The High Energy cosmic Radiation Detection (HERD) Facility onboard China's Future Space Station

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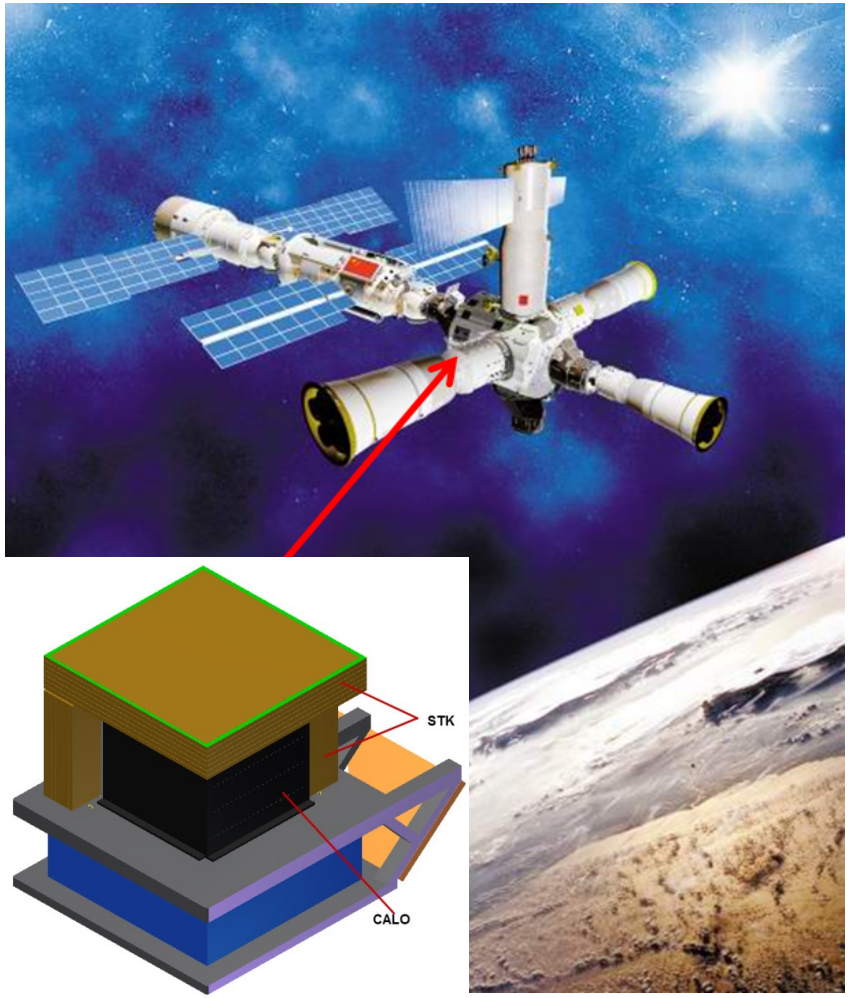
The 28th Texas Symposium on Relativistic Astrophysics
Geneva
17 December 2015

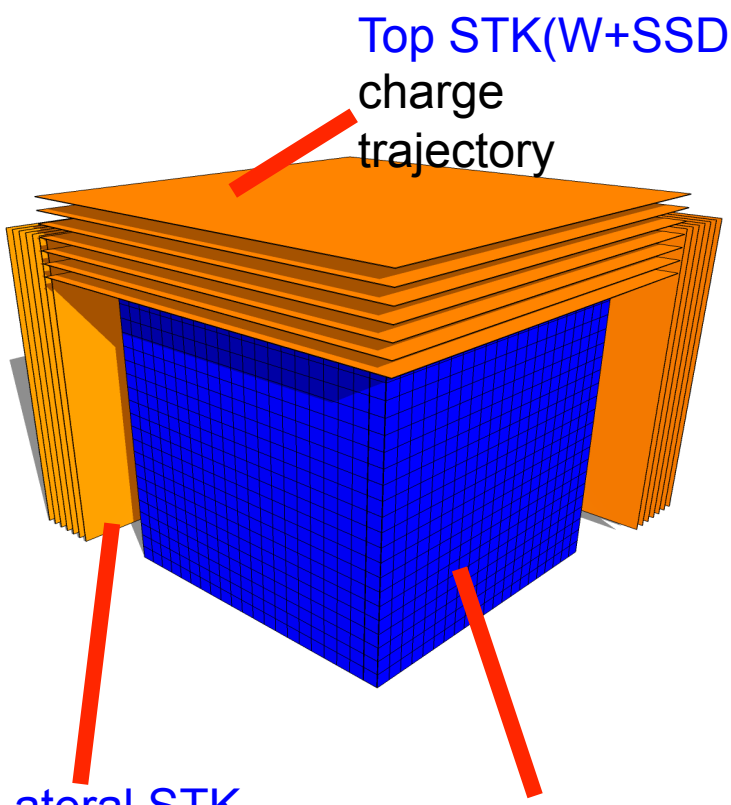
Introduction



- One of several space astronomy payloads of the cosmic lighthouse program onboard China's Future space station.
- Planned for operation starting around 2020.
- Designed as a next generation space facility focused on:
  - indirect DM search (Better statistical measurements of e/γ between tens of GeV to 10 TeV)
  - Origin of Galactic CR (precise spectrum and composition measurements from 100GeV up to the knee energy)
  - Gamma-ray astronomy (including survey, polarization, monitoring of GRBs, down to 100MeV,)

HERD specifications

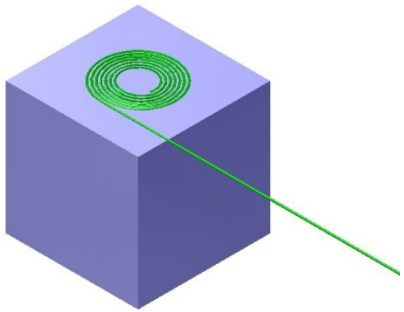
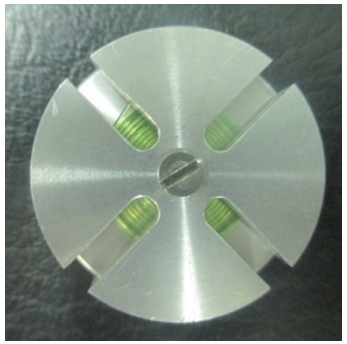
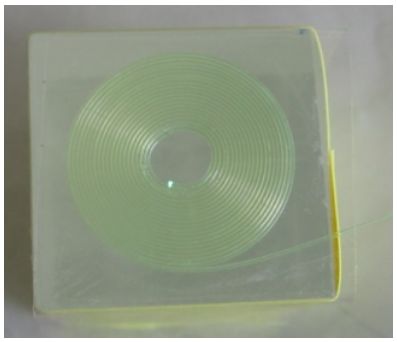
traditional 'top-down" style➔
3D & 5 side sensitive,
improve Acc.



Key & new tech.	High granularity calorimeter with ICCD readout
Calorimeter	10^4 cubic LYSO crystals, 3*3*3 cm^3 each, 55 X0 , 3 λ0
Silicon Trackers	7 layers sandwiched with W on all five sides, 2 X0
Energy resolution(e)	< 1% @ 200 GeV (sensitive range: 100 MeV - 10 TeV)
Energy resolution(p)	20% @ 10 GeV – 1 PeV
Acceptance (e/γ)	3.8 m^2sr @ 200 GeV
Acceptance (p)	2.6 m^2sr @ 100TeV
e/p separation	< 10^{-5}
Charge resolution	0.1 c.u.
Angular resolution	0.1° (>10GeV)
Weight	~2800 kg
Power	~1500 W

Technical solution

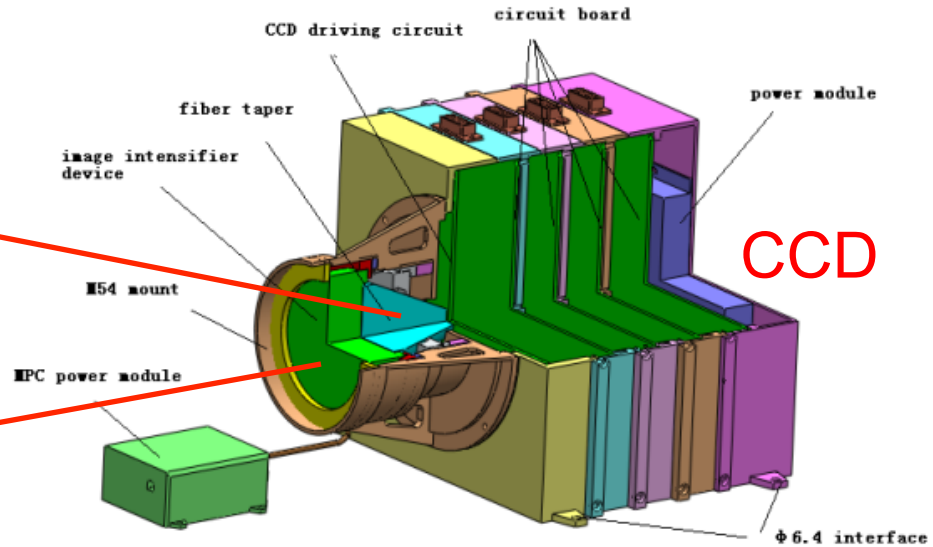
- LYSO Crystal + WLS fiber

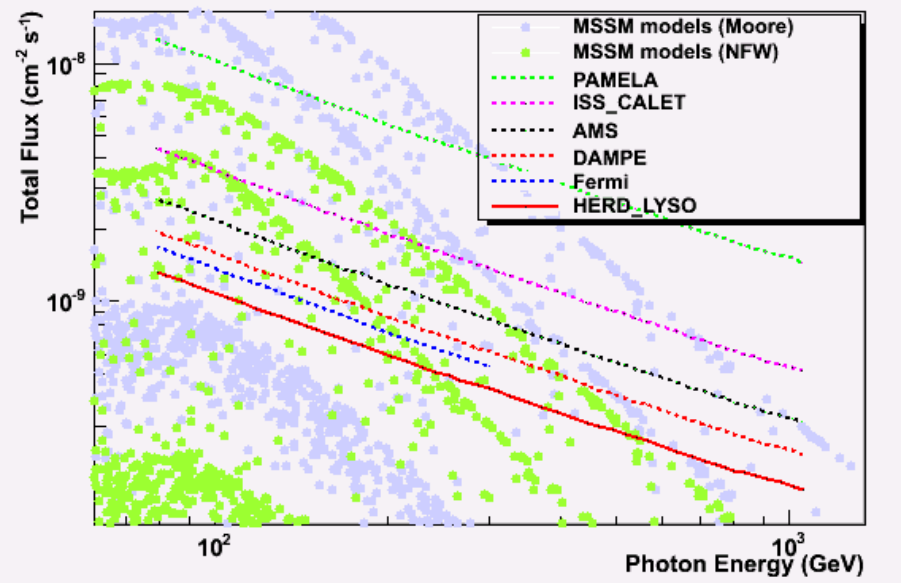

- WLSF + ICCD

Image intensifier

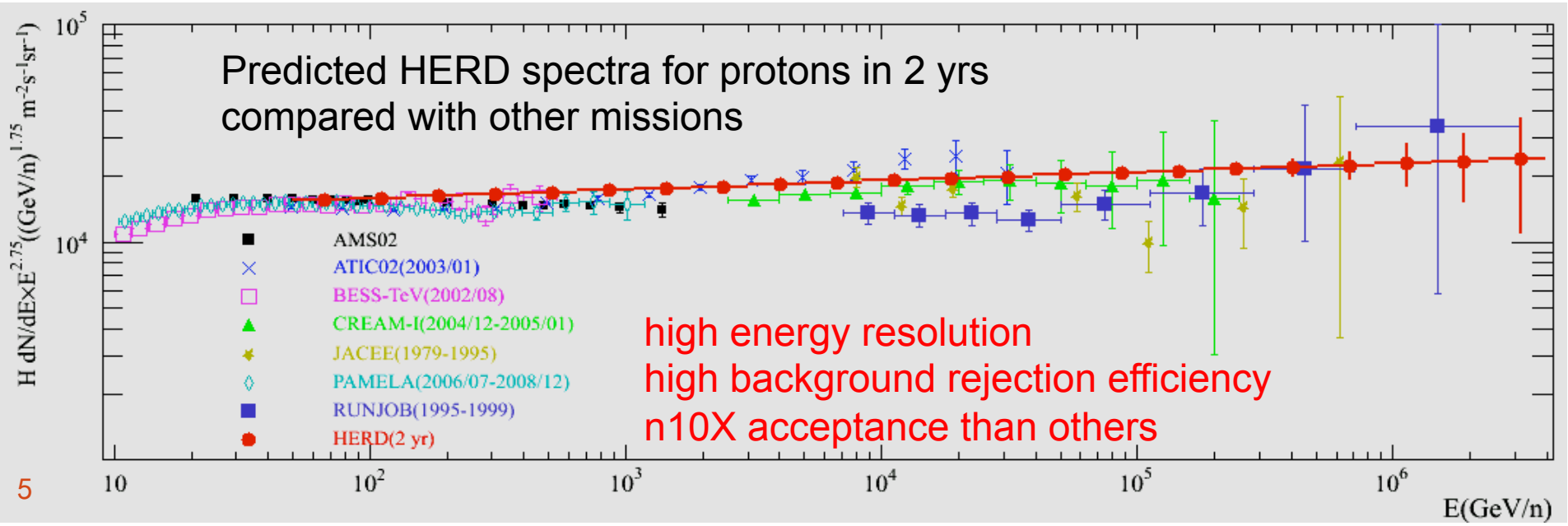
Taper



Expected performances (DM, CR)

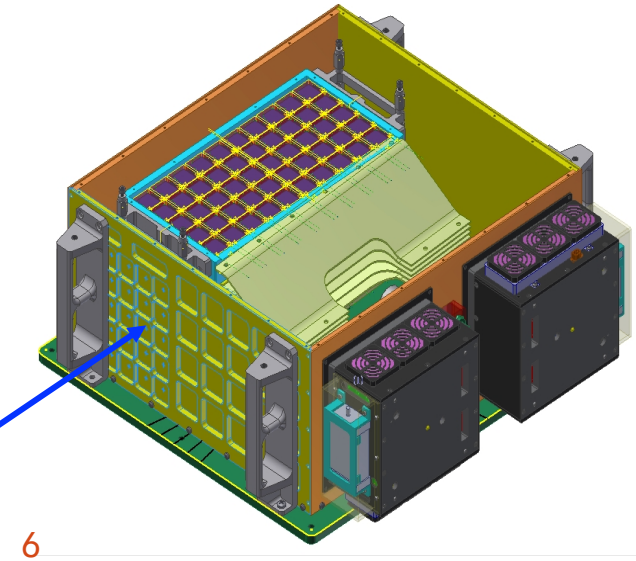


DM gamma-ray line sensitivity (1 yr) in comparison with other missions with operation periods:
2006-2016(PAMELA);
2011-2021 (AMS02);
2016-2021 (CALET, DAMPE);
2008-2018 (Fermi);
2020-2021 (HERD)



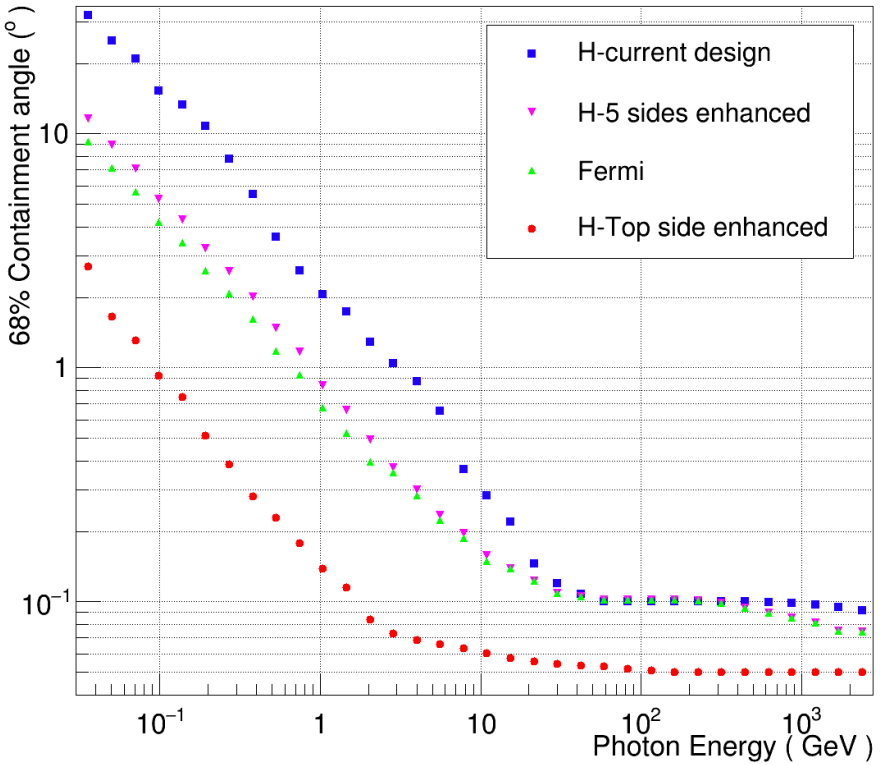
HERD prototype beam test @ CERN SPS

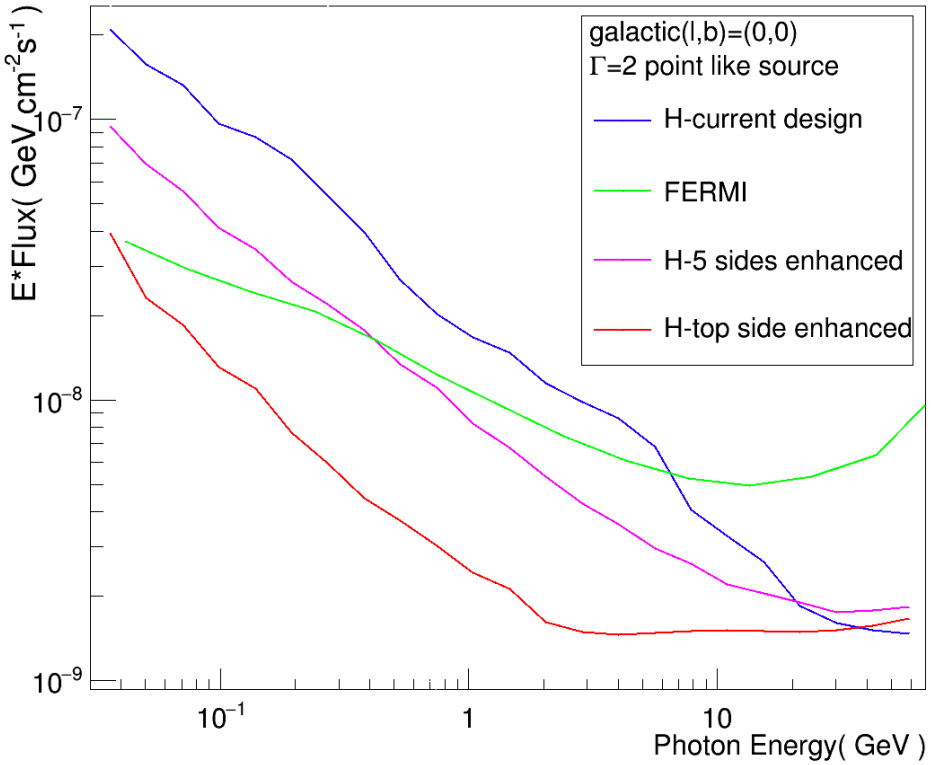
- 1/40 CALO prototype for beam test at CERN SPS in November 2015
- To validate the hardware and software, and at the same time the performance of the design
- 8M events from proton, electron and fragmentation particles of primary Pb ions on a production target were collected at energies from several tens of GeV up to 400 GeV
- Data analysis is under processing



Time	Beam Particle	
Start Time 2015/Nov/ (D/h:m)	Type	P (GeV/c)
13/00:38	pion+	50
13/04:46	e-	200
13/09:02	beam tuning by CCC	
13/12:41	proton	400
13/18:42	pion+	50
13/20:00	no beam	
13/23:39	pion+	50
14/02:50	proton	350
14/09:23	e-	150, 100, 50, 40, 10
14/23:16	pion+	50
15/03:17	e-	30 ,20, 10, 250
15/13:58	e+	100
15/15:27	no beam	
15/16:43	e-	100, 50
15/21:11	e+	50
15/22:30	e-	80GeV
15/23:30	pion+	50
16/03:38	proton	350
16/05:30	e-	200

Extended Optimization for Gamma-ray Astronomy





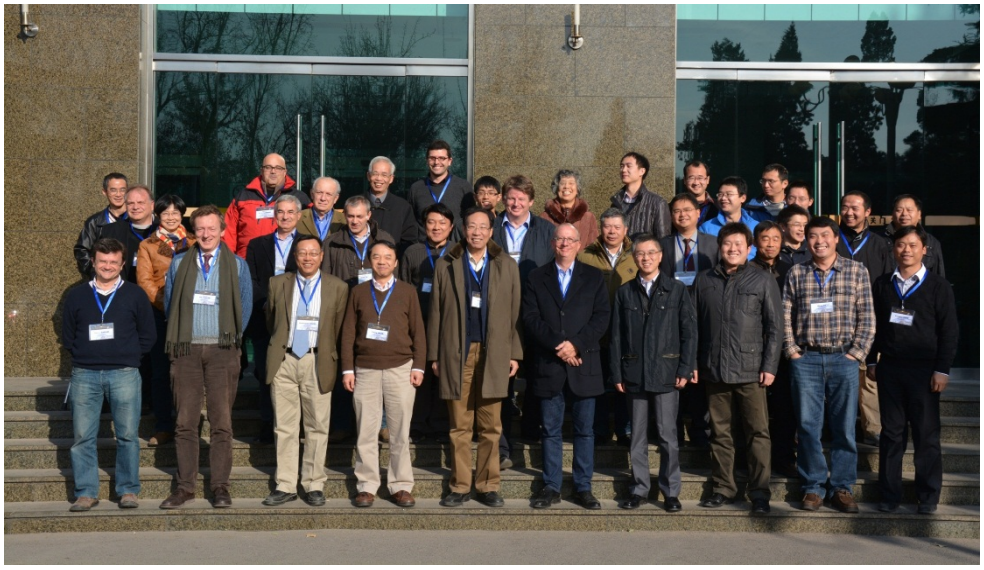
~100 MeV to higher energy, the performance of angular resolution is the first priority for gamma-ray astronomy,

- Current STKs design: 7 layers, 2 X0, same five sides covered.
- All five side enhanced STKs: 15 layers, 1 X0, enhanced for all five sides.
- Top side enhanced STKs: 30 layers, 0.5 X0, enhanced only for top side.

With an enhanced design of STKs, HERD will have adequate capability for gamma-ray (survey, transient monitor, polarization), and be the most sensitive instrument in space in the post-Fermi era.

HERD collaboration

- 100 collaborators, 20 institutes and universities
- From China, Italy, Switzerland, Sweden and USA
- PI, Shuangnan ZHANG, Institute of High Energy Physics (IHEP Beijing)



2nd HERD workshop，2013.12.2，Beijing

HERD Beam Test, 2015.11.11-20, CERN

3rd HERD workshop，2016.01.18-20，Xi'An, China

Welcome!