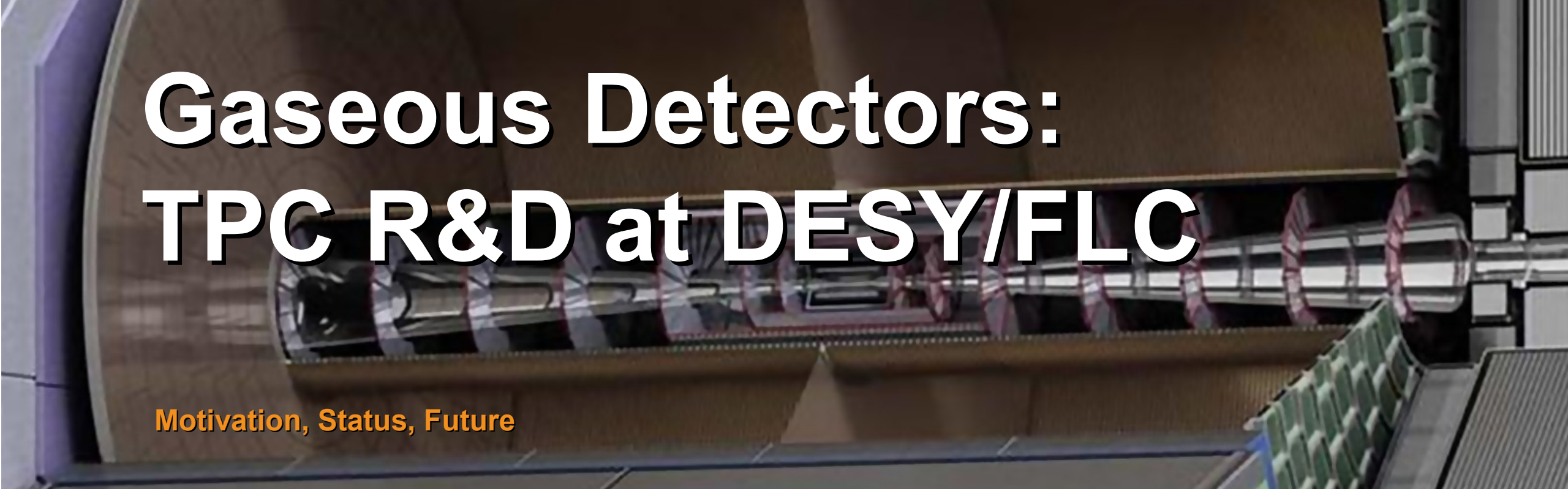


Gaseous Detectors: TPC R&D at DESY/FLC

Motivation, Status, Future

Ralf Diener

Detector R&D Meeting
DESY, 21.08.2019

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

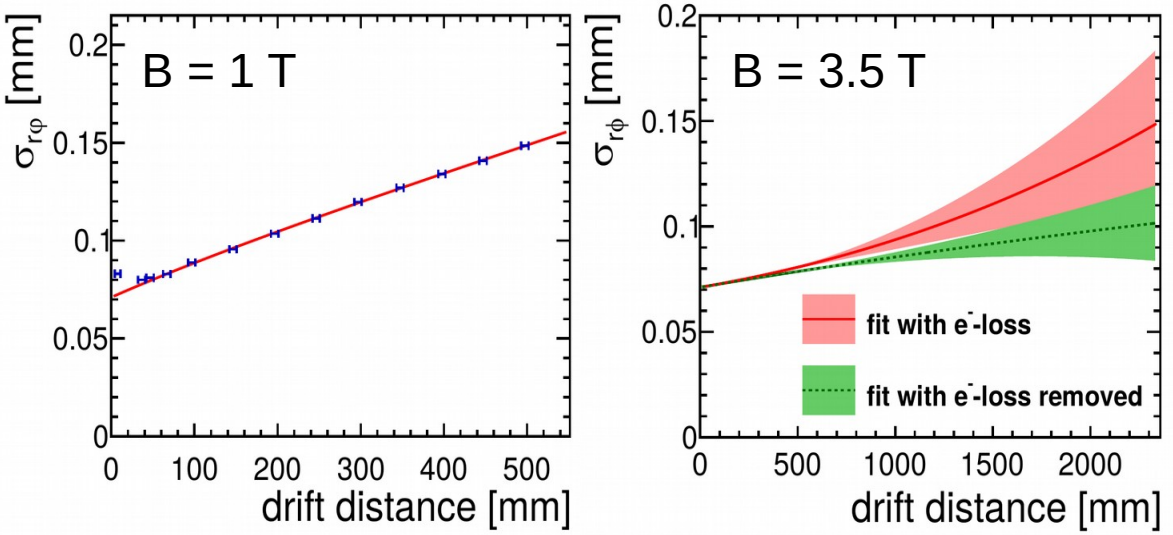
MTDTS

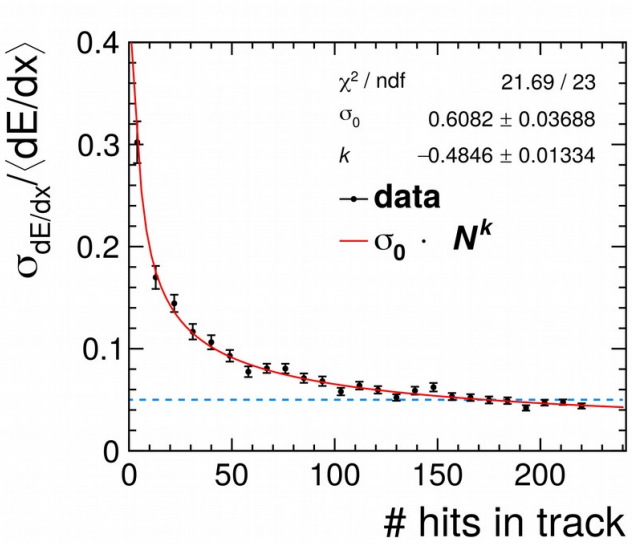
DESY.

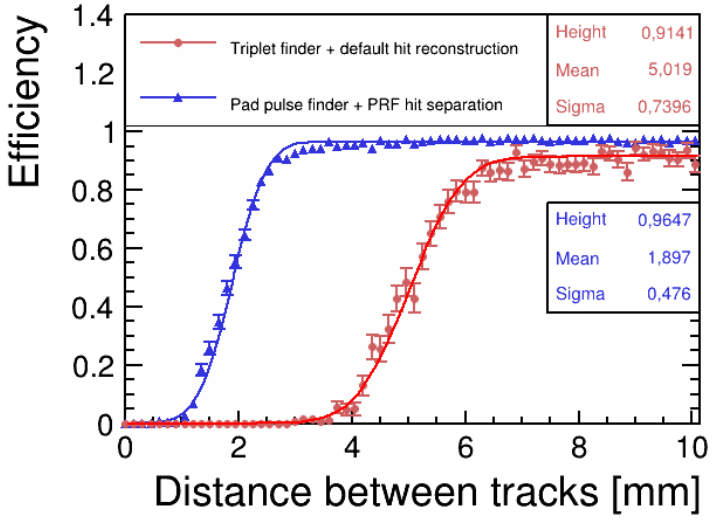
Motivation & Status

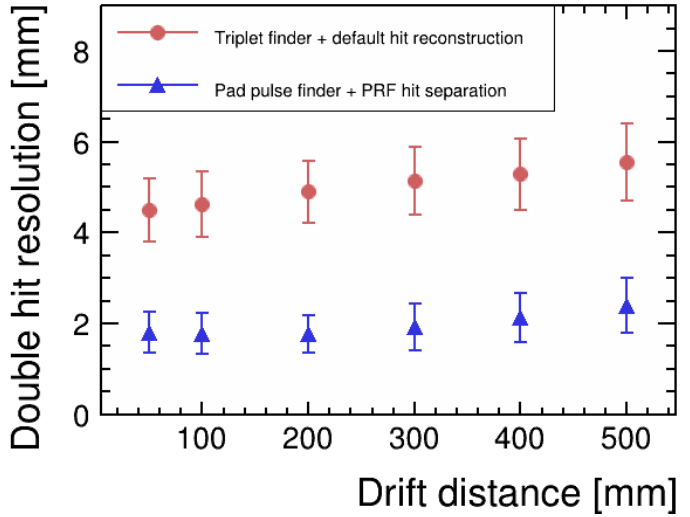
TPD R&D @ FLC

- Light weight, high precision TPC for ILD @ ILC
- Shown in prototype measurements
  - Meeting requirement on point resolution ≤ 100 µm
  - Double hit/track separation: ~ 2 mm (pad ≳1 mm)
  - dE/dx resolution ~ 5 %
- Next step: Momentum resolution (using new Si hodoscope)



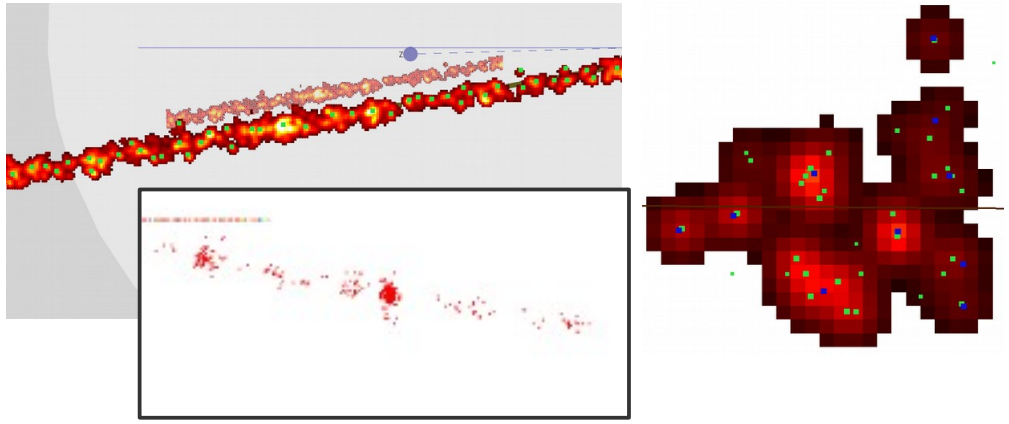






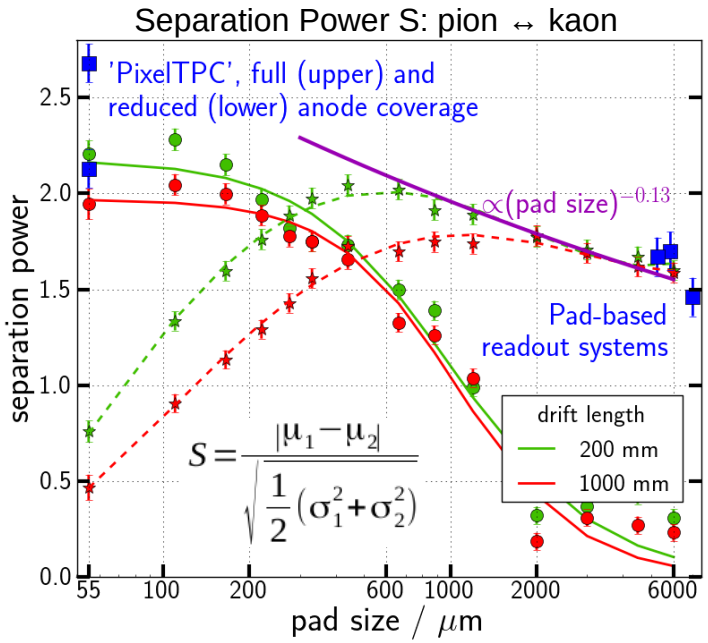
Pixelized TPC

Highly Granular Readout / Ropperi

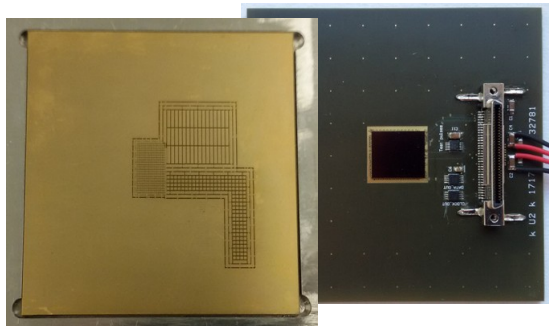


- Information in gas detector in the primary ionization clusters
  → resolve these to get most out of the measurement
  - **High, angle independent spatial resolution**
  - **Excellent particle identification (dE/dx)**

  → Combination gaseous TPC + silicon detector readout
  (highly integrated readout)
- GridPix (InGrid: TimePix+Micromegas): single e^- (*"too"* precise)
  → Ansatz: TimePix + pad board → Optimize readout granularity



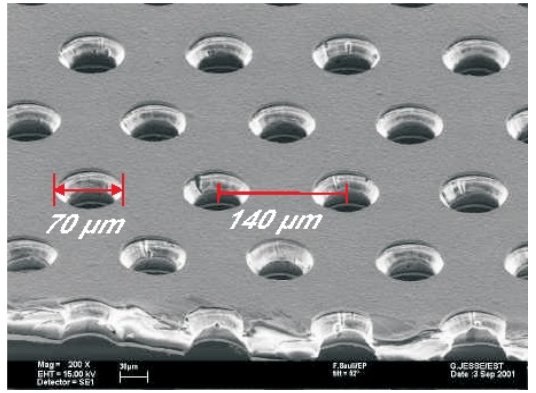
- Ongoing studies point towards pad sizes of a few 100 µm
- Hardware tests: capacitance, S/N?
  - First bonding tries not overly successful
    → Process optimization?
    New board material? Interposer?
    ...

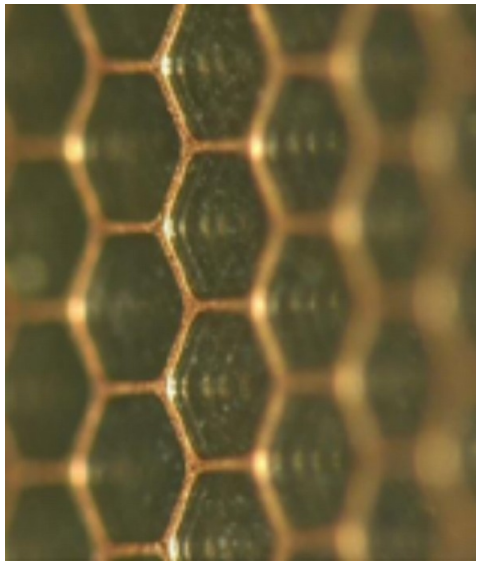


Ion Gating

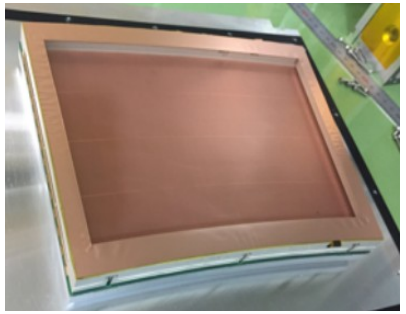
High Transparency GEM

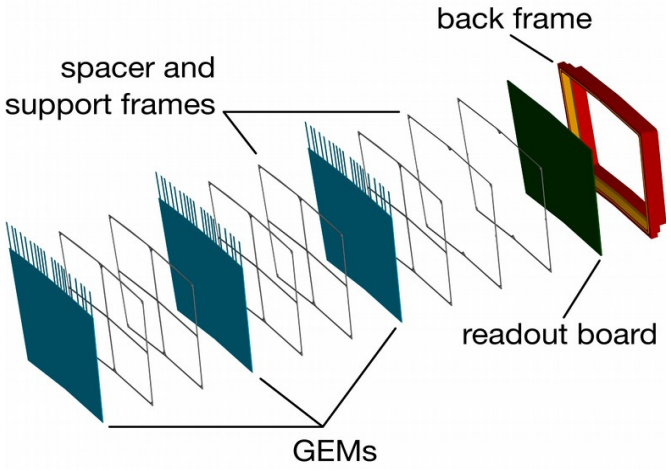
- Gating ions from the amplification stage (keeping them from entering drift volume) with highly transparent GEM
  → **Light weight, easy to integrate ion gate**





- Promising results from Japanese colleagues
  - 82.3 % optical transparency, ~ 86 % electron transmission (at 3.5 V)
  - Minimal impact on spatial and dE/dx resolution



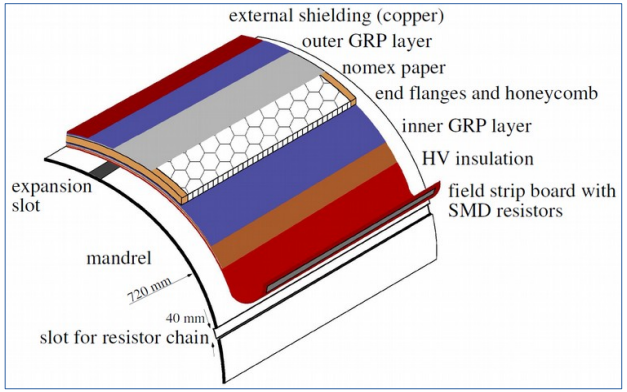


- Future @ FLC ?
  - Basic tests of transmission, amplification + ion stopping power
  - Integration into DESY readout module
    → performance test

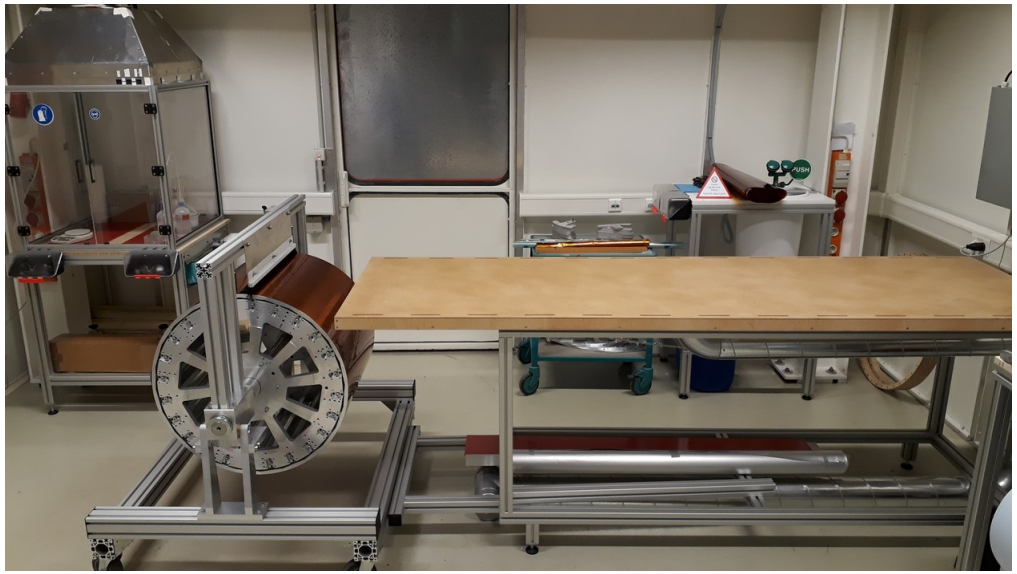
TPC Field Cage - Composite Materials & More

Scaling Up Expertise

- Field cage requirement: Integrated
  (gas vessel + field shaping + HV shielding)
  - High mechanical precision (order of 100 µm)
  - High HV stability (25 kV)
  - Low material (close to 1 % X_0)



- First iteration (external) → Does not meet all specs
- Now: develop methods and tooling
  based on experience with small prototypes
  - Lab for testing and building installed
  - Many issues solved,
    many material and procedure tests performed
  - Ongoing effort



FLC-TRCK

Manpower (head count, not FTE)

- Staff (all part time)
  - Group leader
  - 2 staff scientists
- Post-doc
  - 1 in AIDA^{2020} (silicon hodoscope)
- PhD
  - 3 finishing
  - 1 in silicon hodoscope
- Technical staff (all part time)
  - 2 engineers
  - 2 technicians
  - 1 constructor of technical items (in education)

Summary / Outlook

Gaseous Detectors @ FLC-TRCK Group

- Existing expertise to build and operate gaseous (GEM) detectors
  - Continued support and improvement of common infrastructure (test beam)

- Detector R&D:

  - GEM+Pad Readout:
    prove momentum resolution

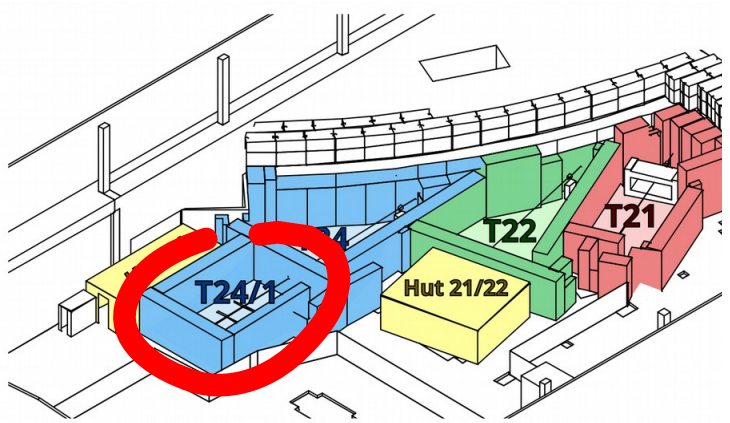
  - Gating GEM:
    studying performance + integration

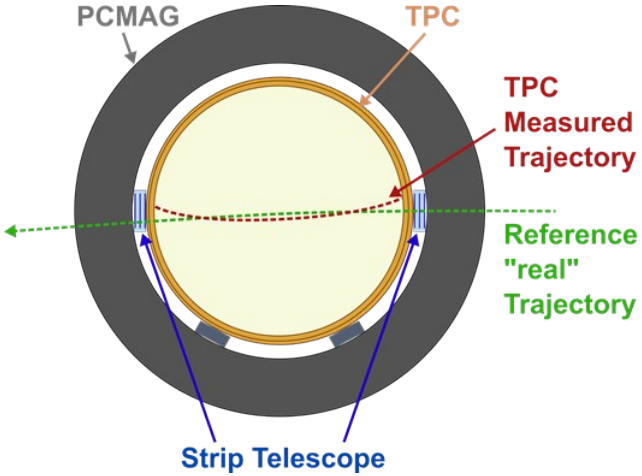
  - Cluster Readout - marrying Gas & Silicon:
    prove of principle + optimization

Backup

Area T24/1 @ DESY II Test Beam Facility

- Setup for TPC / gas detector tests in area T24/1
  - 1 T large bore, superconducting solenoid magnet mounted on movable stage (usable diameter ~75 cm)
  - All necessary infrastructure
    - Beam+cosmic trigger
    - High voltage and gas systems
    - 2PCO$_2$ cooling plant (TRACI type)
  - Close to going into user operation: precise Si strip hodoscope





Set up with support of European Infrastructure funding (EUDET/AIDA) and LCTPC collaboration