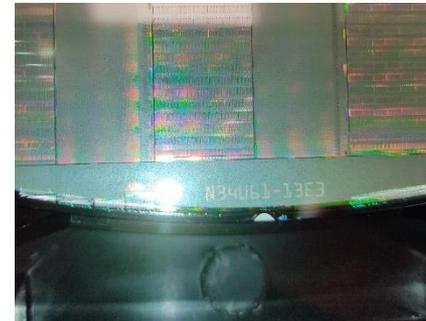
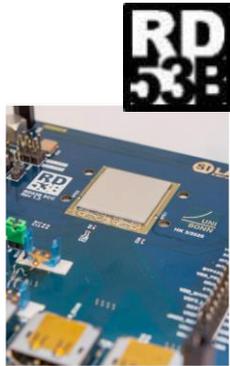


ATLAS ITK Wafer probing

RD53A /
ITKPIV1



Journées des métiers de l'Electronique de l'IN2P3 et de l'IRFU

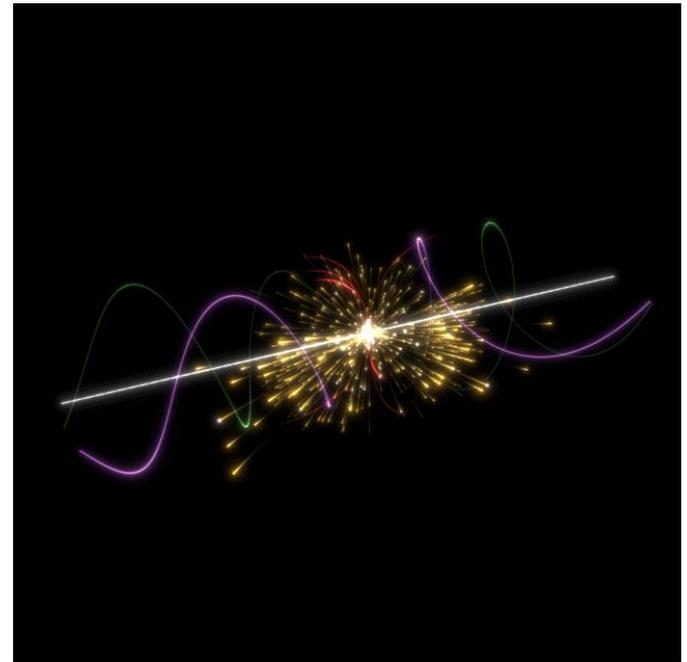
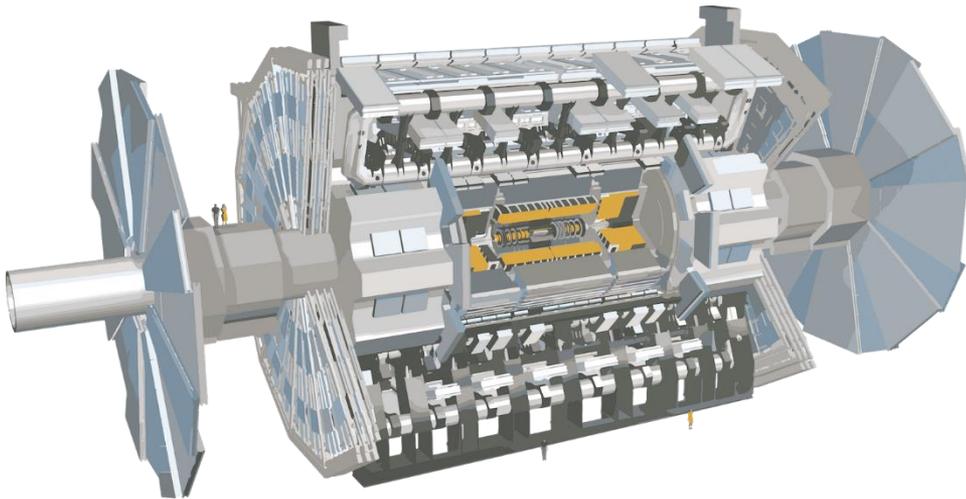
Maurice Cohen Solal, Jimmy Jeglot, Yahya khwaira, Abdenour Lounis, Abdelali Slimani-cherif, Christophe Sylvia, Ana Torrento, in collaboration with Mark Standke (BONN)

Journées VLSI - FPGA - PCB et Outils CAO de l'IN2P3

- <https://indico.in2p3.fr/event/17125/contributions/62508/>
 - See : https://indico.in2p3.fr/event/17125/contributions/62508/attachments/48152/60751/Jeglot-Journee_VLSI_mai_2018.pdf
 - C3 (configuration Column Chip)
 - C3 DAQ•Software d'acquisition•
 - Tests enradiation
 - RD53a
 - System YARR (CERN)
 - System BDAQ53 (BONN)
 - Tests des Ring-Oscillator
- Maurice Cohen-Solal,
Jimmy Jeglot,
Olivier Lemaire,
Philippe Vallerand,
Christophe Sylvia,
Jihane Maalami,
Stéphane Trochet,
- Abdenour Lounis,
Kostiantyn Sakhatskyi,
Vasyldrozd,
Thibault Lédjam (InternShip at
LAL)
RD53a With
CERN/IN2P3 collaboration.

LHC & ATLAS

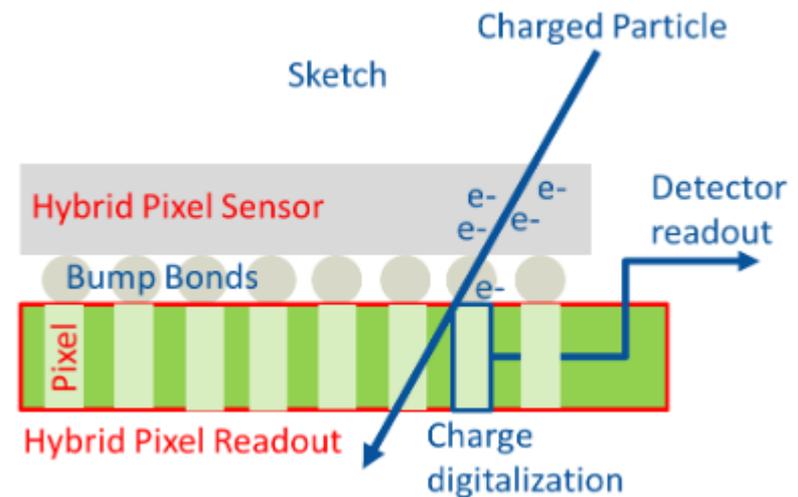
- ATLAS (A Toroidal LHC ApparatuS) is one of two general purpose particle detectors at the Large Hadron Collider (LHC). With the **High Luminosity (HL-LHC) upgrade**, the objective is to increase the LHC's luminosity by a factor of **10 beyond** its original design value. For this purpose **ATLAS (ITk)** will have to be upgraded to cope with the increased radiation, speed and vertex resolution.



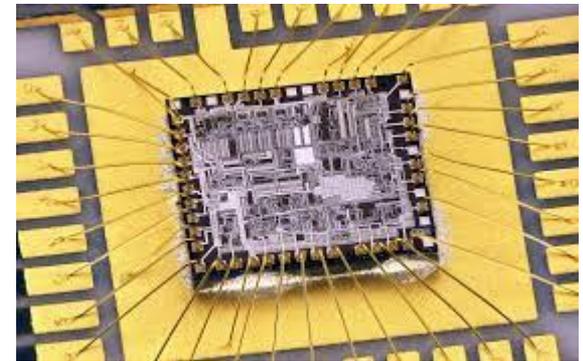
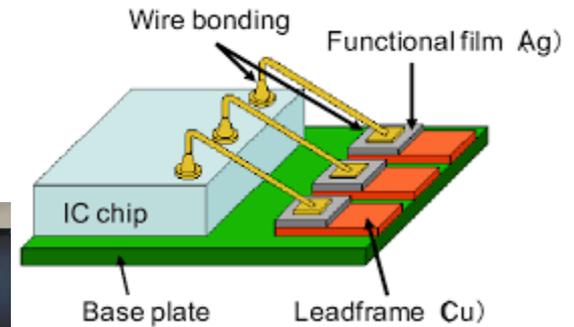
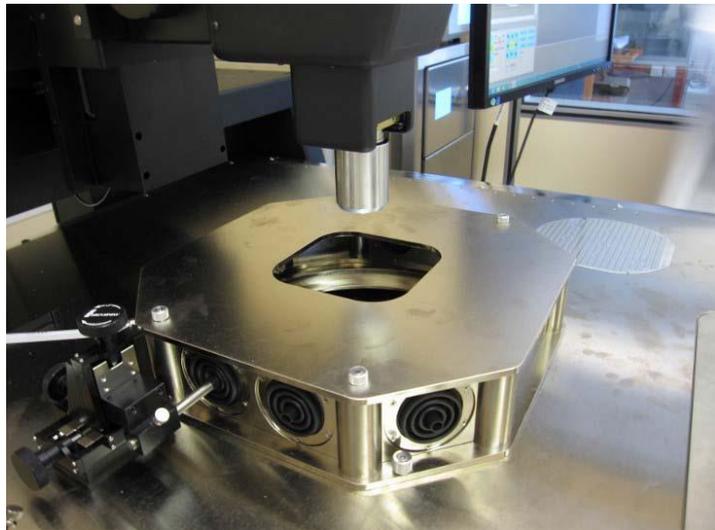
- The **ATLAS Inner tracker (ITk)** will consist of five layers of **Hybrid Pixel Detector modules**. Each module consists of a charge collecting Sensor chip, collecting the deposited charge of traversing ionizing particles and guides this charge via a **bump bond** to the Hybrid Pixel Readout Chip.

ITK CHARACTERISTICS

- 5 layers of Pixel Modules
- Active area 12.7 m²
- Pixel size: 50x50 (and 25x100) μm²
- ~10000 Hybrid modules
- ~33000 electronic readout chips
- 4 Layers of Silicon Strip Detectors



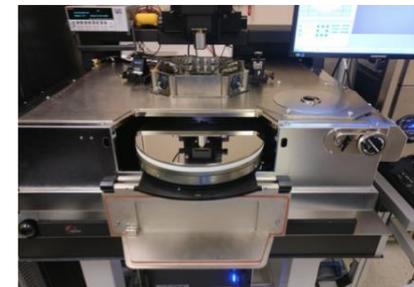
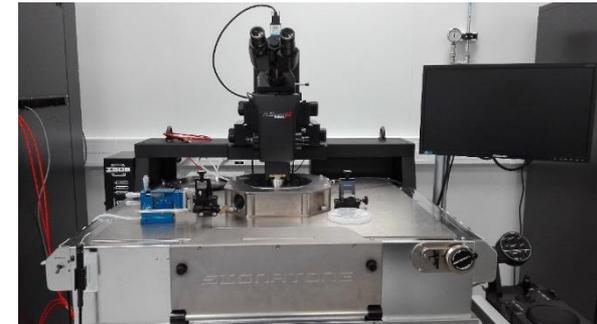
Plateforme P2IO de tests et de bonding de détecteurs et circuits électroniques constitué d'une station sous pointes (IJCLAB) et d'une machine à bonder (Irfu-Saclay)





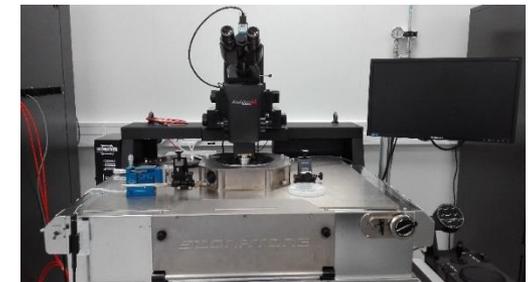
A new 80 m² ISO7 class clean room has been constructed and delivered early February 2020 after eight month work. The clean room is housing the Signatone™ P210 probe-station and a full chain of modern equipment for pixel module characterization and development.

- Have chosen complete thermal system against full automation and performance (<100 fA, 100 fF levels)
- Partly-automated machine: aliment and positioning with vision assisted software
- open software allows any kind of programming (Labview, Python, C...)
- Features:
 - **30cm** workholder in a **micro chamber**: black box & faraday cage, triaxial connectors Any kind of characterization (DC, AC -50GHz, S, noise, 1/f)
 - Large choice of DC & RF probes
 - Wafer level tests or single die
 - Probe card holder for specific probe
 - configuration Micrometric resolution
 - 12° spin correction
 - **Temperature control -60° to 200°**
 - Installed in a clean room at IJLAB



Semi-automatic Prober

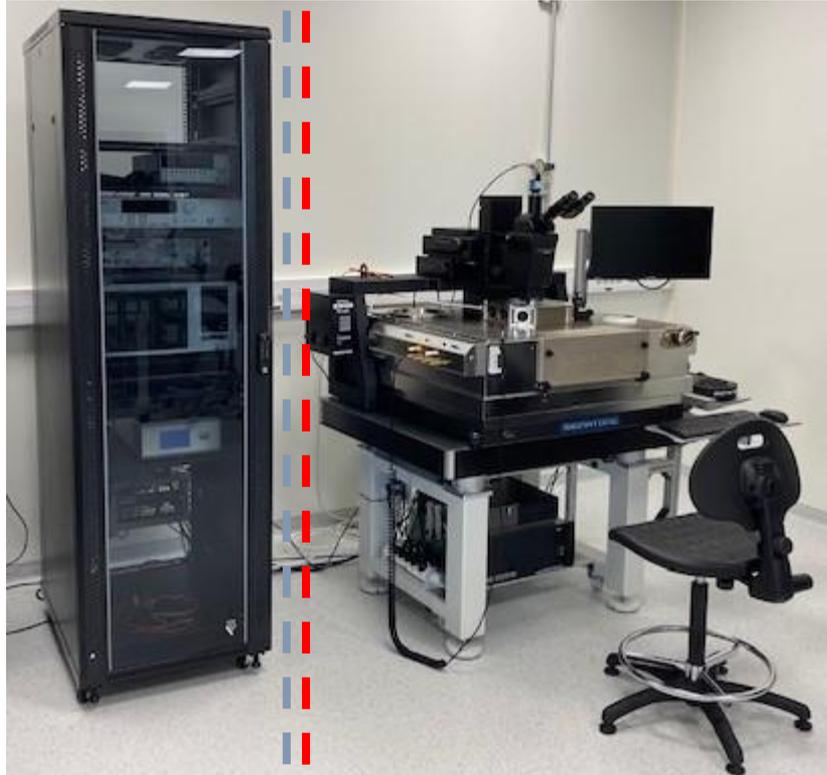
- Large Size Chuck (300 mm)
 - Mobility range = 300 mm in X et Y, 10 mm in Z,
 - Faraday cage, black box
 - High resolution Microscope, photo, caméra
 - Feed Through (coax, triax, ...)
 - Precise Positioning (very limited damages risks)
 - Large variety of probes , and positionners (kelvin probes)
 - Full black box
 - Cooling plant (from -60 °C to 200 °C)
 - Embeded Signatone & Kethley software (master & slave)
 - Variety of microscope lens
 - Compressor : 11 Bar 100m³/h
- Signatone Prober**
- Chuck upgraded up to 10 KV
SHV connectors for Kethkley DAQ
ISDB Discharge Box with Interlock and
discharge chuck during unloading



Setup Signatone Probestation

Acquisition and control rack

- Temperature control
- High voltage supply
- Keithley data acquisition system

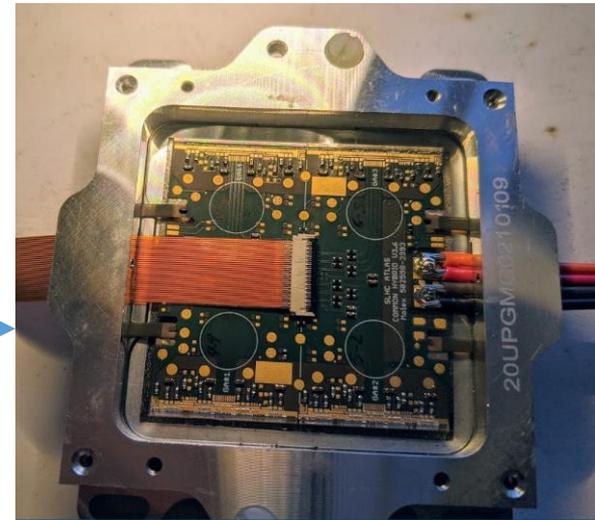
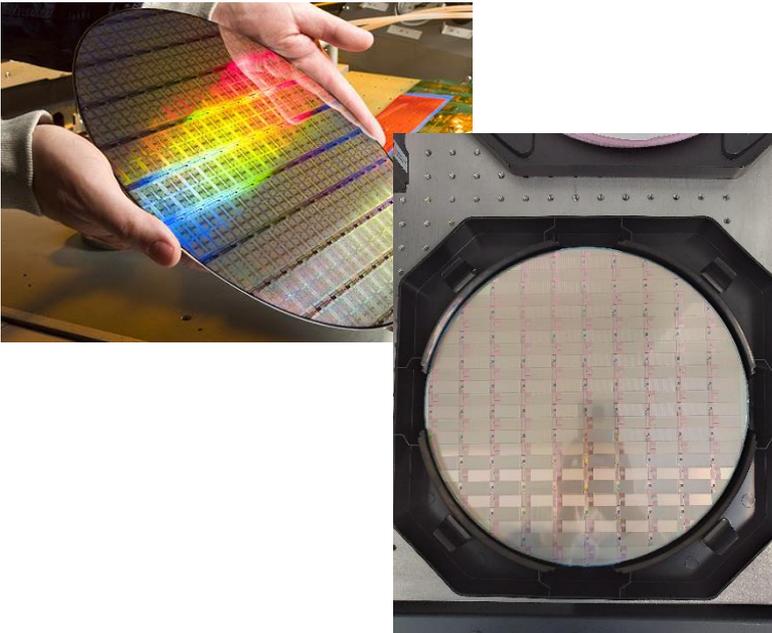


Signatone

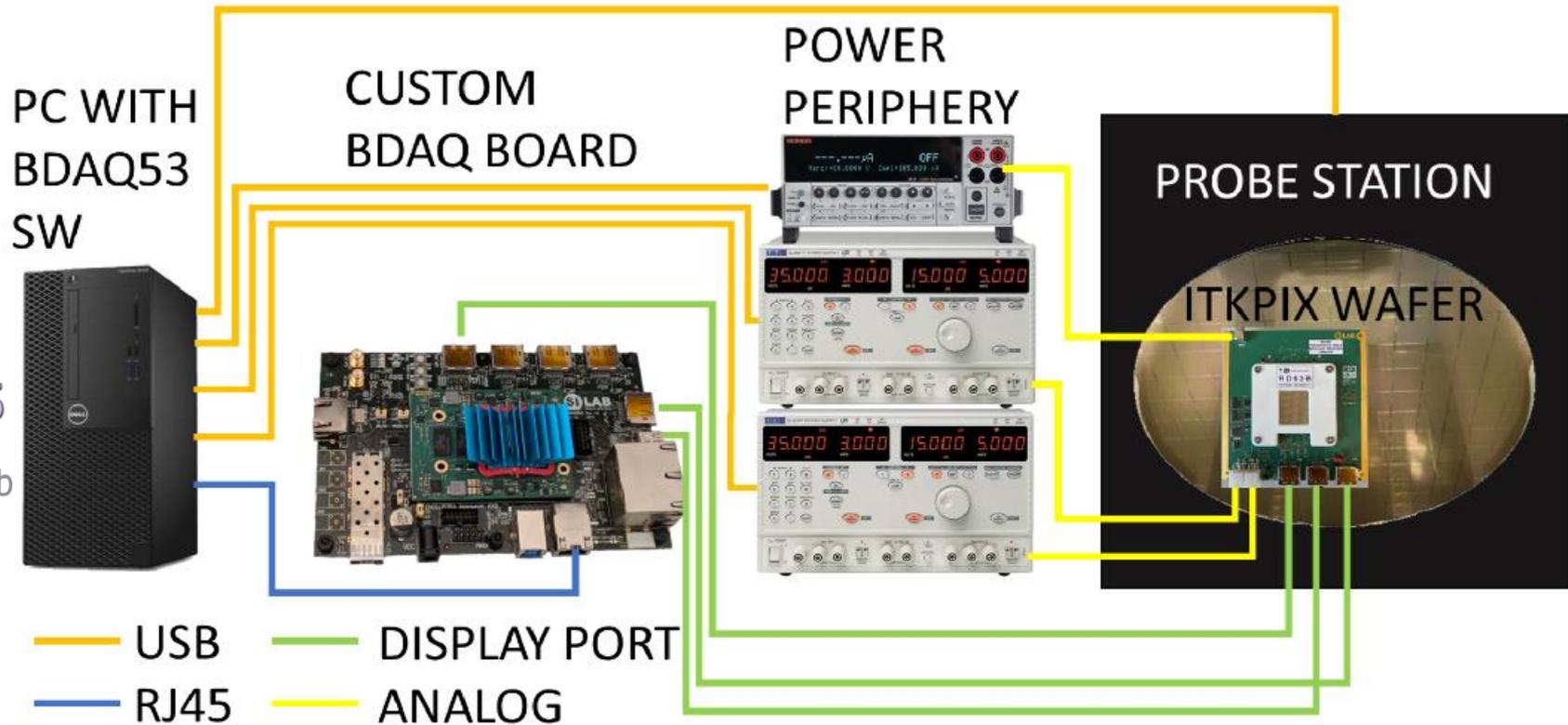
- Acquire signals from the internal nodes of a semiconductor device

ITKPIX WAFER

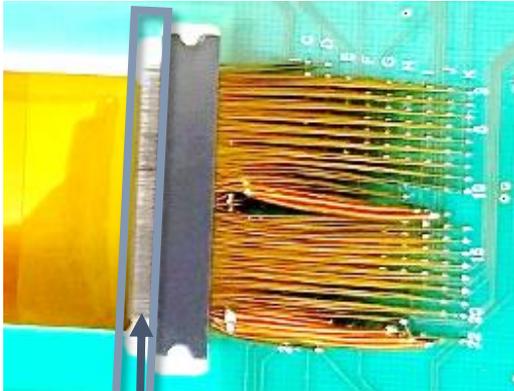
- Manufactured in **65nm CMOS TSMC technology**.
- De-spite the age of the technology, production of complex chips still involves statistical production uncertainties.
- Chip needs to be tested after manufacturing before being assembled as **modules**.



Wafer probing setup



Probecard rd53a



~ 200
tungsten
probes

Analog MUX output

Needles



DP2 (VCC /I2C)

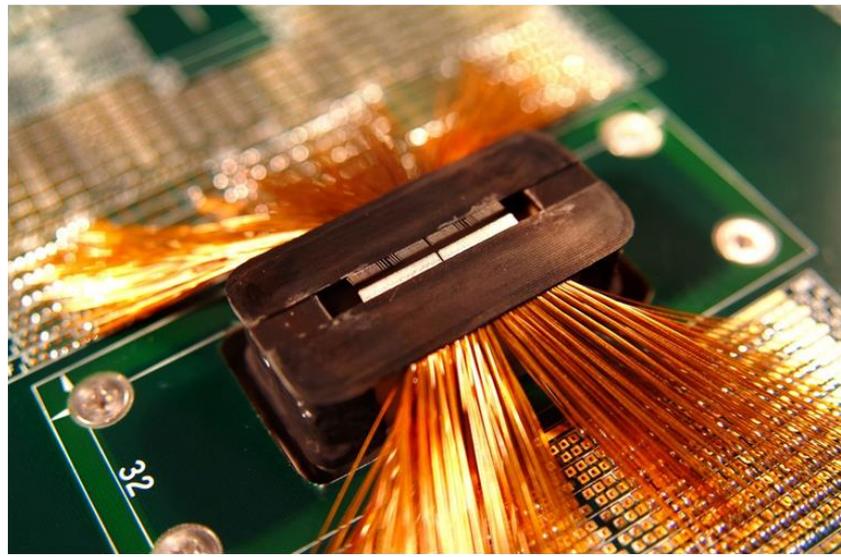
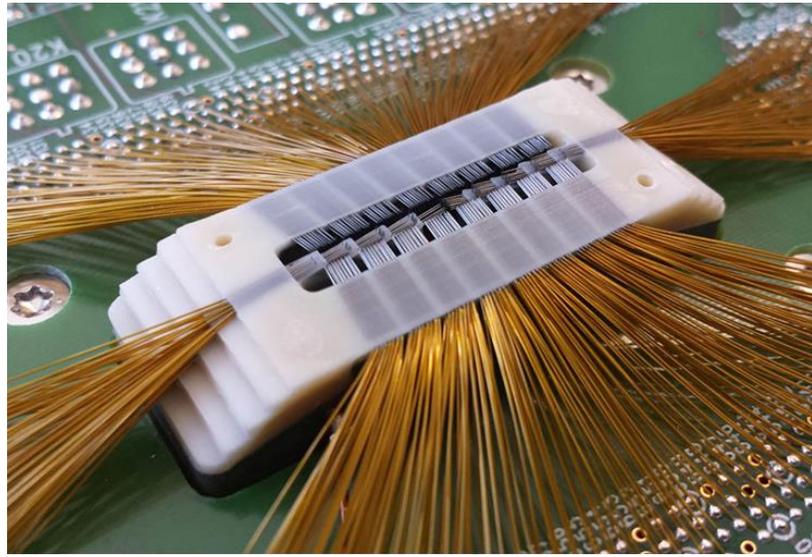
DP1 (Data)

VAUX_IN

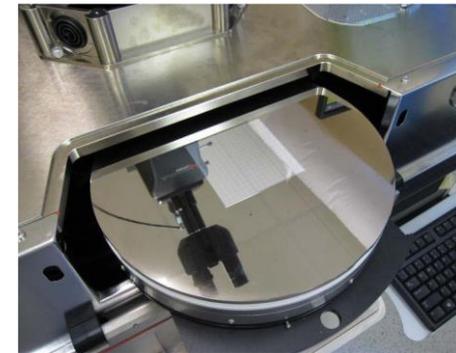
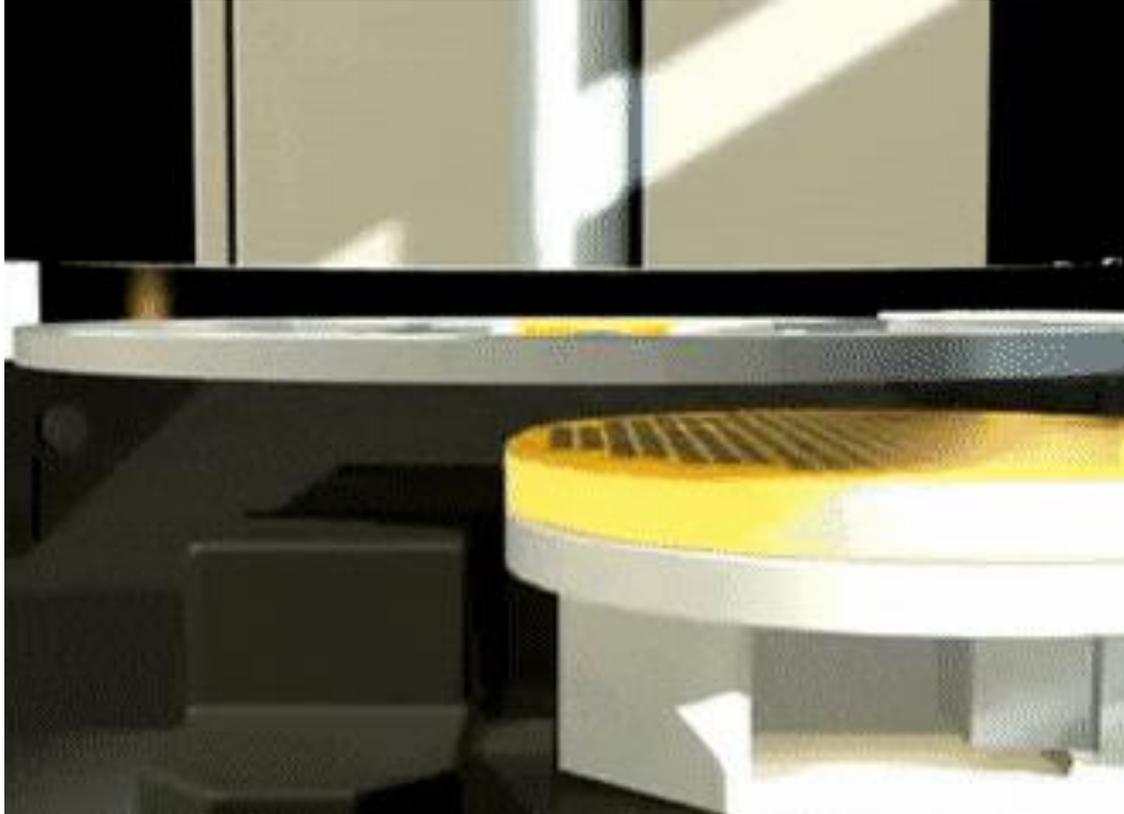
VDD_IN



Probe card manufacturer



Probe card / wafer



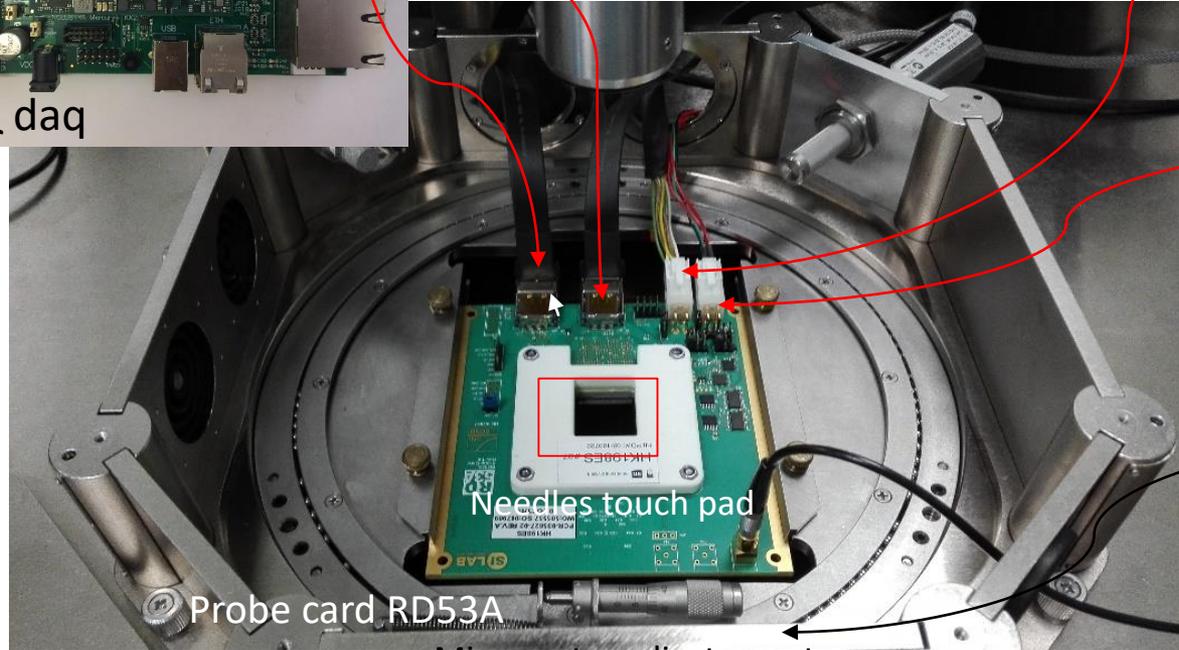
RD43a waferprobing setup



BDAQ daq

CMD & DATA displayport
câble

I2C displayport
câble



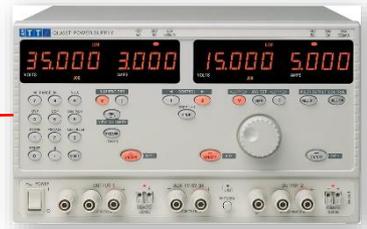
Needles touch pad

Probe card RD53A

Micrometre ajustement



Main power supply QL355



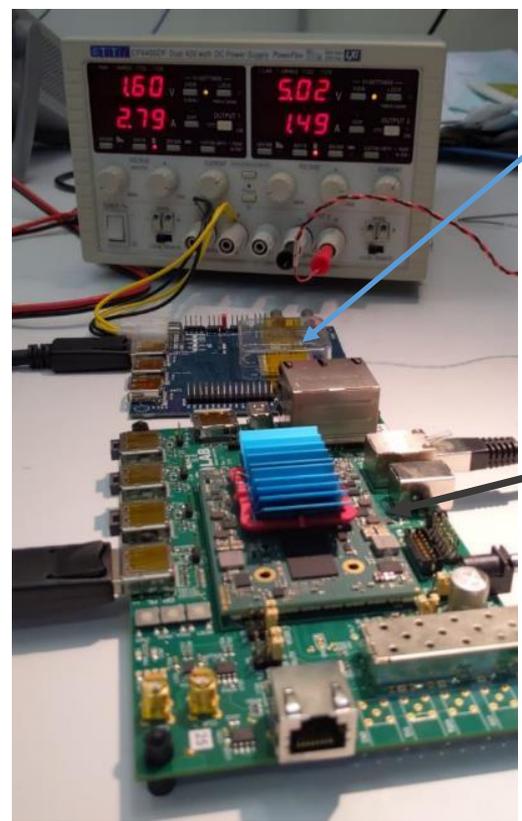
Aux power supply QL355



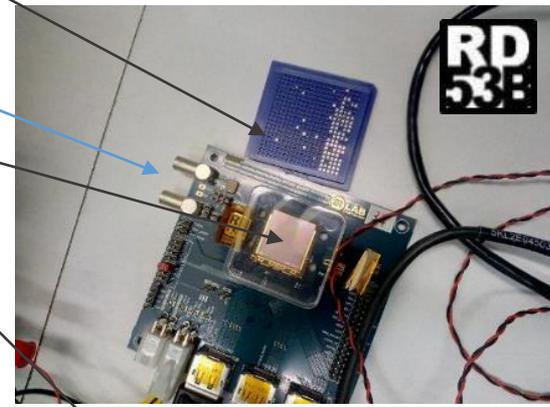
2400

In collaboration with
 Mark Standke mark.standke@cern.ch
 Fabian Hügging huegging@uni-bonn.de

ITkPixV1 Setup at IJCLab

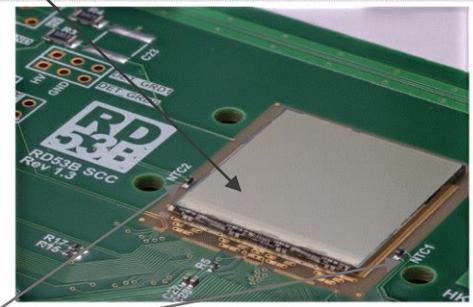


SCC Card
ROMIC chip (1mm x 1mm)
ITkPixV1 chip (21mm x 20mm)
153 600 electronics channels
BDAQ board



Script in Python 3
NTC1 read by ADC's
FPGA is OK

ITkPix-V1 on Single Chip Card (SCC)

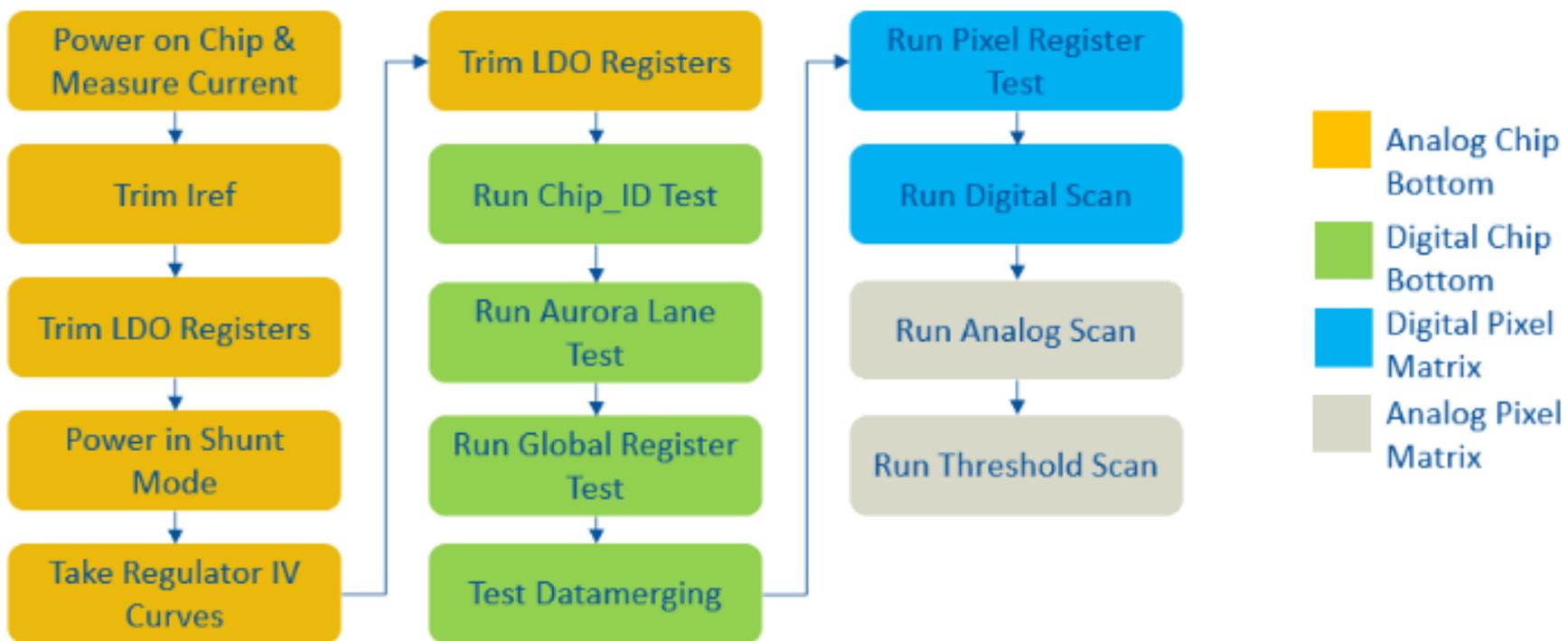


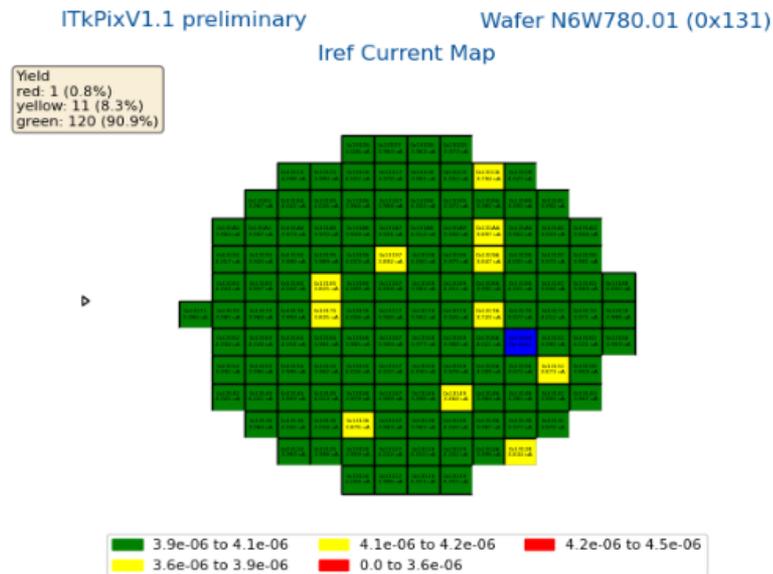
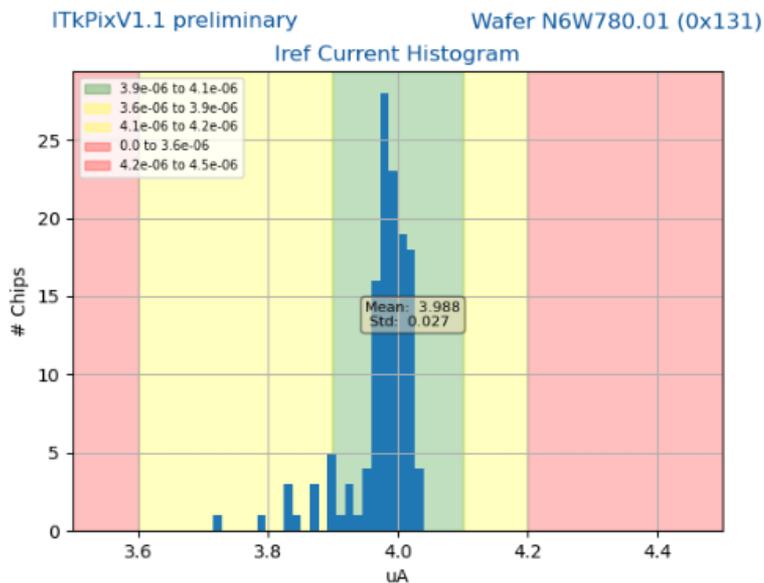
NTCs

Bonn custom designed with Mercury + KX2 FPGA module is the platform for BDAQ53

Test in climate chamber on going

Functionality test





- Reference current histogram after trimming for 132 chips
- Wafer map for reference current after trimming

See : http://cds.cern.ch/record/2775147/files/2021_07_01-TIPP_proceedings_wafer_probing.pdf

- We have installed the wafer and the needlecard in the probestation with the new câbles. –
- We have aligned the needles with the Wafer and the LEDs have turned on when touching the Die pads and the script has been executed correctly (True, True). –
- In order do some tests we have executed the `probe_chip_rd53a.py` script on two chips (8,11 and 7,12),
- Aligement between probecard and wafer is done.

- M. Garcia-Sciveres et. al. “RD53B Manual,” Geneva, (2019)
<http://cds.cern.ch/record/2665301>.
- M. Daas, et al. “BDAQ53, a versatile pixel detector readout and test system for the ATLAS and CMS HL-LHC upgrades,” Nucl. Instrum. Meth. A986, 164721 (2021)
doi:10.1016/j.nima.2020.164721
- ITk public results
- <https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ITkPublicResults>.
- More Plots
- <http://itkpixv1.web.cern.ch/itkpixv1/wafer/index.html>.
- Probing Script
- <https://gitlab.cern.ch/silab/bdaq53/-/blob/waferprobingdev/bdaq53/waferprobing/>.
- Itk Scheme
- <http://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/UPGRADE/PLOT-UPGRADE-2014-001/>