



CLICdp Vertex and Tracker Working-Group Plans 2019

CLIC week 2019 – CLICdp plenary
January 21st, 2019

Mathieu Benoit (UniGE),
Dominik Dannheim (CERN),

on behalf of the CLIC Vertex and Tracking
Detector Technology Working Group

Hybrid planar sensor technology



- Planar pixel sensors bump bonded to r/o ASICs
- Considered for vertex detector

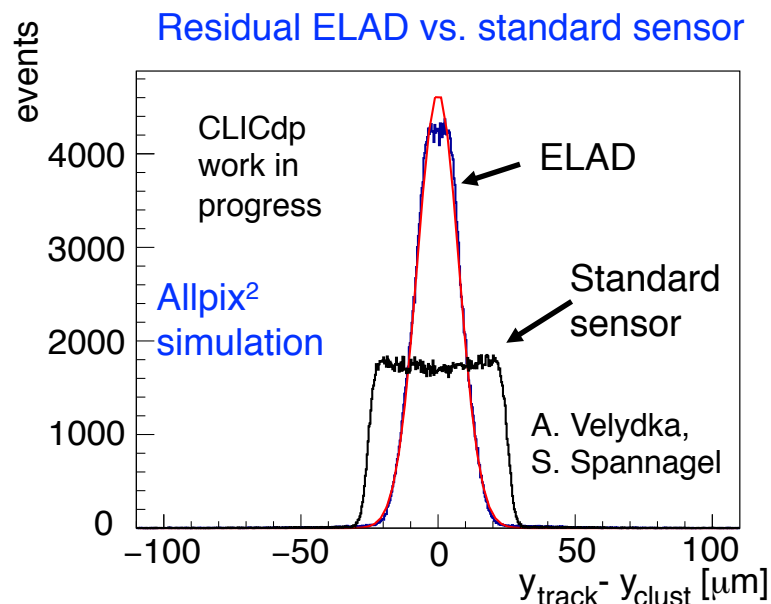
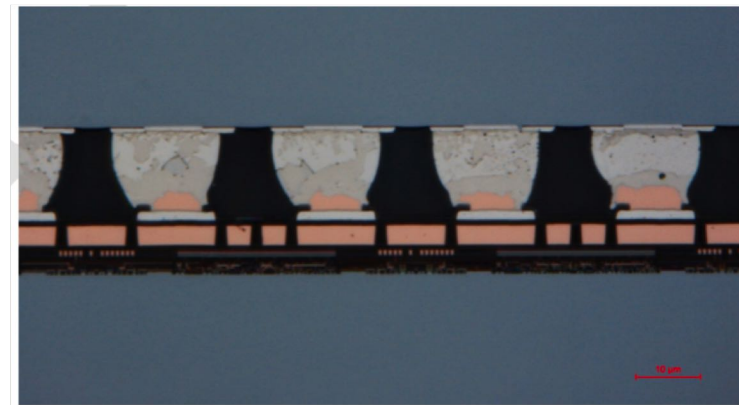
Ongoing work:

- **CLICpix2 planar-sensor assemblies:**
 - Bump-bonding process qualification (with IZM)
 - Analysis of SPS test-beam and lab data
- **ELAD sensors for enhanced position resolution**
 - Sensors designed, simulated (TCAD/Allpix²)
 - Planning for production in progress

Plans for 2019:

- Lab + test-beam measurements for **CLICpix2 planar-sensor assemblies**
- Bump-bonding of CLICpix2 with from 2nd AIDA-2020 active-edge FBK sensor production (incl. thin sensors $\sim 50 \mu\text{m}$)
- First tests of **ELAD sensors?**

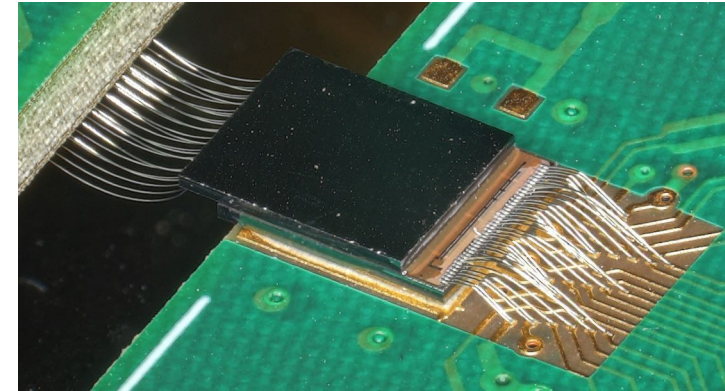
Bump bonded CLICpix2 + Advacam sensor



Capacitively coupled HV-CMOS sensors

- Active HV-CMOS sensors capacitively coupled to r/o ASICs
- Thin glue layer replaces costly small-pitch bump bonds
- Considered for vertex detector

C3PD/CLICpix2 glue assembly



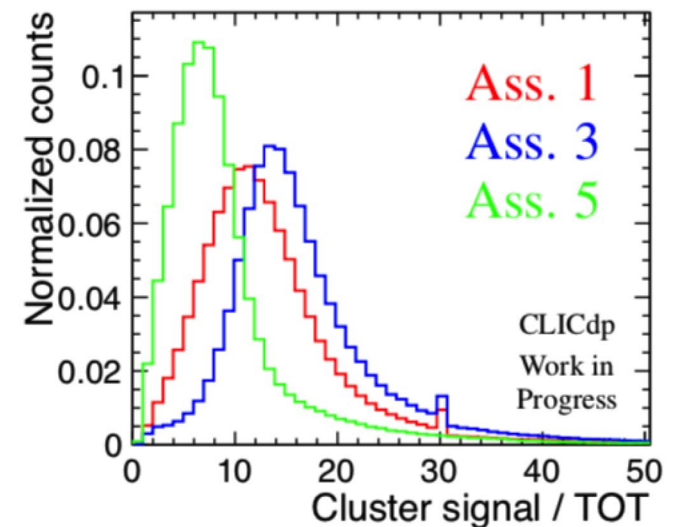
Ongoing work:

- Analysis of C3PD+CLICpix2 SPS TB data for **high-resistivity C3PD** samples

Plans for 2019:

- Improve **calibration** procedure (response uniformity); investigate noise behaviour
- Produce and test samples with **different resistivities**
- Wrap-up the study (PhD thesis Iraklis)

C3PD+CLICpix2 MIP cluster signal



Monolithic HV-CMOS sensors



- High-Voltage-CMOS sensors with integrated readout
- Considered for tracker

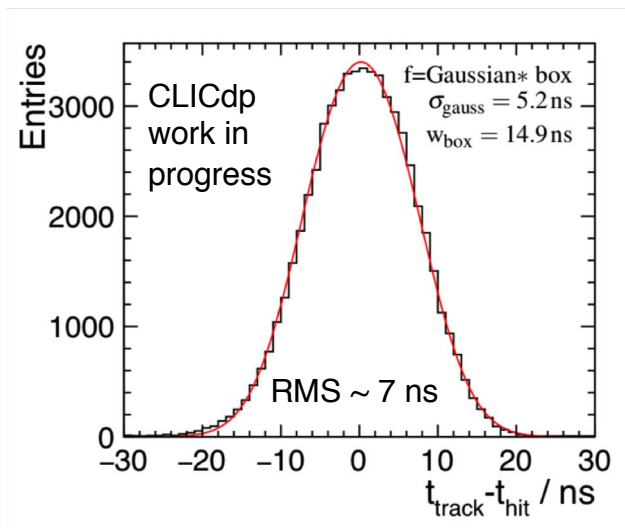
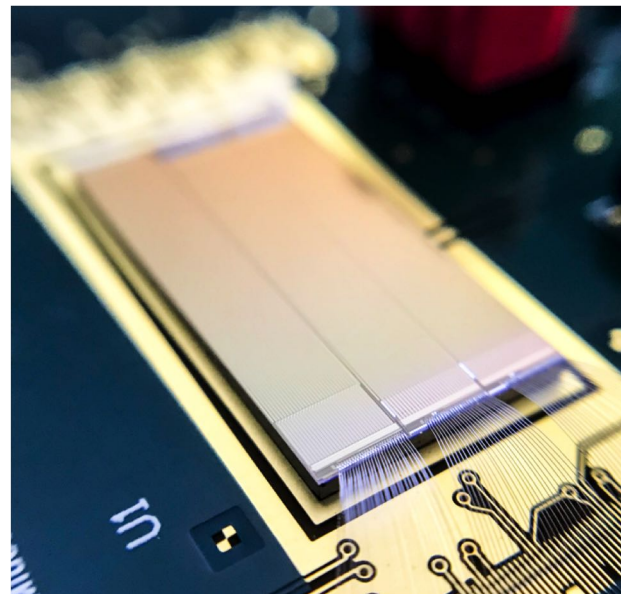
Ongoing work:

- **ATLASPIX** prototypes in AMS 180 nm HV-CMOS process:
40 x 130 μm^2 pitch, column-drain readout
- Analysis of SPS test-beam data

Plans for 2019:

- Sample **calibration**
- Wrap-up analysis of 2018 test-beam data
- Further **beam tests** at DESY (rotation scans)
- **New submission** with adapted geometry,
fully targeted to CLIC requirements (smaller width)

ATLASPIX HV-CMOS prototype



Talk by Jens Kröger on Tuesday:
Testbeam studies of monolithic HV-CMOS sensors

Integrated HR-CMOS sensors



- CMOS sensors with integrated readout on High-Resistivity (HR) substrate
- Currently considered for tracker

Ongoing works:

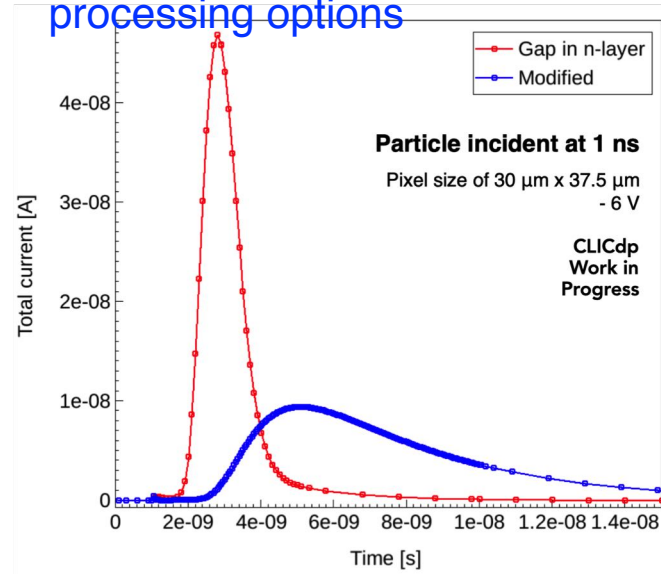
- TCAD [simulations](#) / [optimization](#) of HR-CMOS process (timing, charge-collection efficiency, spatial resolution)
- [CLICTD](#) design: technology demonstrator for fully integrated tracker chip in 180 nm TowerJazz process

Plans for 2019:

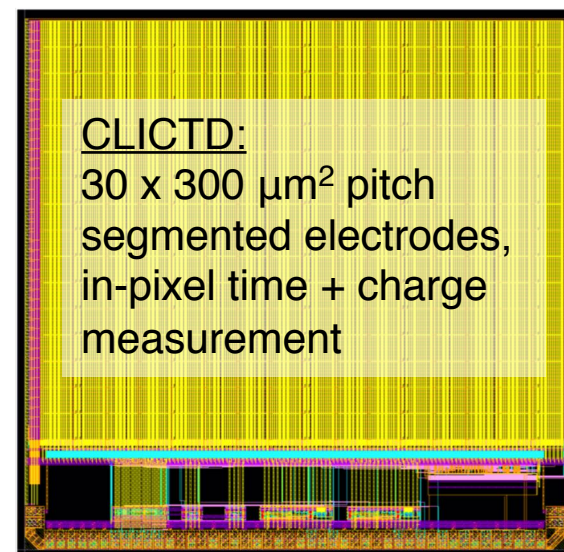
- [Submission of CLICTD](#) (target Feb-11)
- [CaRIBOu](#) integration of CLICTD
- Lab and test-beam [characterization](#) of CLICTD

Talk by Iraklis Kremastiotis on Tuesday:
CLICTD status and plans

TCAD simulation of different processing options



CLICTD mask set



Monolithic SOI sensors



- Sensor and electronics **integrated** on single wafer with high-resistivity substrate, separated by **insulation oxide layer** + buried p-wells
- Considered for vertex and tracker

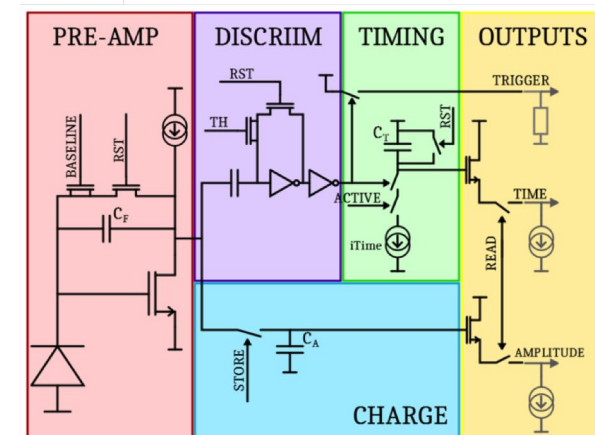
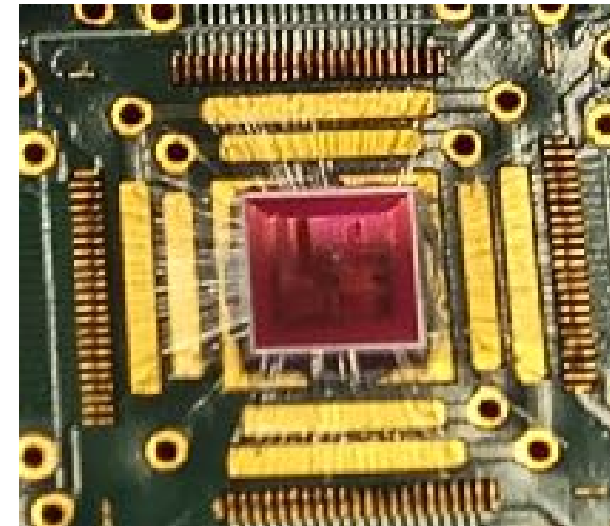
Ongoing work:

- **Analysis of TB data** from SOI technology demonstrators
- Production of **CLIPS** test chip targeted towards CLIC vertex requirements

Plans for 2019:

- Wrap-up **TB analysis** results (PhD thesis Szymon and Roma Bugiel)
- CaRIBOu **DAQ for CLIPS**: chip board, firmware, software
- First lab and beam tests for **CLIPS**?

Cracow SOI test chip



Talk by Roma Bugiel on Tuesday:
SOI testbeam analysis
Talk by Szymon Bugiel on Tuesday:
Status of CLIPS monolithic SOI CMOS chip

- TCAD device simulations of pixel sensors
- Allpix2 MC simulations: combines Geant4, drift-diffusion model, TCAD fields

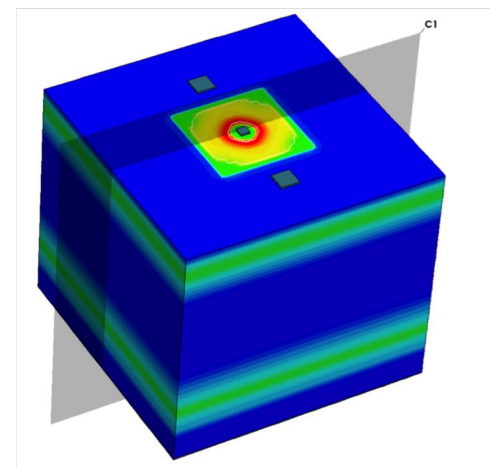
Ongoing work:

- 3D TCAD simulation of CMOS sensors
- Allpix² release v.1.3.1
- Modeling of CMOS sensors, validation with TB data

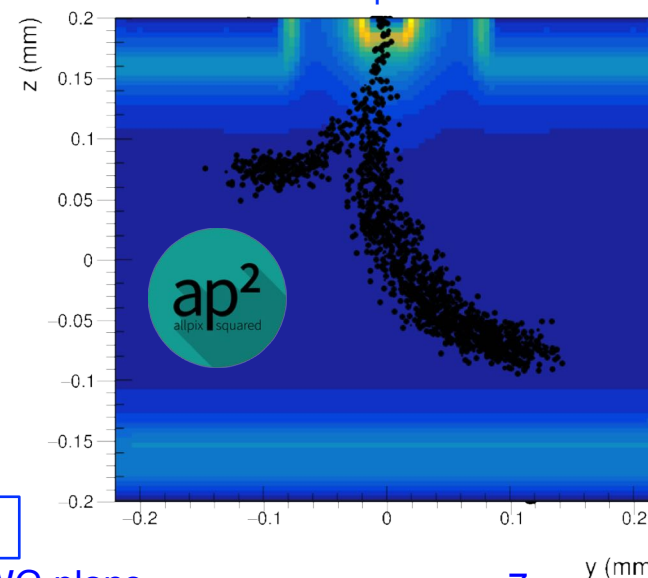
Plans for 2019:

- Allpix² extensions: transient simulations (timing), charge multiplication, life time, multi-threading
- More Allpix² use cases / validation (e.g. ATLASpix)
- 3D TCAD and Allpix² simulations for sensor optimization / comparison with data

3D TCAD simulation of E-field in HR-CMOS sensor



MIP in under-depleted HV-CMOS pixel sensor



3D TCAD electrostatic

3D TCAD transient:
Precise sensor modeling
--> Timing

Allpix2 Monte Carlo simulation:
Stochastic effects
→ Clustering, efficiency,
spatial resolution

Talk by Magdalena Munker on Tuesday: TCAD simulation of CMOS sensors

DAQ

- CaRIBOu: flexible scalable DAQ hardware and software system for pixel-detector R&D

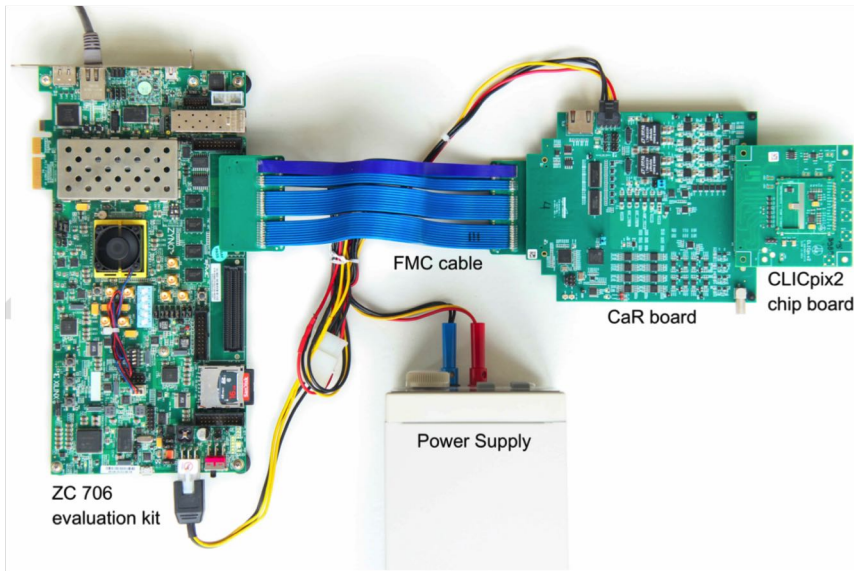
Ongoing work:

- Consolidation of firmware architecture, to improve re-usability of common blocks
- Clean-up of Peary software framework, to improve maintainability

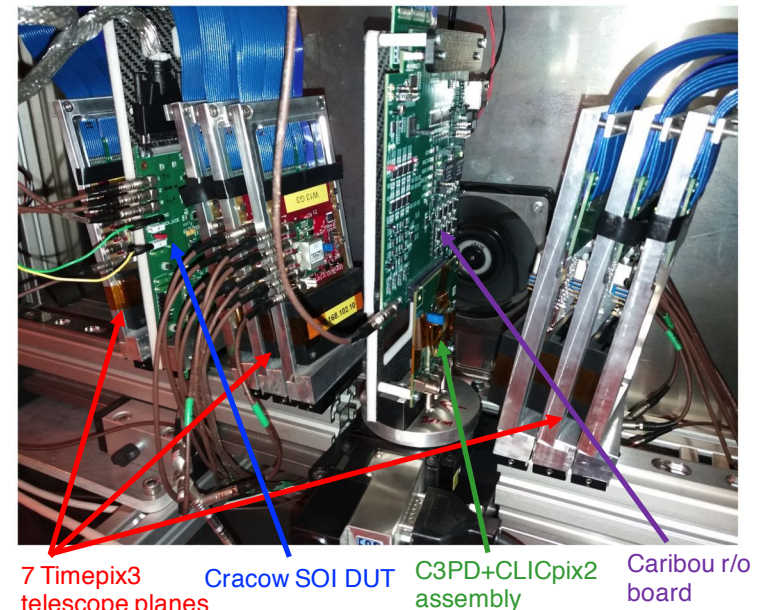
Plans for 2019:

- CaRIBOu integration in DESY test-beam DAQ (EUDAQ2)
- CLICTD, CLIPS integration
- New CaR board hardware release with enhanced features
- User manual

Caribou lab setup



C3PD+CLICpix2 with CaR board in test beam



2019 beam tests at DESY



- CERN SPS beam-test facility not operational during LHC **LS2** (2019/20)
- Beam tests at **DESY II** (~5.4 GeV electrons), like in 2012/13 during LS1
- Preparations for mechanics and DAQ integration in DESY infrastructure (EUNET telescope / EUNDAQ2)
- **5 x 1 week** of CLICdp pixel beam time in 2019
- Planned TB programme:
 - **EUNDAQ2 integration:**
 - Timepix3 (SPIDR r/o) timing plane
 - CaRIBOu hardware + software
 - Commissioning and data-taking:
 - **ATLASpix** (incl. rotation scans)
 - **CLICpix2** planar sensor assemblies
 - **CLICTD**
 - **CLIPS?**
 - **ELAD?**



DESY Te

Ralf Diener, Norbert Meyners, Marcel Stanitzki - DESY Test Beam Coord

		TB21	
	Week		DATURA
7-Jan-19	2		
14-Jan-19	3		
21-Jan-19	4		
28-Jan-19	5	Startup	
4-Feb-19	6	CMS-Pixel-Phase2	X
11-Feb-19	7	CMS-Pixel-Phase2	X
18-Feb-19	8	CLIC PIXEL	X
25-Feb-19	9	ELAD	X
4-Mar-19	10	ATLAS-X0	X
11-Mar-19	11	CMS-Pixel-Phase2	X
18-Mar-19	12	CMS-Pixel-Phase2	X
25-Mar-19	13	TBMST	X
1-Apr-19	14	ACDC	
8-Apr-19	15	CMS-Pixel-Phase2	X
15-Apr-19	16	CMS-Pixel-Phase2	X
22-Apr-19	17	Setup Time	
29-Apr-19	18	ATLAS-ITk-Strips	X
6-May-19	19	CMS Outer Tracker	X
13-May-19	20	CMS Outer Tracker	X
20-May-19	21	CMS-Pixel-Phase2	X
27-May-19	22	CMS-Pixel-Phase2	X
3-Jun-19	23		
10-Jun-19	24	CLIC PIXEL	X
17-Jun-19	25	TBMST	X
24-Jun-19	26	CMS-Pixel-Phase2	X
1-Jul-19	27	CMS-Pixel-Phase2	X
8-Jul-19	28	GammaMeV	X
15-Jul-19	29	CLIC PIXEL	X
22-Jul-19	30	X-Ray-Crystal-Rad	X