Status of the ITS O2 code

- **ITS detector geometry**
- **Simulations:** Transport, ALPIDE response, digitization
- **Reconstruction:** Cluster finding, cluster-topology code, track finding (see Maximiliano's slides)
- **Quality Control & event display**
- **Calibration & alignment**

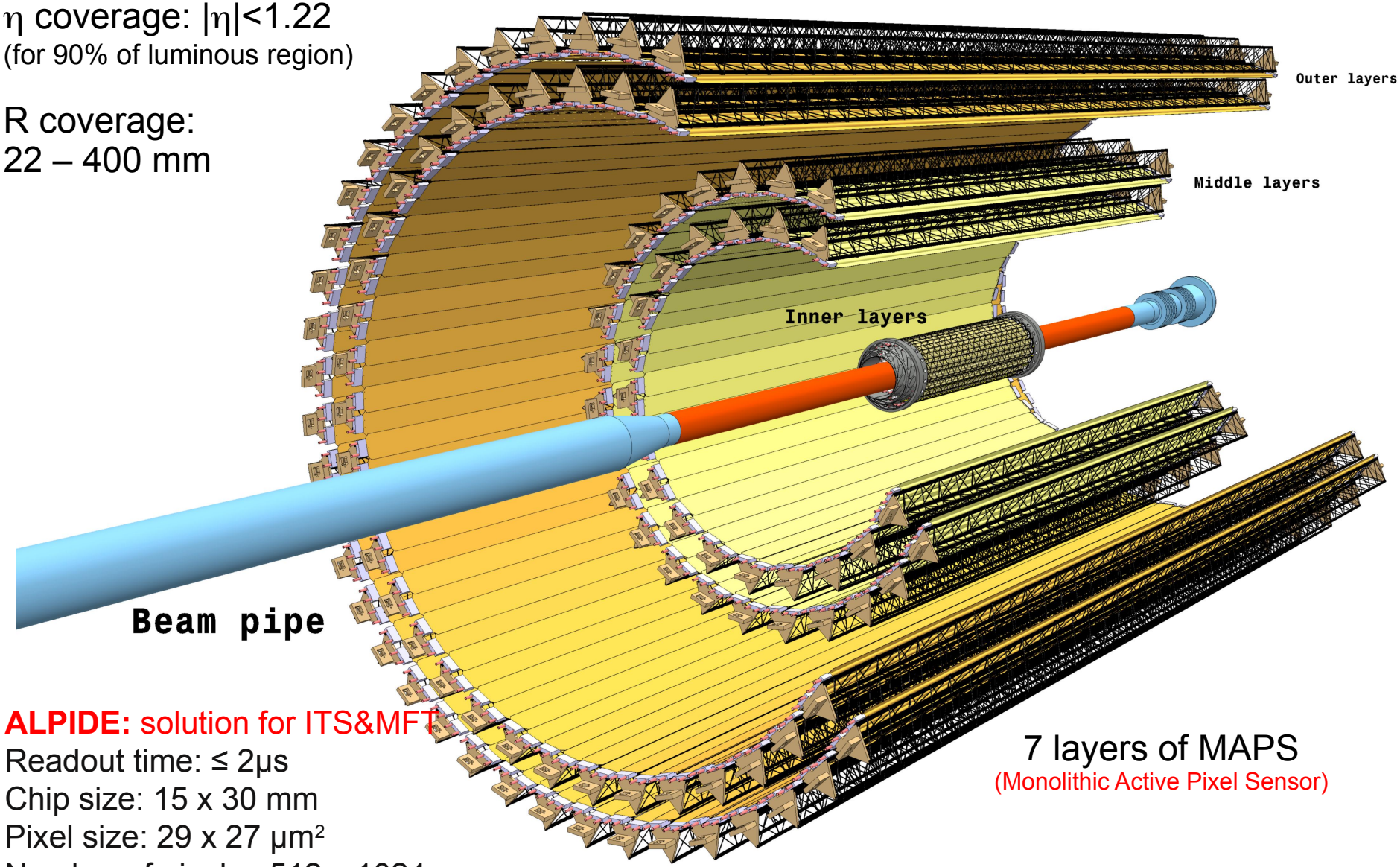
Layout of the upgraded ITS

12.6 G-pixel camera
(~10 m^2 of Si, ~13.6M CHF)

ALICE

η coverage: $|\eta|<1.22$
(for 90% of luminous region)

R coverage:
22 – 400 mm



ALPIDE: solution for ITS&MFT
Readout time: ≤ 2μs
Chip size: 15 x 30 mm
Pixel size: 29 x 27 μm^2
Number of pixels : 512 x 1024

7 layers of MAPS
(Monolithic Active Pixel Sensor)

End-of-2017 view on the ITS code

- **Geometry:**
  - Operational
  - Remaining details and changes in the HW design being implemented
  - Alignable volumes coming this year (will be the same as in AliRoot)

    Next year: Sagging degrees of freedom, services outside the physics acceptance
- **Simulation:**
  - “Box” particle generator
  - MC transport with Geant3
  - ALPIDE response using the output of external “microscopic” chip simulations
  - Time-aware digitization: triggered and continuous mode

    (to be finalised: strobe boundaries, access to the params in CDB)

    Next year: Try also (multi-threaded) Geant4 ?

    Synchronization with other detectors in continuous mode ?

End-of-2017 view on the ITS code

- **Reconstruction:**
  - Cluster finder (the same for the MC and real data)
  - Code to handle the cluster shapes (being ported from AliRoot)
  - Track finders
    - CookedTracker (“classical”, CPU) : functional, reasonably fast, multi-threaded
    - CATracker (“Cellular Automaton”, CPU and GPU) : see Max’s presentation
  - MC labels decoupled from clusters and tracks, written to a separate branch, can optionally be suppressed

    Next year: Development of the CATracker, cluster compression, Cluster class based on shapeID and expernal LUT, wrapping the reconstruction code in “O2 devices”
- **Quality Control & Event Display:**
  - An initial estimate of the ITS QC requirements sent to the O2 WP7
  - A simplified representation of the ITS geometry for the Event Display provided to the O2 WP9

    Next year: All the rest
- **Calibration and alignment:**

  Next year: Everything

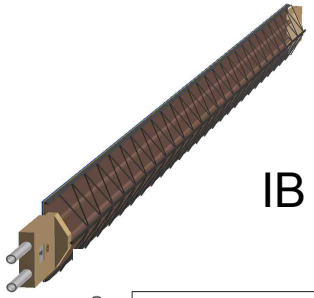
Tasks & Manpower

	Task	Contact	People	When
2	General ITS geometry	Mario Sitta	Parinya	--> 2017
3	Sagging geometry	Cristina Bedda	Mario, Ruben	2018
4				
5	ALPIDE simulation	Davide Pagano	Stefano, Germano, Enrico	--> 2017
6	Time dependent digitiser	Ruben Shahoyan		2017
7				
8	Time dependent clusteriser	Ruben Shahoyan		2017
9	Cluster finder (CPU)	Iouri Belikov		2017
10	Cluster finder (FPGA) ?	Anisa Qazi ?		
11	Cluster topology	Luca Barioglio		2017 -->
12				
13	CA tracker (CPU, GPU)	Maximiliano Puccio		2017 -->
14	CA tracker (GPU)	Iacopo Colonnelli		2017 -->
15				
16	Primary vertex finder	Matteo Concas		2018
17				
18	Compression of clusters			2018
19				
20	Calibration (noise, dead)			2018
21	QC & event display			2018
22				
23	O2 “devices”			2018

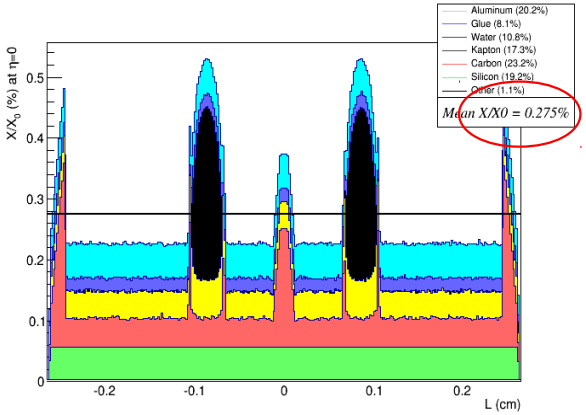
- 5 – 7 active developers (~50 people on the mailing list)
- New young people expressing an interest to join
  - Tsukuba, Japan (Kana Nakagawa)
  - Prague, Czech Republic (Artem Isakov)

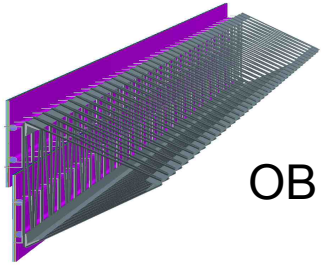
Supporting slides

ITS geometry for full simulation & reconstruction (Mario)

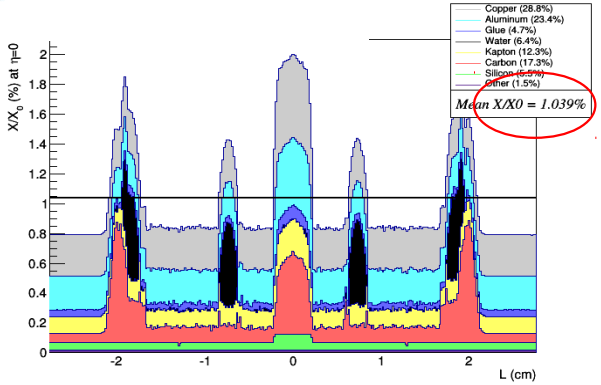


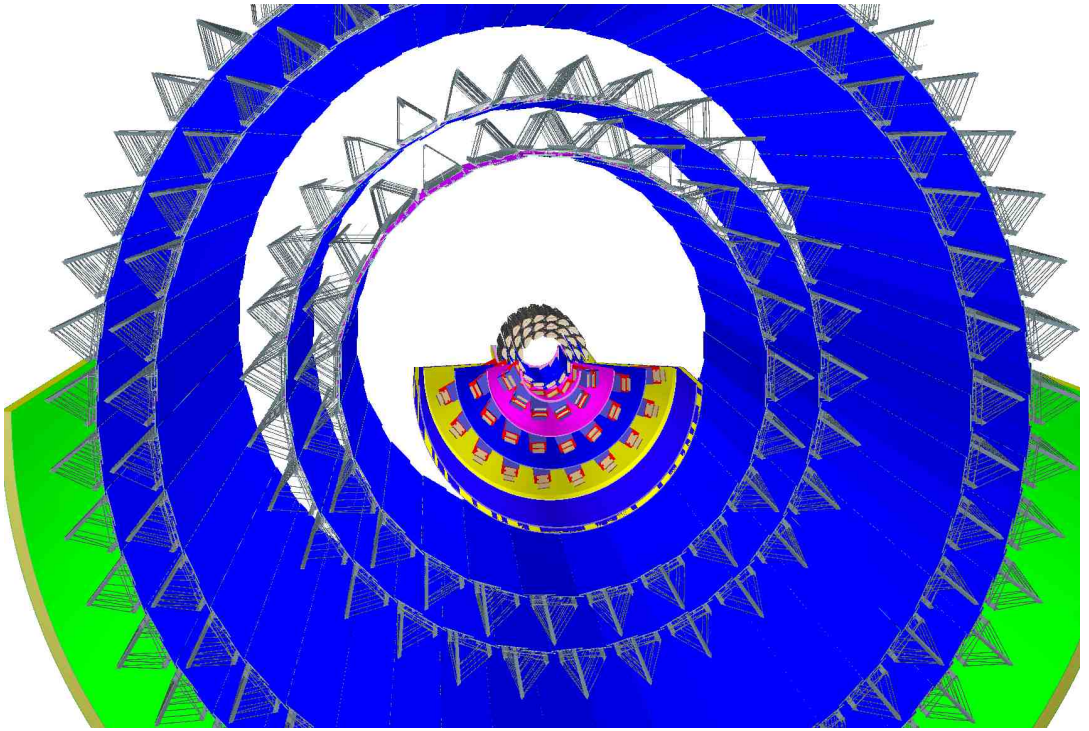
IB stave





OB stave



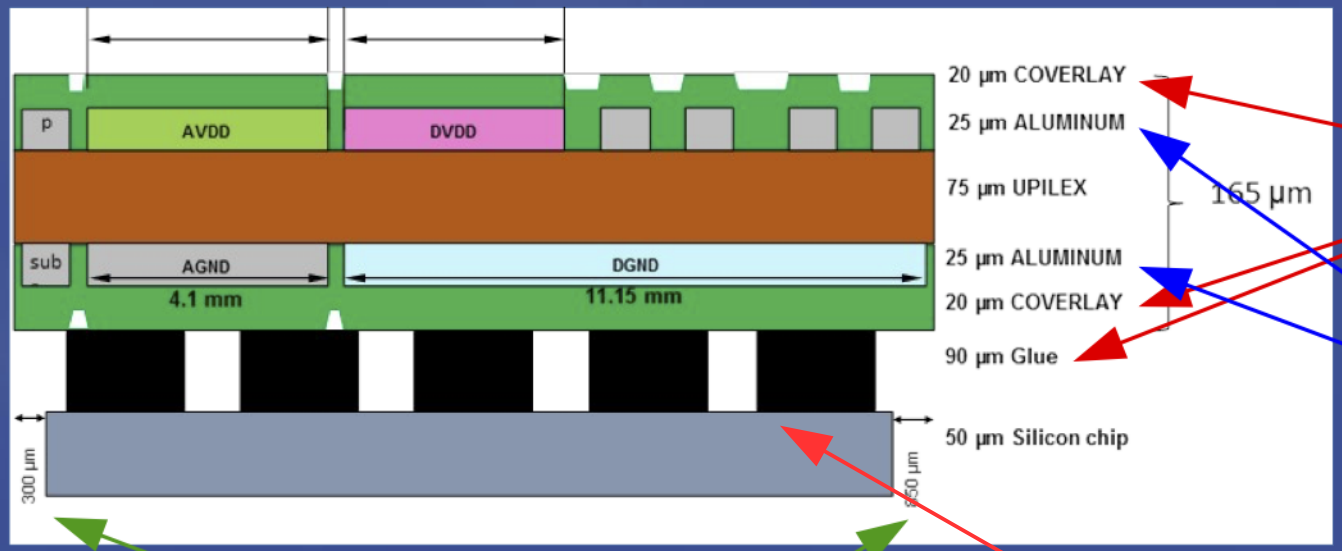


Very detailed and close to the final state.
But, no alignment yet.

Updates in the ITS geometry
(Mario)

New IB Cross Section

Antonello, 5 Oct 17



Implemented

Splitted

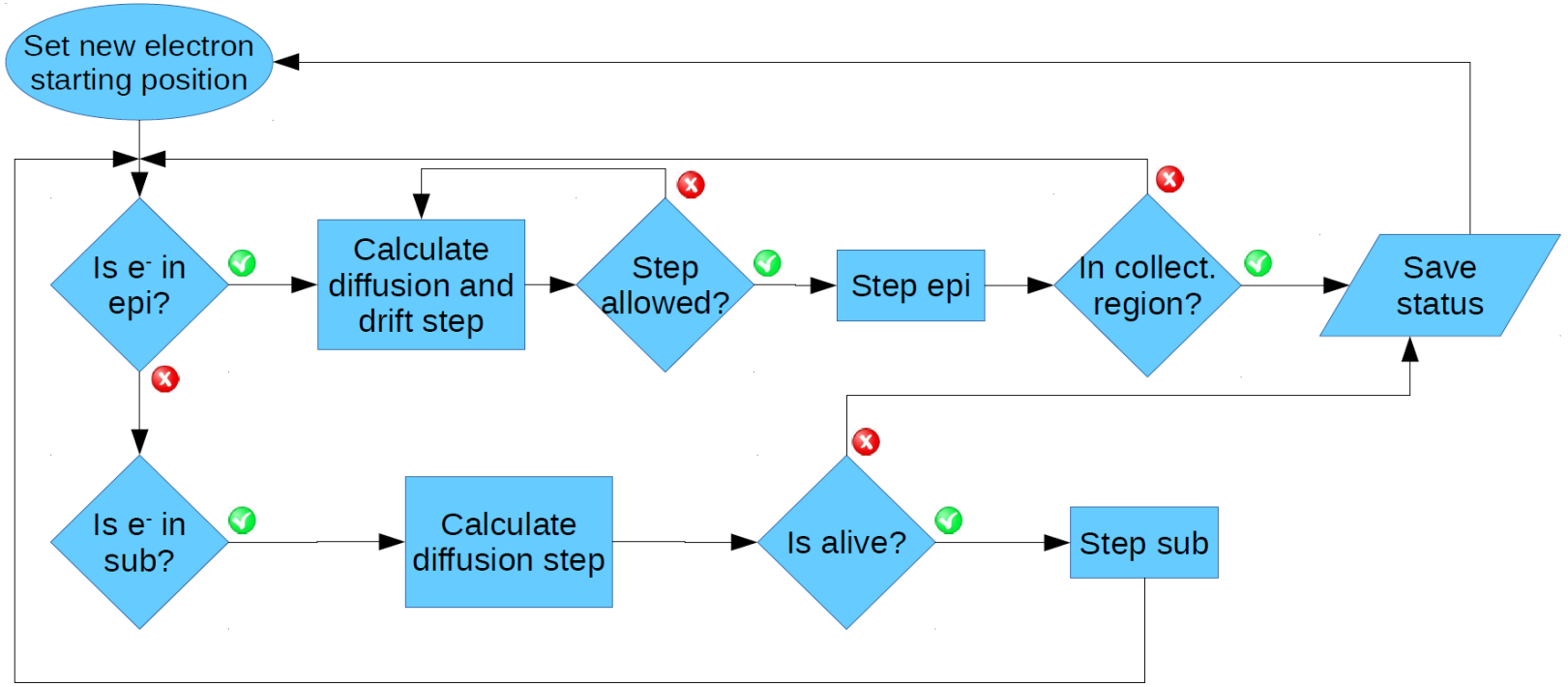
FPC is wider

Metal SiO_2 stack 15 µm

ALPIDE response

(Miljenko Šuljić, Jacobus W. van Hoorne)

Algorithm

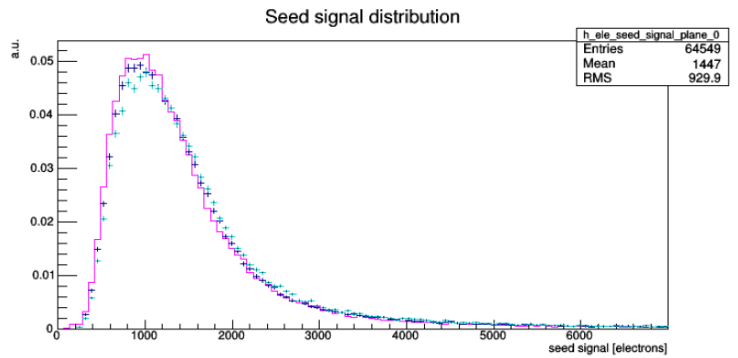


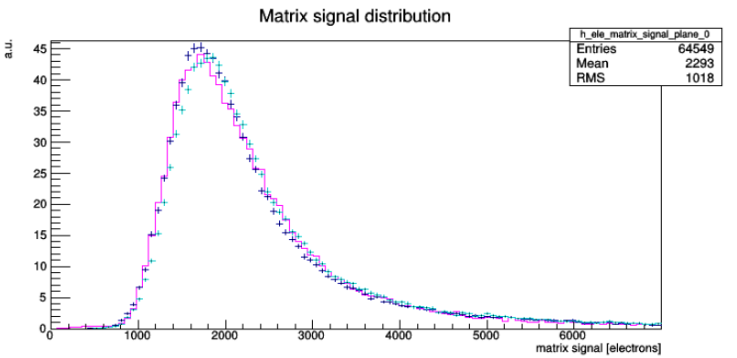
"Microscopic" simulations using the electrical field extracted from TCAD

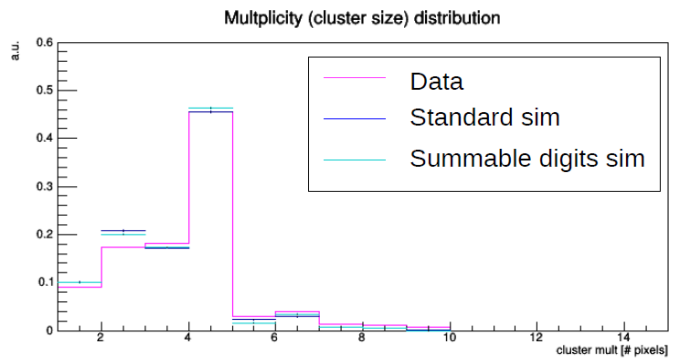
ALPIDE response compared with data

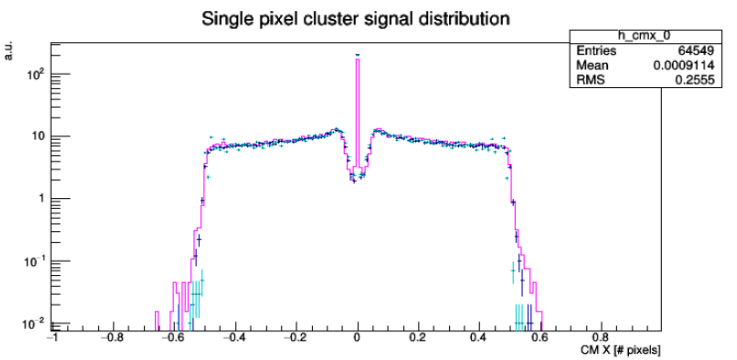
(Miljenko Šuljić, Jacobus W. van Hoorne)

MIP - 25 um epi, -3 V_{bb}, Investigator





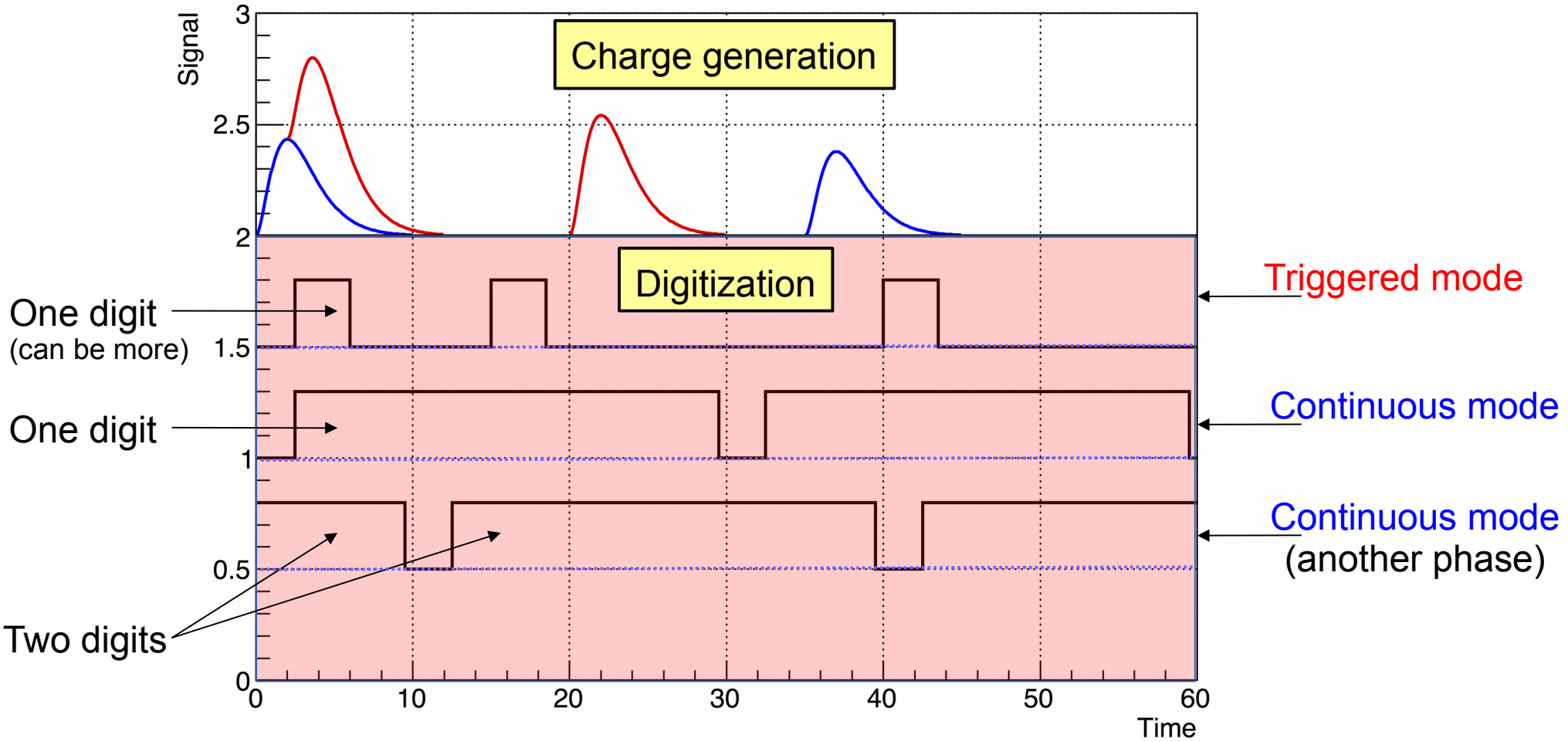




The agreement of both “microscopic” and “on-grid” simulations with the data is just amazing !

Time-aware ITS digitization

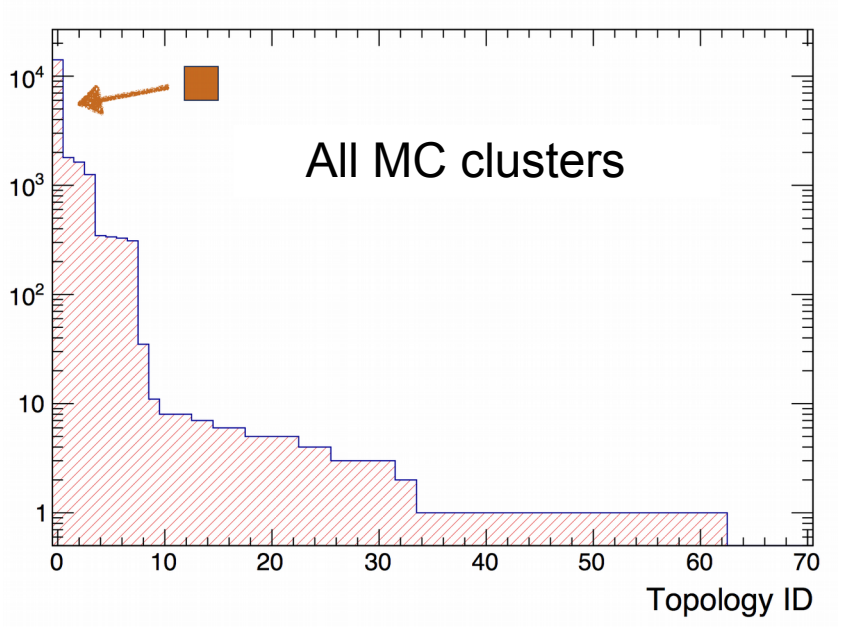
(Ruben)



At the end, we want to be able to generate the data in TimeFrame format

Porting the cluster-topology code

(Luca Barioglio)

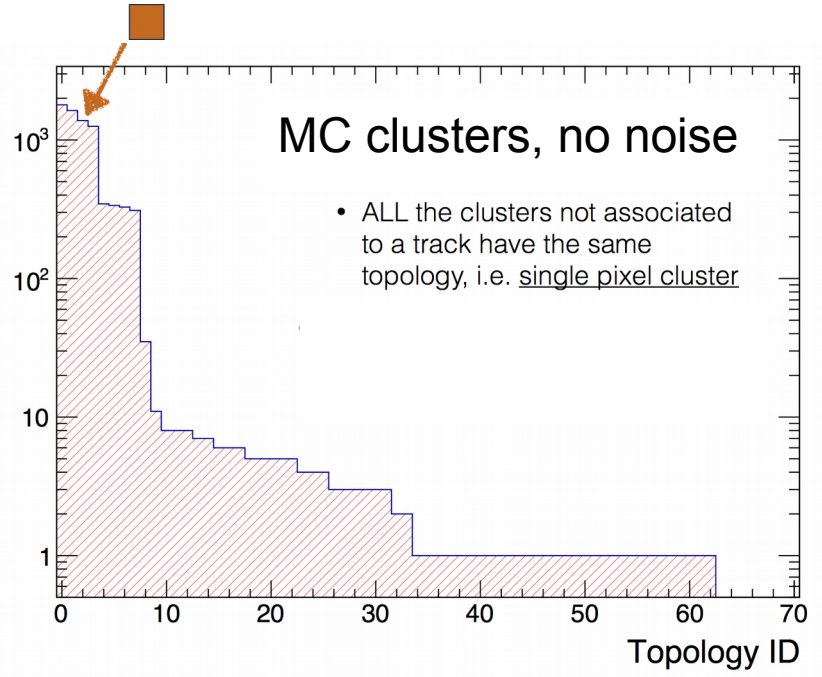


Topology	counts
	14106
	1793
	1631
	1254
	346
	337
	328
	310

Number of clusters: 20295

Topology	counts
	35
	11
	8
	7
	7
	6

Topology	counts
	6
	6
	5
	5
	5
…	…



Number of clusters: 7659 (noise: 12726)

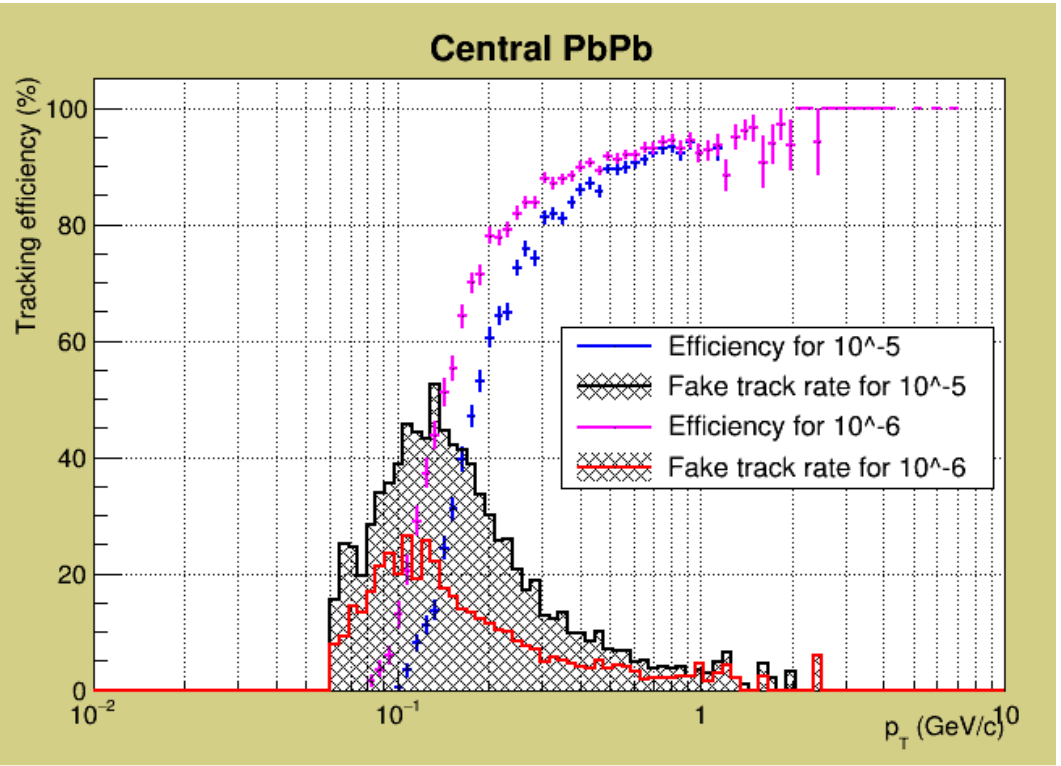
Topology	counts
	1793
	1631
	1380
	1254
	346
	337
	328
	310

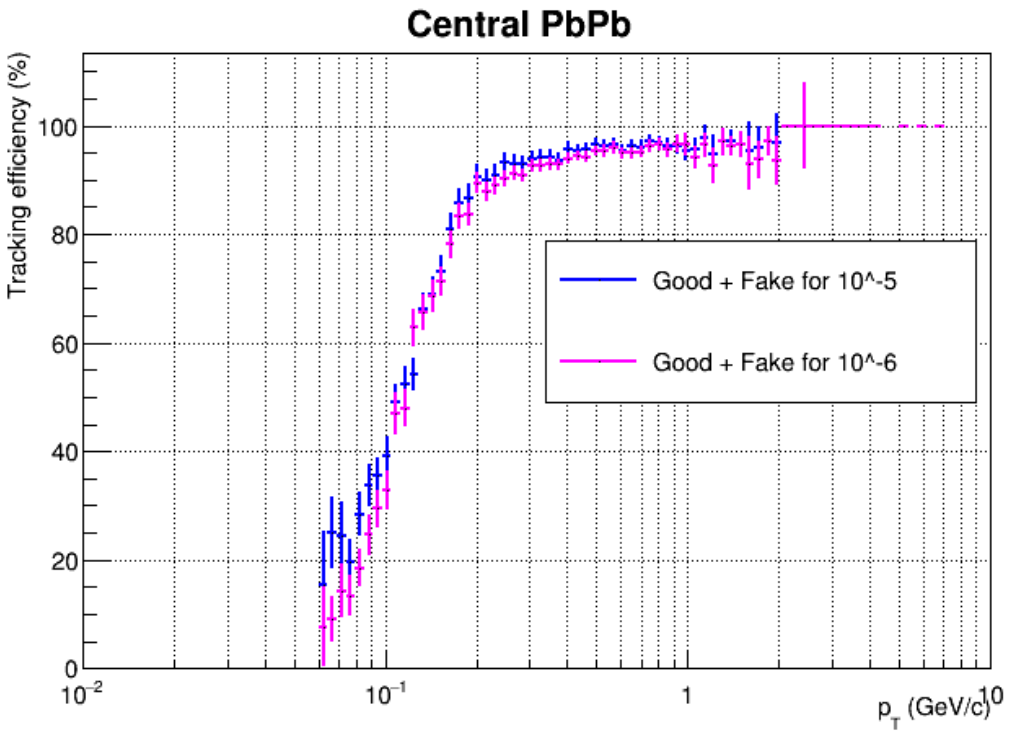
Topology	counts
	35
	11
	8
	7
	7
	6

Topology	counts
	6
	6
	5
	5
	5
…	…

Tracking time vs the level of noise (louri)

Number of fake hits: $12.6 \times 10^{9} \times 10^{-5} = 1.26 \times 10^{5}$ (compare: dN/dy ~2000 for central PbPb)





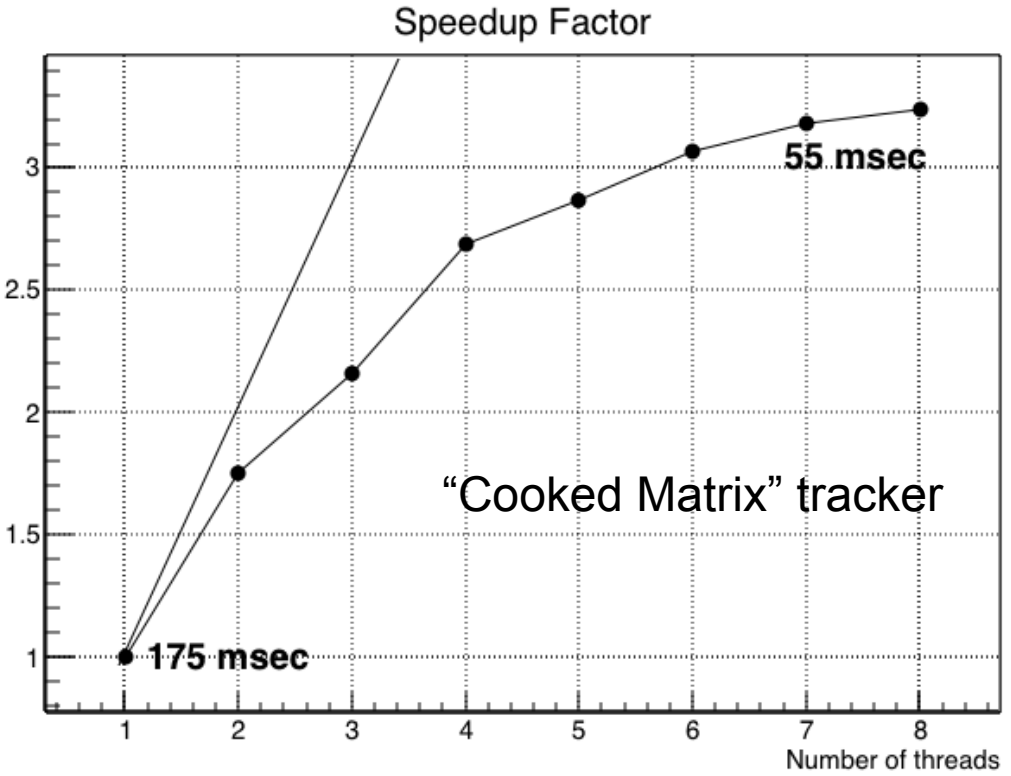
"Cooked Matrix" tracker:

- Noise "hit rate" 10^{-5} : real time 23 s/ev (4 threads on 4-core 2.66 GHz CPU)
- Noise "hit rate" 10^{-6} : real time 1.5 s/ev (4 threads on 4-core 2.66 GHz CPU)

(Compare: the interaction rate is 50 kHz)

Tracking time vs # of threads (louri)

- **2011 mac, 2 GHz Intel Core i7**
  - 4 cores, 8 threads
- **4000 pions in |η|<0.9**
  - $0.2<p_T<2.0$ GeV/c, flat
  - No noise
  - Constant 0.5 T mag. field



C++11 multi-threading works !

Linux/gcc and macOS/clang

(bottle neck of the moment – cluster sorting)

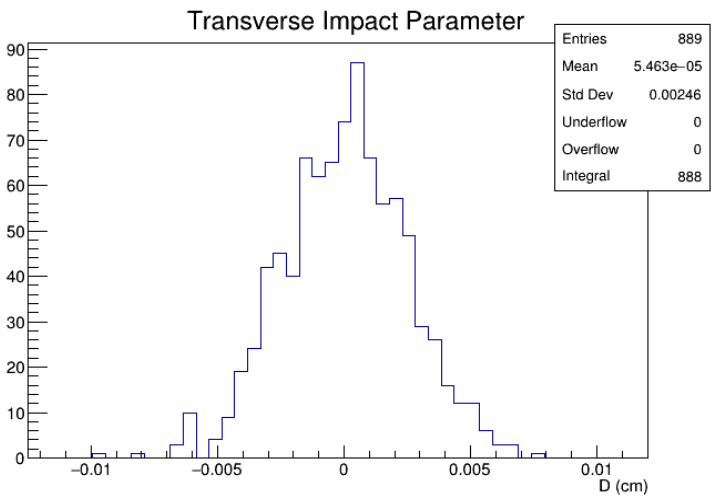
Comparison with MC (Iouri)

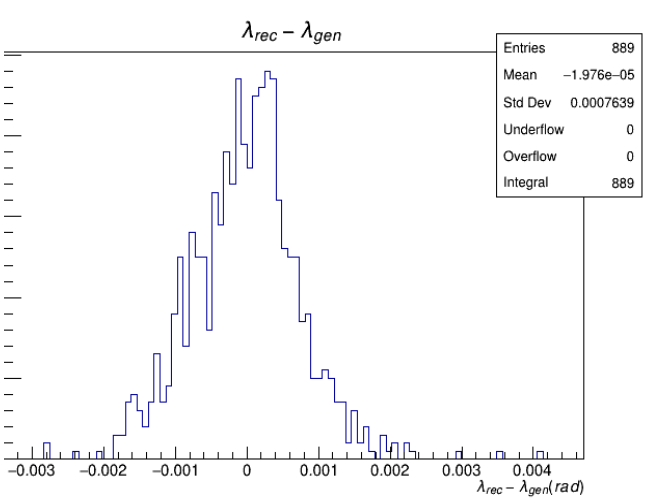
basic but functional

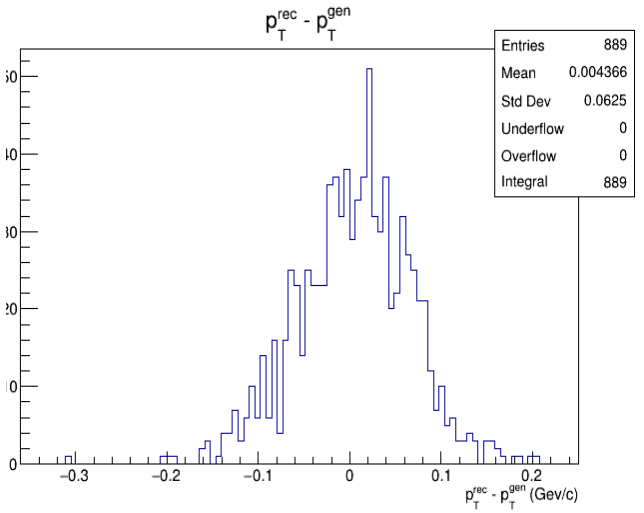
- Average tracking efficiency (7-cluster tracks):

```
Event 0/10
Good found tracks: 2897,  efficiency: 0.869187
Event 1/10
Good found tracks: 2888,  efficiency: 0.866487
…
```

- “rec – gen” plots (integrated over p_T) :







Upgraded ITS in AliEve

An event with 35 MC and 29+4 reconstructed vertices (ITSU stand-alone, Pythia6 @ 14 TeV)