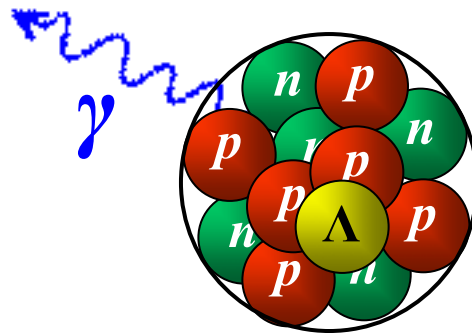


*The new FINUDA challenge:
 γ -ray spectroscopy of hypernuclei
at DAΦNE*



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**IEEE
NUCLEAR SCIENCE
SYMPOSIUM
and
MEDICAL IMAGING
CONFERENCE**

HAWAII 2007
OCTOBER 27 - NOVEMBER 3

Honolulu, Hawaii, USA
Hilton Hawaiian Village
Beach Resort @ Spa

welcome

 **IEEE**

 **NUCLEAR &
PLASMA SCIENCES
SOCIETY**

www.nss-mic.org/2007

Outline

- Discovery potential of the strangeness nuclear physics
- Need of sub-MeV resolution apparatuses
 - ❖ γ -ray spectroscopy
- Ideas for FINUDA spectrometer upgrade at DAΦNE/DAΦNE2

Open questions

☞ (low-energy) ΛN interaction

- detailed knowledge of the **hypernuclear fine structure**
 - evaluation of the **spin dependent terms** of the ΛN interaction
- measurement of **angular distribution** of γ -rays
 - determination of **spin** and **parity** of **each** observed **level**

☞ Impurity nuclear physics

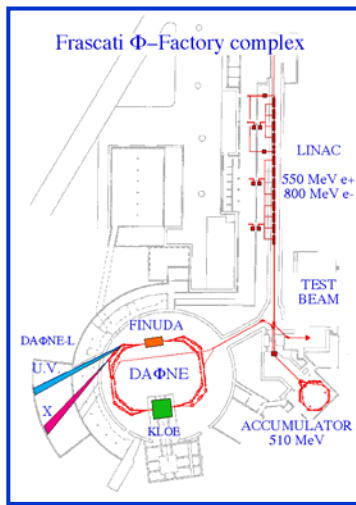
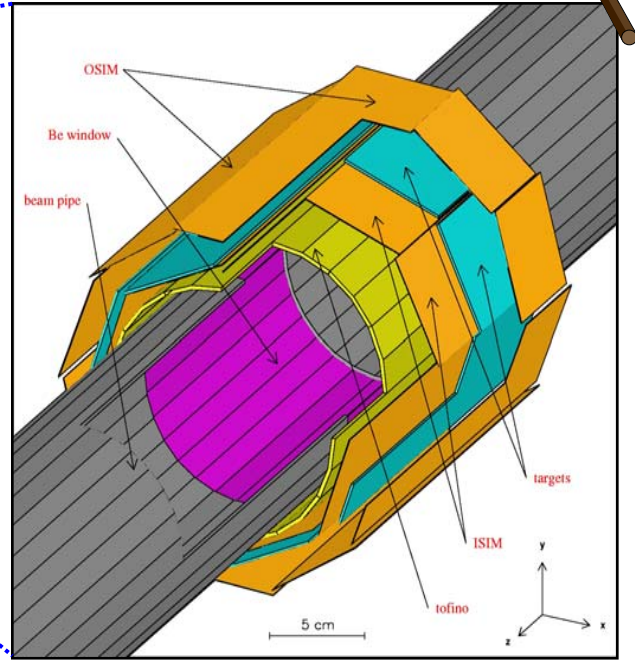
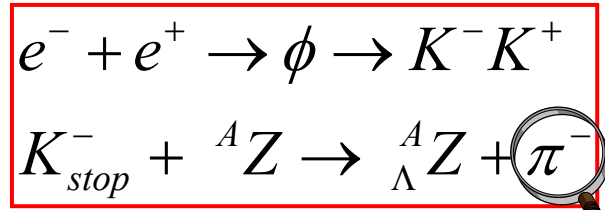
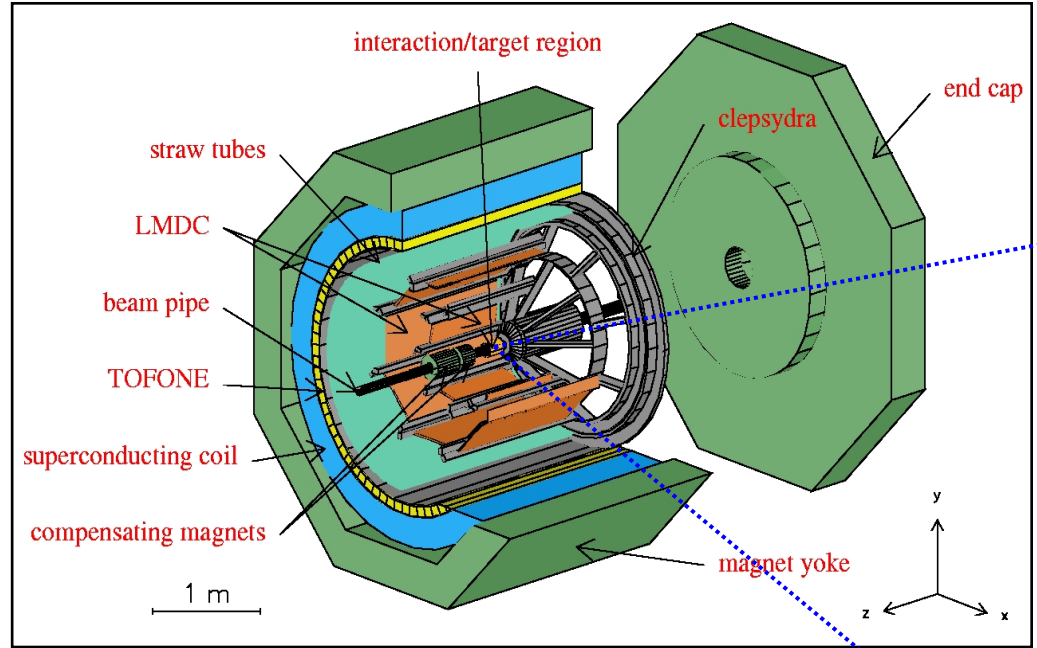
- measurement of transition probability **$B(E2)$**
 - information on the **size** and **deformation** of hypernuclei
 - measurement of nucleus **core shrinking** → **glue-like role** of Λ

☞ Properties of hyperons in nuclear matter (medium effect)

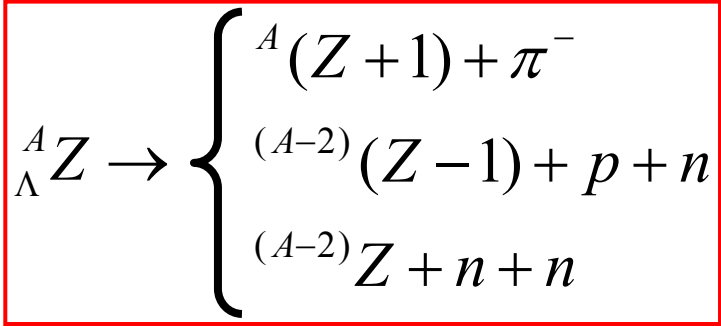
- measurement of transition probability **$B(M1)$**
 - **g-factor** value for Λ in nuclear matter



FINUDA @ DAΦNE

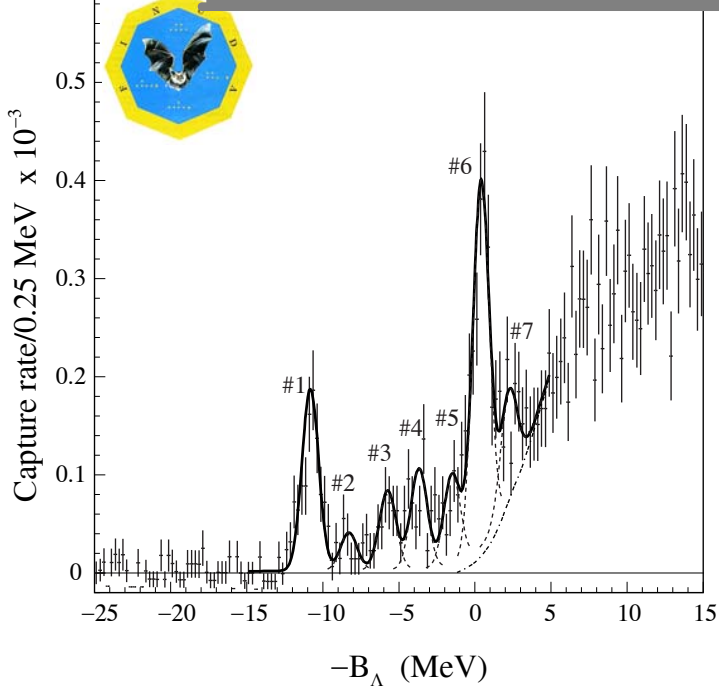


energy	510 MeV
luminosity	$5 \cdot 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$
σ_x (rms)	2.11 mm
σ_y (rms)	0.021 mm
σ_z (rms)	35 mm
bunch length	30 mm
crossing angle	12.5 mrad
frequency (max)	368.25 MHz
bunch/ring	up to 120
part./bunch	$8.9 \cdot 10^{10}$
current/ring	5.2 A (max)



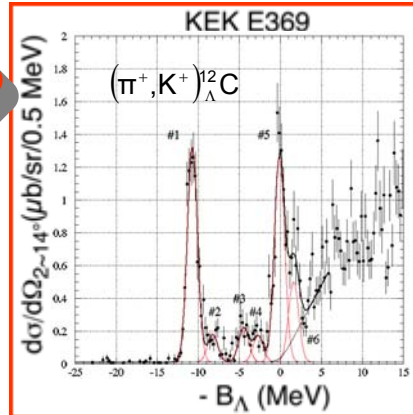
The status of the art

M. Agnello *et al.*, Phys. Lett. B 622 (2005) 35

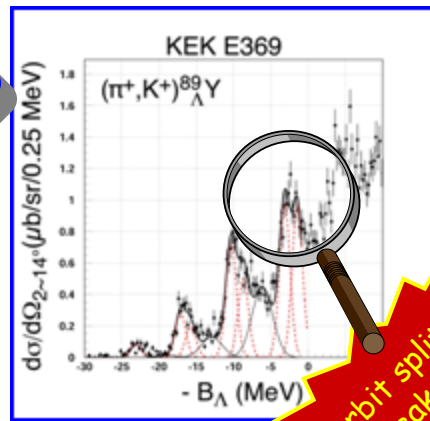


$\Delta E \sim 1.29 \text{ MeV FWHM}$

$\Delta E \sim 1.45 \text{ MeV FWHM}$

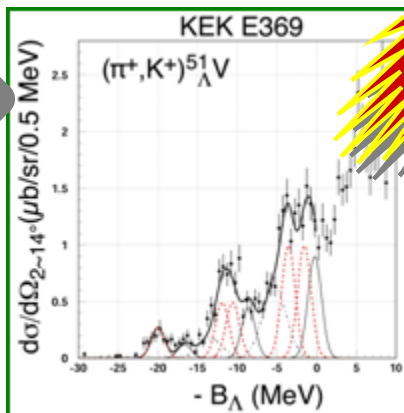


$\Delta E \sim 1.65 \text{ MeV FWHM}$

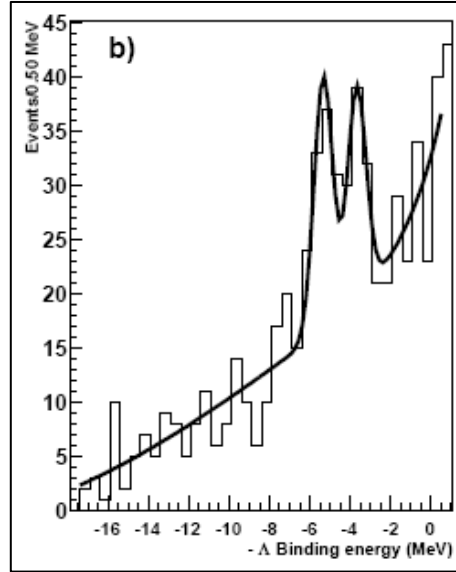
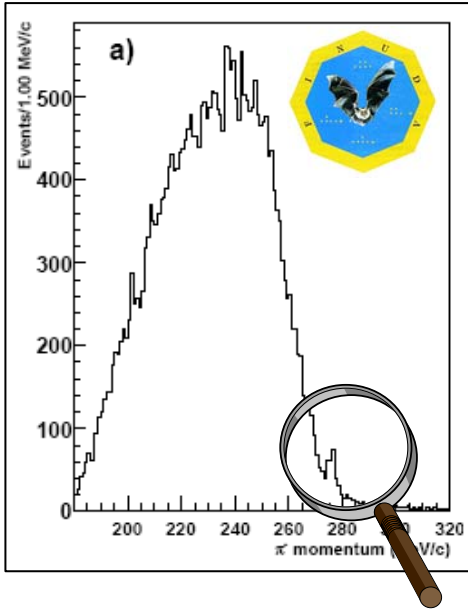


f-orbit splitting
into two peaks observed?

$\Delta E \sim 1.95 \text{ MeV FWHM}$



The status of the art

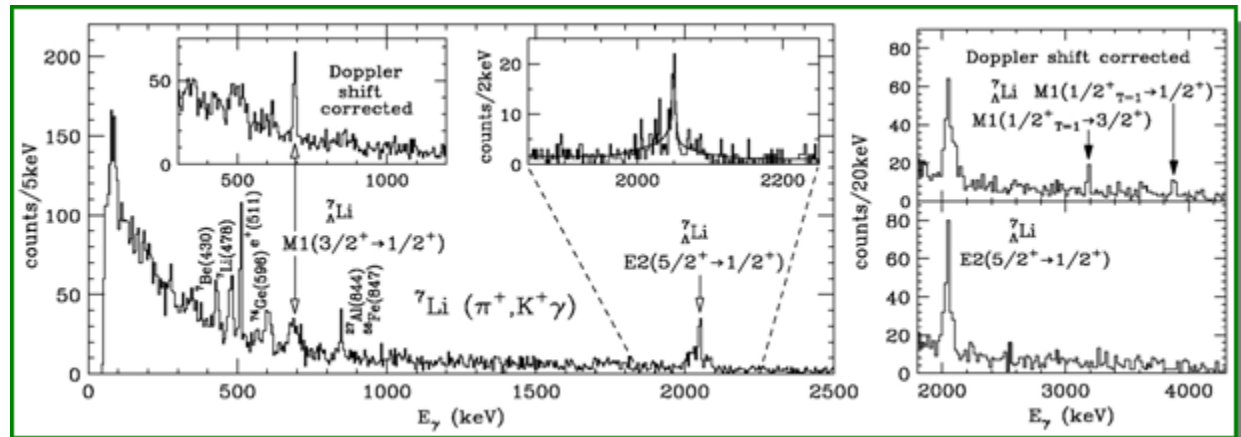


$\Delta E \sim 1.1 \text{ MeV FWHM}$

3 order of magnitude!!!

$\Delta E \sim 2 \text{ keV FWHM}$

KEK E419

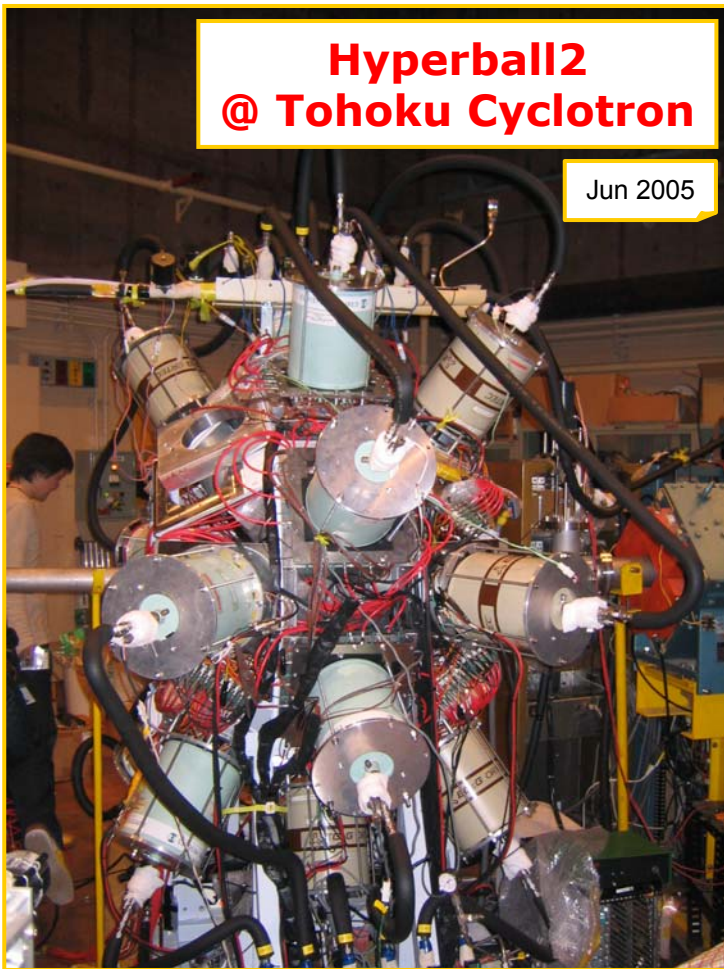


The γ -ray spectroscopy domain

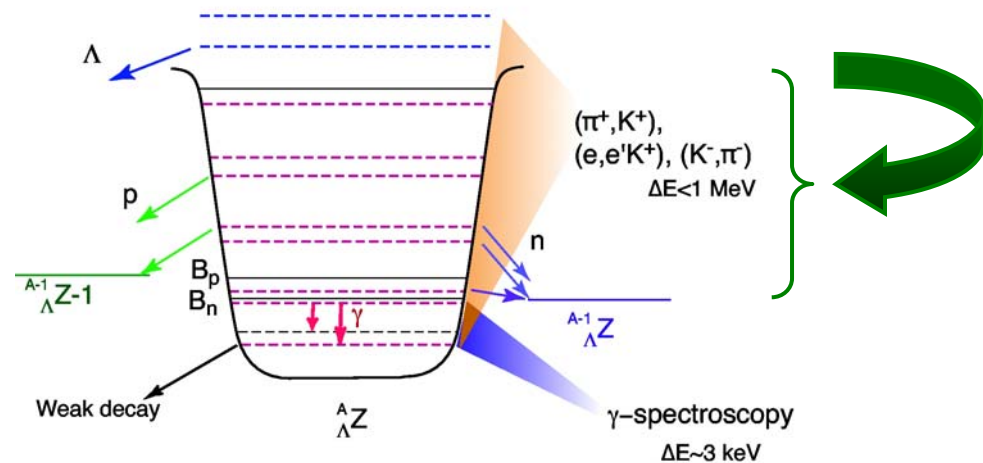
The region of high excitation energy in heavy Λ -hypernuclei cannot be explored with γ -spectroscopy

**Hyperball2
@ Tohoku Cyclotron**

Jun 2005



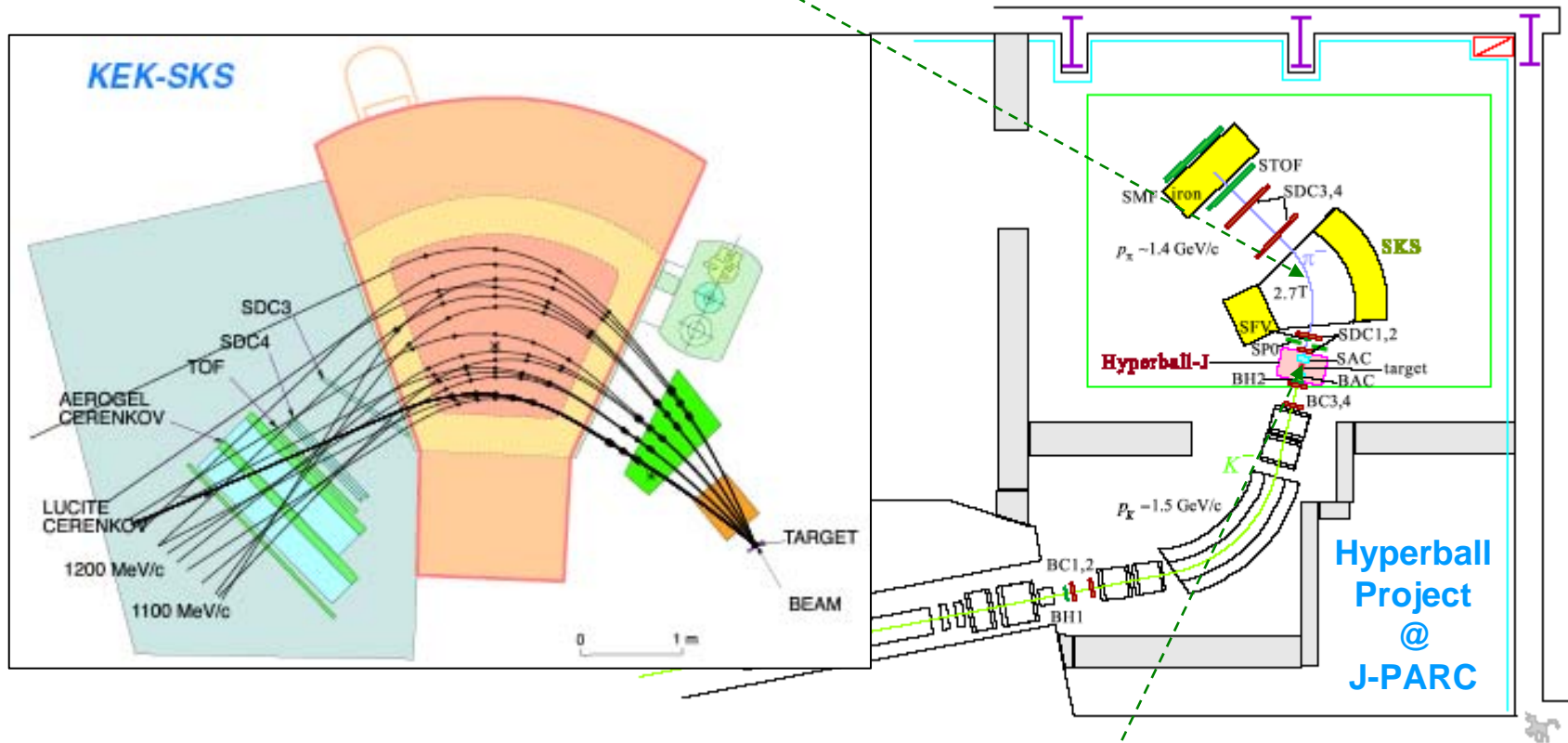
**FINUDA
@ DAΦNE**



Parallel vs. serial

one-arm spectrometer → small acceptance

- $\Delta E \sim 4 \text{ MeV}$ (FWHM)
- $\Delta\Omega \sim 110 \text{ msr}$



HPGe array → large acceptance

- $\Delta E \sim 1 \div 2 \text{ keV}$ (FWHM)
- $\varepsilon \sim 7\%$ (@ 1 MeV)

Experimental challenges



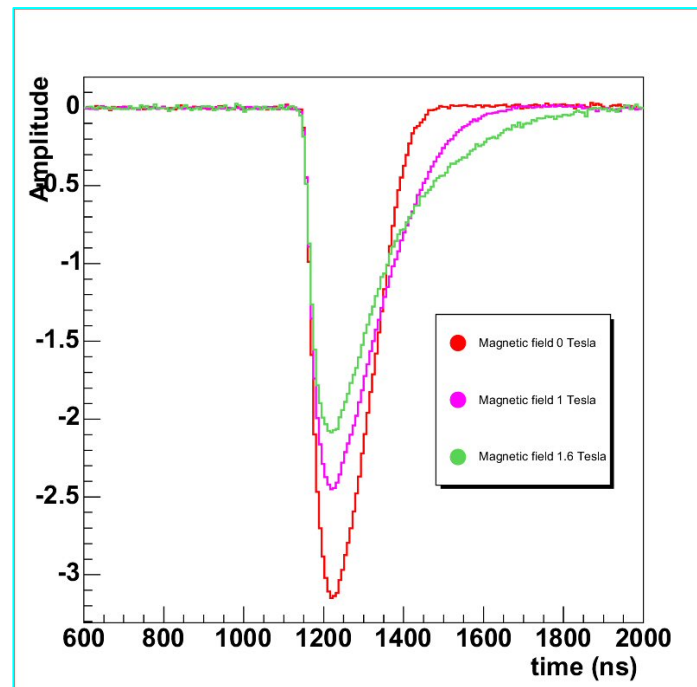
JRA6



Do **HPGe crystals** work in (**strong**)
magnetic field?

☞ Penning effect? (**sparks**)

☞ Hall effect? (**FET breakdown**)



Experimental challenges



JRA6



Do HPGe crystals work in (strong) magnetic field?

➡ Penning effect? (sparks)

➡ Hall effect? (FET breakdown)



To what extent the **energy resolution** is **affected**?

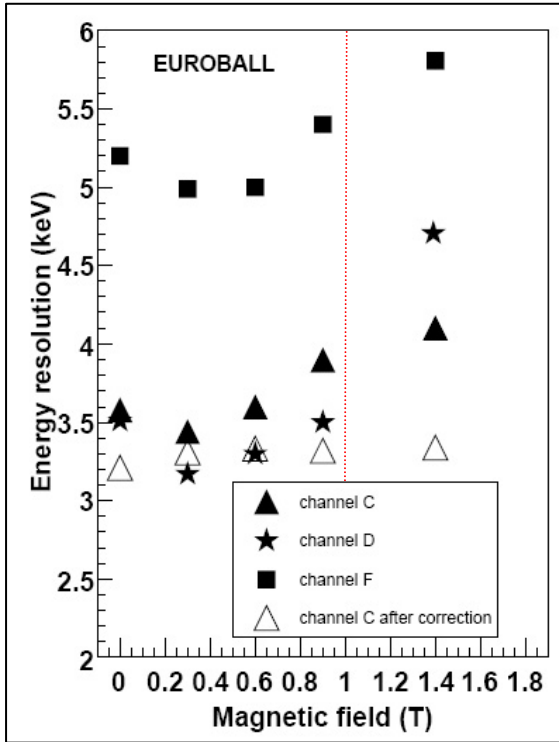
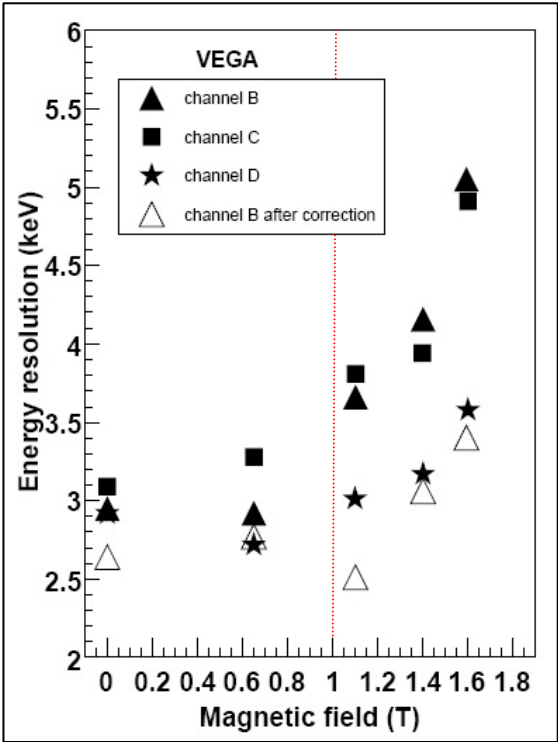
HPGe energy resolution in magnetic field



JRA6



NIM A 573 (2007) 410



Experimental challenges



JRA6



Do HPGe crystals work in (strong) magnetic field?

☞ Penning effect? (sparks)

☞ Hall effect? (FET breakdown)



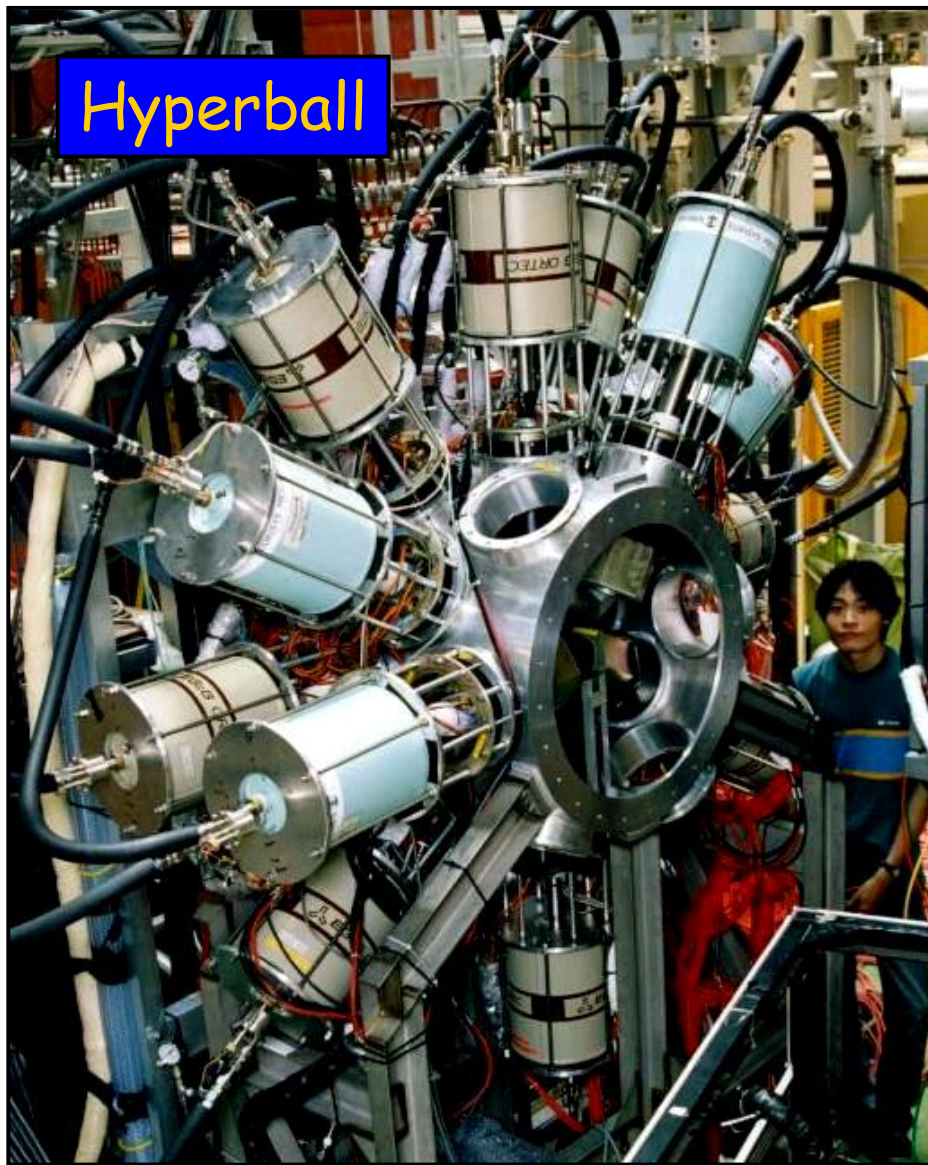
To what extent the energy resolution is affected?



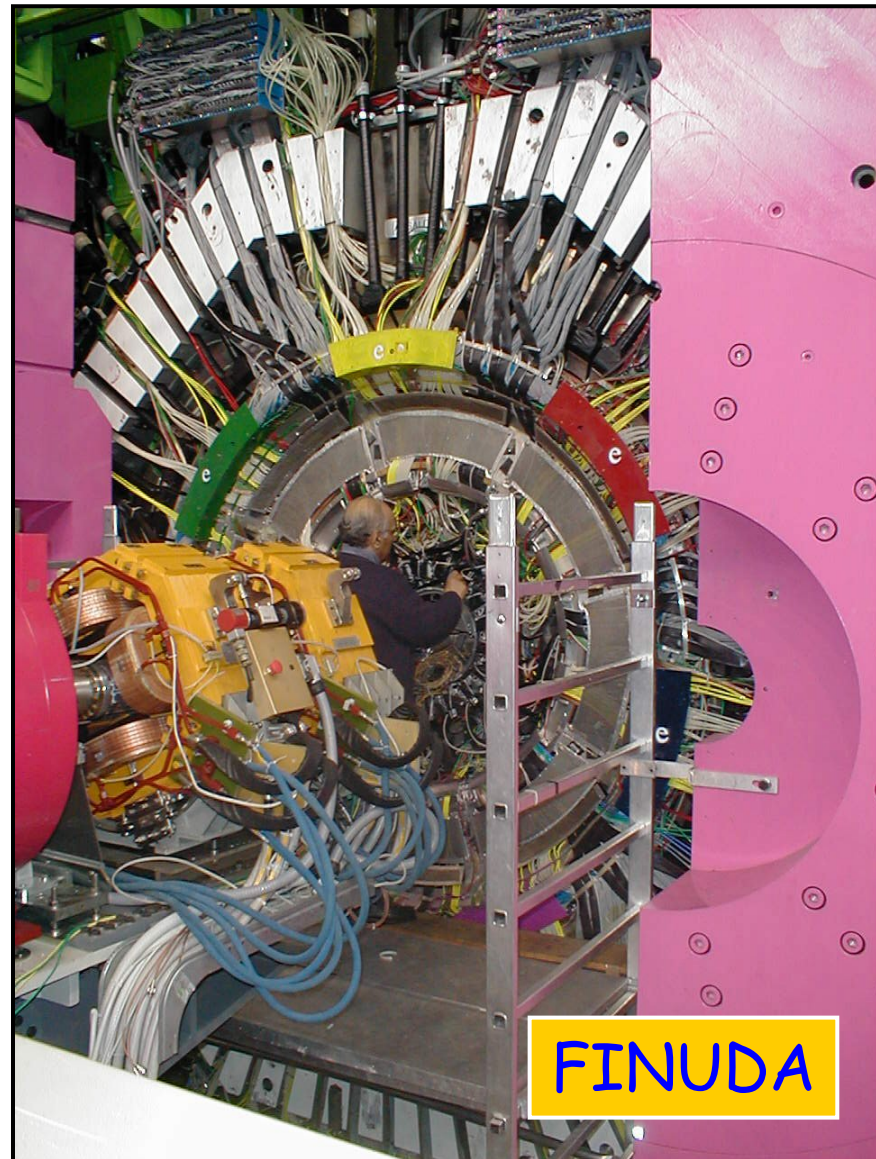
How to **minimize** the **mechanical interferences**?

An exacting integration

Hyperball



FINUDA



The hyper-triple cluster concept design



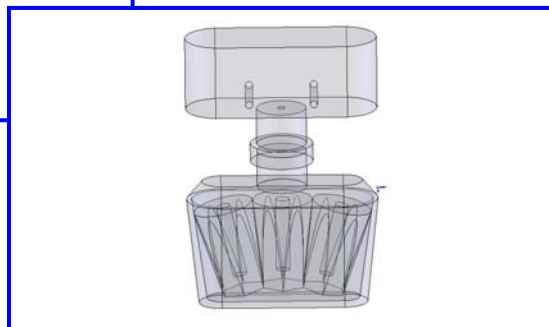
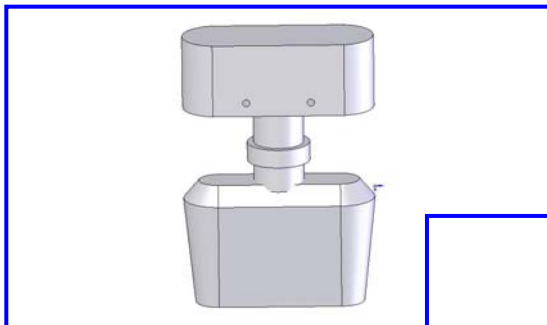
JRA6



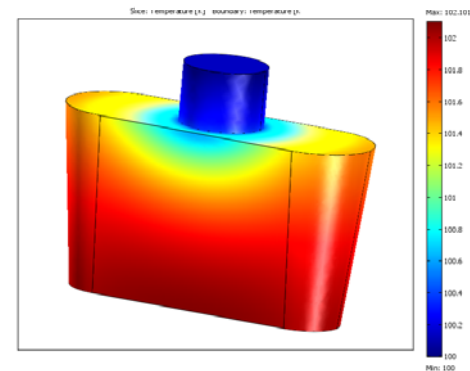
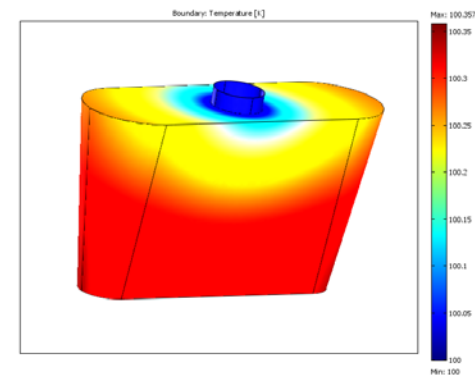
X - COOLER II, AMETEC, ORTEC



mechanical design

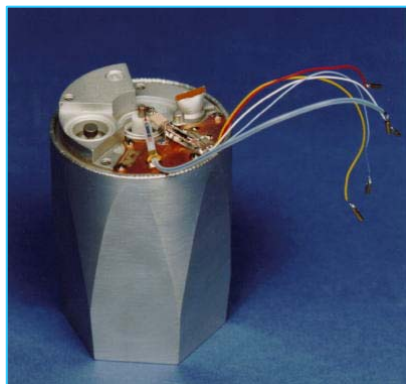


thermal studies

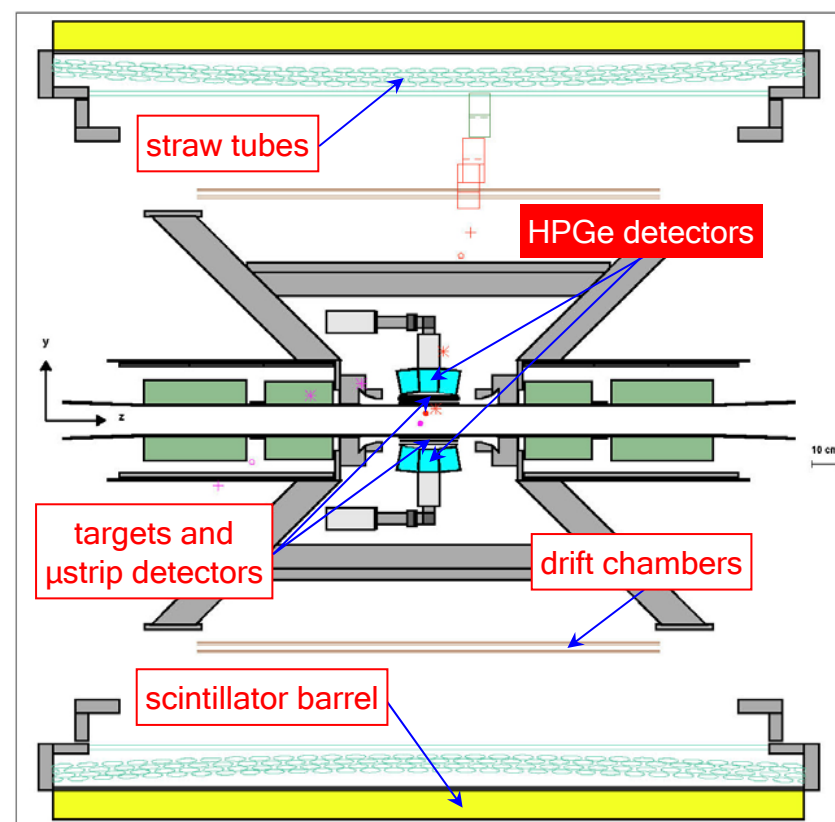
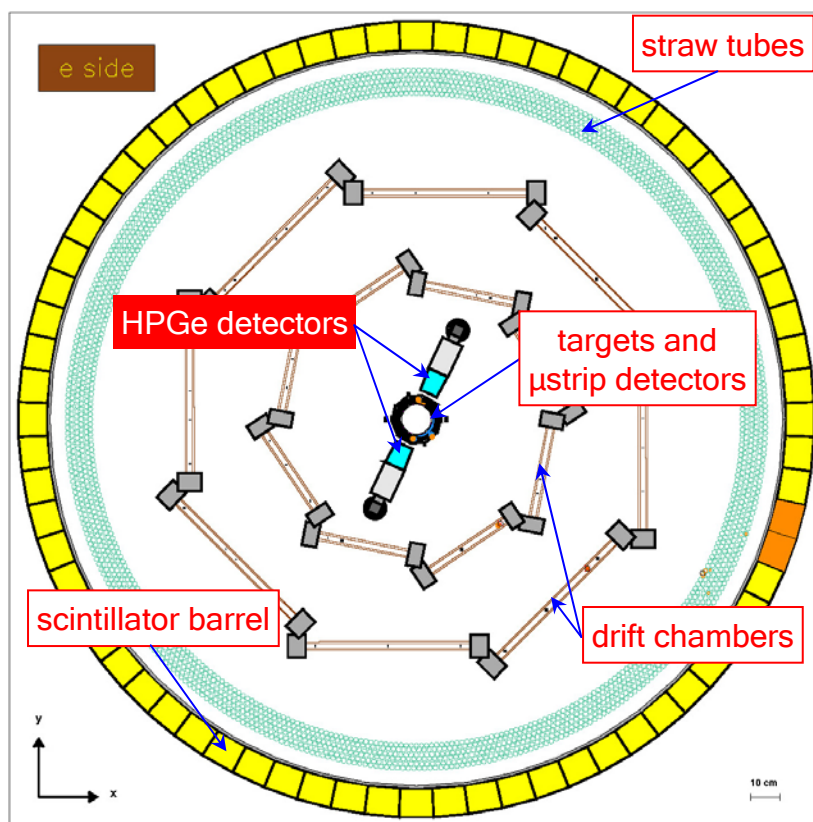




A look to the future



Geometrical acceptance
reduced to 82%



Summary

- ☑ strangeness nuclear physics still has a great discovery potential
- 👍 explorative run on γ -ray spectroscopy is feasible with:
 - 👉 present DAΦNE machine
 - 👉 minor investment on FINUDA apparatus
- ❖ DAΦNE luminosity upgrade will allow European Groups to carry on a significant scientific program