New Concept

How to go more granular with limited number of electronic channels

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Why we need a new scheme

For the SDHCAL in the future lepton colliders there will be about 7 10^7 channels
Only about 2-5 10^3 will be fired for each collision. So the channels are idle almost all of the time.

Power pulsing scheme can reduce their power consumption but not their cost…
Power pulsing is not possible for other experiments (CEPC for instance)

Can we do something to save power and money without impacting the physics?

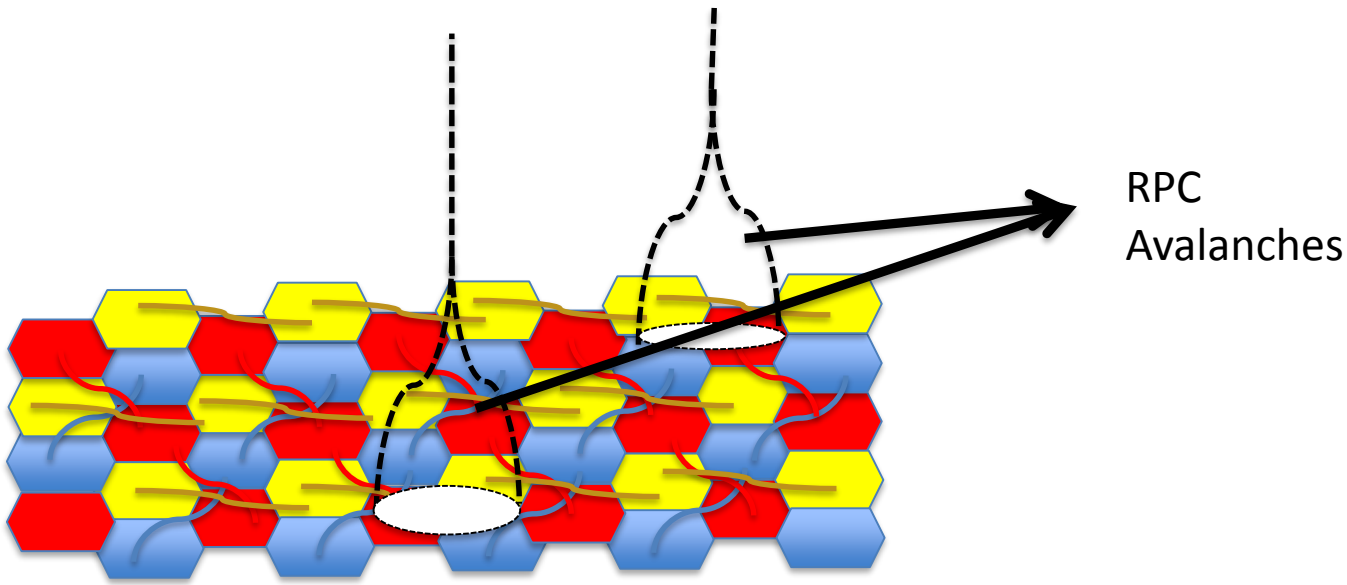
Reducing the number of pads/pixels is not an option since this leads to less granularity → bad PFA

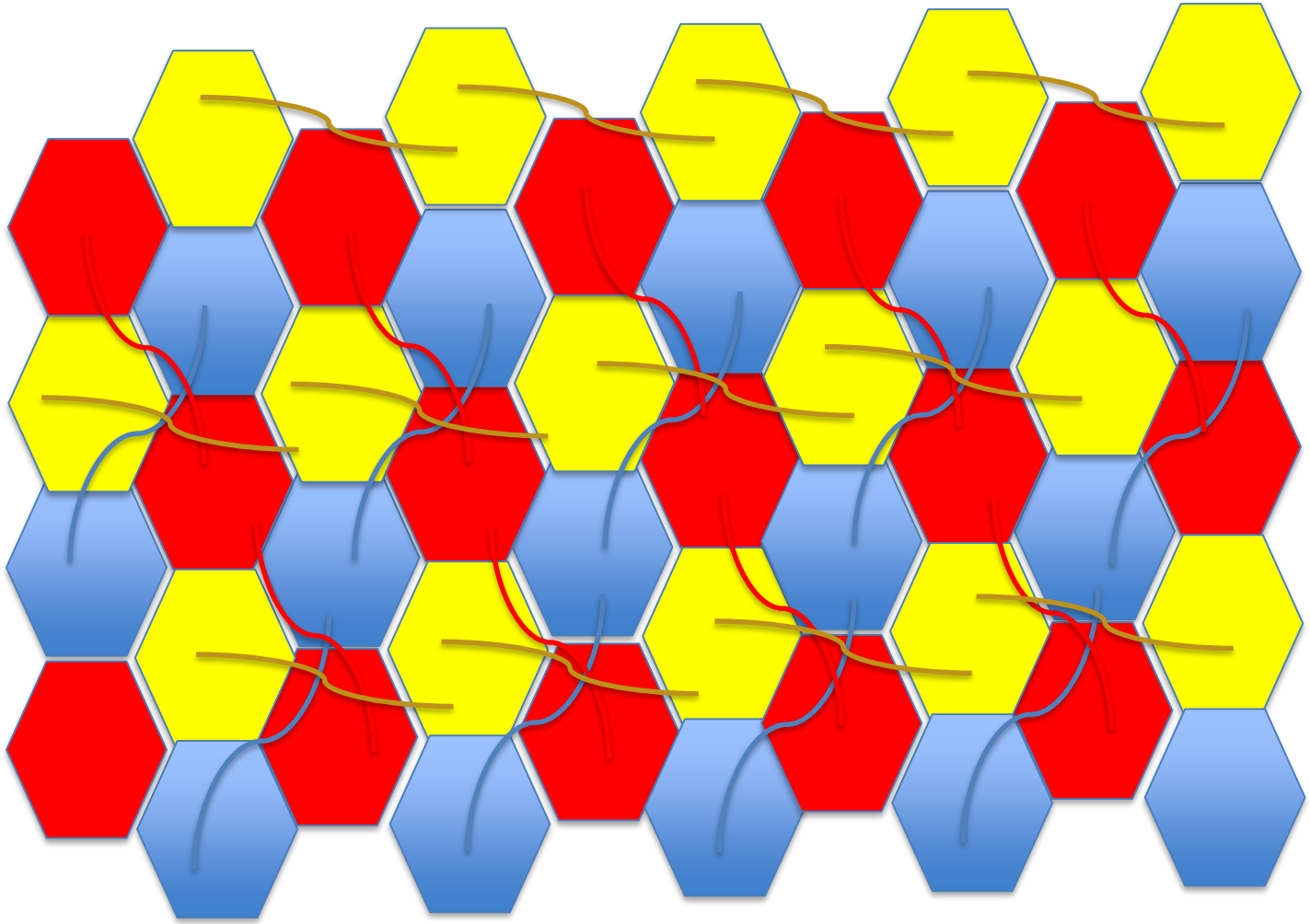
But there maybe a trick……..

There is one…..

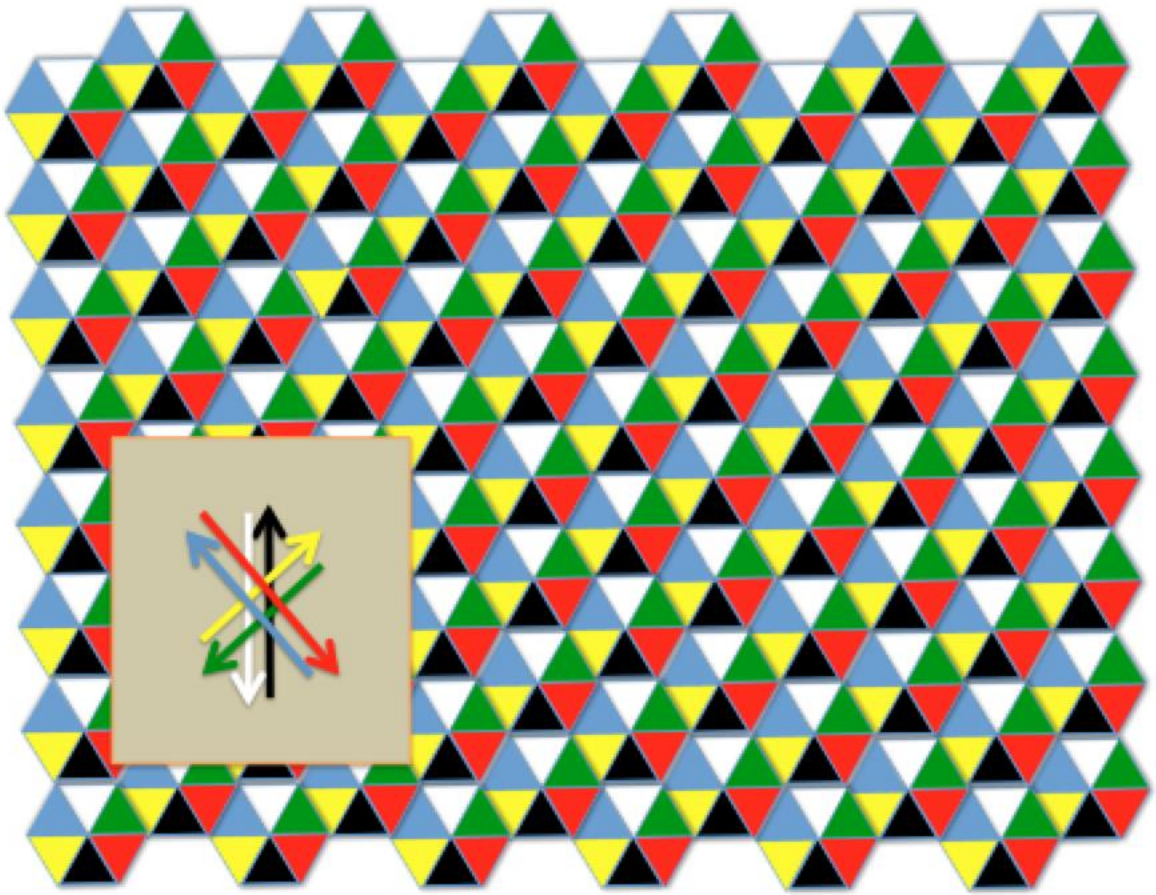
The principle is simple: the **charge is shared among several pads/pixels**. **The pads/pixels are inter-connected in a smart way** so one can identify the position of the impinging particle by identifying the fired strips and thus find the hit as the crossing points.

In addition there is no ambiguity as far as the number of particles crossing the particles is not very high thanks to the use of at least 3 directions strips.



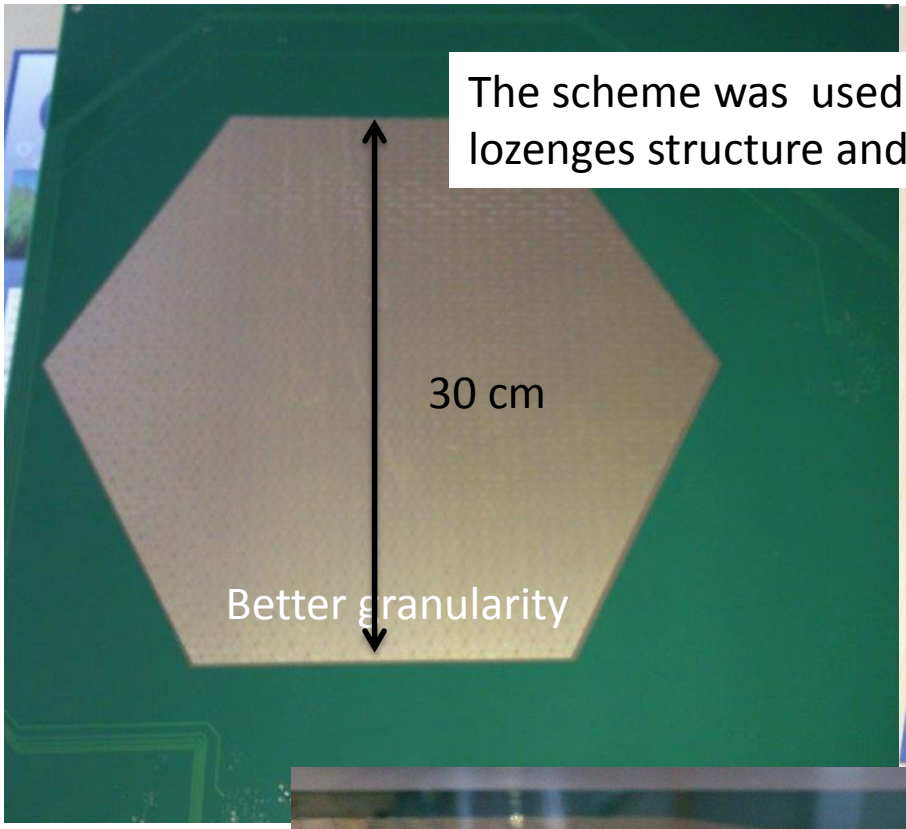


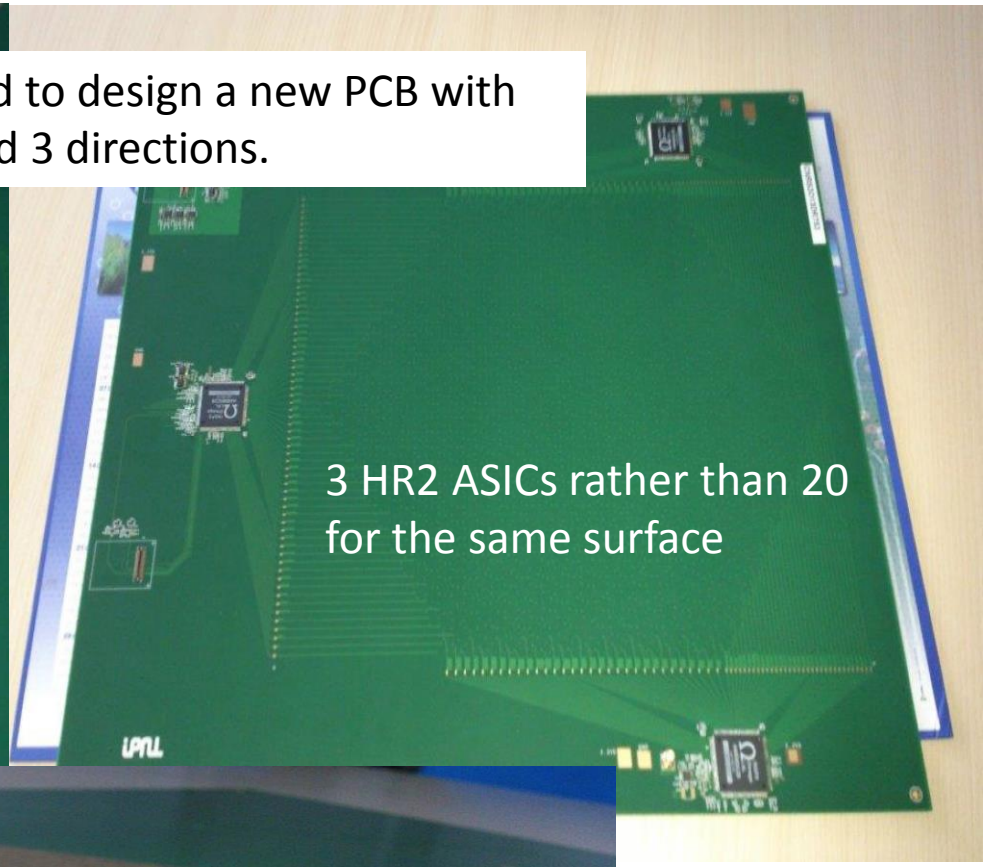
- Several shapes of pixels/pads can be used: triangles, lozenges, pentagons, hexagons the most convenient is the triangular shape
- The pixel/pad size should be a slightly smaller to the charge extension to feed at least two
- Having 3 or more directions allow one to eliminate ambiguities (ghost particles)

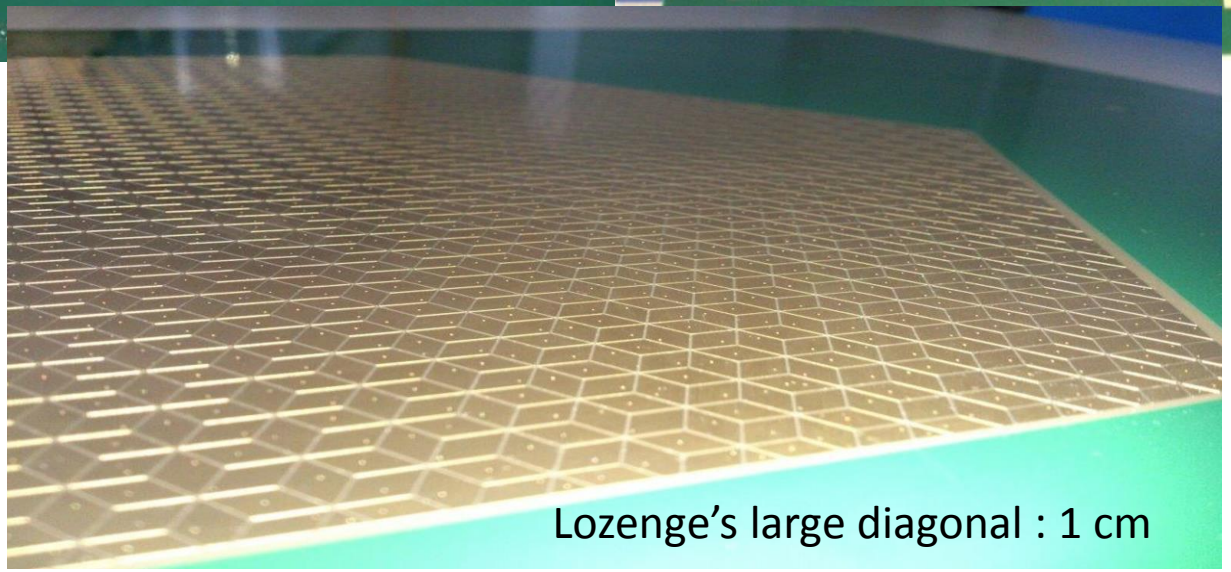


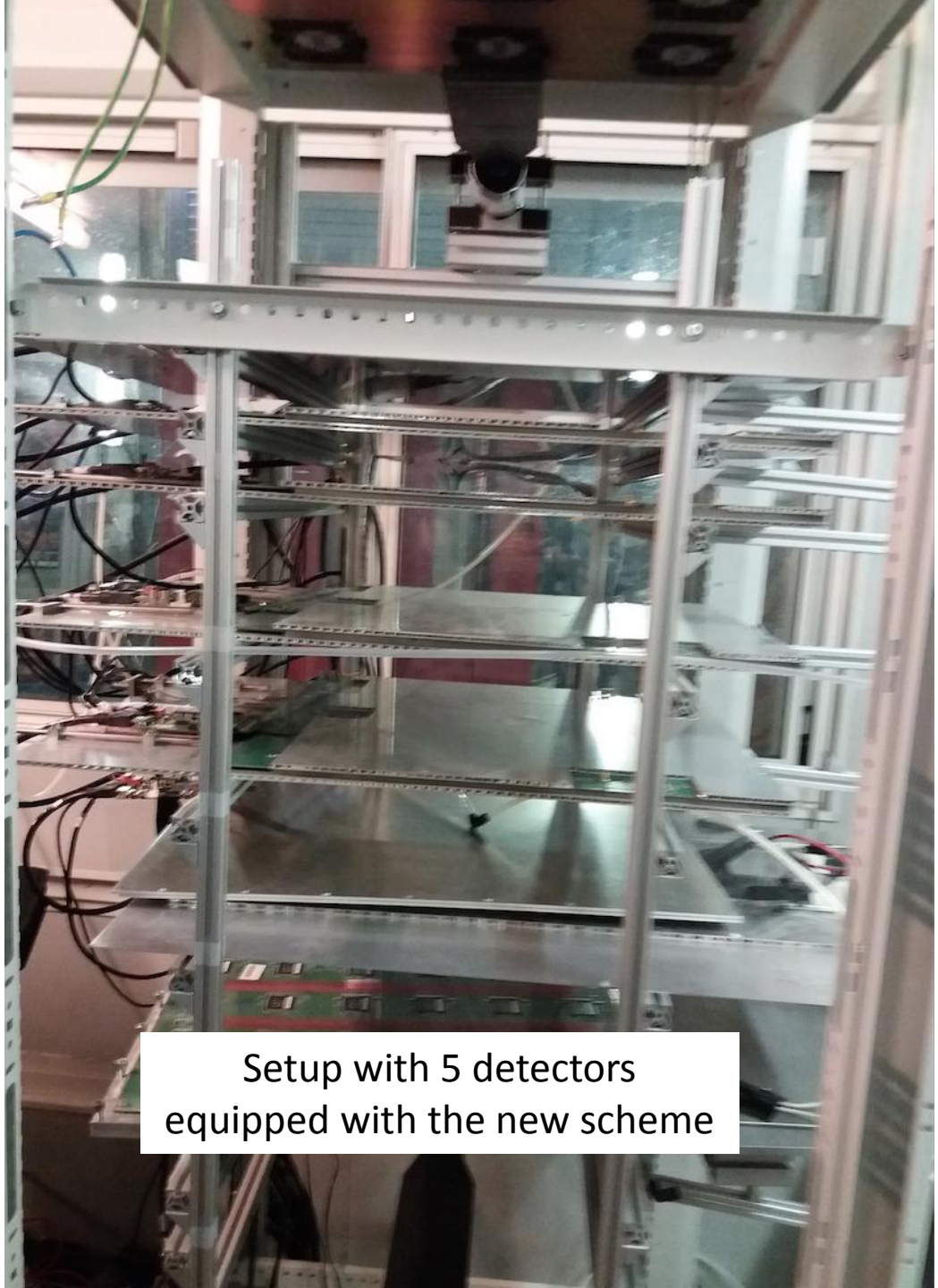
One can read the signal from both sides and get profit of the difference in time arrival to improve the position resolution and get the absolute time as well.

The scheme was used to design a new PCB with lozenges structure and 3 directions.

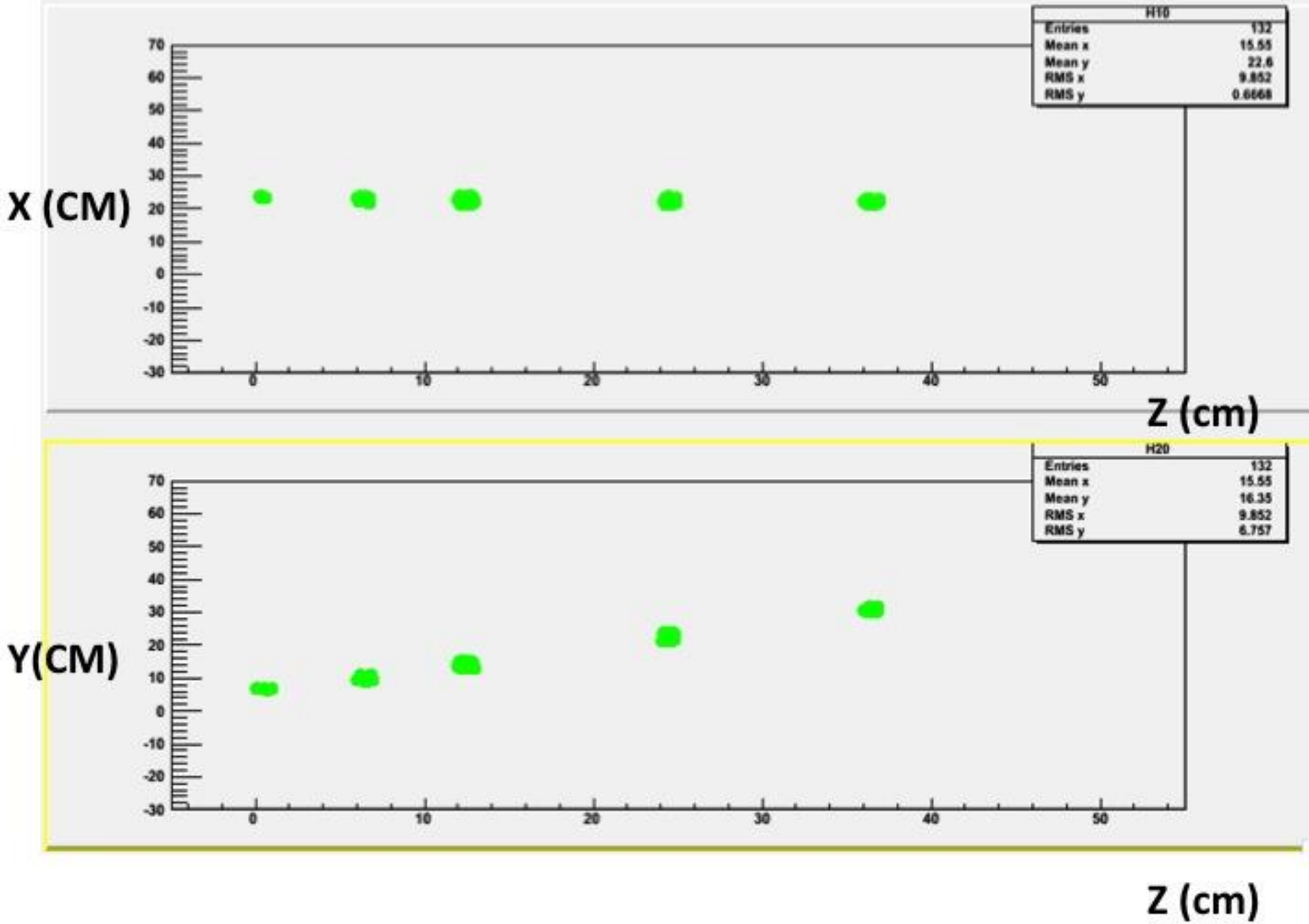




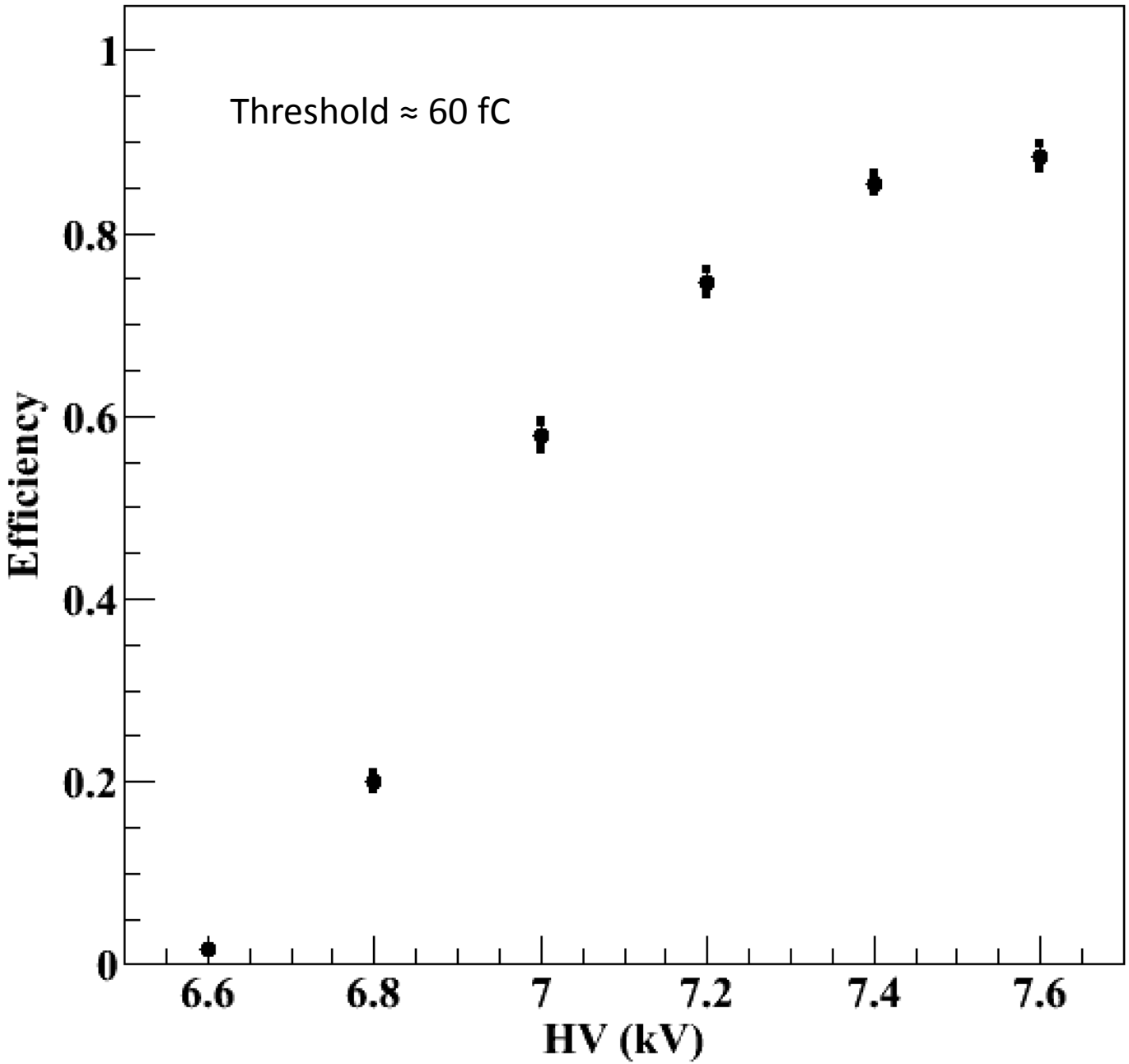


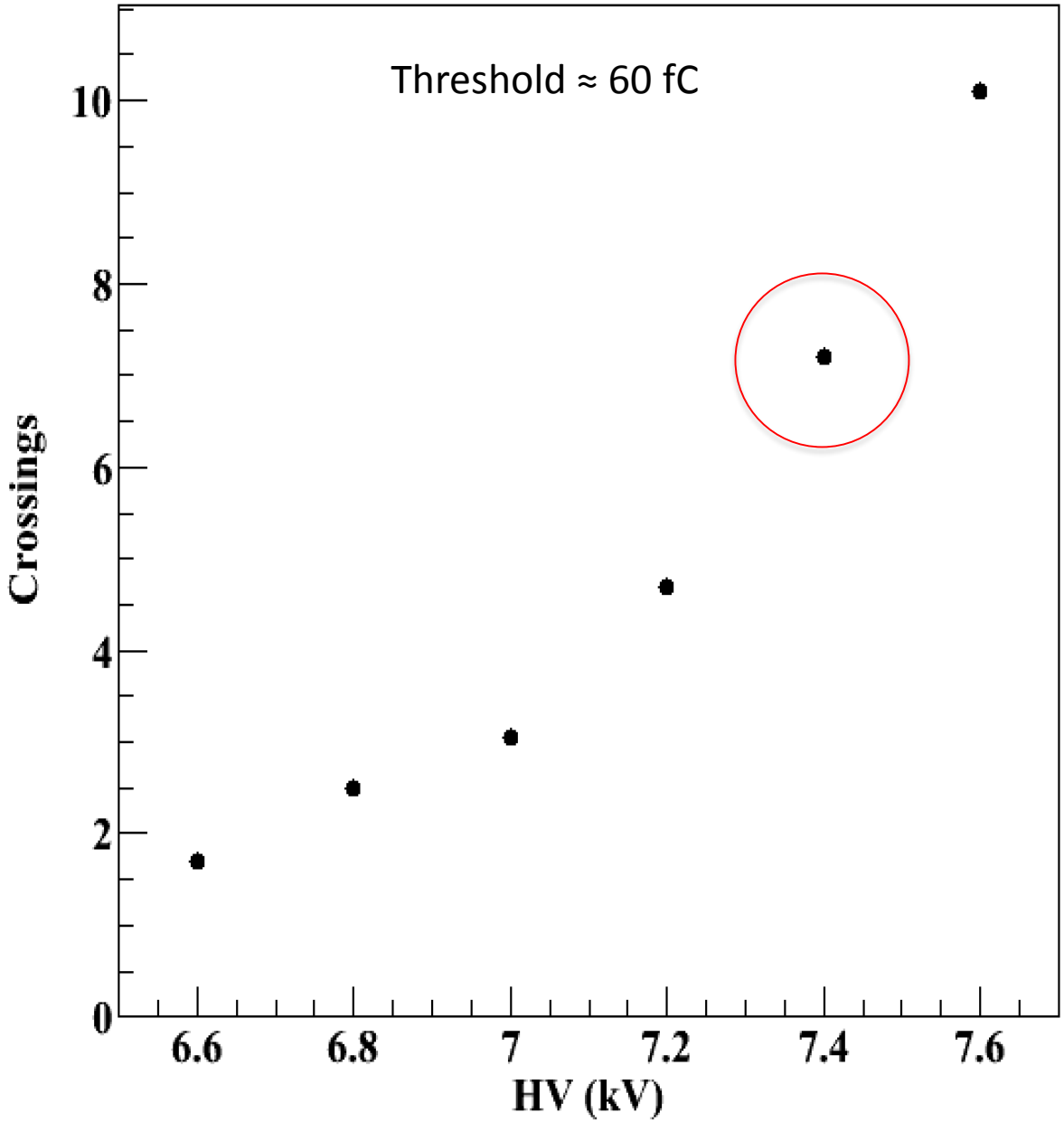


Setup with 5 detectors
equipped with the new scheme

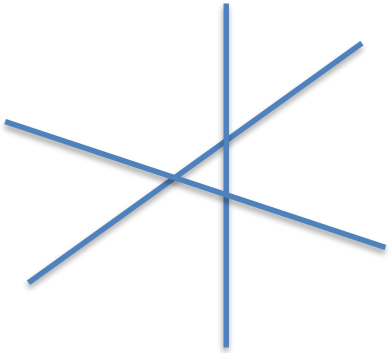

H10
Entries 132
Mean x 15.55
Mean y 22.6
RMS x 9.852
RMS y 0.6668
X (CM)
Z (cm)
H20
Entries 132
Mean x 15.55
Mean y 16.35
RMS x 9.852
RMS y 6.757
Y(CM)
Z (cm)

Efficiency vs HV

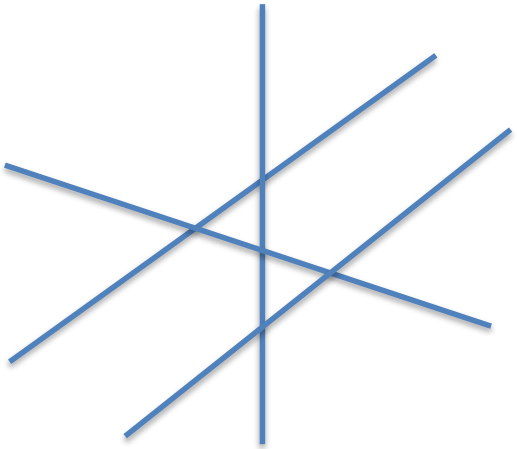




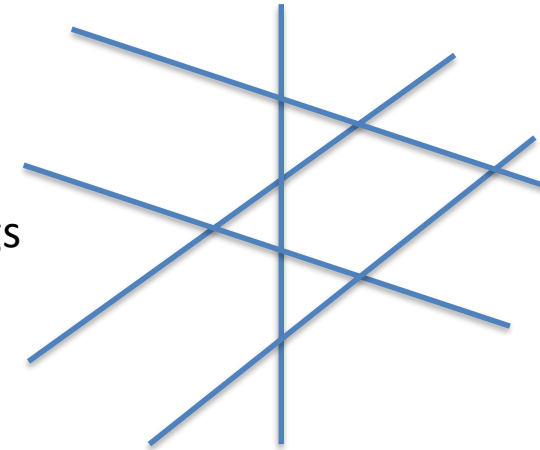
3 crossings



5 crossings

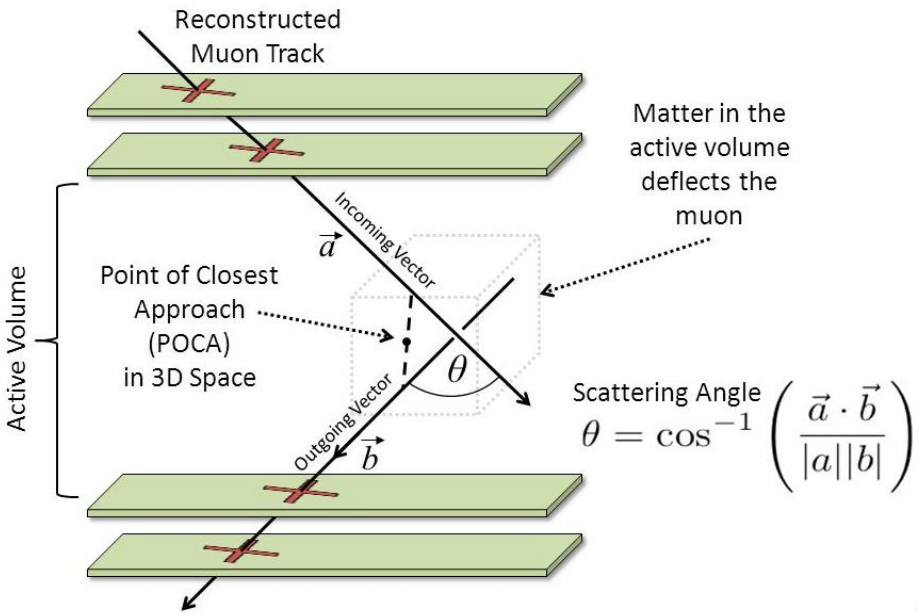


8 crossings



The new concept was patented by the Lyon university and the CNRS under **PCT/EP2018/053561-FR3062926, author : I.Laktineh**

A good amount of funding is dedicated to demonstrate a large setup with the aim to use this setup to detect dense object hidden in containers.

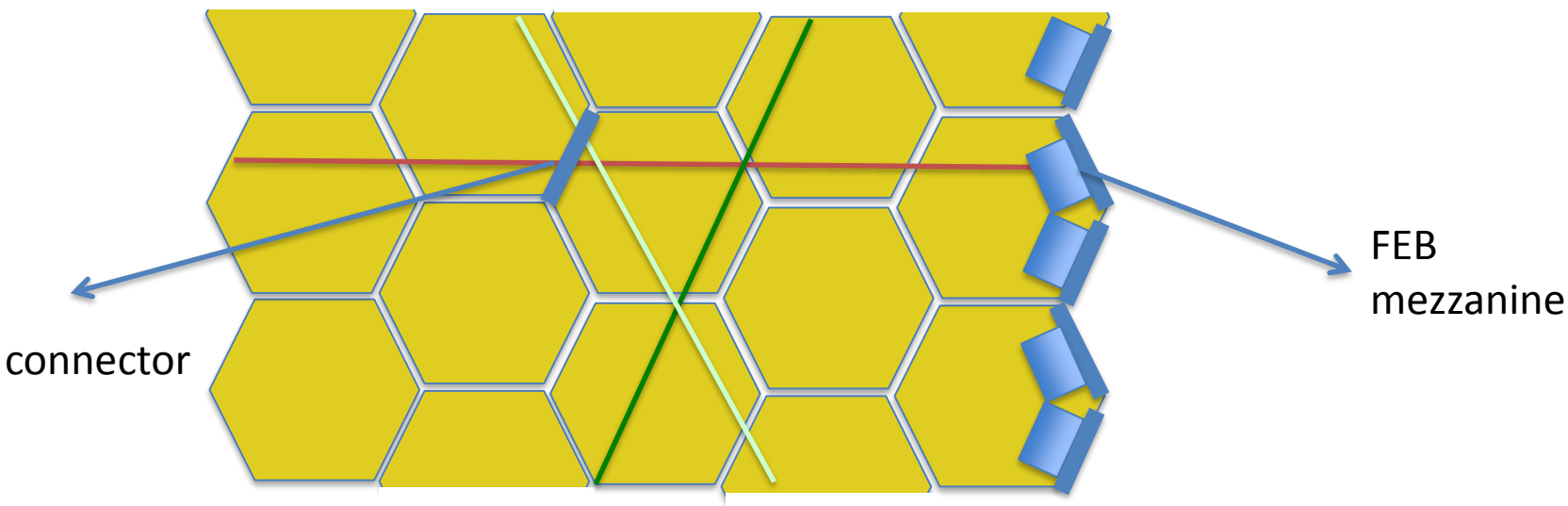


Ongoing work

How to build larger PCB?
Using PCB-unit
A PCB-unit will be equipped with connectors allowing:

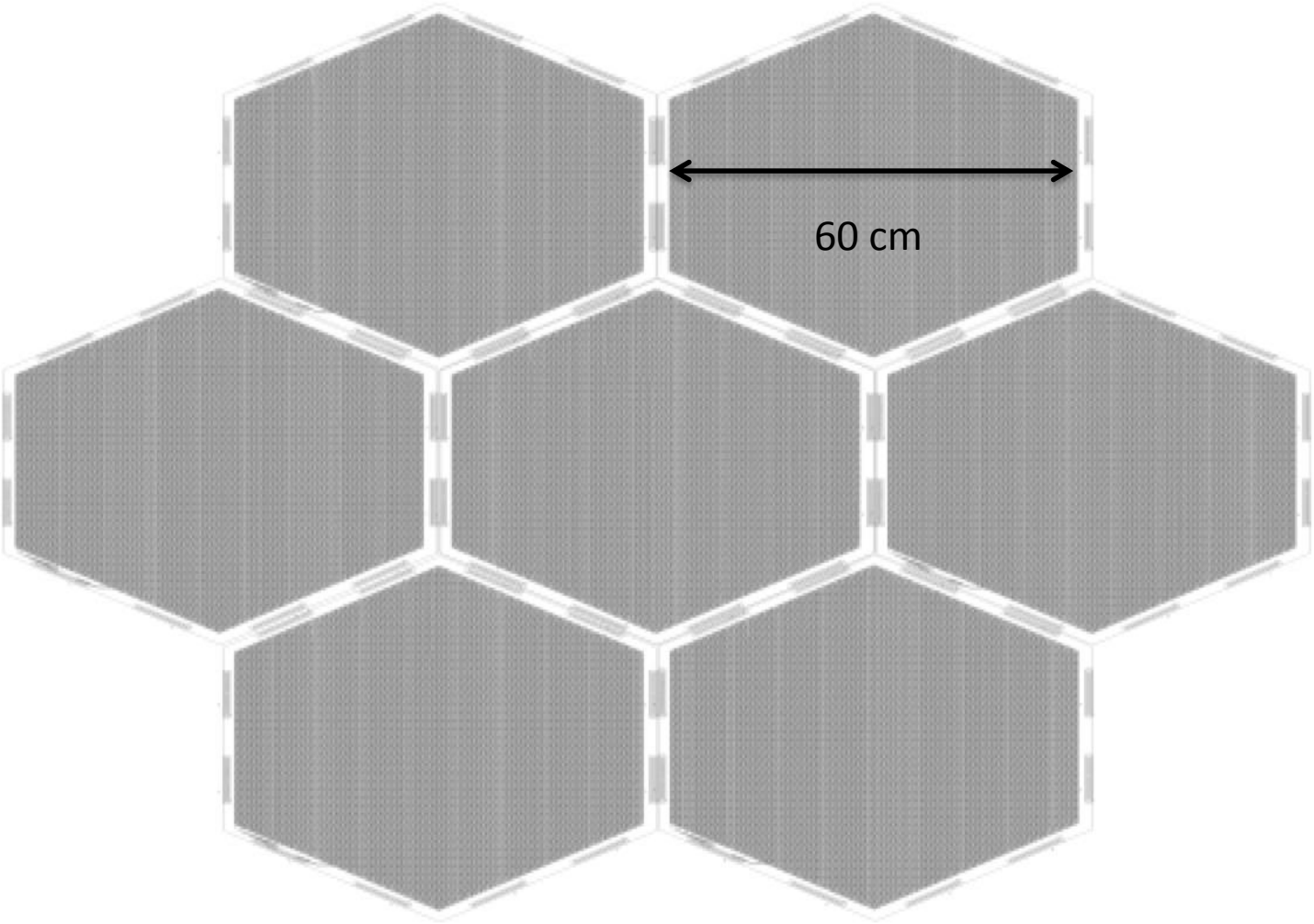
- ❑ Either to connect two PCBs
- ❑ Or to plug a mezzanine that host the ASICs and the DIF's FPGA as well as Ethernet or wireless communication protocols

HR2 is a low impedance ASIC using a current conveyer preamplifier.



The connector should have a low inductance. In this case long strips of several meters (maybe tens of meters) could be used as far as the signal reduction is acceptable. This will represent a huge reduction of electronic channels.

Schematics



We are working on a simple mezzanine to host the HR and the FPGA

Conclusions

The new scheme could be of a big impact on experiments that needs large area detectors while requiring high granularity.

It was validated for cosmic detection. For hadronic showers test beam is needed. Hopefully this can be done in next TB.

Some work is needed to estimate the cost reduction but a reduction factor of 100 in electronic channels seems to be easily achieved.

The scheme is not limited to gaseous detector….we are developing other devices based on different technology.