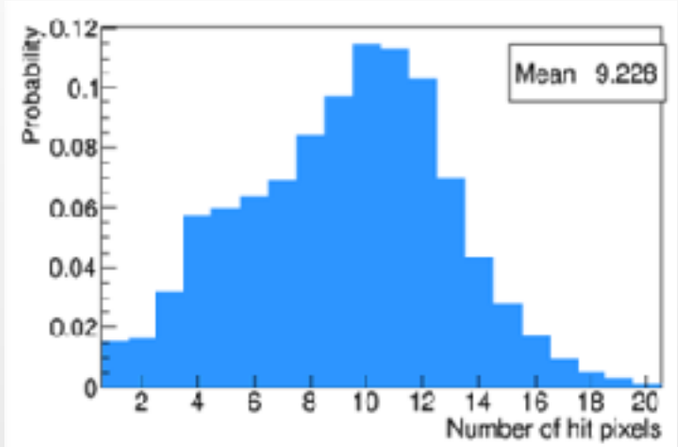
MEG

M. De Gerone

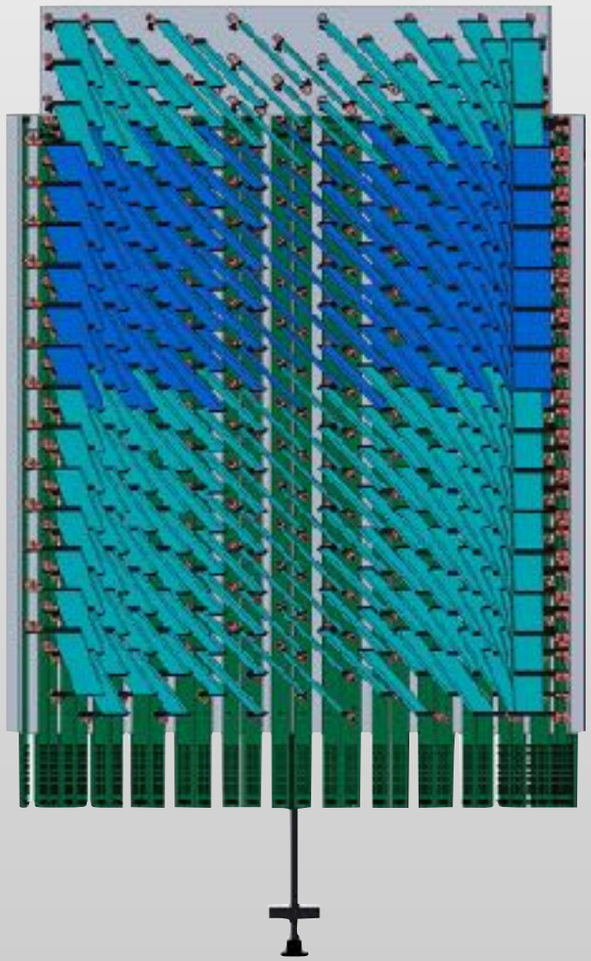
CdS Preventivi 2018

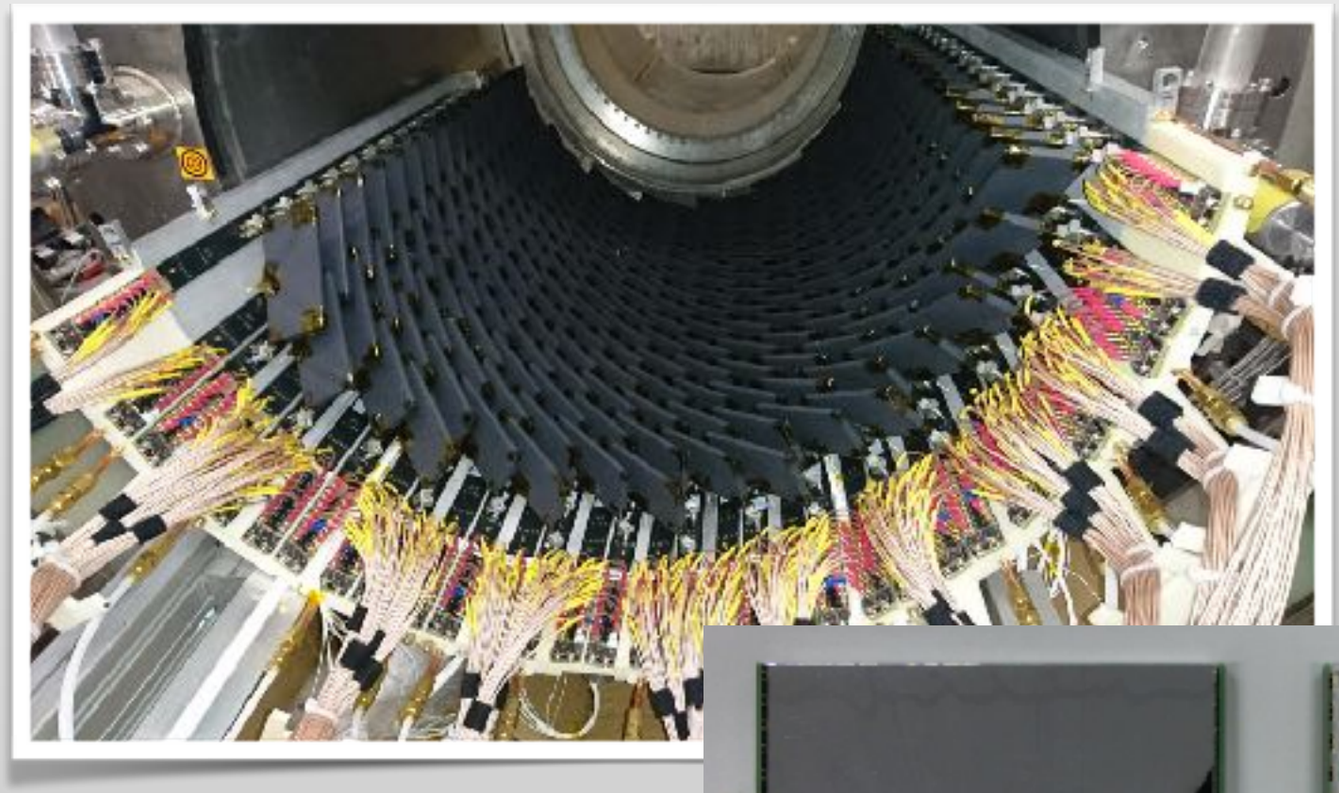
The MEG II Timing Counter (reminder)

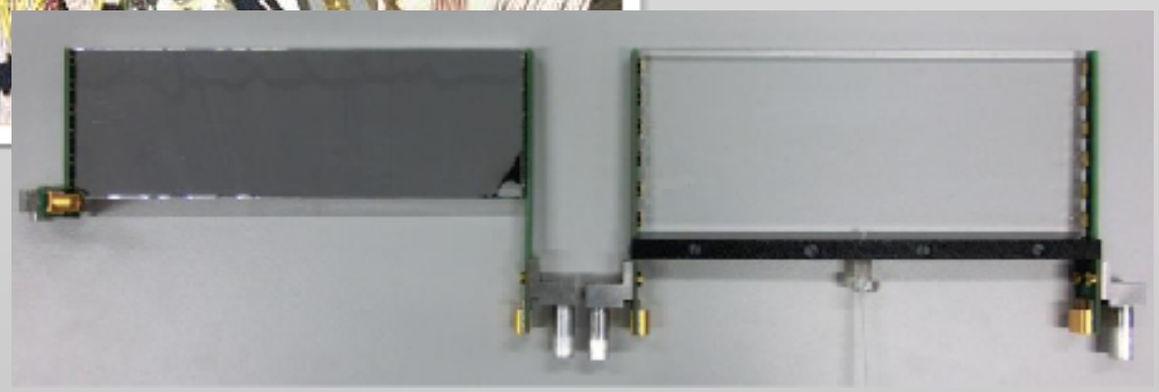
- A new pixelated detector with expected $\sigma(t_{e+})$~30/35 ps.
- Exploit multi-hits time resolution.
- 2 detector x 256 pixels each (symmetric down/up-stream the target).
- Optimized pixel sizes (50 or 40 mm tall) for better e^+ trajectories interception.
- Low budget material along e^+ tracks.



Number of hits per e^+ track from $\mu \rightarrow e\gamma$ (MC)







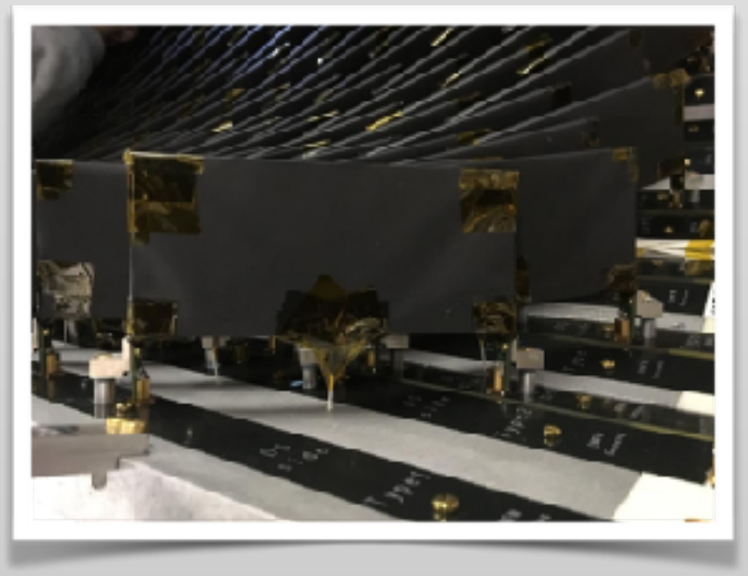
CdS Preventivi

Summary: what's new since last year

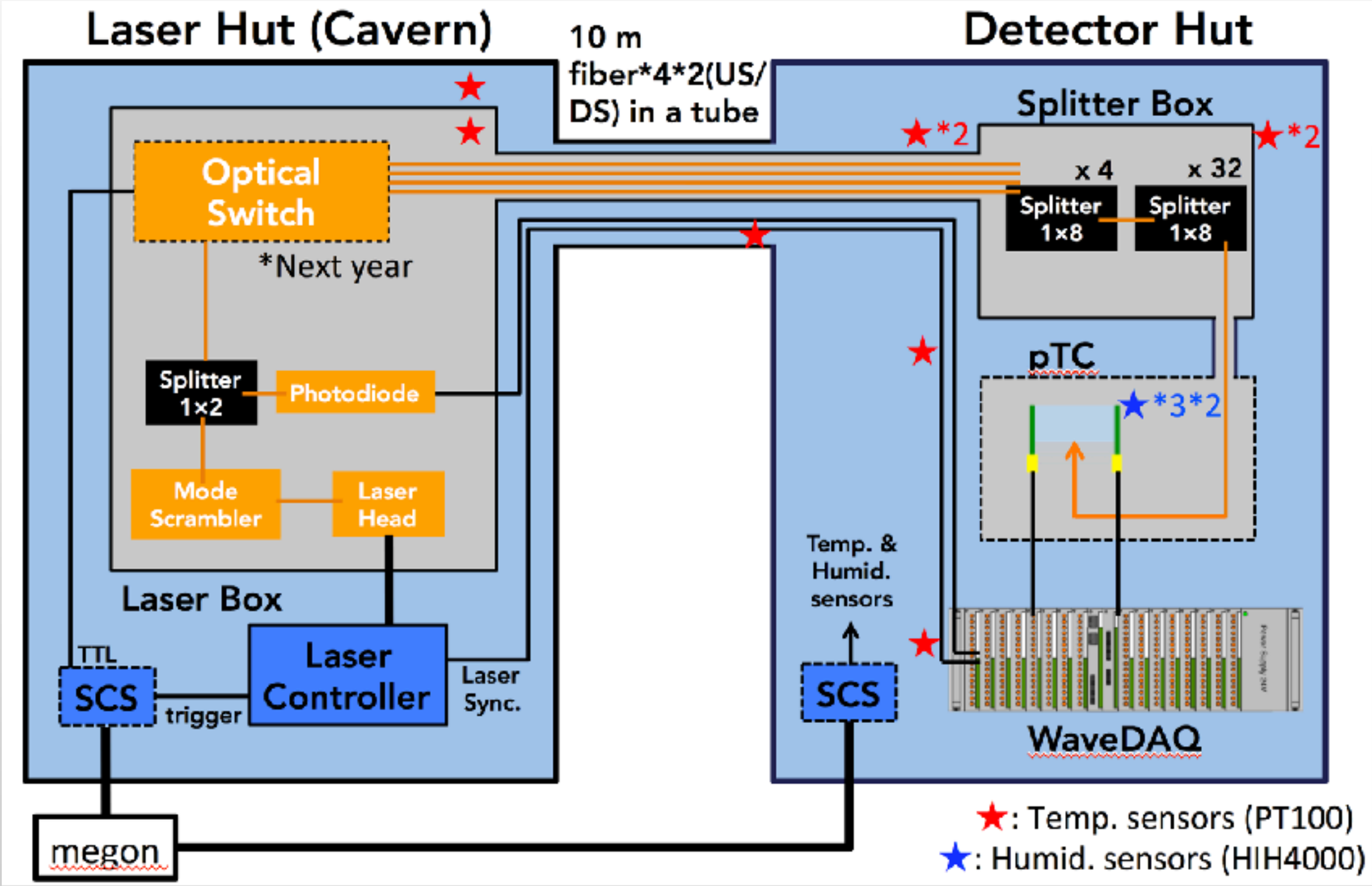
- **2 full detectors completed** and installed in MEG II framework.
- **Laser calibration system completed** and installed.
- Calibration run during summer 2017.
- Development of analysis tools.
- Studies about SiPMs radiation damages.
- **Michel run in fall 2017.**
  - First result from data analysis: time resolution, stability, calibration…

Calibration system

- A **laser source with an optical splitter system allows light injection** simultaneously on each pixel.
- **Laser power and system temperature are continuously monitored** in order to guarantee the best stability.
- Laser and optical splitter system are connected by means of 4 x 10m long fibers.
- Connection in splitter box are made in such away to be able to recover different length fibers allowing an easy handling
- Splitter box is placed very closed to the TC detector (just below the COBRA edge)
- **A fundamental calibration tool for inter-pixel calibration, detector stability, DAQ check** etc…
- Already tested on a small (40) pixels subsample during pre-engineering run 2016, calibration system was completed and installed for both detector in 2017.



Calibration system (sketch and pics)



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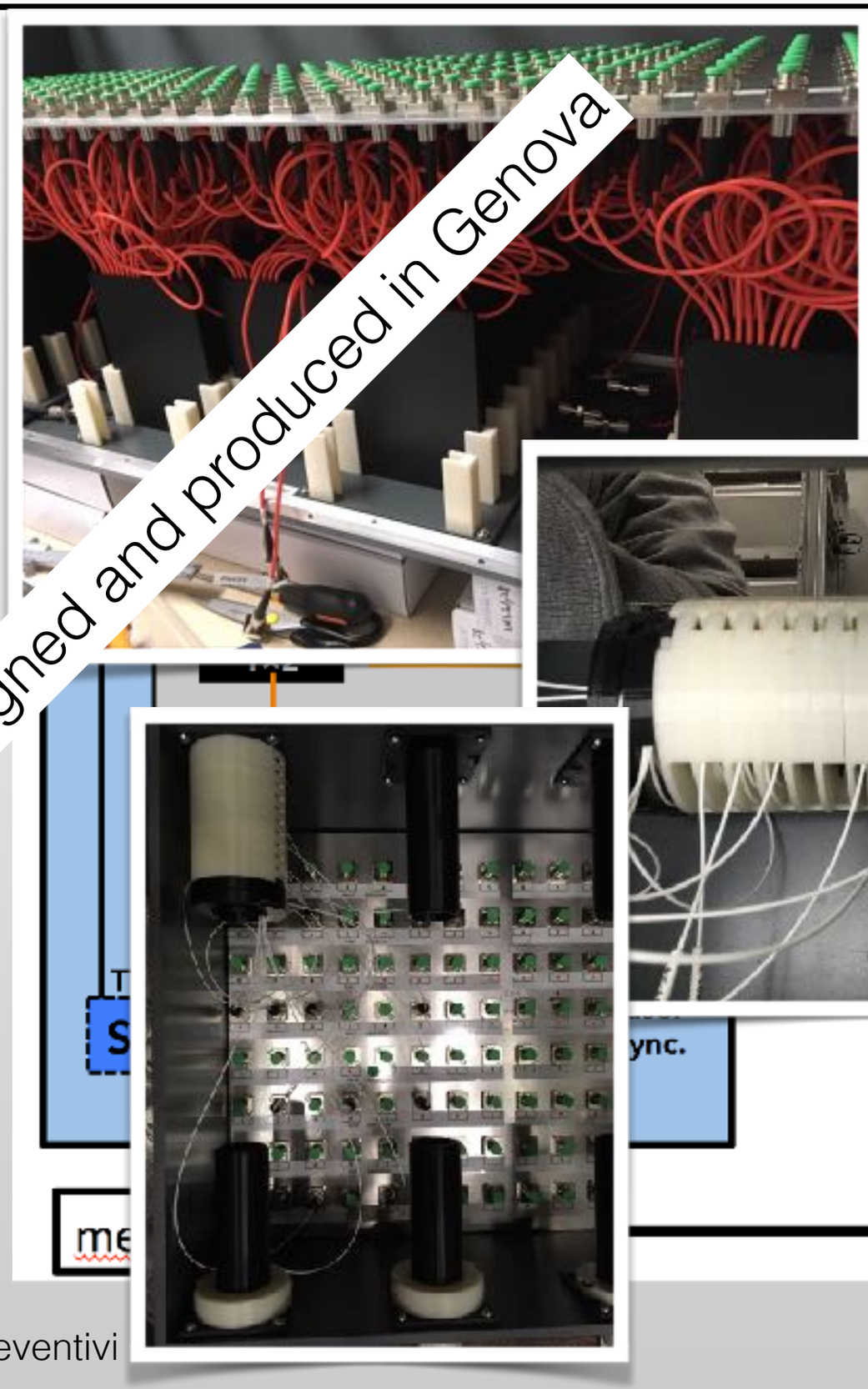
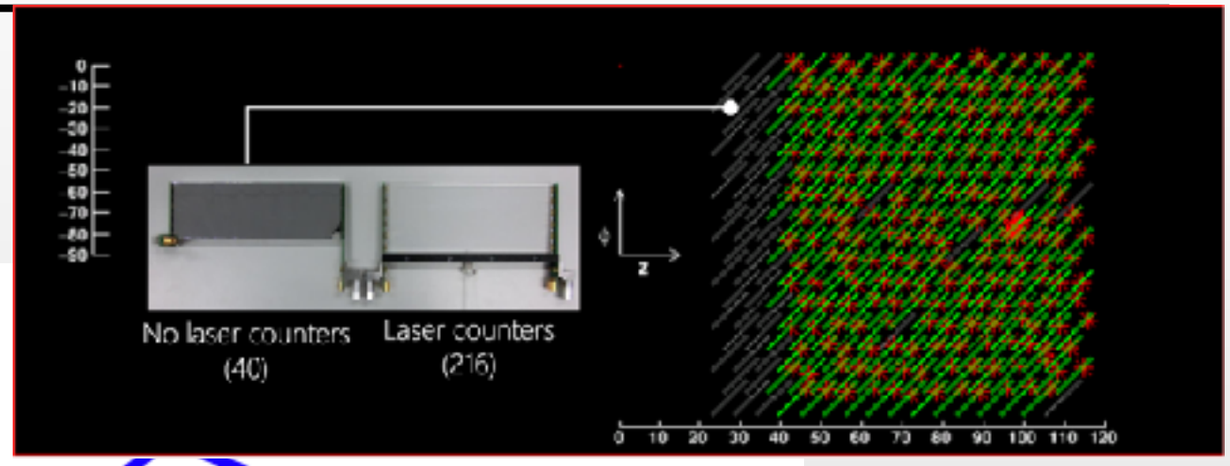
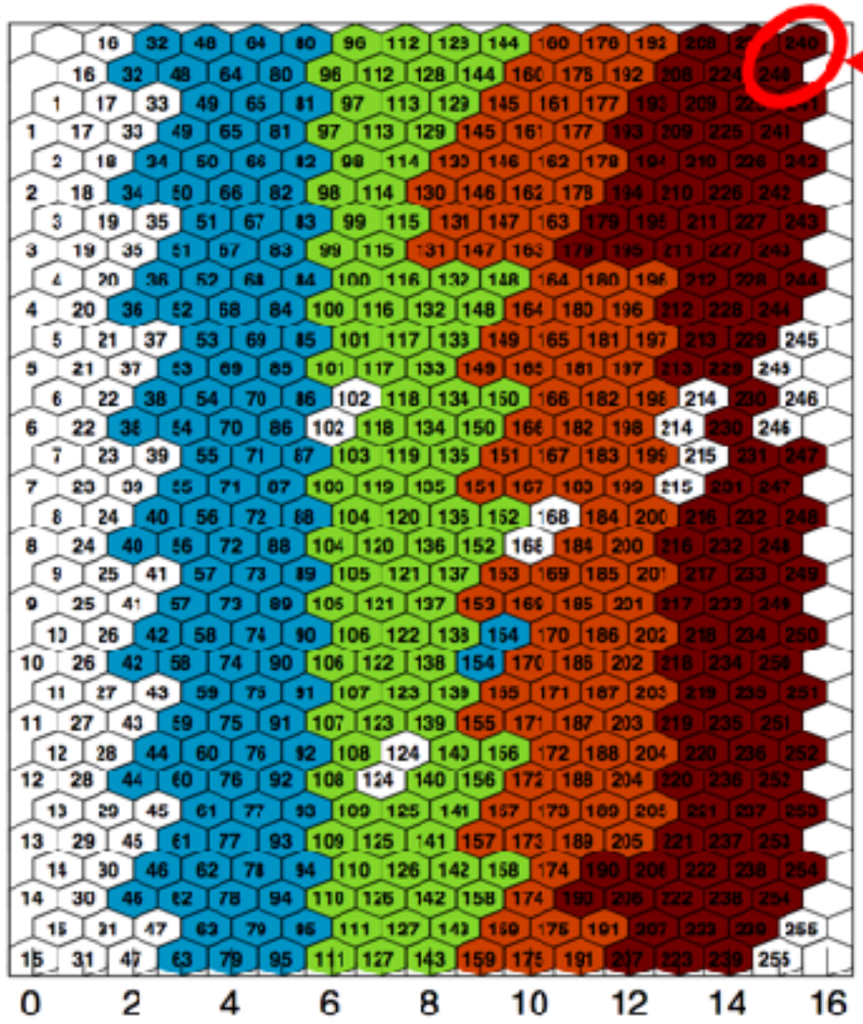


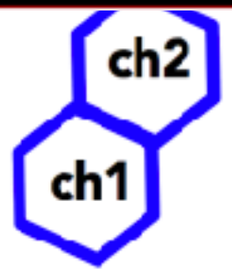
Laser run in summer 2017



Channel Map



No Laser **Fiber#1** **Fiber#2** **Fiber#3** **Fiber#4**



- DS: 256 counters, 512 channels
- No laser for inner counters.
- Different color corresponds to different 10 m fiber.
- Position: white is not used
  - 1 bad channel.
  - 4 dead channels.
  - 2 bad WD connection.
  - 2 dead fiber.
  - 1 power monitor.
  - 1 laser sync.
  - **Elog: 944 in detail**

Michel run 2017

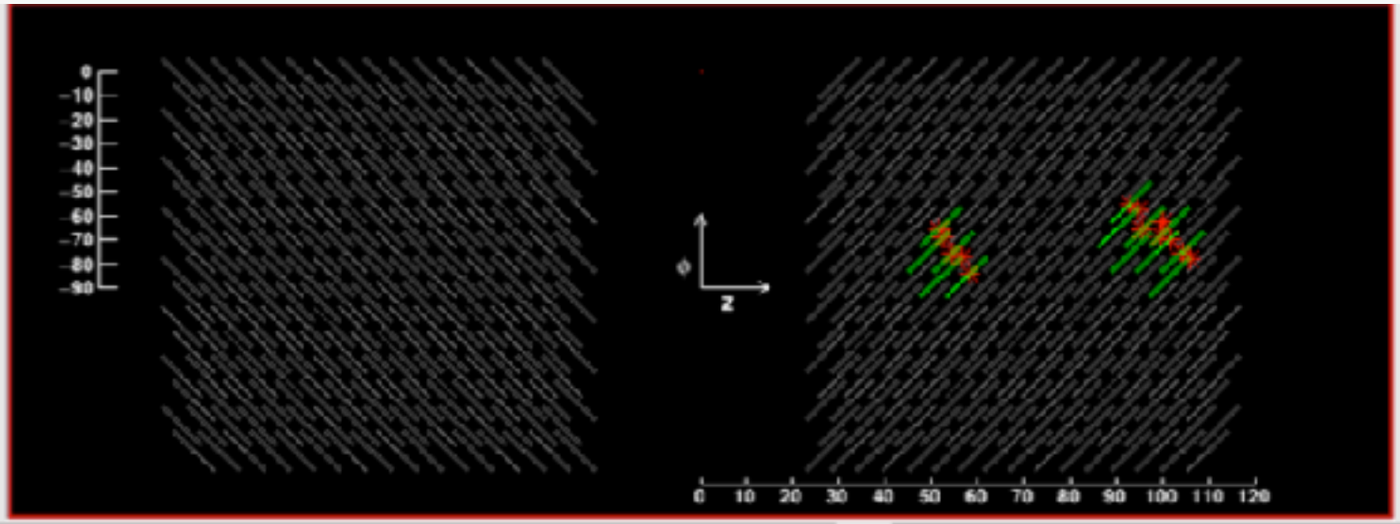
A ~**15 days Michel run** was done in December 2017 with the following main goals:

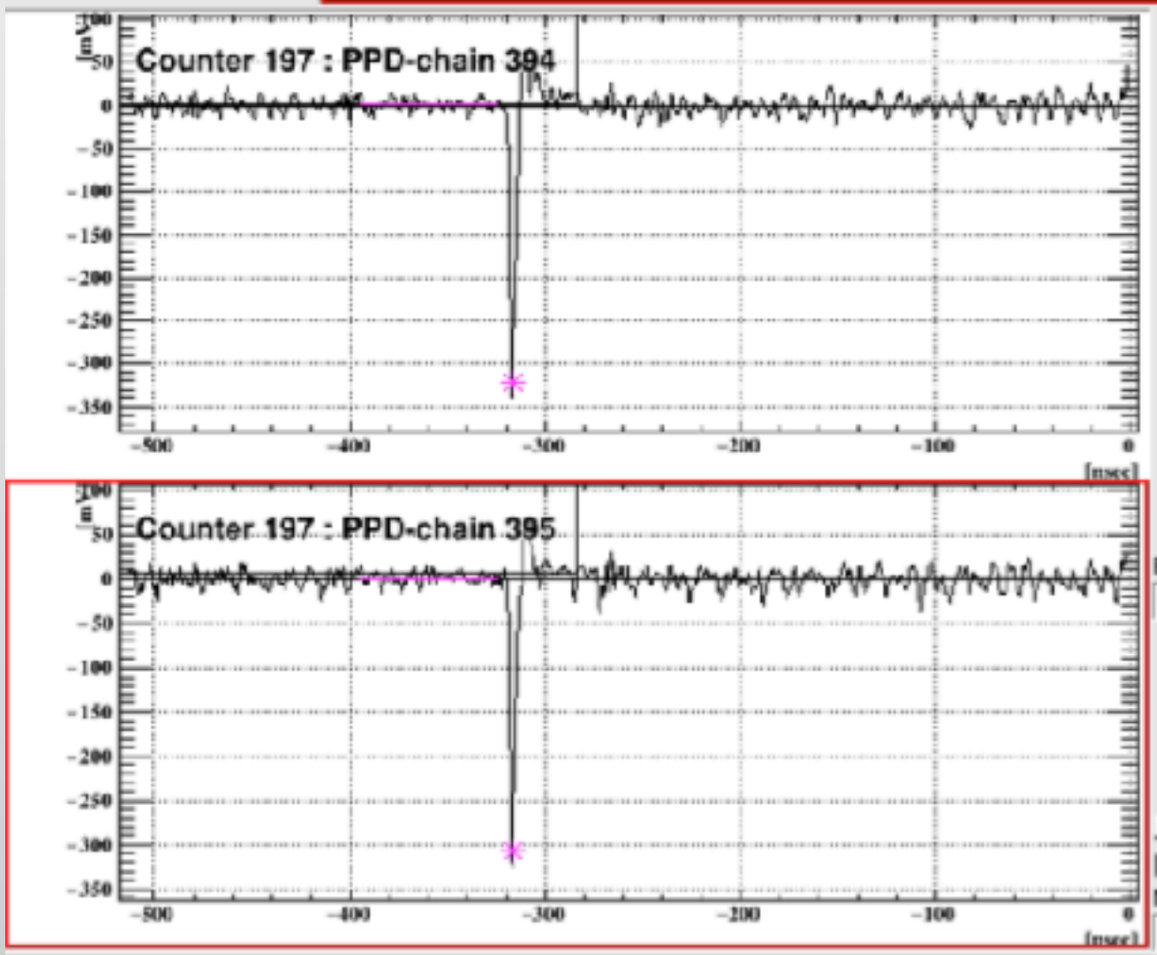
- **Full detector operation**
- **Time resolution check** in final MEG II conditions
- Operate full laser system and confirm goodness of calibration technique
- Operate slow control system (TC cooling and monitoring)
- Confirm background behavior (hitmap, rate, etc)
- Some of this item are still on-going…

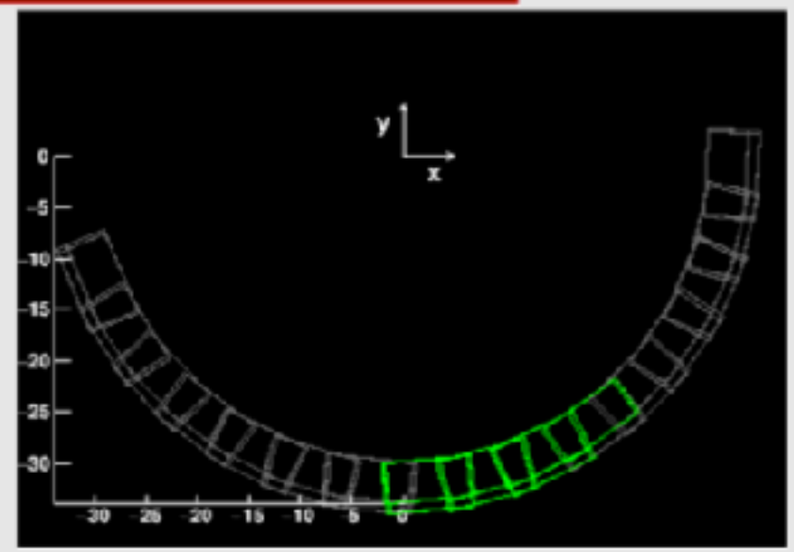
Mon	Tue	Wed	Thu	Fri	Sat	Sun
Nov. 13	14	15	16	17	18	19
← Start Laser Run						
20	21	22	23	24	25	26
27 Beam Ready	28 Michel Run →	29	30	Dec. 1	2	3
4 ← Beam Shutdown	5	6 Today	7	8 Michel Run →	9	10

Michel run 2017: event display

Nice Michel tracks clearly visible!







Pixel number with hit
#197, 214, 198, 199, 215, 216, 231, 87, 72, 88, 182, 70, 71,
0
Rec track MC hit MC track only e+
MCTrack indeces to be desplayed (eg. type 0,12,13 below and press Enter key

Michel run 2017: first results

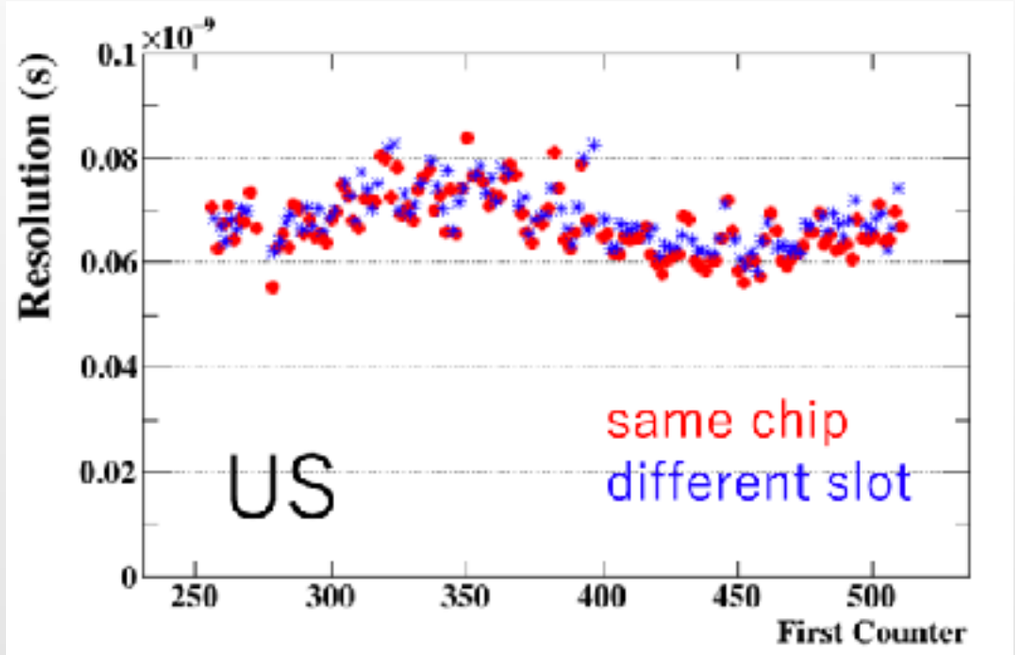
Example: check of the double hits resolution (2 adjacent counters):

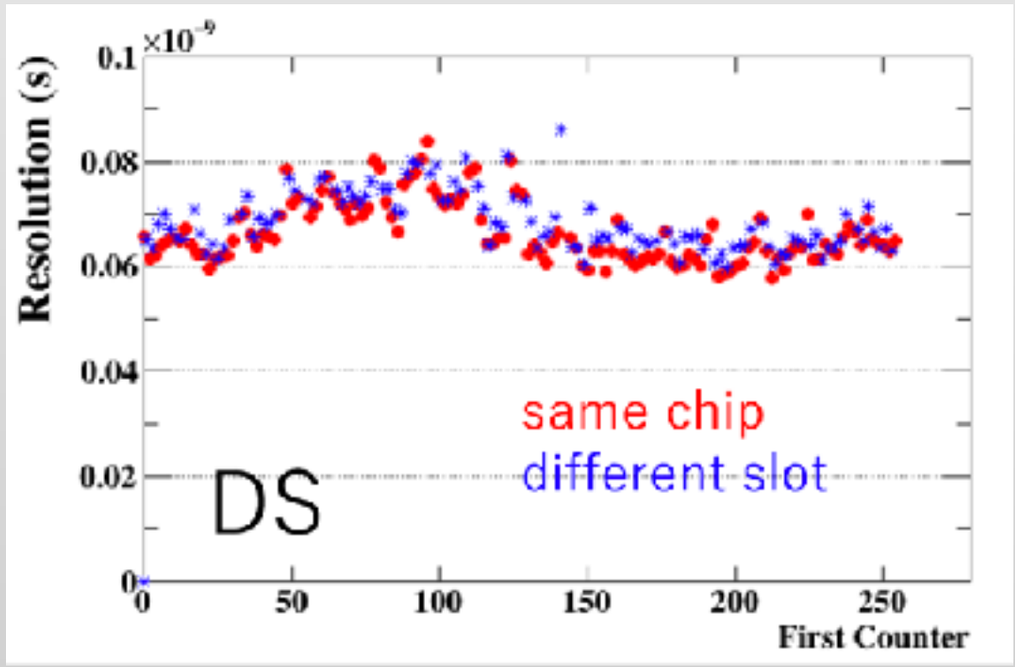
combination on same DRS chip: $\sigma\ (T_{i+1} - T_i)/2$

combination on different DRS chip: $\sigma\ (T_{i-15} - T_i)/2$

We did not see any strong influence from electronic jitter now.

Resolutions stay in the range 60 - 80 ps





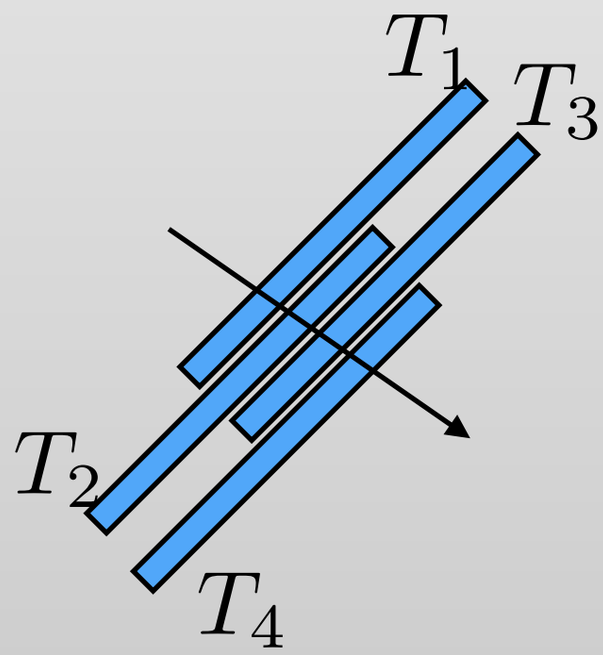
Michel run 2017: first results

Multi-hit resolution was checked by using the so called **“even-odd” analysis**.
After having choosen a counter combination to be analysed, the sigma of the quantity:

$$\frac{\sum_i^{N/2} T_{2i+1}}{N} - \frac{\sum_i^{N/2} T_{2i}}{N}$$

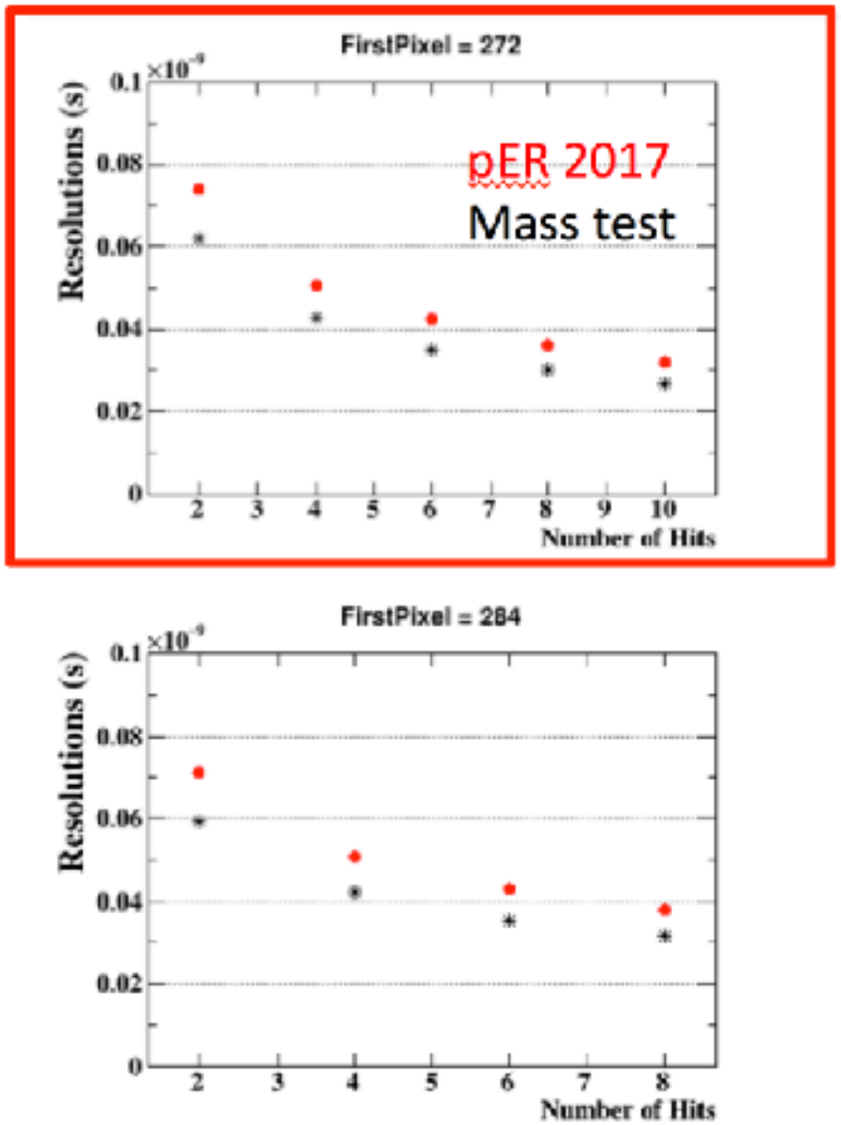
is used to evaluate the multiple hits time resolution.
As an example, for N = 4:

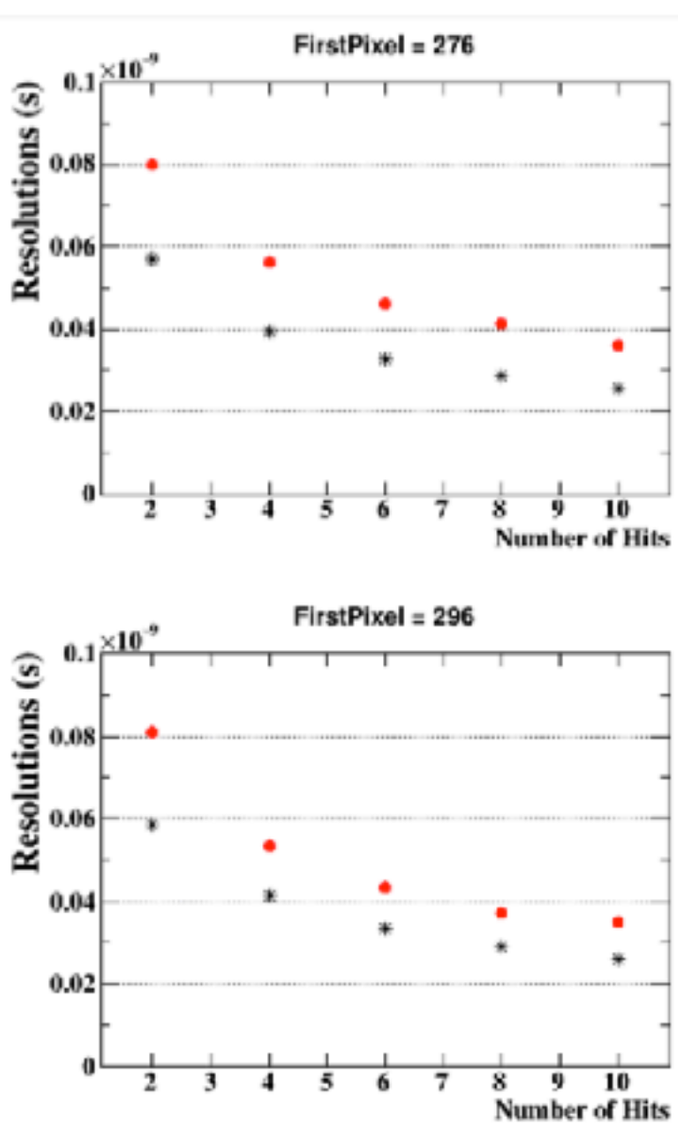
$$\frac{\frac{T_1+T_3}{2} - \frac{T_2+T_4}{2}}{2}$$



Michel run 2017: first results

Example: 4 different pixels subsets starting from pixel id 272:





Michel run 2017: first results

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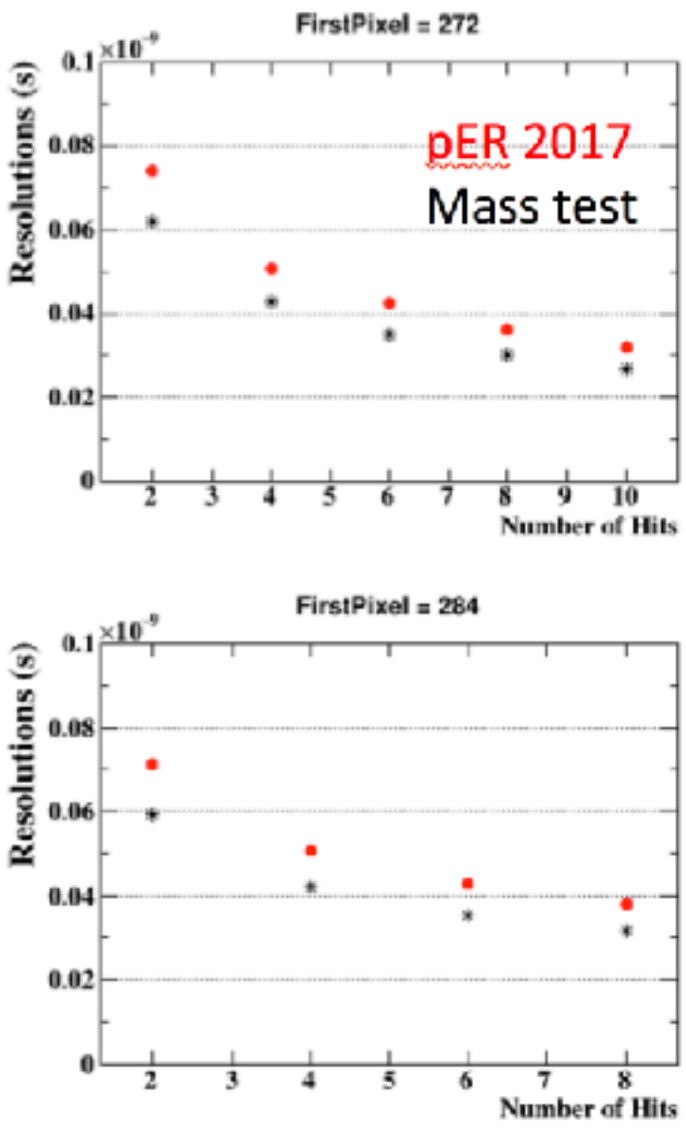
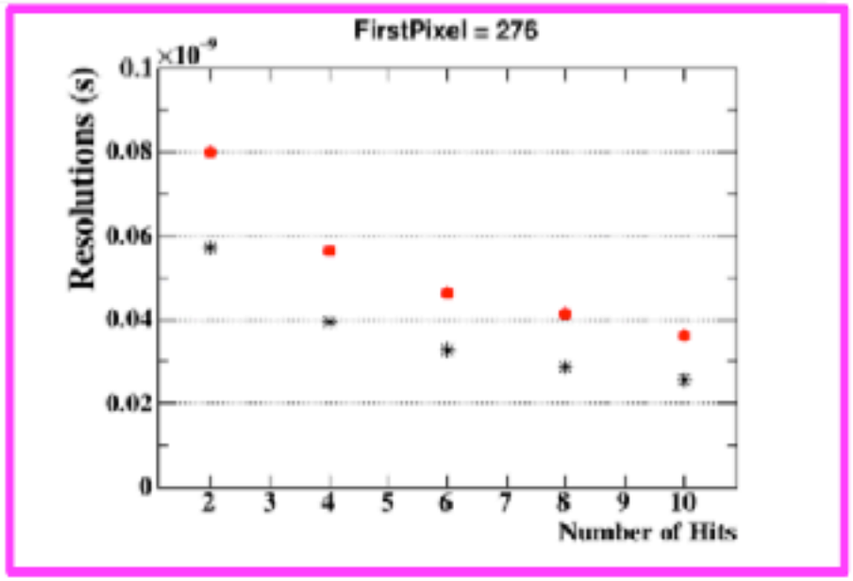
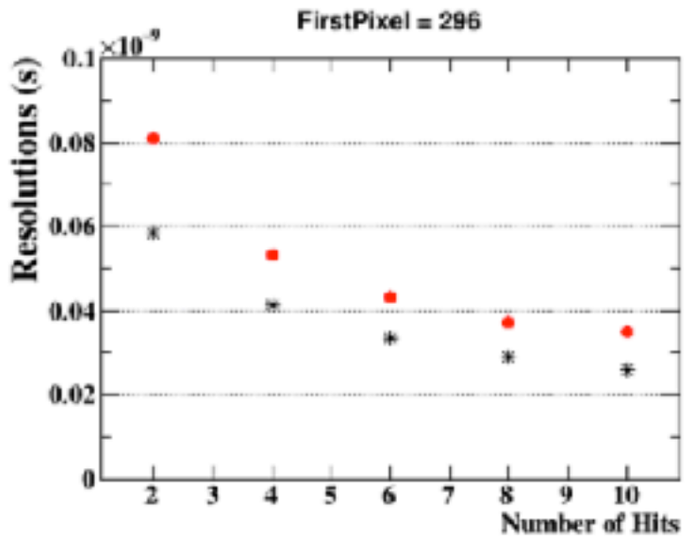
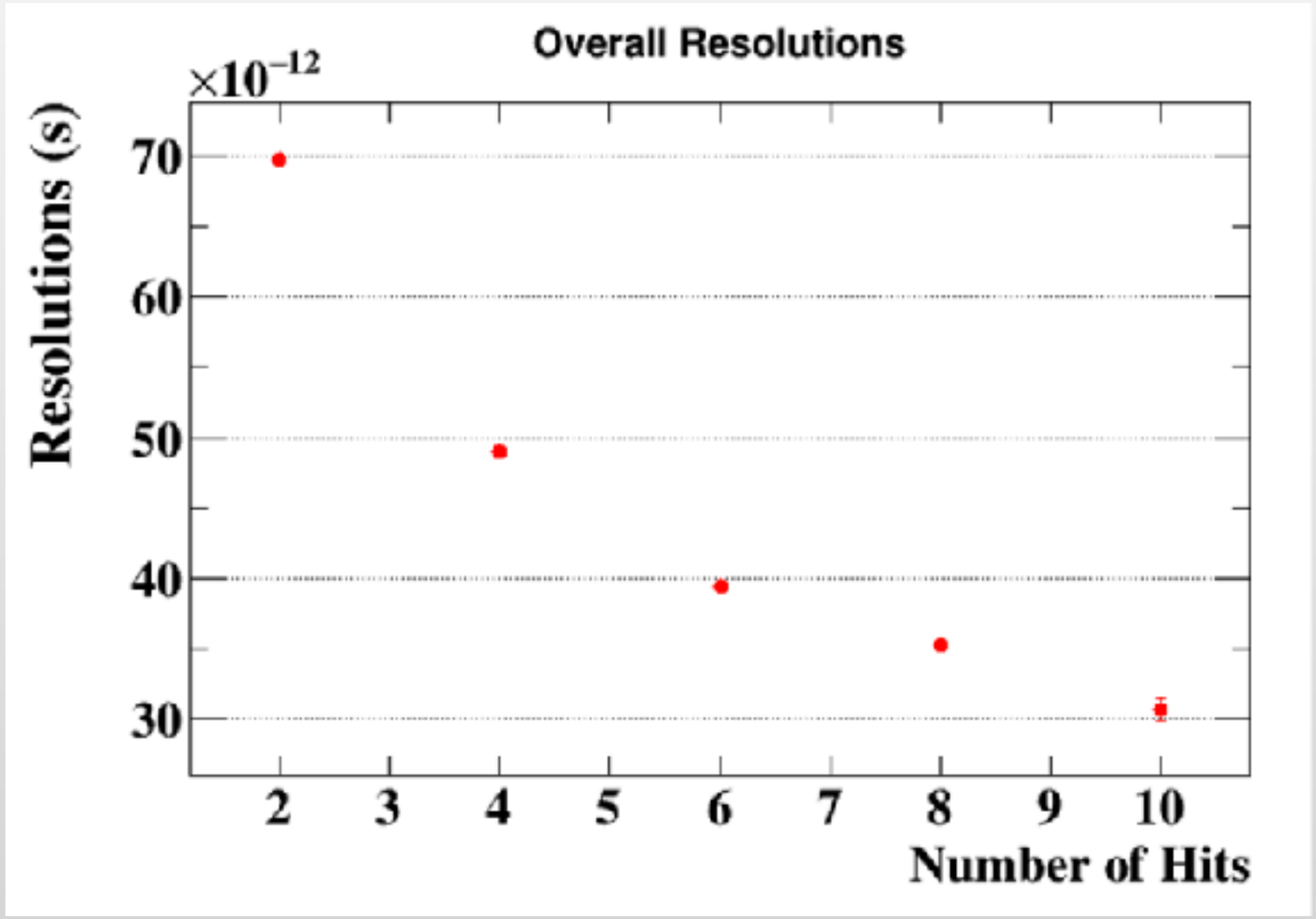




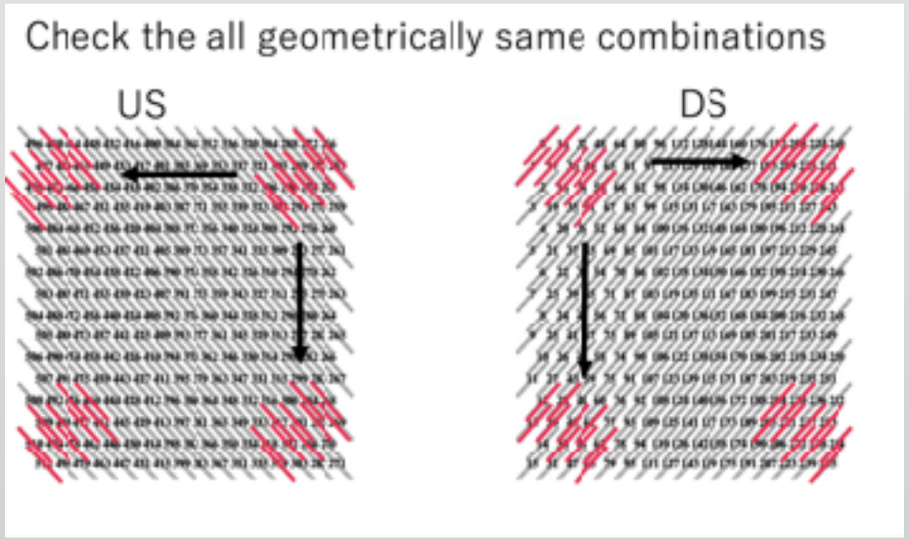


Michel run 2017: first results

Overall TC performance obtained by **averaging resolutions from all the geometrically equivalent combinations**.

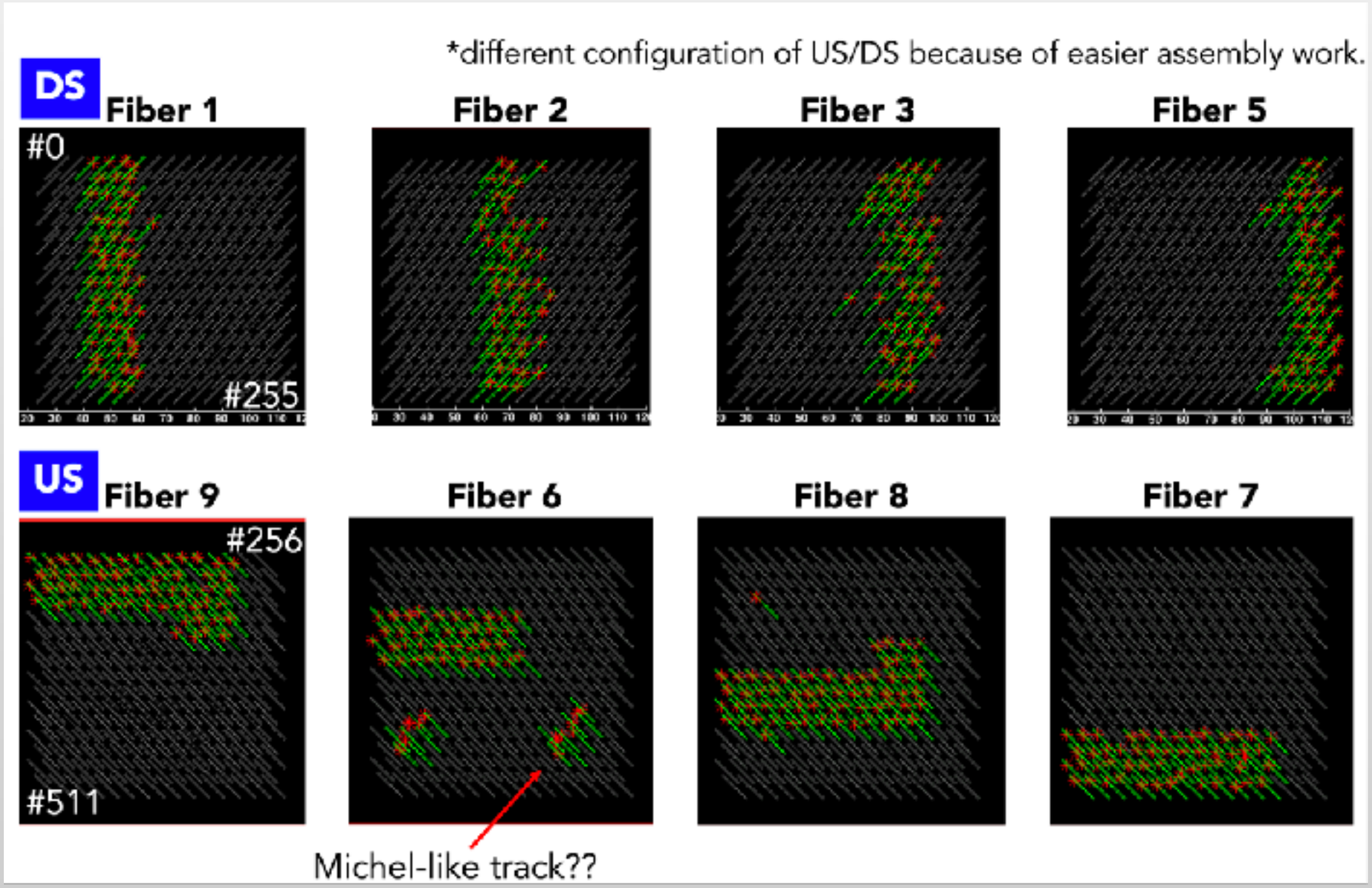


We obtained:
~ 35ps @8hits
~ 30ps @10hits
for the overall TC resolution.



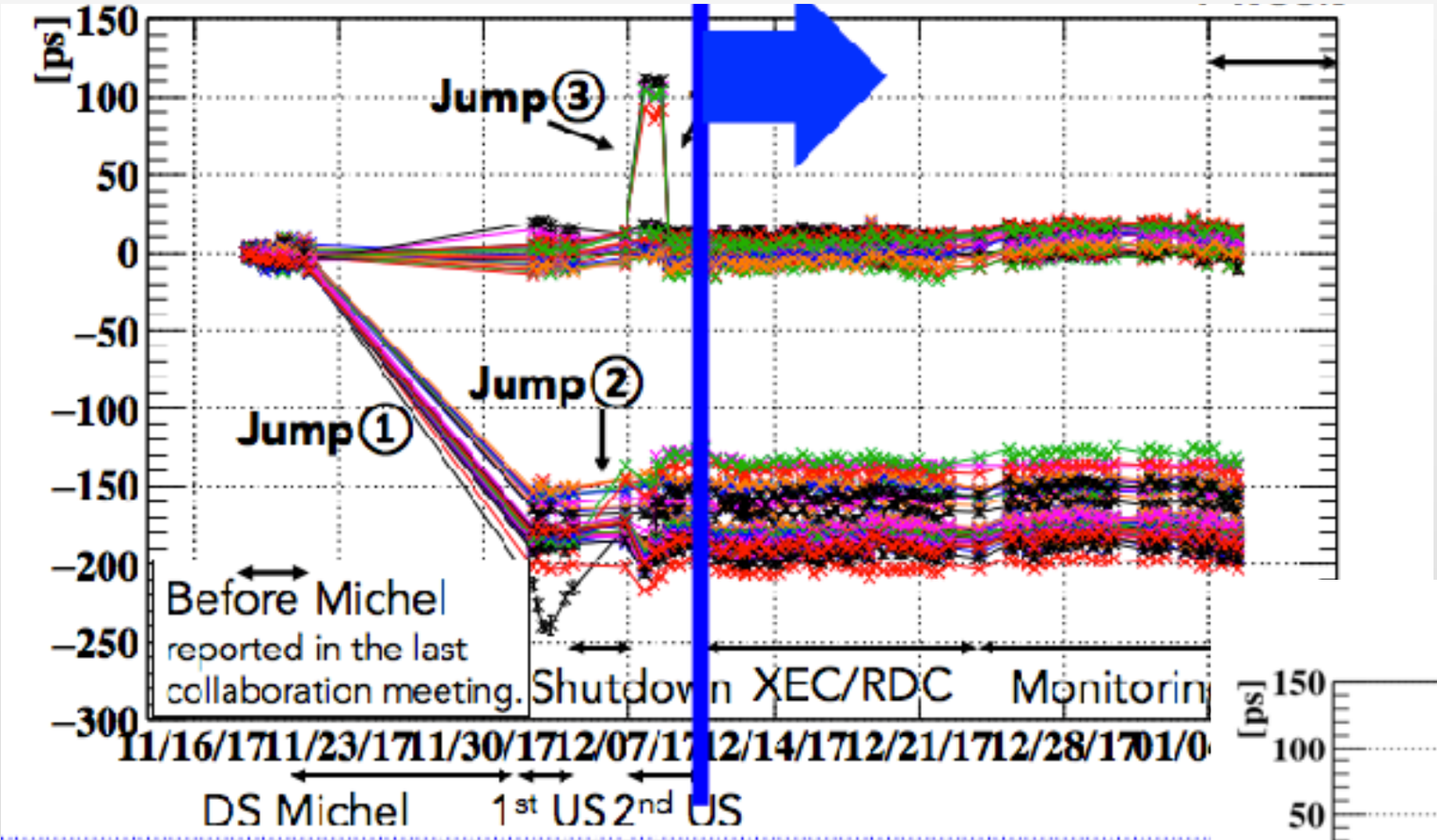
Michel run 2017: first results

Laser calibration was used in the same way already showed for laser run 2017.
8 fibers (instead of 4) were used to illuminate both TC detectors.

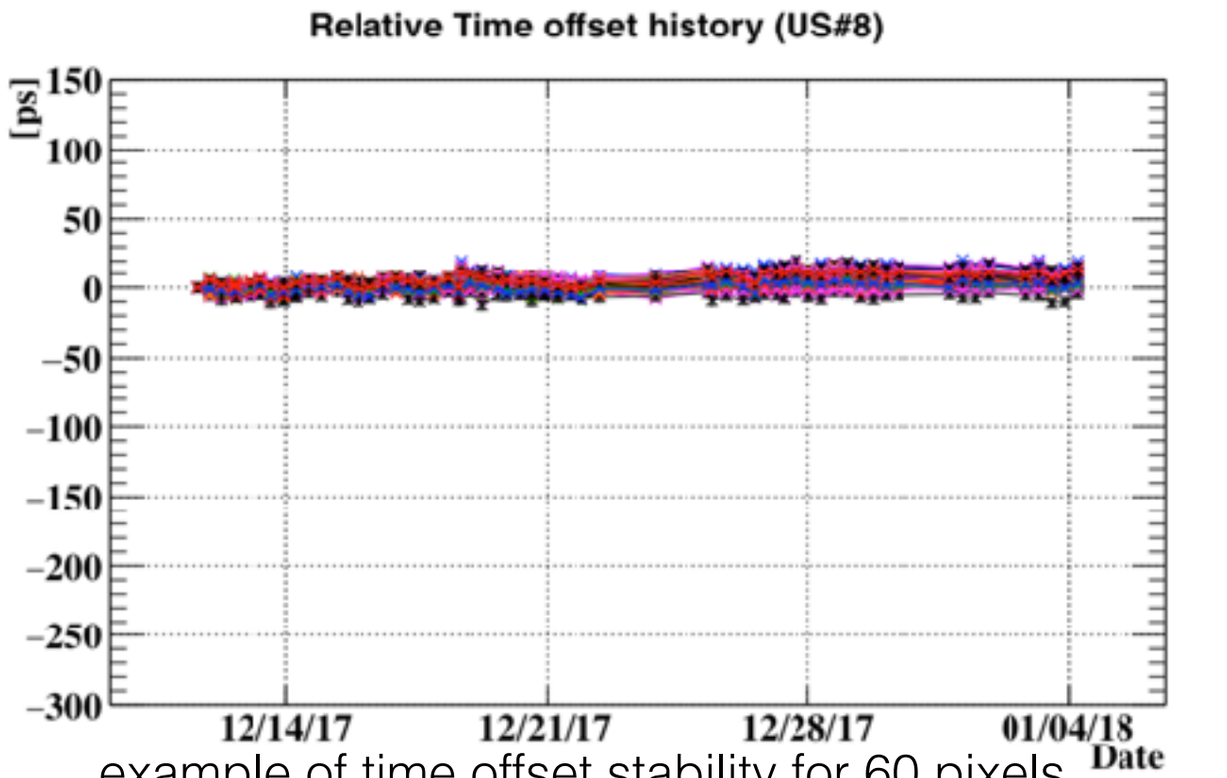


Michel run 2017: first results

Time offset stability was monitored during 1.5 month run (Dec. 2017).



“Jumps" in the plot are due to TDAQ area activities -> not an issue



example of time offset stability for 60 pixels

Stability is ~2.5 ps.

Prossime attività

- Entrambi i detector sono stati estratti dal magnete per interventi di manutenzione ordinaria (sostituzione di alcune fibre e pixel).

- Verrà implementato un upgrade del sistema di raffreddamento per termostatare il detector

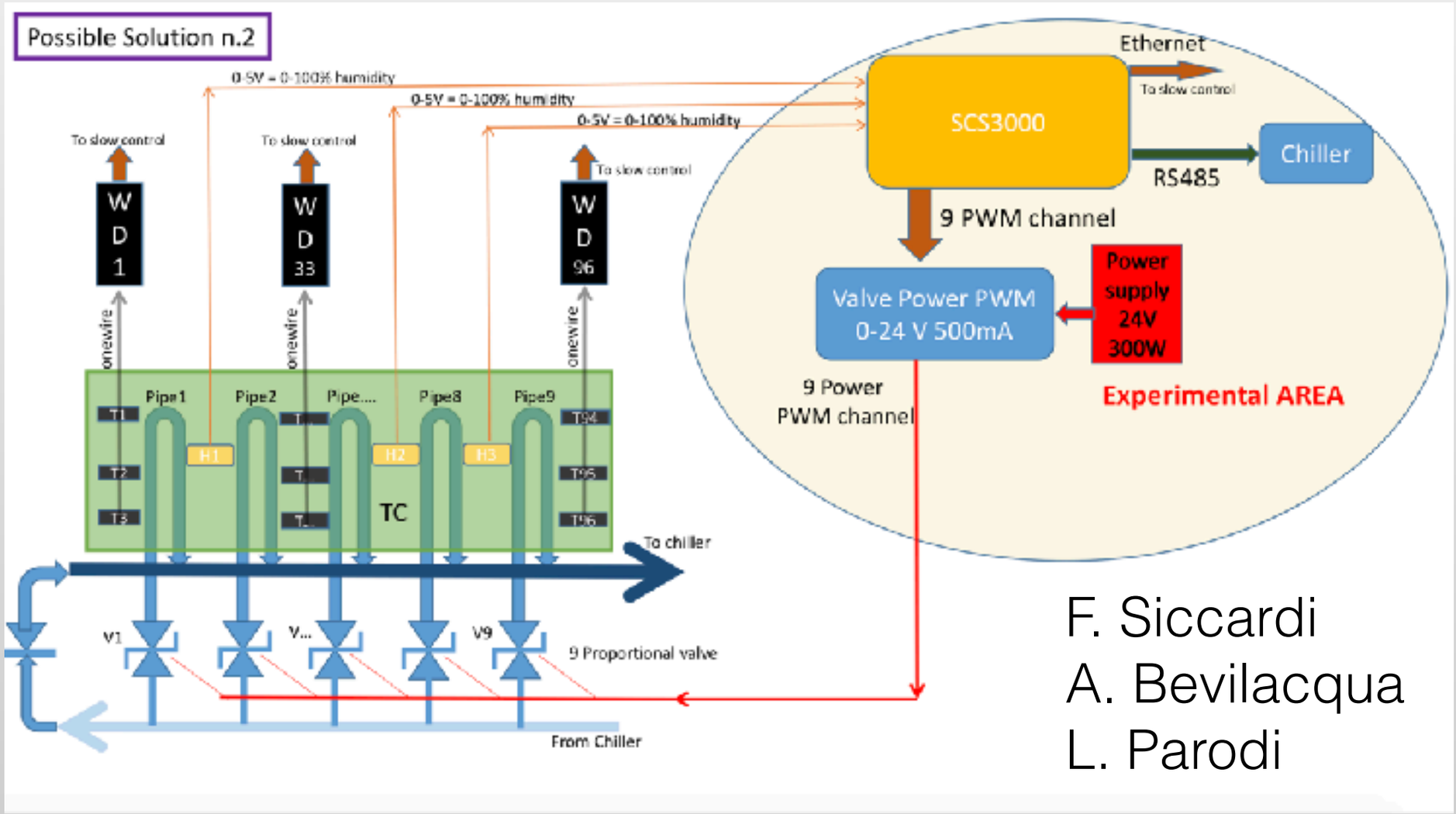
- I detector verranno inseriti nuovamente nel rivelatore di MEG entro fine dell'anno (schedula da decidere, dipende da altri rivelatori)

- Presa dati a fine anno da definire (probabile priorità ad altri detector)

- La maggior parte dell'impegno HW è completata, Genova rimane responsabile del mantenimento del detector (+ Tokyo Univ.).

Sistema di raffreddamento

- Sistema di raffreddamento con feedback in temperatura
- Mantiene stabile punto di lavoro SiPM e uniformità detector
- Progettato e costruito a Genova, poi integrato nello slow control MEG



F. Siccardi
A. Bevilacqua
L. Parodi

Anagrafica e servizi

Biasotti	0.3
De Gerone	0.6
Gatti	0.3
Giovannini	0.3
Grosso	0.5
Totale FTE	2.0
A. Bevilacqua	
F. Siccardi	

Richieste ai servizi:

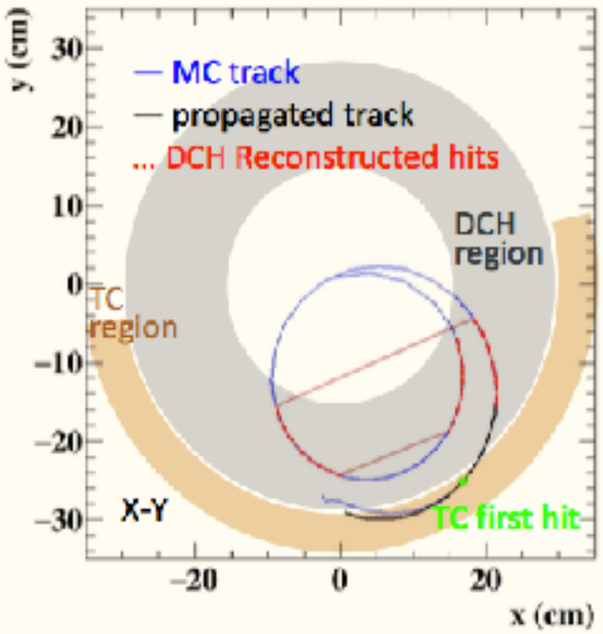
- < 2 m.u. pro. mec.
- < 2 m.u. officina meccanica

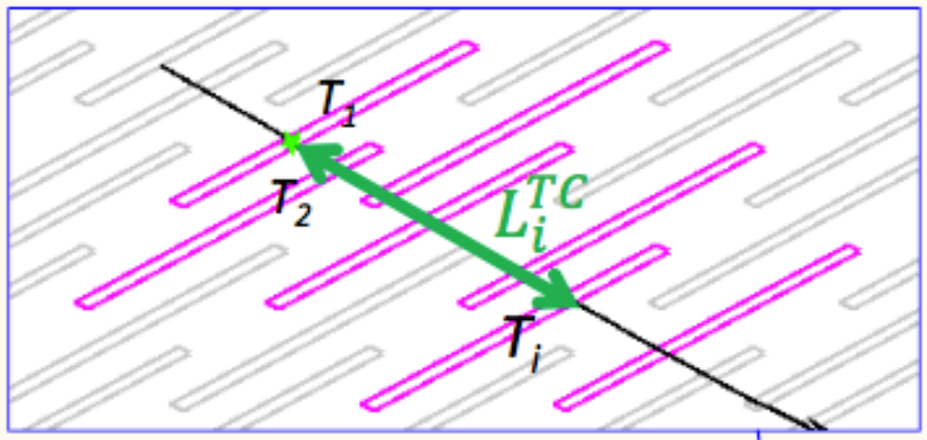
Attività connesse al commissioning del detector, alla sua integrazione nel rivelatore di MEG II, implementazione del sistema di raffreddamento.

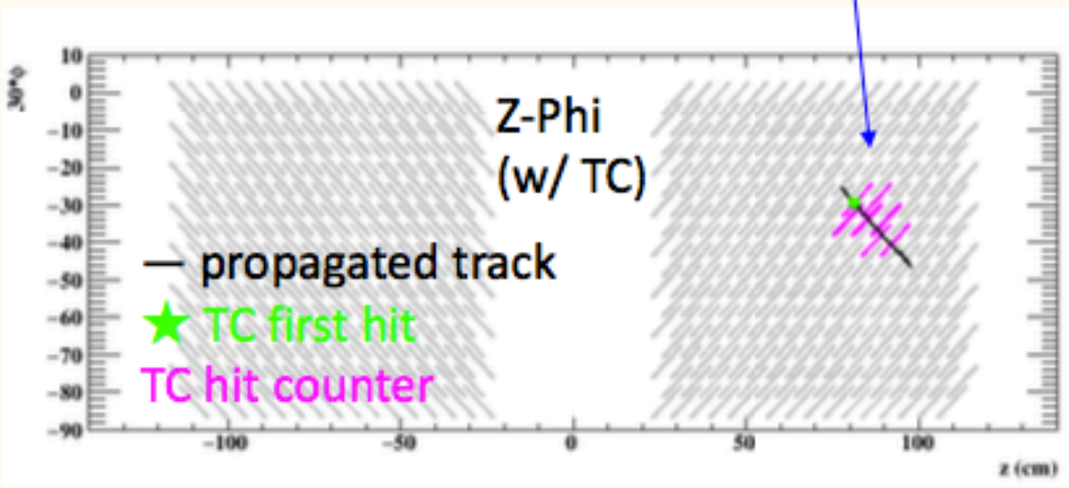
Back up slide

Developing analysis tool…

We are also developing our analysis tools, taking advantage of both data and MonteCarlo.
As an example: matching between DCH and TC and overall positron timing resolution.







1. DCH reconstructs track from vertex to TC first hit. (L_{DCH})
2. TC reconstructs time at first hit by each counter.

Measured time by ith counter

$$T_{TC} = \sum_i^N (T_i - L_i^{TC}/c)/N$$

Path length from a first counter to ith counter

$$T_{e^+} = T_{TC} - L_{DCH}/c$$

Developing analysis tool…

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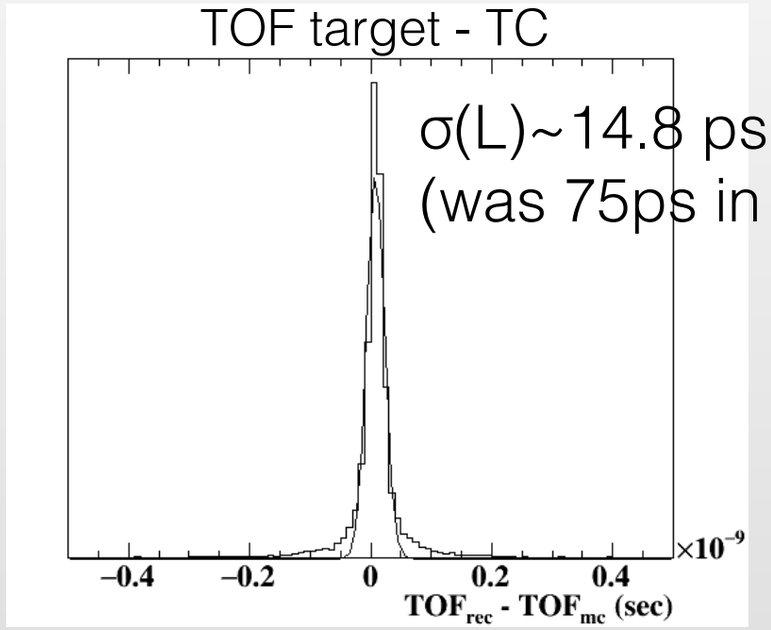
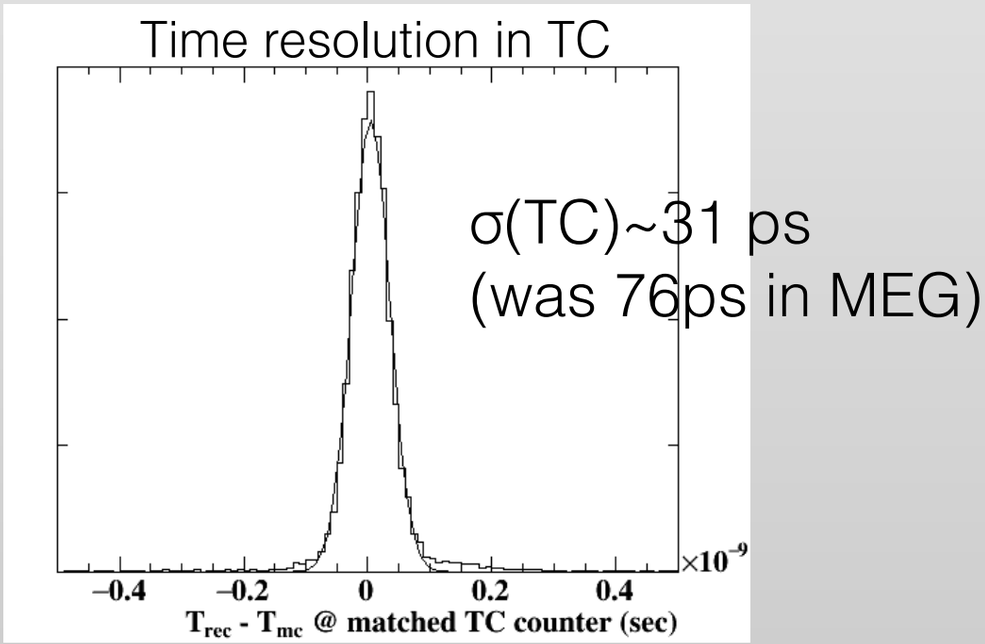
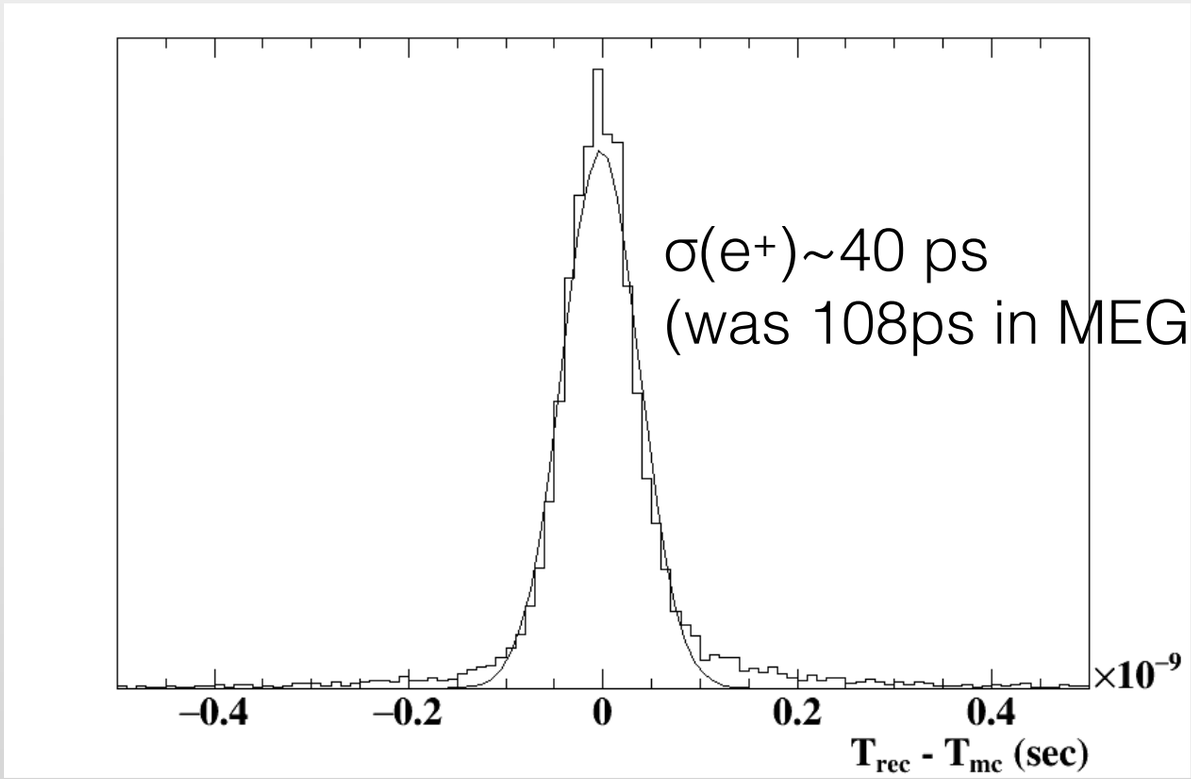
As an example: matching between DCH and TC and overall positron timing resolution



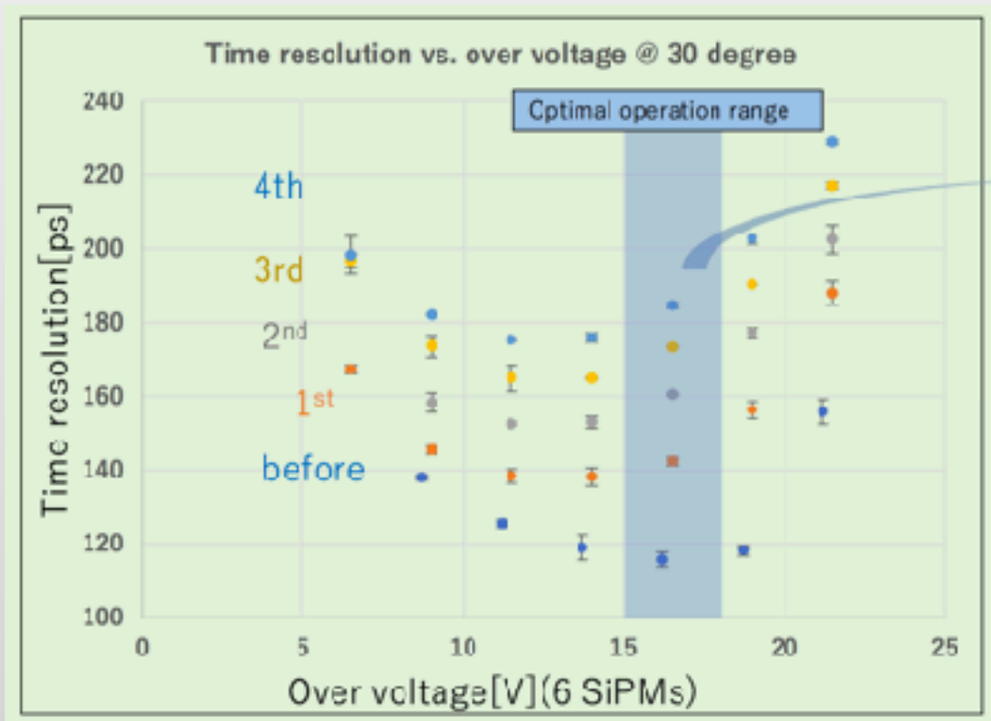


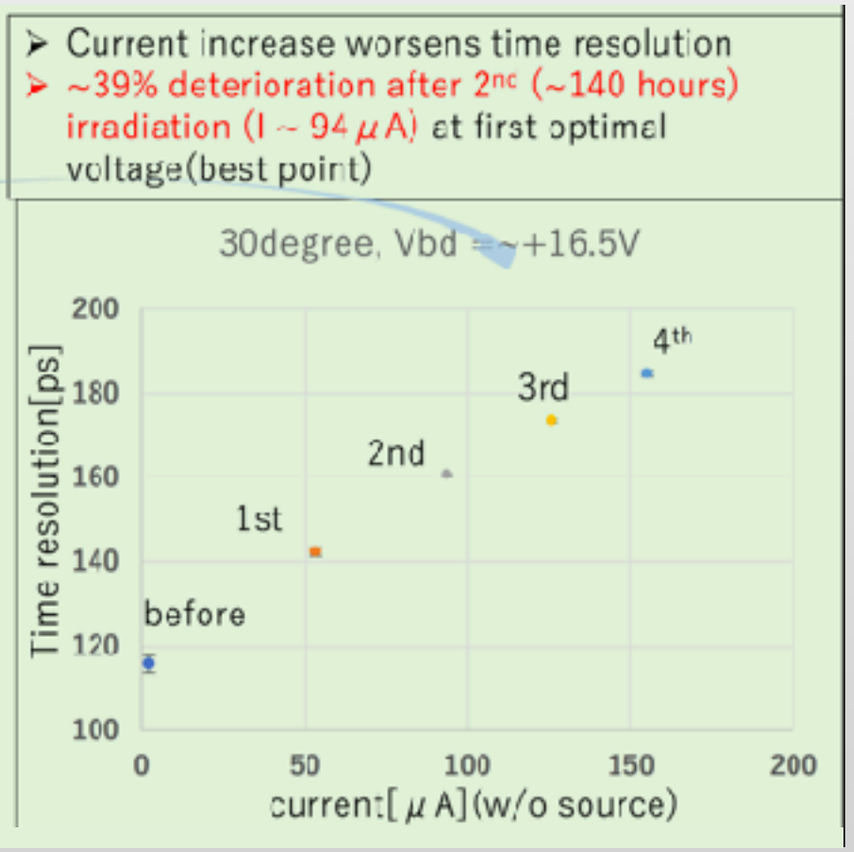


More than a factor 2 improvement in e+ overall resolution!

SiPMs ageing studies

- During last BVRs we reported about possible deterioration of SiPMs performances due to radiation damage - SiPMs ageing.
- In last year we investigated this issue by means of dedicated test:
  - sample irradiated under beam at BTF (Frascati, IT)
  - sample irradiated with ^{90}Sr source
- Effect on timing resolution were extracted by studying pixels equipped with those irradiated samples.





current value at optimal working point:

- before: 2 μA
- 1st: 53 μA
- 2nd: 94 μA
- 3rd: 126 μA
- 4th: 155 μA

100 μA should correspond to MEG II 2 full years of run.

SiPMs ageing studies

- SiPMs cooling can be very effective in reducing radiation damage effect.
- Degradation decrease from 39% to 5% if working temperature decrease from 30 to 10 deg.
- We will upgrade the Timing Counter cooling system during this year in order to try to cool down detector around 10 deg.