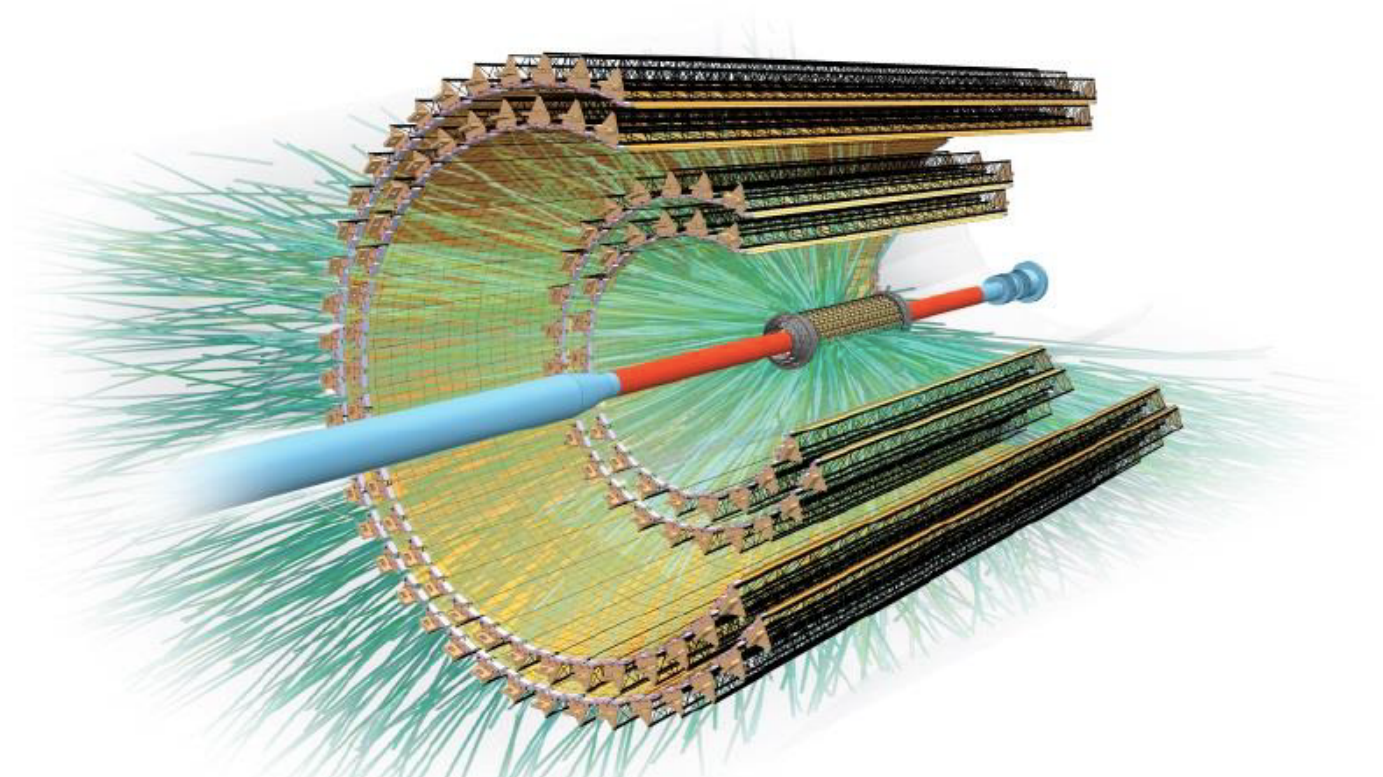


ALICE ITS Upgrade Status Report

In-Kwon YOO - Pusan National Univ.
for ALICE collaboration

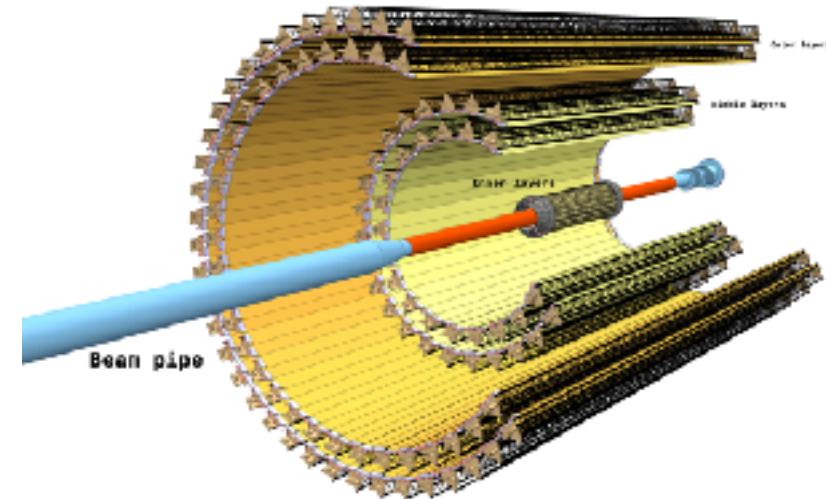


1. ALICE ITS Upgrade Motivation
2. Pixel Chip Performance, Status and Plan
3. Module and Stave Status and Plans
4. Barrel Mechanics Milestones
5. Readout Electronics
6. Overall ITS Construction and Integration Schedule

ALICE ITS Upgrade Motivations and Strategy

- Main detector requirements

- Higher tracking efficiency and resolution at low p_T
 - Granularity \uparrow Material budget \downarrow
- High-statistics, un-triggered data sample
 - RO rate \uparrow Data size \downarrow (Online)



➔ New Silicon Tracker (Inner Tracking System) for HL LHC (installation during 19/20)

- Improve impact parameter resolution by a factor of 3

- Get closer to IP (1st layer): 39 - 430mm ➔ 23 - 400mm ($|\eta| \leq 1.22$)
- Material budget X/X₀ per layer: ~1.14% ➔ ~0.3% (inner)
- Reduce pixel size: 50 μ m x 425 μ m ➔ 28 μ m x 28 μ m

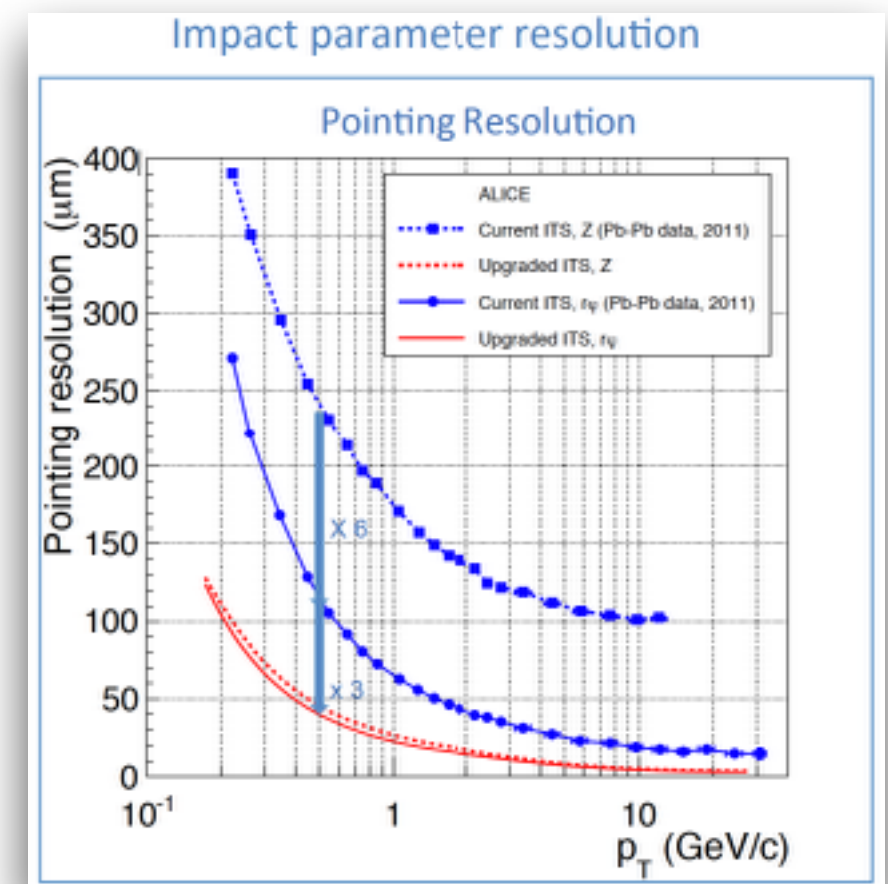
- Improve tracking efficiency and p_T resolution at low p_T

- Increase granularity: 6 layers ➔ 7 layers w. reduced pixel size

- Fast readout: 1 kHz (1kHz) in PbPb (pp) ➔ 100 kHz (400kHz) in PbPb (pp)

- Power density < 40mW/cm²

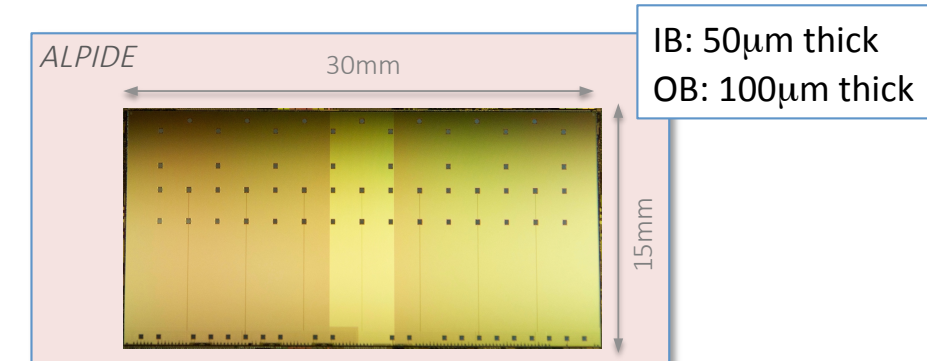
- Fast insertion/removal for yearly maintenance



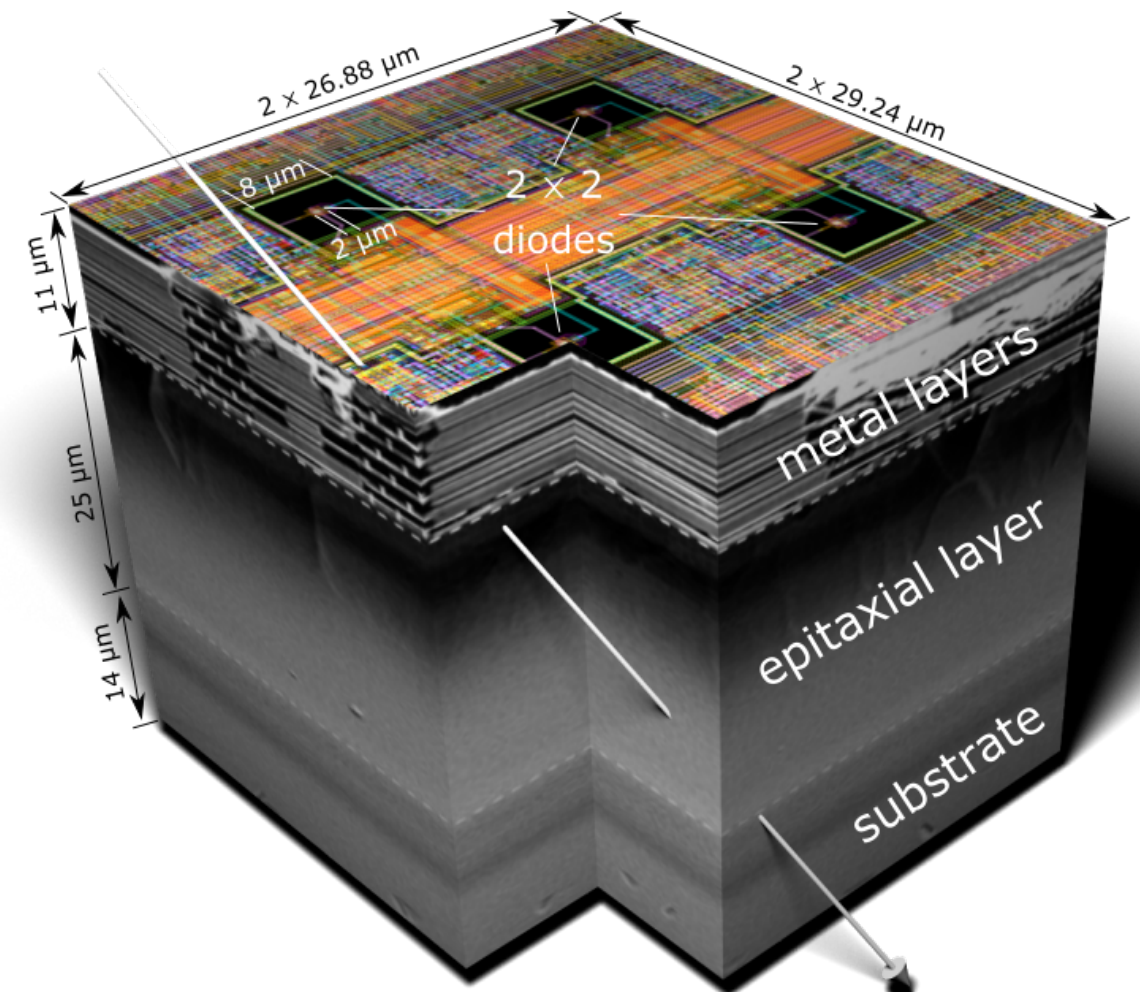
ALPIDE (ALice Pixel DEtector)



- CMOS Pixel Sensor using 0.18 μm CMOS Imaging Process
 - ▶ High-resistivity ($>1\text{k}\Omega \cdot \text{cm}$) p-type epitaxial layer (25 μm) on p-type substrate
 - ▶ Small n-well diode (2 μm ϕ) ~ low capacitance (fF)
 - ▶ $-6\text{V} < V_{\text{BB}} < 0\text{V}$ to increase depletion zone around n-well diode
 - ▶ Deep p-well shields n-well of PMOS transistors
- Full CMOS circuitry within active area



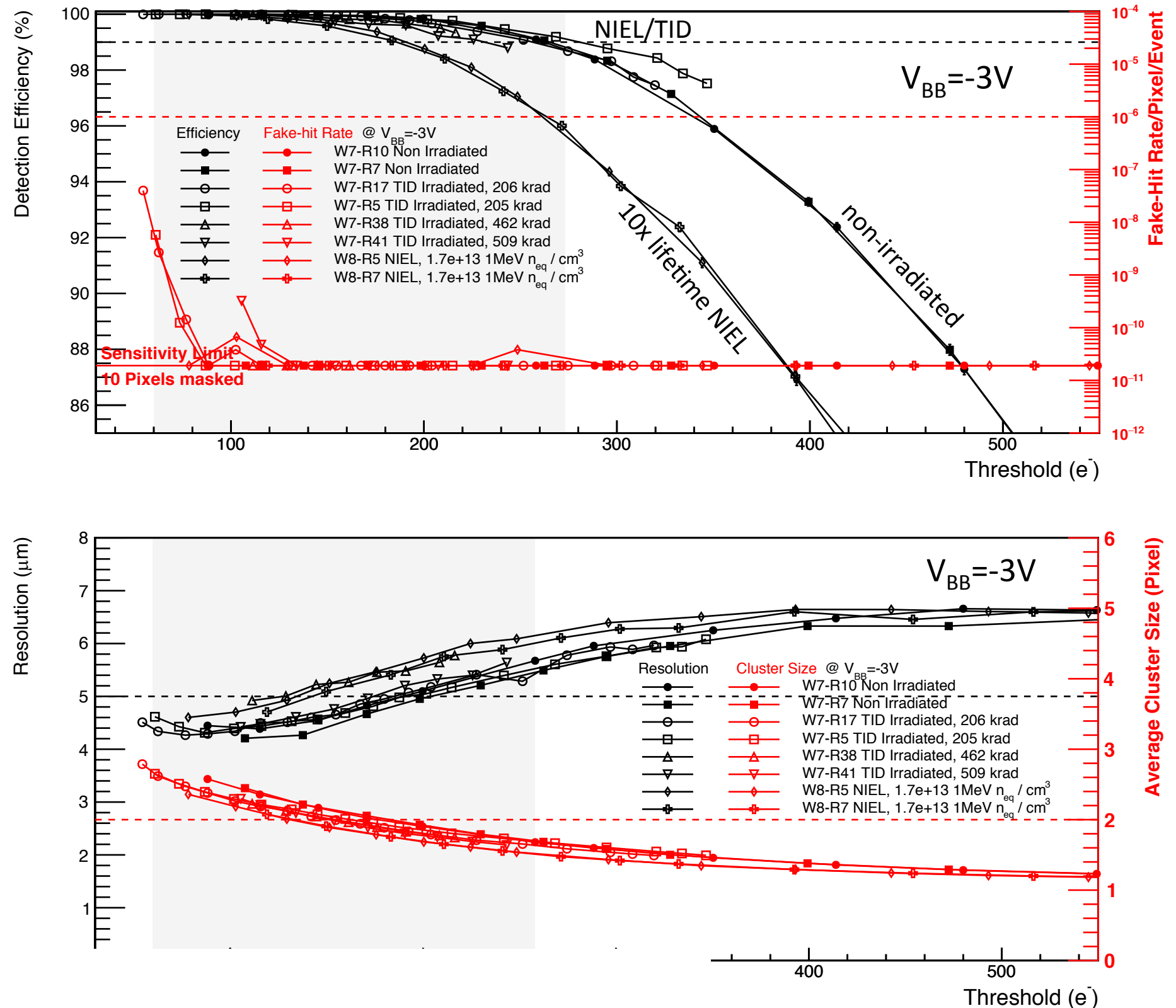
- Pixel: 27 x 29 x 25 μm^3
- 130,000 pixels/ cm^2 ~ Total 10 m^2 , 12.5 G-pixels
- Spatial resolution ~ 5 μm in 3D
- Max. particle rate: 100MHz/ cm^2
- fake-hit rate ~ 10^{-10} pixel/event
- Power ~ 300 nW/pixel



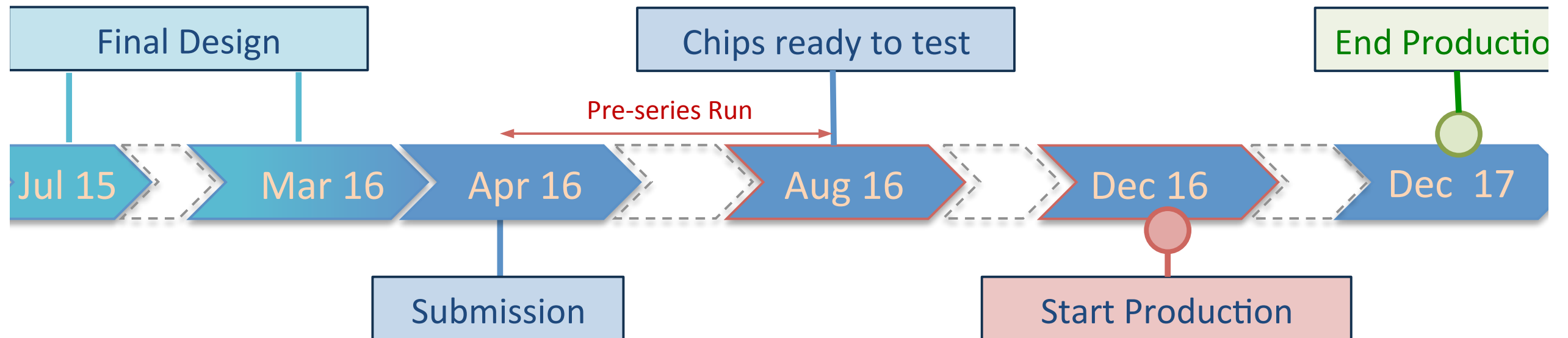
ALPIDE (ALice Pixel DEtector) Performance



- Detection efficiency and Fake-hit rate
 - Resolution and Cluster size
- Non-irradiated and NIEL/TID chips ~ similar
 - Sufficient operational margin after 10 x lifetime NIEL dose
 - Resolution $< 5\mu\text{m}$ at Threshold $< 150\text{ e}$
 - Resolution $\sim 6\mu\text{m}$ at Threshold of 300 e
 - Chip-to-chip fluctuations negligible



ALPIDE (ALice Pixel DEtector) Plan



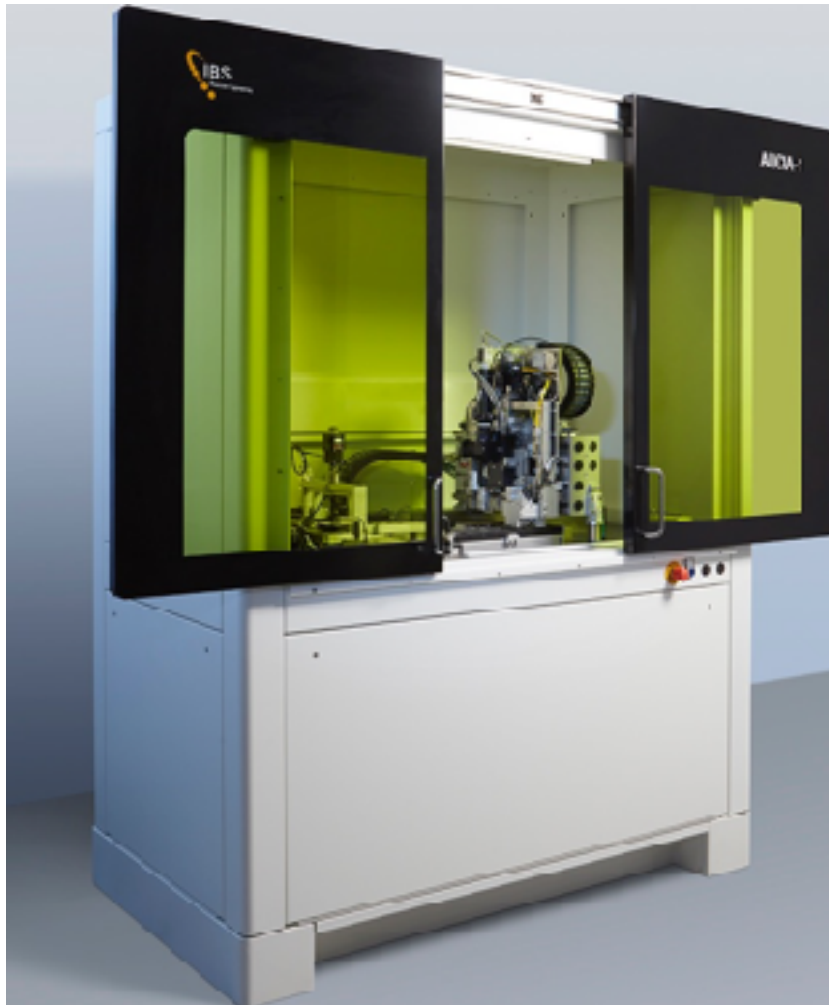
Pixel Chip Finalization and Production Timeline

- | | | |
|-----------------------------------|--------|---|
| ▶ Engineering Design Review | Oct 15 | ✓ |
| ▶ Complete design of final ALPIDE | Mar 16 | ✓ |
| ▶ Pre-series Run | Aug 16 | ✓ |
| ▶ Validation of final chip | Nov 16 | ✓ |
| ▶ Production Readiness Review | Nov 16 | ✓ |
| ▶ Start Series Production → | Dec 16 | ✓ |

March 2017

- Delivery of first batch of wafers
TOWER => FUREX (KR)
- Delivery of first batch of chips
FUREX => Yonsei, Pusan/Inha (KR)
- 30% of Chip production completed by Tower (current)

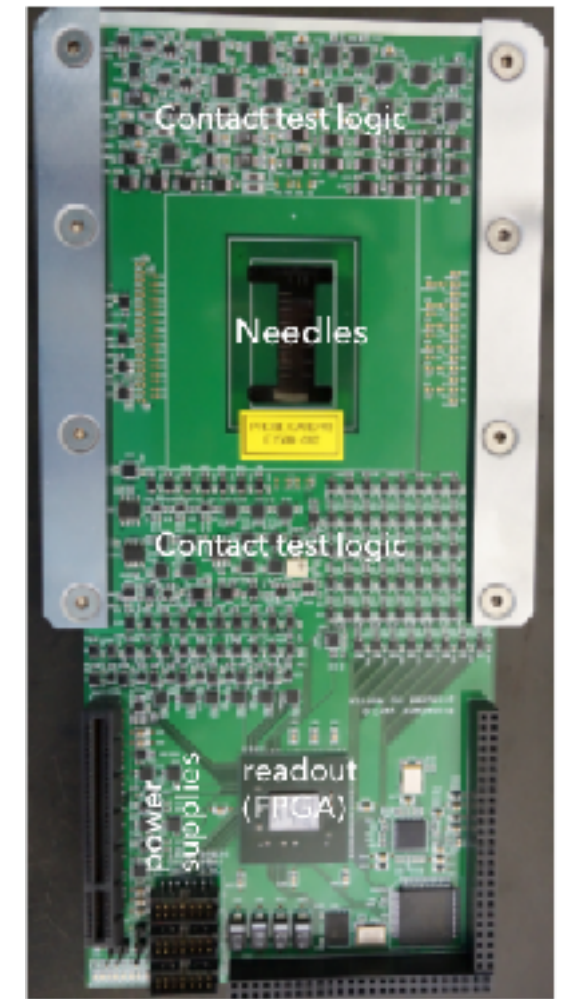
ALPIDE - Mass Chip Test



ALICIA (IBS)
3 machines
1 Pusan/Inha (KR), 2 CERN



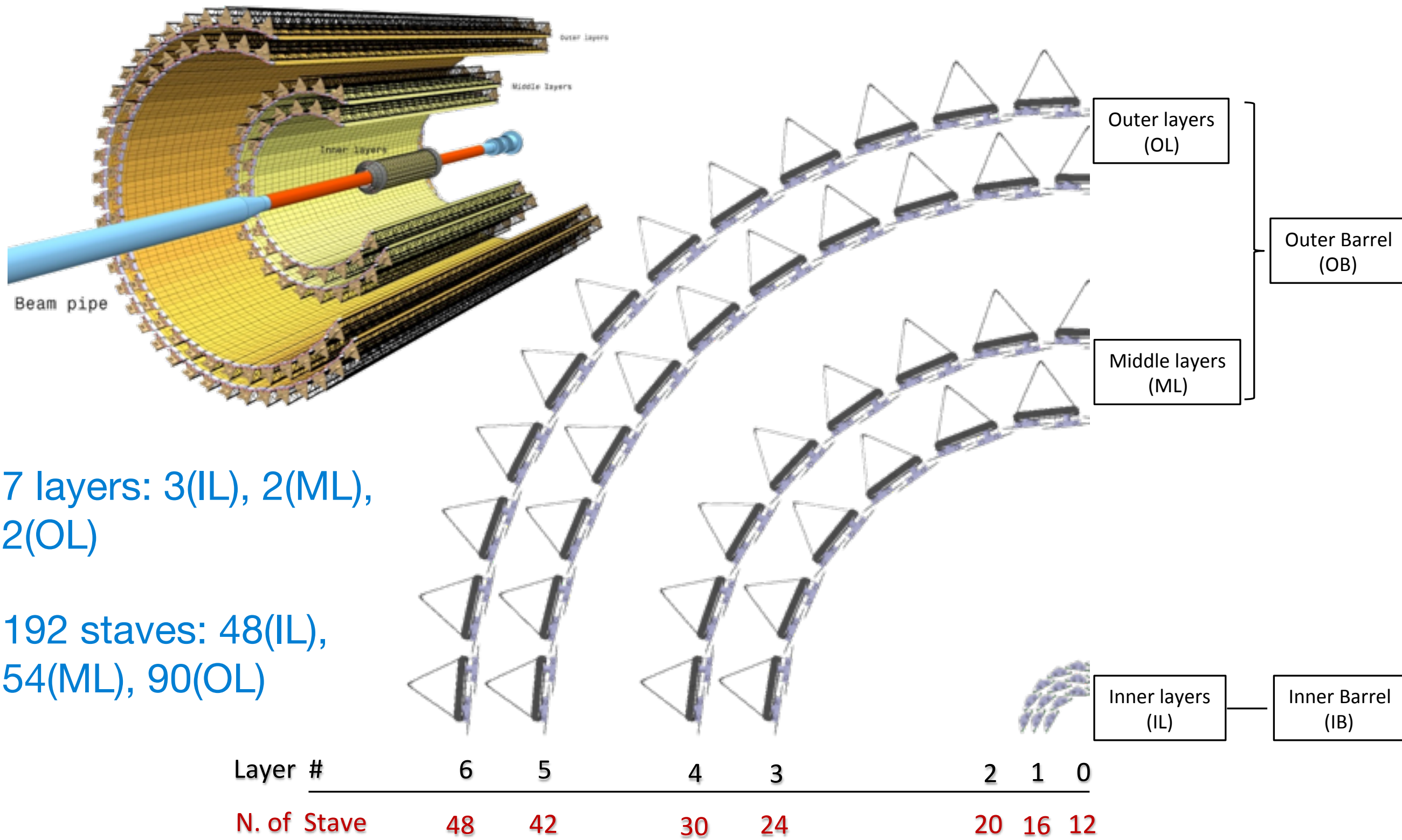
Corea-YS01 (C-On)
1 dedicated chip ATE
Yonsei (KR)



Probe Card
CERN, Yonsei,
NOTICE + EQ&G (KR)

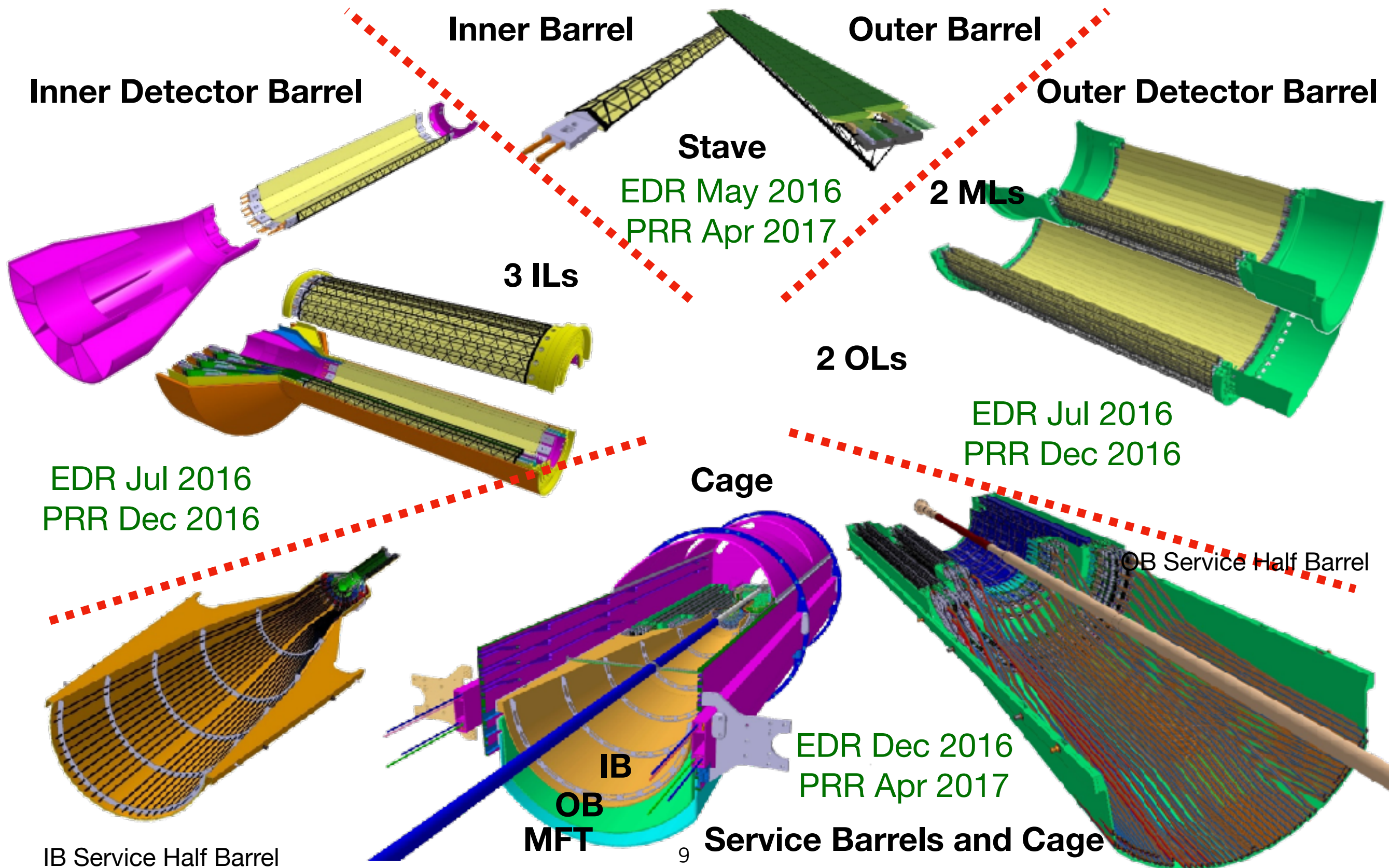
Dress rehearsal at Yonsei & Pusan/Inha: DONE on 31 Mar. 2017

Detector Barrel Staves

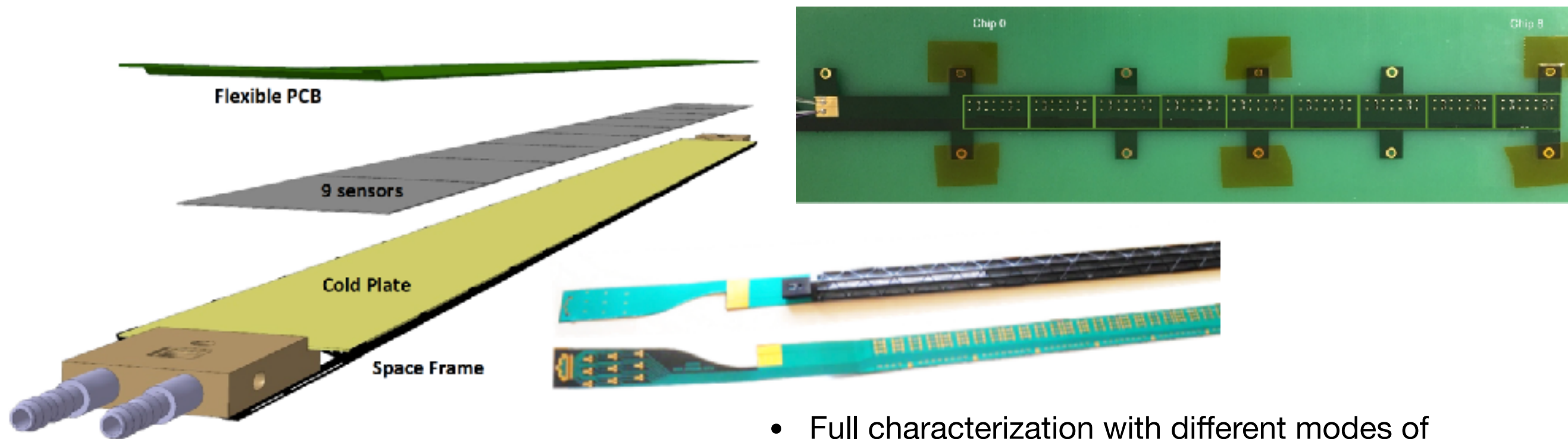


- 7 layers: 3(IL), 2(ML), 2(OL)
- 192 staves: 48(IL), 54(ML), 90(OL)

Detector Barrel and Service Barrel Mechanics

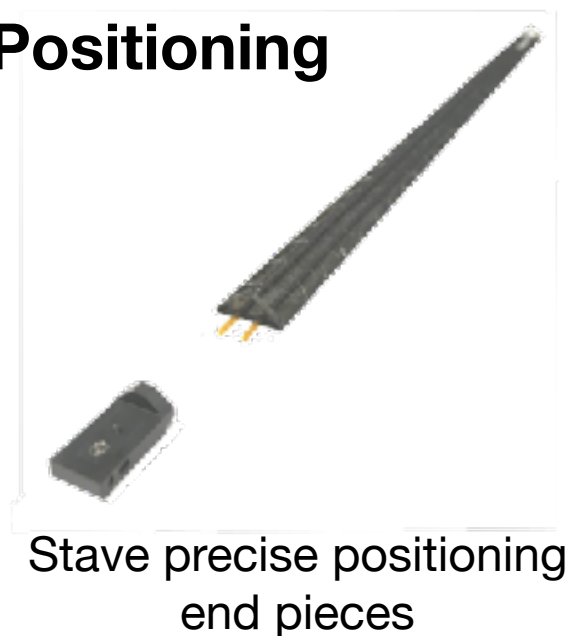


IB - Stave Production

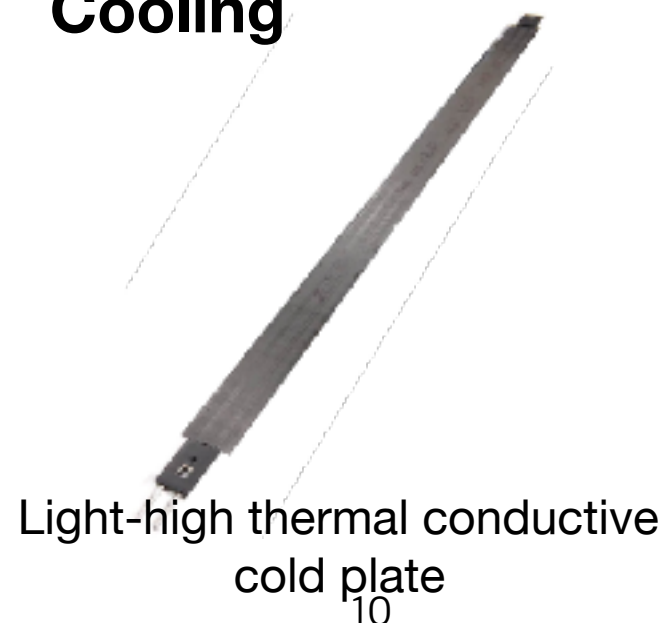


- Full characterization with different modes of operation, RO rates and environmental conditions (supp. V and T)
- Sensor performance same as for standalone chip

Positioning



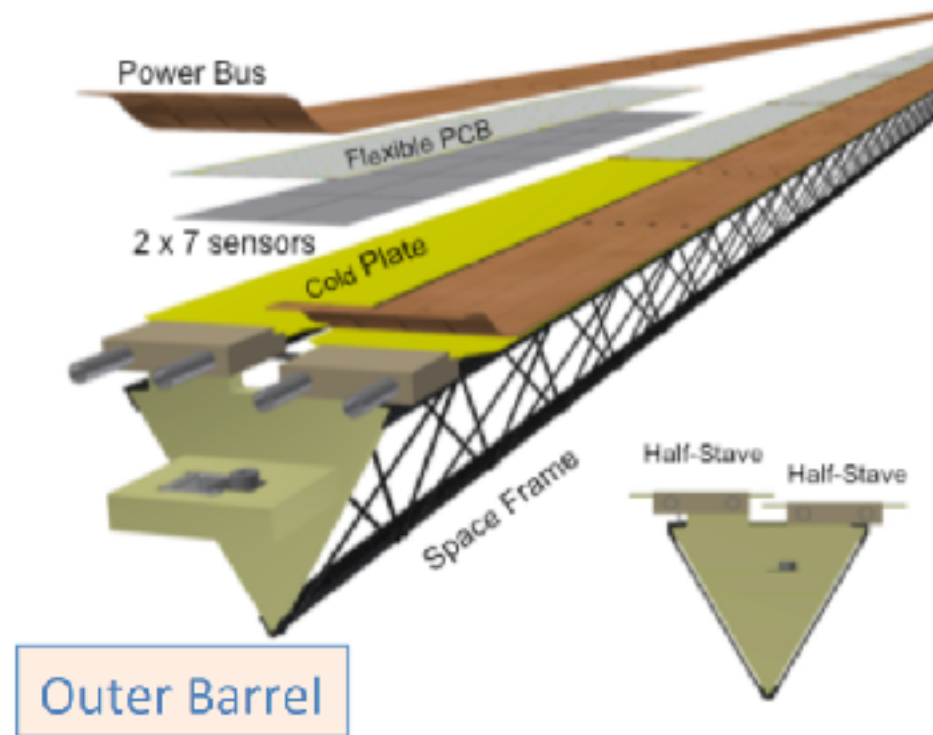
Cooling



Stiffness



OB - Stave Production



- Full characterization with different modes of operation, RO rates and environmental conditions (supp. V and T)
- Sensor performance same as for standalone chip



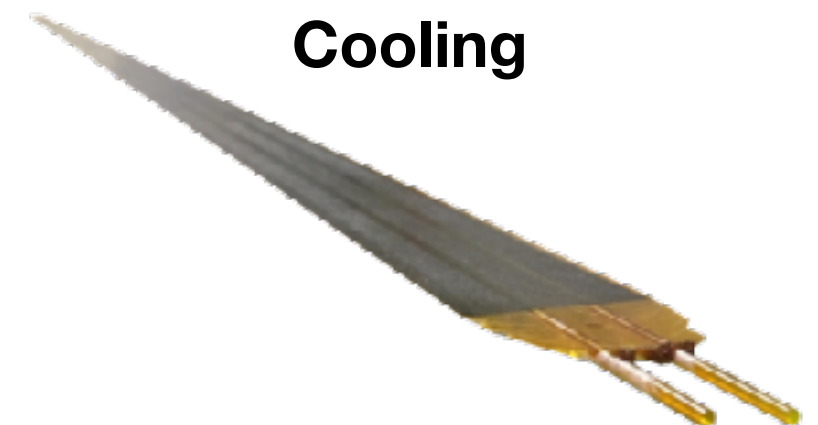
Positioning

Stave precise positioning
end pieces

Stiffness



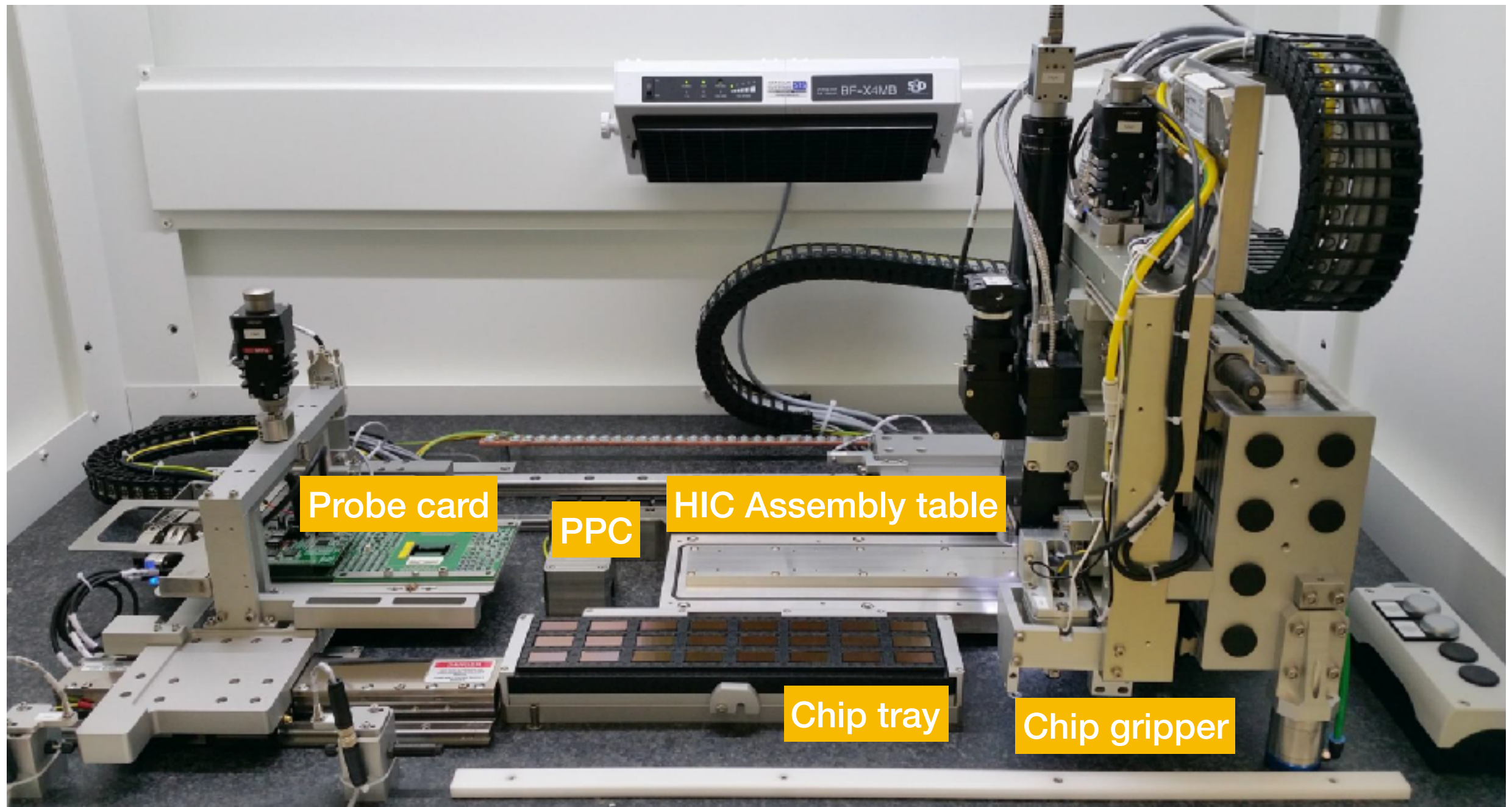
Light-stiff mechanical
space frame



Cooling

Light-high thermal conductive
cold plate

Module Assembly Machine

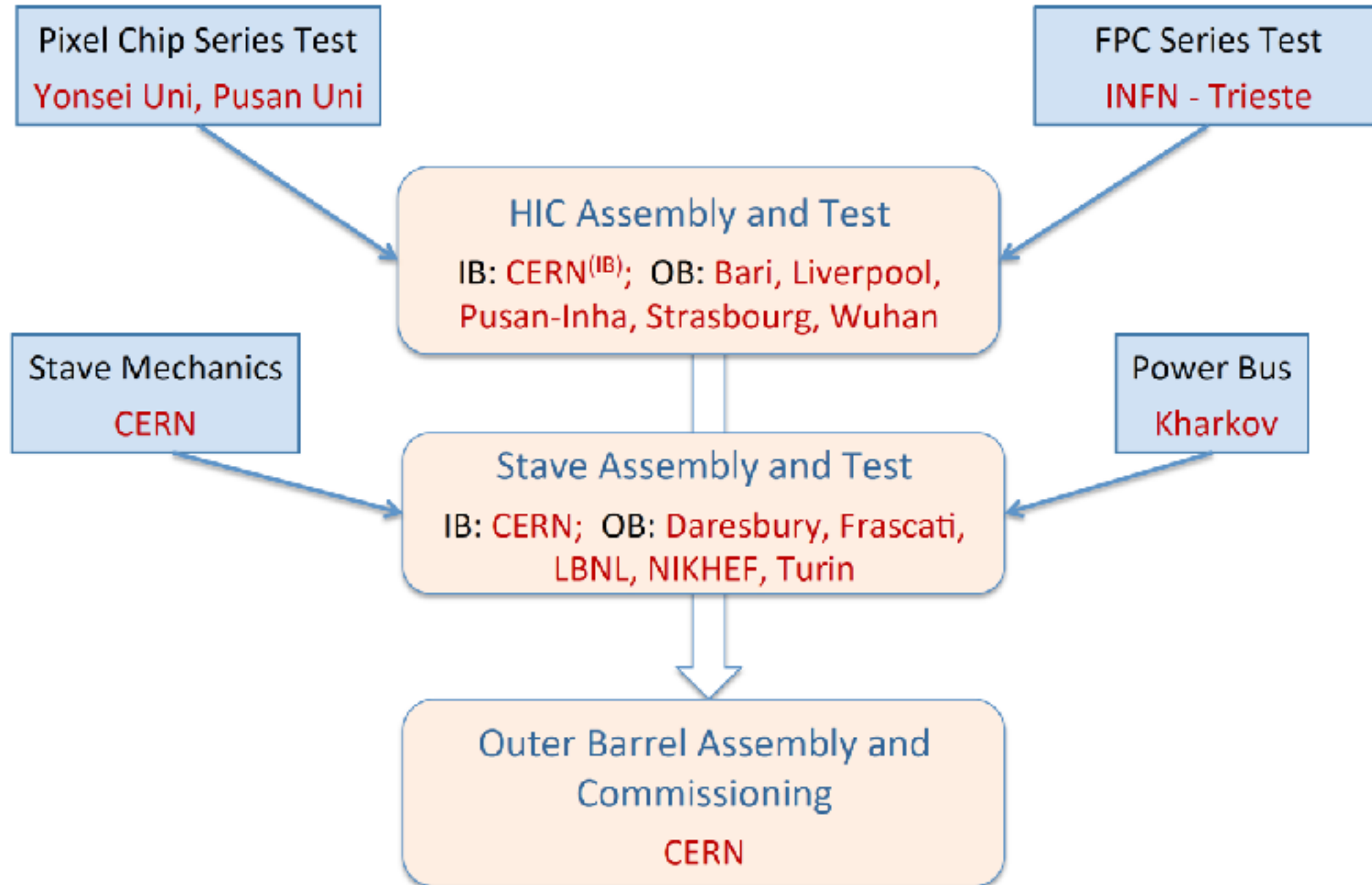


Site Acceptance Tests

Name	Institute	FAT date	FAT status	Delivery	SAT date	SAT status
ALICIA-3	Bari, Italy	03/10/16	OK	Week 41	17-20/10/16	OK
ALICIA-2	Pusan/INHA, Korea	10/10/16	OK	Week 43	07-11/11/16	OK
ALICIA-6	Wuhan, China	10/10/16	OK	Week 44	17-23/11/16	OK
ALICIA-5	Strasbourg, France	27/10/16	OK	Week 46	21-24/11/16	OK
ALICIA-4	Liverpool, UK	27/10/16	OK	Week 49	12-14/12/16	OK
ALICIA-7	Saclay, France (MFT)	28/11/16	OK	Week 03 (2017)	16-20/01/17	OK



OB Stave Construction Flow

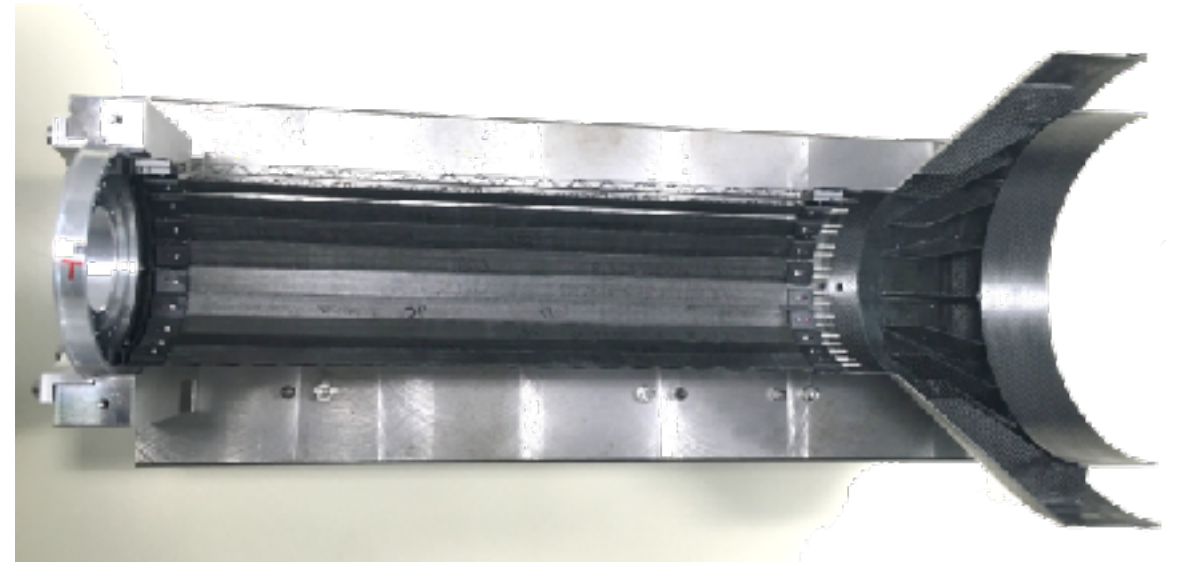
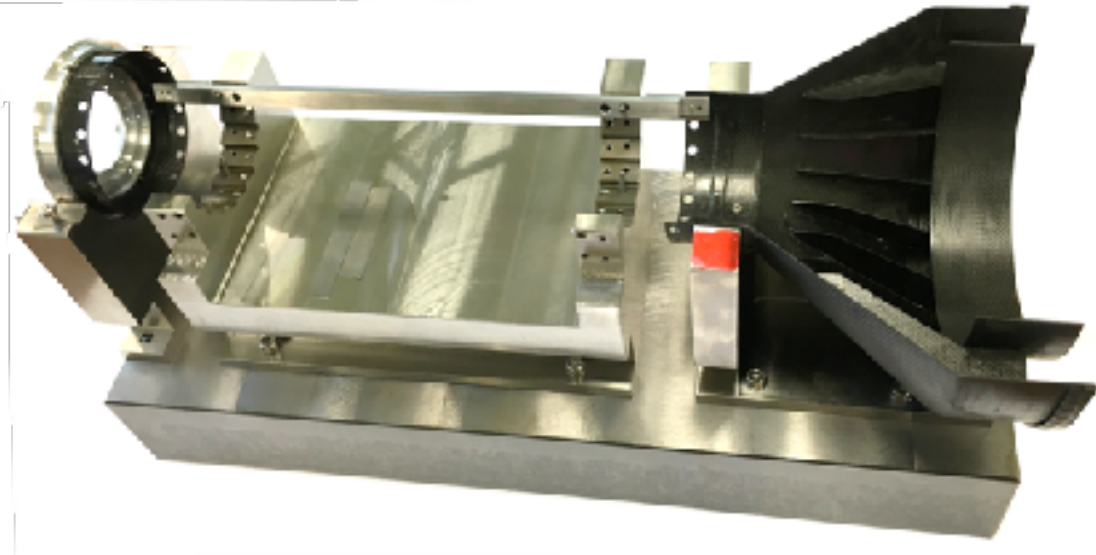


Detector Barrel and Service Barrel Mechanics

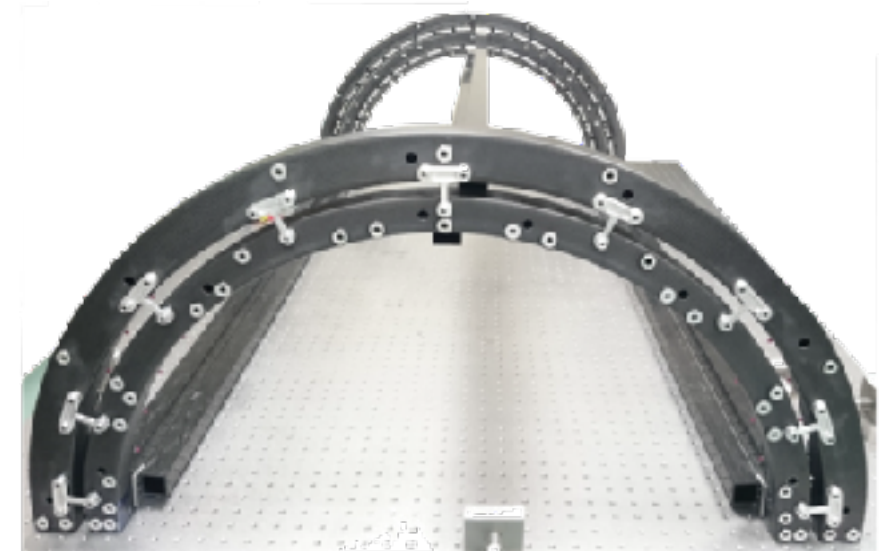
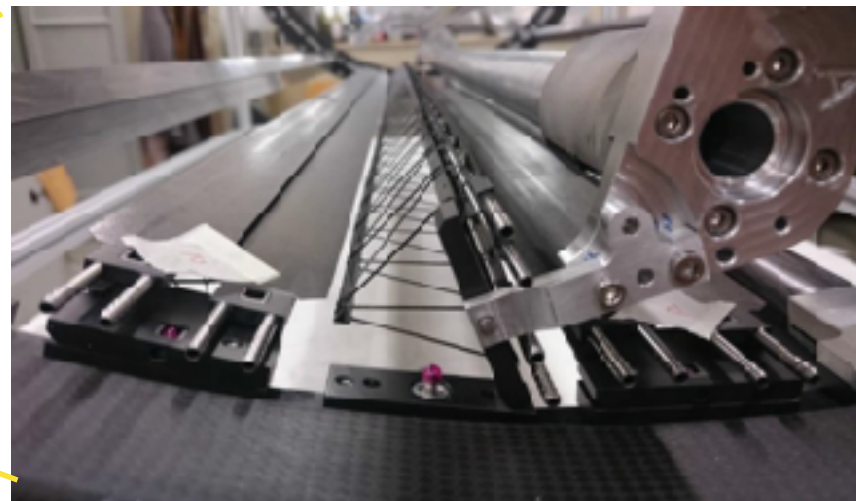
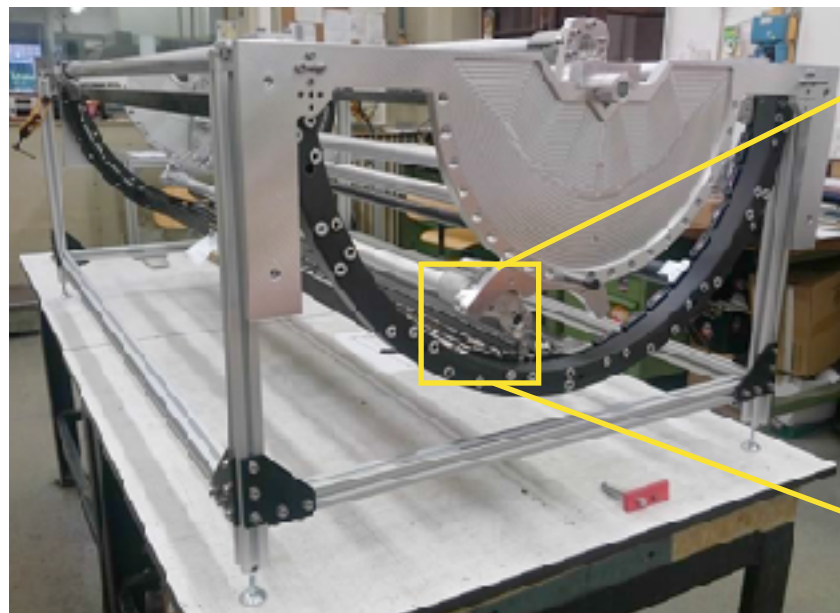
Prototype of IB End Wheels (EWs), Space Frames and Cold Plates

End Wheel C side

End Wheel A side



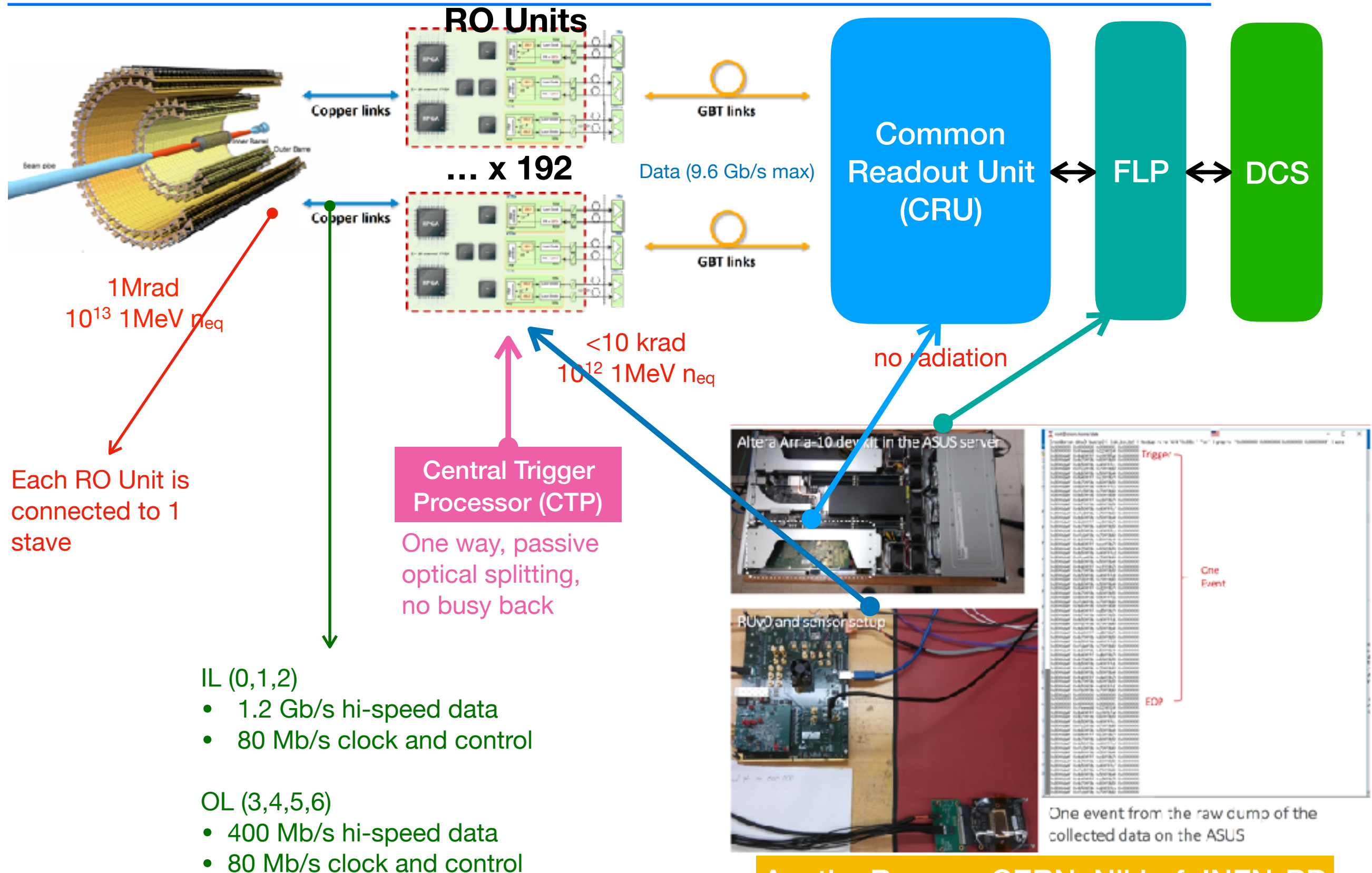
Prototype of OB End Wheels (EWs), Space Frames and Cold Plates



OB End Wheel & Space frame

OB End Wheel

Readout Electronics - EDR (Jan 17)

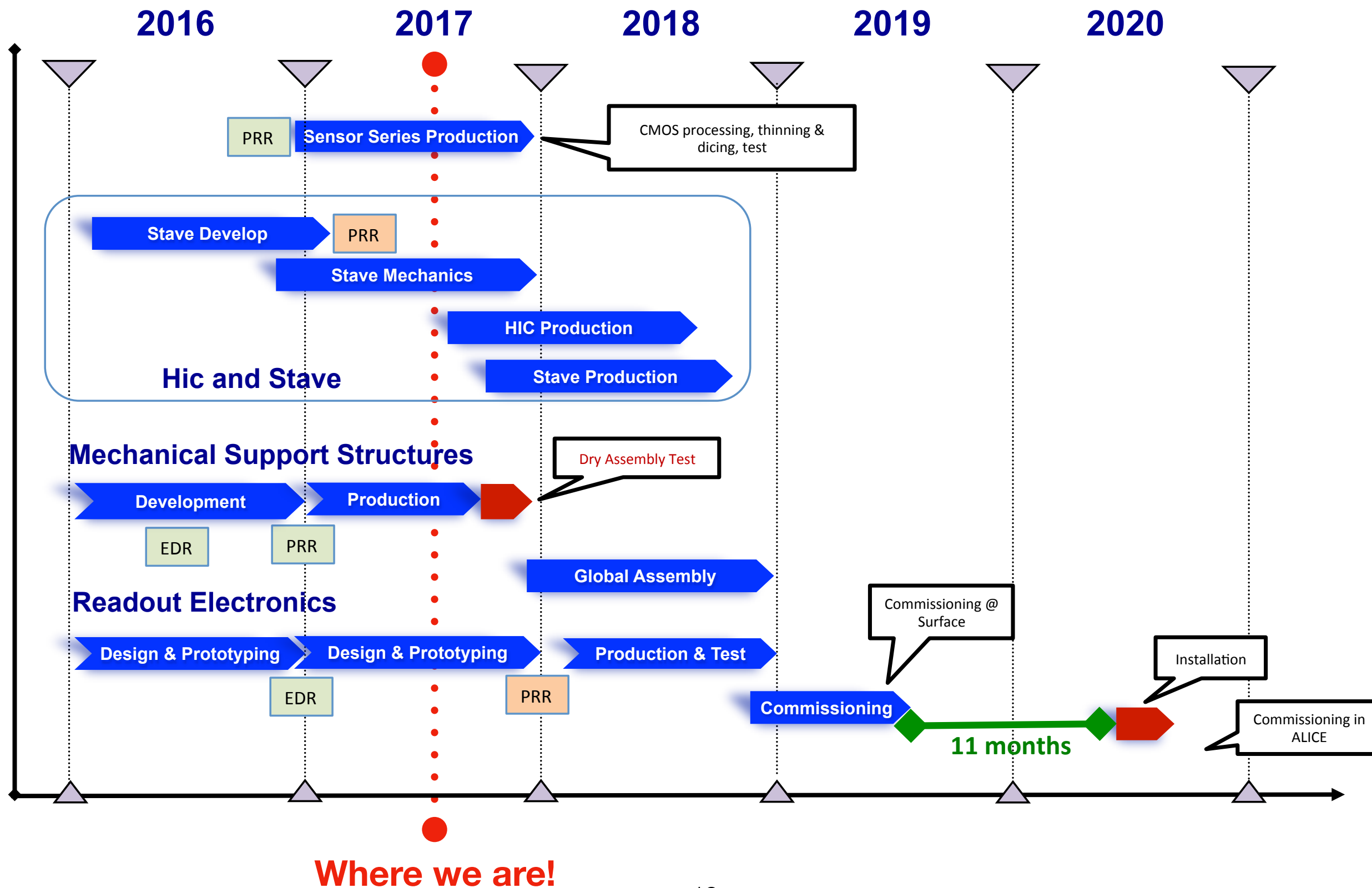


ALICE ITS Upgrade - Status and Plan



System`	Review	Schedule	Status
Pixel Sensor Chip	EDR	OctÂ 2015	✓
Pixel Sensor Chip	PRR	Sep 2016	✓
HIC & Stave	EDR	May 2016	✓
HIC & Stave	PRR	DecÂ 2016	✓
Detector Barrel Mechanics	EDR	Jul 2016	✓
Detector Barrel Mechanics	PRR	Nov 2016	✓
Service Barrel Mechanics	EDR	Nov 2016	✓
Service Barrel Mechanics	PRR	Feb 2017	✓
Cooling Plant	EDR	Jul 2016	✓
Cooling Plant	PRR	Dec 2016	✓
Readout Electronics	EDR	Dec 2016	✓
Readout Electronics	PRR	Dec 2017	

Overall ITS Planning



All components are ready to go for sequential batch procedures.

Veel dank