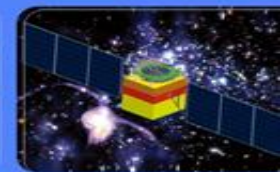


The Status of the HICAL

2025-02-18

WWW.IHEP.CAS.CN



Qian Sen, on behalf of the HICAL Group
qians@ihep.ac.cn

Current status of the GS-HCAL Glass Scintillator

Multi-Physics Instrument (多物理场谱仪)

样品准备

SiO₂-B₂O₃-AlF₃-GdF₃-Gd₂O₃-CeF₃

(GS1, 成分工艺一样, 性能好-典型如光产额最高1000/1500, 衰减500ns/1μs)

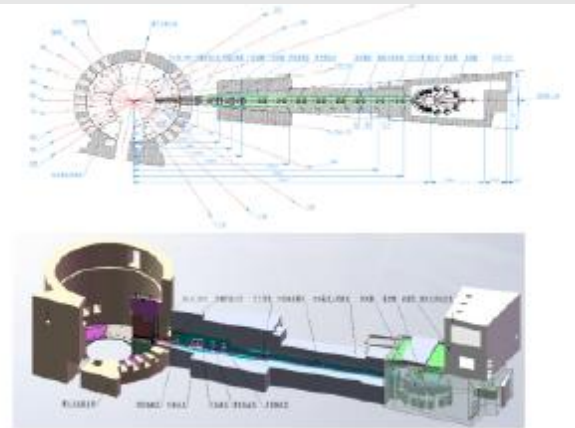
SiO₂-B₂O₃-AlF₃-GdF₃-Gd₂O₃-CeF₃

(GS1, 成分工艺一样, 性能差-典型如光产额低200, 衰减500ns)

参比样品

SiO₂-B₂O₃-AlF₃-GdF₃-Gd₂O₃ (GS1-不含Ce)

SiO₂-B₂O₃-Al₂O₃-Gd₂O₃-Ce₂O₃ (GS1-去掉GdF₃-其余均为纯氧化物参比样)

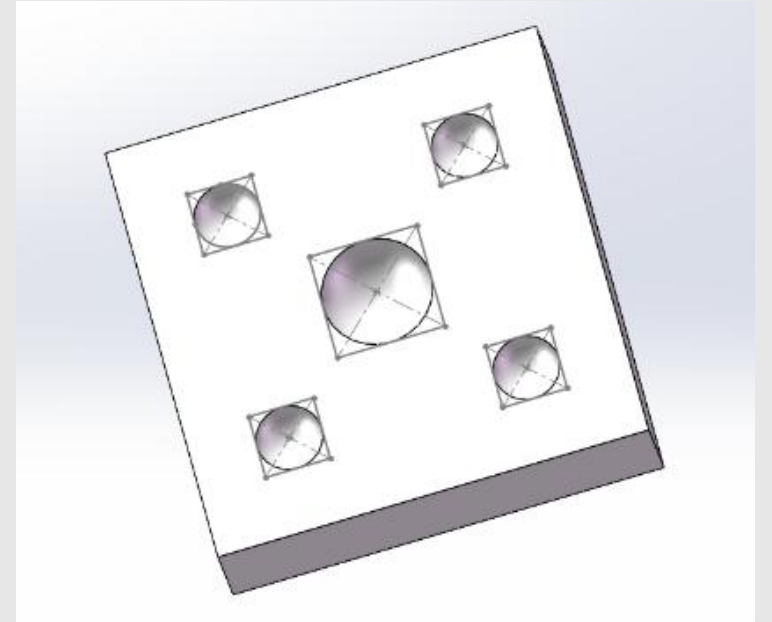


设计指标

参数名称	设计参数
慢化器	退耦合水
第一飞行距离	30m
第二飞行距离	1~2.8m
Q值范围	0.1~50 Å ⁻¹
样品处中子通量	10 ⁷ /n/s/cm ²
最佳Q分辨率	0.3%
波长范围	0.1-3 Å
斩波器	双TO斩波器, 3台带宽斩波器
最大样品尺寸	30mm×30mm
探测器类型	20大气压3He管

- ❑ the GS sample will be tested at CSNS for the construction;
- ❑ the same sample will be tested at the Synchrotron radiation light source in Shanghai;
- ❑ There is a special group (not all the number of GS group), will do this research work.

- ❑ We will fixed the GS1 for the mass production at the end of this mounth;
- ❑ There are three group member will do the mass production job;
 1. **Beijing Glass Research Institute**
 2. **Shanghai Institute of Optics and Fine Mechanics**
 3. **China Building Materials Academy**
- ❑ The 50pics GS samples will be produced before the TDR review meeting;
- ❑ The GS sample holding the SiPM will be produced by the factory.



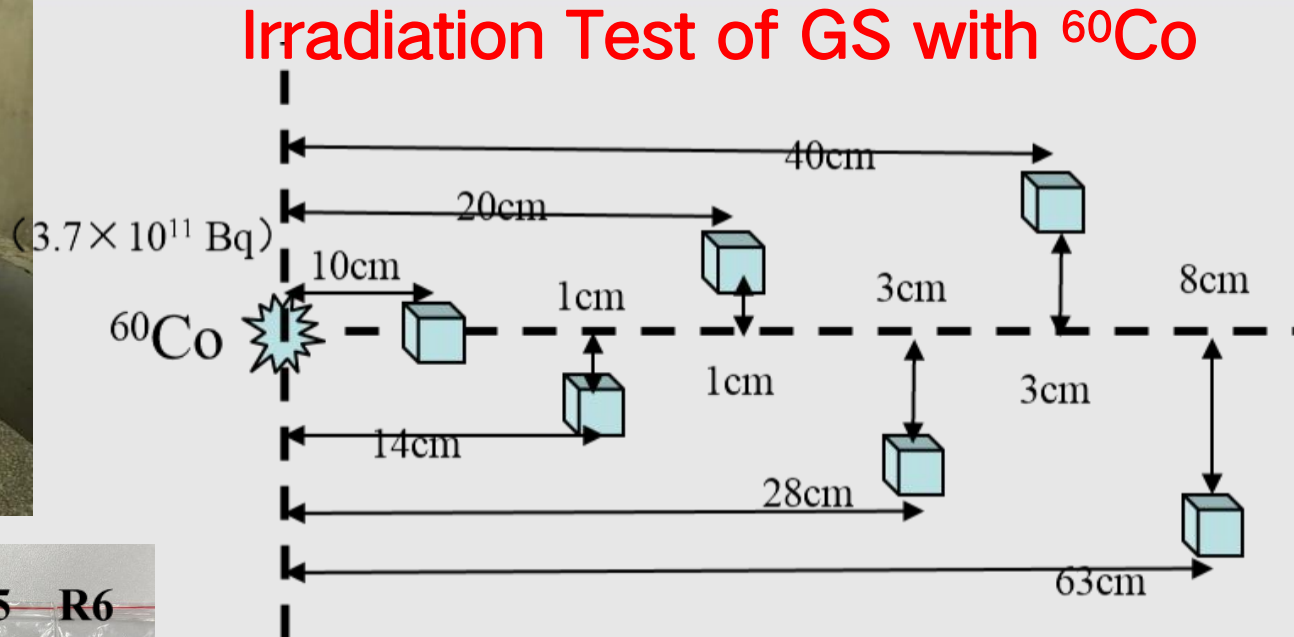
Current status of the GS-HCAL SiPM

- ❑ Visit the “Capital Photonics Technology (Tianjin) Co., Ltd.” on 13th.Feb;
- ❑ To discuss the cooperation between the HCAL and SiPM company.
- ❑ CPT agree to join the HCAL group to develop and supply the new type of the SiPM with PDE~60%, pixel~40um;



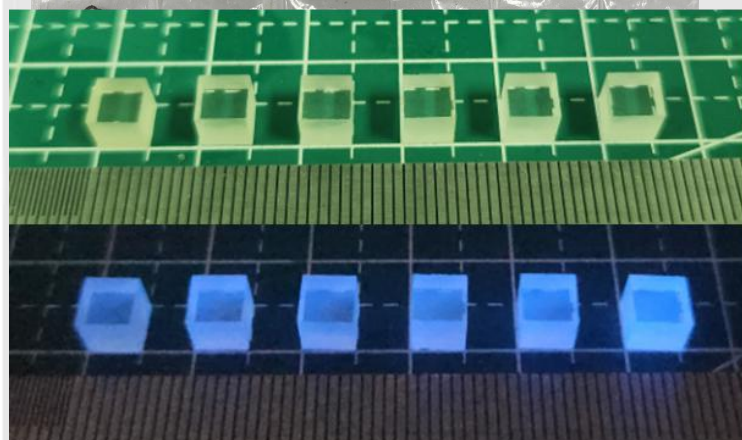
Current status of the GS-HCAL Glass Scintillator

--by Hupeng



Distance (cm)	Dose rate (Gy/h)	Total dose (Gy@37.5h)
~10	~10	~375
~14	~5.1	~191.3
~20	~2.5	~93.8
~28	~1.26	~47.3
~40	~0.624	~23.4
~63	~0.25	~9.4

R1 R2 R3 R4 R5 R6

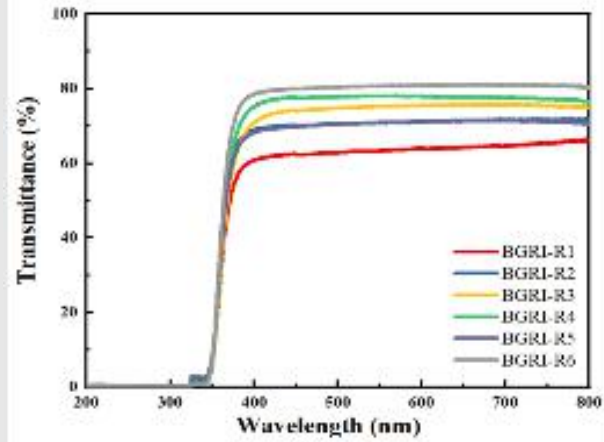


- 6 glass samples ($5 \times 5 \times 5 \text{ mm}^3$) were irradiated with a ^{60}Co source of 3.656×10^{11} Bq and were placed with different distance to obtain different dose
- Significant discoloration (color centers) can be observed in #1 and #2, and detailed performance tests will be finished this week

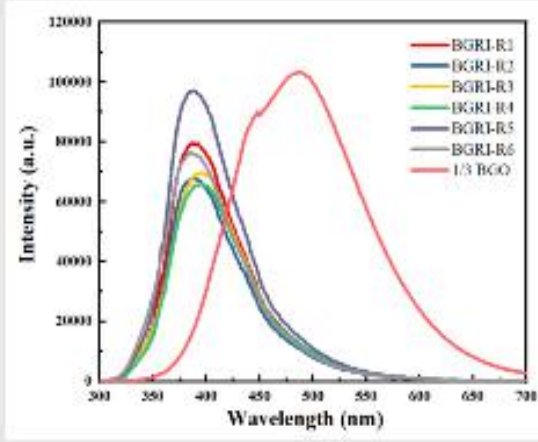
before irradiation

after irradiation

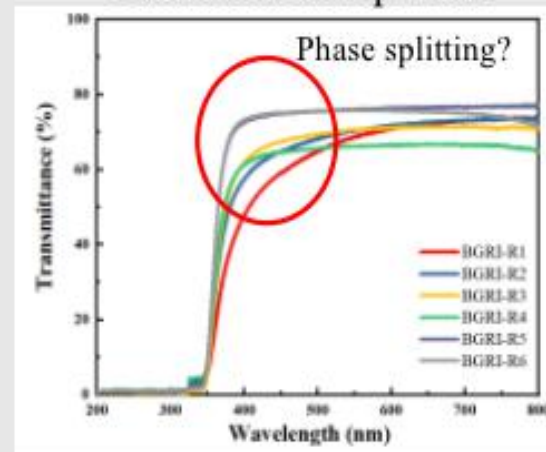
Transmission Spectra



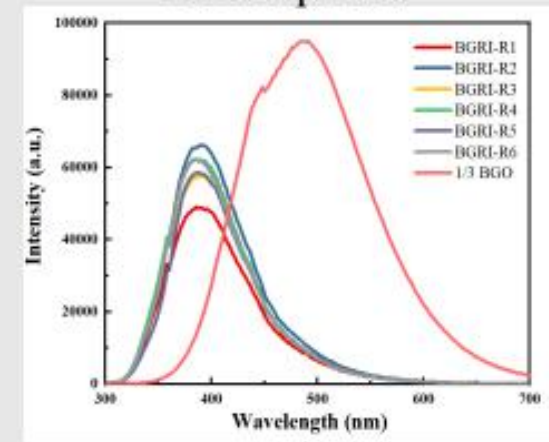
XEL Spectra



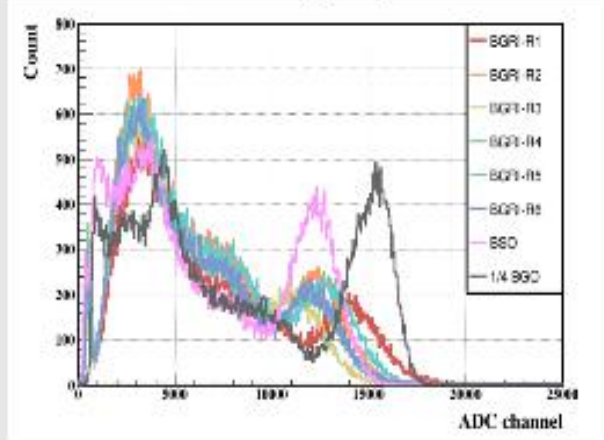
Transmission Spectra



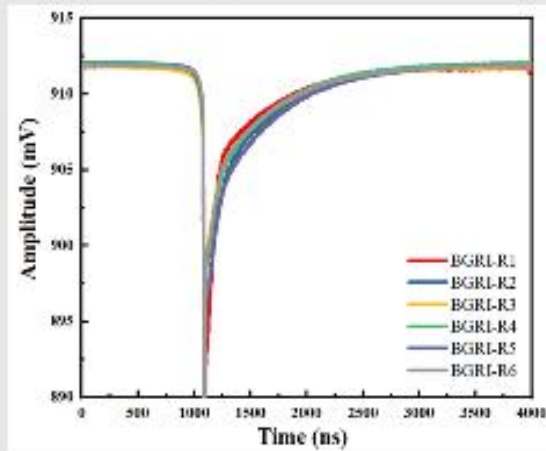
XEL Spectra



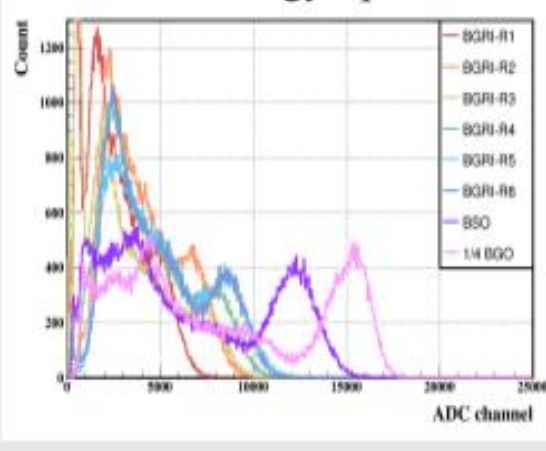
^{137}Cs Energy Spectra



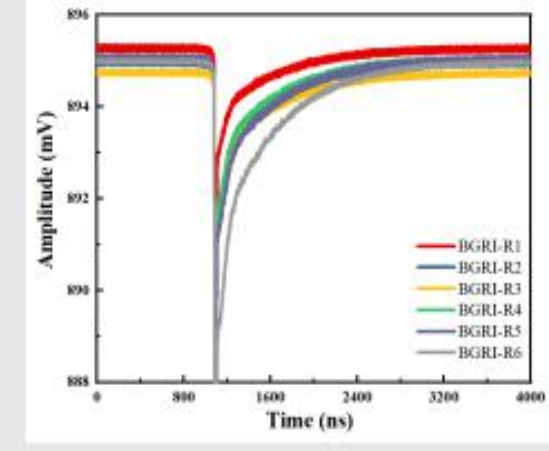
Average Waveforms

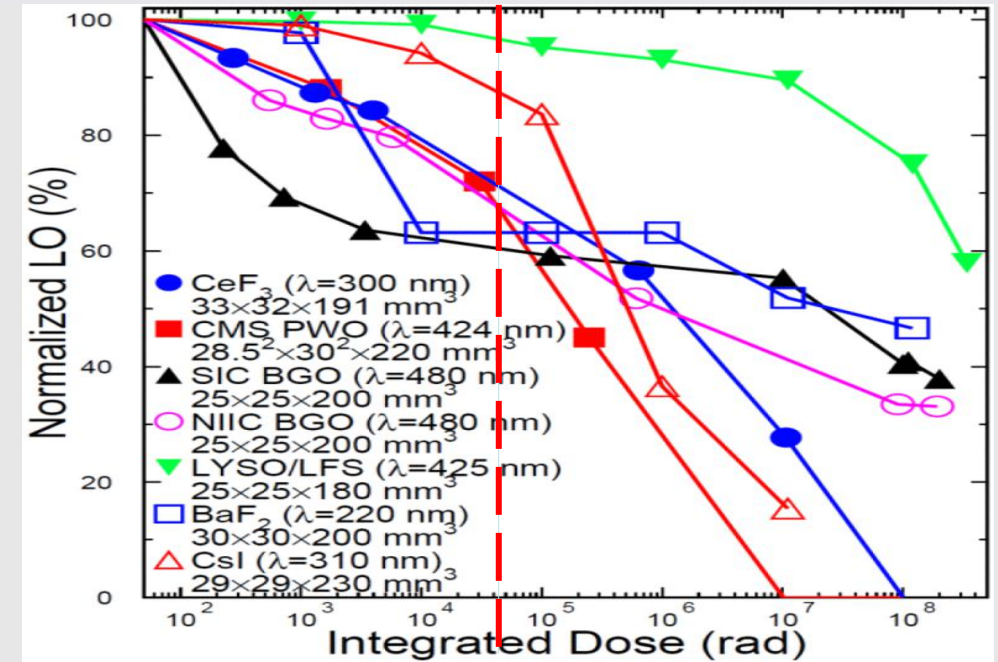
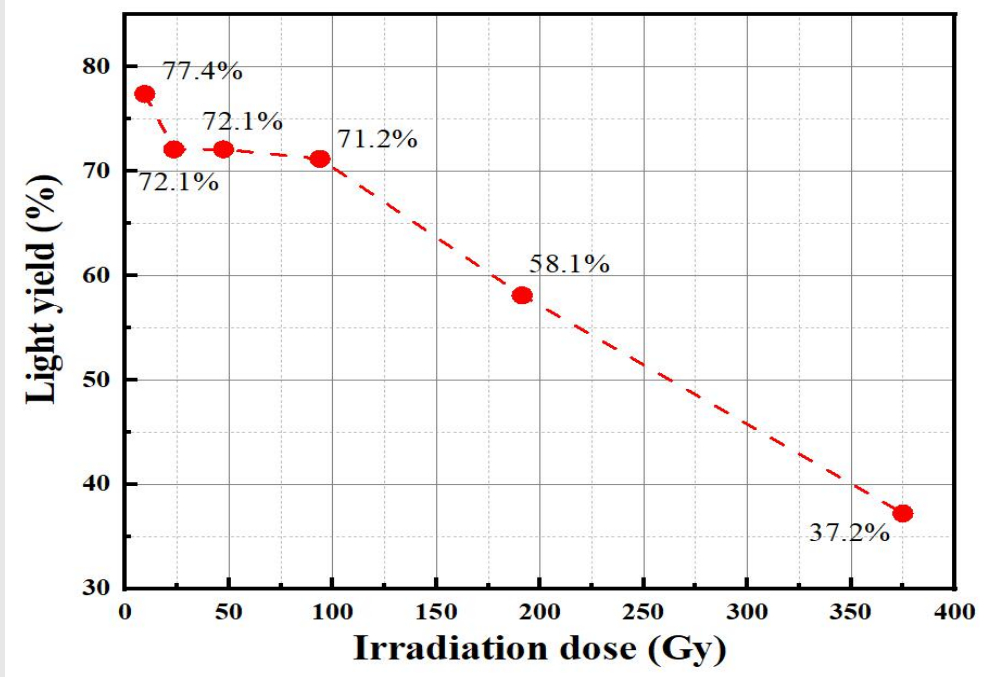


^{137}Cs Energy Spectra



Average Waveforms



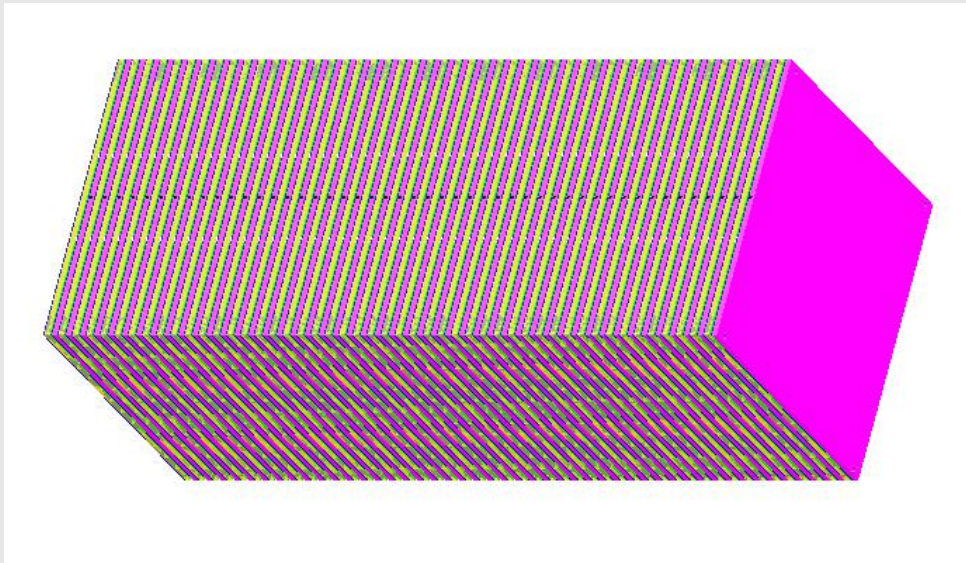


- ❑ The light output of the glass sample will be reduced to 37% of its original level after exposure to a dose of ~375 Gy, which is basically consistent with the proton irradiation results (~320 Gy in total 20 years.);
- ❑ The irradiation resistance of the crystal is much better than the GS, and the BGO can reserve ~60% light output after exposure to a dose of 400 Gy;
- ❑ The shape of irradiation resistance curve is different for crystals, but the trend for GS and BGO is similar
- ❑ The change of emission peak and decay time are not significant;

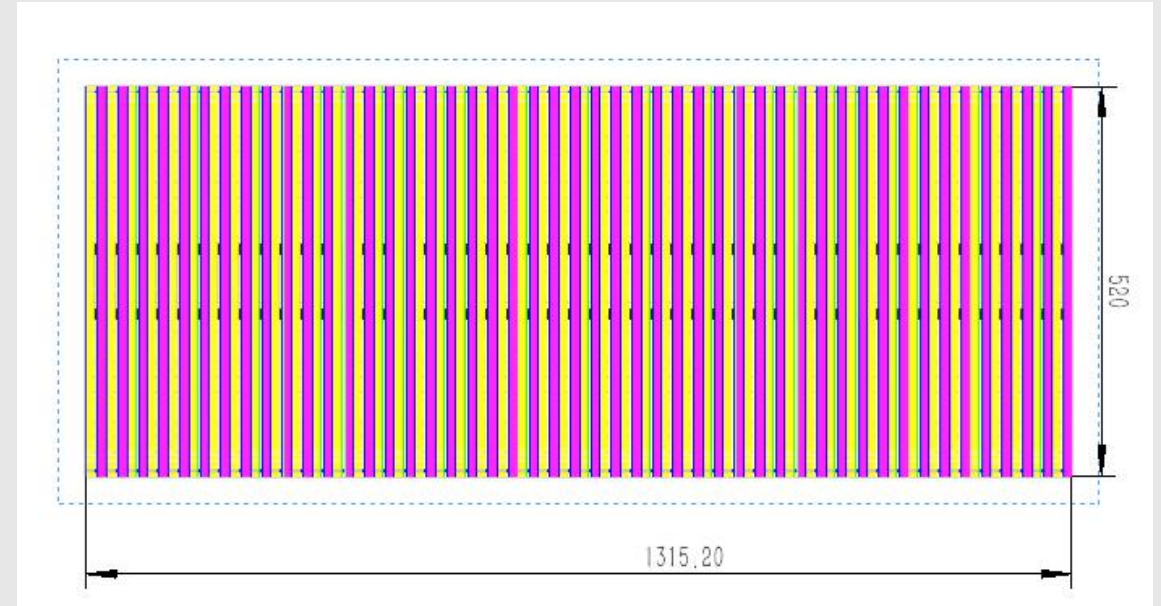
Current status of the GS-HCAL **Detector**

- The Plan of the Prototype of GS-HCAL in the next two years (2025-2026).
the CPM plan will be finished by Boxiang Yu and Jiawen Zhang.
- The Prototype of the HCAL was designed right now.

Prototype design



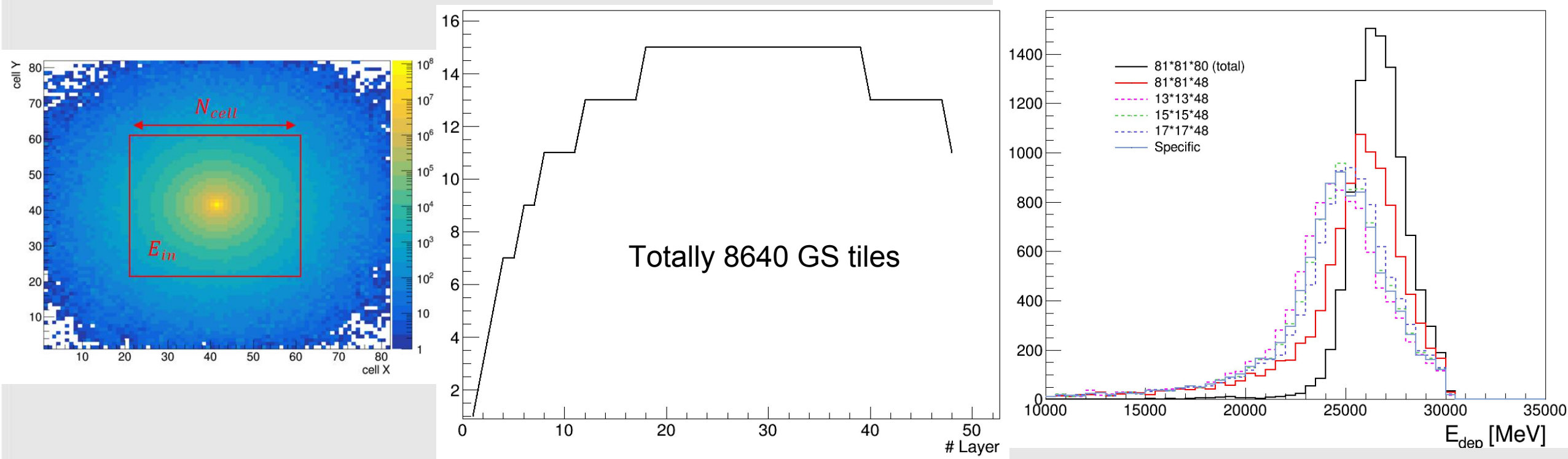
- Total: 48 layers
- Each layer: 13*13 glasses



- Verifying cooling scheme

Prototype scale optimization

- A trapezoid module:
 - ✓ Another criterion: lateral leakage $E_{out}/E_{total}^{48 \text{ layers}} < 0.1\%$.
- Energy response
 - ✓ 8640 GS tiles relatively equivalent response to 15*15*48 module (10800 tiles) .



Cooperation -- DRD6

- Contact person per subtask: to be the link between the coordinators and the project community.
- 2025-02-16: to be the contact person for the ScintClassHCAL project.
----email by the WP1 convener Adrian. Irlles;
- I will join the DRD6 Collaboration meeting on 1st.Apr to introduce the CEPC-GS-HCAL and invite more group to join us.

Hadronic sections	Task 1.2: Hadronic section with optical tiles	
	Subtask 1.2.1: AHCAL	Scintillating plastic tiles/Steel
	Subtask 1.2.2: ScintGlassHCAL	Heavy glass tiles/Steel
	Task 1.3: Hadronic section with gaseous readout	
	Subtask 1.3.1: T-SDHCAL	Resistive Plate Chambers/Steel
	Subtask 1.3.2: MPGD-HCAL	Multipattern Gas Detectors/Steel
	Subtask 1.3.3: ADRIANO3	Resistive Plate Chambers+Scintillating plastic tiles/ Heavy Glass

Backup

The Manpower of the HCAL

- 1. The PS-HCAL
 - Jianbei Liu, Haijun Yang, Boxiang Yu, Yunlong Zhang,
- 2. The GS-HCAL : Sen Qian (IHEP)
 - Sub-system: 2 Conveners + others
 - Physics: Manqi Ruan(IHEP), Haijun Yang(SJU),
 - Software: Sengsen Sun(IHEP);
 - Design: Fangyi Guo(IHEP), Hengne Li(SCNU),
 - Glass Scintillator: Sen Qian(IHEP), Jing Ren(HEU), the GS collaboration Group
 - SiPM: Yuguang Xie(IHEP), Jifeng Han(SCU),
 - Electronics: Jingfan Chang(IHEP),
 - DAQ: Chen Boping(IHEP),
 - Mechanics: Yatian Pei(IHEP), Junsong Zhang
 - Detector: Boxiang Yu(IHEP), Yunlong Zhang (USTC),

The Manpower of the subsystem of GSHCAL

Physics: Manqi Ruan(IHEP), Haijun Yang (SJTU) ,

Software: Sengsen Sun(IHEP);

Design: Fangyi Guo(IHEP), Hengne Li(SCNU), Qingming Zhang(XJTU), Weizheng Song(IHEP), Peng Hu(261)
Dejing Du(IHEP), Hongbing Diao(SUTC), Jiyuan Chen(SJTU),

--to design the GS-HCAL detector based on the CEPCSW;

Glass Scintillator: Sen Qian(IHEP), Jing Ren(HEU), the GS collaboration Group;

--R&D of the GS for CEPC-HCAL, a special group independent of CEPC;

SiPM: Yuguang Xie(IHEP), Jifeng Han(SCU), Guang Luo(SYSU),

--to do the research of SiPM for CEPC-HCAL, the electronics of SiPM for the GS performance test;

Electronics: Jingfan Chang(IHEP),

--to design the ASIC and FEE for CEPC-HCAL; the power supply, the cables and so on;

DAQ: Chen Boping(IHEP),

Mechanics: Yatian Pei(IHEP), Junsong Zhang(IHEP), Shang Bofeng(ZZU)

--to design the Mechanics of the GS-CEPC-HCAL; also the cell, the module, the cooling system;

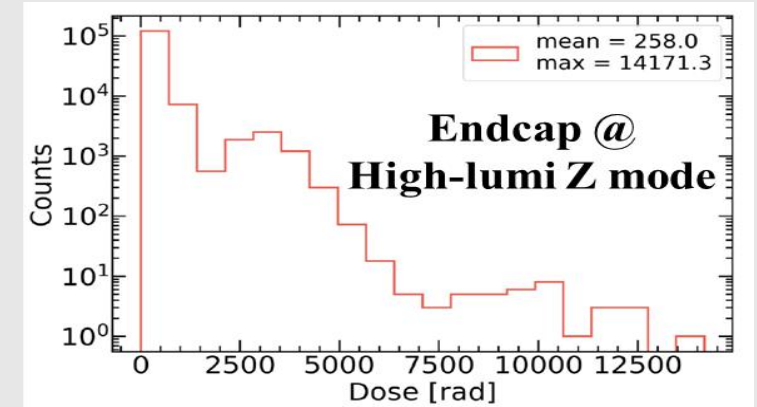
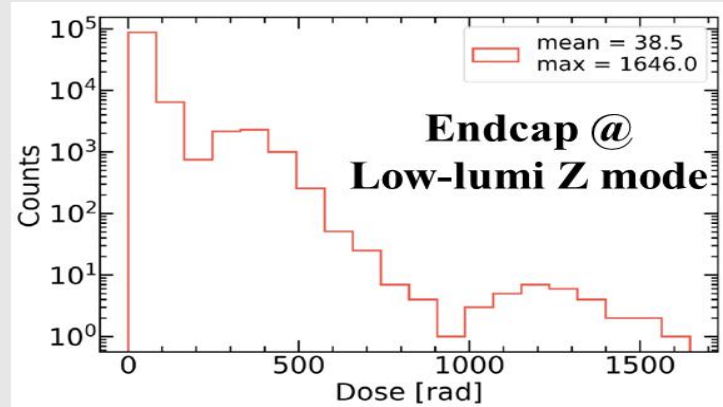
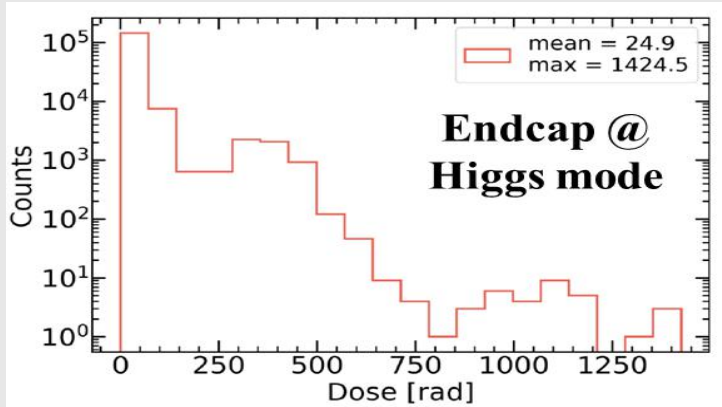
Detector: Boxiang Yu(IHEP), Yunlong Zhang (USTC)

--to study the module of the GS-HCAL with GS and SiPM, the cosmic ray test, the beam test;

Current status of the GS-HCAL Simulation

--by Weizheng Song

Beam induced background simulation (V2)



Running Mode	Endcap @ Higgs mode	Endcap @ Low-lumi Z mode	Endcap @ High-lumi Z mode
Dose of 99% cells/year	< 5 Gy	< 5 Gy	< 50 Gy
Dose Mean/year	0.25 Gy	0.39 Gy	2.6 Gy
Dose Max/year	14.2 Gy	16.5 Gy	142 Gy

- ❑ Beam background for GSHCAL is mainly induced by gamma-rays and electrons
- ❑ The irradiation dose in different running modes for the Endcap has been obtained from the simulation and statistical parameters were summarized