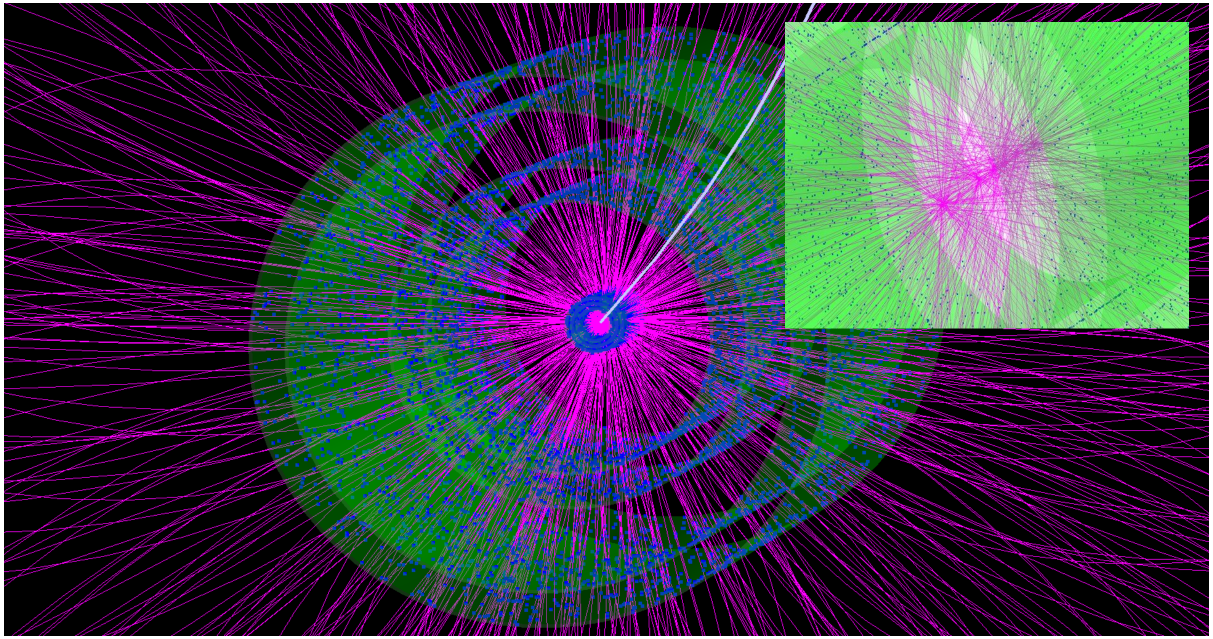
A Large Ion Collider Experiment

ITS Run3 sim & rec status

- **Detector geometry**
  - classical geometry
  - geometry with sagging
- **Simulations:**
  - ALPIDE response
  - digitization
- **Reconstruction:**
  - cluster finding
  - cluster-topology handling
  - Cellular Automaton track finding
- **Overall status & plans**



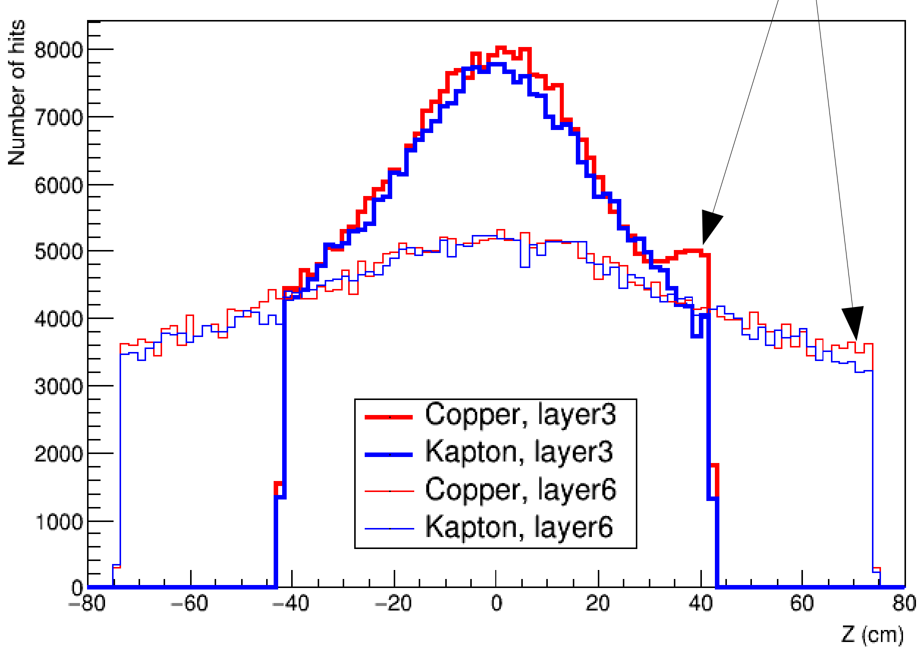
ALICE Offline Week, CERN, 05.12.2018, Iouri Belikov & Massimo Masera

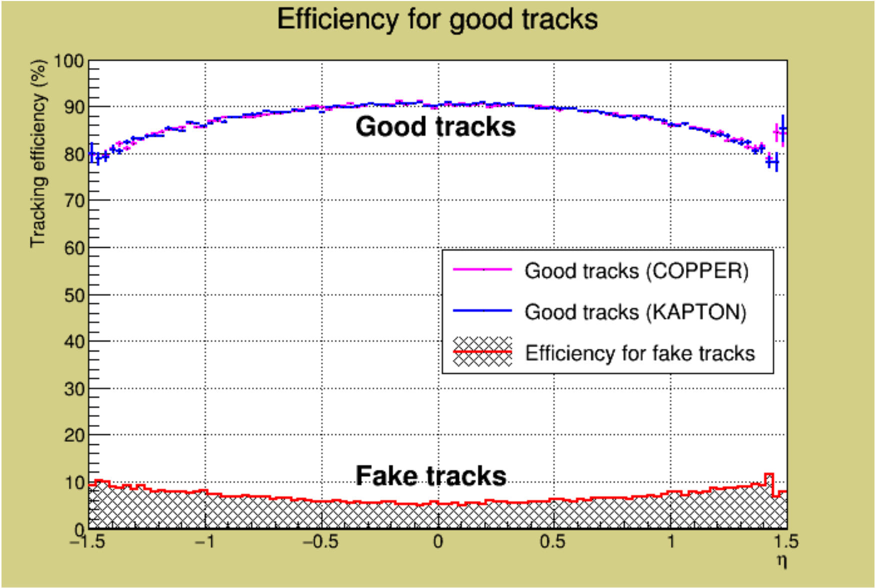
"Classical" geometry

- Fully operational, down to FPC details in the acceptance
- Services (support wheels → patch panels) to be implemented

Checked with old (DCDC) services in AliRoot:
very little impact on the reconstruction

~5% hits more, if "all is copper"



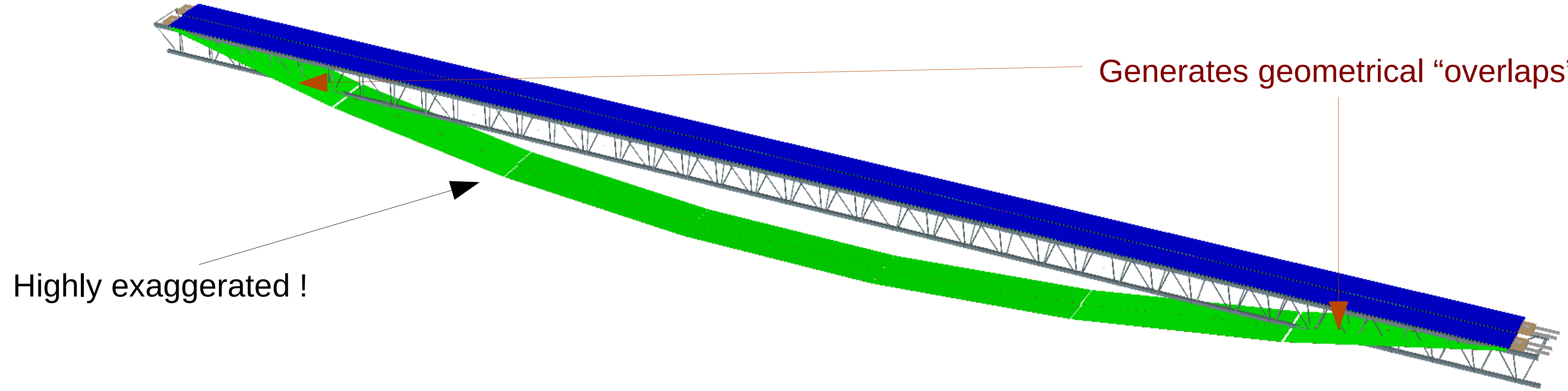


Geometry with sagging

- **To be implemented in 2019**
- **However, we may already say:**
  - Angular and impact parameter resolutions at the primary vertex do not change
  - Marginal deterioration of the momentum resolution
  - The angular track parameters at the outermost layer are slightly affected
  - The positional track parameters change according to the magnitude of sagging (~80 μm at z=0)
  - The ITS standalone tracking efficiency does not change
  - The TPC-ITS track-matching efficiency should not be dominated by sagging (to be demonstrated)

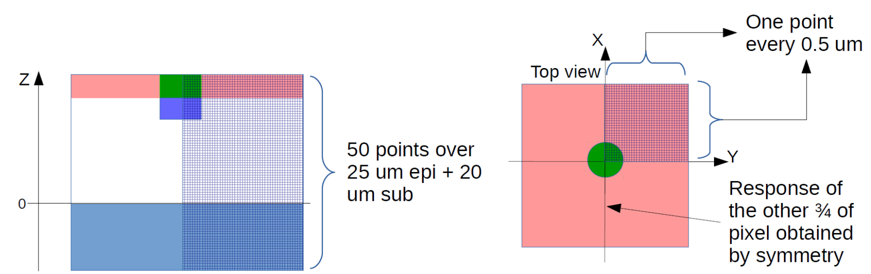
The results obtained with a modified version of the “classical” geometry:

- OB modules shifted and rotated according to expected sag deformations (z and ϕ dependent)
- Good for a quick look at produced effects, but cannot be the final solution

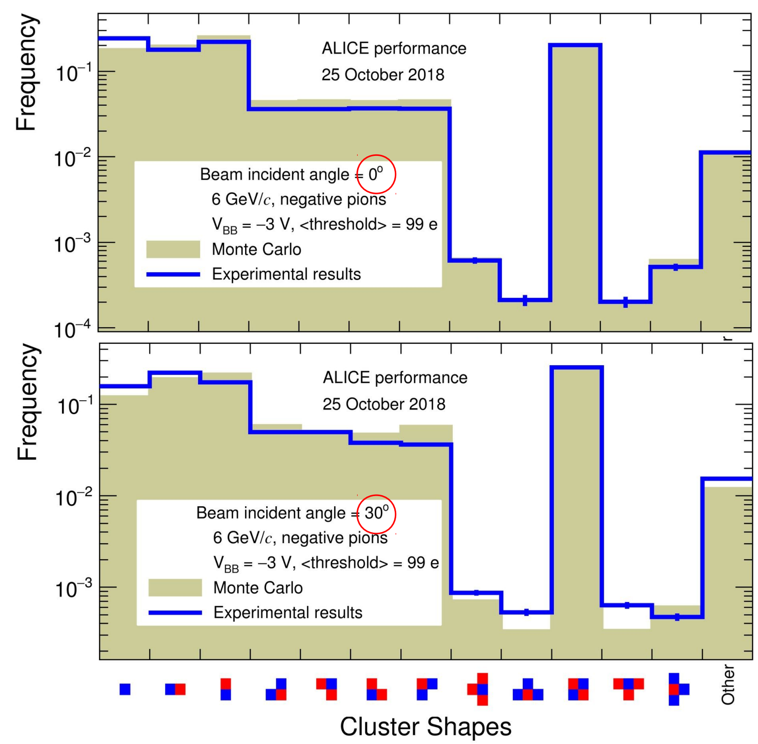


Simulated ALPIDE response

- **Input 3D tables extracted from external to O² simulations**
  - Tables: probability for an electron deposited at (x,y,z) to reach a collecting diode
  - Tables for V_{bb}=-3V provided and successfully used in MC productions
  - Tables for V_{bb}= 0V coming early in 2019



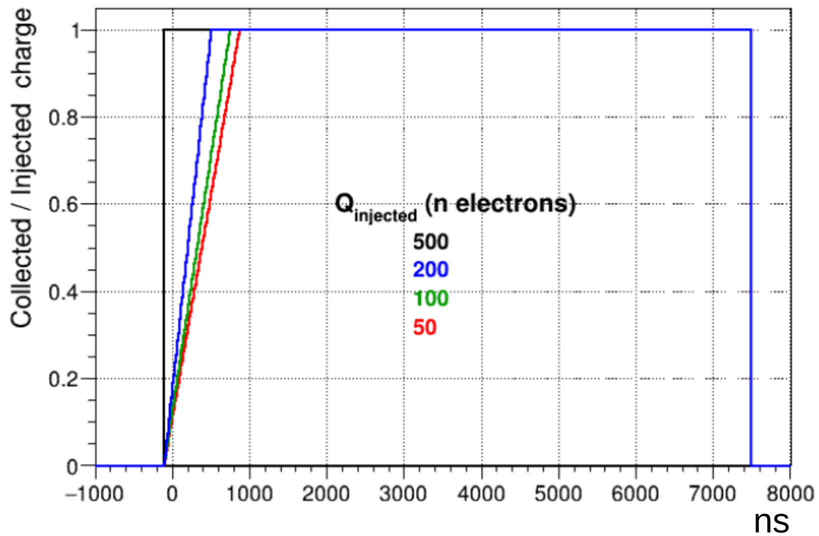
- **The tables are queried when digitizing Geant hits**
  - Electrons distributed along particle trajectories inside sensitive Si
  - "Collection" by pixels in accordance with the provided probability tables
  - Works quite well for MIPs in a wide range of track inclination angles
  - To be checked for highly ionizing particles



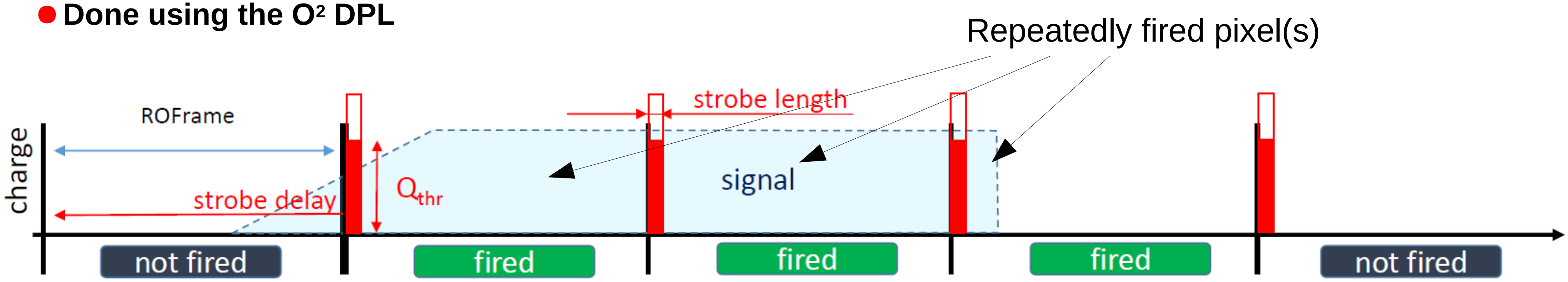
Common code with MFT

Digitization

- **An effective time response applied as a function of the number collected electrons**
  - Extracted from actual measurements
- **The output of the time response compared with a threshold and a strobe**
  - The threshold, strobe delay and length are parameters
  - Additional parameter for continuous readout: time interval between strobes



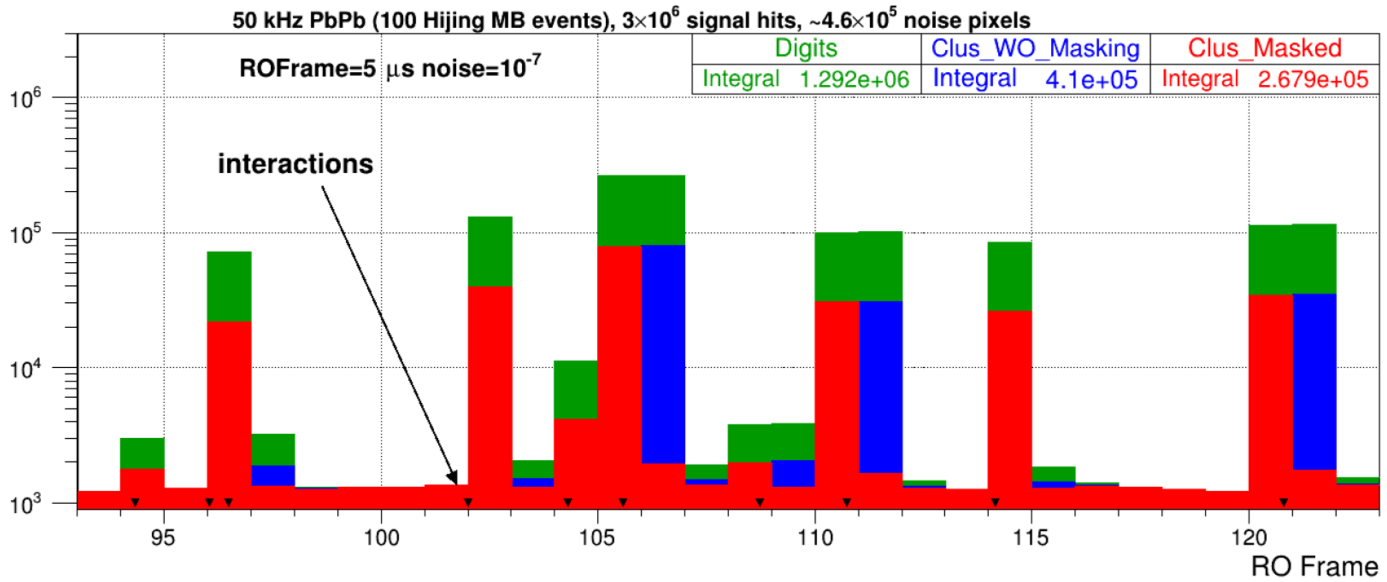
- **Done using the O^2 DPL**



Common code with MFT

Cluster finding

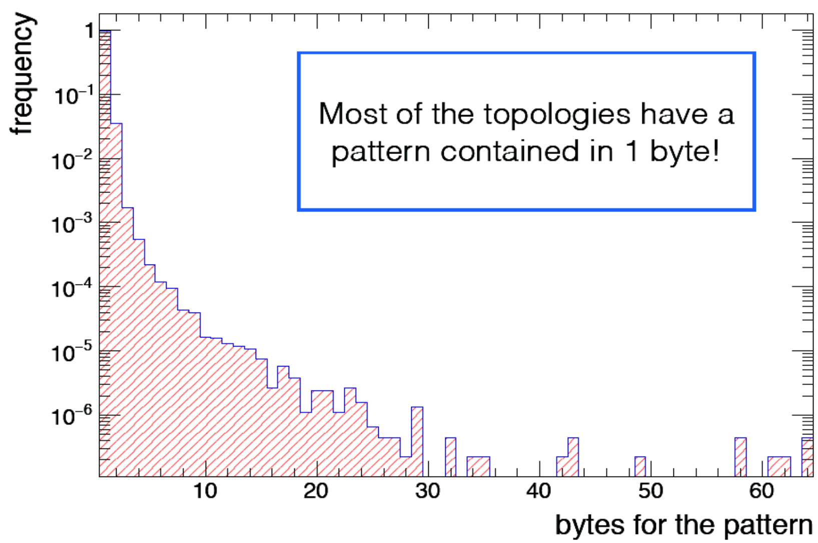
- **New : Treatment of repeatedly fired pixels**
  - Two buffers: “previous” and “current” readout frames
  - “Previous” used to mask the repeated pixels propagated to “current”
  - Virtually instant switching between the buffers (std::vector::swap)



Common code with MFT

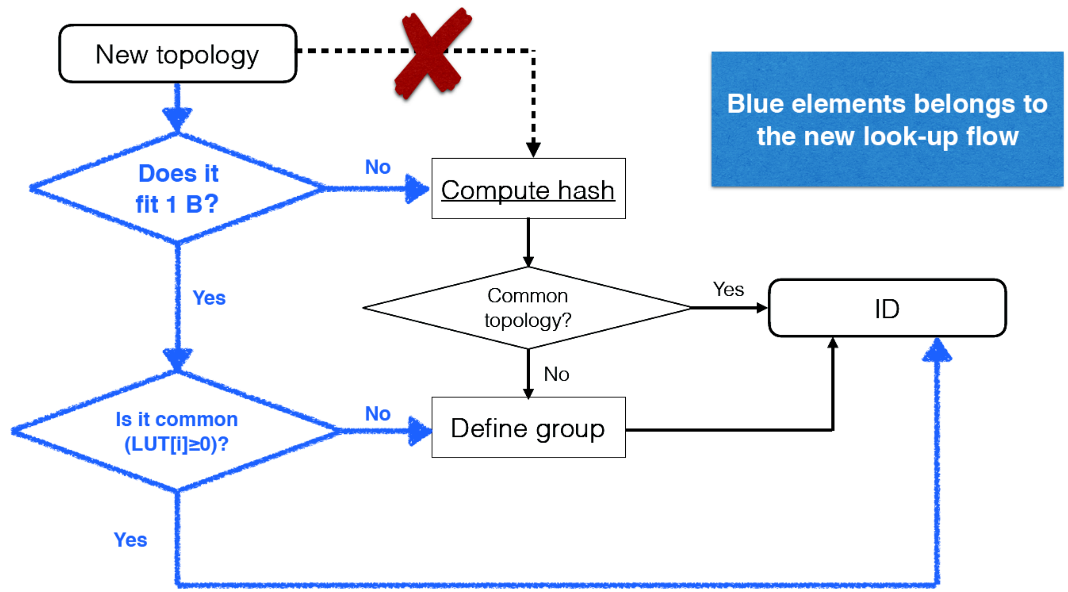
Cluster-topology handling

- Cluster objects (data volume ~ number of recorded events): {row,col} of ref. pixel + cluster ID
- LUT (fixed size): offsets with respect to the ref. pixel + σ's



Fraction of topologies with the bit pattern contained in N bytes

```
Up to 1 B : 0.961552
Up to 2 B : 0.997095
Up to 3 B : 0.998826
Up to 4 B : 0.999379
```

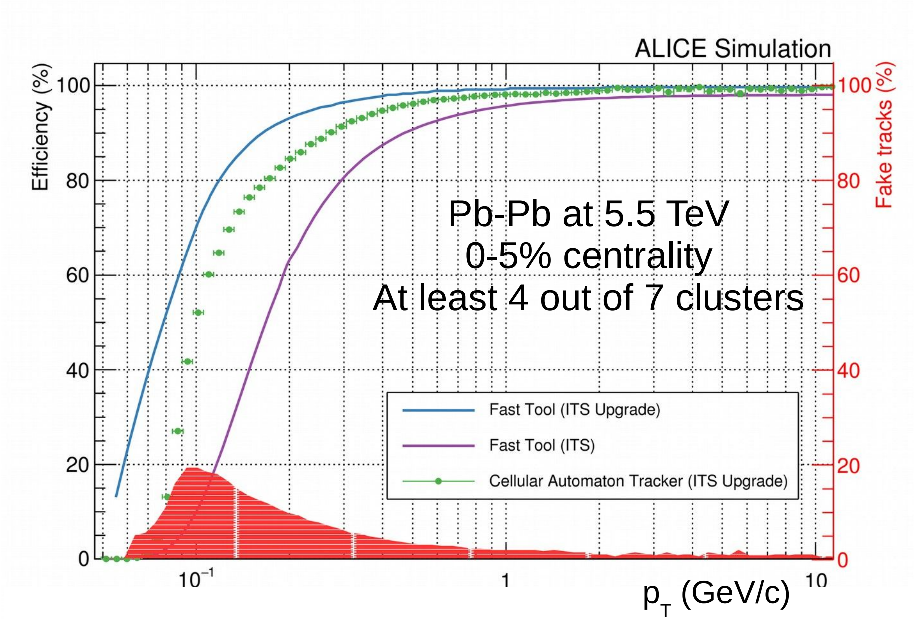


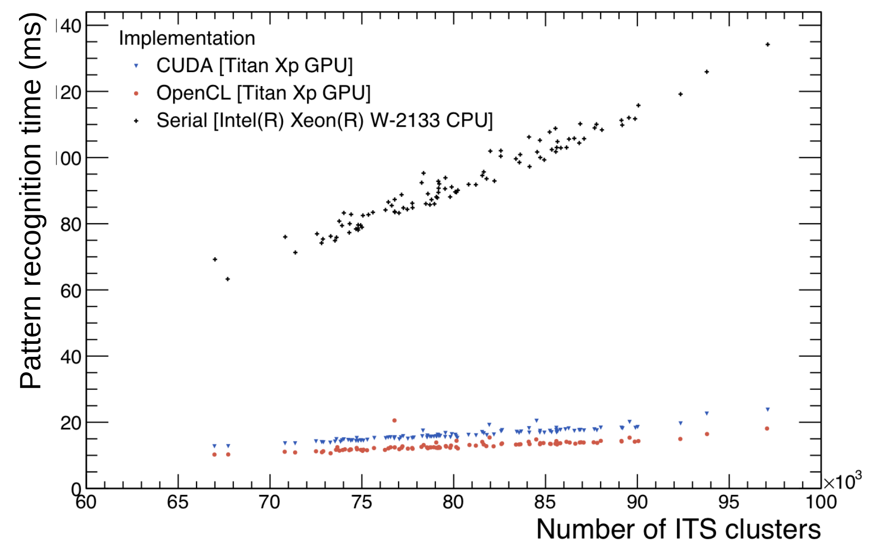
The new algorithm is more than 3x faster !
The time needed to identify the topologies is totally negligible compared with the CF time

Common code with MFT

Cellular Automaton track finding

- Work-in-progress development
  - Pattern recognition with **Cellular Automaton (CPU & GPU)**
  - Track fitting with **Kalman Filter (CPU, soon on GPU)**
  - Parts of GPU code common with the TPC
- Challenge: wrong cluster-to-track association at low p_T
  - Multiple scattering, fluctuations of energy losses...
- The **GPU** version is **2.5x – 5x** faster
  - The gain factor increases with the number of pileup events
- Can already be used for the on-line TPC calibration
  - Parameters tuned for high-p_T tracks



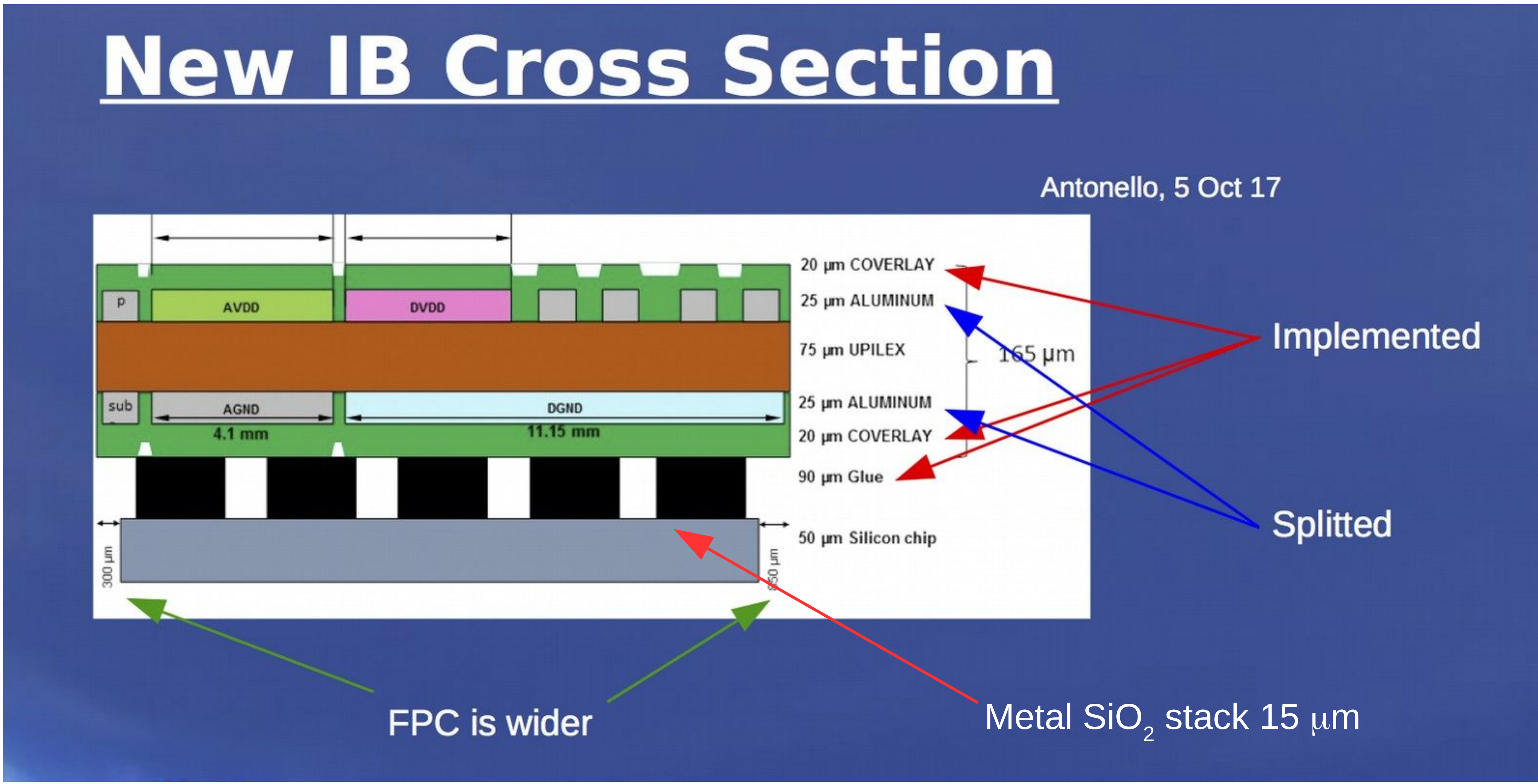


ITS O^2 overall status & plans

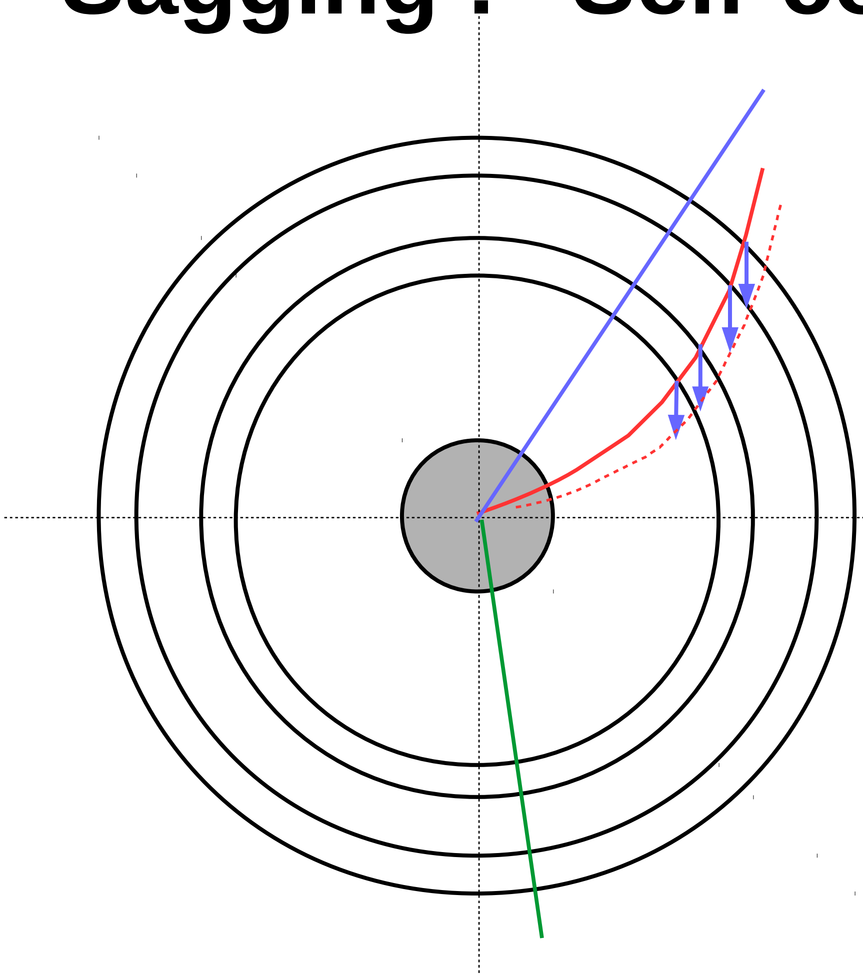
1	Task	Contact	People	When	Comments
2	General ITS geometry	Mario Sitta		Done	No services yet
3	Sagging geometry	Mario Sitta	Cristina Bedda	Q4 2019	
4					
5	ALPIDE response simulation	Artem Isakov	Miljenko Suljic	Q1 2019	Vbb=0 missing
6					
7	Time dependent digitiser	Ruben Shahoyan		Done	
8	Digitisation in DPL			Done	
9					
10	Raw data decoder	Ruben Shahoyan		Q4 2018	Ongoing discussions with WP10
11	Cluster finder (CPU)	Iouri Belikov	Ruben Shahoyan	Done	
12	Time effects in clusterisation	Ruben Shahoyan		Done	
13	Clusterisation in DPL			Q1 2019	
14	Cluster finder (FPGA)	Anisa Qazi ?		Done ?	Repetitive signal handling in FPGA ?
15	Cluster-topology handling	Luca Barioglio		Done	To be integrated with the Cluster Finder
16					
17	Primary vertex finder (CPU)	Matteo Concas	Ruben Shahoyan	Done	May need a new approach
18	Primary vertex finder (GPU)	Matteo Concas	David Rohr	Q2 2019	May take longer
19					
20	CA tracker (CPU)	Maximiliano Puccio		Done	
21	CA tracker (GPU)	Maximiliano Puccio	Matteo Concas, David Rohr	Q2 2019	
22	Tracking in DPL			Q2 2019	Connected with the primary vertexer in DPL
23					
24	Comparison with Monte Carlo	Arthur Gal	Iouri Belikov	Q4 2019	Sevice task (~30% of time)
25					
26	Event display			2019	Needed: Simplified geomety, data convertor
27					
28	Calibration (noise, dead)				
29					
30	Quality Control				

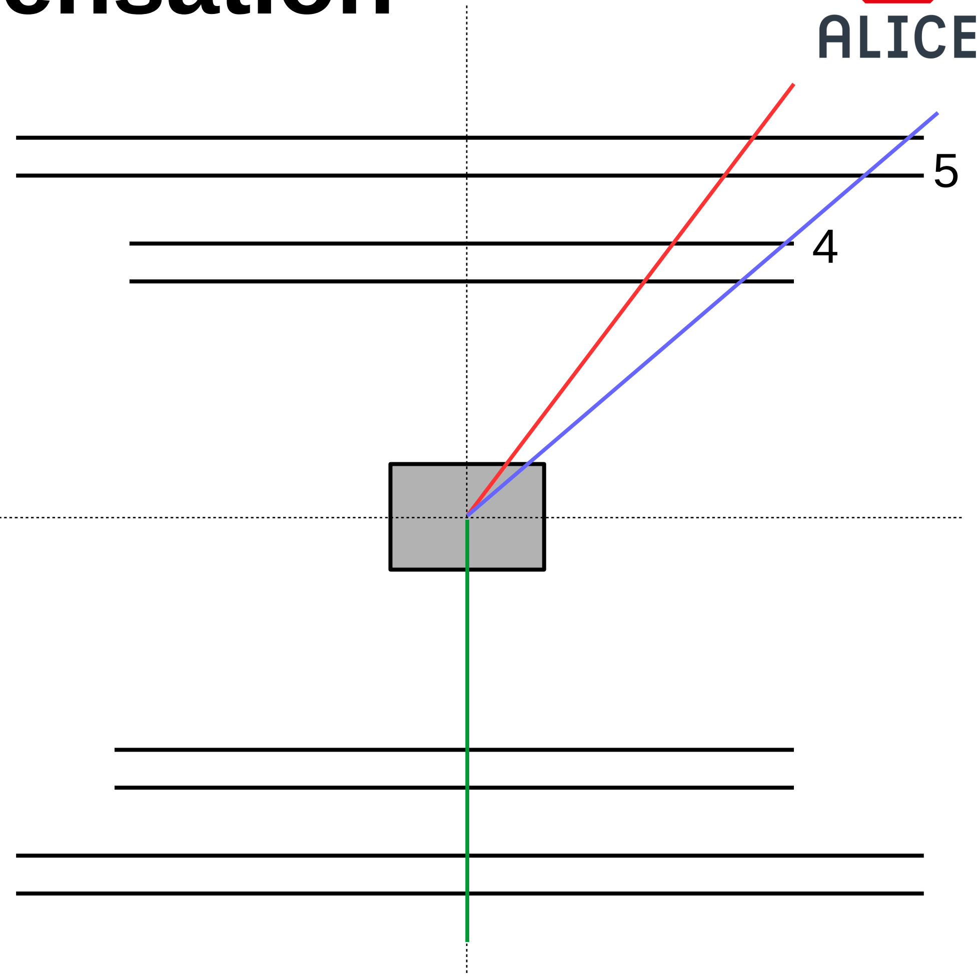
Backup slides

ITS geometry: down to FPC details



Sagging : "Self-compensation"





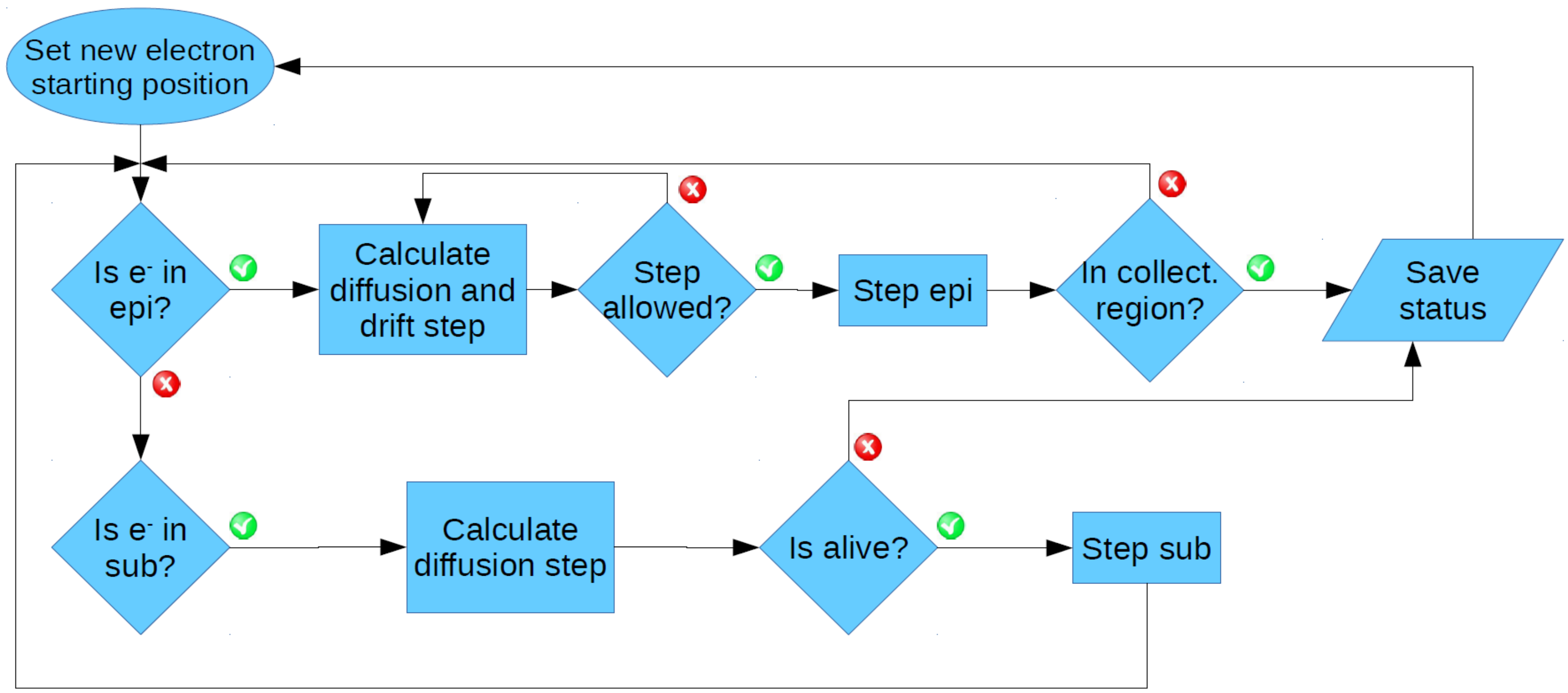
The **maximal sag** is f(ϕ).
Each track has its own maximal sag.
But this max sag is the same (ϕ ~ const) within this track. →
The track directions at the outer layer do not change (almost).

The **local sag** is f(ϕ,z).
The directions of the green track are not affected.
The directions of the blue track do get distorted.
But this distortion is not large, because the local sags are small.
The red track is the most affected.

ALPIDE response, external to O^2 part

(Miljenko Šuljić, Jacobus W. van Hoorne)

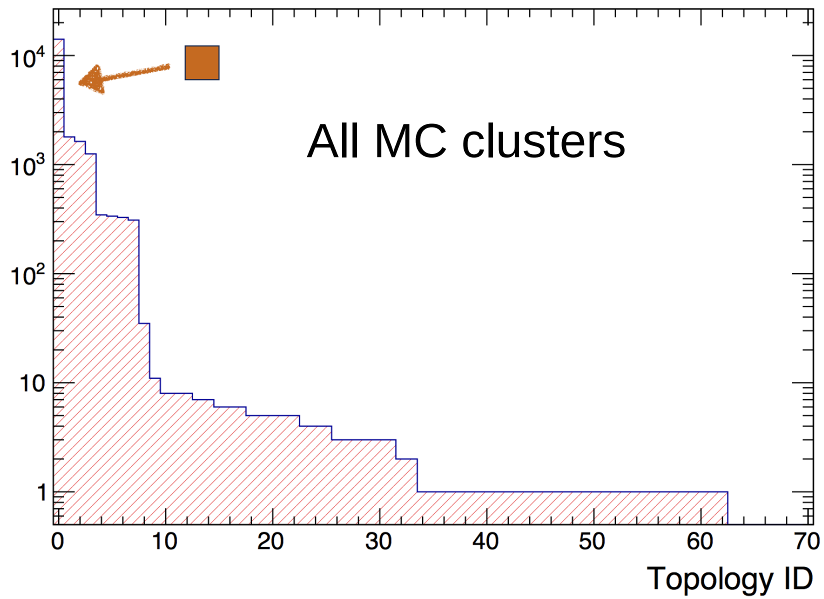
Algorithm



31/05/17 MAPS simulation - Miljenko Šuljić 13

“Microscopic” simulations using the electrical field extracted from TCAD

Cluster-topologies

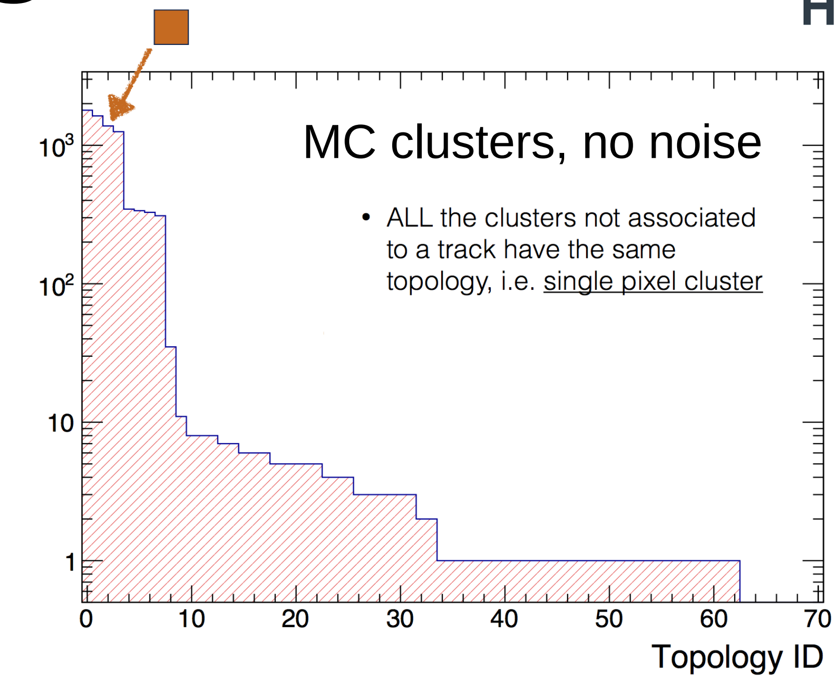


Number of clusters: 20295

Topology	counts
	14106
	1793
	1631
	1254
	346
	337
	328
	310

Topology	counts
	35
	11
	8
	7
	7
	6

Topology	counts
	6
	6
	5
	5
	5
…	…



Number of clusters: 7659 (noise: 12726)

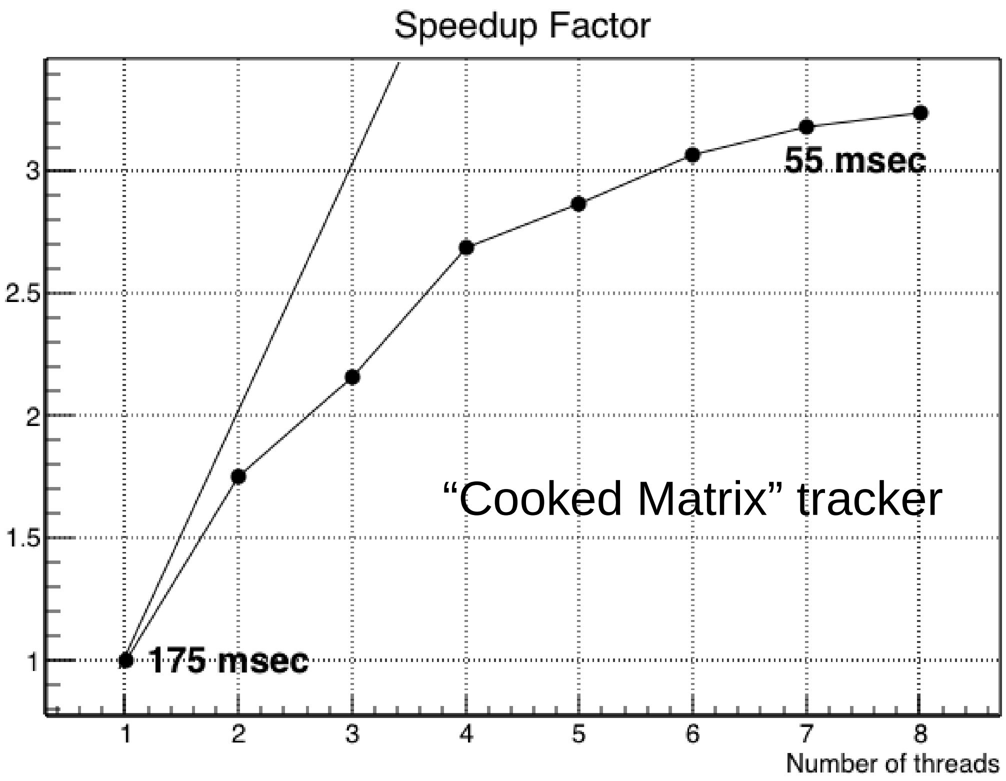
Topology	counts
	1793
	1631
	1380
	1254
	346
	337
	328
	310

Topology	counts
	35
	11
	8
	7
	7
	6

Topology	counts
	6
	6
	5
	5
	5
…	…

Tracking time vs number of threads

- **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



Native C++11 multi-threading

Linux/gcc and macOS/clang

(bottle neck of the moment: Cluster sorting)