The ALICE ITS production with Korean industry – Status and Outlook

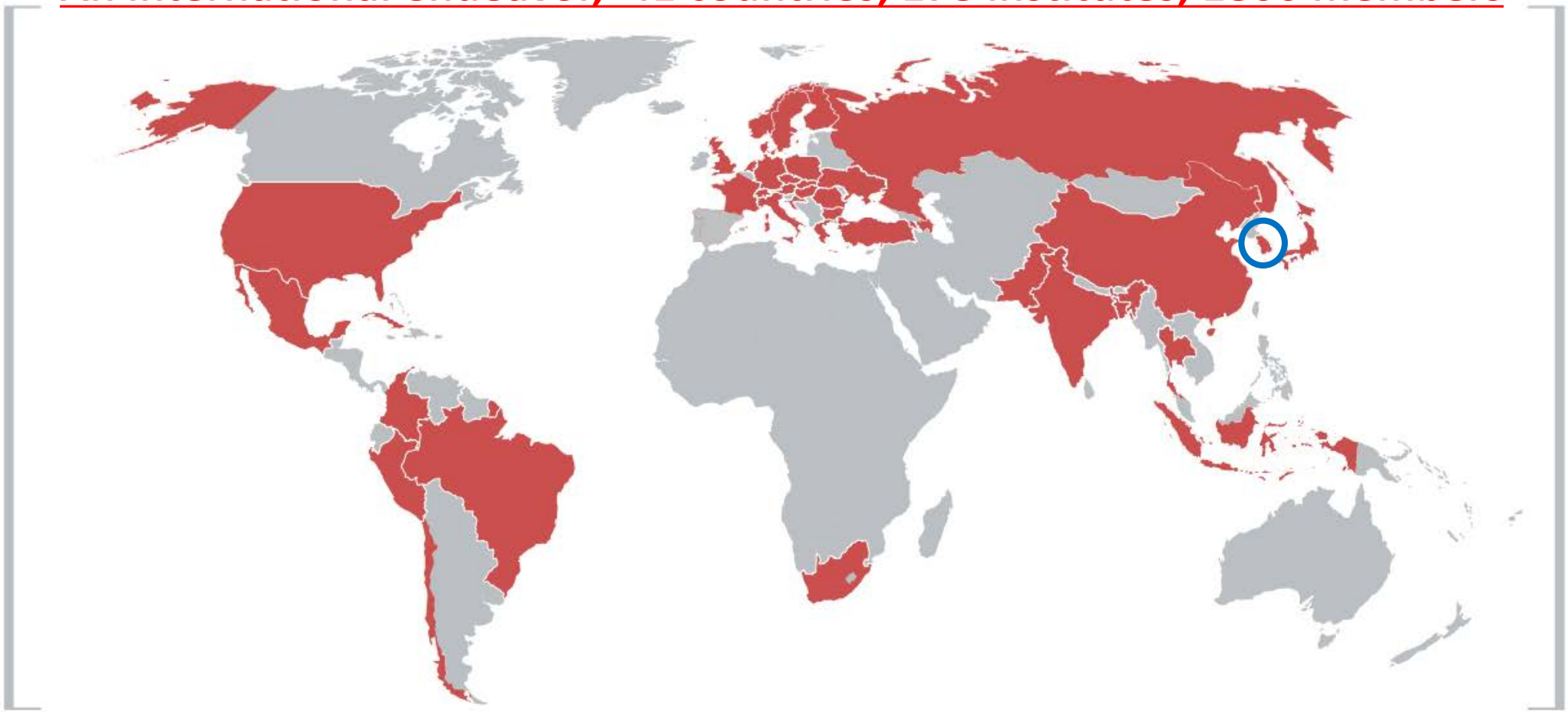
Y. KWON – YONSEI UNIV.

FOR THE ALICE COLLABORATION

ALICE COLLABORATION

AS JANUARY 2018

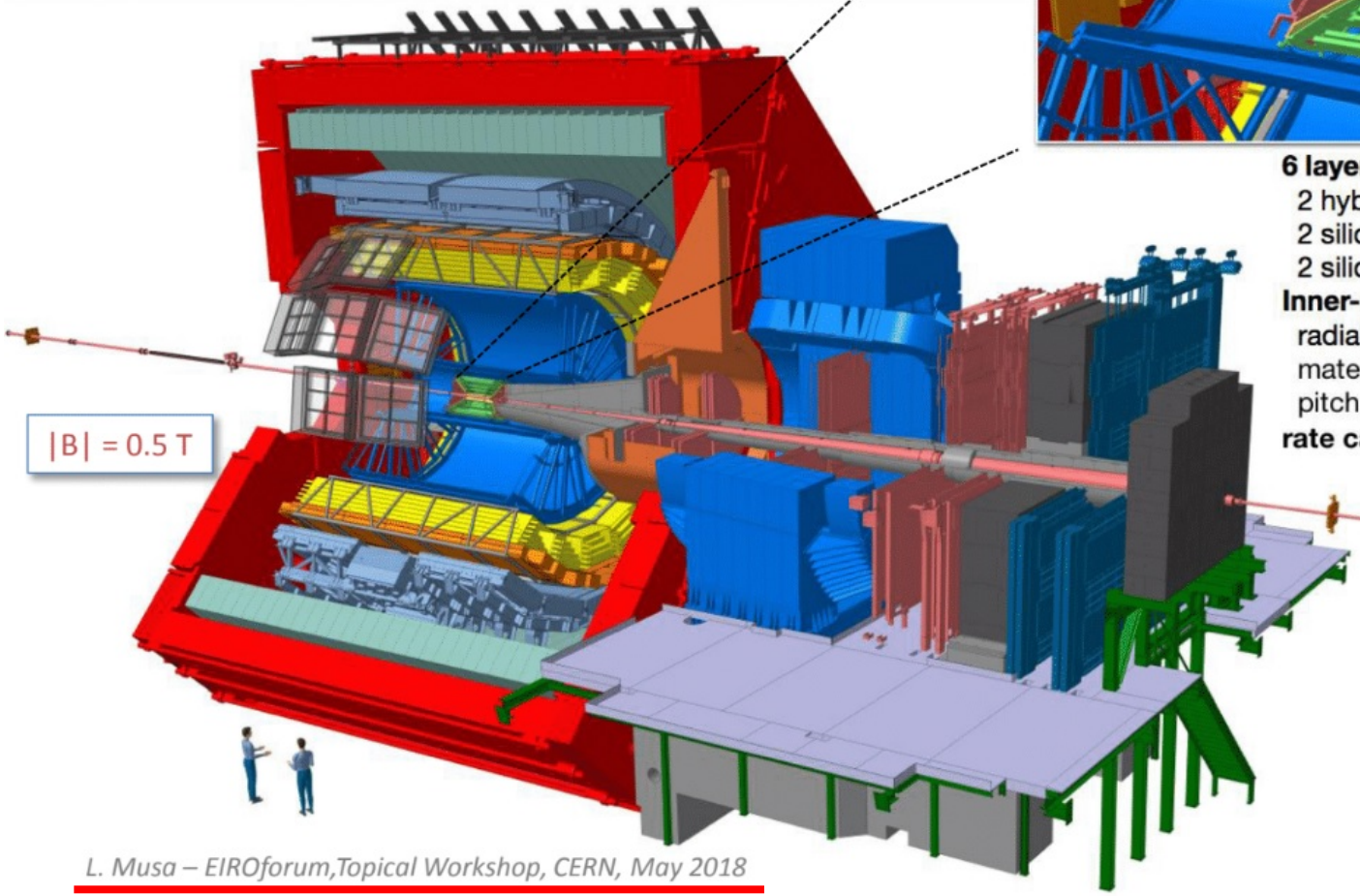
An international endeavor, 41 countries, 178 institutes, 1800 members

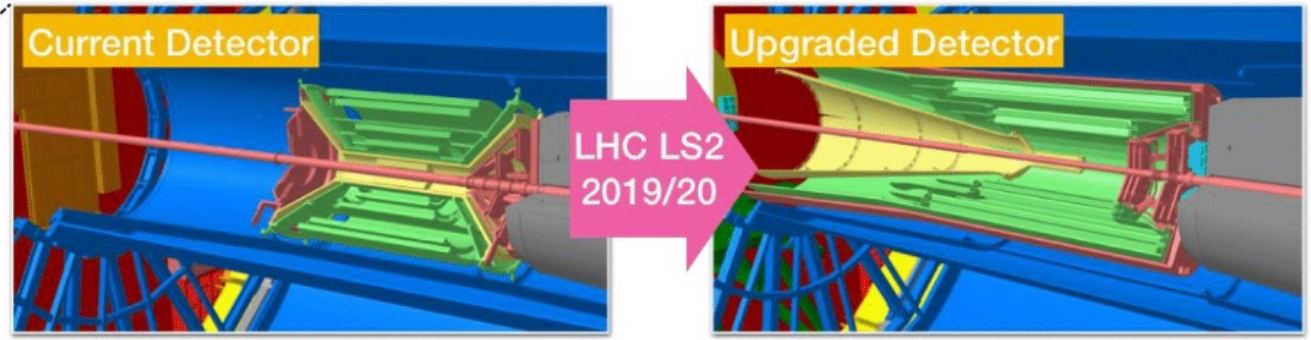


New Inner Tracking System based on CMOS sensors for ALICE

New Inner Tracking System (ITS)
- CMOS Pixels

→ improved resolution, less material, faster readout





6 layers:
2 hybrid silicon pixel
2 silicon drift
2 silicon strip

Inner-most layer:
radial distance: 39 mm
material: $X/X_0 = 1.14\%$
pitch: 50 × 425 μm²

rate capability: 1 kHz

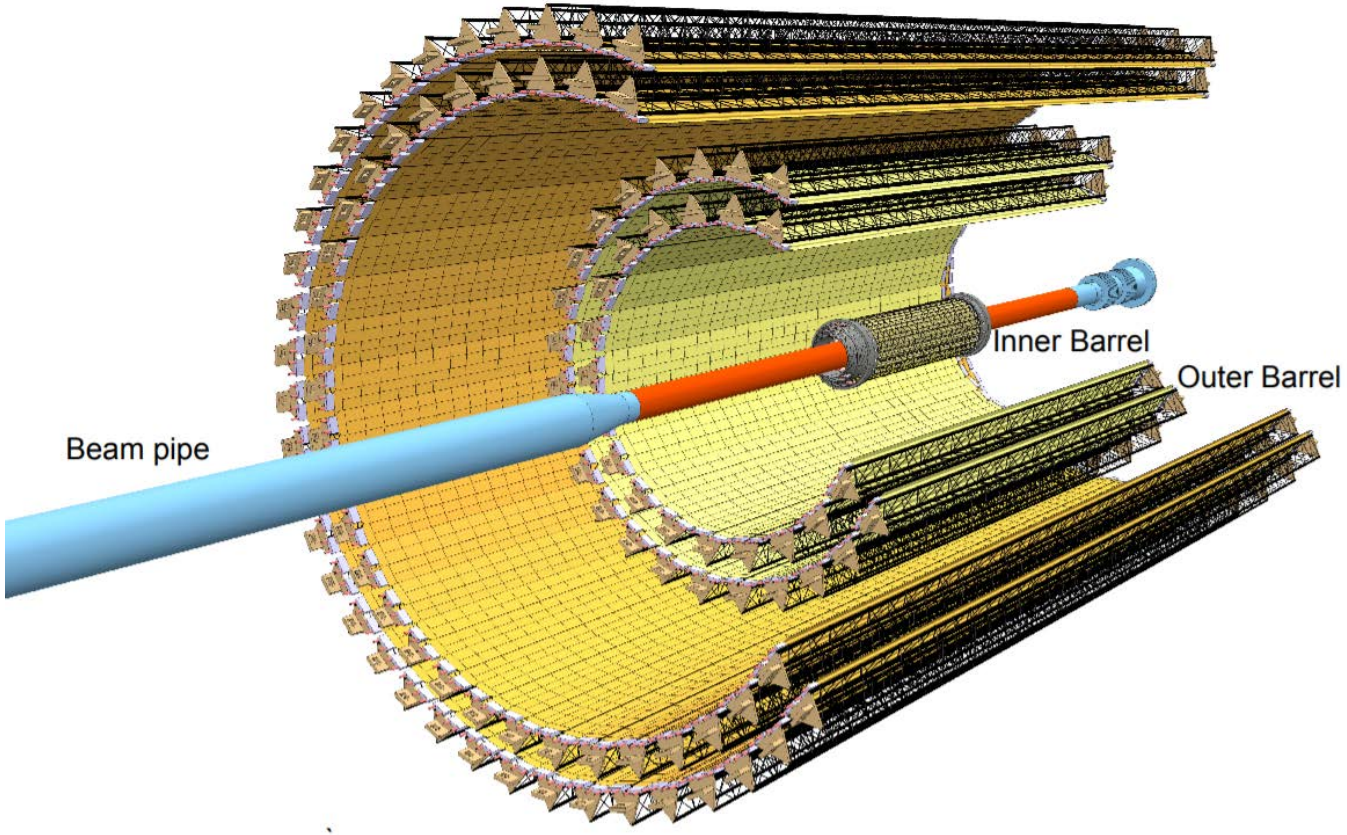
7 layers:
all Monolithic Active Pixel Sensors

Inner-most layer:
radial distance: 23 mm
material: $X/X_0 = 0.3\%$
pitch: O(30 × 30 μm²)

rate capability: 100 kHz (Pb-Pb)

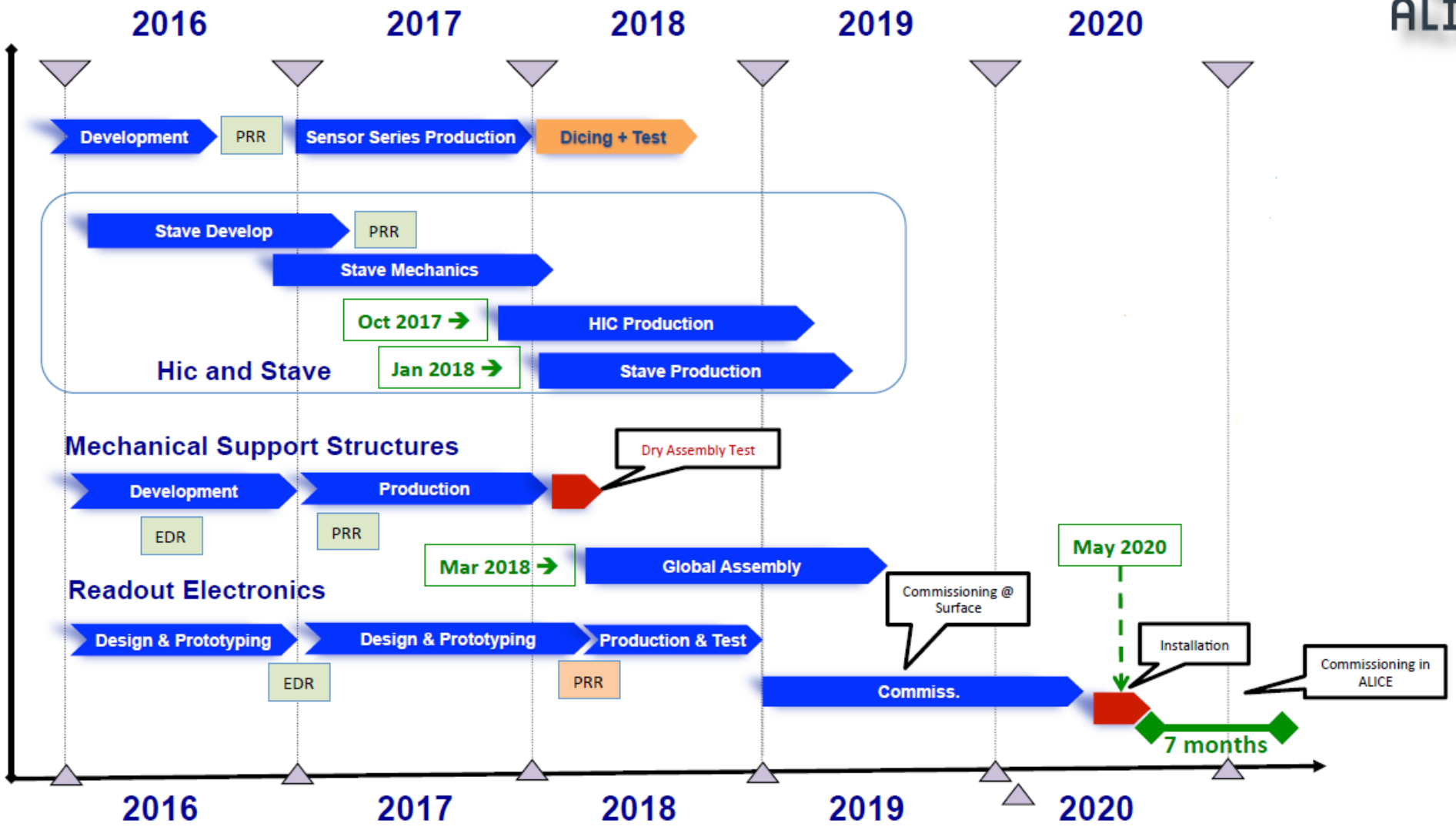
L. Musa – EIROforum,Topical Workshop, CERN, May 2018

Production



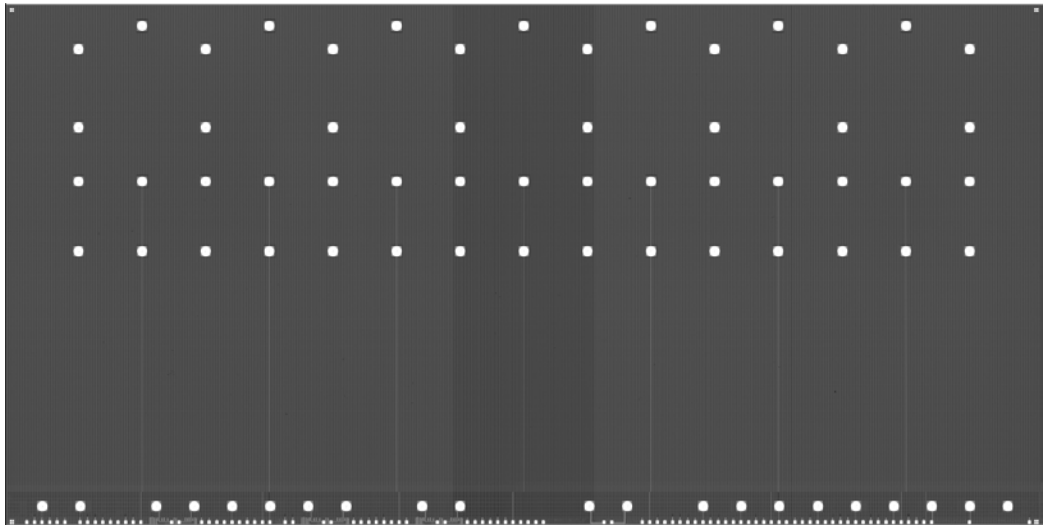
Schematic view

ITS Planning (Simplified Global View)



L. Musa (CERN) – ALICE Upgrade Asian Workshop, Hiroshima, June 2018

Pixel Sensor



NIM A824(2016) 434
M. Mager, on behalf of ALICE.

Monolithic **A**ctive **P**ixel **S**ensor

180 nm CMOS Image Sensor line

Pixel, Front End/ Digitization /Memory cell /Readout electronics, all in one.

Size of 15(mm) x 30(mm) x 0.1/0.05(mm)

27(μ)x29(μ) pixel, 500k pixels

Low noise (efficiency 99%, fake hit rate < 10^{-5})

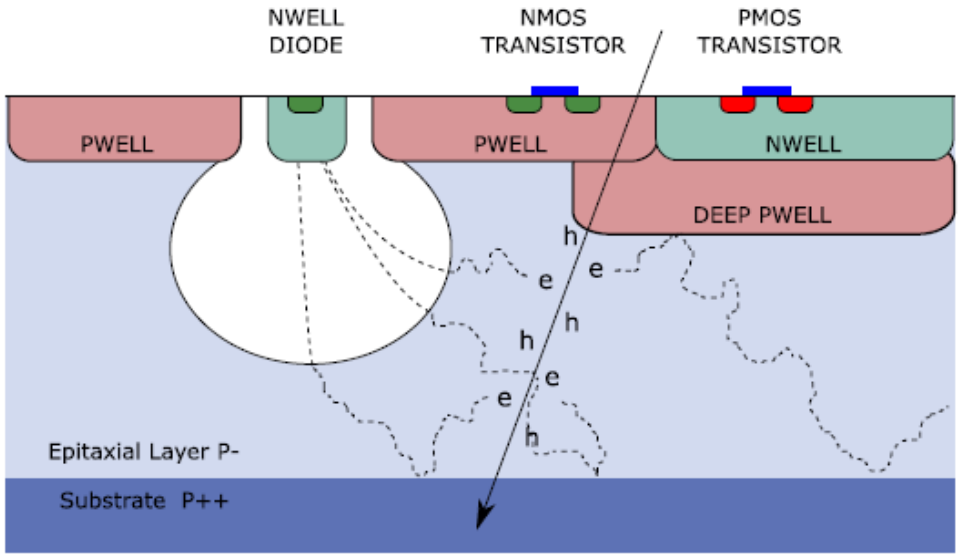
Low power (40 mW/cm^2)

Radiation hardness:

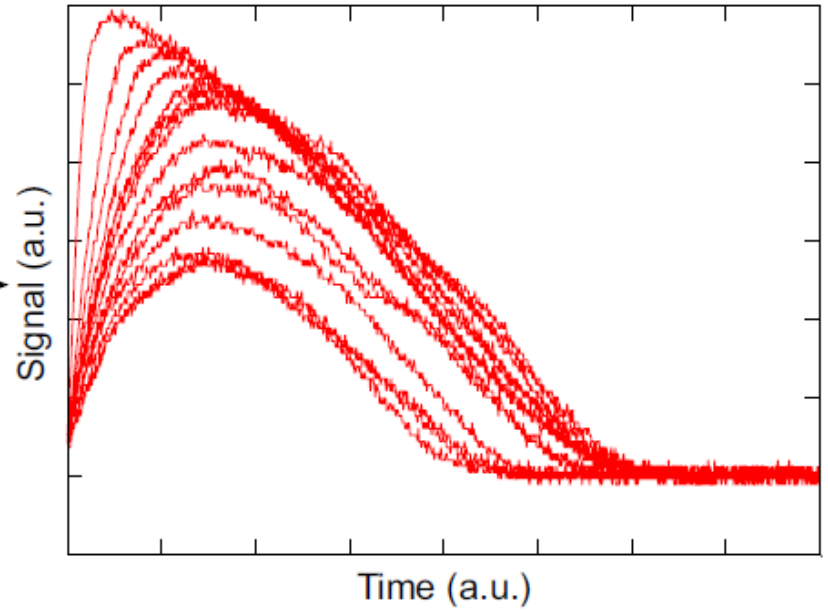
~10^{13} (1 MeV n_{eq}/cm^2), 2700 (krad)

Pixel Sensor

Charge creation & collection

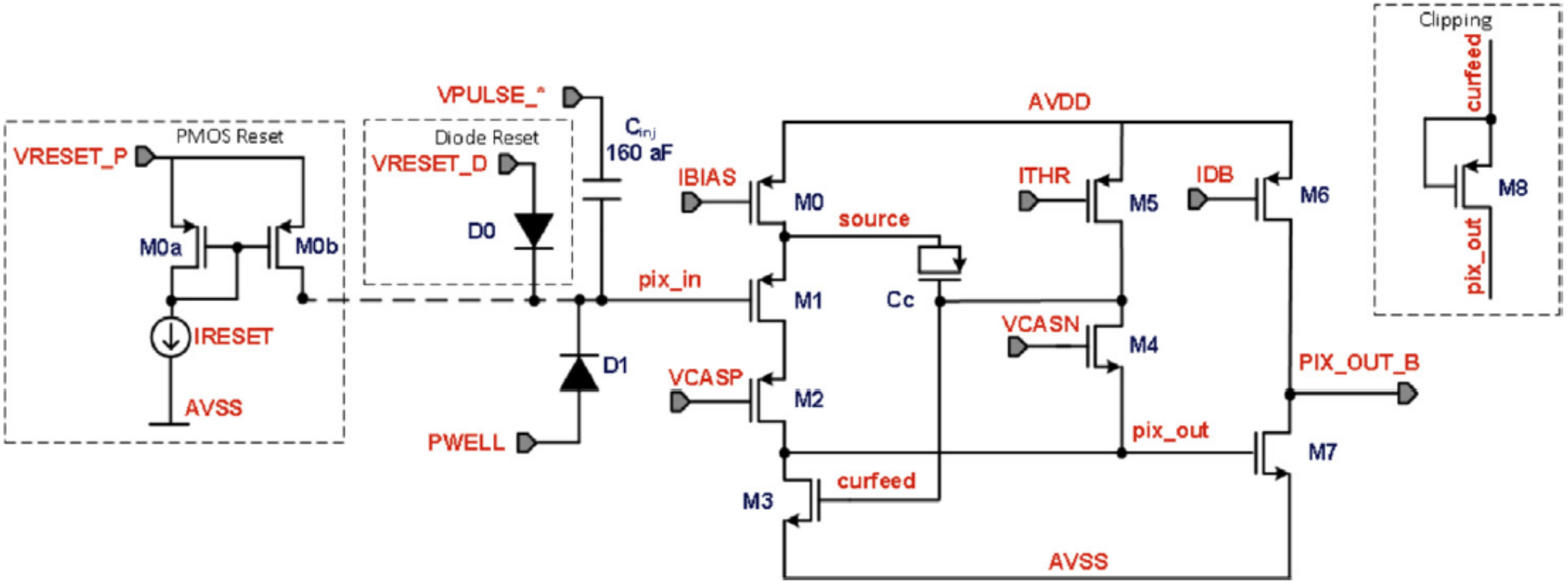


Signal detection & shaping



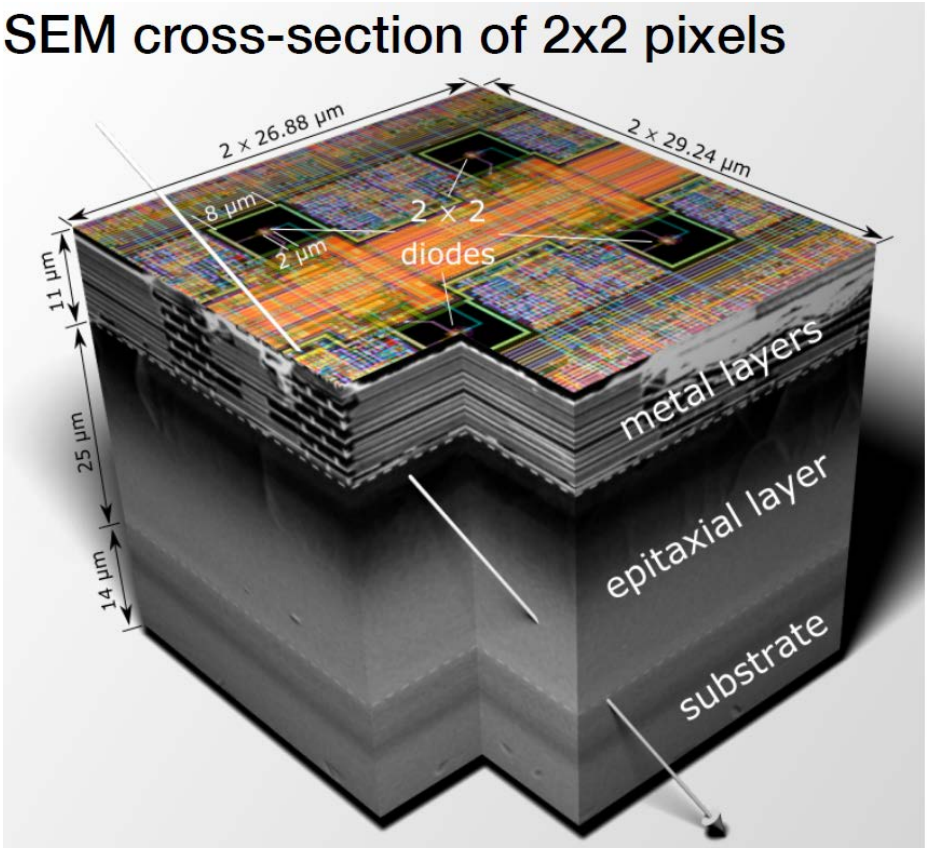
Characterization of pixel sensor: participation by Pusan/Inha university and Yonsei University

Pixel Sensor

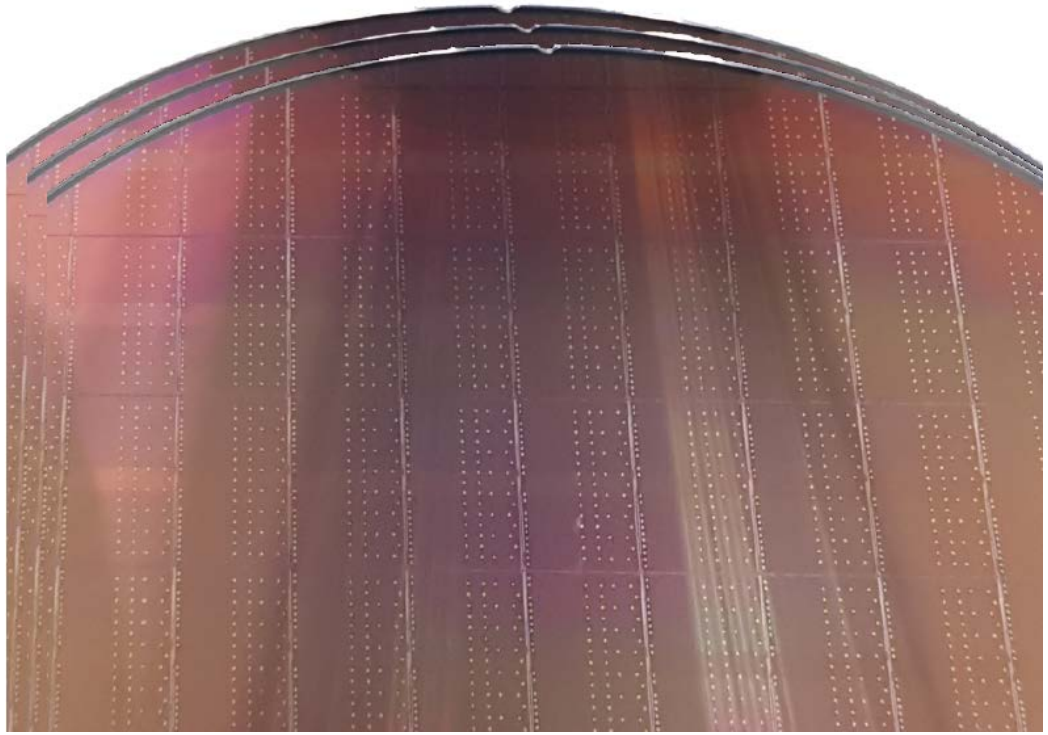


Front-End Electronics: participation by Yonsei(Dongguk) university

Pixel Sensor

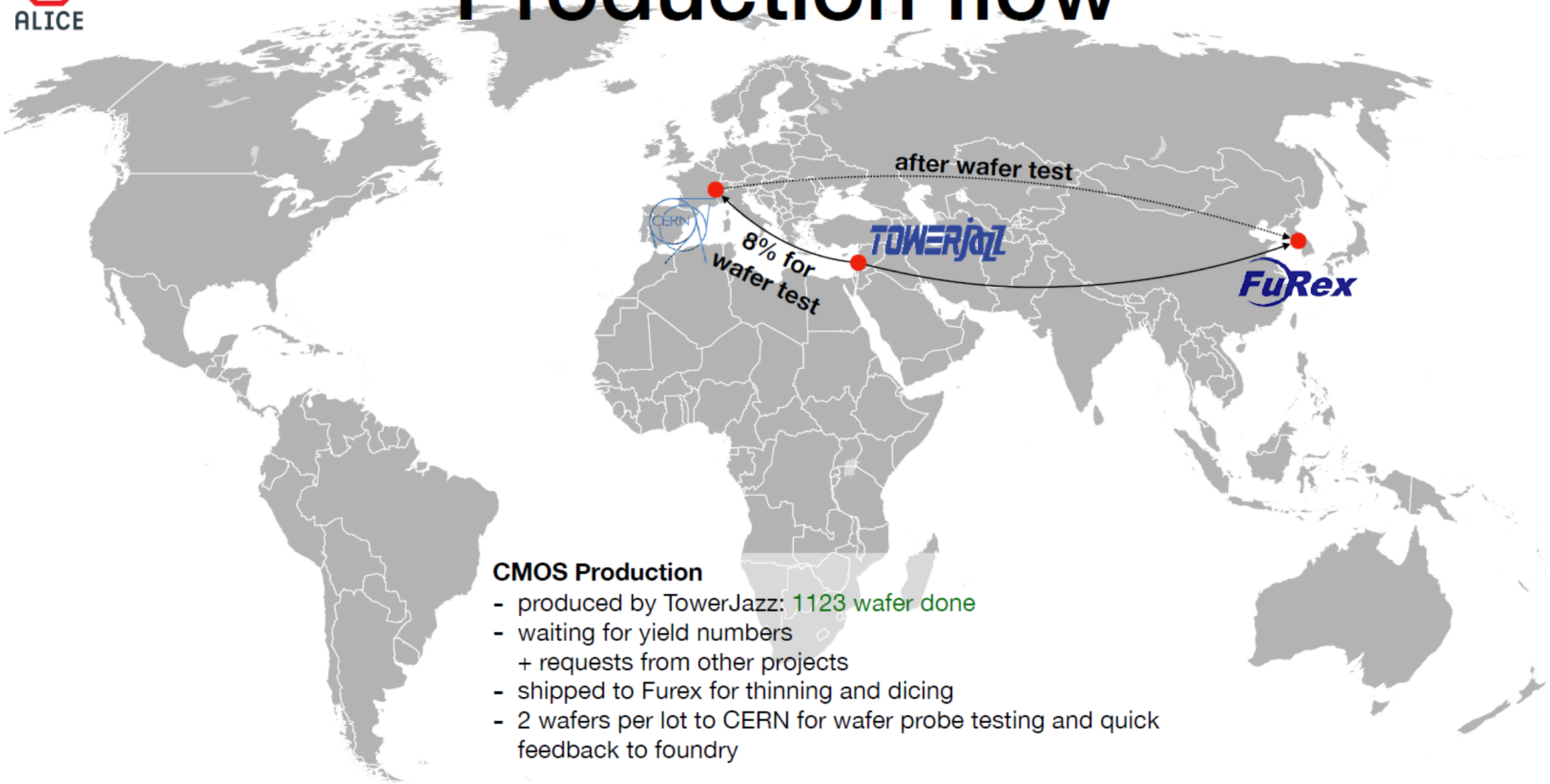


Finalized design



Produced by TowerJazz, Israel

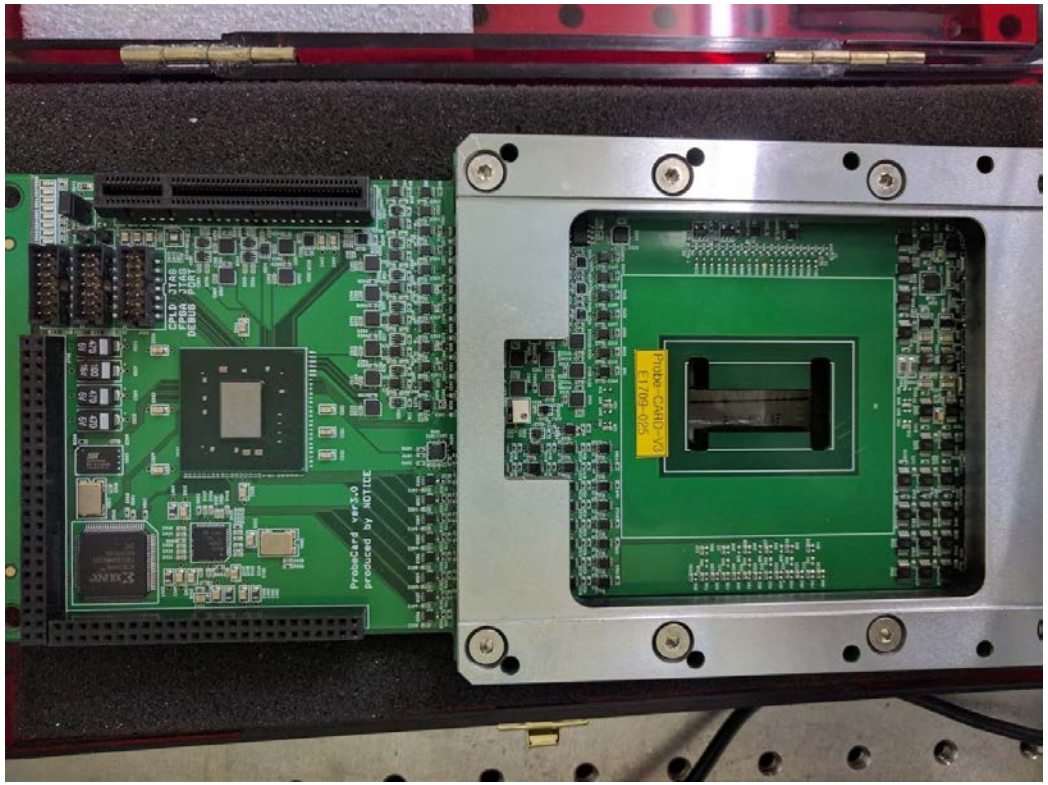
Production flow



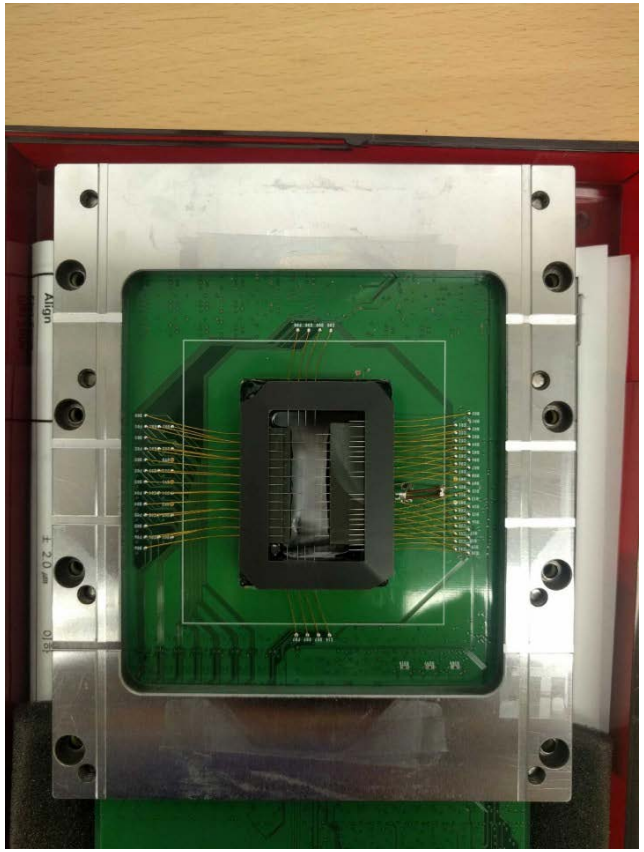
CMOS Production

- produced by TowerJazz: 1123 wafer done
- waiting for yield numbers
  + requests from other projects
- shipped to Furex for thinning and dicing
- 2 wafers per lot to CERN for wafer probe testing and quick feedback to foundry

Probecard to test sensor

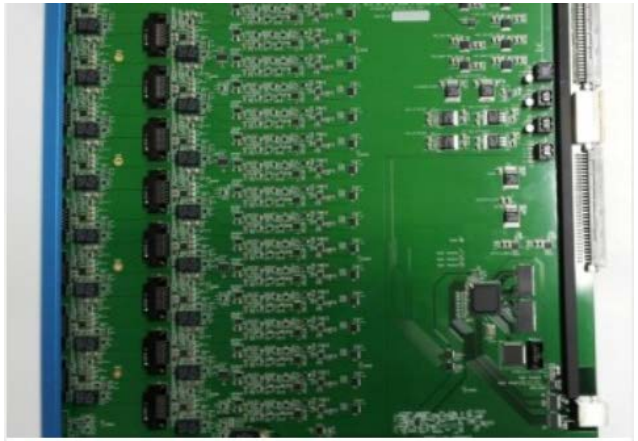


Electronics fabricated by NOTICE



Prober fabricated by EQENG

NOTICE, Probecard electronics (Anyang, Gyeonggydo, S. Korea)

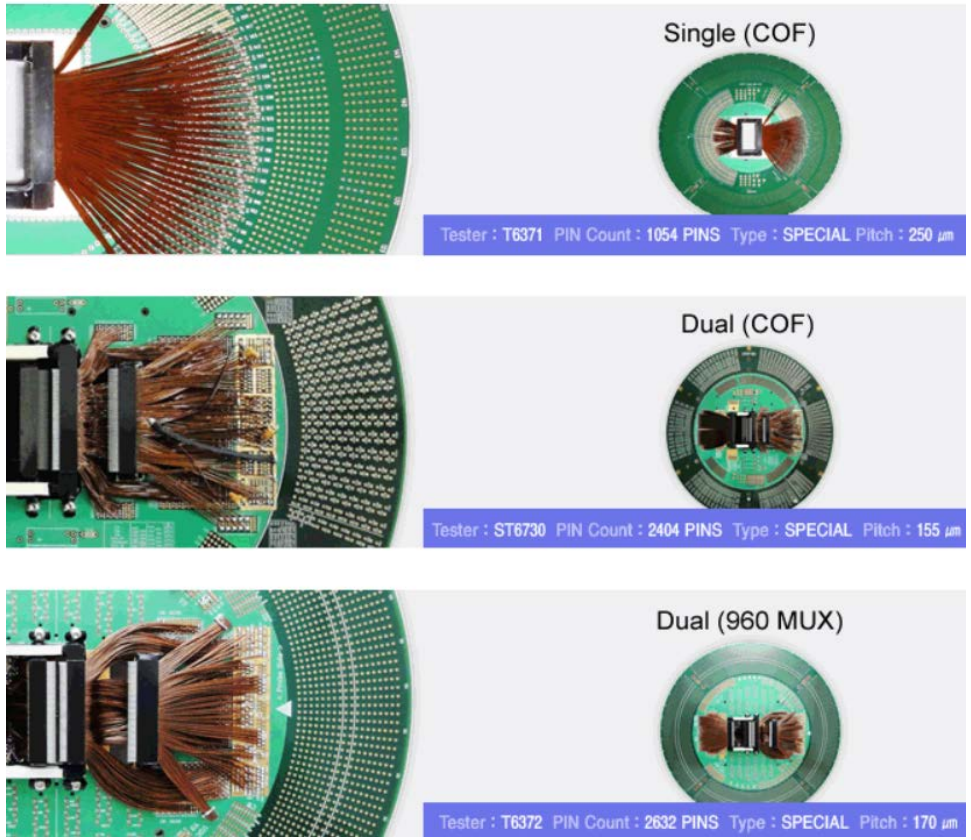


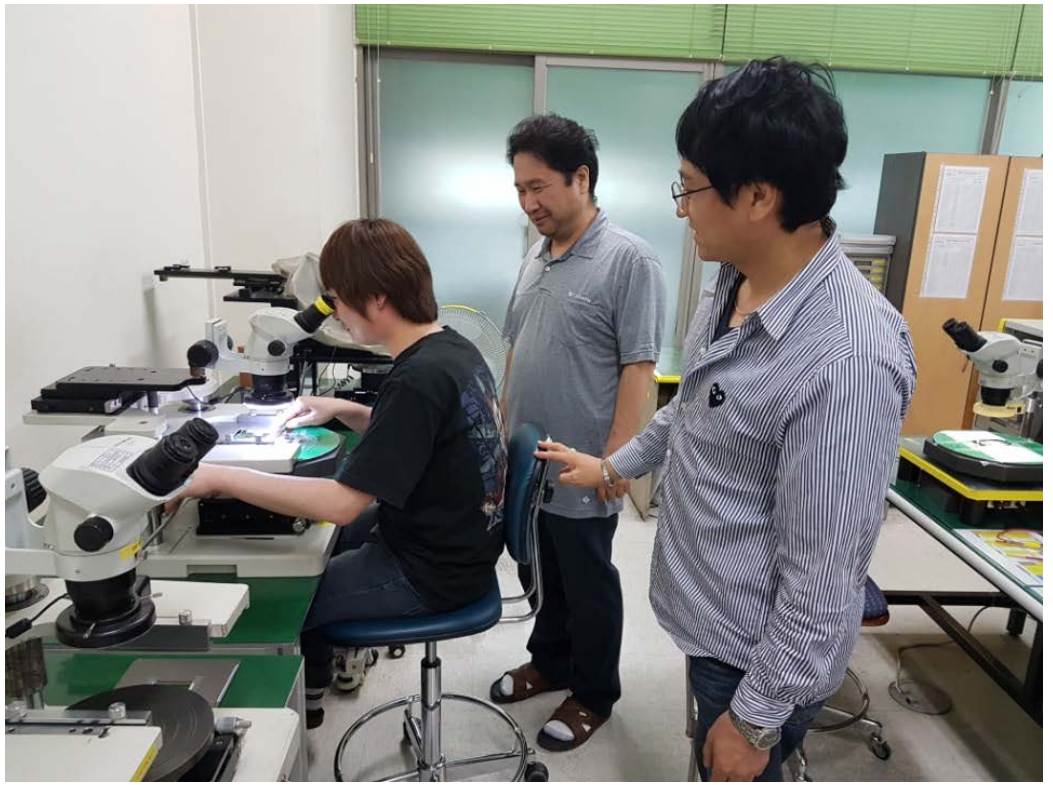
SDB-2012

Shaper and Digitizer board SDB-2012 shaper and digitizer board is a electronic board for Belle experiment in KEK laboratory. It performs shaping of the signals from calorimeter detector's preamplifiers. The shaped signal is sampled and...

Custom electronics

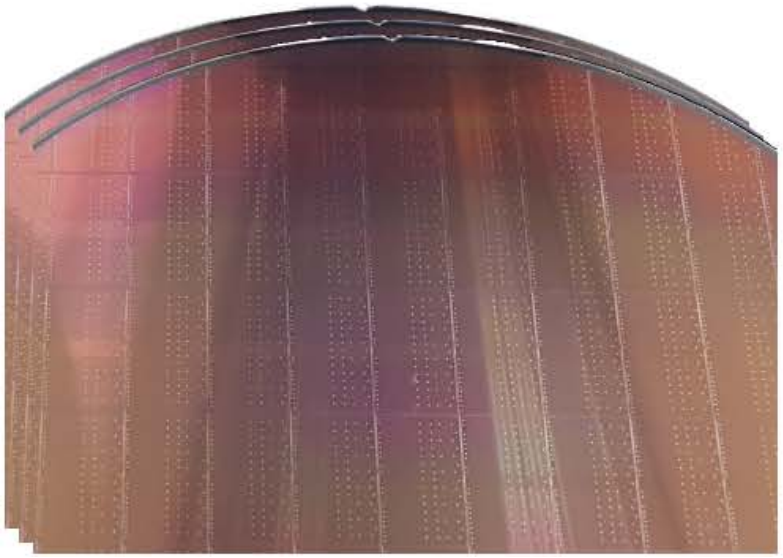
EQENG, probecard prober (Sungnam, Gyeonggydo, S. Korea)





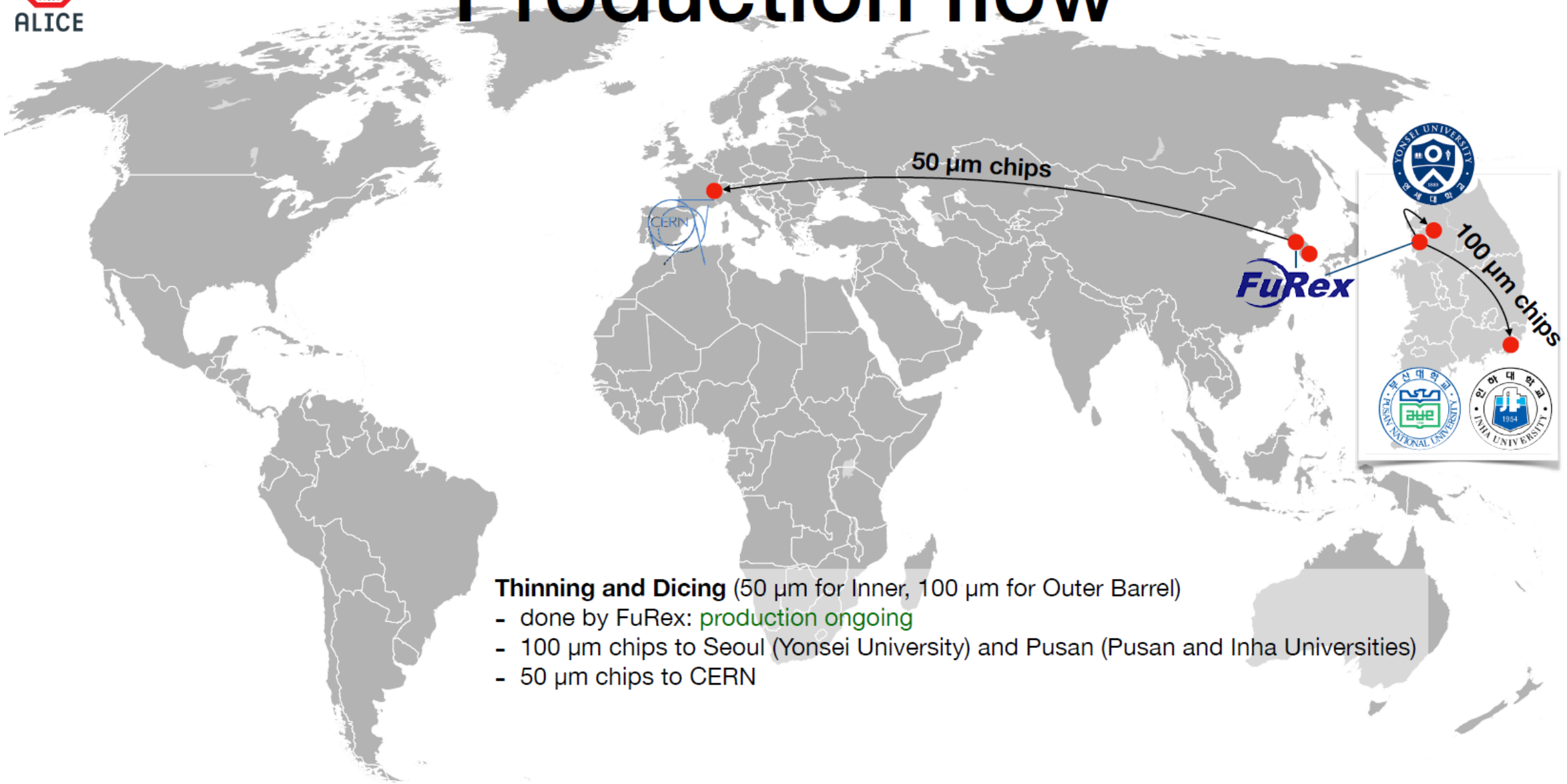
FuRex, thinning & dicing (Ansan, Gyeonggydo, S. Korea)

Wafer Thinning & Dicing



Processed by FUREX, Korea (Die-picking of 50 µ thick ones done by hand at CERN)

Production flow



Thinning and Dicing (50 µm for Inner, 100 µm for Outer Barrel)

- done by FuRex: production ongoing
- 100 µm chips to Seoul (Yonsei University) and Pusan (Pusan and Inha Universities)
- 50 µm chips to CERN

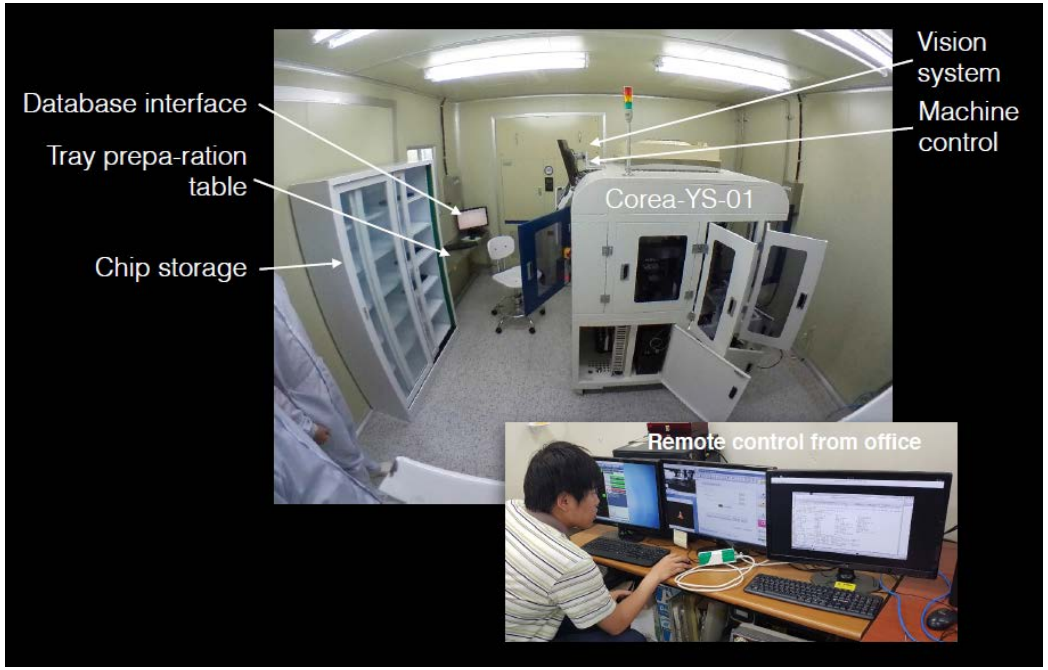
Automatic Production Test Equipment

ALICIA, IBS (Pusan/Inha)

COREA-YS-01, C-On (Yonsei)

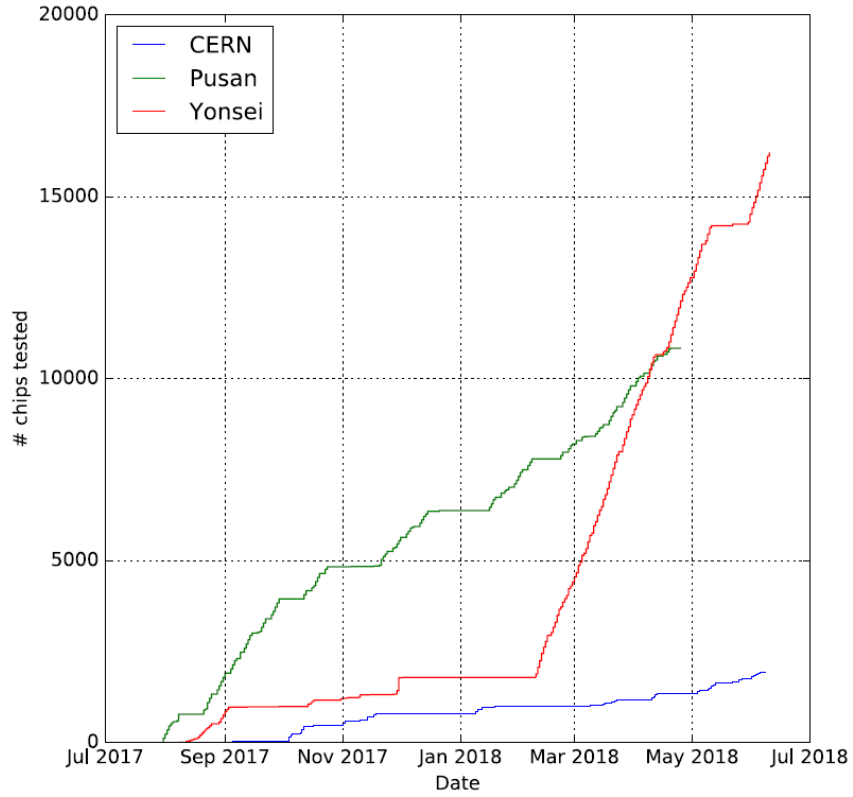
C-On, COREA-YS-01 (Namdonggu, Incheon, S. Korea)

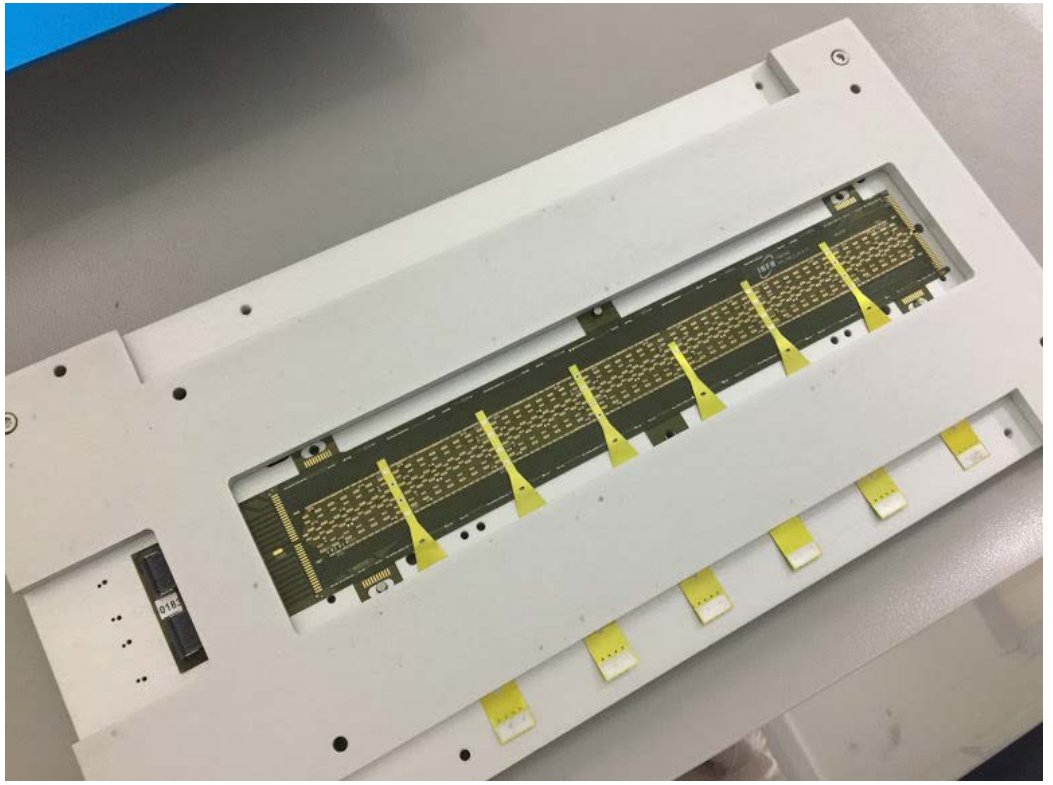
COREA-YS-01 in operation



BIT @ Yonsei Univ.
JbTech, Ansan, Gyeonggydo

Current





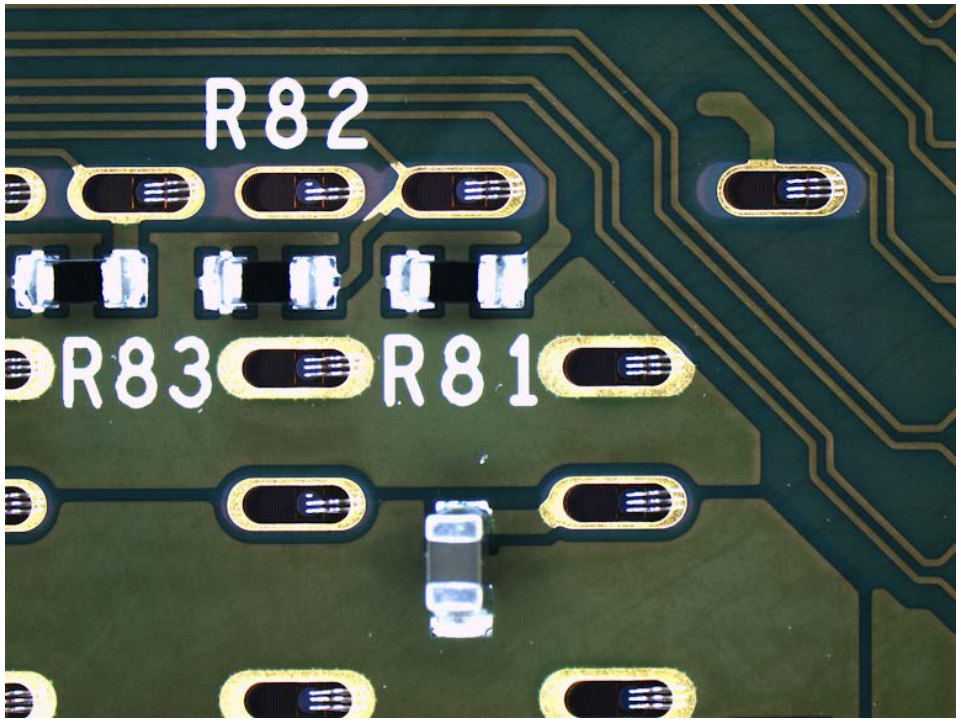
ALICIA-2 @ Pusan/Inha towards outer barrel Hybrid Integrated Circuit production.

Production flow

Module assembly and distribution (100 µm)
at Bari, Pusan, Liverpool, Strasbourg, Wuhan
production ongoing

Stave assembly

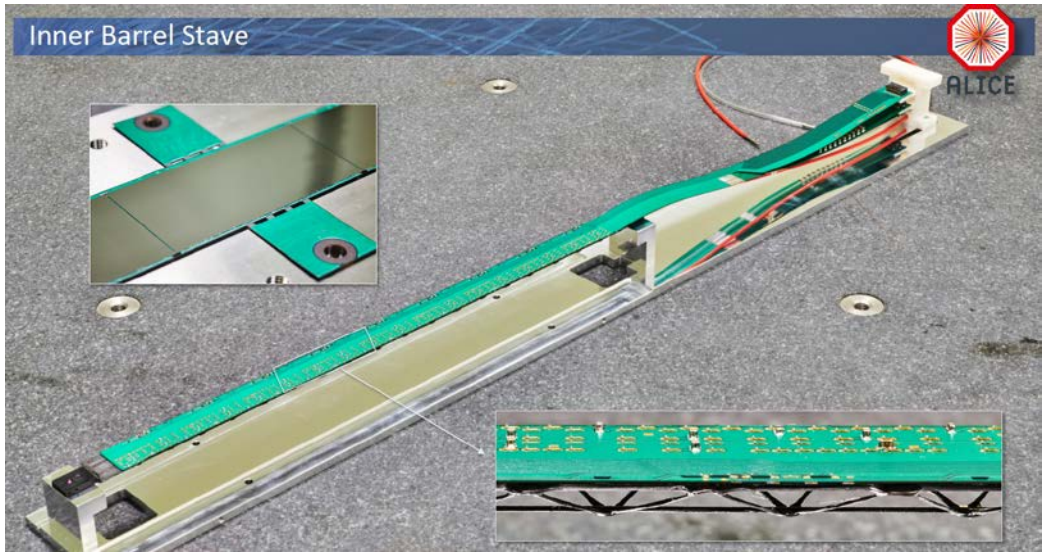
Under development



MEMSPACK
(Uiwang, Gyeonggydo, S. Korea)

Production flow

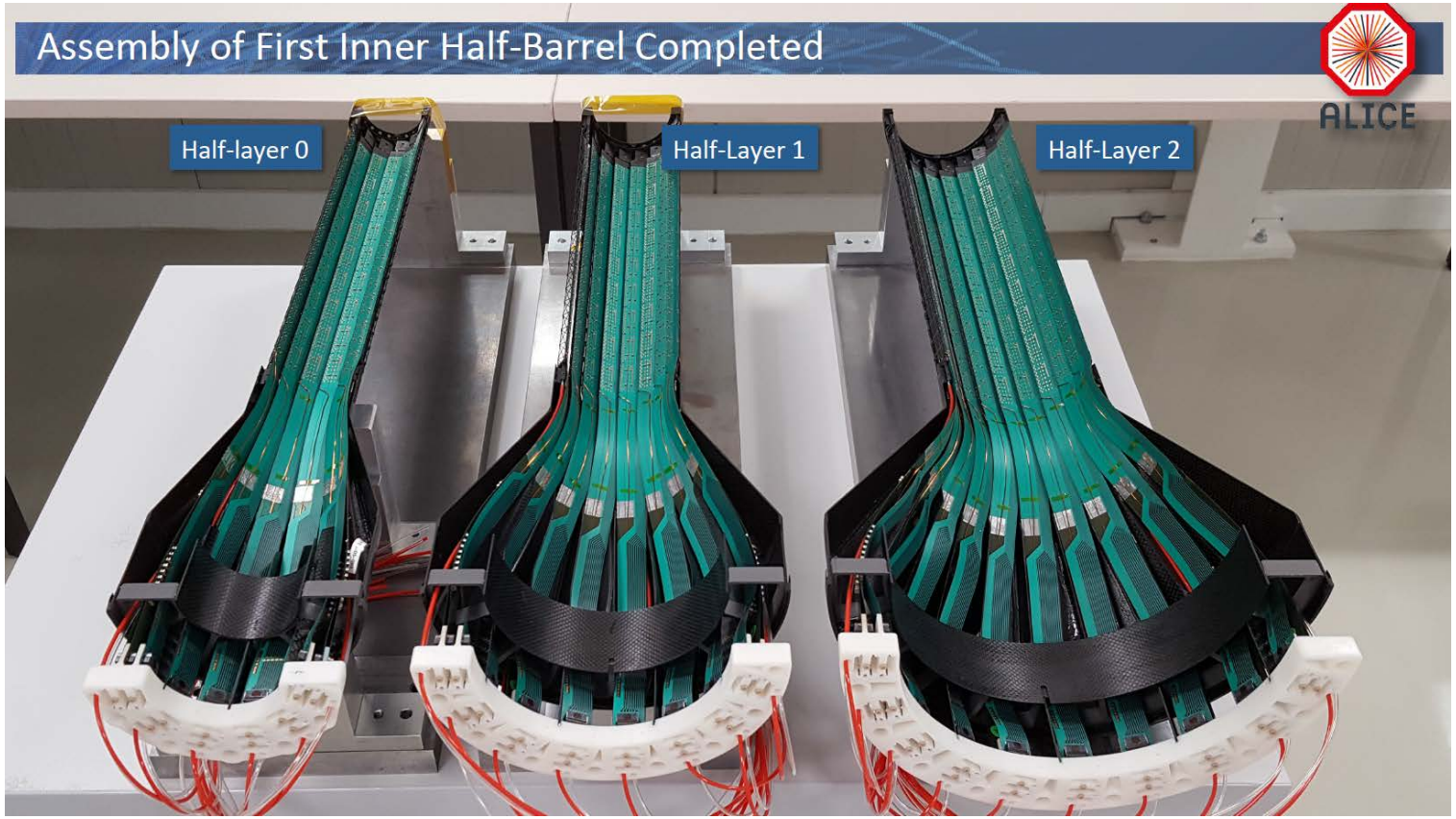
Staves for Inner and Outer Barrel



Inner Barrel

Outer Barrel

The 1st Assembly



Installation & Commissioning Timeline

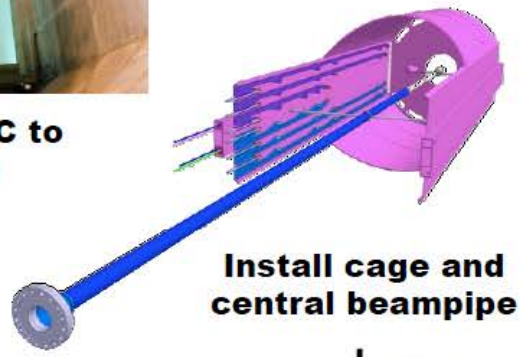
Activities in the ALICE PIT in 2020

Bring TPC to UX25

3 Feb ‘20

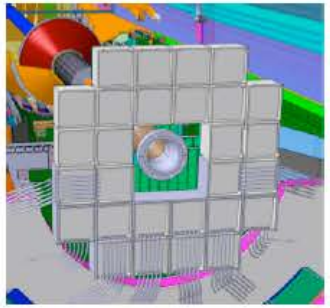
Reinstall Miniframe

26 Feb



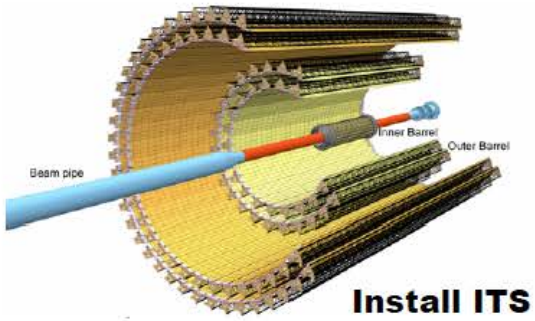
Install cage and central beampipe

7 Apr



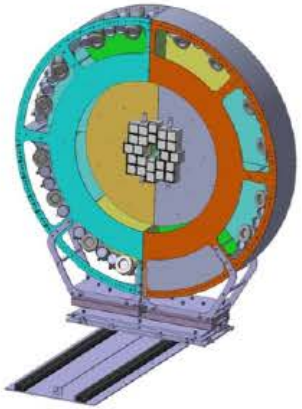
Install MFT and FIT-C

15 Apr



Install ITS

27 May



Install FIT-A

19 Aug

6 months commissioning

22 Feb ‘21

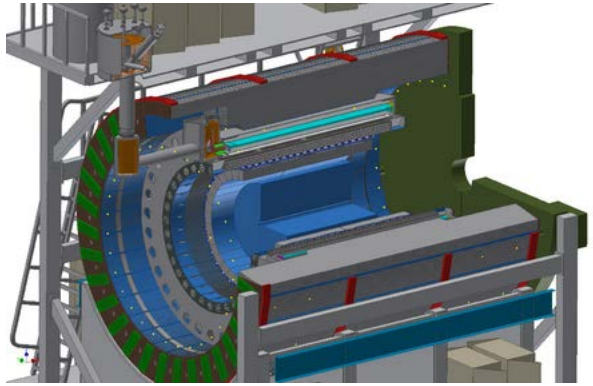
LS2 ends

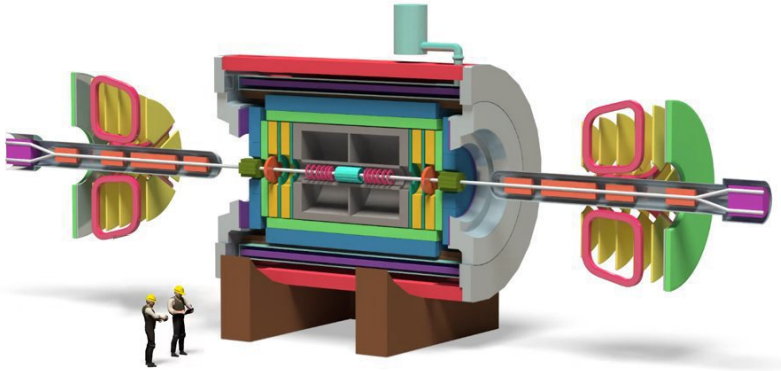
L. Musa (CERN) – ALICE Upgrade Asian Workshop, Hiroshima, June 2018

Outside near future discussions

Future experiments

- SPHENIX at BNL
- NICA(**N**uclotron-based **I**on **C**ollider f**A**cility) at Dubna





Nuclear medicine

- pCT

Summary & Prospect

We described the current status of the ITS upgrade with the focus on the contributions by the Korean industry.

The upgrade includes fabrication and processing of ALPIDE, an advanced MAPS fabricated by the CMOS image sensor process.

Medium and small sized Korean companies, FuRex, NOTICE, EQENG, and C-On have made significant contributions in thinning & dicing, prober electronics, prober, and automatic test equipment, and more contributions are expected from another Korean company, which shows the strong Korean background in the ALPIDE-like sensor.

Application of ALPIDE to the next generation experiments and nuclear medicine is already under discussion.

The collaboration appreciates the passion and devotion of the Korean engineers and technicians from these companies, and welcome more contributions from Korea in similar future projects.