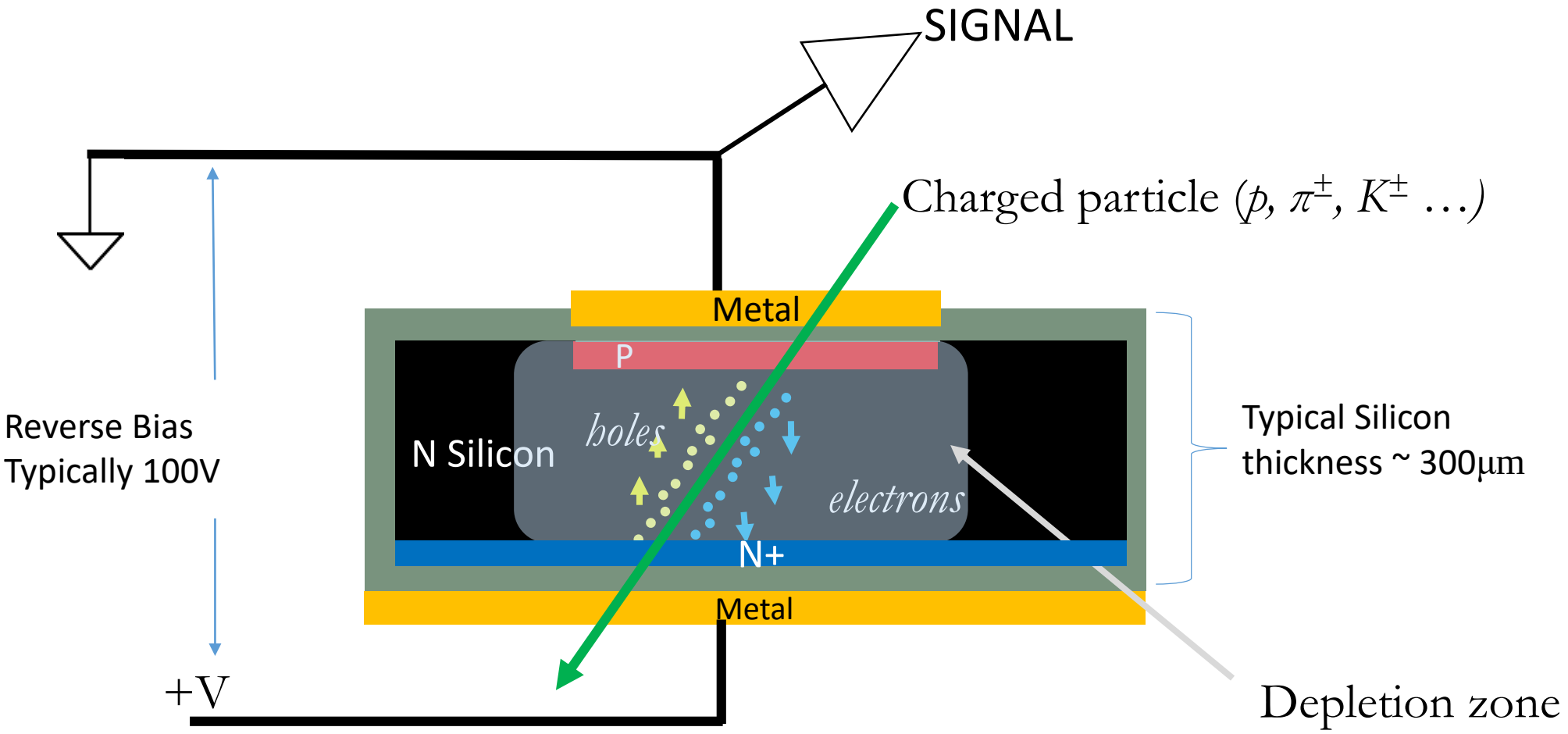
Particle ID in WCTE

Pradeep Sarin, IIT Bombay
+ 4 x PhD students + 4 x UG research interns
+ many collaborators: past, present and future

Silicon detector : "Solid State Drift Chamber"

PN diode operated in deep reverse bias to deplete the bulk of thermally generated (noise) carriers

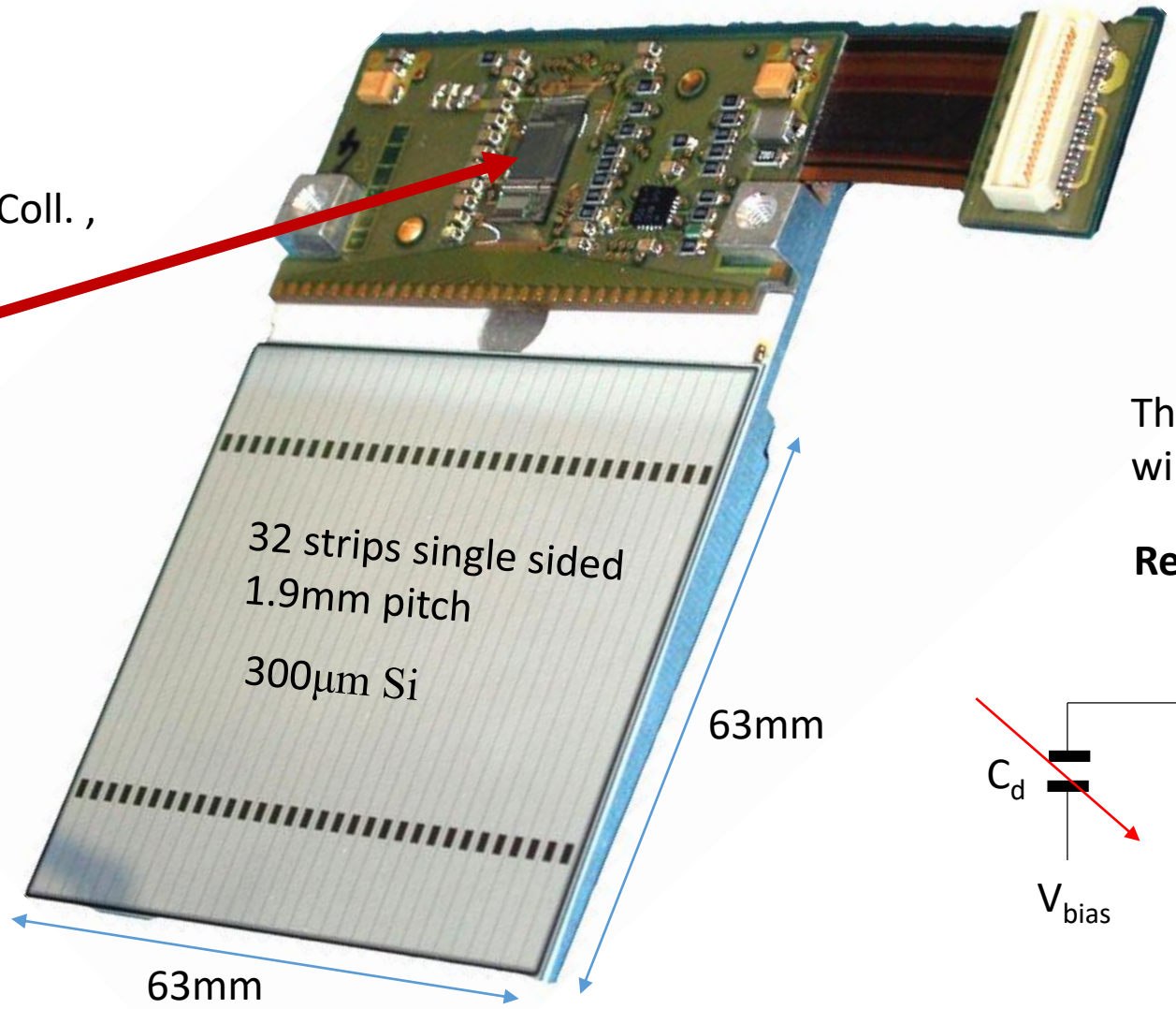
MIP generates signal e-h pairs – picked up as induced charge in the metal electrodes



1st Gen Silicon Strip detectors

https://cds.cern.ch/record/432224/files/p162.pdf

APV25
Imperial Coll. ,
RAL, UK



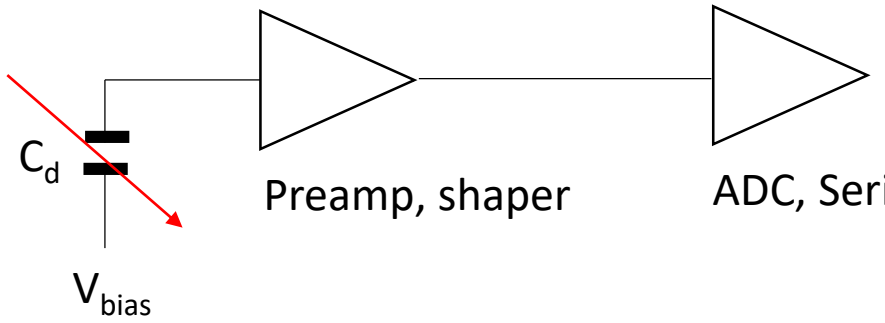
Spares from large inventory manufactured in India for CMS @ LHC

Pic of fully assembled module from
Dr. Anita Topkar, BARC Electronics Division

Approx. 20 bare sensors available

These are spare sensors, stored for a long time – will have to check yield (noisy strips?)

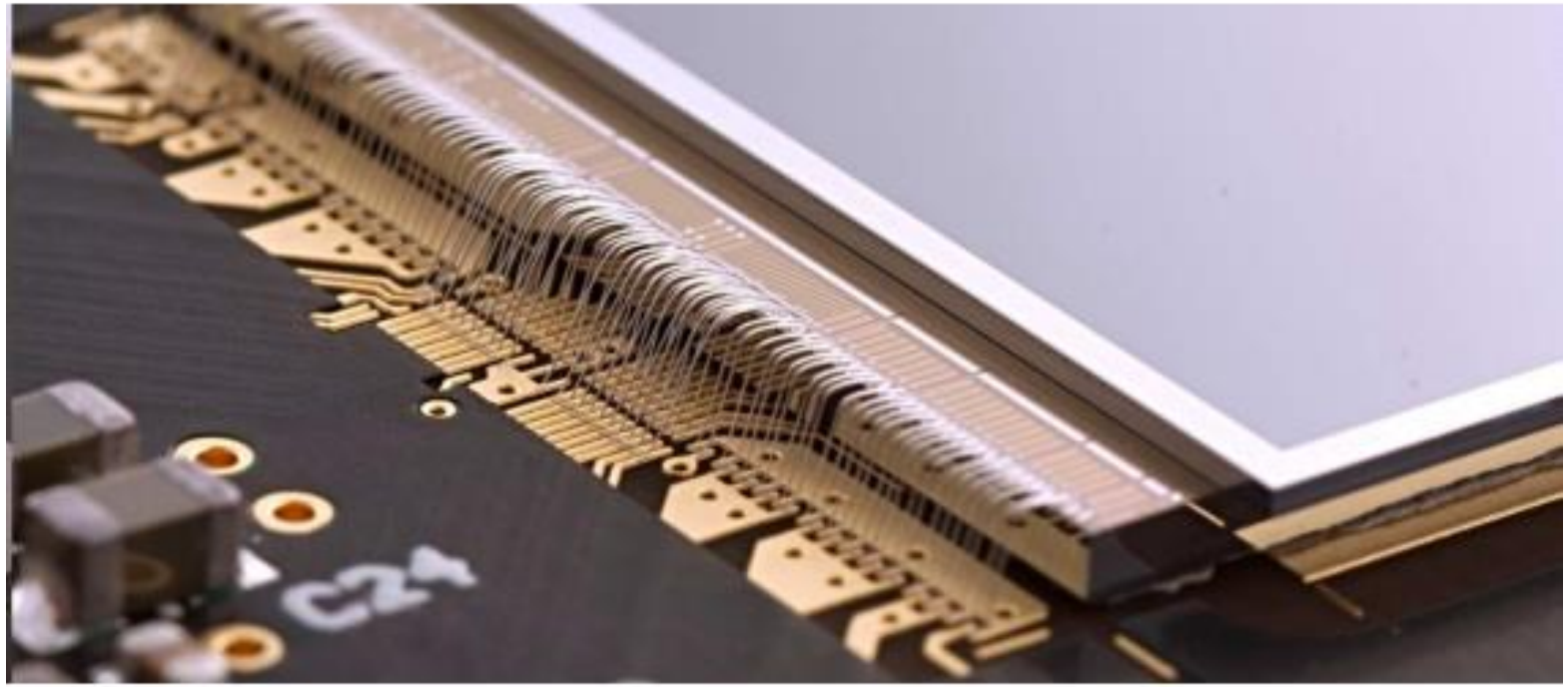
Readout electronics needed

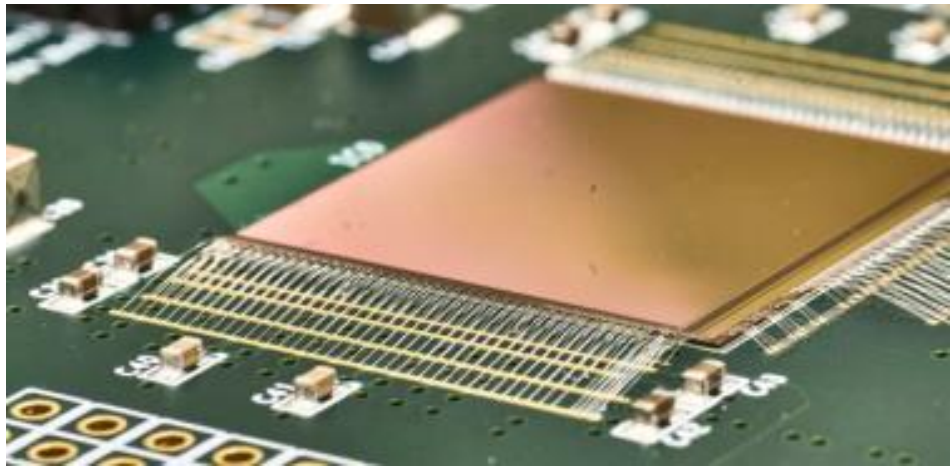


SKIROC (CALICE, IN2P3) candidate for readout?
http://hal.in2p3.fr/in2p3-00308913/document

Challenge:

Systems integration with high-end readout chips designed for millions of channels' readout @ 40MHz

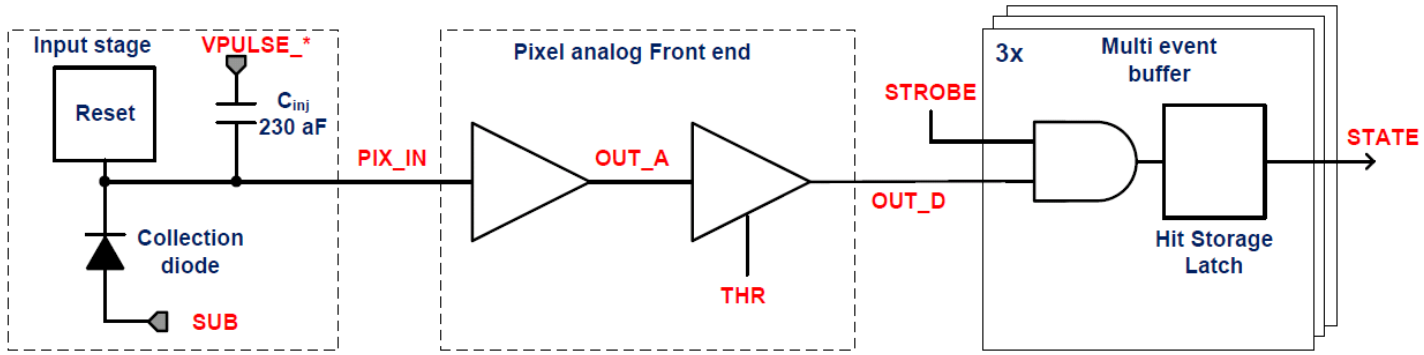


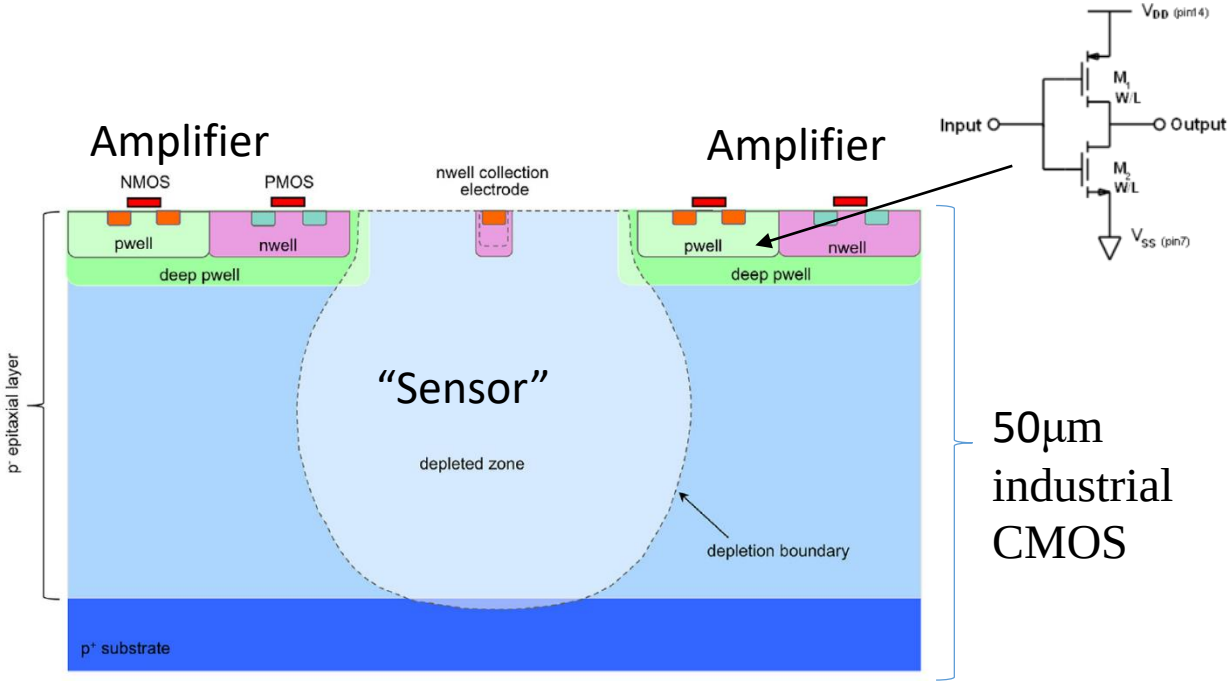


Images courtesy of Ian McGill, CERN Bonding Lab

Current Gen: MAPS

Monolithic Active Pixel Sensors





50µm industrial CMOS

Sensor
+ Analog FE
+ Digitizer
+ Trigger
+ Buffer RAM
= Monolithic "Active" Sensor

Images from
Heinz Pernegger, Tanu Kugathasan
CERN-EP
Talks at VERTEX2018 conference
https://indico.cern.ch/event/710050/

MIMOSA28 – testbeam setup for BESIII @ DESY (Strasbourg)
https://doi.org/10.1016/j.nima.2020.164810

ALPIDE (ALICE)
https://doi.org/10.1016/j.nima.2016.05.016

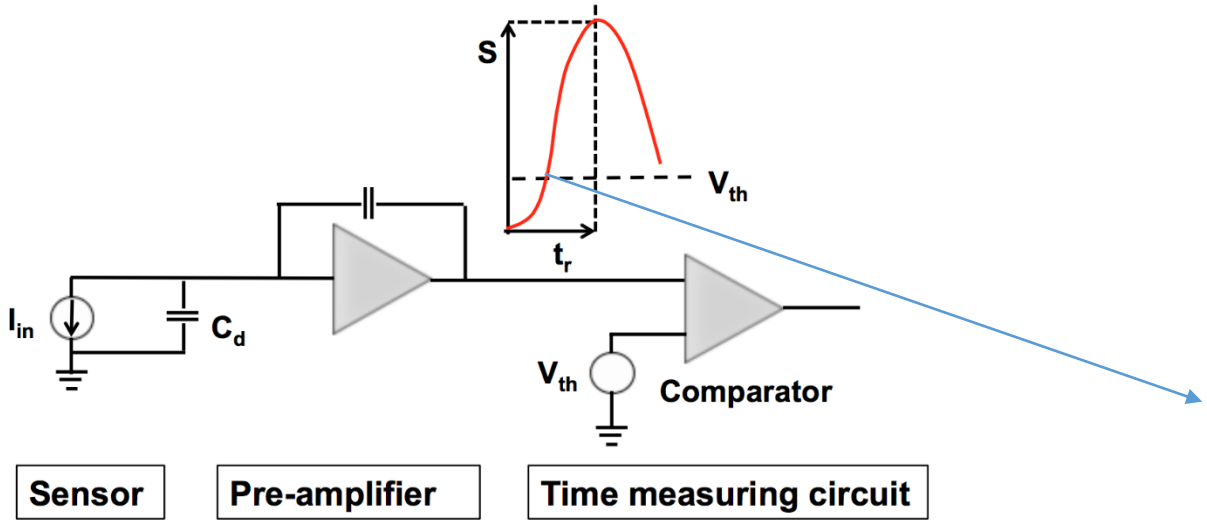
MALTA, ATLASPix, MonoPix (ATLAS)

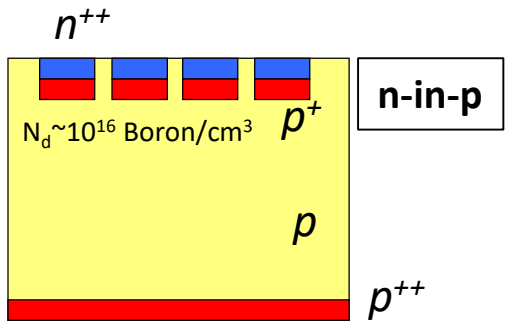
Future: UFSD

Ultra Fast Silicon Detectors "4D tracking"

Response is optimized to get hit timing *in addition* to hit location
Tracking + TOF in one detector!

University of Turin, INFN Turin, Piedmont, Torino, FBK (2015-)





n,p doping is fine tuned to achieve very high bias E field in the detector

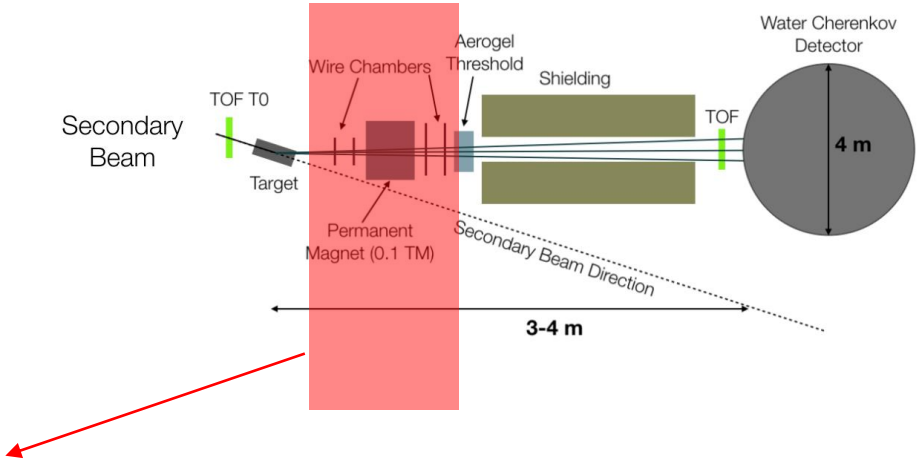
LGAD (Low Gain Avalanche Detector

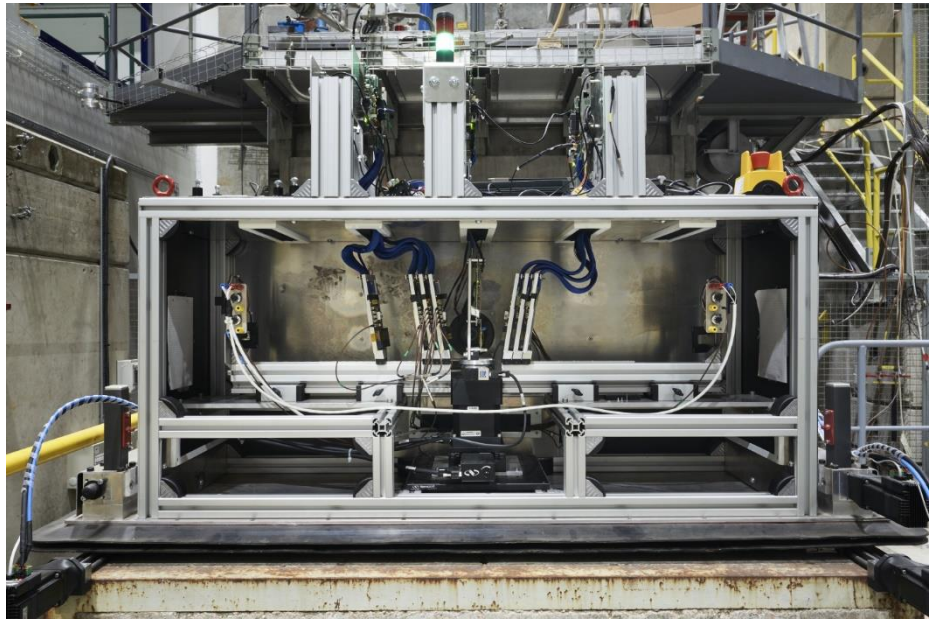
Time of arrival of the signal (and hence particle hit) is precisely measured.

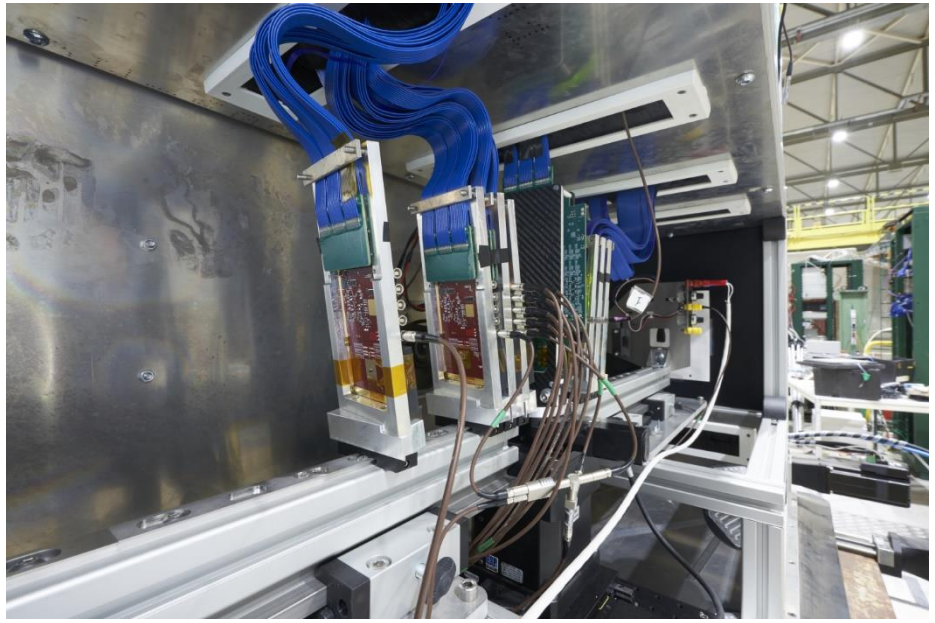
Figures from Nicola Cartiglia's talk at VERTEX2018 conference

WCTE Setup

Typical testbeam settings used CERN east







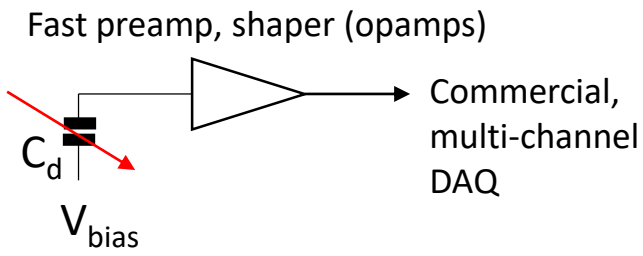
Note:
Silicon detectors need to operate in the dark!

Such a setup is typically enclosed in a light shield.

WCTE Setup
– as simple as possible, and no simpler

Options:

1) Use 1st gen CMS sensors?
   – very coarse x,y resolution
   – need to stack two back-to-back to get x,y
   + readily available ~
   + possibly, discrete readout: 32 ch. per sensor



2) Beg, borrow, steal a new generation MAPS set of devices…
   Several recent and ongoing testbeam tests of new gen. devices lead to older modules being set aside
   Contacting collaborators to check availability

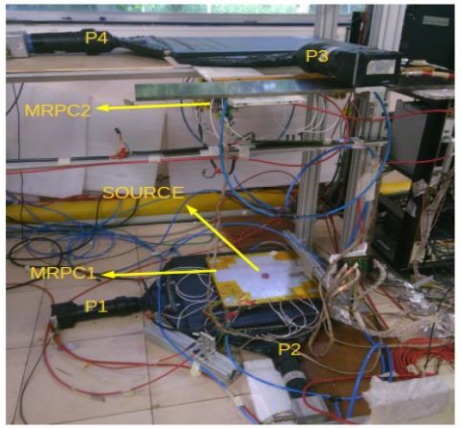
WCTE TOF

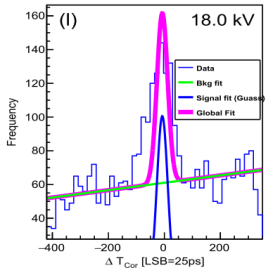
India Neutrino Observatory (INO)
Tata Institute of Fundamental Research (TIFR) is nodal R&D center for RPC fab

Have plenty of spare capacity to fabricate up to 2m x 2m RPC

Basic testing with lab sources possible @ TIFR

Gas distribution system at CERN?
High res electronics?





Eg: a PhD student's test setup to make a PET scanner with 2 multi-gap RPC's

Summary

Working on the simplest possible silicon spectrometer suitable for WCTE needs
Position resolution and material budget of readily available sensors is a concern?

TOF: RPC's should not be a problem
Gas distribution system @ CERN?
High res electronics?