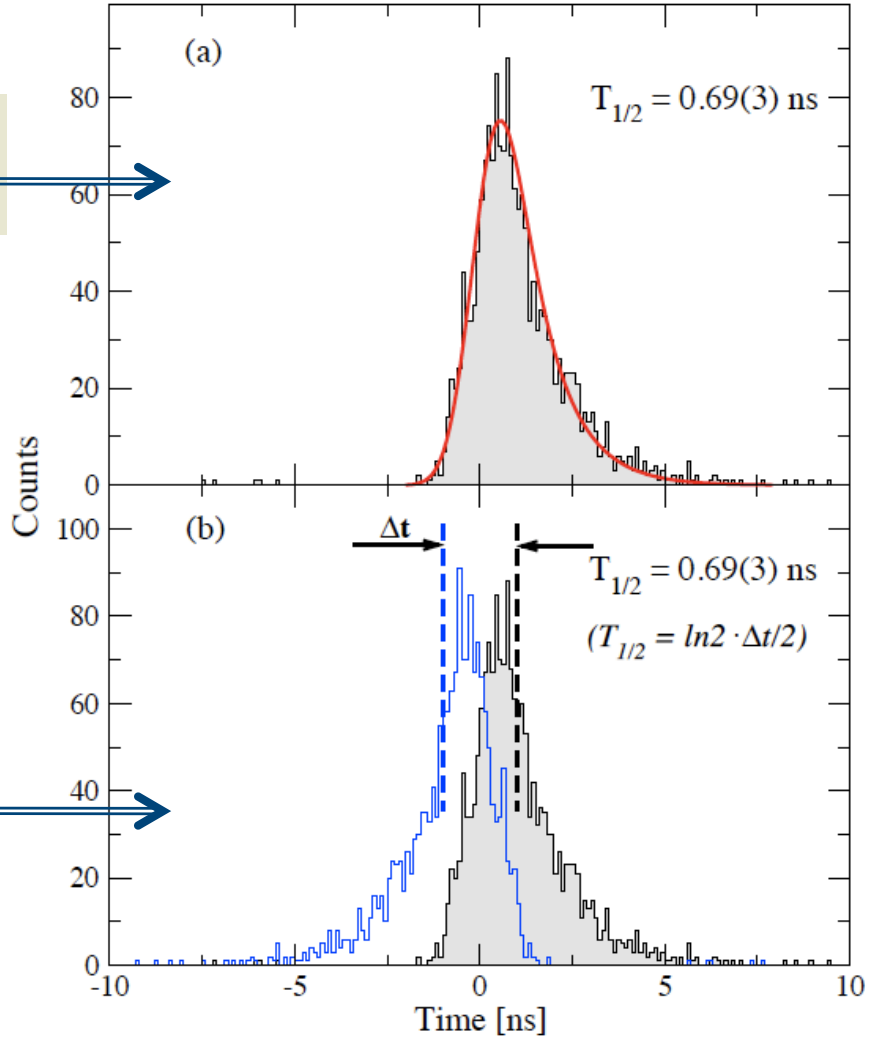


In-beam Fast-Timing : ^{107}Cd test case

Fit of the decay curve convoluted with effective detector response

Consistent result using both methods

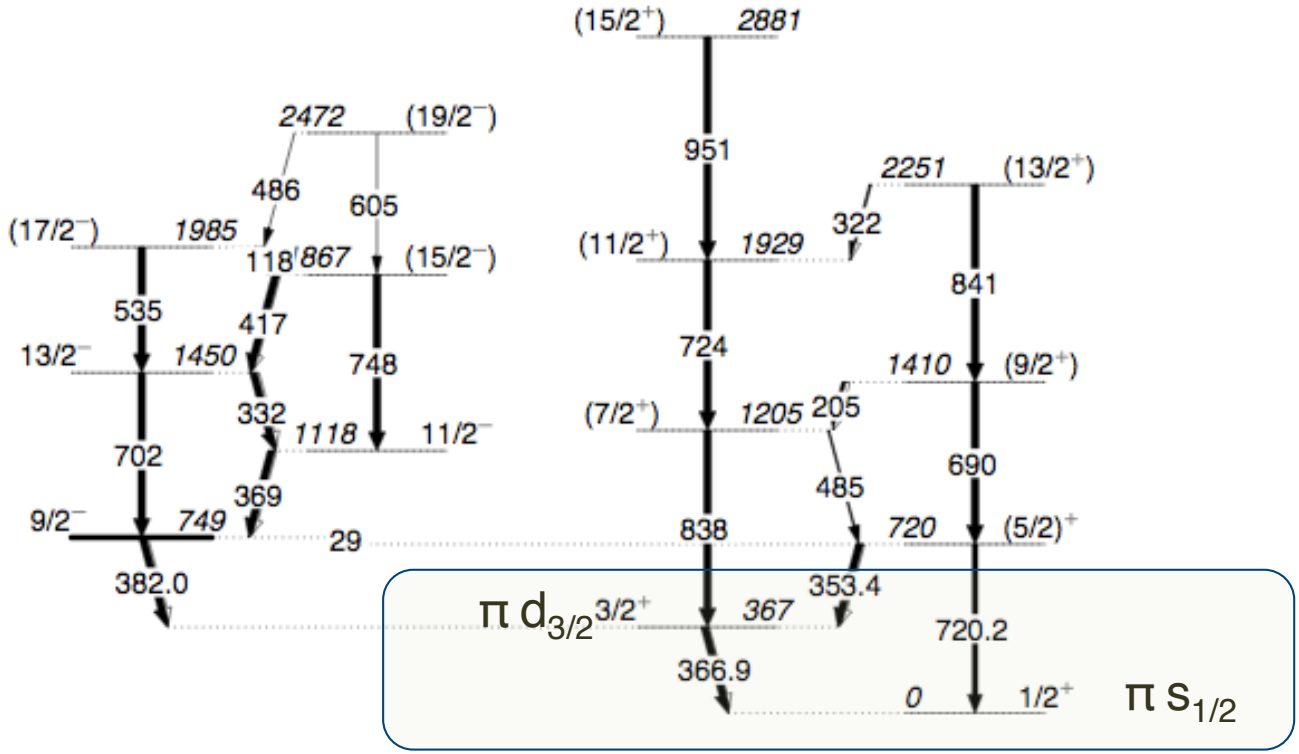
Centroid shift method



Spectroscopy of ^{199}Tl

- ^{197}Au(α,2n)^{199}Tl at 24 MeV beam energy

  8 HPGe and 5 $LaBr_3$:Ce detectors

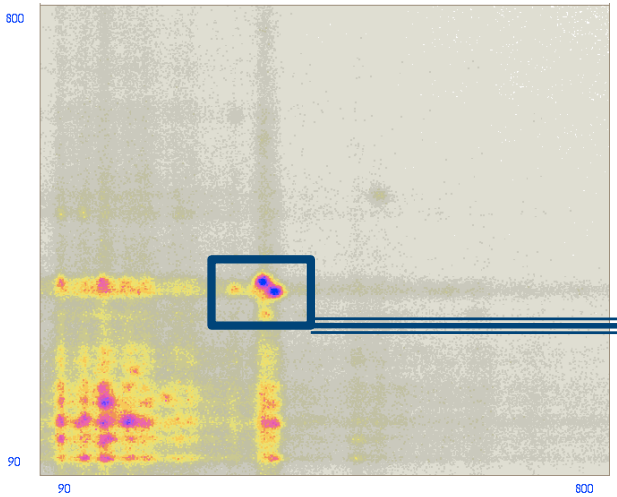


$T_{1/2}$=28.4(2) ms

If these states have pure single-particle configurations, one expects lifetime of several hundreds of picoseconds for the 367 keV level

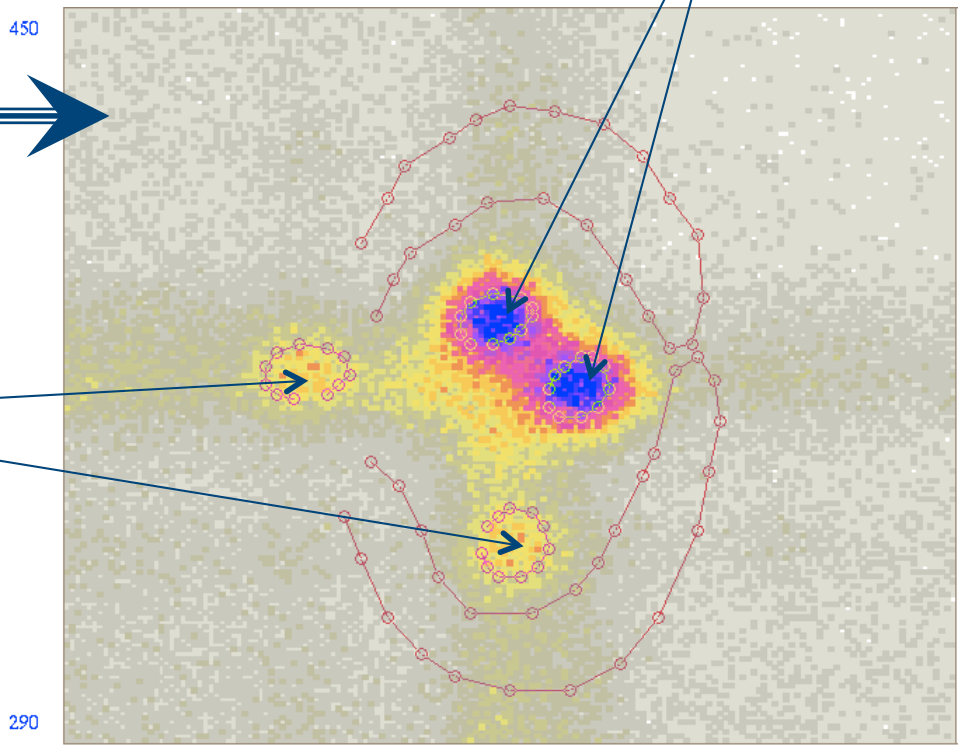
Lifetime of the 367 keV level

γ-γ-Δt cube with $LaBr_3$:Ce detectors



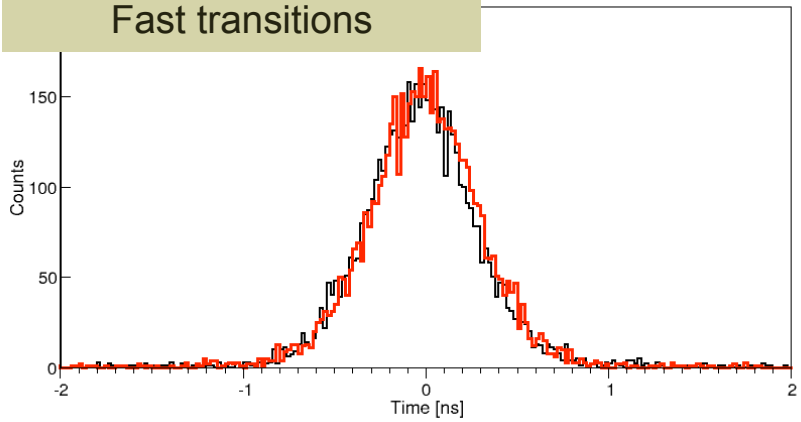
381 keV – 367 keV coincidence

332 keV – 369 keV coincidence

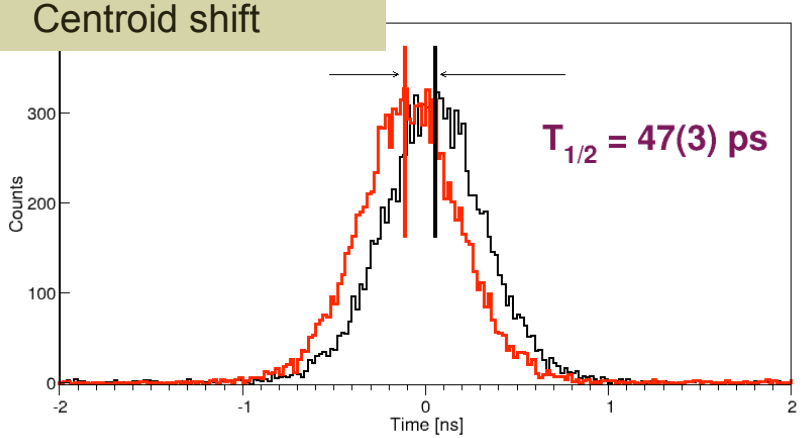


Lifetime of the 367 keV level

332-369 keV coincidence
Fast transitions



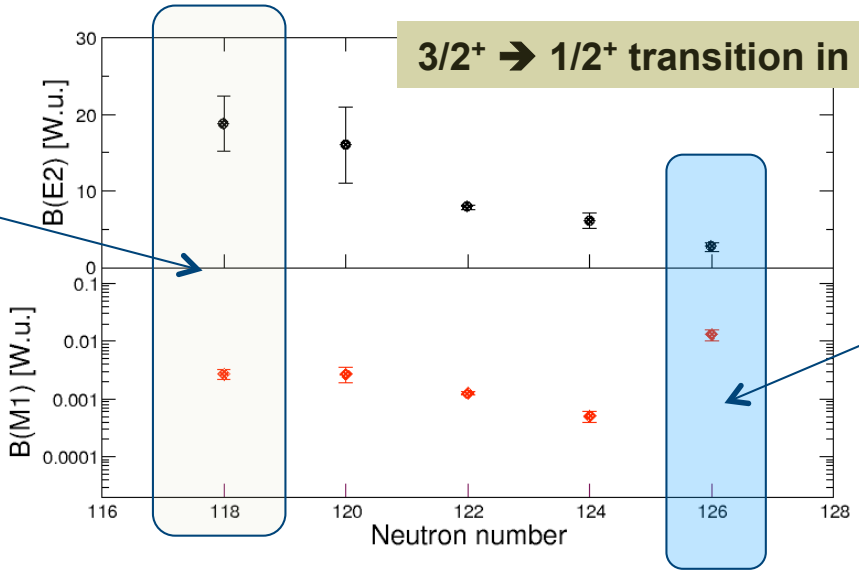
367-381 keV coincidence
Centroid shift



$3/2^+$ ➔ $1/2^+$ transition in odd-A Tl isotopes

Present data

Increased collectivity
of the two states

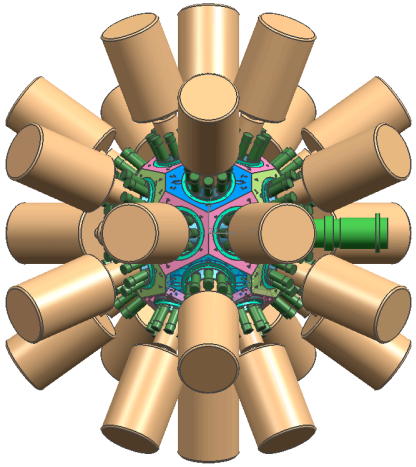


One hole in doubly-magic ^{208}Pb
Single-particle states

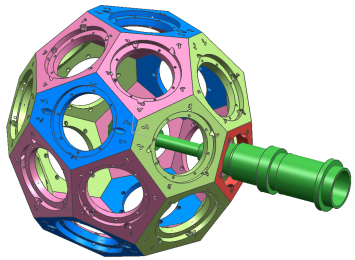
Forthcoming developments

Array of 25 HPGe 55% detectors

with BGO anti-Compton shields



- Increase granularity
- Increase P/T ratio
- Increase detection efficiency



Absolute detection efficiency ~ 1%

Expected commissioning : end of 2011

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