Summary of WP7 activities

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AIDA-2020 Kick-off meeting

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Objective and tasks of WP7-NA6 (I)

- Define technological guidelines for the production of advanced silicon pixel sensors for HEP tracking and timing applications.
- Improve access to a pool of specialised foundries for the production of planar and 3D sensors
- Optimize the technology of Low Gain Avalanche Detectors (LGAD), for tracking and timing applications
- Validation of the produced sensors

Task 7.1 Scientific coordination (MPG-MPP, CSIC-IFCA)

Task 7.2 TCAD simulations (CERN, INFN-PG, INFN-TIPFA, INFN-TO)

- Optimize the design of thin 3D and planar pixel cells compatible with the new read-out chips in 65 nm CMOS technology (50x50 um^2 and 25x100 um^2 for LHC applications, 25x25 um^2 for CLIC)
- Understand the low gain avalanche mechanism in LGAD sensors
- TCAD model for the description of radiation damage in silicon detectors

Objective and tasks of WP7-NA6 (II)

Task 7.3 Common process optimisation for hybrid pixel sensors (FBK, CSIC-CNM)

- Development of the production process for 3D, LGAD and planar pixel sensors on thinned substrates
- Processing of inter-experiment Multi-Project Wafer runs

Task 7.4 Detector validation for tracking devices (CERN, MPG-MPP, INFN-FI, INFN-MI, UNIMAN)

- Characterization of 3D and planar hybrid pixel sensors with laboratory measurements and beam-tests

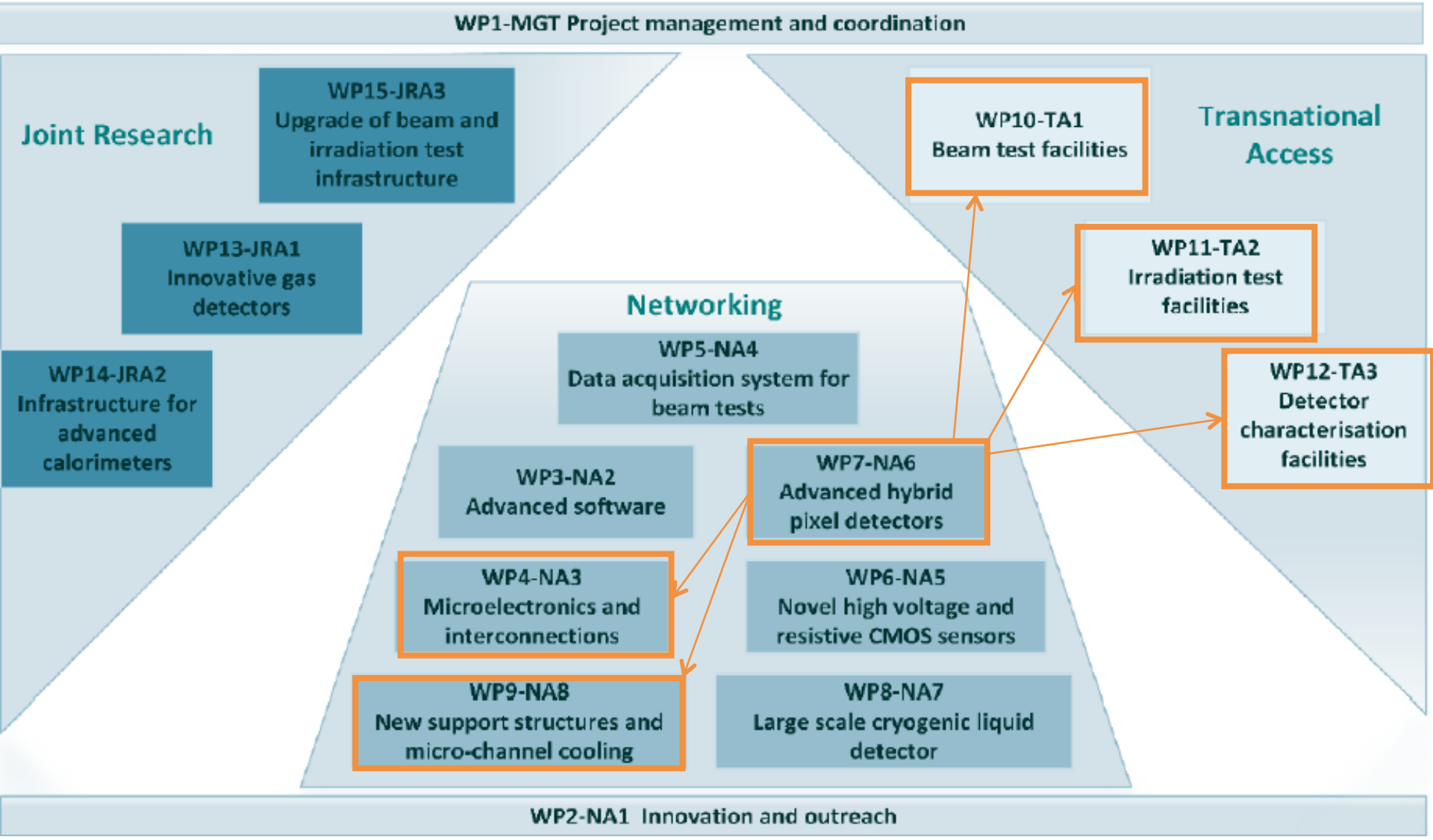
Task 7.5 Detector validation for LGAD sensors (INFN-TO, CSIC-IFCA)

- Characterization for the LGAD detectors in terms of charge collection and time resolution

Deliverables table WP7

Deliverable	Responsible Group	Month due
D7.1 Simulation of 3D pixel sensor cells	INFN	M18 (OCT 2016)
D7.2 Simulation active edge	CERN	M18 (OCT 2016)
D7.3 LGAD simulation	INFN	M18 (OCT 2016)
D7.4 TCAD model radiation damage	INFN	M46 (MAR 2019)
D7.5 Wafer Layout MPW run WP7	CSIC	M30 (NOV 2017)
D7.6 Initial pixel characterization	UNIMAN	M24 (APRIL 2016)
D7.7 Final pixel characterization	MPG-MPP	M46 (MAR 2019)
D7.8 LGAD characterization	INFN	M46 (MAR 2019)

AIDA 2020 Dependencies WP7 – WP4 – WP9



Dependencies WP7 – WP4 – WP9

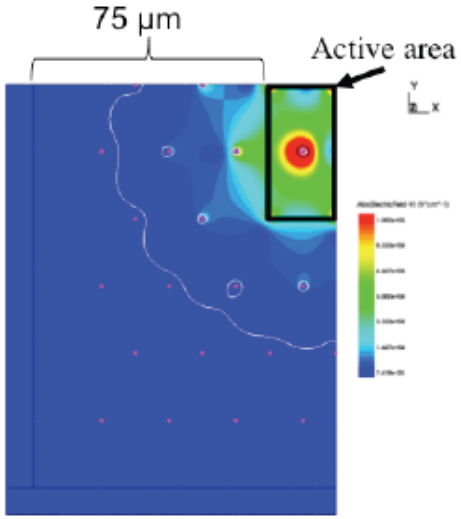
- **WP4**: most of our deliverables are connected to the production of the RD53 full scale demo chip.
  - Final ATLAS and CMS Phase II chips will be probably too late for the sensor MPW run
  - From Jorgen Christiansen presentation at the LHCC meeting on 3rd of June: demo chip submission mid-end 2016 → well compatible with deliverable on MPW runs design by end 2017
  - Timely availability of chip samples of this production is key ingredient to the success of WP7 activities
- **WP9** : power dissipation of pixel modules in the inner layers at the end of life of the detectors is still an open challenge for the design of the cooling systems. Micro-channel cooling could be a possible solution → collaborate with WP9 efforts
- We share with **WP6** common production and characterization issues: interconnection, irradiations, test-beam

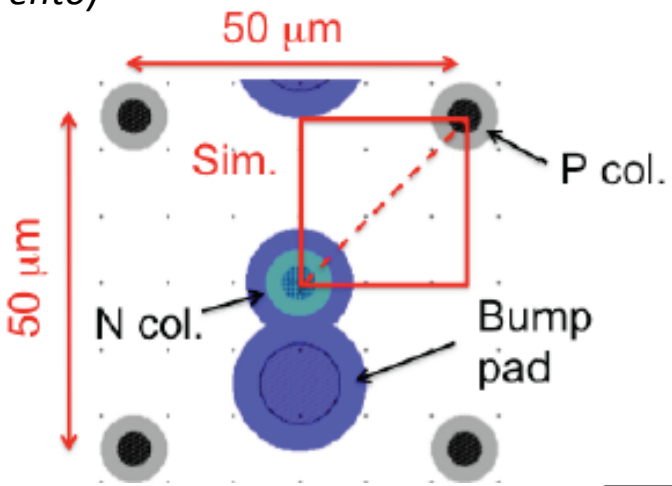
Beyond the deliverables: additional networking activities

- **Task 7.2 Simulation**
  - Detailed comparison of process simulation results with standardized pixel cells
  - Identify set of data from irradiated sensors for simulation validation
  - Build a set of common test-structures to be implemented in future production
- **Task 7.4 and 7.5 Detector Validation**
  - Work in collaboration with WP4 to facilitate the interconnection of the MPW sensor productions
  - Sharing of available pixel read-out systems, profiting from the joint development of a single chip for ATLAS and CMS in the RD53 collaboration
  - Common irradiation and organization of WP7 test-beams possibly starting already from 2016 → interact with WP10-TA1

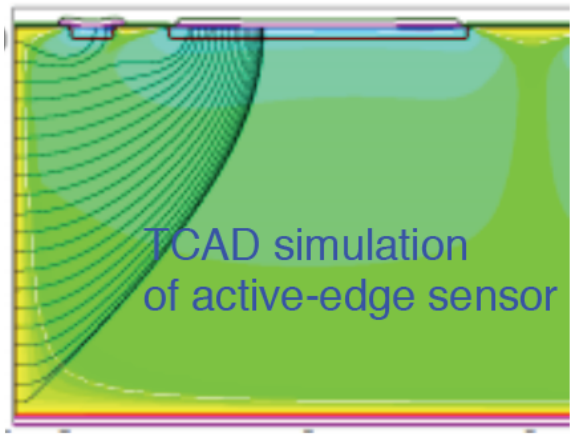
Activities ongoing towards Deliverables (I)

Simulation of active edge for 3D and pixel cells with a pitch compatible with the RD53 chip (Trento)





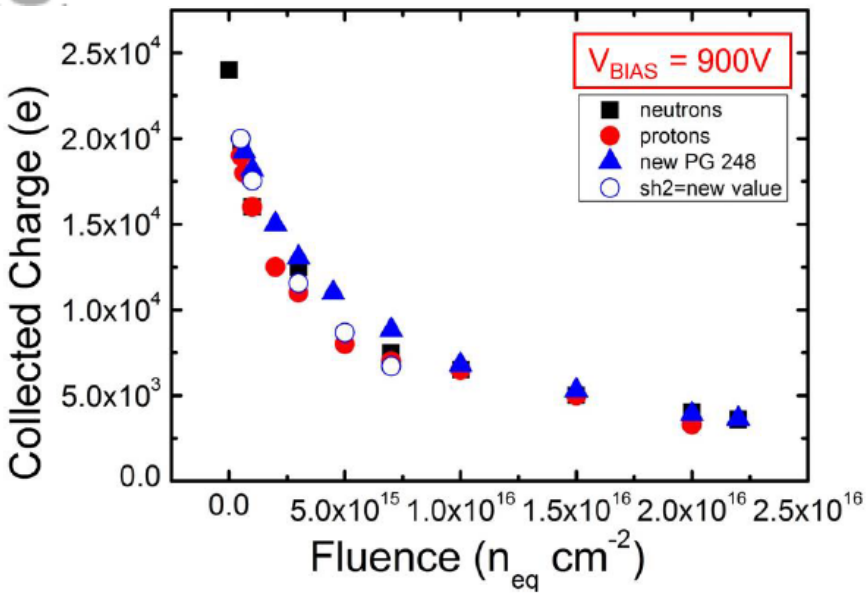
Simulation of active edge for planar sensors (CERN-LCD)



❑ Task 7.2 Simulation

TCAD modelling of device behaviour with fluence (Perugia) → extend the predictive capabilities to HL-LHC fluences (Perugia)

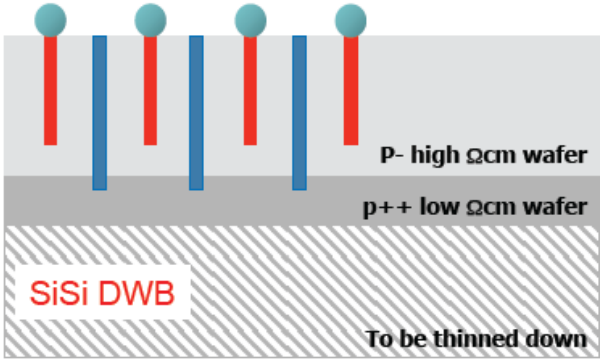
Comparison with literature data/ dedicated measurements

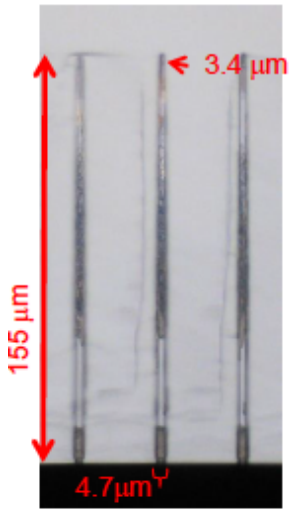


Activities ongoing towards Deliverables (II)

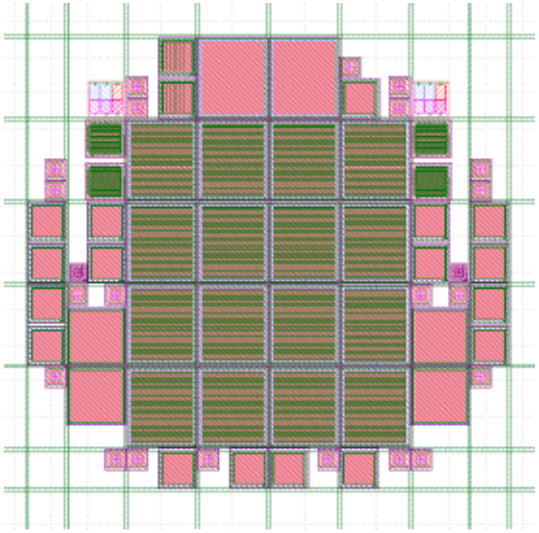
❑ **Task 7.3** Process optimization for hybrid pixel sensors

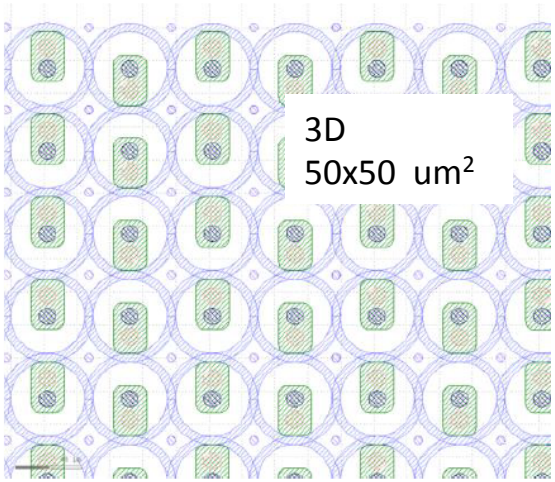
FBK technological tests for 3D sensors on 6" Si-Si or SOI wafers → reduction of column diameter to 5 um



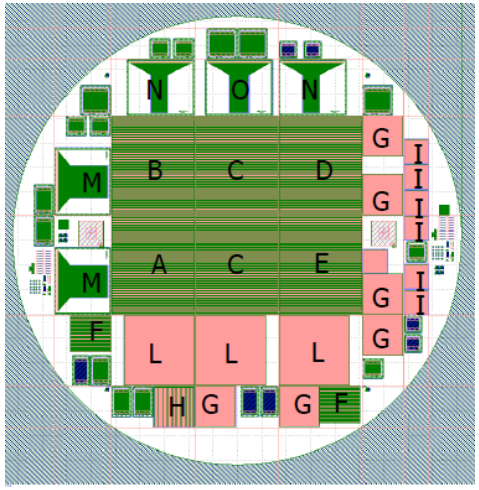


CNM joint 3D production (ATLAS, CMS, LHCb) with 50x50 um² sensors, cryogenic deep etching to achieve 5 um columns



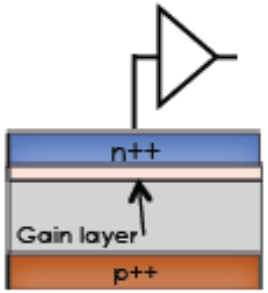


CNM planar production on 6" SOI wafers



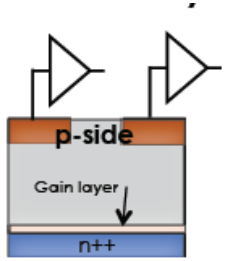
Activities ongoing towards Deliverables (III)

- **Task 7.2+7.3** Simulation and optimization of LGAD sensors

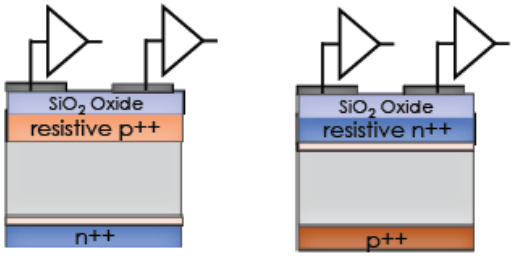


standard

Investigation of alternative designs for LGAD sensors to achieve gain on pixelated devices (Torino)

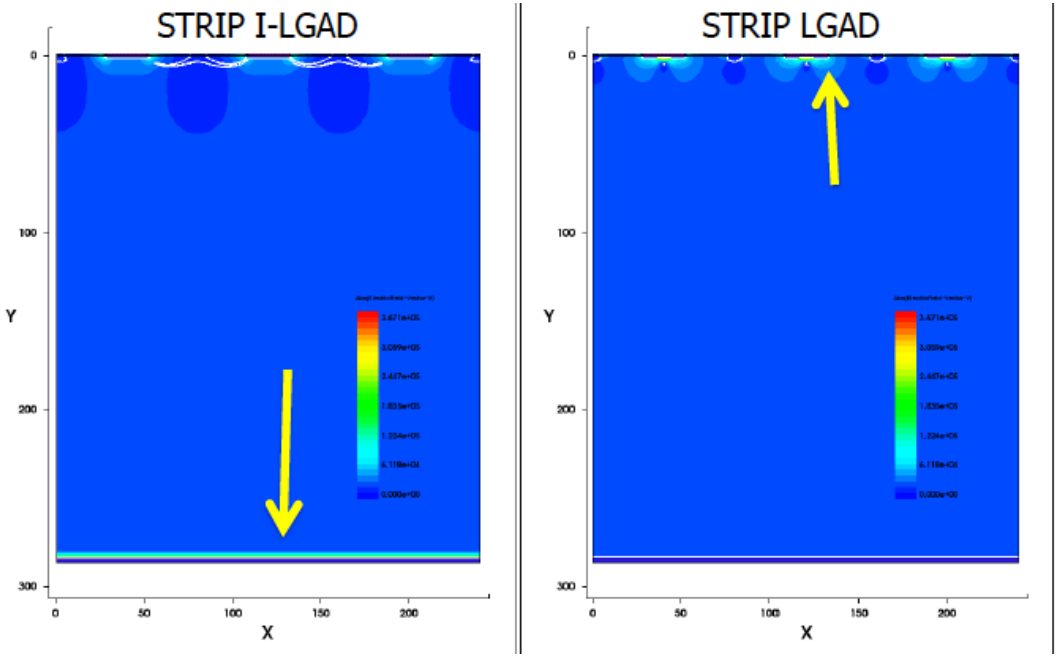


p-in-p, Ohmic side segmentation



AC segmentation via resistive n++/p++ layer

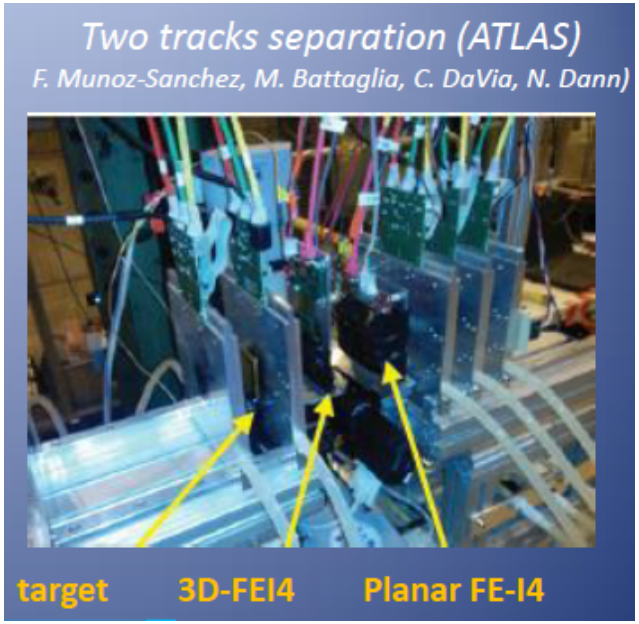
2D TCAD simulation of electric field in standard and "inverted" LGAD strip sensors (CSIC)



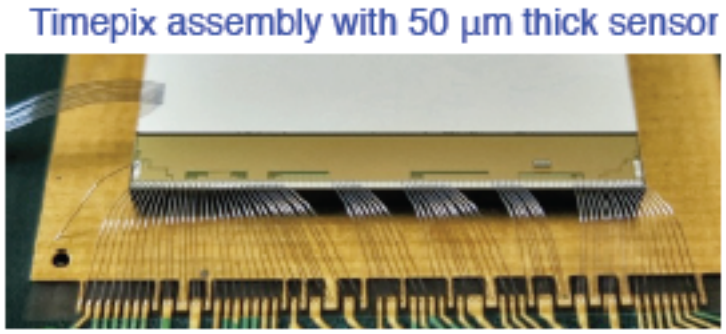
Activities ongoing towards Deliverables (IV)

❑ **Task 7.4+7.5** Detector validation

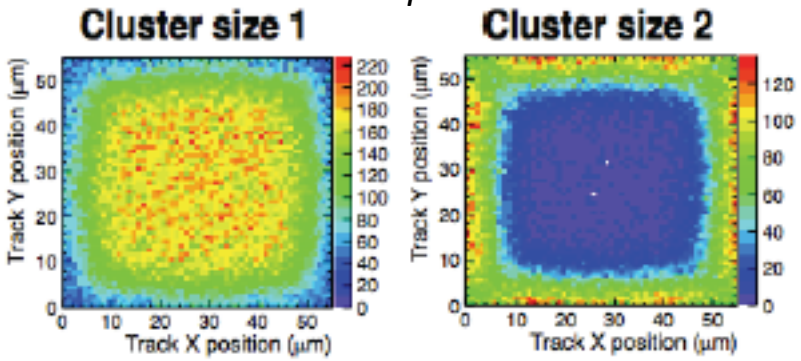
Intense characterization activity on-going with prototype 3D and planar hybrid pixel modules: laboratory measurements and beam tests



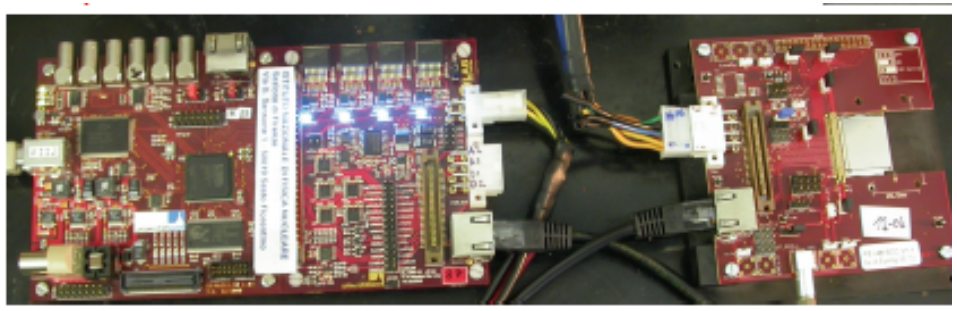
Investigation of ultra-thin hybrid pixel modules for CLIC (CERN-LCD)



Timepix



Study of powering options for pixel modules (Firenze)



Organizational matters
To do list

- Proposal of holding 5 Vidyo meetings a year in addition to the annual AIDA-2020 meeting
- 2 Workshops will be organized in the second year as foreseen by the milestones to discuss technological choices for the production of:
  - thin 3D and planar sensors in the MPW runs
  - LGAD for timing and tracking applications
- Define contact persons responsible for each of the tasks
- Collect expression of interests of the groups to collaborate on particular tasks beyond their official responsibilities
- List the collaborating groups in addition to WP7 beneficiaries

Conclusions

- Main outcomes of the kick-off meeting:
  - **Detailed review** of the **activities** and **interests** of beneficiaries.
  - **No uncovered items** concerning the work-package implementation (task, deliverables, milestones)
- Absolute need to maintain a constant exchange of information across WP7, WP4 and WP9
- Many of our deliverables are strongly dependent on the timely availability of the full scale RD53 demo chip
- Wp7 is composed by highly motivated groups with complementary expertise in the field, the networking activities promise to help us to overcome the challenges ahead of us!