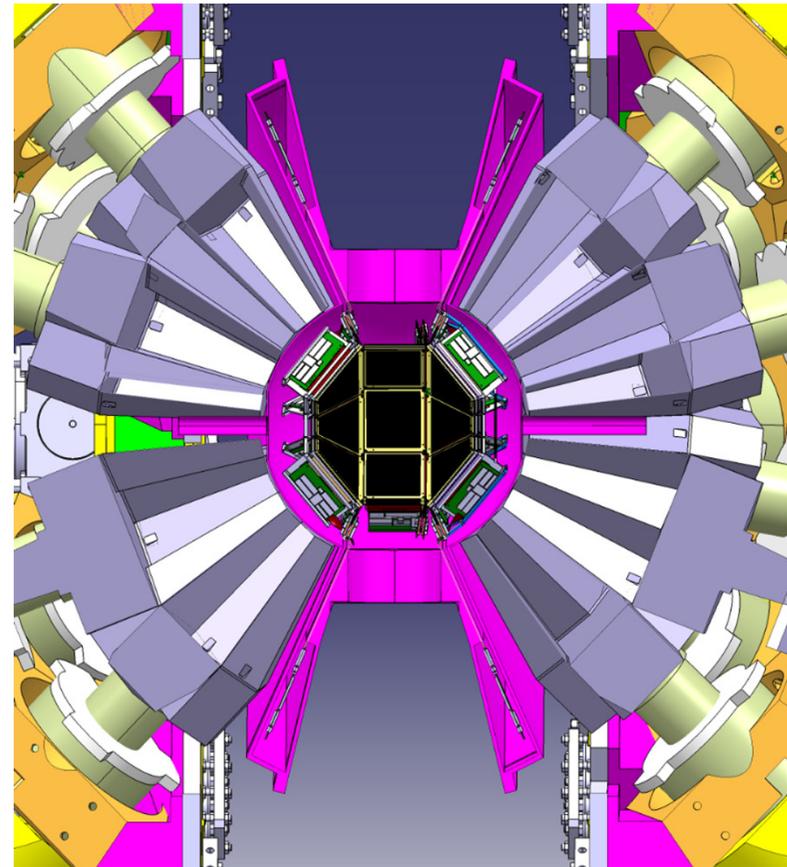
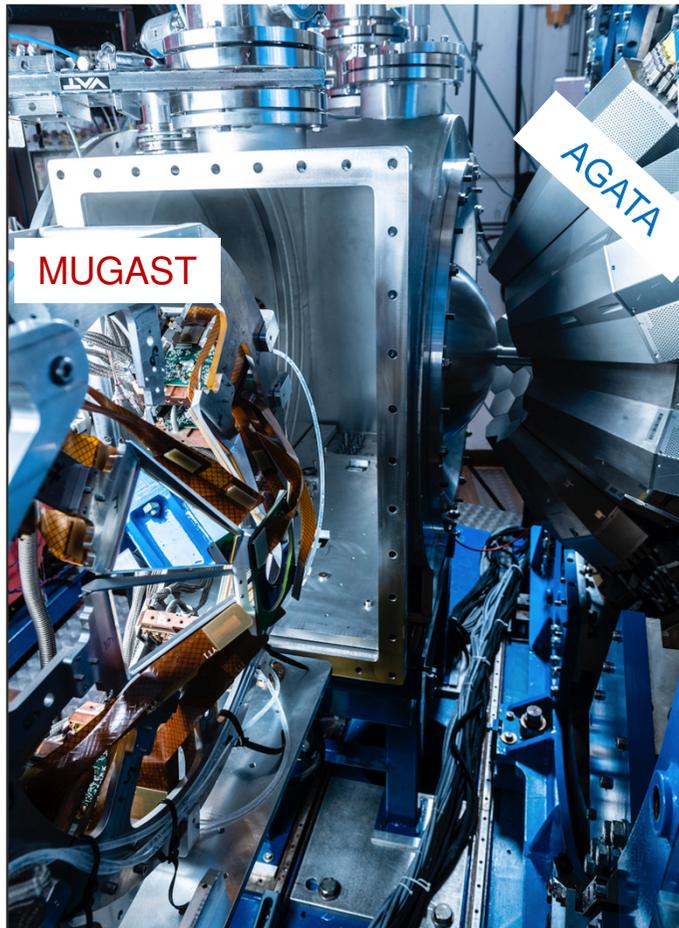


# GRIT

Granularity, Resolution, Identification, Transparency  
**Status and timelines**

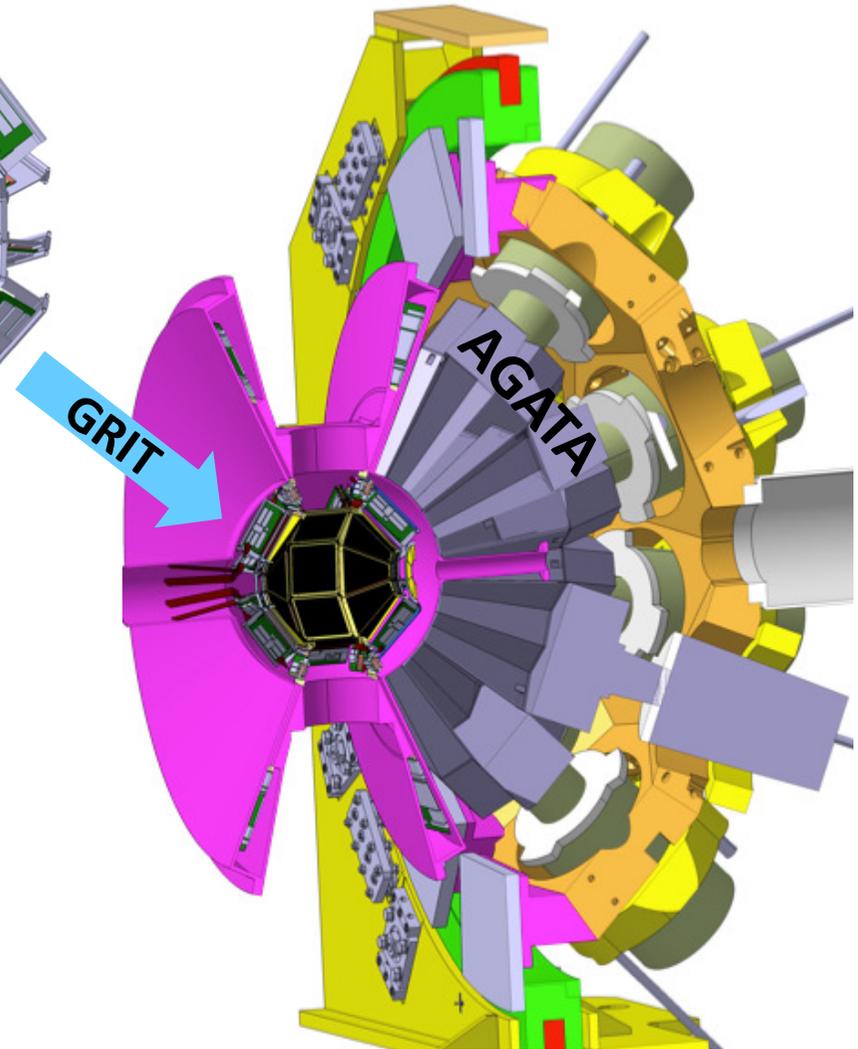
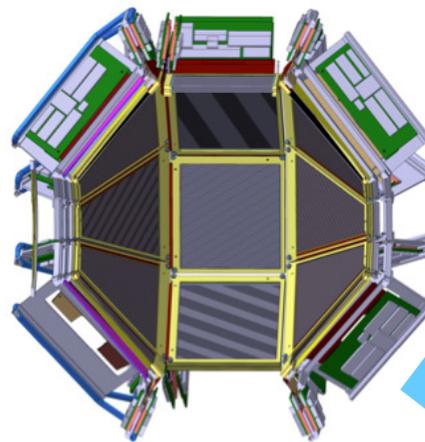
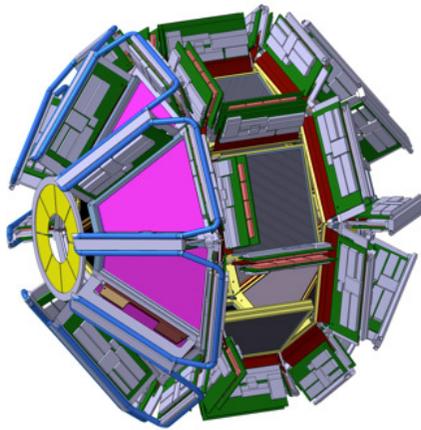


D.Beaumel, IPN Orsay

# The GRIT project

(Granularity, Resolution, identification, Transparency)

$4\pi$  Si array fully integrable in AGATA & PARIS



- High efficiency for particles
- High granularity (strip pitch < 1 mm)
- Large dynamical range

## Layers of Silicon

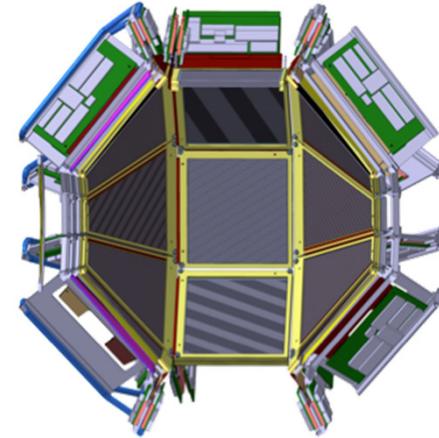
- 500  $\mu\text{m}$  DSSD pitch < 1mm
- 1.5 mm DSSD pitch  $\sim$ 5mm

- Special targets (Cooled  $^3,^4\text{He}$  cell, pure H, tritium)
- PID using Pulse Shape Analysis techniques
- New Integrated electronics

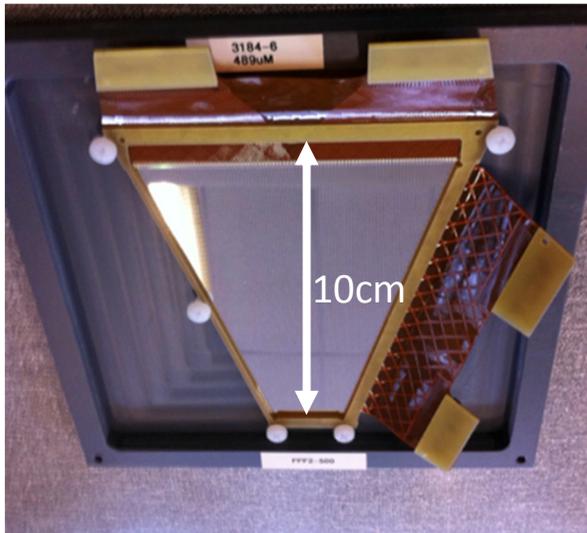
# Detectors for GRIT

## Detectors for the first layer

- Trapezoid and squared geometries
- 6" wafers, 128 X + 128 Y
- Special packaging: very thin frame
- Kapton readout,  $\sim 90^\circ$  w/r surface
- NTD, random cut, reverse mount
- Thin and thick



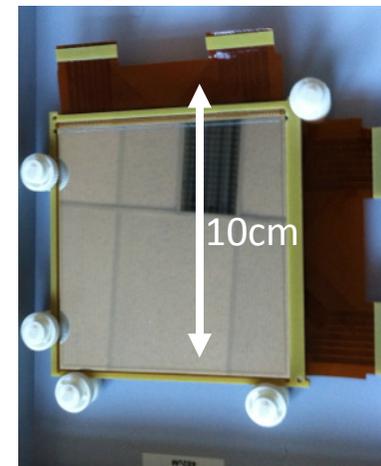
## Trapezoidal DSSD



Commissioned:

- ✓ 2 prototypes 500um IPNO
- ✓ 4 pre-series (Surrey U., IPNO, Santiago) (MICRON SC Ltd., UK)

## Squared DSSD



Commissioned :

- ✓ 2 prototypes 500um INFN (MICRON SC Ltd, UK)

Under development

- ✓ 2 proto 500 um BARC Mumbai (Semiconductor Lab , Chandigarh, India)

***Detectors for the second layer to be developed***



Visit to Micron SL (May 2019)

## PLAN

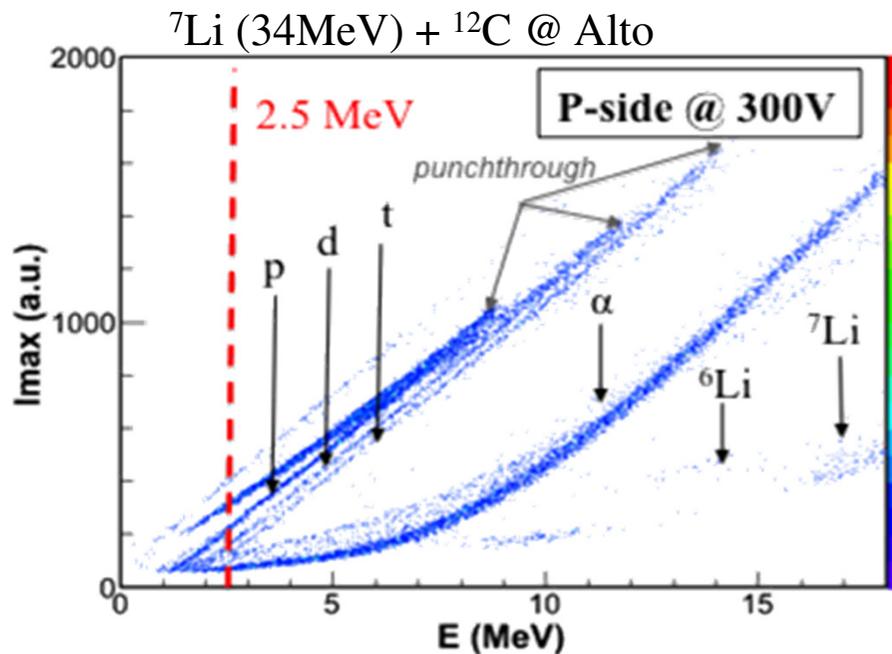
- 2 thin trapezoids for next MUGAST campaign (2019)
- NRF+protos of 2<sup>nd</sup> layer, 1.5 mm thick, Trapez. and Square. (2019)
- Serial detectors (2020~2025)

Support from Normandy region (Grant of F.Flavigny)

# R&D on Pulse Shape Discrimination

Initial detector:

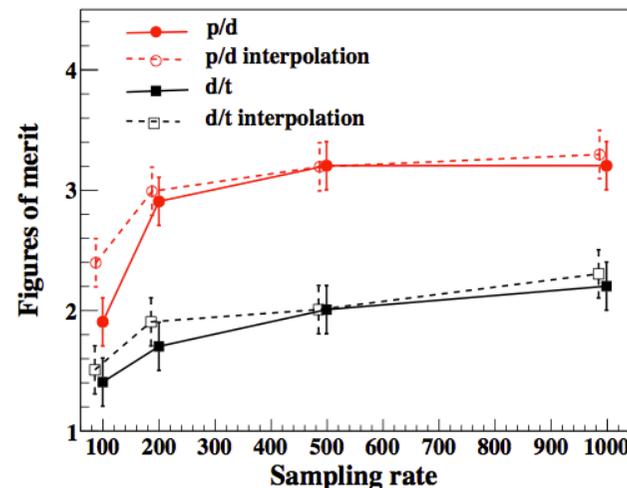
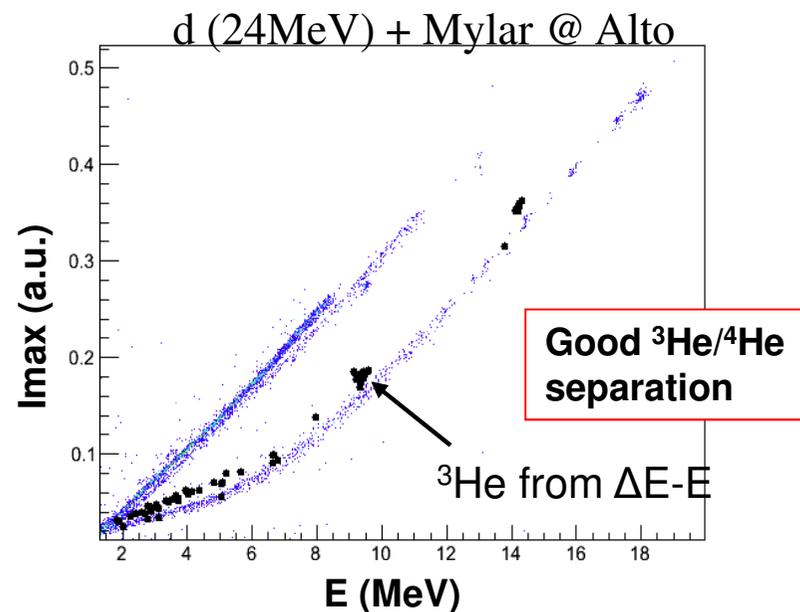
- 500 um nTD DSSD
- 128X+128Y, 8° cut
- Pitch<500um
- Special packaging



New data under analysis

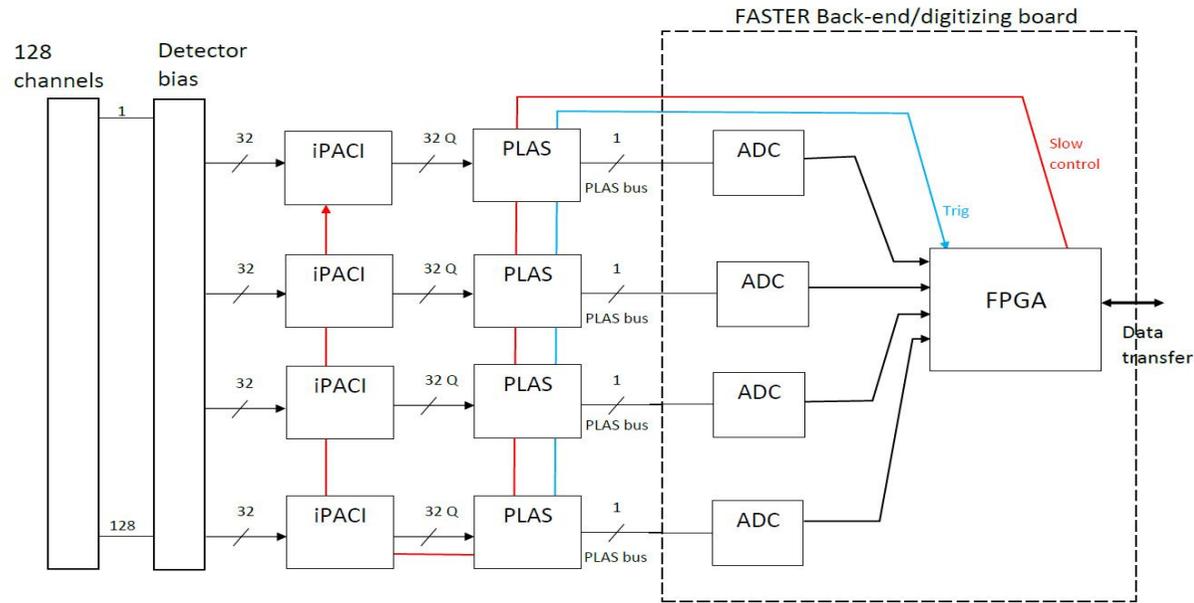
- Test of PSD with trapezoid
- Effect of radiation damage

*Crucial to set electronics specs.  
(e.g. sampling rate,...)*



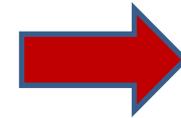
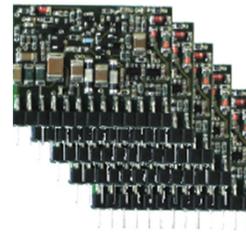
# Electronics of GRIT

## GLOBAL SCHEME

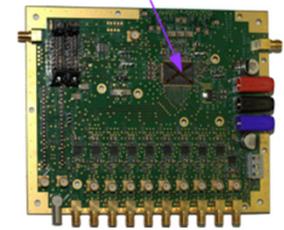


## BUILDING BLOCKS

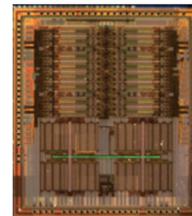
- ASIC version of the PACI preamp. (IPNO) + TOT preamp ASIC for 2<sup>nd</sup> layer (Milano)



iPACI



- **PLAS Analog memory circuit**  
*R.Aliaga et al., NIM A800(2015)*  
Fast sampling analog memory (200Mhz)  
Version 1 available  
Version 2 to be submitted  
LPC Caen now in charge  
Change of technology required



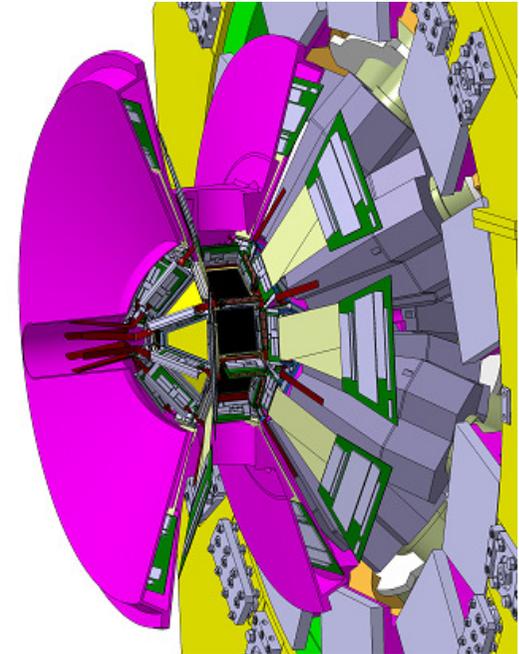
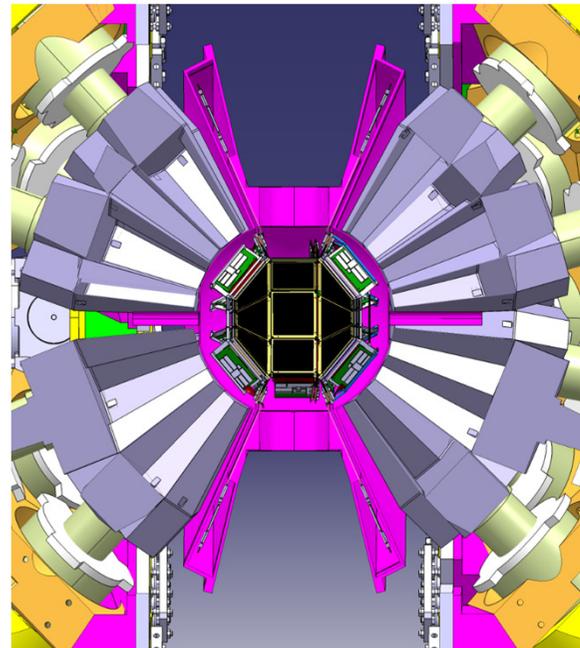
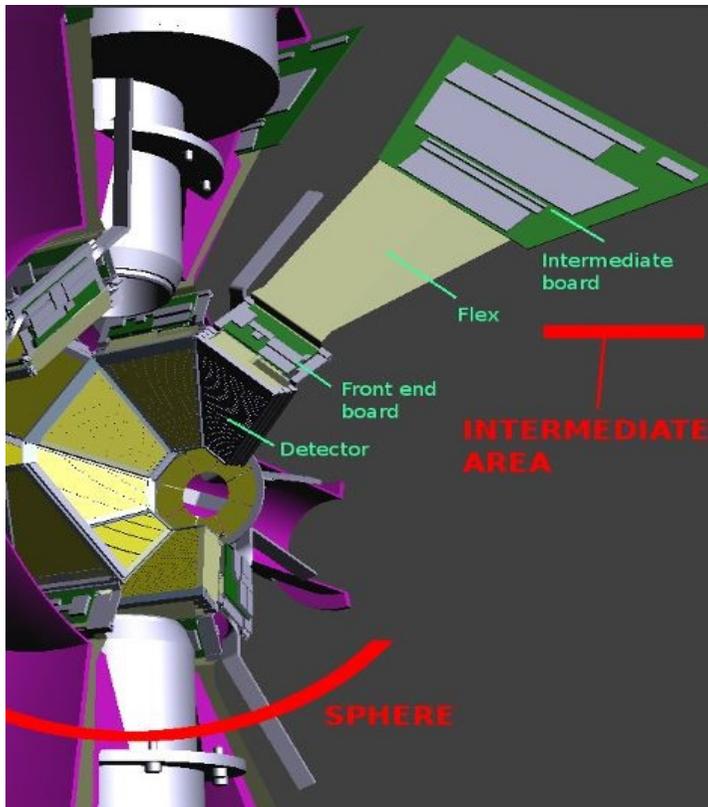
- **FASTER backend**



# GRIT Mechanical design

## Constraints

- AGATA inner radius = 23cm
- Transparency to gamma-rays
- Special targets integration (CHyMENE, Orsay He)
- 7000 electronics channels
- FEE under vacuum -> few KW
- Connectics and feedthroughs
- ...



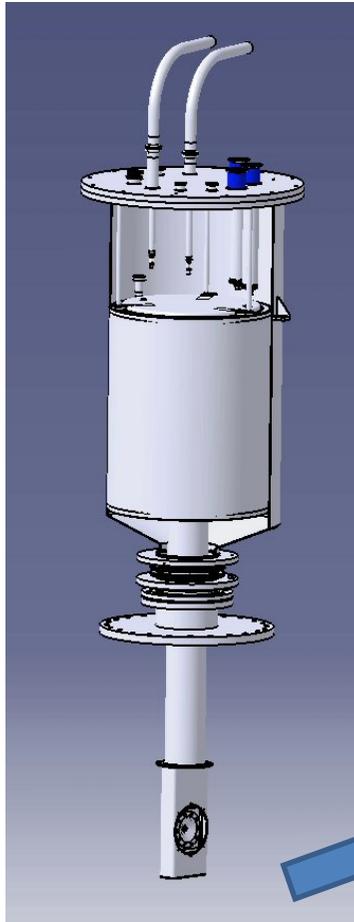
- Preliminary detailed design was achieved
- Final version to be completed (IPN Orsay)

# Special targets for GRIT

## The Orsay Helium target

Cooled gas cell at  $T \sim 5\text{K}$

$^4\text{He}$  and  $^3\text{He}$  versions

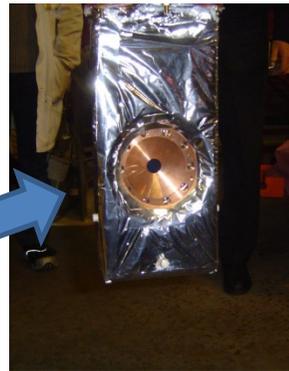


### Reactions with $^{3,4}\text{He}$ probe

- $(^3\text{He},d)$  proton shell evolution
- $(^3\text{He},p)$  for np pairing
- $(^4\text{He},^3\text{He})$  for neutron shells selective for high-L orbitals Complementary to  $(d,p)$

....

$\varnothing$  16 mm,  
2-3mm-thick cell  
Havar windows  $3.8\mu\text{m}$   
 $T = 5\text{K}$ ,  $P = 1\text{ bar}$



### Status:

- $^3\text{He}$  version has been developed
- Used in MUGAST-AGATA campaign at GANIL

## The CHyMENE system

Continuous extrusion of  $^1\text{H}$  or  $^2\text{H}$  through an extruder nozzle

Collaboration: CEA/IRFU Saclay

(project coordinator: A. Gillibert)

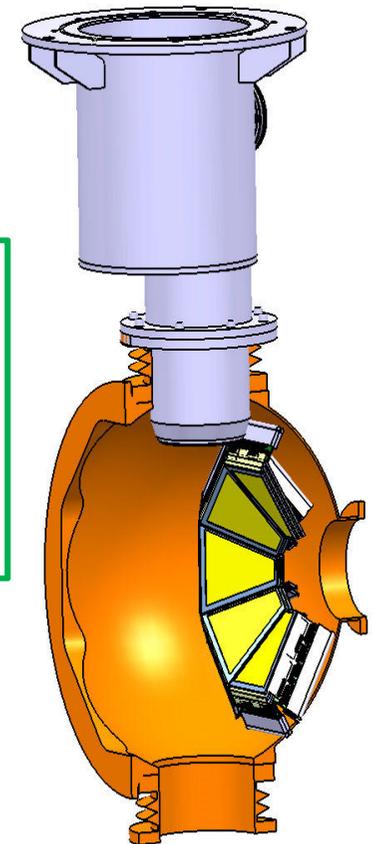
CEA/DAM Bruyères, IPN Orsay

Funded by the French agency ANR

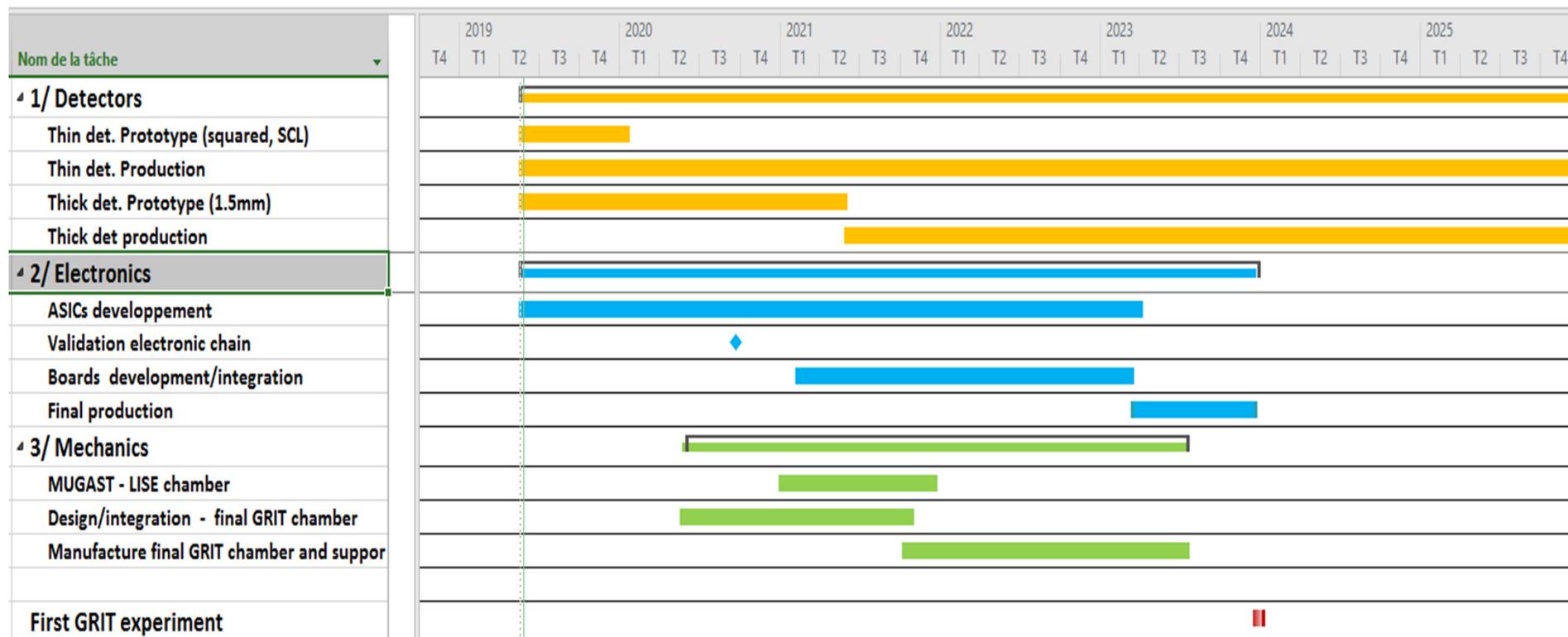
Suppression of  $^{12}\text{C}$ -induced background (in CH<sub>2</sub> and CD<sub>2</sub> targets)

### Status:

- Tested under beam at ALTO in May 2019  
20 and 100  $\mu\text{m}$   $^1\text{H}$
- $^2\text{H}$  version to be developed



## Gantt chart for GRIT development and construction



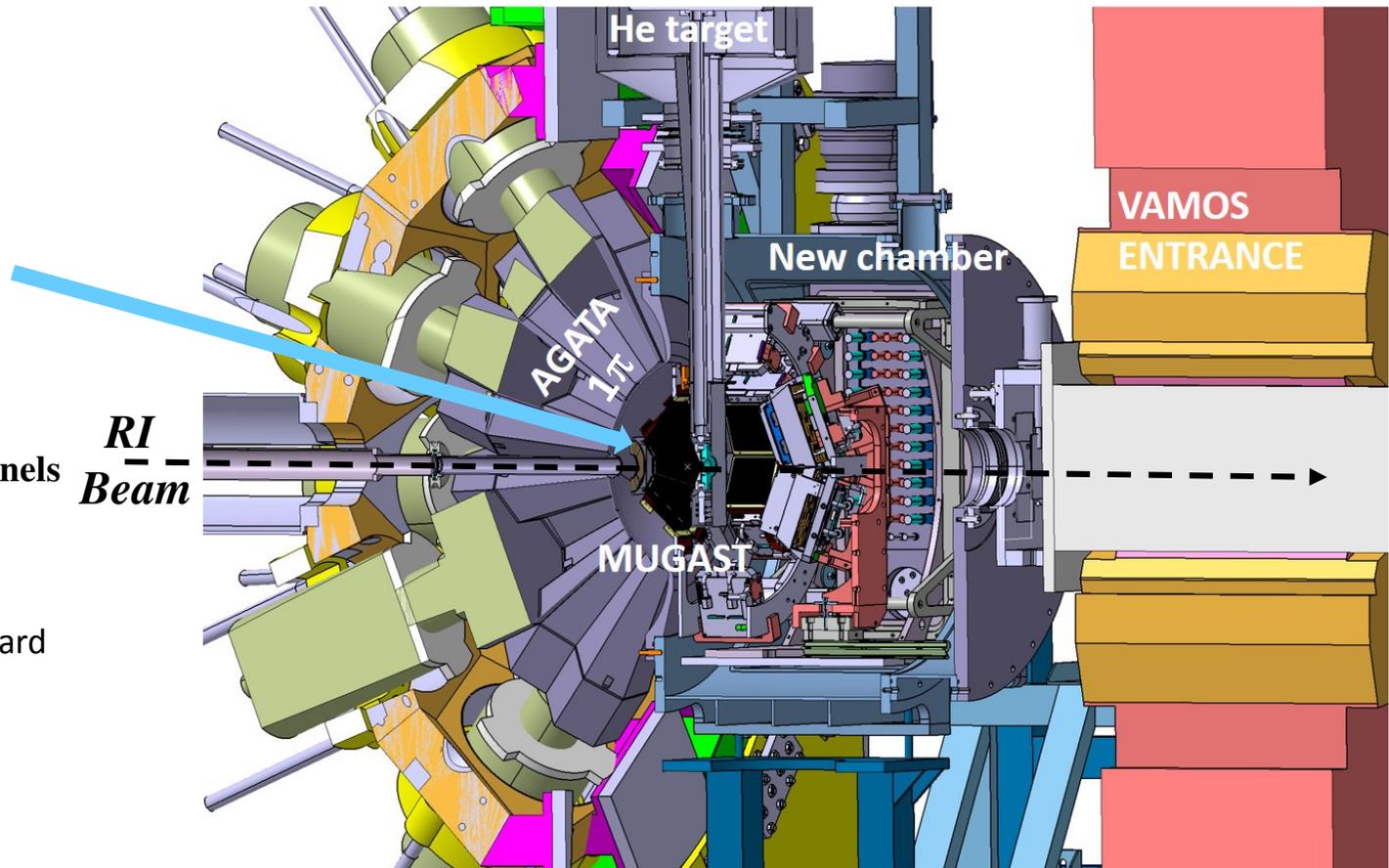
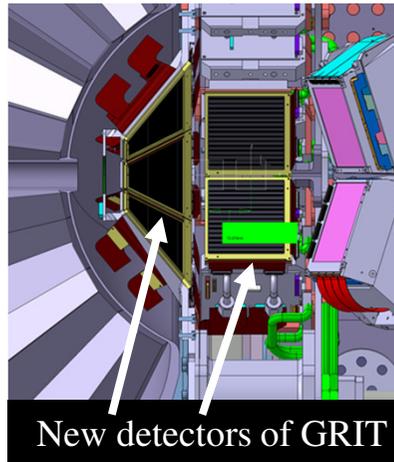
### Major developments

- Si detectors
  - In close collaboration with MSL (UK), and Mumbai (SLC Chandigharg, India)
- Electronics
  - Main developments by In2p3 IT's (iPACi, PLAS, boards,connectics) and use of FASTER backend (LPCC)
- Mechanics
  - Challenging design (Detectors, targets and FEE integration, cooling, connectics), to be performed at IPN Orsay

# MUGAST: an intermediate step towards GRIT

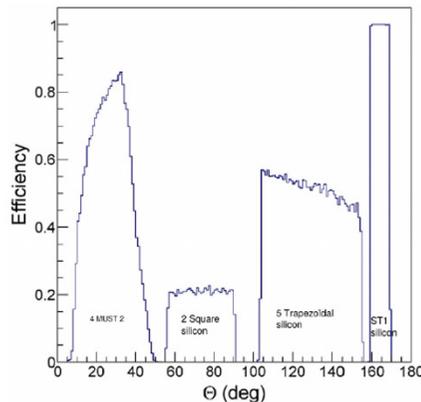
- MUGAST:**
- New detectors of GRIT + MUST2 electronics + few telescopes
  - Coupled with AGATA @ VAMOS

⇒ **First High resolution Direct Reactions studies at Ganil (SPIRAL1 beams)**



~ 3000 channels  
**MUGAST configuration:**

- 5 trapezoids backward
- 2 Squared around 90deg.
- 4 MUST2 telescopes forward

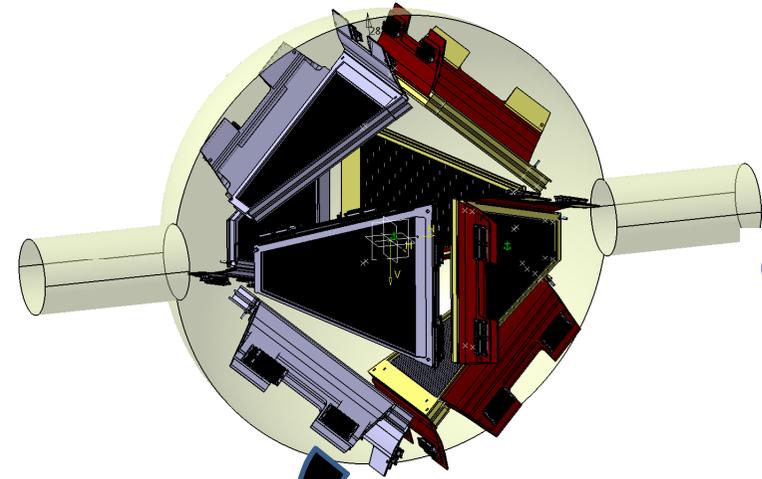
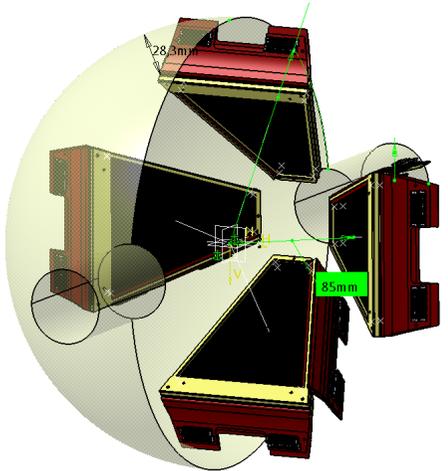


Efficiency for 1 $\pi$  AGATA : ~10% at 1 MeV

Funding: In2p3+P2iO, Surrey, INFN,  
 GANIL, Santiago

**First Campaign in 2019**  
 Coordinator: *M. Assié, IPNO*

# A MUGAST-EXOGAM configuration (Conceptual design)

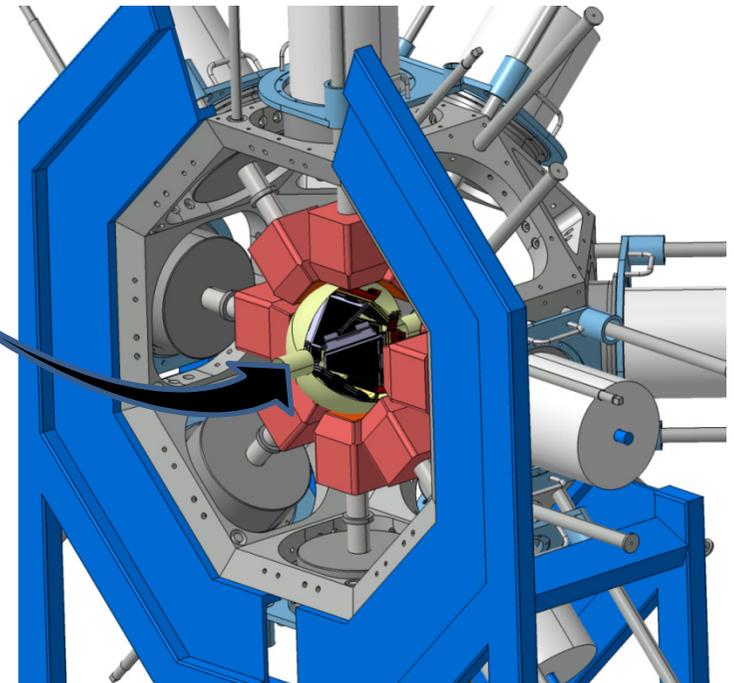


Chamber radius: 150mm  
 $D_{\text{target}} = 85\text{mm}$

- Conceptual design based on the use of 2x4 GRIT Trapezoids (2 layers : 0.5+1.5mm)
- MUST2 FEE to be deported upstream and/or downstream the detectors

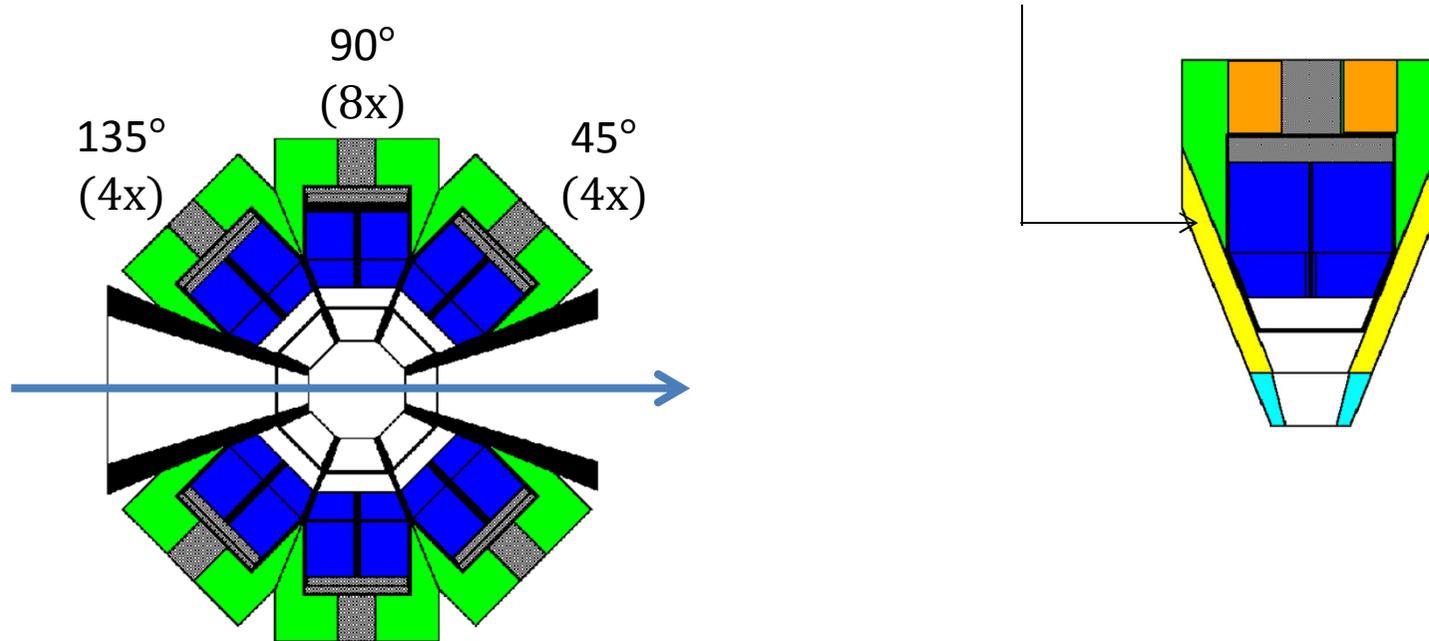
Developments needed :  
New chamber and new det↔FEE connectics

Design: E.Rindel



# EXOGRAM

2 configurations with 16 detectors : with(B) or w/o(A) side shield



	Photopeak efficiency (%)		Peak-to-total (%)		$D_{\text{target}}$ (mm)
	662 keV	1.3 MeV	662 keV	1.3 MeV	
EXOGRAM configuration A <sup>a</sup>	28	<b>20</b>	57	47	<b>115</b>
EXOGRAM configuration B <sup>b</sup>	17	<b>12</b>	72	60	<b>150</b>
Gamma-Cube <sup>c</sup>	15	<b>10</b>	72	60	<b>68</b>

(GEANT calc.)

## Present: MUGAST@GANIL/VAMOS

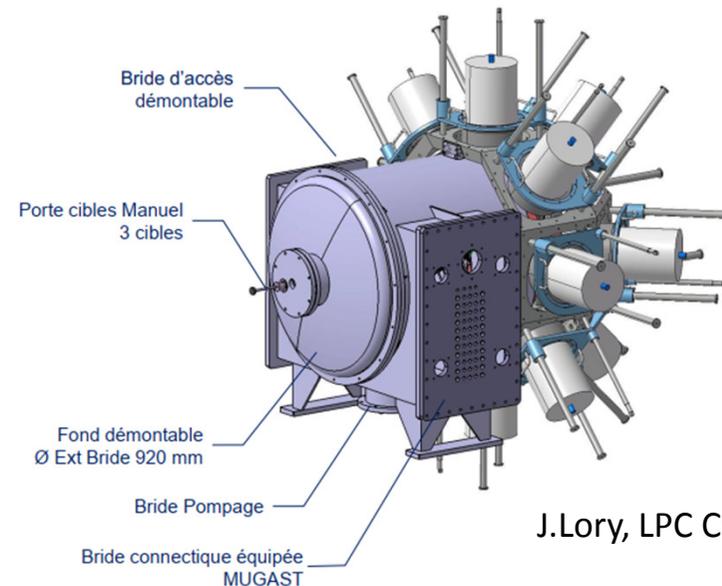
First step towards  
GRIT

- Positive scientific evaluations
  - ✓ GANIL PAC
  - ✓ GANIL Scientific committee
  - ✓ IPNO Scientific committee
- Selected for AGATA campaigns at GANIL in 2019 and 2020

## Next Step: MUGAST@GANIL/LISE

A new compact, 2-layer Si configuration  
12 EXOGAM modules at 15cm from target

- Detectors for 2<sup>nd</sup> layer (1.5mm)  
*Status: to be ordered in 2019-20*
- New chamber /connectics  
*Status: Designed / to be designed*



	2019	2020	2021	2022	2023	2024 ~
MUGAST@VAMOS	➤➤➤					
MUGAST@LISE				➤		
GRIT (SPES, GANIL, Isolde, Ariel, RIKEN, FAIR ?)						➤