# Bellell Detector Status

Koji Hara (KEK IPNS)

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## **Belle II Detector**

<u>KL and muon detector (KLM):</u> Resistive Plate Counter (barrel) Scintillator + WLSF + MPPC (end-caps)

EM Calorimeter (ECL): CsI(Tl), waveform sampling

electron (7GeV)

Beryllium beam pipe 2cm diameter

Vertex Detector (<u>VXD</u>) 2 layers DEPFET (<u>PXD</u>) 4 layers DSSD (<u>SVD</u>)

> <u>Central Drift Chamber (CDC)</u> He(50%):C<sub>2</sub>H<sub>6</sub>(50%), Small cells, long lever arm, fast electronics

Particle Identification Time-of-Propagation counter(barrel, <u>TOP</u>) Prox. focusing Aerogel RICH (fwd, <u>ARICH</u>)

> positron (4GeV)

General purpose  $4\pi$  Detector Improved PID, Vertex detector High background tolerance

### Belle → BelleII Upgrade



### KLM

Use glass resistive plate chamber (RPC) of Belle KLM except for endcap and innermost layers in Barrel

→ endcap and innermost two layers in barrel are replaced with scintillator + MPPC to reduce deadtime



### Scintillator Module



### Scintillator modules have been installed in 2013-2014







## ECL

- Use Belle ECL CsI(Tl) crystals and PIN diodes
  - 30cm long CsI(Tl) (16.1X0)
  - 2x(2cm2) PIN diodes
  - 2 preamplifiers
- Readout electronics has been upgraded
  - Shorter shaping time 0.5 µs
  - Waveform sampling
  - $\rightarrow$  Reduce background noise effect
- Endcap Belle ECL have been installed again in 2017-2018





### CDC



CDC Installed in Oct. 2016



Upgraded to new CDC with smaller cell, longer lever arms

	Belle	Belle II
inner most sense wire	r=88mm	r=168mm
outer most sense wire	r=863mm	r=1111.4mm
Number of layers	50	56
Total sense wires	8400	14336
Gas	He:C <sub>2</sub> H <sub>6</sub>	He:C <sub>2</sub> H <sub>6</sub>
sense wire	W(Φ30μm)	W(Φ30μm)
field wire	Al(Φ120μm)	Al(Φ120μm)



### **Bellell Roll-in**



WKEK T

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BelleII moved to the beam line on Apr. 11, 2017

AS KEK

## ARICH



Forward endcap PID is upgraded from threshold type Cherenkov counter (ACC) to ring image Cherenkov counter (ARICH)

- Aerogel as radiator
- Hybrid Avalanche Photo Detector (HAPD)

Completed Aerogel and HAPD planes being combined (2017 Aug.)





## **ARICH Cooling Issue**

Found heat extraction is not sufficient

• temperature sensors:

46°C(right), 51°C(top) 45°C (left), 37°C(bottom)

- Temperature of electronics ("merger" FPGA) is in still acceptable range
- Can be a potential problem for HAPD (under investigation)
- Additional cooling bodies installed in Jan. 2018
- $\rightarrow$  not much improved

Additional cooling methods are being studied

 add direct cooling by extracting ARICH and separating endcap ECL during phase2-3 transition Position of the temperature sensors





### Vertex and Beastll Detectors in Phase 2



Phase2 vertex detectors are consists of partial PXD and SVD, BeastII detectors for beam background characterization

## PXD and SVD for Phasell

1 sector of PXD and SVD are installed in the direction where the largest beam background is expected.

- 2 layers of PXD (4 half ladder modules)
- 4 layers of SVD

Establish safe operation and confirm beam background condition for phase3



**4 PXD modules** 

**PXD** 

**4 SVD layers** 

### **BeastII Detectors**

- To study individual BG components
- Time evolution of BG
- DAQ runs continuously independent of BelleII Global DAQ

### Phase 2 BEAST

TPCs

TPCs installed and running continuously. Multichip operation and calibration using internal alpha source

• He3 Tubes Functionality verified



FANGS

3 staves installed and working at a time Digital and analog parts OK. Chip tuning OK. (FE-I4 ATLAS Near Gamma Sensors)

### CLAWS 2 staves installed Functionality verified

(sCintillation Light And Waveform Sensors)

PLUME

2 ladders installed

Threshold study and noise maps. Temperature evolution with time. Data transfer stability

(Pixelated Ladder with Ultra-Low Material Embedding)











Phase2 Beam pipe and Diamond Sensors



Phase  $2 \rightarrow 8$  sCVD sensors Phase  $3 \rightarrow 8 + 12$  sensors

Diamond sensors has been also tested in phase1
Readout system and abort generation system
has been installed
→ Ready for the phase 2 first beam

## **Phase2 VXD Installation**







- Phase2 VXD has been installed in Nov. 2017
- Also provided important test for installation tools and procedure for phase3
- Careful preparation based on the experience of phase 2 is important
  - number of cables/pipes will be x10

### **Bellell Global Commissioning**



Global cosmic ray run with BelleII detector taken after roll-in in 2017 July-Aug., Nov. (partial BelleII)

Global Bellell (phase2) cosmic ray run started in 2018 Feb.

- Already took some long (>hours) runs usable for detector check and calibration
- Tuning of central DAQ and each detector electronics are being performed towards 30kHz data taking (maximum rate planned for BelleII phase3)





Pt resolution after Initial calibration of CDC with GCR2017 data

 Belle CDC only:

  $\sim 0.28P_t \oplus 0.35$  (%)

 GCR2017 July:

  $\sim 0.13P_t \oplus 0.31$  (%)

Already better than Belle CDC at the first step

### "First Events" in 2018 GCR



### **Phase 3 Vertex Detector**



## Phase3 SVD



SVD Ladder production has almost finished.

• A few spare production remaining in 2018 March.

SVD assembly table has been built in the clean room at Tsukuba exp. hall B1.

- Mount ladders on support structure
- Attach cooling pipes, install temperature sensors
- Check of mounted ladders for cooling, electrical performance, position precision
- etc.





- SVD is assembled in two half shells
- Ladder mount started in 2017 Sep.
- First half (+x side) completed in 2018 Jan.
- Complete second half by May
- System test of SVD half shells May~
- Combined with beam pipe and PXD in Aug.

### Phase3 PXD









Ladder Production status (as of 2018 Feb.) <u>Strategy</u>

- Start with smaller batches of L1 modules (half ladder), then larger batches of L2
- 50% contingency

### <u>L1</u>

- modules done
  - 8 ladders assembled 1 b-grade ladder and 1 c-grade ladder

### <u>L2</u>

- all modules done up to SMD, testing ongoing
- Ladder assembly started in beg. of Feb.

#### Ladder Mount Preparation

- Assembly tools and test stand being prepared
- Half shell Assembly and Test at MPI&DESY (March May)
- $\rightarrow$  Deliver PXD half shells to KEK (June)



## Phase3 VXD Assembly At KEK



Phase3 VXD Assembly Table being Prepared



SVD Half shell attachment test using phase2 setup

- Phase3 Beampipe delivery in 2018 March
  - Solved Au peel-off problem in the first production
- VXD assembly setup for Phase3 being prepared
  - Basic test has been done with Phase2 setup

### Assembly schedule

- Beampipe, shield monitor assembly Apr.
- System test of SVD/PXD half shells May-Aug.
- Integration of Beampipe, PXD and SVD Aug.
- System test of integrated PXD+SVD ~Sep.
- VXD installation to BelleII in Oct.-Nov.



Cable trays and hand crane used for Phase2  $\rightarrow$  Phase 3 design in progress

## Summary

- Belle Detector has been upgraded to BelleII
  - Improved vertex and tracking detectors
  - Improved particle ID
  - Improved background tolerance for condition in SuperKEKB
- Phase2 BelleII Detector Installation has been completed and being commissioned
  - Global cosmic ray data taking with all detectors involved has started
  - Calibration and detailed check of detectors are starting
  - Phase2 BelleII detector and BeastII detectors are waiting for the first beam

### **Toward Phase3**

- Final vertex detectors are being assembled
  - First half shell of SVD completed
  - PXD L1 ladders has been assembled
  - Assembly setup of full phase3 VXD is being prepared based on phase2 experience
  - Phase3 VXD will be ready for installation to BelleII in Nov. 2018
- ARICH cooling reinforcement is planned
  - Basically in parallel with VXD works

- BelleII Detector Introduction
- KLM
- ECL
- CDC
- **TOP**
- Roll-in
- ARICH
- PhaseII SVD+PXD, BEASTII
- PhaseIII SVD+PXD
- TRG/DAQ
- Global Cosmic Ray Test 1
- Global Cosmic Ray Test 2
- パス: Computing + Soft