Development and simulation of a new preshower detector for the FASER experiment at the LHC

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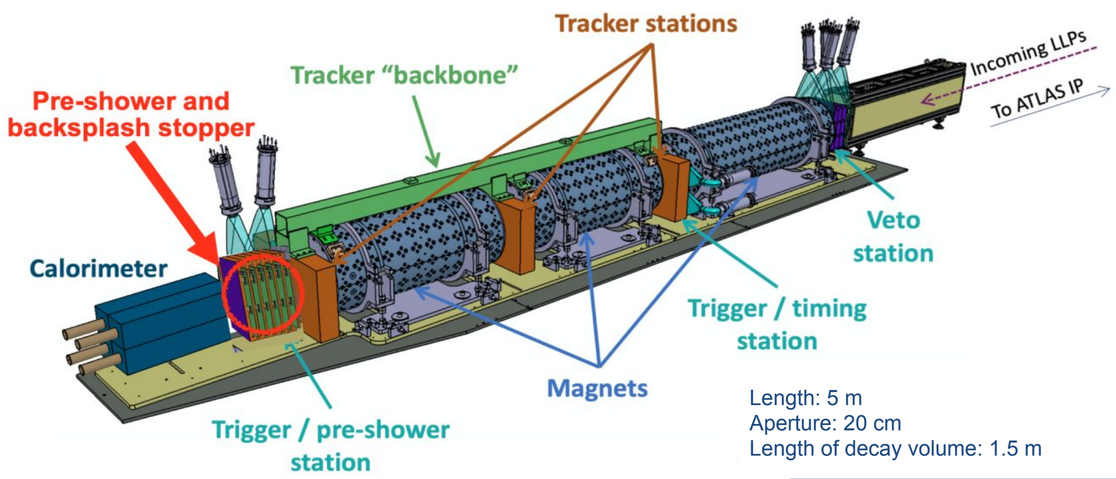
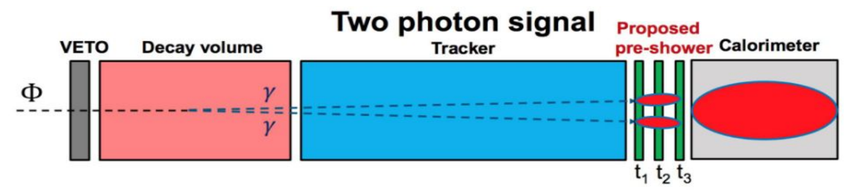
Faser Experiment

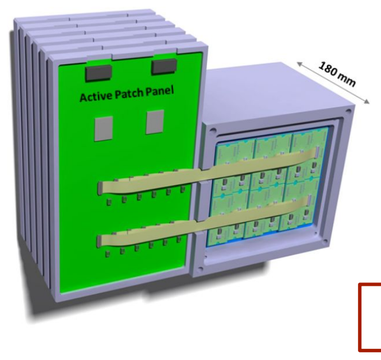
- The **ForwArd Search ExpeRiment (FASER)** at the LHC is precisely aligned with the collision axis in ATLAS, 480 m away from the collision point.
- Its design is optimized for the search of **Long Lived Particles (LLPs)** decaying into two charged leptons, like dark photons. Those particles are advocated to be the portal between the SM and a still undiscovered hidden sector.
- **Enable the measurement of LLPs decaying into two photons:** axion-like particles (ALP), CP-odd scalars.



Length: 5 m
Aperture: 20 cm
Length of decay volume: 1.5 m

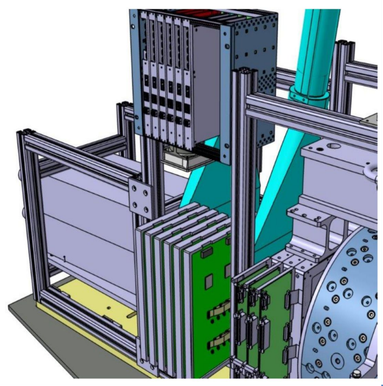
The new Pre-shower Detector





- Requirement: **detect and discriminate two photons with O(1) TeV energy and 200 μm separation.**
- Composed by six tungsten layers, each followed by plane of monolithic silicon pixel detectors in SiGe BiCMOS technology.

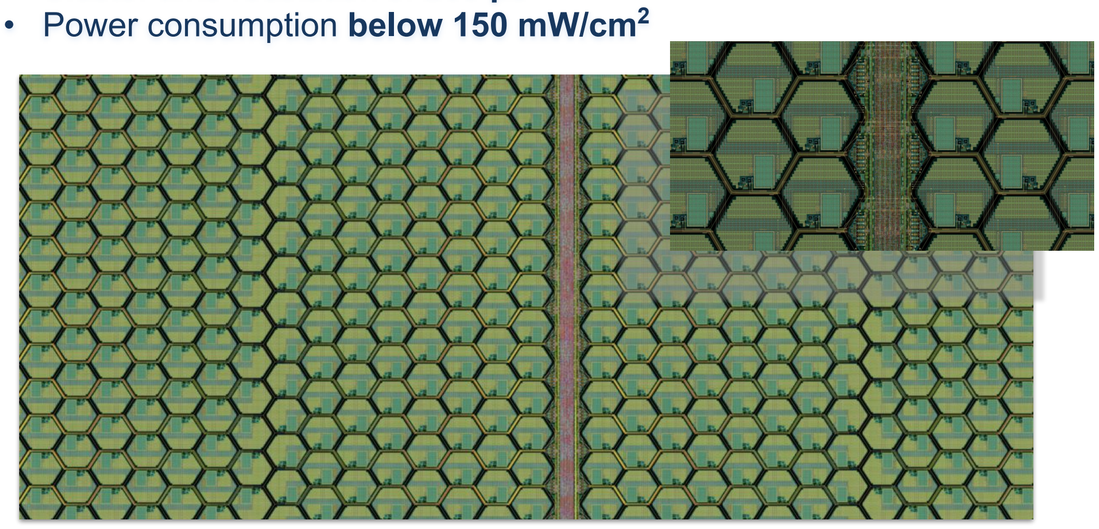
High Granularity Detector

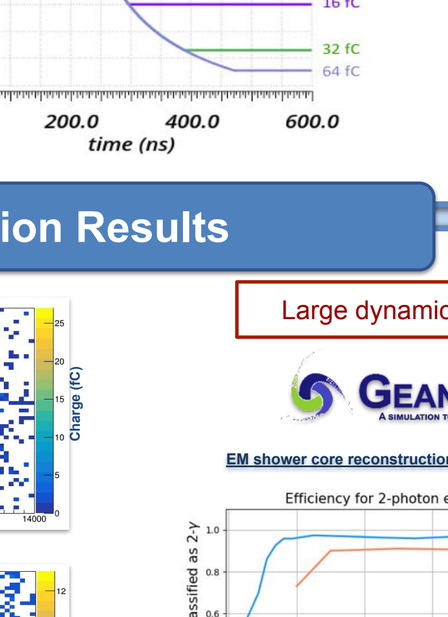


- It will **measure ultra-collimated EM showers** and **identify their charge centroid**.
- Data during the last year of the LHC Run 3 period.

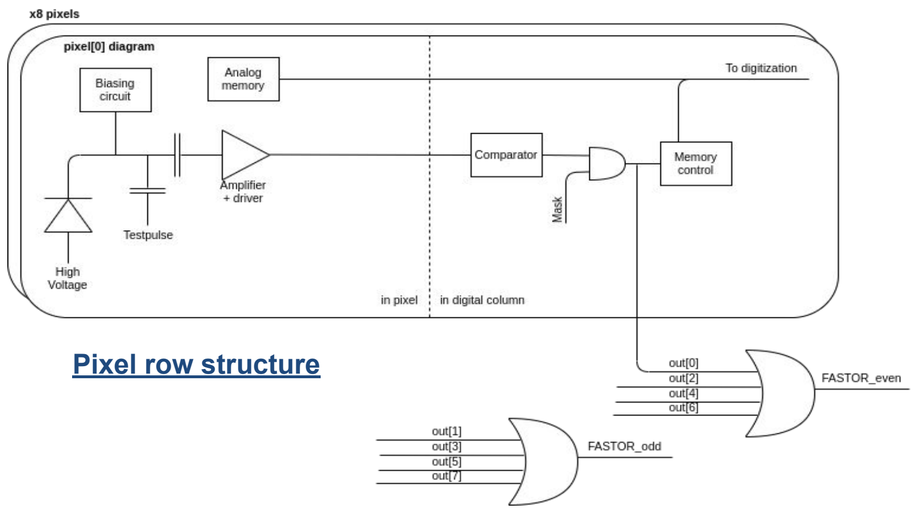
The Detector ASIC

- **Monolithic ASIC** in **130nm SiGe BiCMOS** from IHP microelectronics,
- Design in collaboration between **CERN, University of Geneva and KIT**
- **Image & Track** core of E/M shower
- The ASICs will have **hexagonal pixels of 65 μm side** and an active area 23.5 x 15.0 mm^2
- **Local analog memories** are used to store the charge
- **Ultra fast readout** with no digital memory on-chip to minimize the dead area
- Cluster time resolution of **200 ps**
- Power consumption **below 150 mW/cm^2**



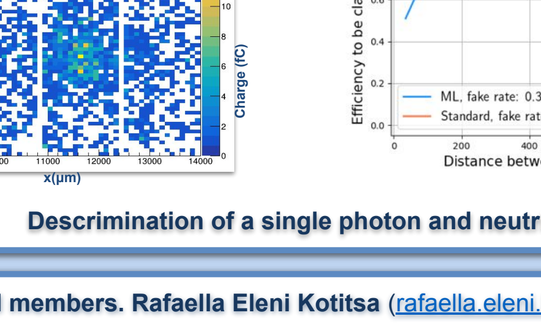


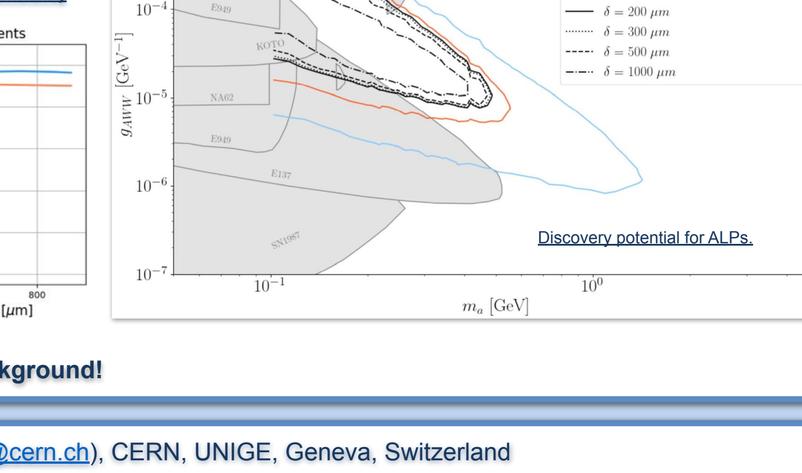
Super-pixel structure



Pixel row structure

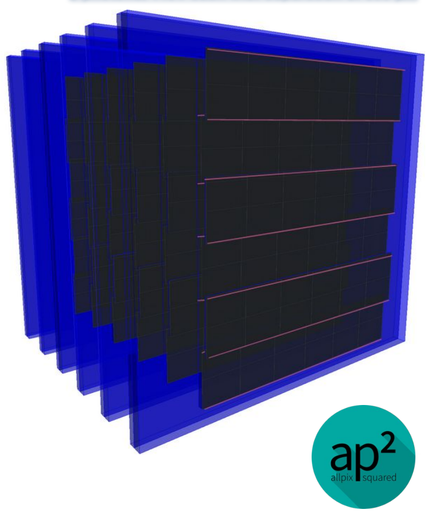
ASIC structure

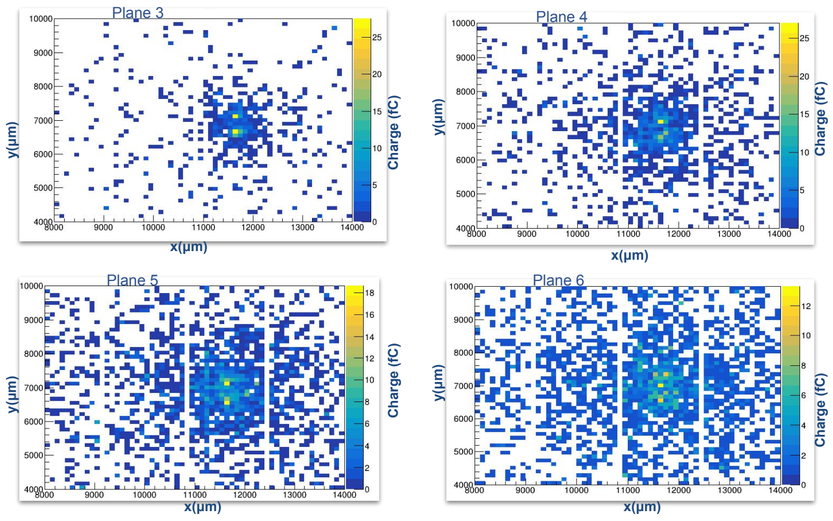




Simulation Results

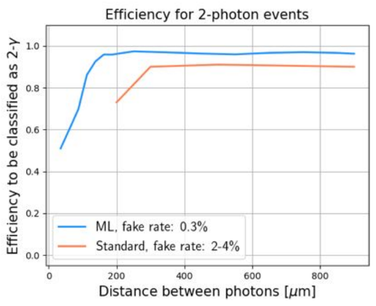
2 photons, 1TeV each with separation of 500 μm





Large dynamic range charge measurement & Possible space charge effects

EM shower core reconstruction efficiency



Discovery potential for ALPs.

Descrimination of a single photon and neutrino background!

Acknowledgements to the FASER collaboration and all associated members. **Rafaella Eleni Kotitsa** (rafaella.eleni.kotitsa@cern.ch), CERN, UNIGE, Geneva, Switzerland