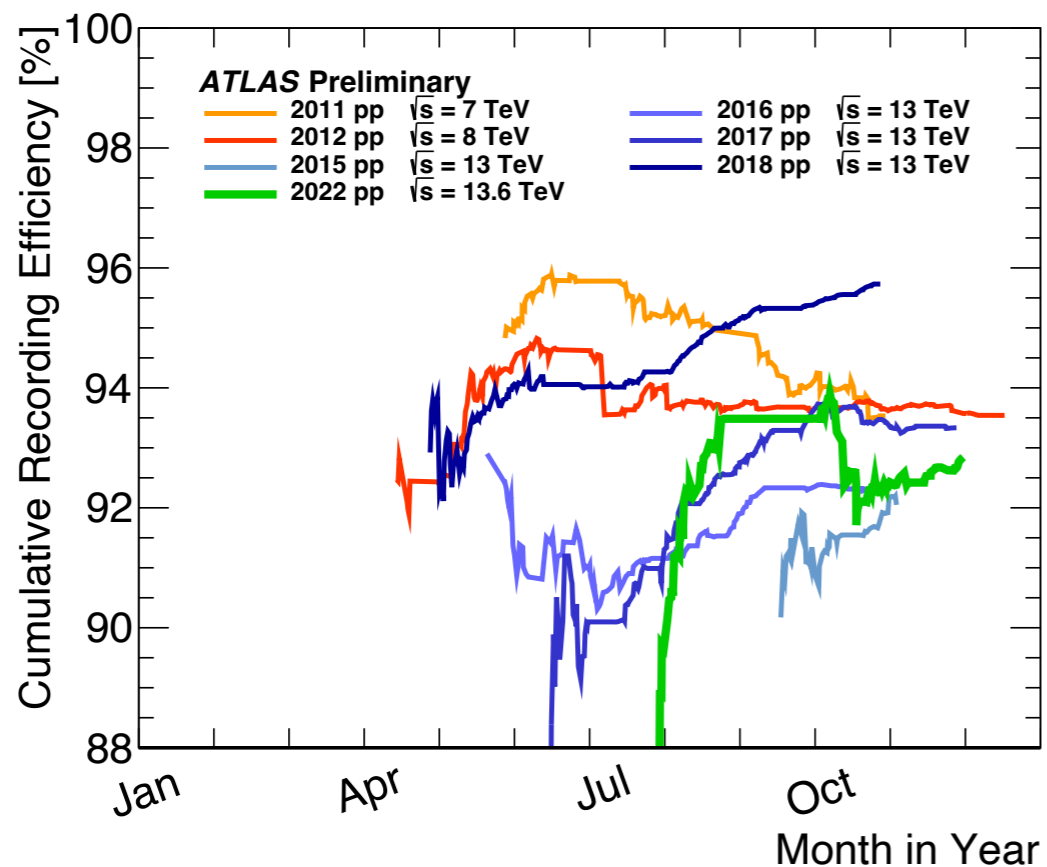
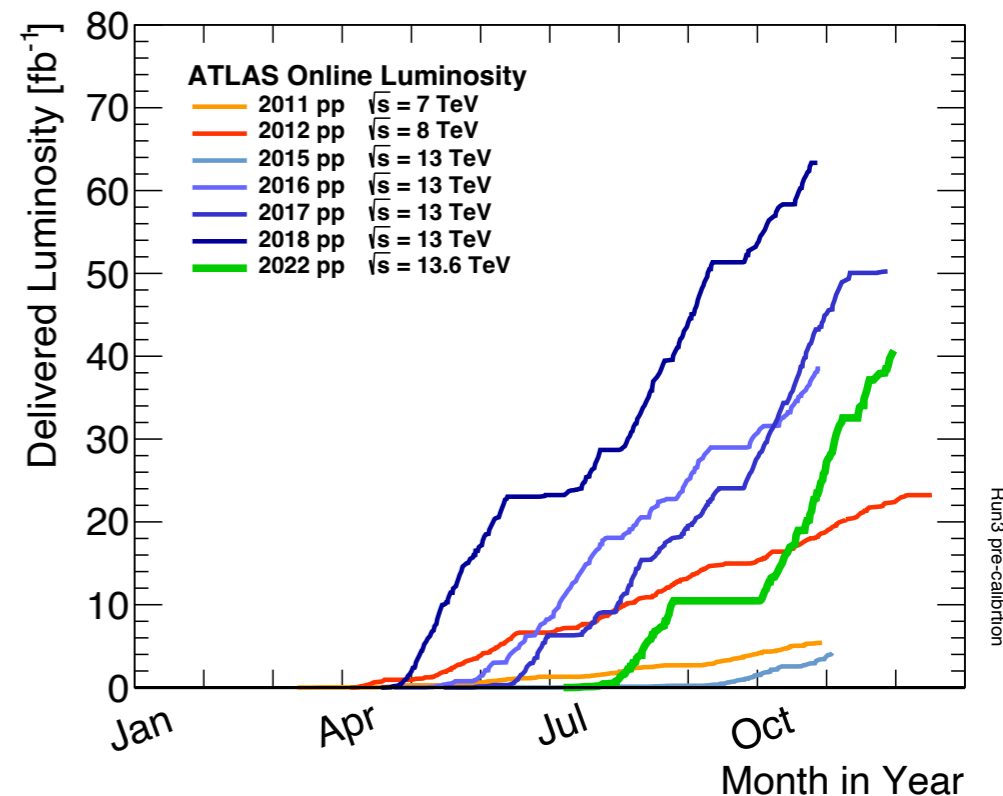
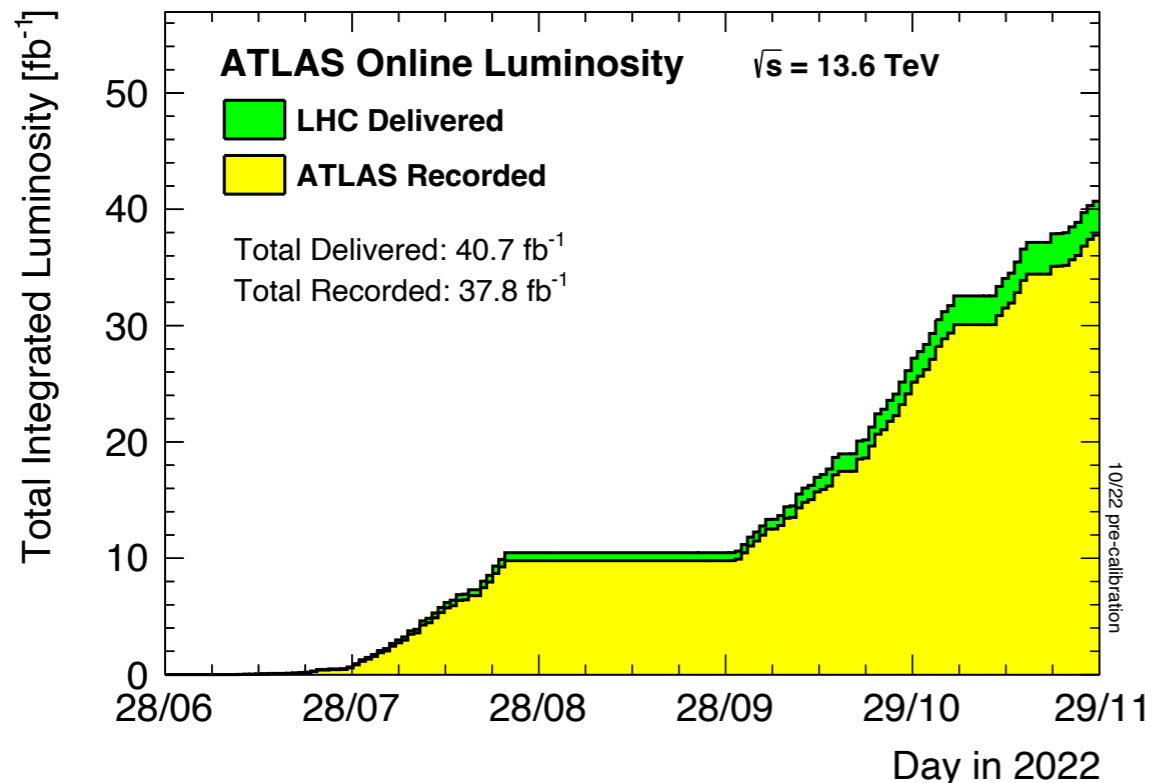


# ATLAS

~ Focus on KEK (+Japanese) Activities ~

Kazunori Hanagaki (KEK)

# Run 3 Started



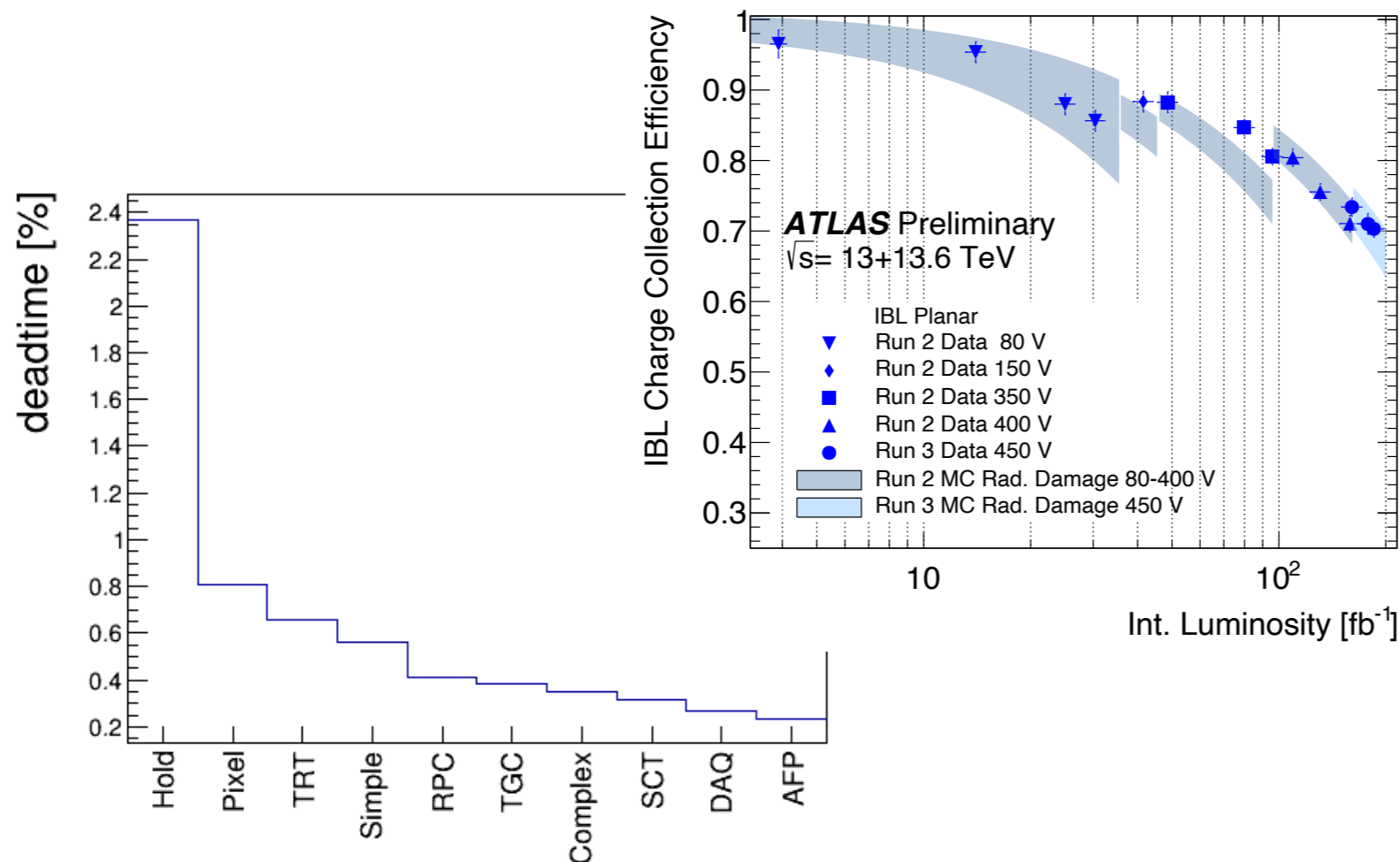
- ❖ Accelerator excellent performance
  - ▶ Luminosity leveling set at around  $1.9E34$
- ❖ Data taking tries to catch up with high luminosity

# ATLAS KEK/Japan Activities

- ❖ Operation
  - ▶ Pixel, SCT, (LAr), TGC, High Level Trigger
- ❖ Phase-II upgrade
- ❖ (Physics ←coherent with High Level Trigger)

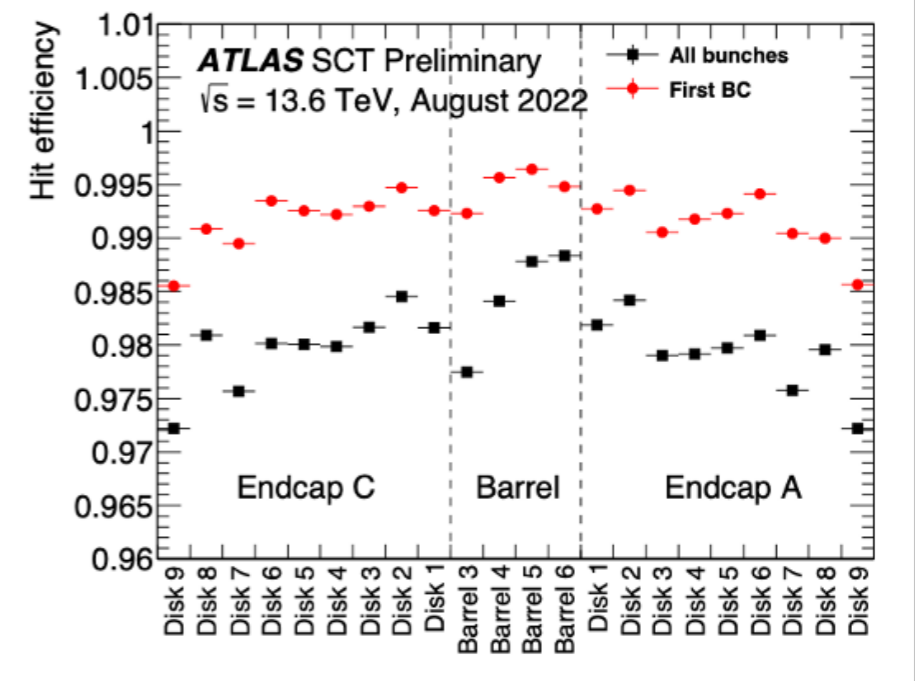
# Pixel

- ❖ KEK leads DQ (Data Quality) and offline software
  - ▶ Universities: Ochanomizu U., Tokyo tech., Waseda U.
  - ▶ Y. Takubo (ATLAS/Pixel DQ convener), S. Tsuno (Pixel offline convener)
- ❖ 3 class-3 tasks: development of Pixel-DQ infrastructure, effect of radiation damage on Lorentz angle and  $dE/dx$
- ❖ 2 qualification tasks: Pixel clustering studies, Pixel monitoring using information of the bytestream errors



# SCT

- ❖ Continuous commitment from Japanese SCT institutes (KEK, Kyushu, Osaka, Tokyo-tech, Tsukuba, Waseda)
  - ▶ ~10 active staffs/students (1 staff and 4 students based at CERN)
- ❖ Operation
  - ▶ Huge effort for DAQ/DCS on-call shift and hardware maintenance
  - ▶ Develop a web-based tool, centralize DAQ/DCS/DQ information for easier and efficient debugging
- ❖ DAQ
  - ▶ Improve cabling between SCT modules and RODs to mitigate tracking inefficiency due to ROD busy
  - ▶ Fix and maintain various calibrations
- ❖ Radiation damage study
  - ▶ Special calibrations (HV, temperature and threshold scan)
  - ▶ TCAD simulation to estimate HV to achieve enough high efficiency as a function of the integrated luminosity toward the end of Run 3





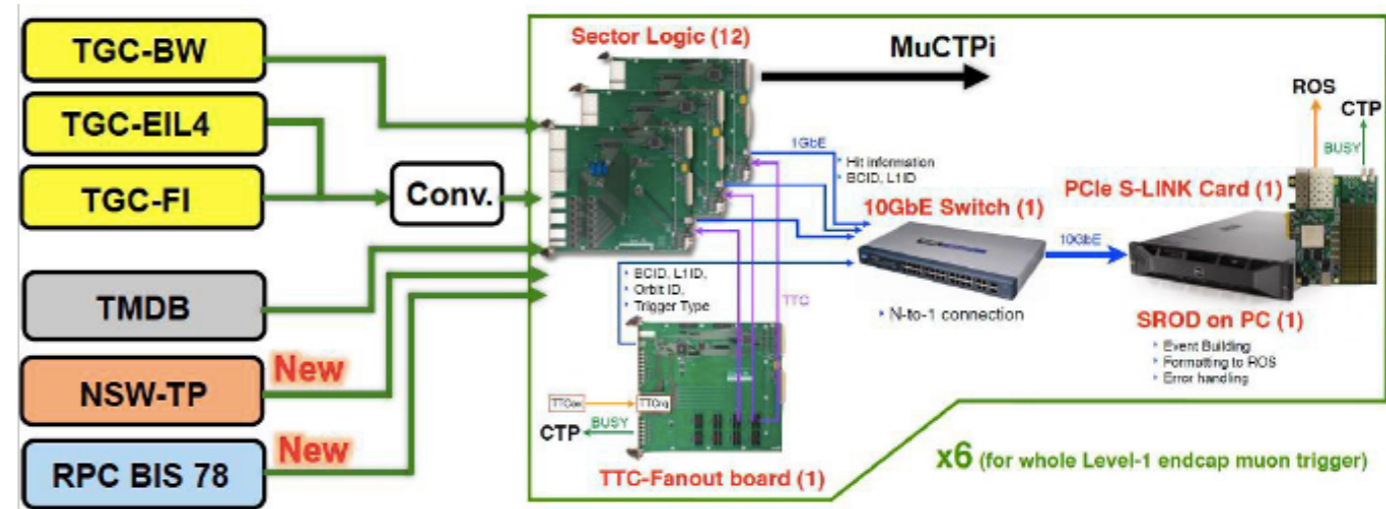
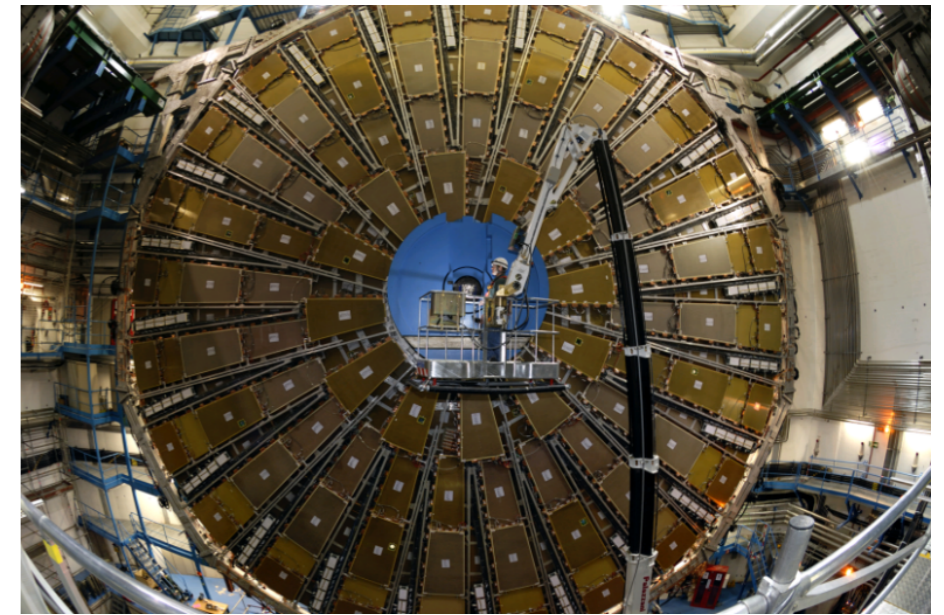
# Endcap Muon Trigger

## Japanese responsibility of TGC operation

- Electronics, Power Supply, Trigger/DAQ, Software, DQ

## Phase-I Upgrade

- Large FPGA resource
  - Flexible muon selection
- Additional inputs from new detectors (NSW, RPC BIS78)
  - Reduce fake muons



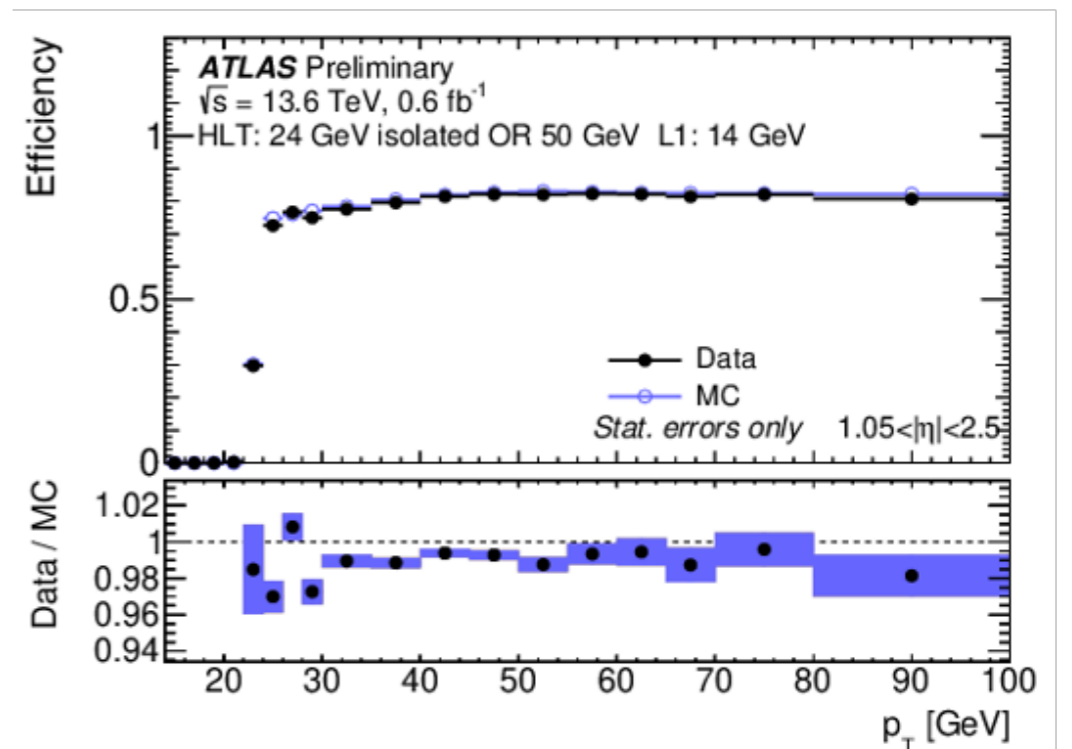
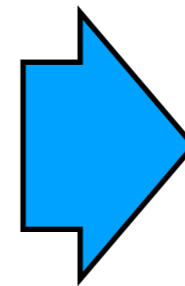
Installation before COVID (2019)



Integration from Japan (2020-2021)



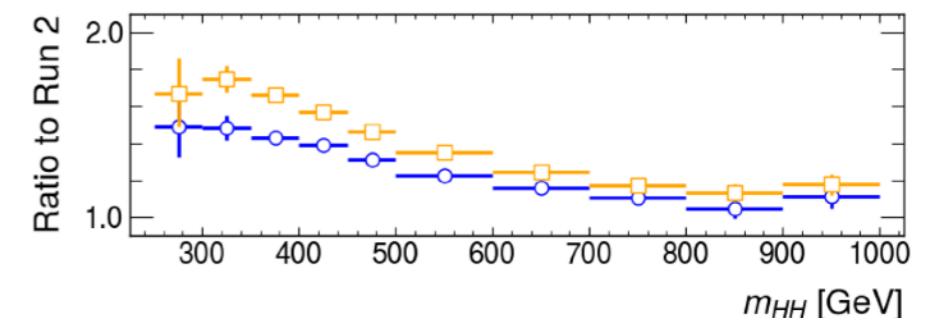
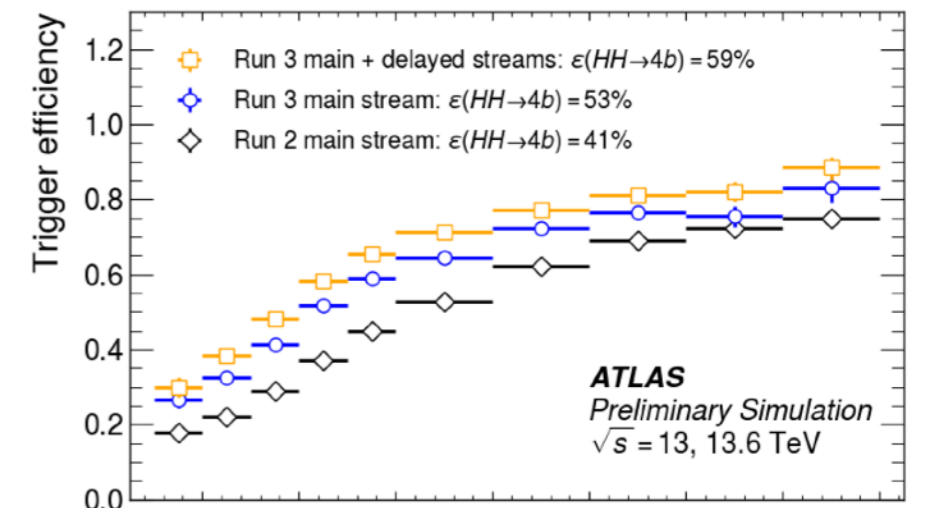
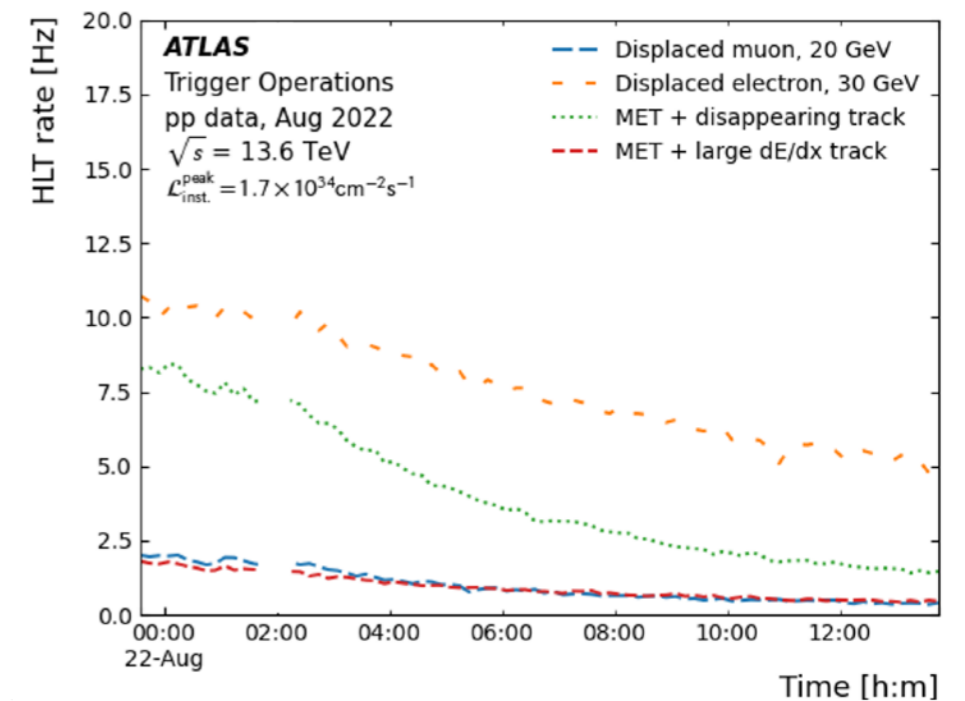
Detector Maintenance and commissioning in LS2 (2021- 2022)





# High Level Trigger

- ❖ Long history to play leading role of High-Level Trigger (HLT)
  - ▶ Coordination on muon HLT
    - K. Nagano (2010-2013), M. Aoki (2013-2016), Y. Nakahama (2019-2021)
  - ▶ Trigger menu coordinator
    - K. Nagano (2013-2015), Y. Nakahama (2016-2017)
  - ▶ Trigger coordinator
    - K. Nagano (2017; Run2)
- ❖ Physics-motivated new trigger developments
  - ▶ Unconventional track triggers
    - disappearing track, large dE/dx track, displaced vertex
    - Coordination role by K.Nagano (2019-) for ID track trigger group
  - ▶  $HH \rightarrow bbbb$ ,  $bb \tau \tau$  triggers with the delayed stream
    - Development and commissioning by Y. Nakahama with Japanese students

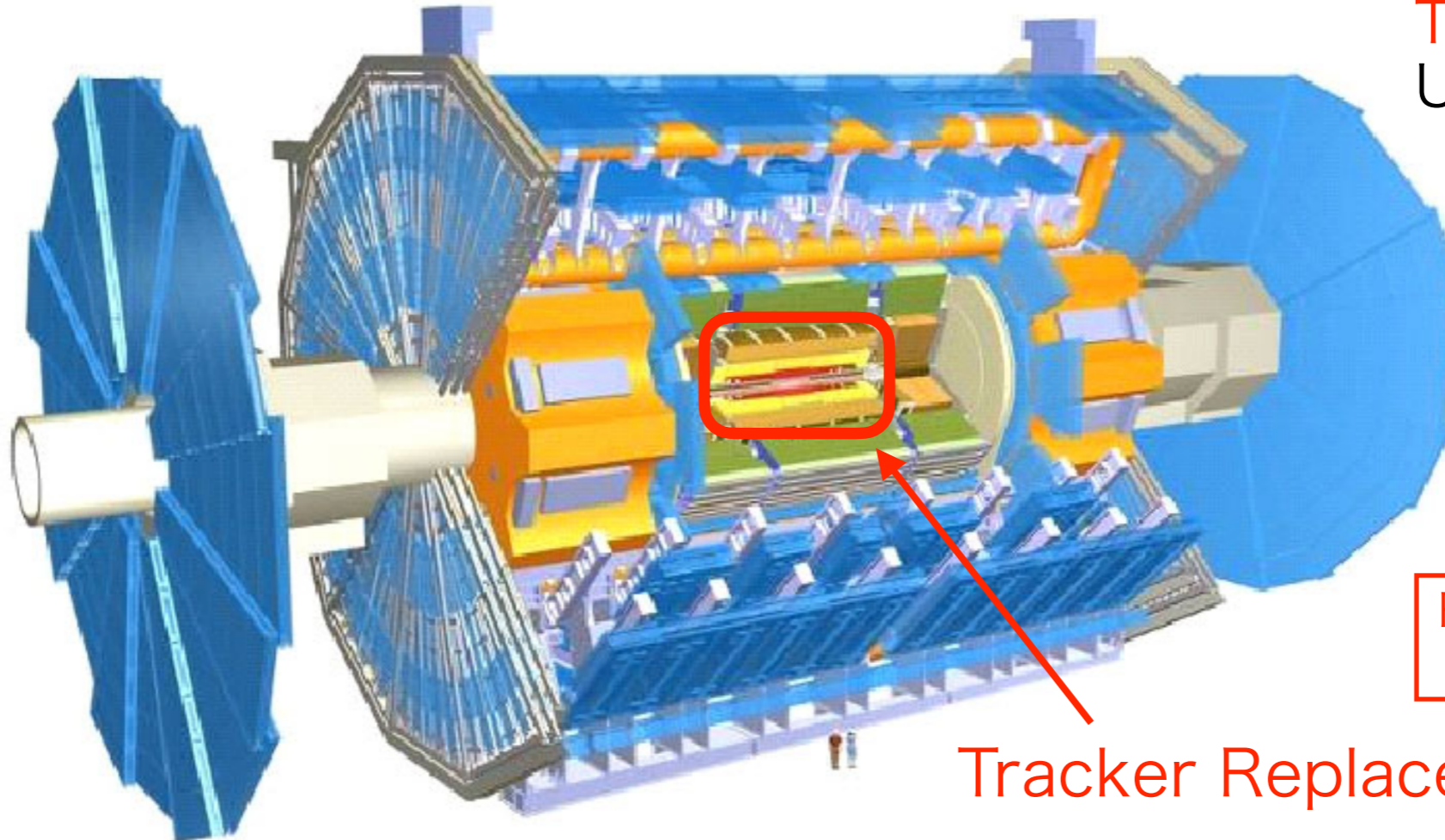


# Phase-II Upgrade

## Electronics replacement

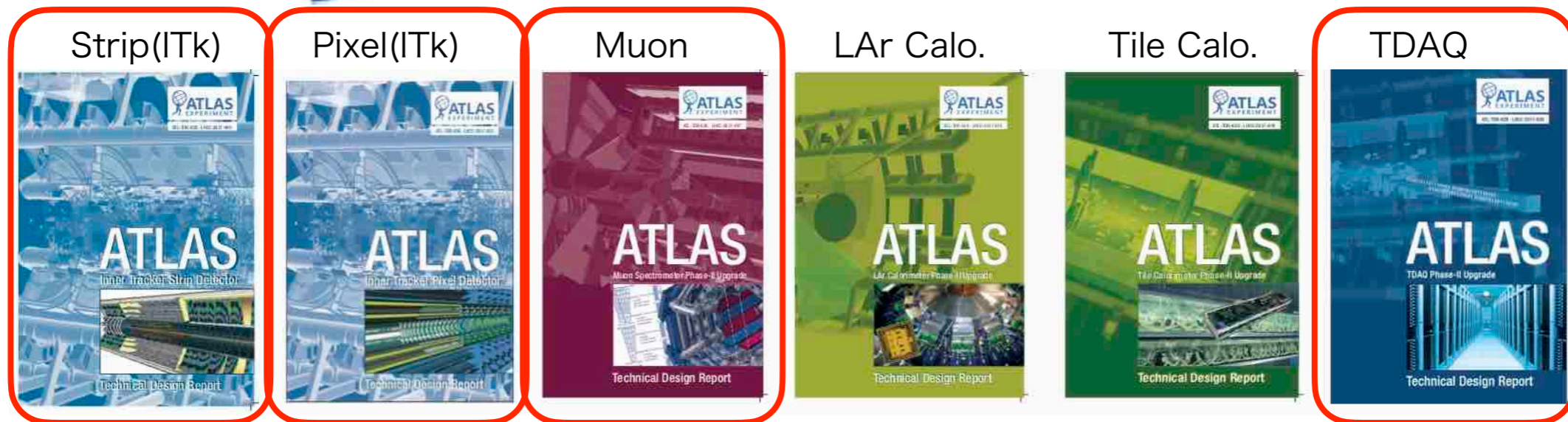
- LAr calorimeter
- Tile calorimeter
- Muon

## Trigger & DAQ Upgrade



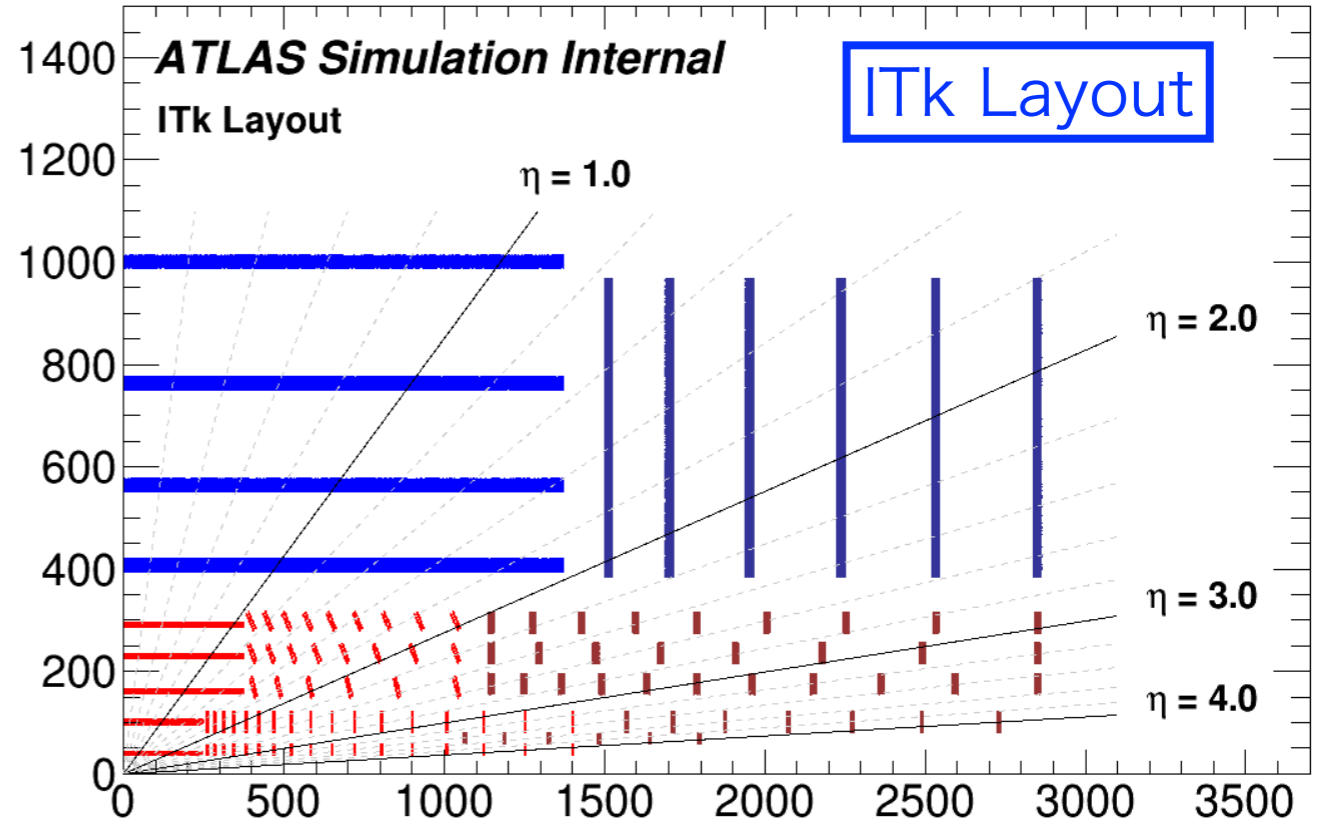
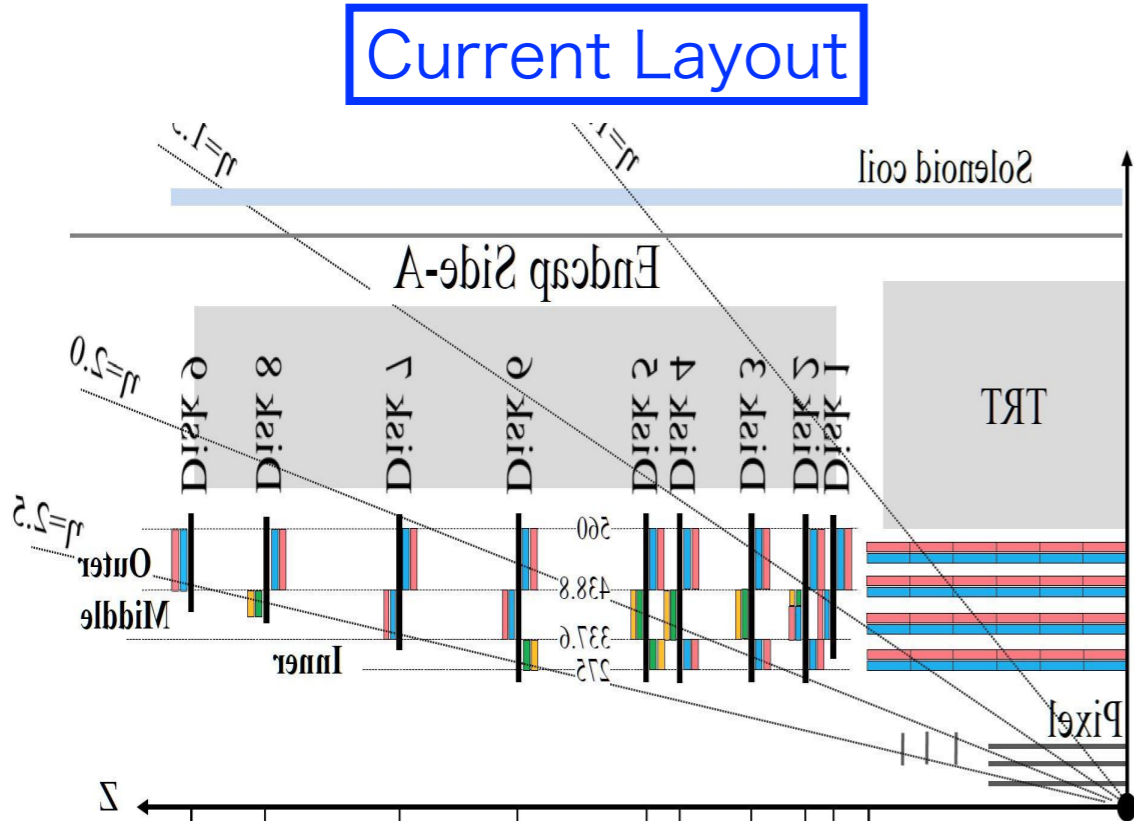
## Tracker Replacement

Red : contribution by KEK/Japan





# Silicon Tracker (ITk)

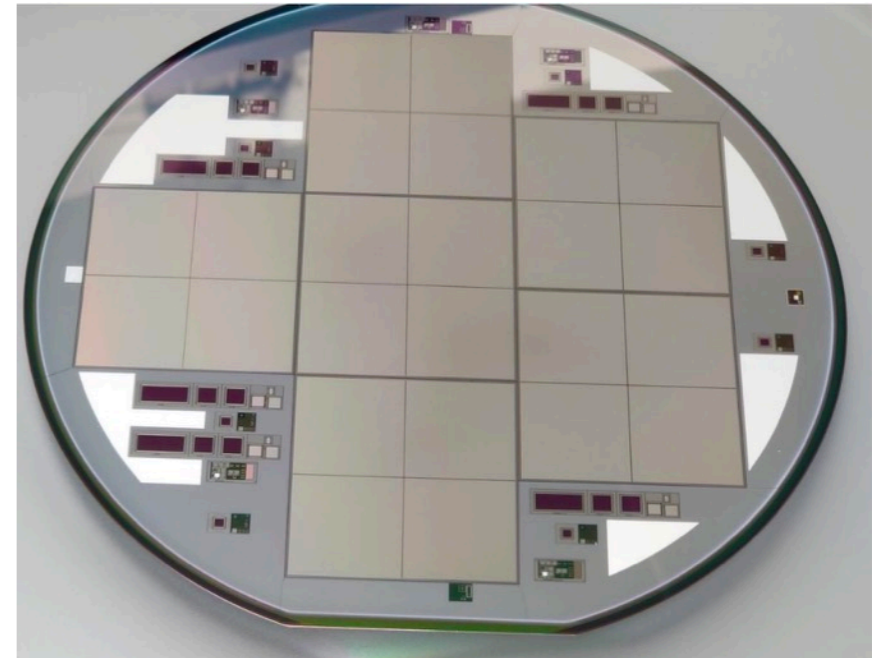


- ❖ Totally new detector
- ❖ Area
  - ▶ Pixel  $2.7\text{m}^2 \rightarrow 13.5\text{m}^2$
  - ▶ Strip  $62\text{m}^2 \rightarrow 165\text{m}^2$
- ❖ The number of channels
  - ▶ Pixel  $90\text{M} \rightarrow >5\text{G}$
  - ▶ Strip  $6\text{M} \rightarrow 60\text{M}$

- Finer
  - Pixel size  $50 \times 400 \mu\text{m}^2 \rightarrow 50 \times 50 \mu\text{m}^2$
  - Strip length  $20\text{cm} \rightarrow 2.4\text{cm}$  (shortest)
 ⇒ faster data transfer
- Radiation harder
  - Innermost  $1 \times 10^{15} \text{ n}_{\text{eq}}/\text{cm}^2 \rightarrow 2 \times 10^{16} \text{ n}_{\text{eq}}/\text{cm}^2$

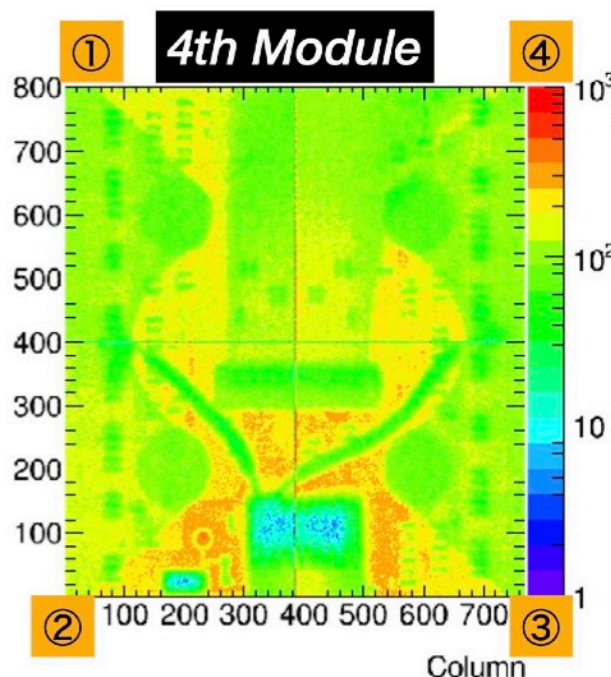
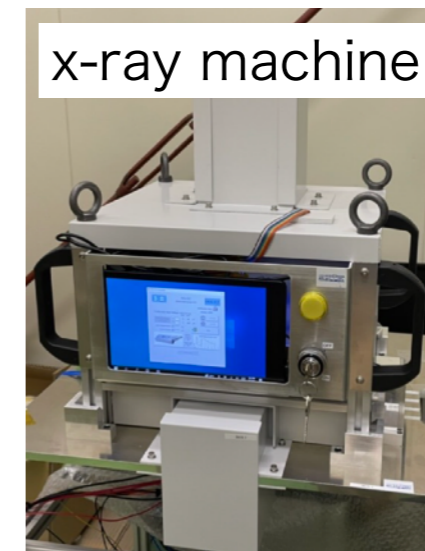
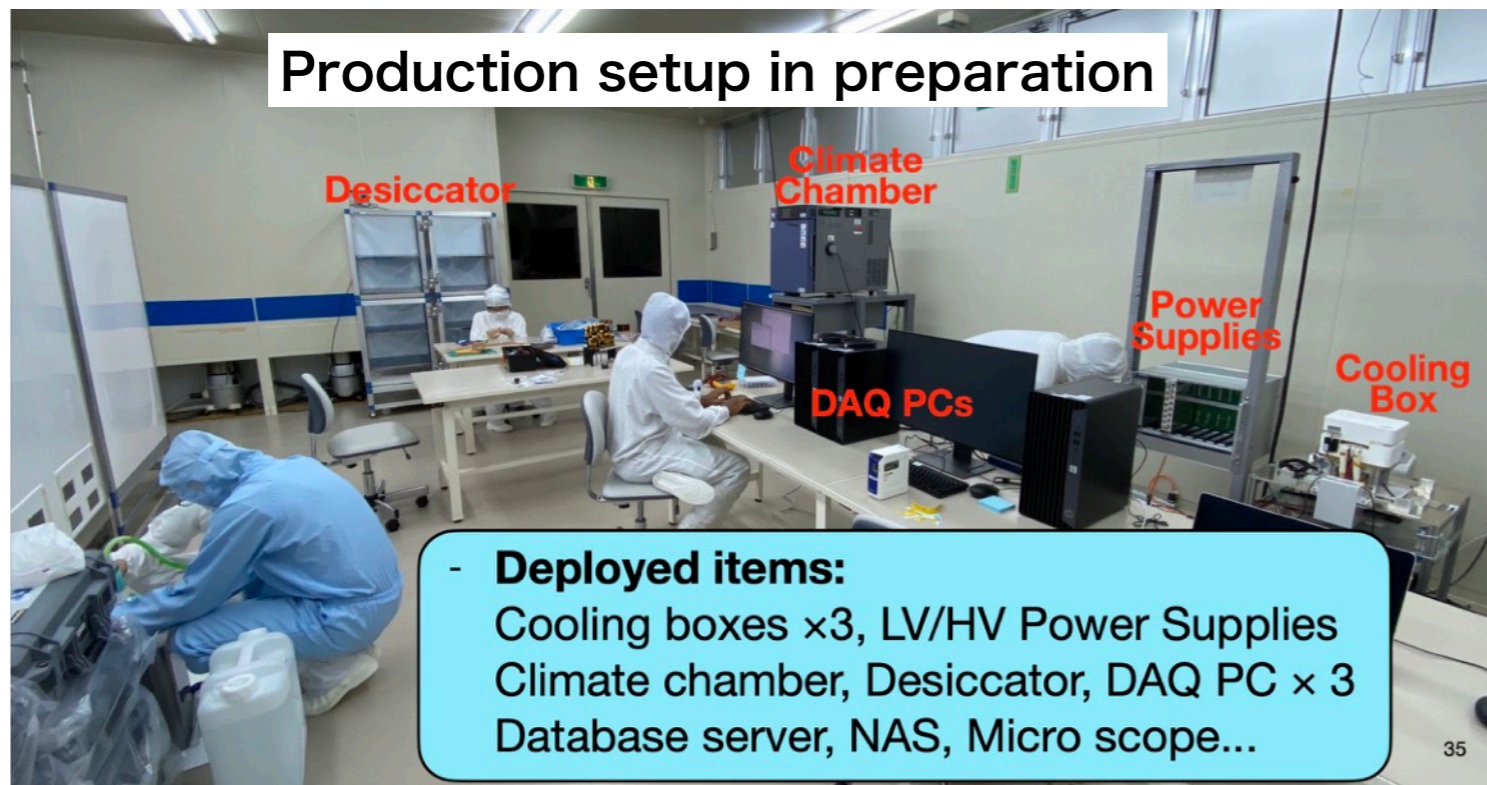
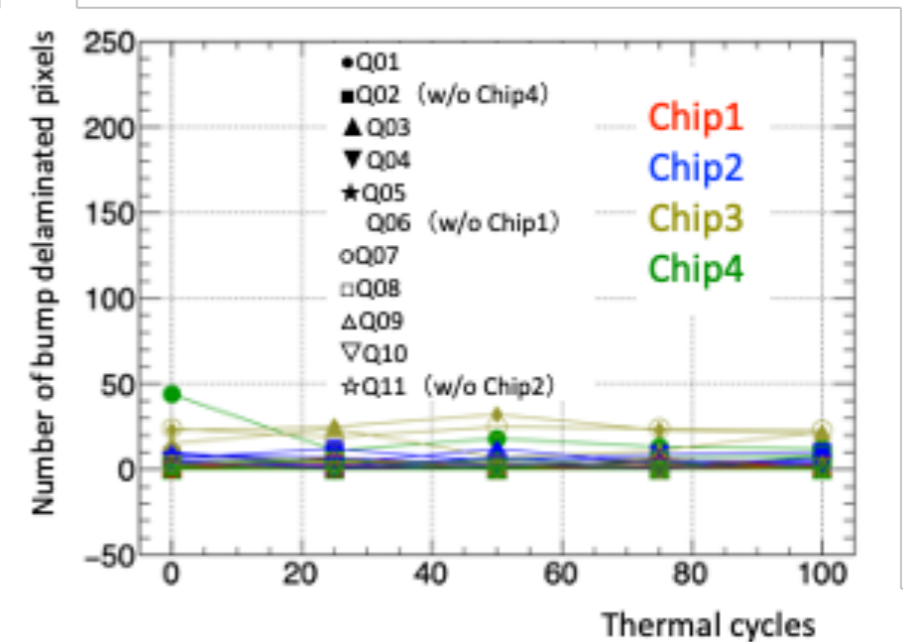
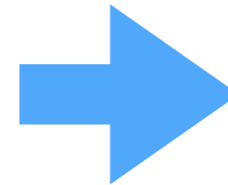
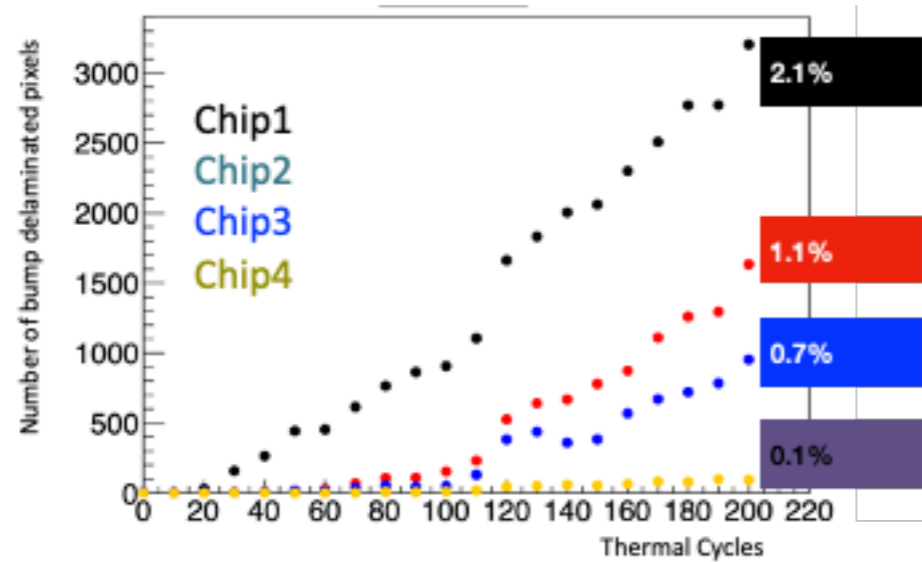
# Japanese ITk Activities

- ❖ Pixel
  - ▶ 2200 Outer Barrel/EndCap modules
    - ~ 25% of total
  - ▶ Sensor
    - 170 good sensors were delivered by June
    - Finished PRR in November → started production
  - ▶ Bump bonding studies on-going
  - ▶ In preparation of mass-production of module assembly
- ❖ Strip
  - ▶ Sensor production, QC/QA
    - A half of Barrel
    - Production is on-going



# Bump Bonding Study and Production Setup

- ❖ Previously observed Bump delamination by thermal cycling
  - ▶ No flux is used to avoid risk of corrosion in Japanese bump bonding
- ❖ With parylene, no delamination observed. 100 cycle [-55,60]°C

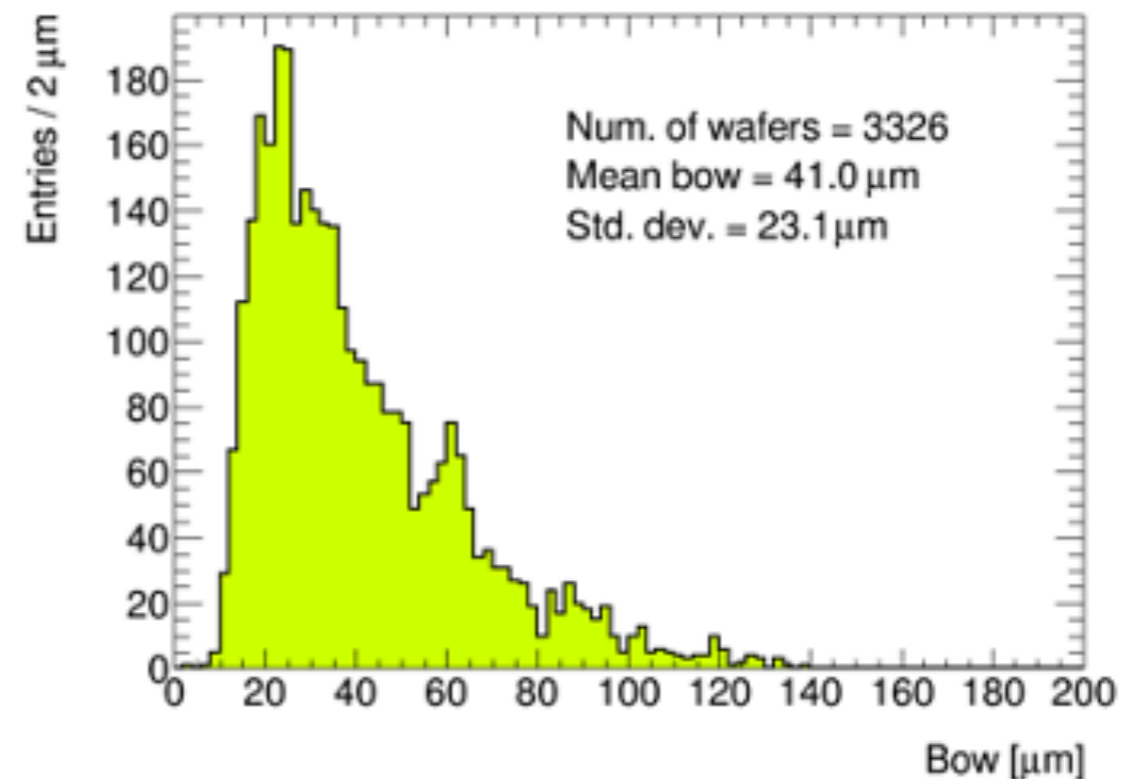
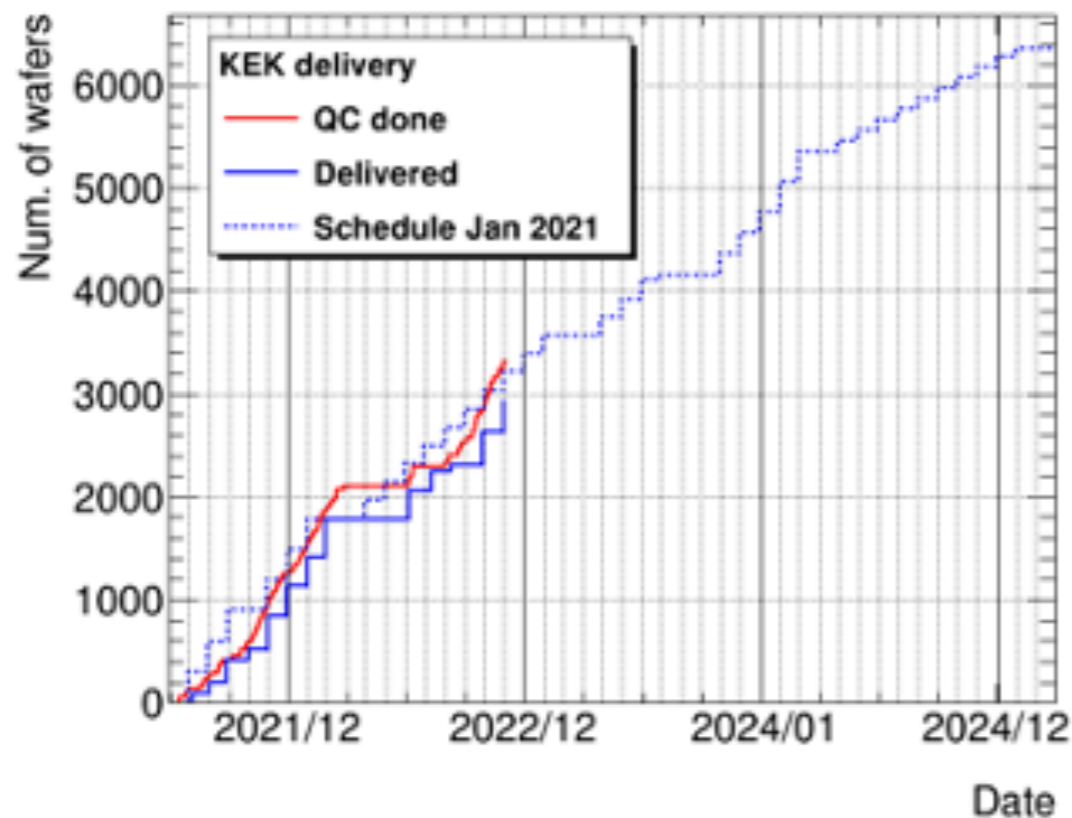




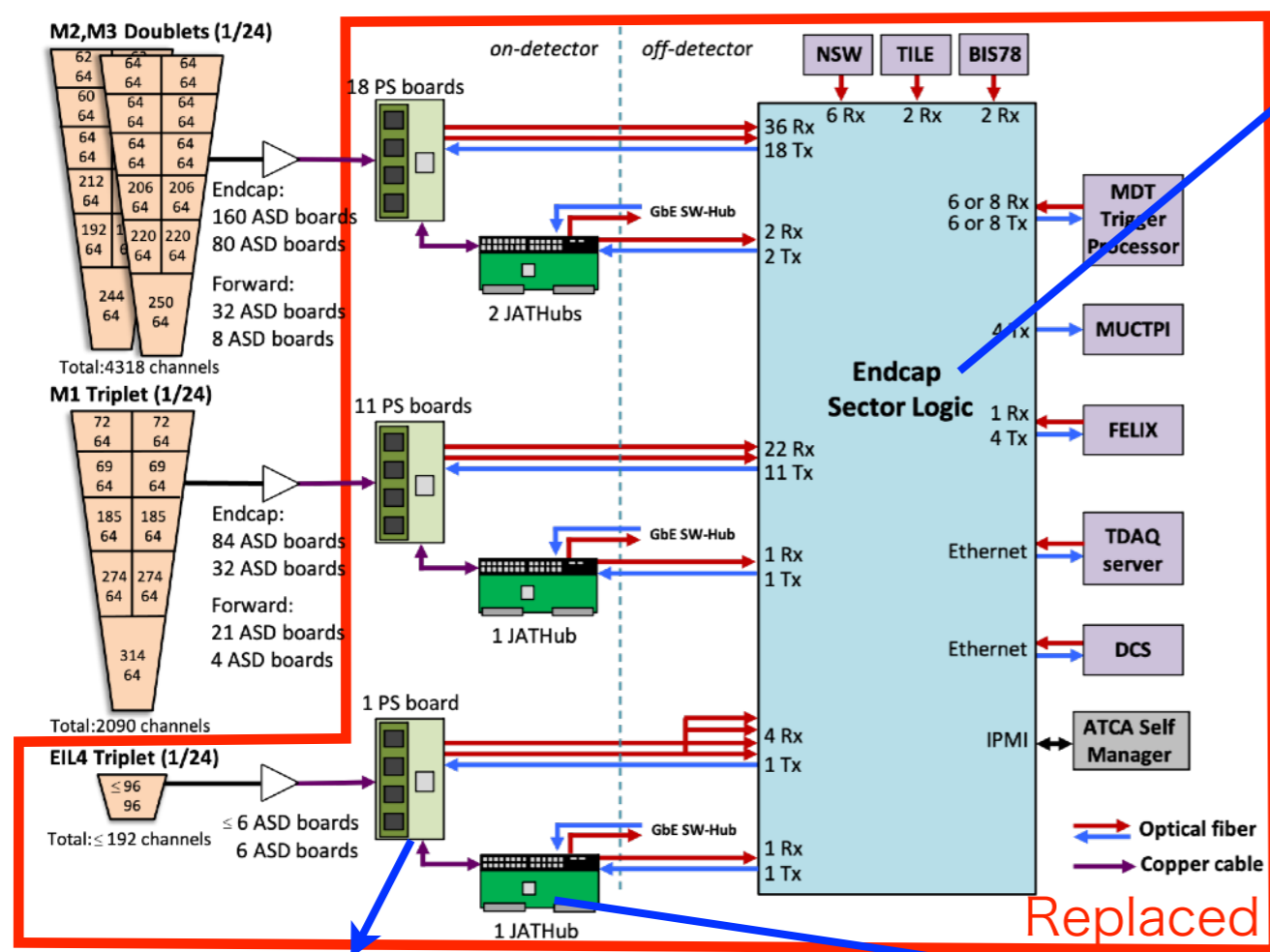
# Silicon Strip Sensor

- ❖ Production is on-going
  - ▶ 2931 sensors delivered
- ❖ Testing results show all sensor satisfy
  - ▶ bow  $< 200 \mu\text{m}$
  - ▶ deficit strip  $< 0.1\%$

QC setup in HPK clean room

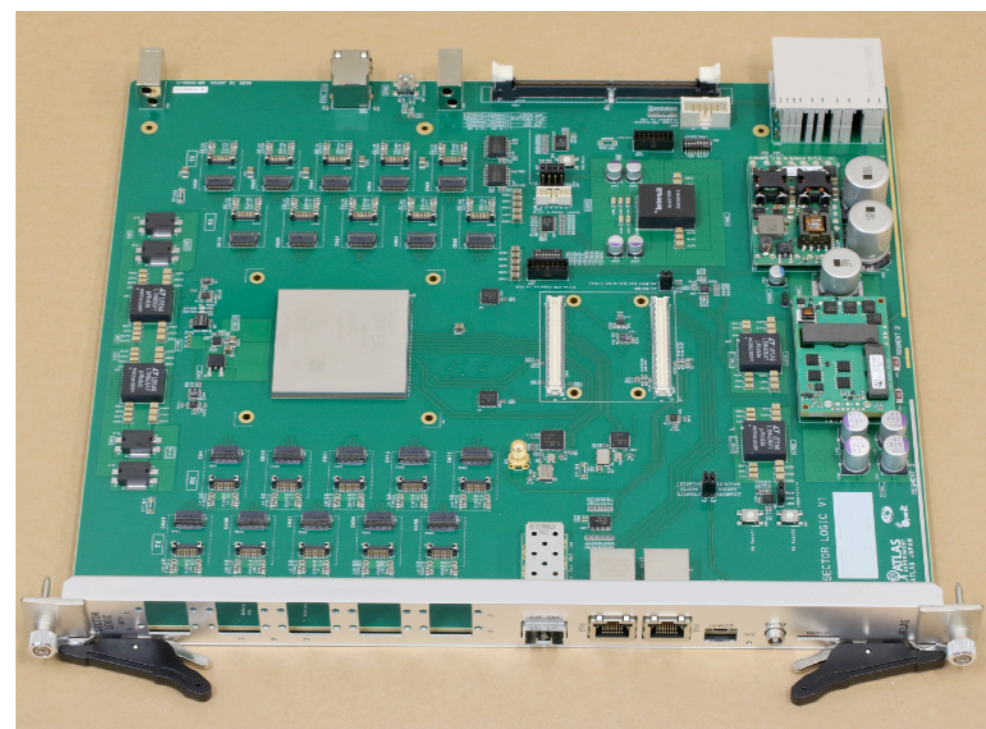


# Endcap Muon Trigger for HL-LHC



50 Sector Logic trigger processor boards

- Run muon trigger/DAQ algorithm
- First prototype has been tested

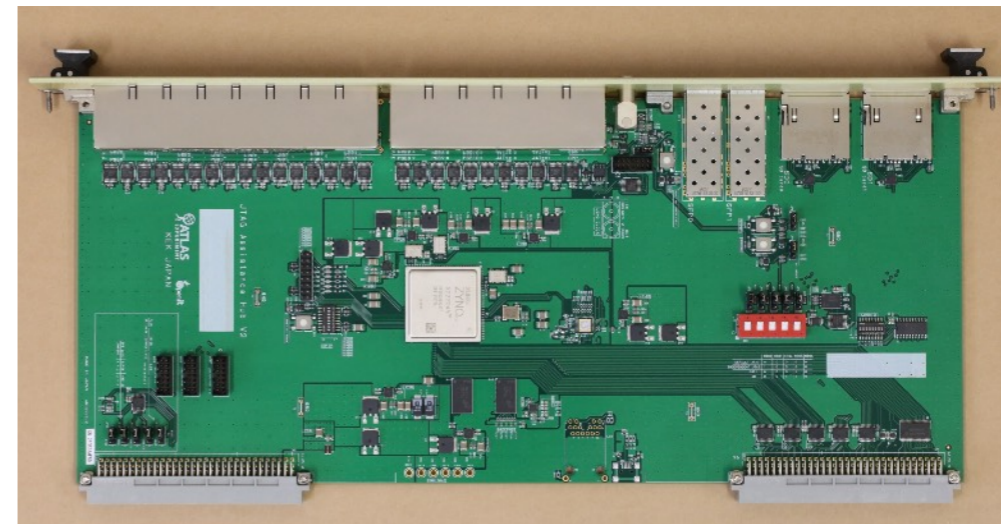
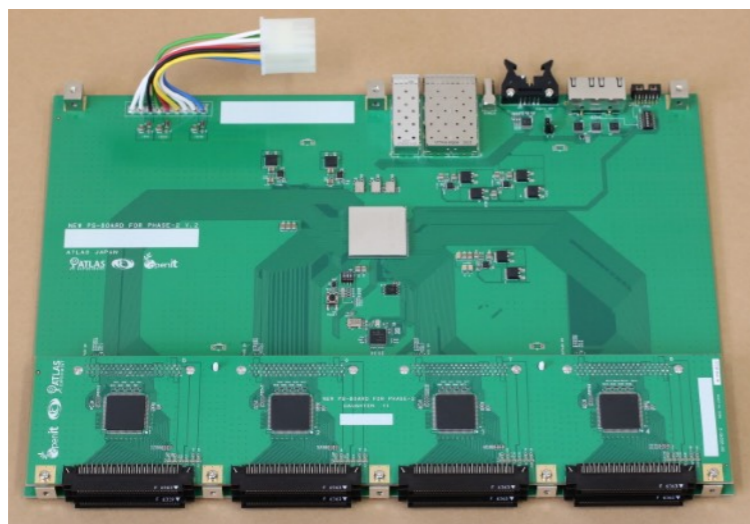


1500 PS boards

- Identify bunch crossing, Send all TGC hit info.
- Final Design Review (2021/8) → Pre-production

150 JATHub boards

- Control/Monitor on-detector FPGAs
- Final Design Review (2021/8) → Pre-production





# Japanese Funding Related Topics

- ❖ Budget framework “Particle physics with the High-Luminosity Large Hadron Collider (HL-LHC)” was approved in 2019
  - ▶ Budget request (KEK→MEXT→MOF) for each single year
  - ▶ FY2022 request now in MEXT→MOF
  - In my personal impression, no serious issues as long as the request budget size is similar to the original plan
    - But we start suffering from
      - increase of procurement cost due to world wide material cost increase
      - weak Japanese Yen
- ❖ KEK DG signed all MoU’s related to ATLAS Phase-II upgrade



# Additional contribution to the current program which is a package of D1 and ATLAS upgrade

- Discussion at KEK with HEP community
  - ▶ HL-LHC additional contribution endorsed as high priority project

- June  
Budget request from KEK to MEXT

- August  
Request from MEXT to MOF

- December  
Decision at MOF

- April next year  
Start funding

KEK to MEXT	Quench heater	RF source	RF distributor	D1-D2 beam pipe	Robot	HTS tape
MEXT judgement	○	○	○	○	no	no
MEXT to MOF	○	Request next fiscal year			N/A	N/A
MOF decision	?	?	?	?	N/A	N/A

• Budget size of RF source and distributor is too large to simply “add” to the current program  
 → Progress evaluation for the whole program next year.  
 With good assessment, MEXT will request to MOF

Ordinary Budget : Budget well planned for a fiscal year (April to March next year) ← Baseline

Supplemental Budget : Irregular budget, for example, to recover from a disaster, to stimulate economy... ← Lucky addition

# Conclusions

- ❖ Japanese contributions to :
  - ▶ Operation
    - Pixel, SCT, LAr trigger, TGC, HLT
  - ▶ Phase-I trigger upgrade
  - ▶ Phase-II Japanese contributions
    - Pixel in preparation for production, finishing R&D
    - Strip sensor production is on-going
    - Muon trigger development in good shape
      - Very close to start the production
      - Difficulties in procurement of electronics parts
  - ▶ Physics