

*EPIC-ZDC*の議論

EIC日本グループ会合

2023年1月26日(木)

後藤雄二 (理研)

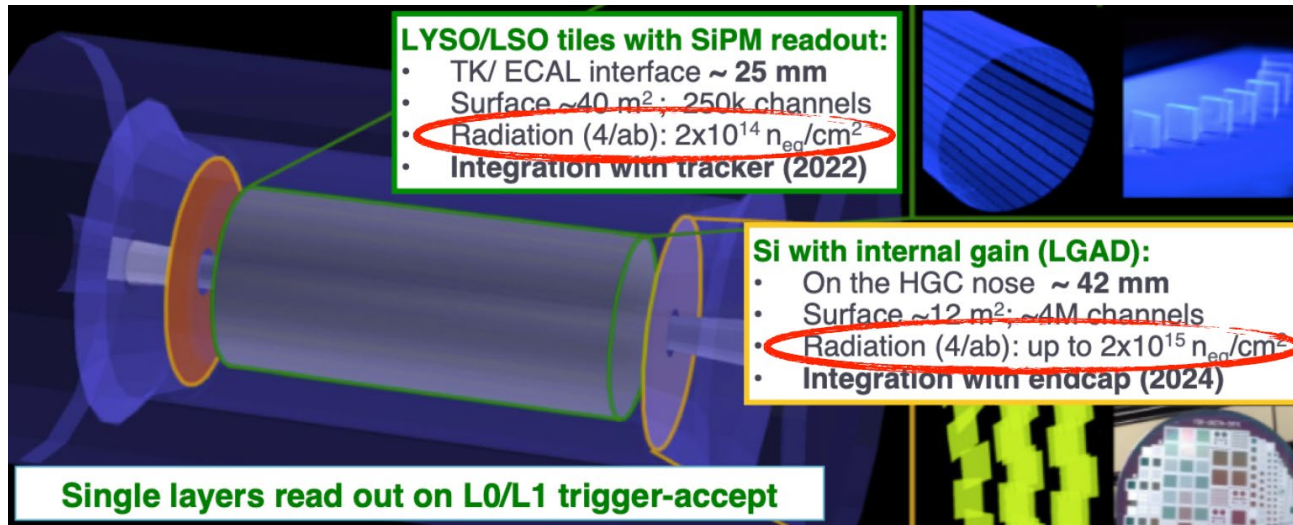
台日協力

- Prof. Chia Ming Kuo (NCU) とミーティング
 - 1/23(月) Ming、Po-Ju、後藤、山崎
- LYSO
 - Producer: Taiwan Applied Crystal
 - One of qualified LYSO producers for CMS MTD
 - Can deliver LYSO crystals with CMS standard wrap
 - Funding can be available in April for constructing a prototype if CHiP phase-2 is approved

	X_0	LY (ph/MeV)	T dep. of LY (%/K)	Decay time (ns)	λ_{em} nm
PbWO₄ (CMS)	0.89 cm	200	-1.98	5 (73%) 14 (23%) 110 (4%)	420
LYSO	1.14 cm	33,200-39,900	-0.28	36	420
SciGlass	2.4-2.8 cm	>100		22-400	440-460

台日協力

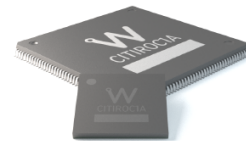
- CMS MTD requirements and technology choice



- SiPM R&D studies by CMS

- Extensive studies of radiation damage, including temperature effects and annealing
 - Increased dark current with dose
 - Reduction of dark current with lower temperature
 - Improved S/N with lower temperature

Readout



- Readout: Citiroc1A from weeroc for multichannel SiPM (Chih-Hsun Lin, IPAS)
- SiPM used by CMS in R&D in 2019: HPK MPPC-HDR2-3015

CMS ECAL
EB → APD: $4 \times 10^{13} n/\text{cm}^2$
EE → VPT (vacuum phototriodes) : $7 \times 10^{15} n/\text{cm}^2$



台日協力

• CMS-BTL LYSO:Ce

- 57mm x 3.2mm x 3mm を16本並べたモジュール (ホドスコープ)

• EPIC-ZDCのCrystal Calorimeter

- 3cm x 3cm (または 2cm x 2cm) x 9cmのタワーを作ることできる
- 台湾グループ (NCU) で読出も含めてプロトタイプを作ることができる (4月くらいが目安)

- EPIC-ZDCのpixel層としてCMS-BTLホドスコープを用いることも考えられる

CMS MTD aspects

Barrel timing layer: (BTL)

- Operation at $T = -30\text{ }^{\circ}\text{C}$ (CO_2 cooling common with TK)
- **LYSO** : $11.5 \times 11.5\text{ mm}^2$
- **Custom SiPM**: active area $< 16\text{ mm}^2$
- **ASIC: TOFHiR** [adapted from TOFPET2]
- LE discrimination with amplitude measurement for time walk correction
- **Challenge: SiPM Dark Count Rate and sensor design**

Endcap Timing layer (ETL)

- Operation at $T = -20\text{ }^{\circ}\text{C}$ (CO_2 cooling common with HGC)
- **LGAD pad size: $1 \times 3\text{ mm}^2$**
- Ganging 3 to 1 at $|\eta| > 2.1$
- **ASIC**: Exploit libraries, and expertise from RD53 (65 nm)
- Ongoing design study (preamp + Disc + ToA and TDC)
- **Challenge: Scale to large area and readout chip with $< 30\text{ ps}$**

Control cards with power, clock distr., control and data links (lpGBT)

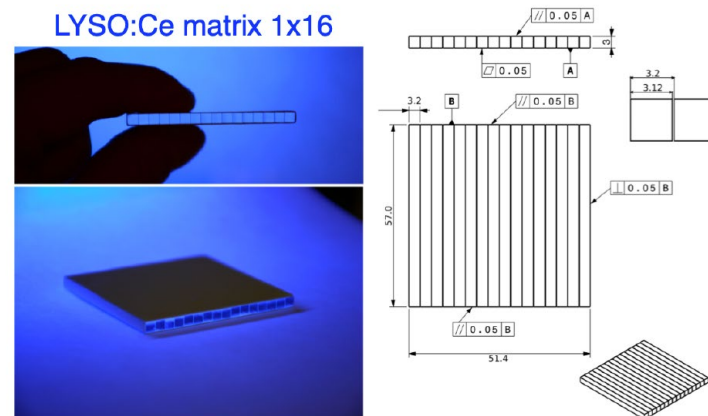
- ▶ Data volume (zero suppression): **1.2 Tb/s BTL + 2.4 Tb/s ETL**

Level-1 trigger up-scope option:

- ▶ Exploit data from regions of interest upon L0 from other systems
- ▶ Requires adjustments of the ASIC logic

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CMS BTL layout



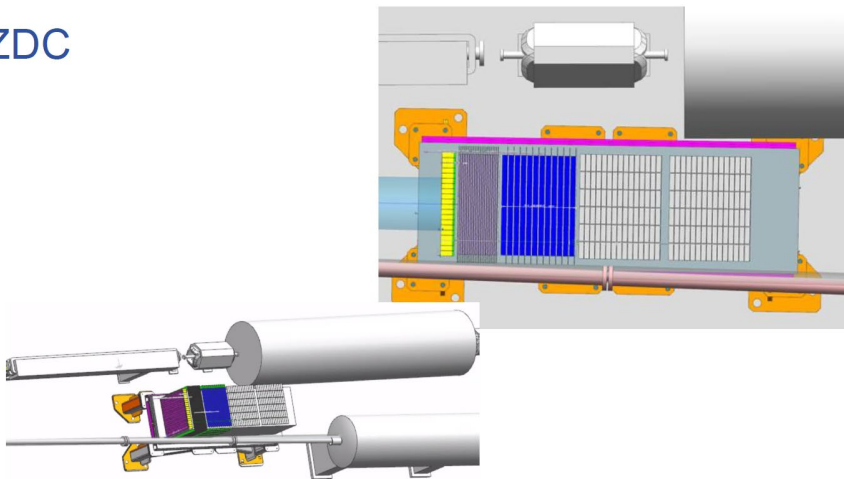
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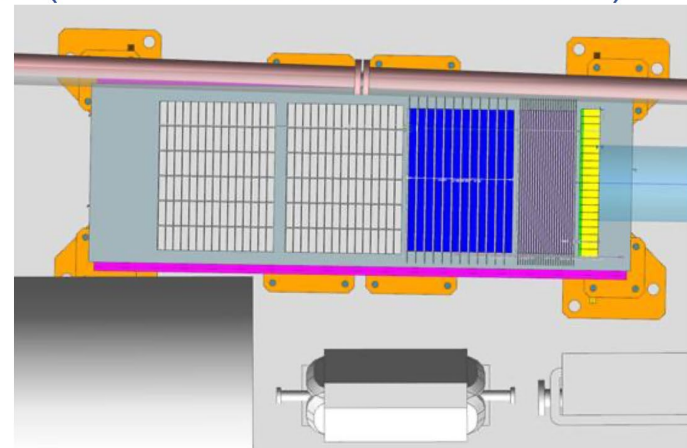
Management issues

- 1/23夜中、Yulia FurletovaらEPIC Far-Forward System関係者とミーティング
- Request to shift ZDC by 4m closer to IR
 - Reduce size? 50cm x 50cm?
 - Impact on physics (acceptance)
 - -t resolution vs granularity
 - Effect of magnetic fields near ZDC

ZDC



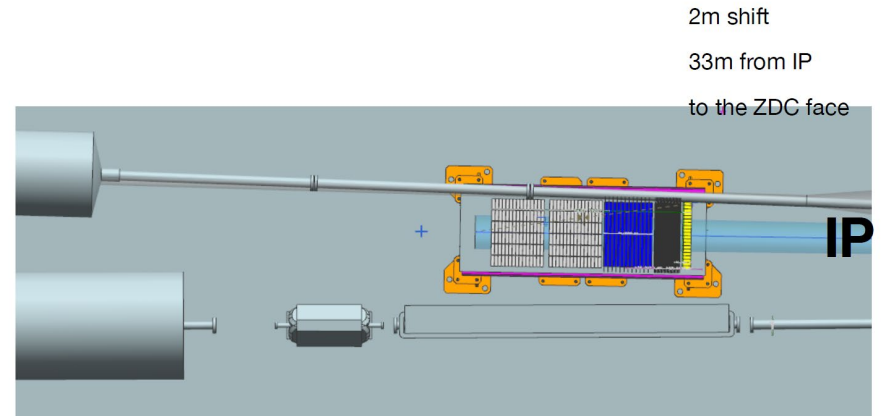
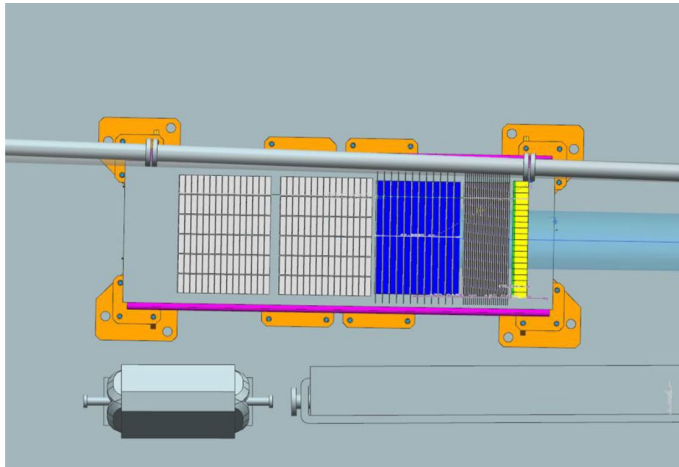
ZDC (35 m to the front face of ZDC)



シフト前 (35m to the front face of ZDC)

Management issues

- Request to shift ZDC by 4m closer to IR



- Detector simulation/reconstruction
 - Dedicated person, connection to software group
- Integration with DAQ
 - Dedicated person, connection to DAQ group
- Mechanical integration in CAD
 - JLab/BNL + ?

Schedule

- Preliminary Design (50% ready) Aug 2023
- Final Design (85% ready) April 2024
- Specs/Docs/First Article etc. (Apr 2024 - May 2025)
- Construction starts: May 2025
- Delivery/Tests : Oct 2026 (?)
- To be ready for installation Oct 2027 (?)

Cost

- We need a vendor quote for each item(s) and a time for production

ZDC

	CD1	ECCE	ATHENA	CD2
Total	\$1,093,120	\$6,953,856	\$1,853,801	\$7,134,182
Material	\$1,093,120	\$6,612,100	\$1,621,127	\$6,627,100
Labor (hours)	4,880	2497	3,990	4600
Labor \$				\$507,082
In -Kind		\$6,953,856	\$1,485,250	\$6,953,856
		Japan		Japan

- We need to finalize the in-kind contribution (including all documents) by CD-2 day (which is now Jan. 2025)
 - Taking into account that CD-2 reviews are typically few months (maybe even a half a year) before the actual CD-2 day, we need to plan to have a DOE-Japan agreement (or at least a good draft of it) to secure the in-kind contributions before June 2024 - within the next 1-1.5 year - otherwise it will be difficult to incorporate everything by CD-2 review.

Other Questions for ZDC

- EMCAL / PbWO4
 - Light guides? Light-loss? Energy resolution?
 - Spatial resolution?
- Imaging CAL
 - HGCROC. Does readout supports a streaming mode?
 - FPGA?? Location?
- HCAL Pb/Sci
 - Layout... 10x10 towers? How to collect light ?
- Shielding?
- Magnetic Field from e-line magnets?
- Space for FPGA and DAQ?

Management issues

- Questions which we need to address (preferably by next meeting, March 6th)
 - In-kind vs DOE contribution (and when we are ready for the contract) (Yuji G.)
 - Timeline - how much time do we need for production and assembly (Yuji G.)
 - Reference design (all)
 - Simulation (Po-Ju , Lynn and others)
 - energy-resolution, -t resolution vs number of layers and granularity
 - Integration with DAQ group (?)
 - Radiation hardness, Si vs Sci (Michael, Yuji Y., all)
 - Shifting ZDC toward the IP by few meters (Yulia, Alex, Po-Ju, all)