

# The development and beam test result of high granularity crystal calorimeter prototype of VLAST

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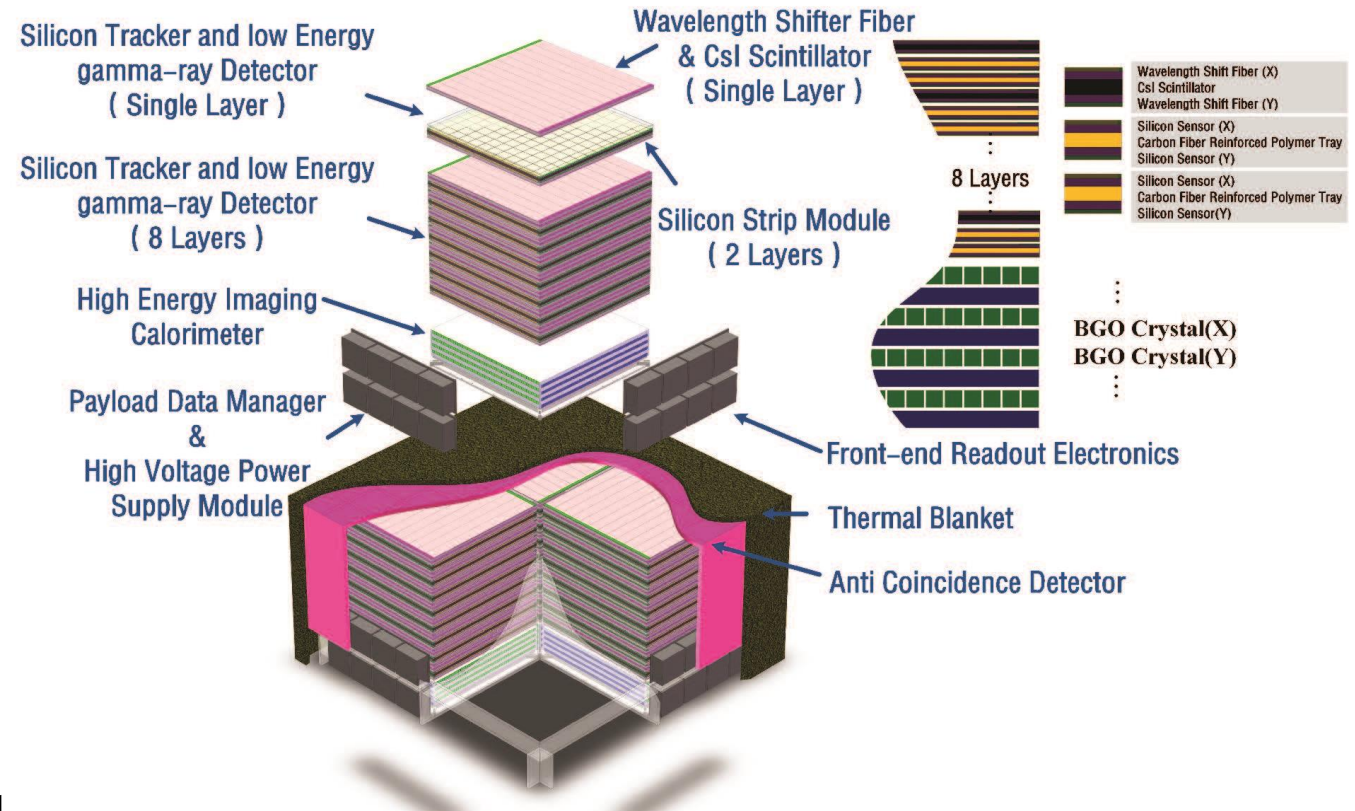


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# VLAST project

- **Very Large Area gamma ray Space Telescope** is expected to have greater acceptance and effective area, therefore it will become a powerful alternative for the next generation of high-energy gamma ray astronomical observations in the universe.
- Physical objective:
  - Explore the generation, propagation, and interaction processes of cosmic rays;
  - Search for existence evidence and line spectrum about DM particles;
  - Discover the origin of extreme high-energy astronomical phenomena;



item	material	energy range	sensitive unit size
ACD	plastic scintillator	electron, light nuclide	300 mm × 300 mm
STED	8 × (CsI + 2 × XY silicon microstrips)	1 MeV – 100 MeV	100 mm × 100 mm
HEIC	BGO crystal (strips or cubes)	0.1 GeV – 20 TeV	25 mm × 25 mm × (1200 mm or 25 mm)

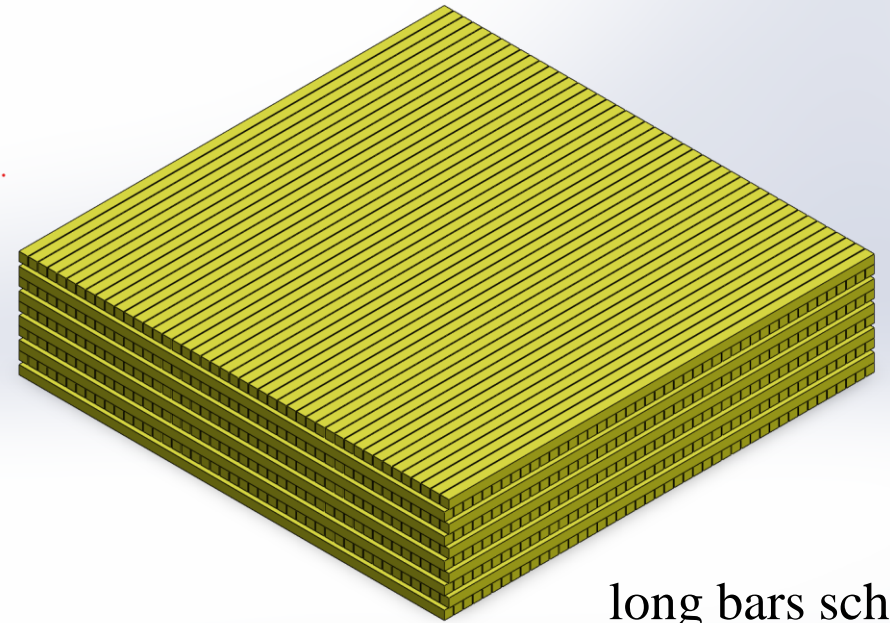


# High Energy Imaging Calorimeter

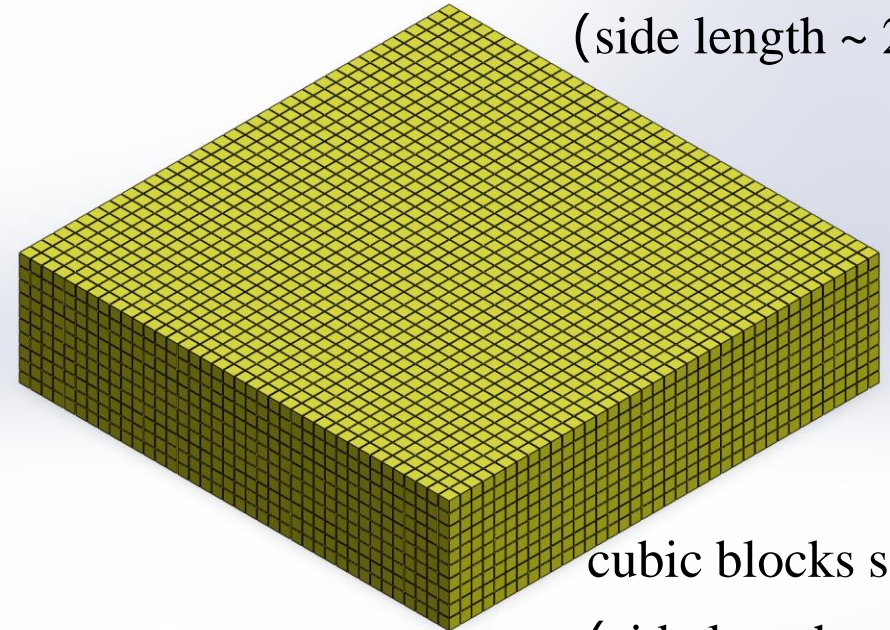
- Sensitive material: BGO crystal;

BGO quantity	value	unit
Z/A	0.42065	mol/g
density	7.130	g/cm <sup>3</sup>
minimum ionization	8.918	MeV/cm
nuclear interaction length	22.32	cm
nuclear collision length	13.49	cm
radiation length	1.118	cm
Molière radius	2.259	cm

- If the long crystal bar scheme is adopted, it will be the first time that meter sized crystals have been applied in experimental detection;
- If the cubic crystal block scheme is adopted, the structure is easier to expand, the **shower profile description** is simpler and clearer, and it has the potential for **side incident particles reconstruction**;



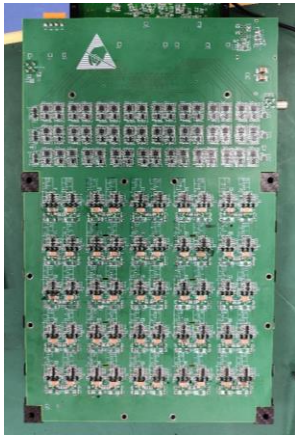
long bars scheme  
(side length ~ 25 mm)



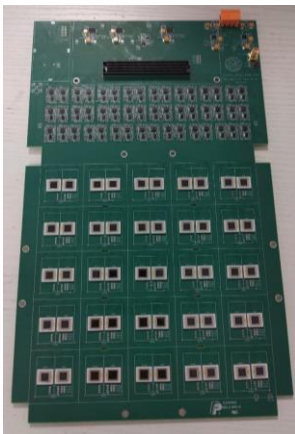
cubic blocks scheme  
(side length ~ 1.2 m)

# Cubic HEIC prototype

PAM Amp. side

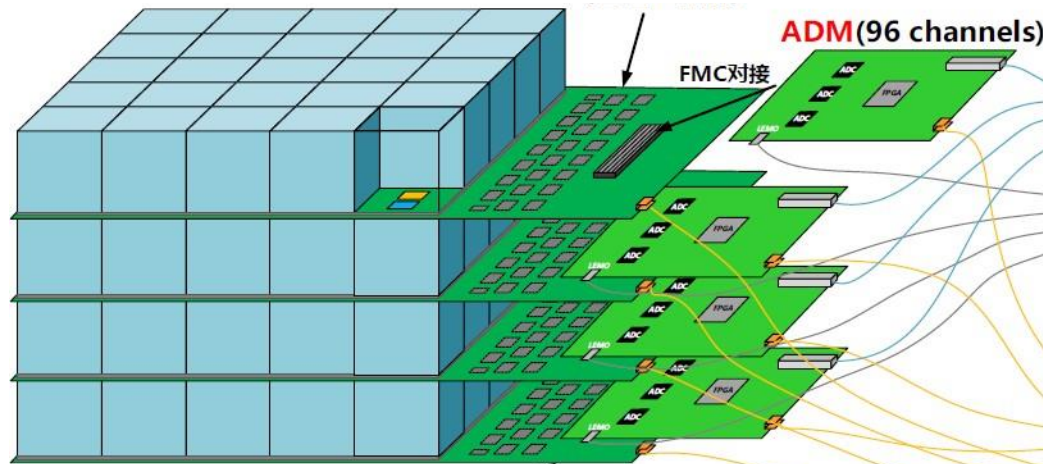


PAM APD side

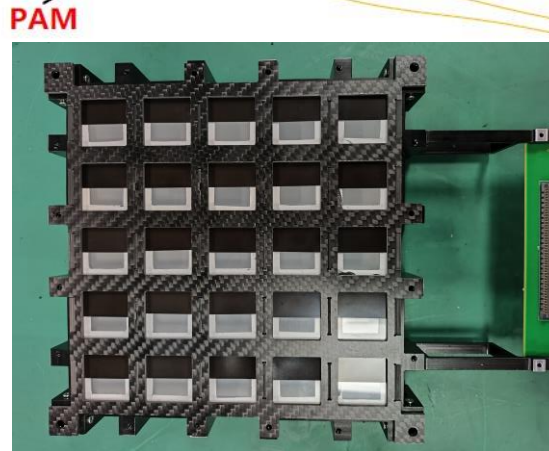


BGO crystal array:  
side length: 30 mm;  
(5 × 5) × 4 layers

high gain and low gain;  
differential drive;  
(PAM both side)



APD type:  
HAMAMATSU  
S8664-55  
large dynamic range  
by plastic filters

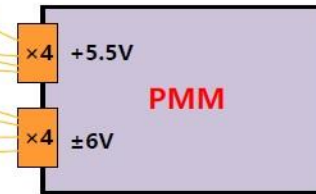
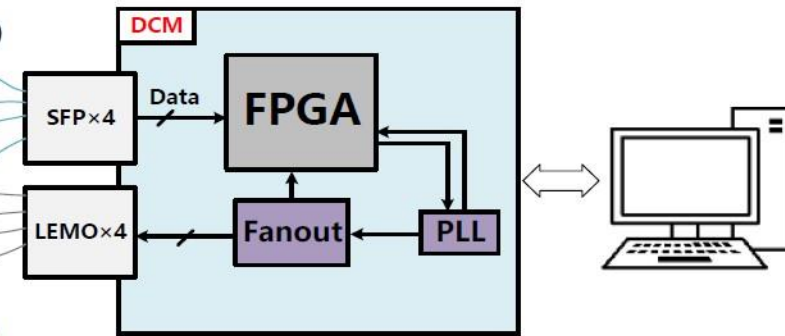


PAM (前放)  
Pre-Amplifier Module

ADM (数字化)  
Analog-to-Digital Module

PMM (电源管理)  
Power Management Module

DCM (数据汇总)  
Data Concentrator Module



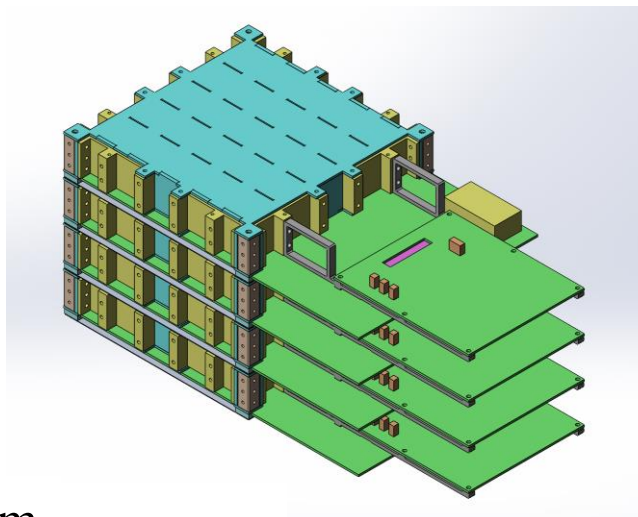
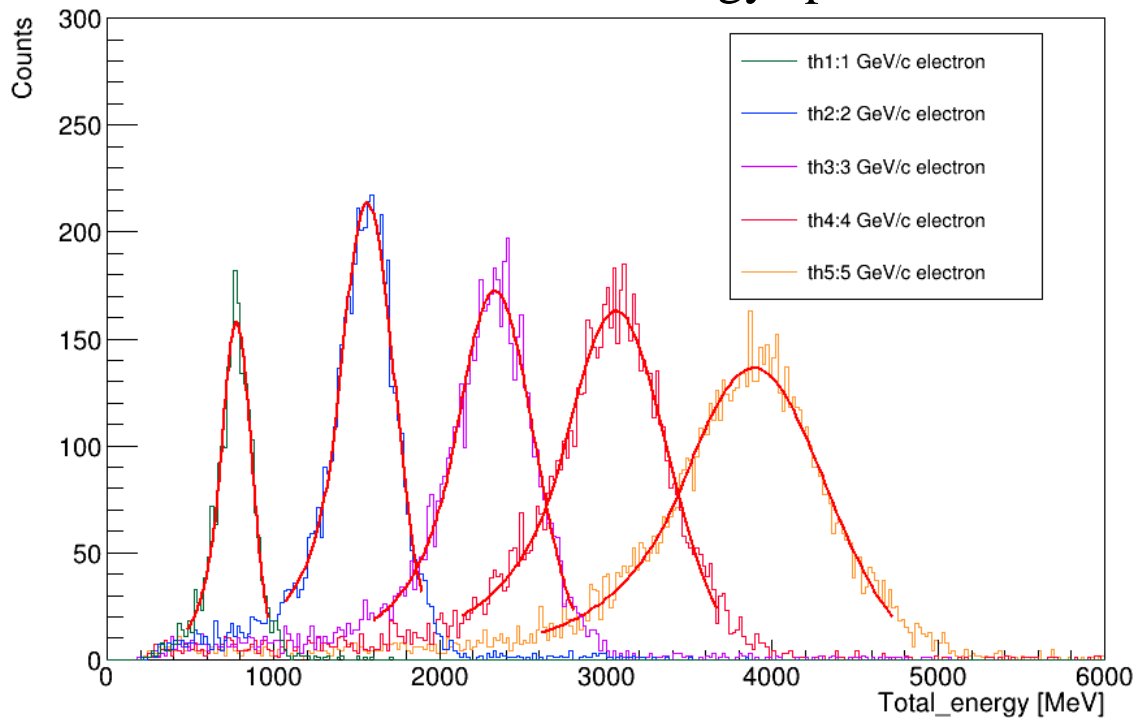
detector dimension: 192 mm × 192 mm × 158 mm



# HEIC-4 layers

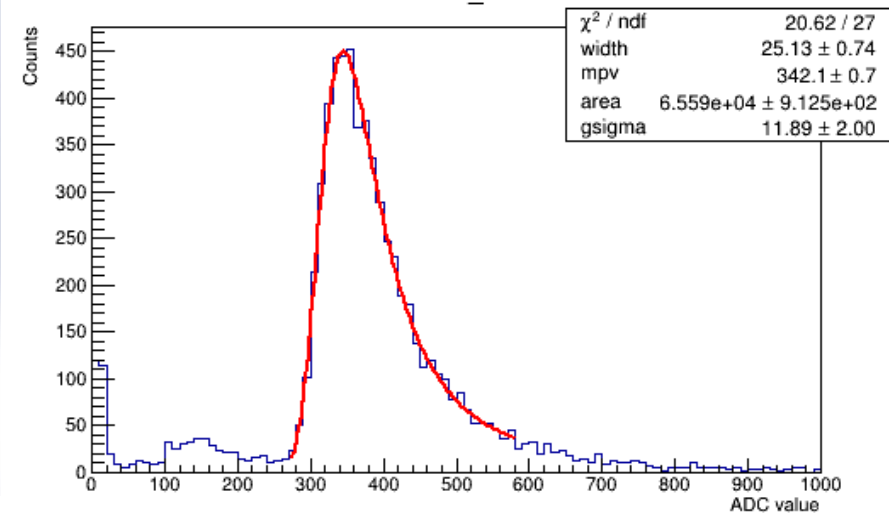
- Beam test in Sep. 2023 at PS @ CERN

1~5 GeV electron energy spectrum

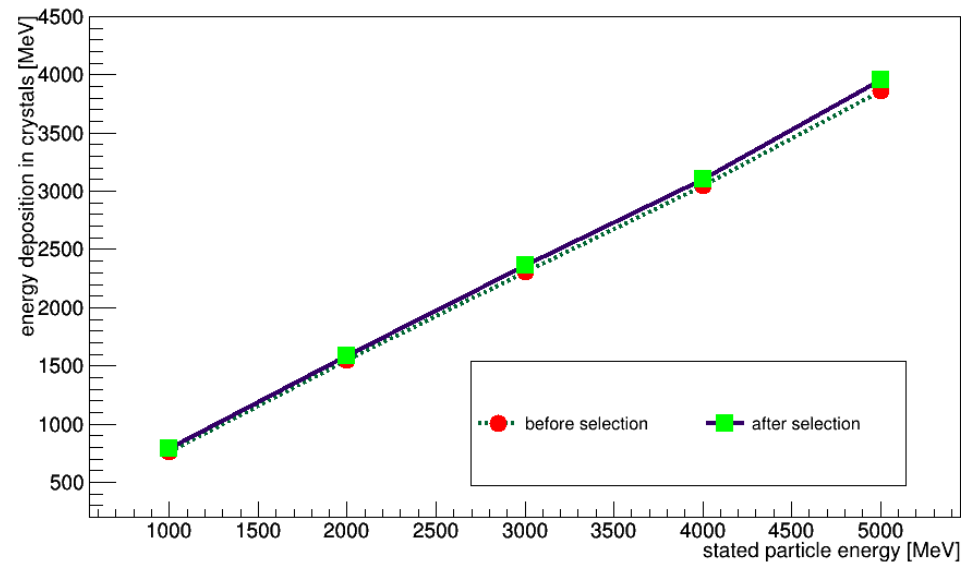


MIPs signal in high gain no filter channel

HH12\_L4



energy linearity



energy resolution ~ 10%

# summary



This report consists of the following contents:

- Very Large Area gamma ray Space Telescope (VLAST) is the next generation of flagship space observatory;
- We attempted to design a prototype of High Energy Imaging Calorimeter composed of cubic BGO crystal;
- We sent the prototype to CERN for beam test, 4-layers configuration in 2023 and 10-layers in 2024, and data analysis is still ongoing;

