The Status of the HCAL

2024-09-10

Qian Sen, on behalf of the HCAL Group

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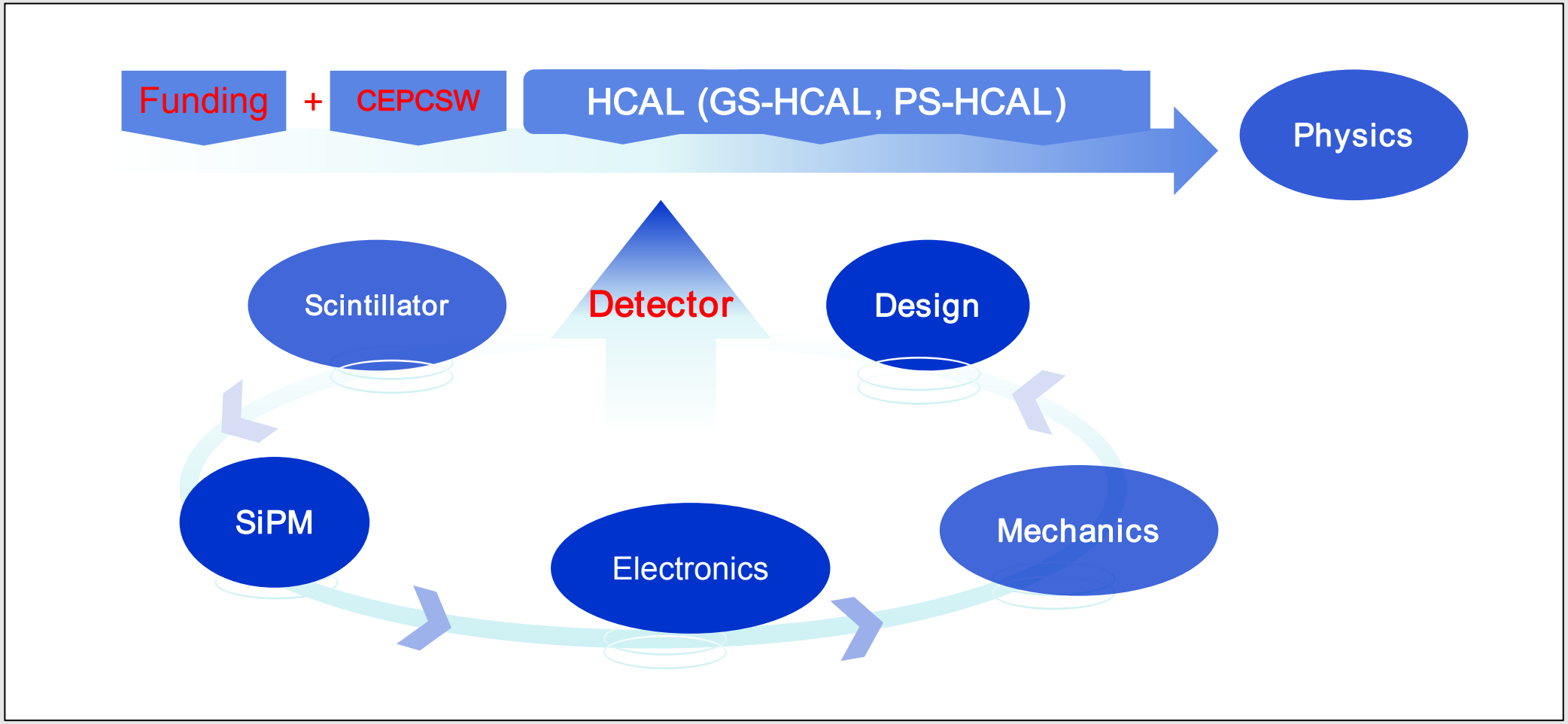
The Sub-system of HCAL



The Manpower of the HCAL （20240910）

- 1. The PS-HCAL
  - Jianbei Liu, Haijun Yang, Boxiang Yu，Yunlong Zhang，……，
- 2. The GS-HCAL
  - 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)**，
  - 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;

Mechanics: Yatian Pei(IHEP), Junsong Zhang(IHEP),

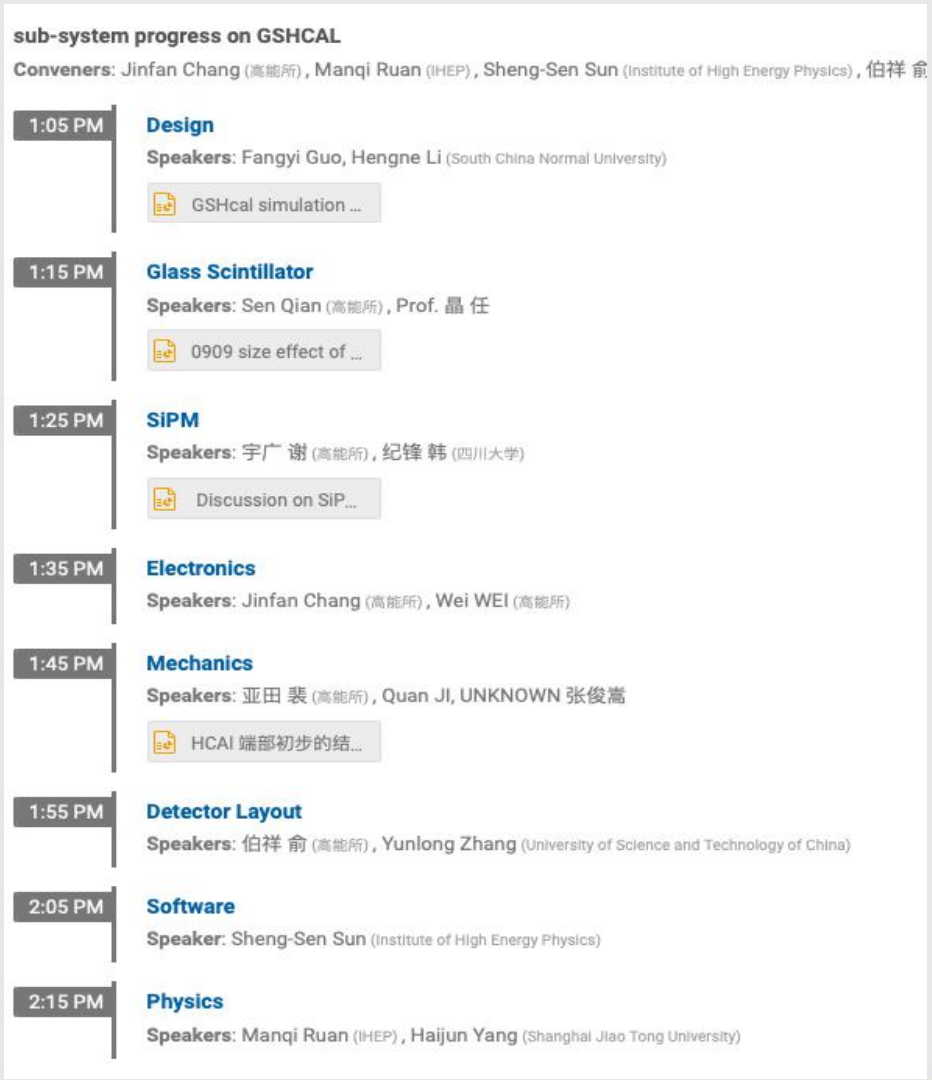
--to design the Mechanics of the GS-CEPC-HCAL; also the cell, the module, the cooling system;

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;

The Weekly Meeting of HCAL

The Indico Page



sub-system progress on GSHCAL

Conveners: Jinfan Chang (高能所), Manqi Ruan (IHEP), Sheng-Sen Sun (Institute of High Energy Physics), 伯祥 俞

1:05 PM **Design**
Speakers: Fangyi Guo, Hengne Li (South China Normal University)
GSHcal simulation ...

1:15 PM **Glass Scintillator**
Speakers: Sen Qian (高能所), Prof. 晶 任
0909 size effect of ...

1:25 PM **SiPM**
Speakers: 宇广 谢 (高能所), 纪锋 韩 (四川大学)
Discussion on SiP...

1:35 PM **Electronics**
Speakers: Jinfan Chang (高能所), Wei WEI (高能所)

1:45 PM **Mechanics**
Speakers: 亚田 裴 (高能所), Quan JI, UNKNOWN 张俊嵩
HCAl 端部初步的结...

1:55 PM **Detector Layout**
Speakers: 伯祥 俞 (高能所), Yunlong Zhang (University of Science and Technology of China)

2:05 PM **Software**
Speaker: Sheng-Sen Sun (Institute of High Energy Physics)

2:15 PM **Physics**
Speakers: Manqi Ruan (IHEP), Haijun Yang (Shanghai Jiao Tong University)

Special Topic Discussion

Design: 2024-08-30 Friday 13:00-14:00;

SiPM: 2024-08-31 Staturday 14:00-15:00; by Sen
2024-09-07 Staturday 20:00-22:00; by Yuguang

Mechanics: This week.

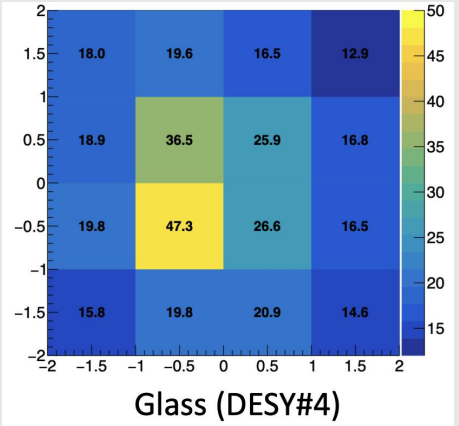
Recent plans for GS-HCAL--Design

--by Fangyi Guo & Hengne Li

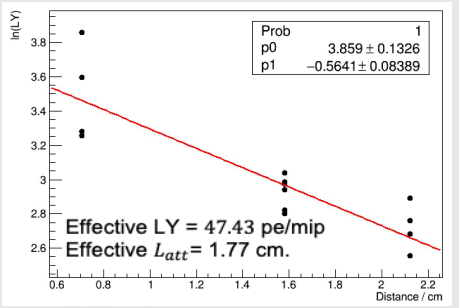
- **Address key parameters to energy resolution:**

	Simulation			Digitization				Design	Data rate
Terms	Leakage	Sampling fraction	Birks effect	Light yield	Attenuation length	SiPM response: saturation, dynamic range, noise, etc.	Electronics: precision, threshold, etc.	Geometry optimization	Beam background simulation; signal occupancy
Status	Done	Done	Doing	Doing	Doing	Todo	Todo	Todo	Doing

- **In simulation: Birks effect has visible effects to energy resolution. A reliable Birks constant is needed from tests / investigations.**
- **Effective light yield and attenuation length: a simplified model in CEPCSW**
  - Application of intrinsic light yield and attenuation needs optical simulation (too slow)
  - Simplified model from DESY beam test: glass tile uniformity scan: $E_{tile} = \Sigma E^{att}_{step}, E^{att}_{step} = E^{truth}_{step} \times e^{-R/L_{att}}, R = R(step - tile\ center)$.
  - Energy response is ongoing.
- **Beam background: simulation samples are generated by Haoyu. Data analysis is ongoing together with ECAL.**

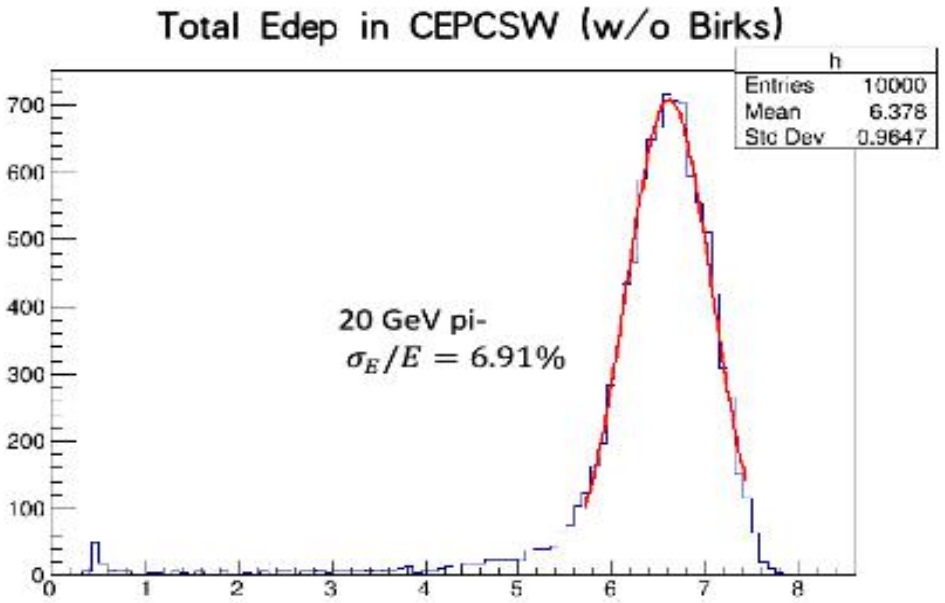


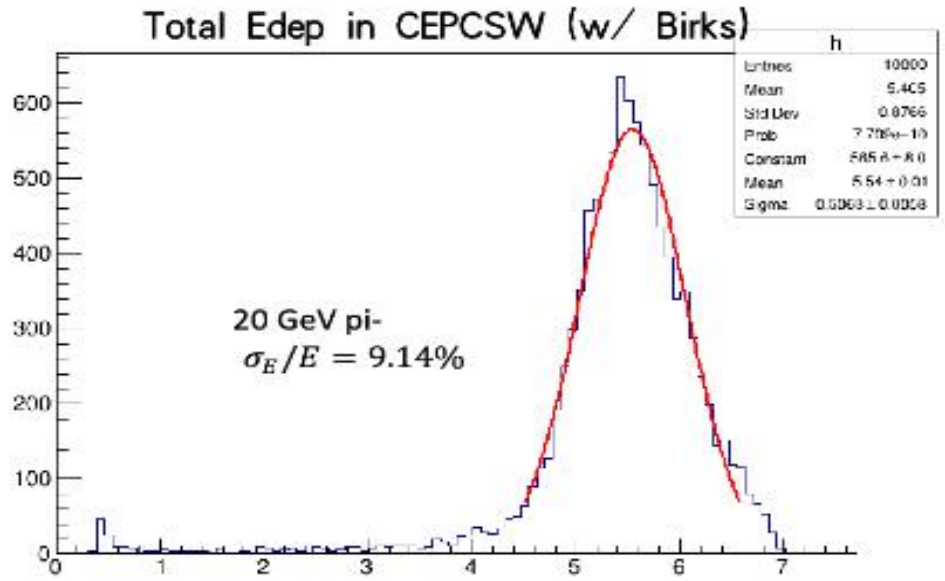
Glass (DESY#4)



Glass simulation: Birks effect

- **Lost the Birks in CEPCSW simulation**
- **Birks constant in standalone: 0.126 mm/MeV is from PS.**
  - For every G4 step: $E_{vis} = \frac{E_{step}}{1+C_{birks}\cdot(E_{step}/Length)}$

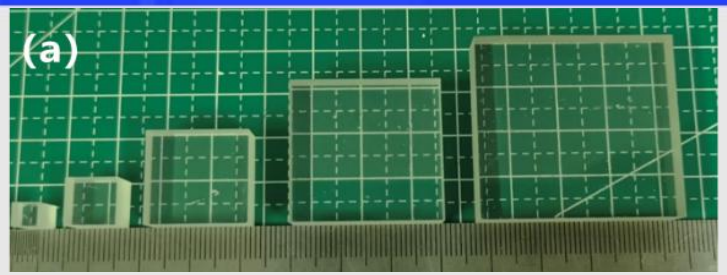


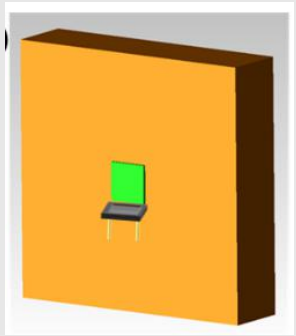


Current status of the GS-HCAL Glass Scintillator

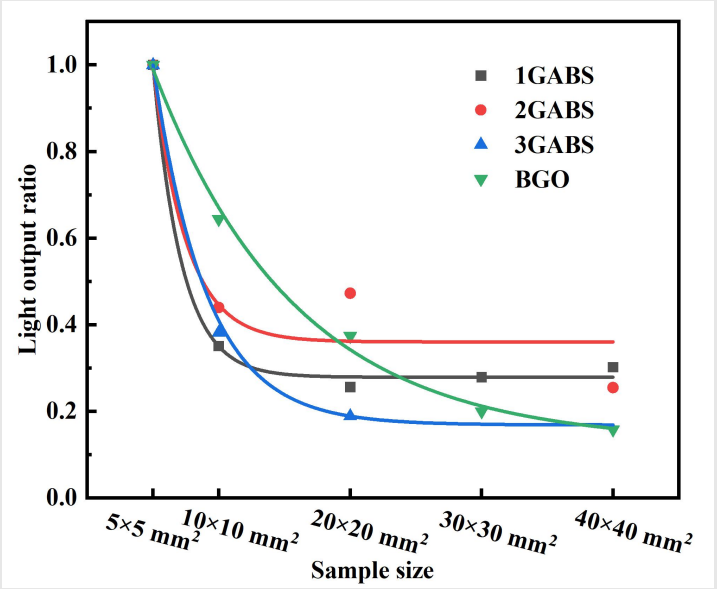
--by Ren Jing

Size effect of Ce-doped glass scintillator

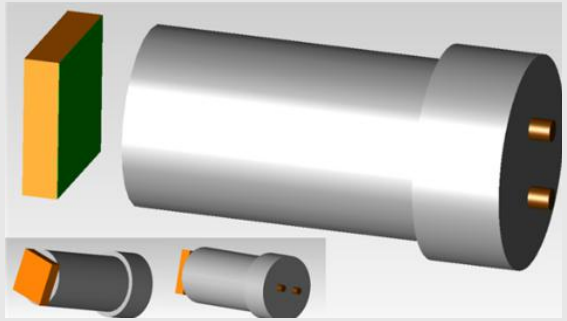




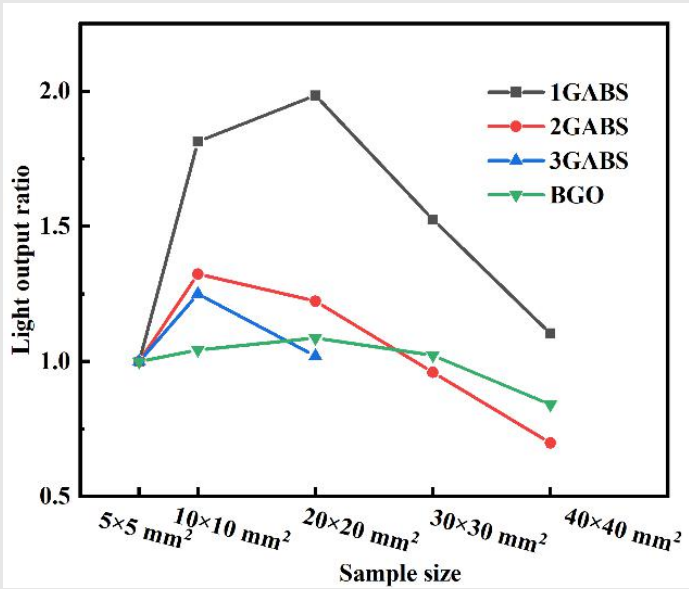
SiPM: 6*6 mm2



For SiPM: LY decrease with increasing size of glass



PMT: 2 inches

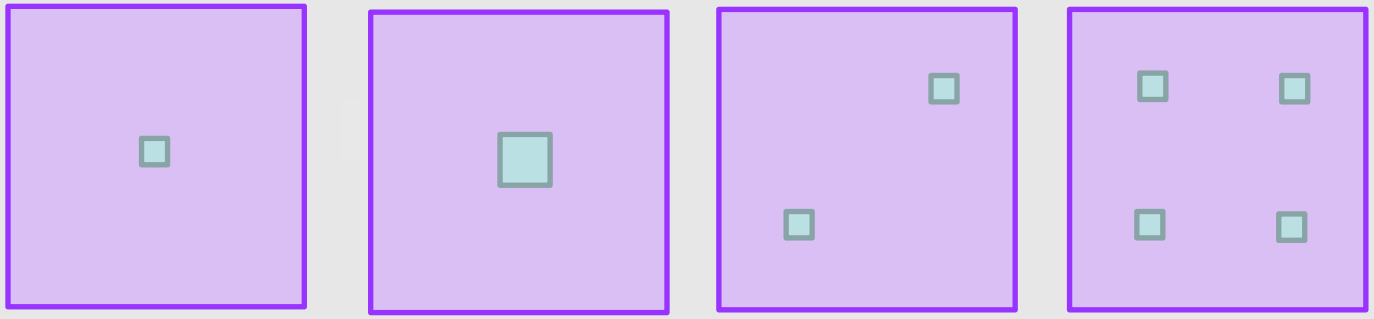


For PMT: LY initially increases and then decreases with size

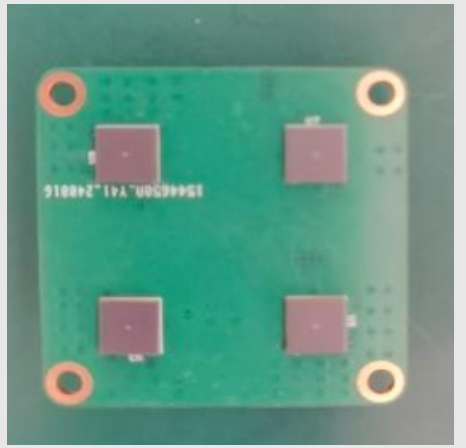
The size of glass plays a role in determining light yield, it is important to make optically homogeneous and suitable size glass samples. This can be done by standardizing the preparation method and improving the glass quality.

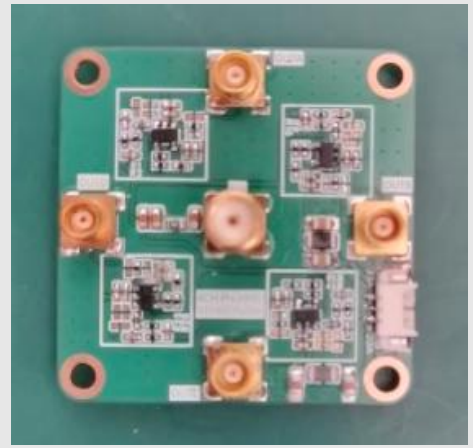
➢ SiPM unit size and coupling experiment

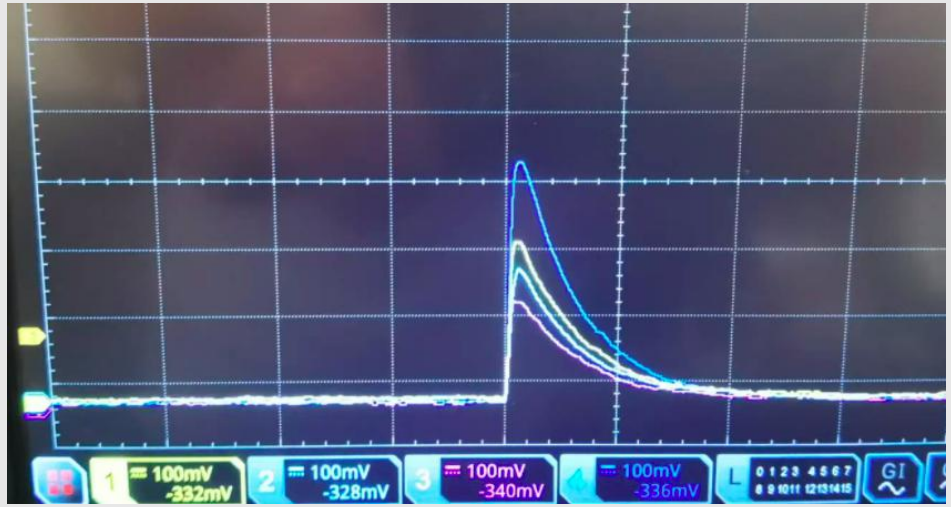
- Surface mount type, size(mm^2):
  1.3×1.3, 3×3, 4×4, 6×6
- Sigle SiPM or multi small size SiPMs(only 1 ch readout)



➢ SiPM PCB board by Xiaolong Wang's Lab

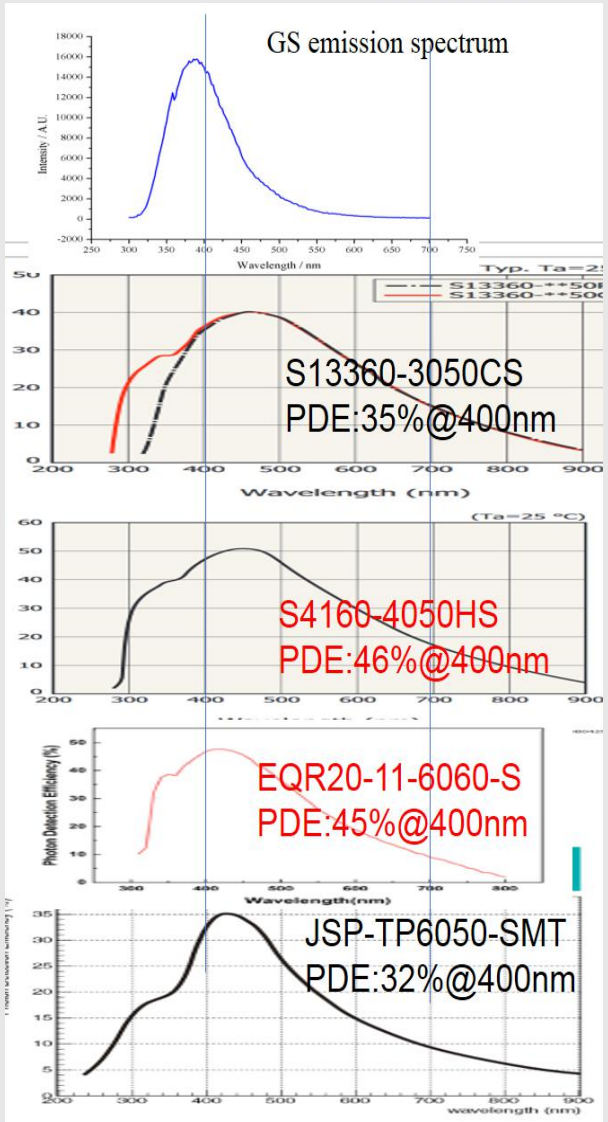




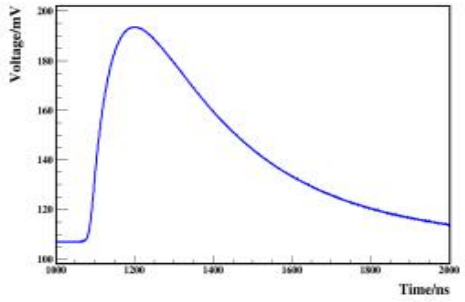


Current status of the GS-HCAL SiPM

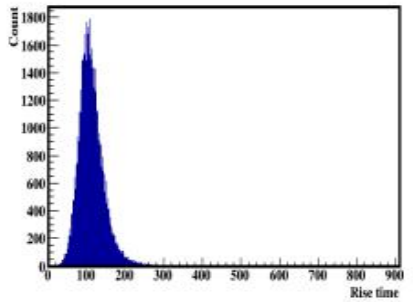
--by Yuguang Xie



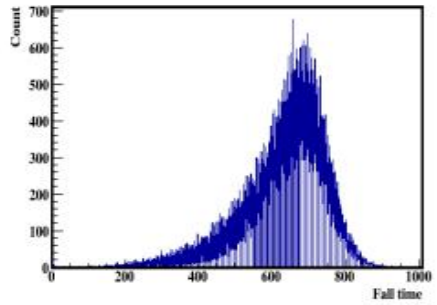
BGO—HPK 6025CS



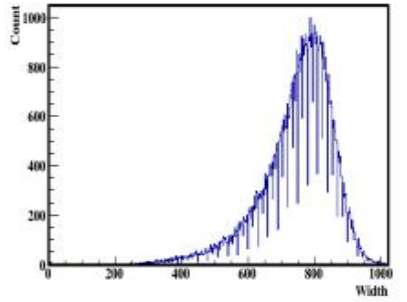
Rise time



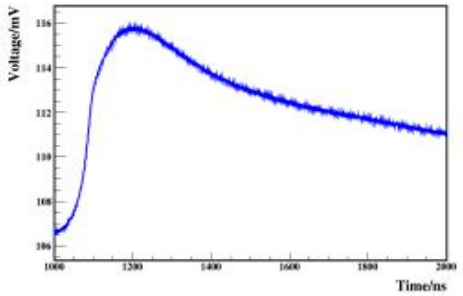
Fall time

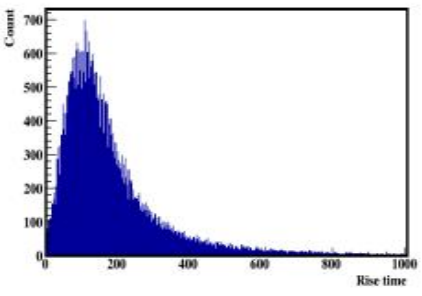


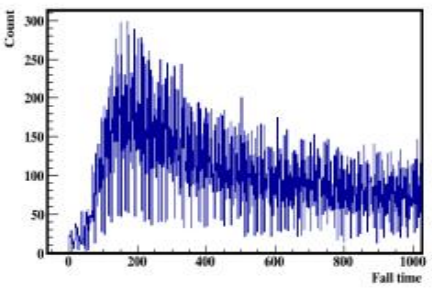
Width

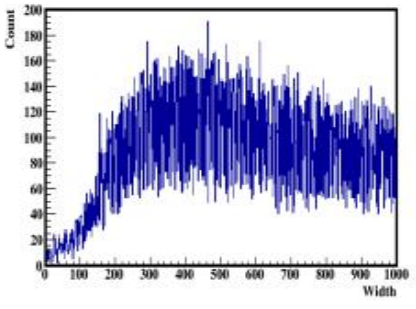


GS1+—HPK 6025CS slow

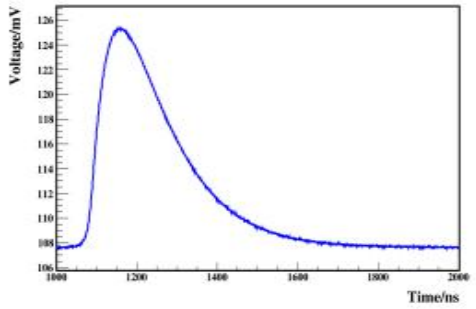


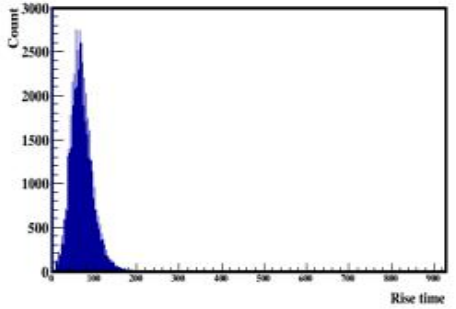


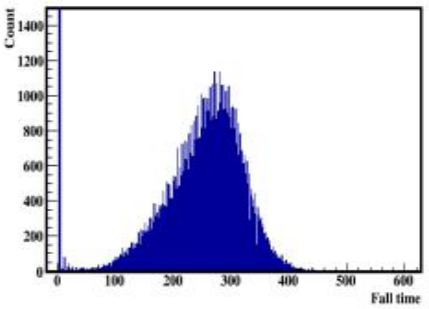


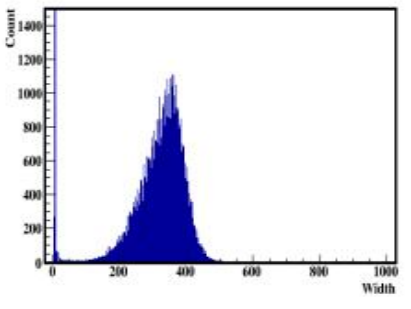


GS1—HPK 6025CS fast









Current status of the GS-HCAL SiPM

--by Yuguang Xie

- Primary SiPM parameters and candidates (after discussion)

No.	Parameters	Requirement	
1	Active area mm^2	>=3*3, 6*6 better	
2	PDE@400nm	> 45%	
3	Gain	>=1e6	
4	DCR	<300kHz/mm^2, Lower better	
5	Pitch /um	20~50	Dynamic range 0.1/0.5~100MIPs (>70MIPs could be corrected)
6	Break down voltage(VB)	Lower better, not crucial	
7	Temperature coefficient	Lower better, not crucial	
8	Terminal capacitance (pF)	Lower better, reduce decay time for FEE	Baseline Q, try Q&T
9	Cost	<=10RMB/pcs	

Current status of the GS-HCAL SiPM

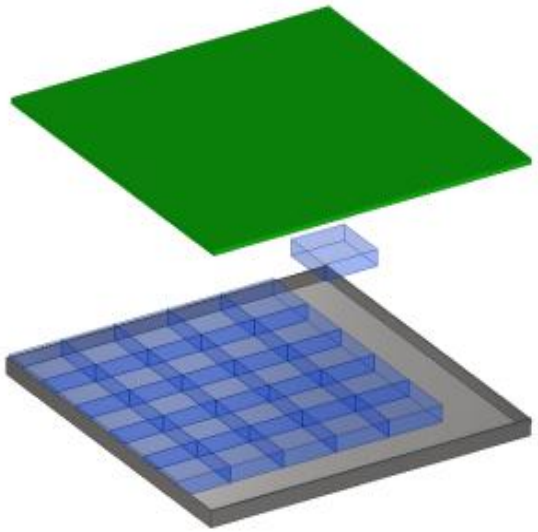
--by Yuguang Xie

➢ Primary FEE requirements (after discussion)

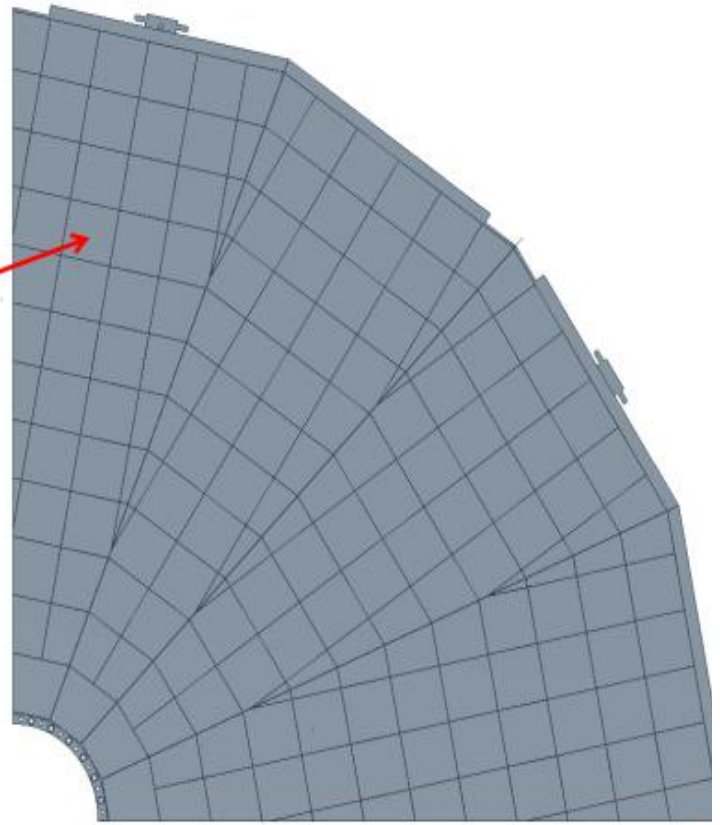
No.	Parameters	Requirement	
1	Gain	>12.5 mV/pC (1p.e. ~ 2mV@gain=1e6)	Noise<1mV; adjustment no need
2	Dynamic range	10~2000 p.e. (0.5~100MIPs,)	20 p.e. of 1MIP for 3*3 SiPM
3	Noise RMS:	~1mV(<0.5p.e)	
4	Single channel event rate	>=? TBD by BG simulation	
5	SNR:	>=10	
6	Time resolution	TBD	If T needed
7	S.p.e resolution	Probably no need	

Current status of the GS-HCAL Mechanics

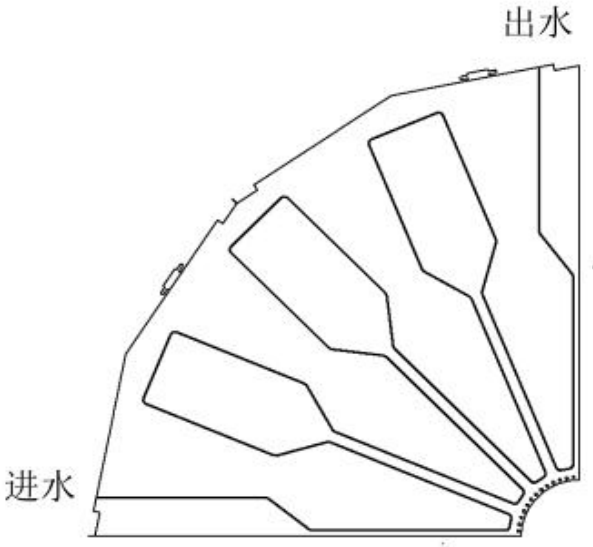
--by Junsong Zhang



6X6=36个玻璃晶体组成一个探测单元模块，
探测单元模块安装在吸收体上



模块之间的立板厚度1mm（暂定）
立板的高度包含整个探测器的厚度（暂定）



水冷水路进行了优化

1/16区域只有一路水

正在进行强度校核和水冷校核