



Alternative approaches for CEPA

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for the CALIFA WG of R3B



Alternative approaches for CEPA

1 – CEPA-CsI Alternative

General Description

Proposed Configuration

Timeline and estimated costs

2 – CEPA-CsI Phase 0

Development for a “Phase 0” section

3 – An evolved approach:

A new phoswich configuration of GAGG/CsI

Alternative approaches for CEPA

1 – CEPA-Csl Alternative

General Description

Proposed Configuration

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CEPA-CsI

CEPA-CsI in short

Full ring detector made of CsI(Tl) scintillator crystals + APDs

Natural extension of current iPhos section

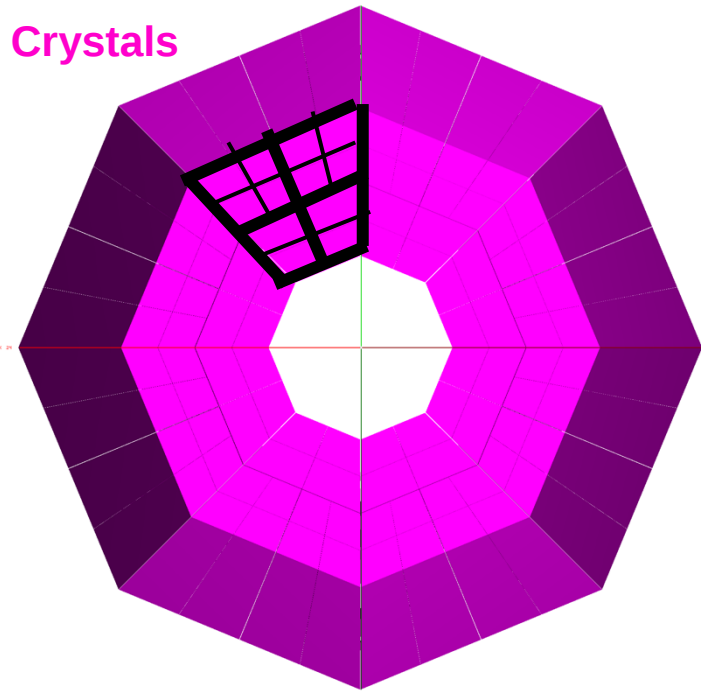
Rather similar properties and performances to iPhos detection units

Simple geometry (next slide)

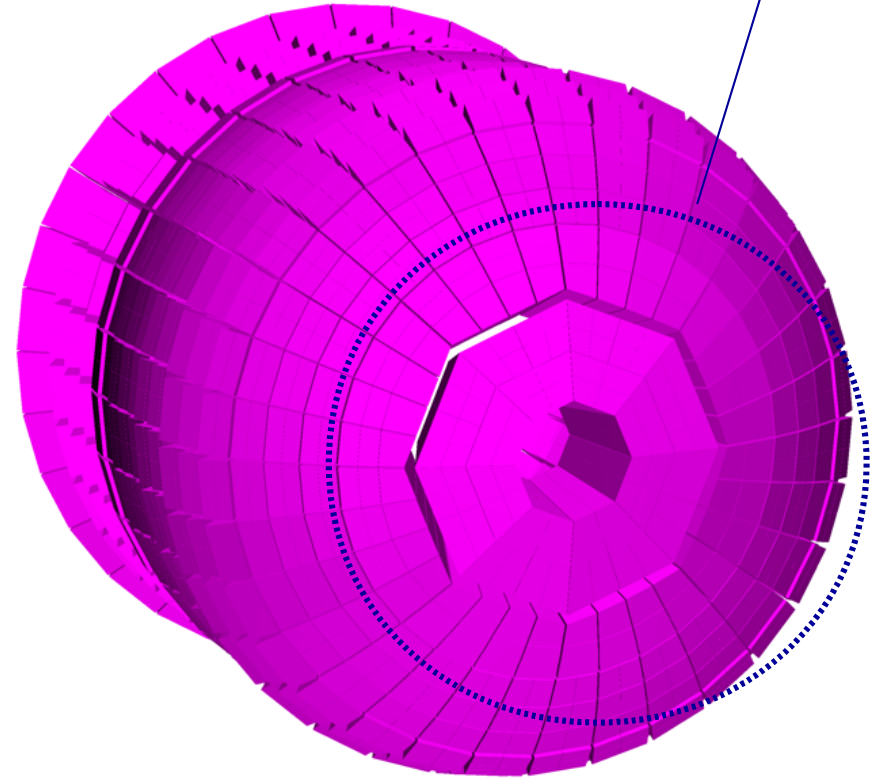
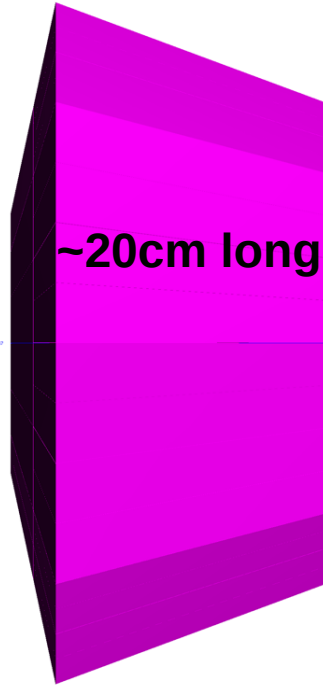
CEPA-CsI

* Using original CEPA geo

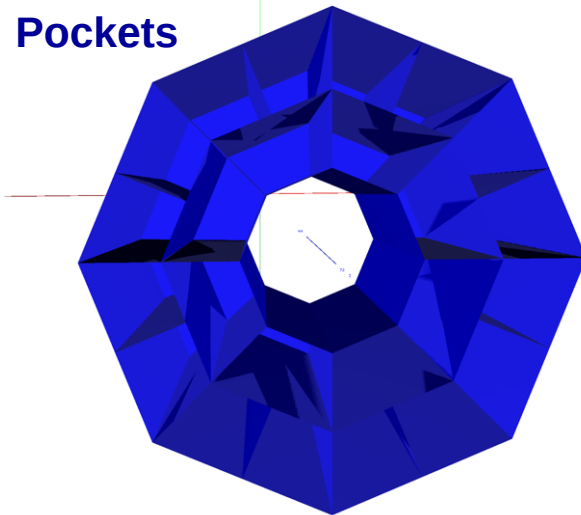
Crystals



~20cm long



Pockets



8 equal segments

12 crystals per segment, arranged in 3 pockets (4 crys/pocket)

Total of 96 CsI(Tl)+APD detection units

CEPA-CsI

PROs	CONS
Got the “Know-how”	Lack of room for preamps & Co. → Need find out a mechanical solution
Familiar with CsI crystals	Rate limited → increase detector granularity (e.g. 20 crys/seg)
Same APDs	If high granularity, smaller APDs (1010)
Same DAQ and Electronics (with some variations maybe)	Timing
Improved Acceptance	...

CEPA-CsI

Rate estimate

	LaBr	LaCl	CsI	GAGG
Decay time	16 ns	29 ns	0.6-3.4 μ s	90 ns
Max. rate/crystal	$6.6 \cdot 10^6$ hits/s	$3.6 \cdot 10^6$ hits/s	$5.3 \cdot 10^4$ hits/s	$1.2 \cdot 10^6$ hits/s
Max. beam rate	$6.3 \cdot 10^9$ pps	$3.5 \cdot 10^9$ pps	$5.0 \cdot 10^7$ pps	$1.1 \cdot 10^9$ pps

I

- Maximum rate: Less than 10 % probability second events comes within decay time
- Assumed poisson distributed events
- Assumed same rate for all crystals, 10 % reaction probability
- LaBr timing resolution: <500 ps, according to Saint-Gobain

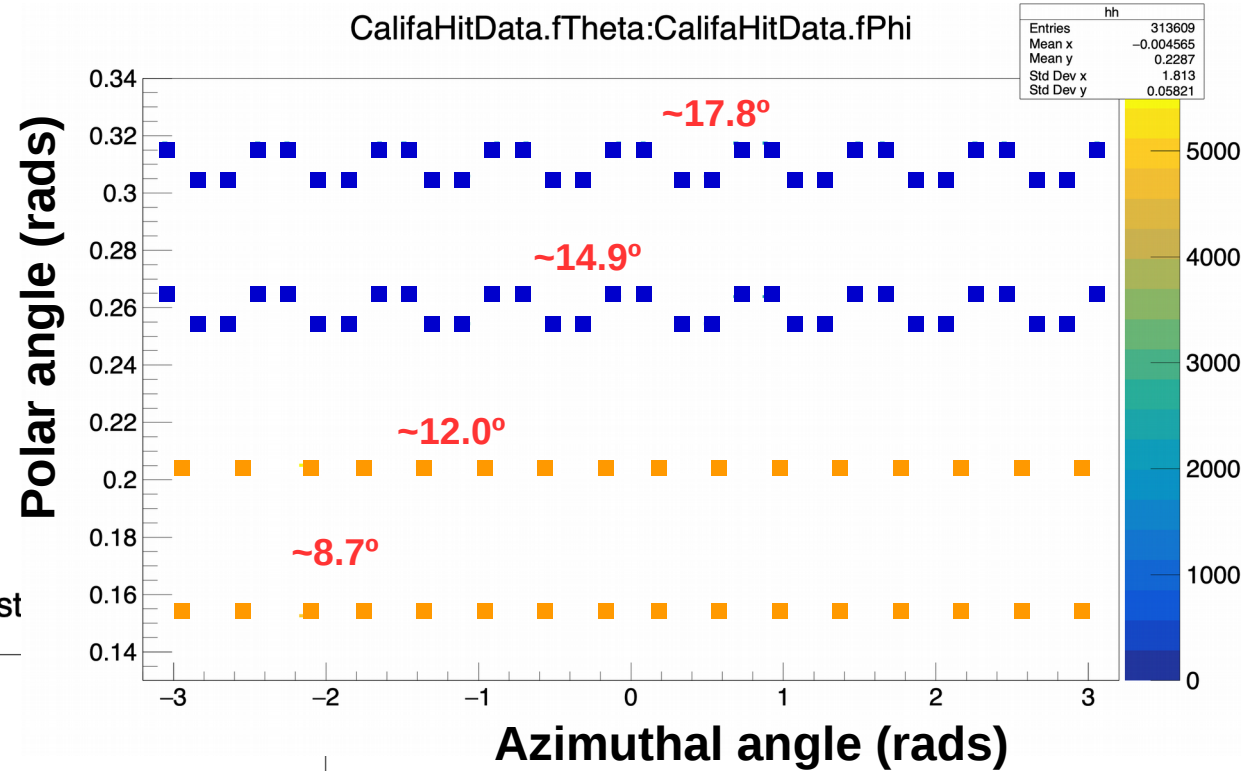
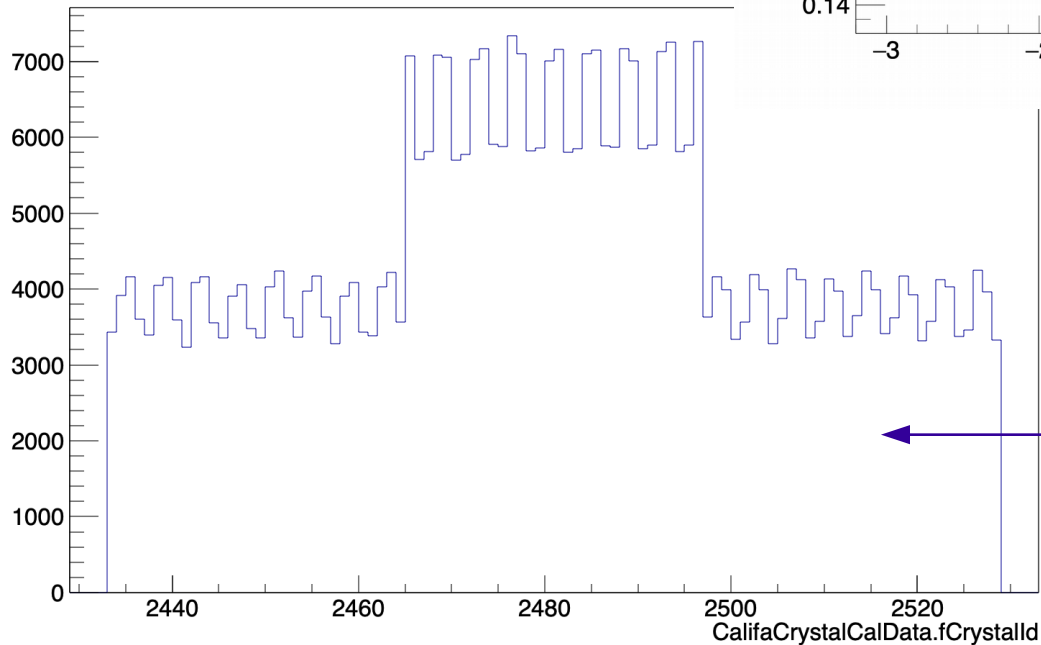
Simulations started!

CEPA-CsI

Angular position of
CEPA-CsI center of
crystals



CalifaCrystalCalData.fCryst



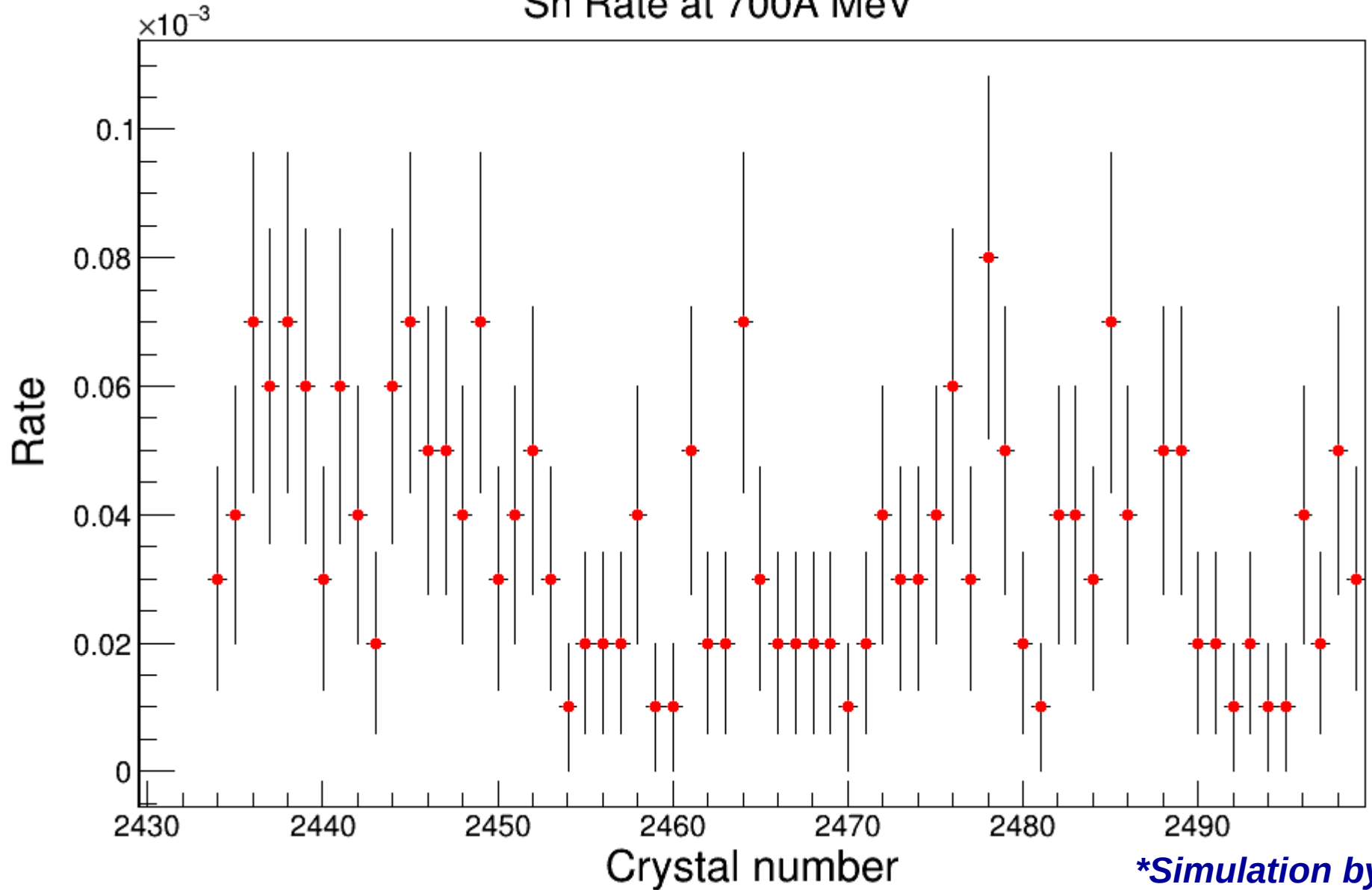
Crystal hits distribution
under illumination from
uniform 2 MeV gammas
with Lorentz boost from
900 AMeV projectile



Simulations started!

CEPA-CsI

^{132}Sn Rate at 700A MeV



****Simulation by
José Luís Rodríguez***

CEPA-CsI

Proposed schedule for the construction of CEPA-CsI full ring

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Final design	■																	
Prototype		■	■	■	■	■	■											
Purchases								■	■	■								
Integration											■	■	■					
Quality check														■	■	■		
Installation																	■	■

Cost estimates for CEPA-CsI full ring

<u>CsI</u> crystals	<u>APDs</u>	Mechanics	Electronics	Others	Total (k€)
155	42	10	25	8	240

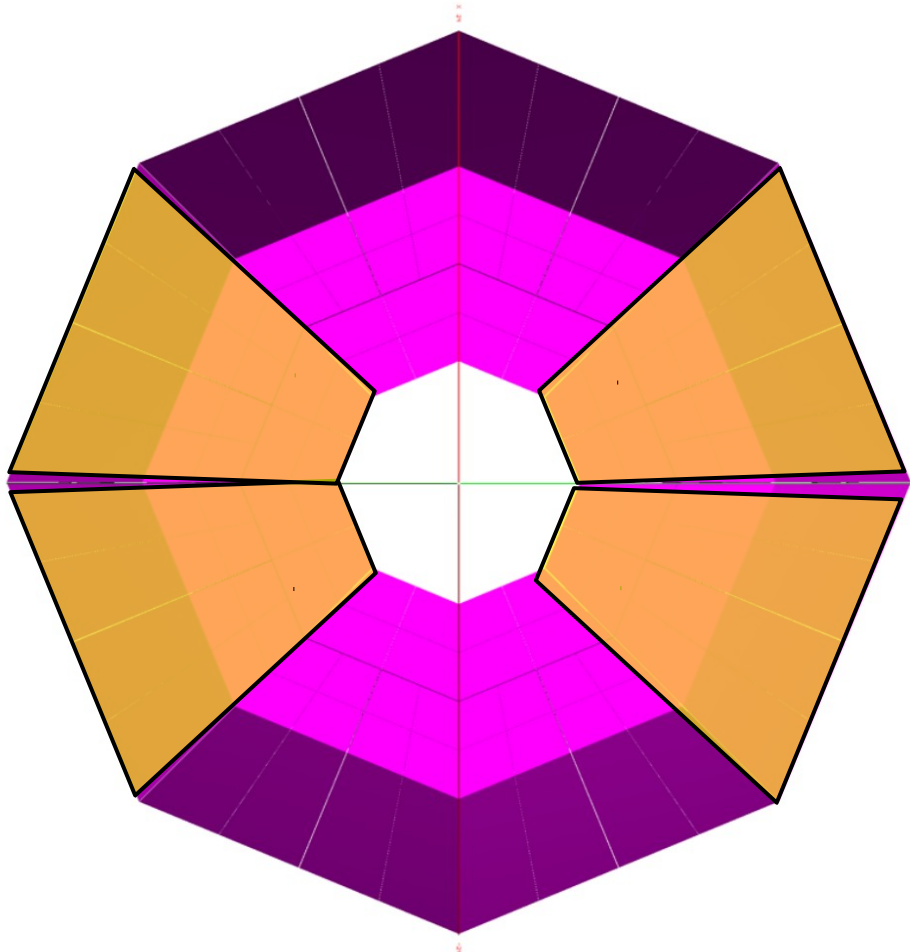
Alternative approaches for CEPA

2 – CEPA-Csl Phase 0

Development for a “Phase 0” section

CEPA-Csl

"Phase 0"



***CEPA-Csl Phase 0
Development***

**Temporary approach of 4 segments
(half ring)**

Current tracker angle coverage

Affordable prize (~140k)

Could be ready for December 2021

...

Alternative approaches for CEPA

3 – An evolved approach:

A new phosphorus configuration of GAGG/CsI

An evolved approach, but:

Keeping the original CEPA idea!

**A phoswich assembly made of
CsI and new GAGG crystals
with APD readout**

Why GAGG/CsI/APD ?

**We know them all
and might fulfill CEPA requirements**

(working on such devices for a different application)

An evolved approach:

A phoswich assembly made of CsI and new GAGG crystals with APD readout

GAGG scintillators properties

Fast rise time: 50 to 150 ns

Emission wavelength: 540 nm

Light yield: 30000 to 54000 ph/MeV

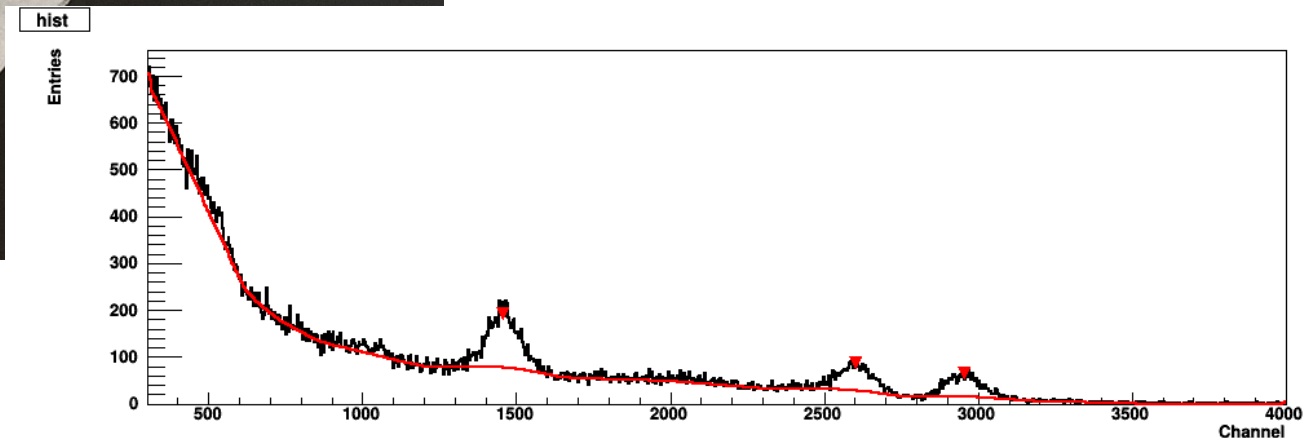
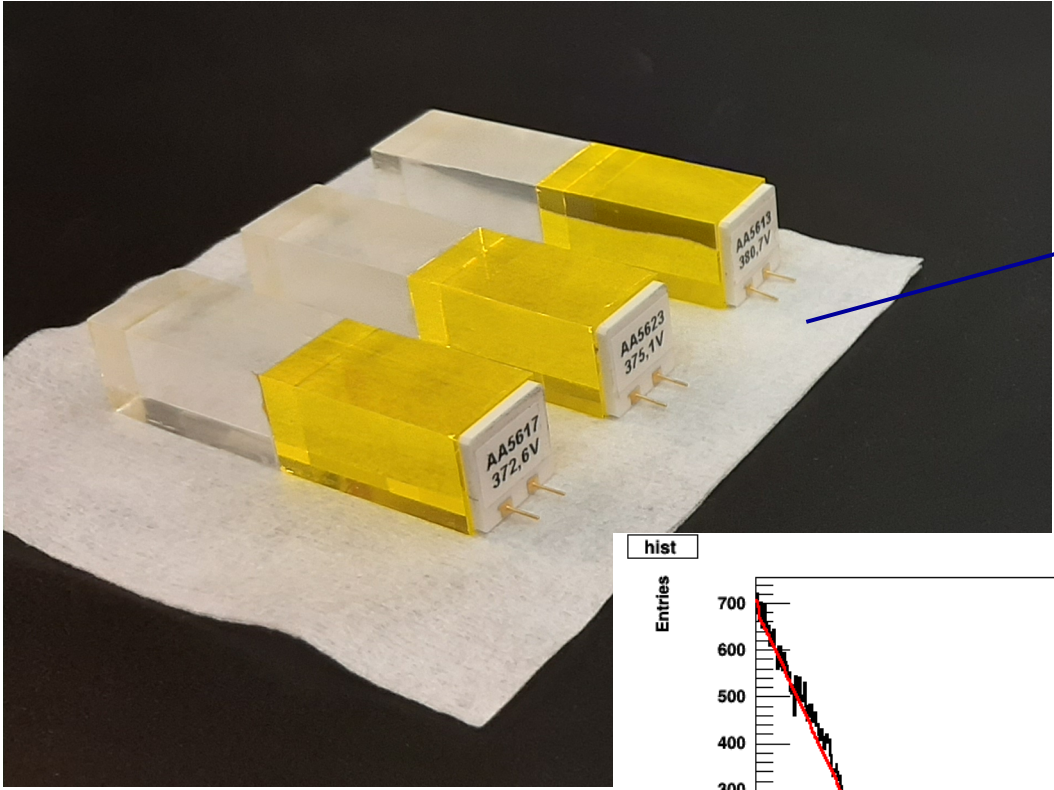
Energy resolution: 4.5% to 7% at 662 keV

Non hygroscopic

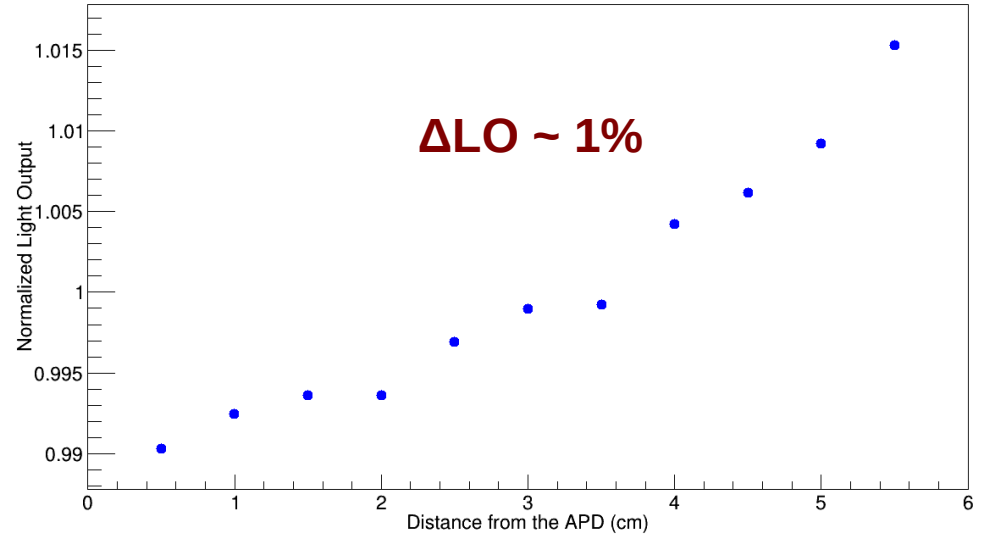
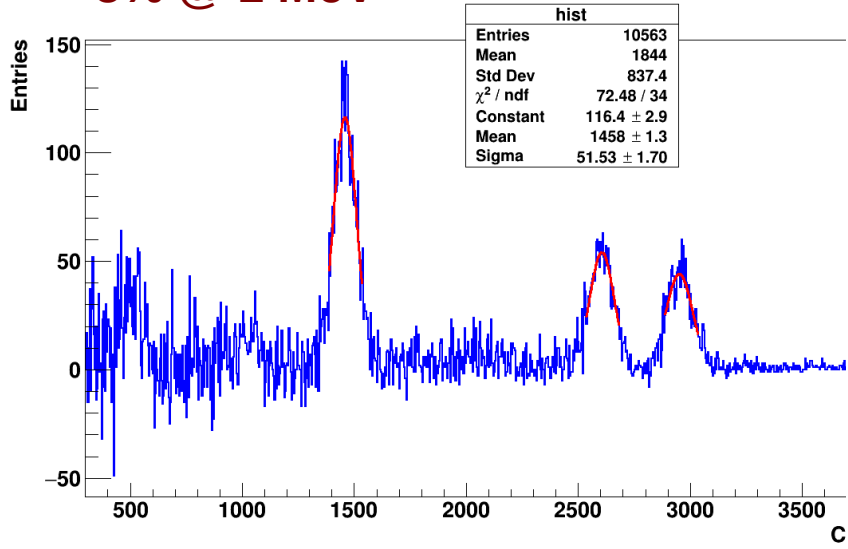
Easy to cut/manipulate

CsI-GAGG-APD Phoswich (15 x 15 x 60 mm³)

Different application!!



5% @ 1 MeV



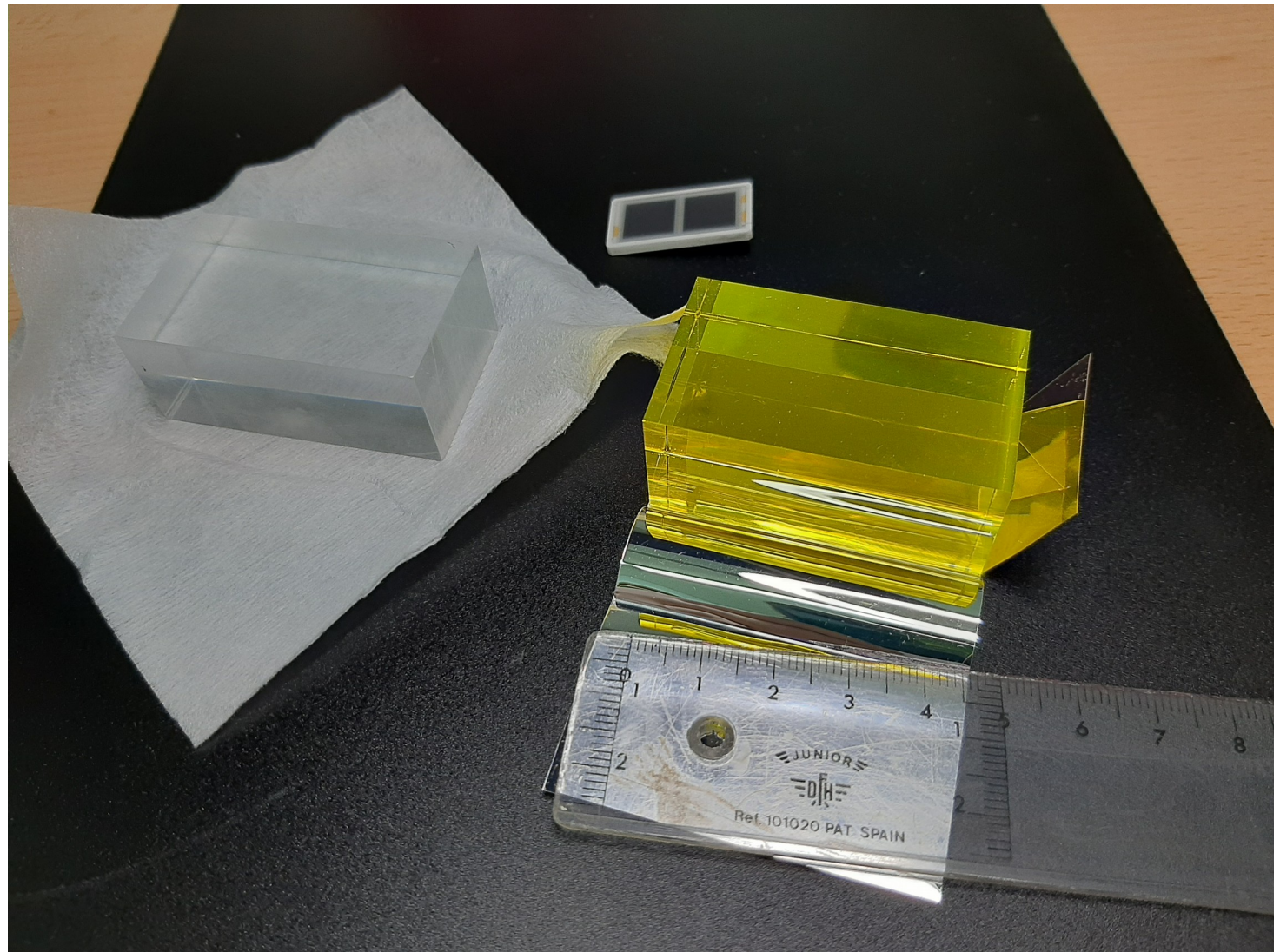
An evolved approach:

A phoswich assembly made of CsI and new **GAGG** crystals with APD readout

*From:
Epic Crystal
Co.,Ltd*

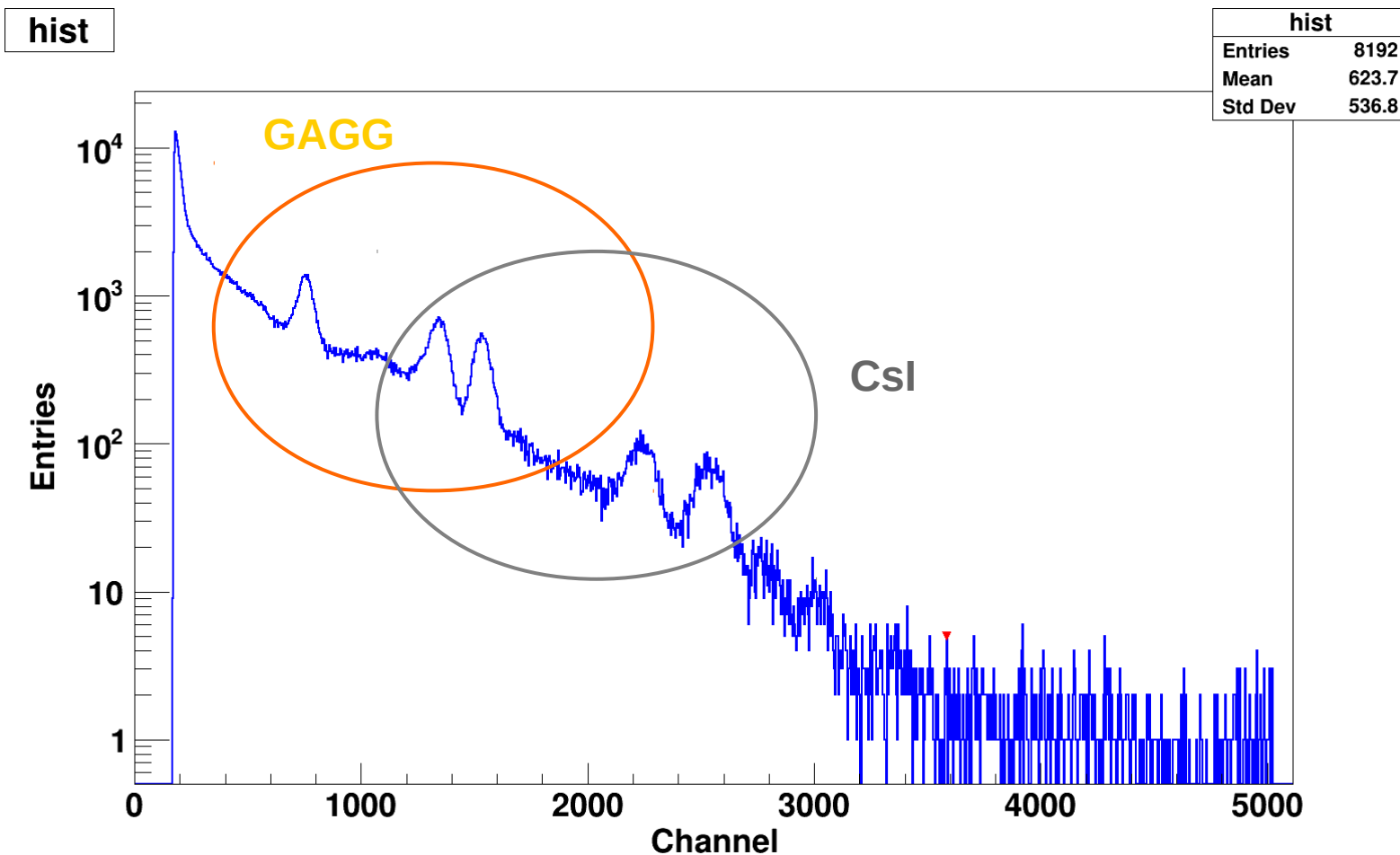
**20 x 30 x 50
mm³**

**$E_{res} < 6\%$
(@ 1 MeV for
each piece)**



An evolved approach:

A phoswich assembly made of CsI and new GAGG crystals with APD readout



An evolved approach:

A phoswich assembly made of CsI and new **GAGG** crystals with APD readout

PROs	CONs
APD readout	APD readout → PreAmps needed
Expected better energy resolution for punch-through protons	Adapt DAQ and electronics (Dual range PreAmp?)
Timing measurement for gammas ?	GAGG crystals are rather expensive (~80 euro/cm ³)
Improved Acceptance	...
...	...

A different approach:

A phoswich assembly made of CsI and new GAGG crystals with APD readout

Proposed schedule for the construction of a CEPA-GAGG (assuming previous CEPA-CsI).

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
GAGG crystals design	■																
GAGG purchases		■	■	■	■	■	■										
CsI crystals disassembly		■	■														
CsI crystals cut				■	■	■	■										
Phoswich Integration								■	■	■	■	■					
Quality check													■	■	■		
Installation																■	■

Cost estimates for CEPA-GAGG (assuming previous CEPA-CsI)

	Crystal s	APDs	Mechanic s	Electronics	Others	Total (k€)
CEPA-CsI	155	42	10	25	8	240
CEPA-GAGG	540				20	560
						800

Assuming 35% GAGG – 65% CsI in volume

Our proposal in short:

1 - Set up CEPA-Csl Phase 0 by Dec. 2021

2 - Meanwhile, R & D in CEPA-GAGG/Csl

3 - Recycle CEPA-Csl to go to CEPA-GAGG/Csl