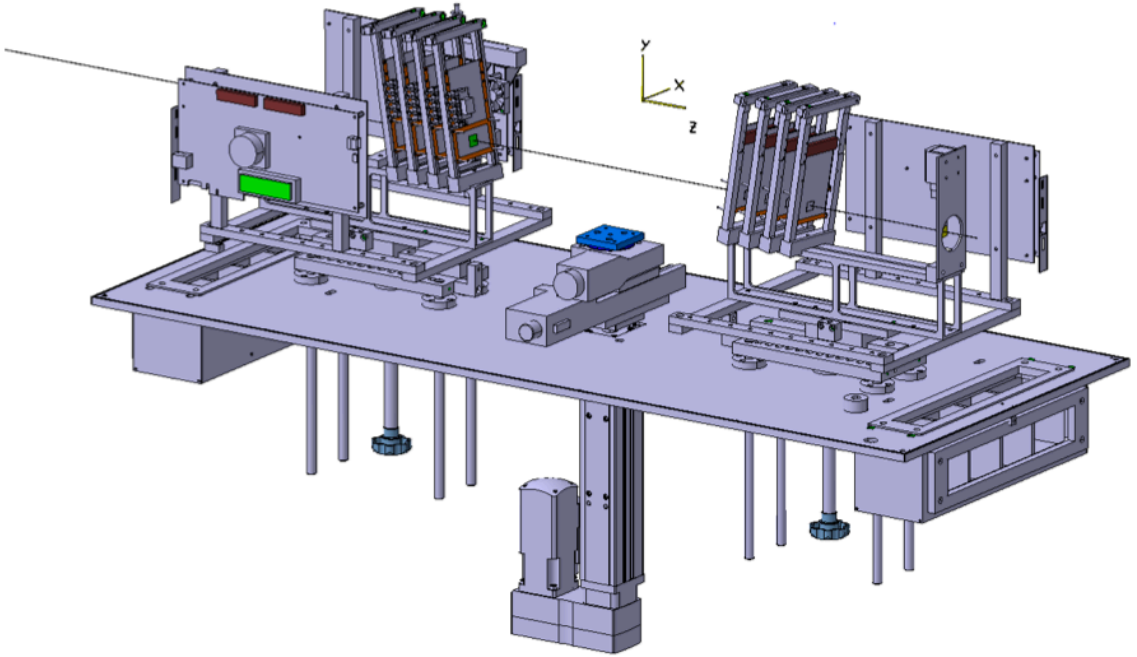
University of BRISTOL

More thoughts on test beam(s)

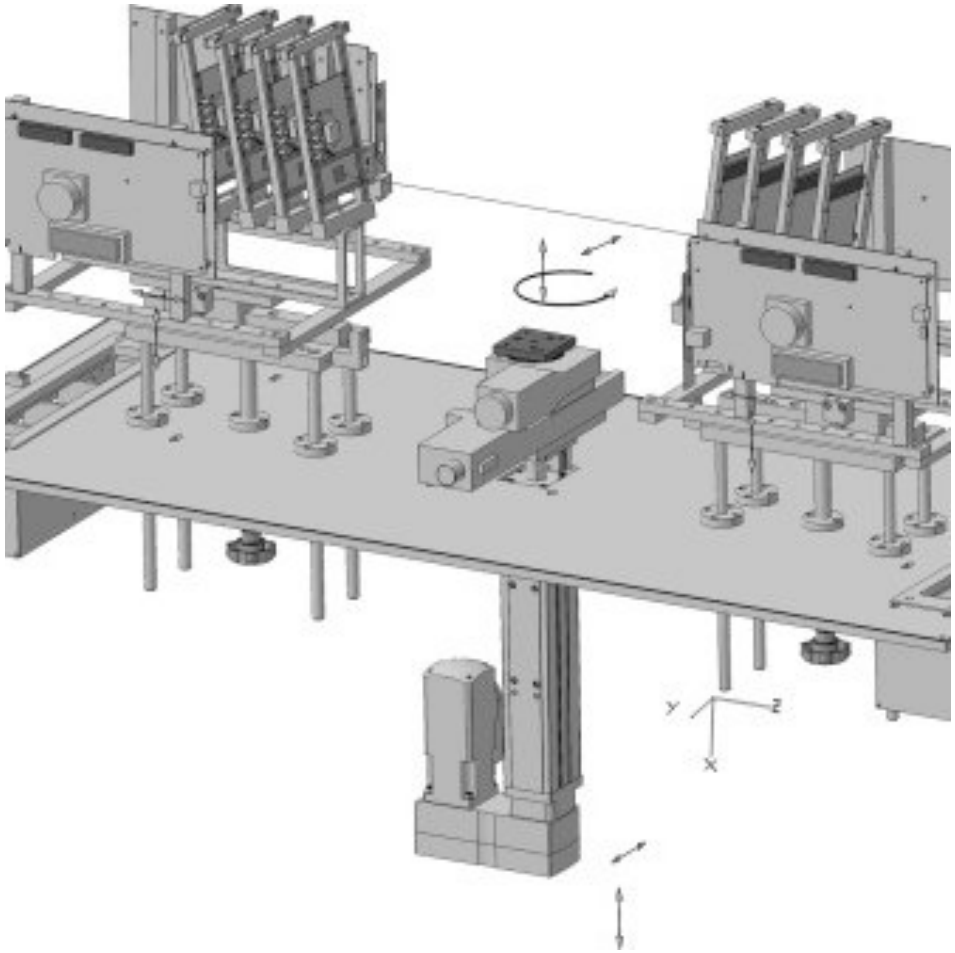


Dr. Jaap Velthuis

Why a testbeam program?

- Ultimate test of a sensor system
  - Puts down a clear marker that the system works!
  - Know where particle hits the sensor
  - “Only” way to measure efficiency, purity and position resolution
  - Performance with angled tracks

- Also gives a target we need to reach

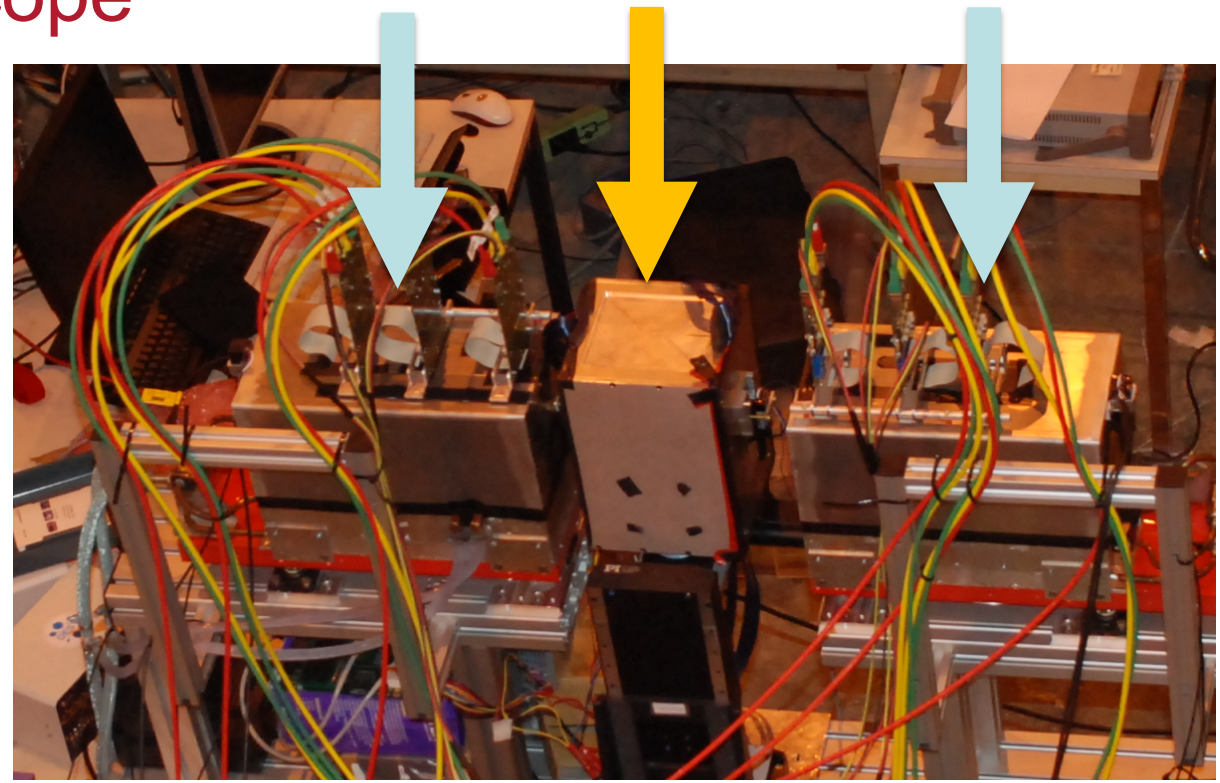


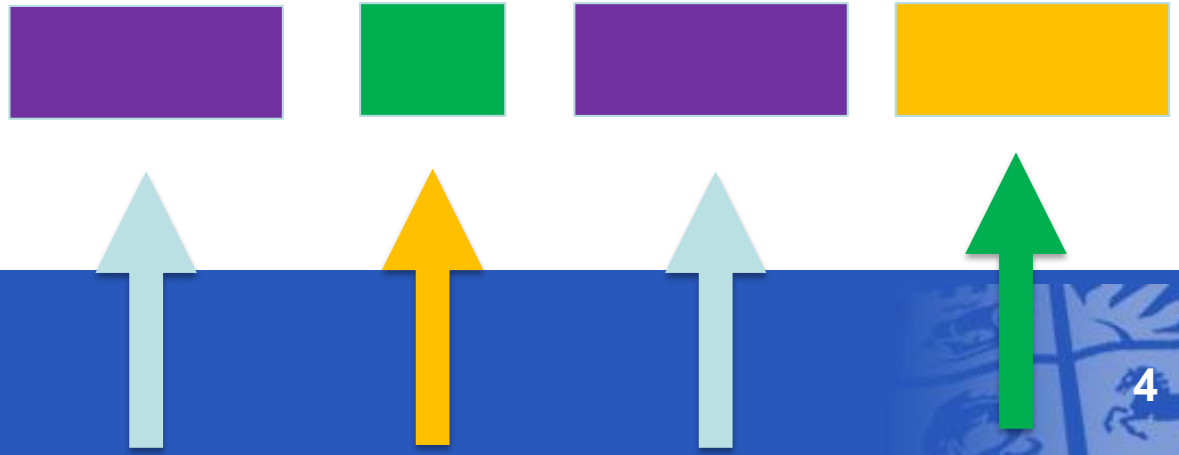
Plan

- Build a telescope in China
- Build a telescope in Europe
  - Testbeam at DESY
  - Testbeam at CERN (SPS)
- DESY testbeam time applied for for April 2022.

Proposed telescope

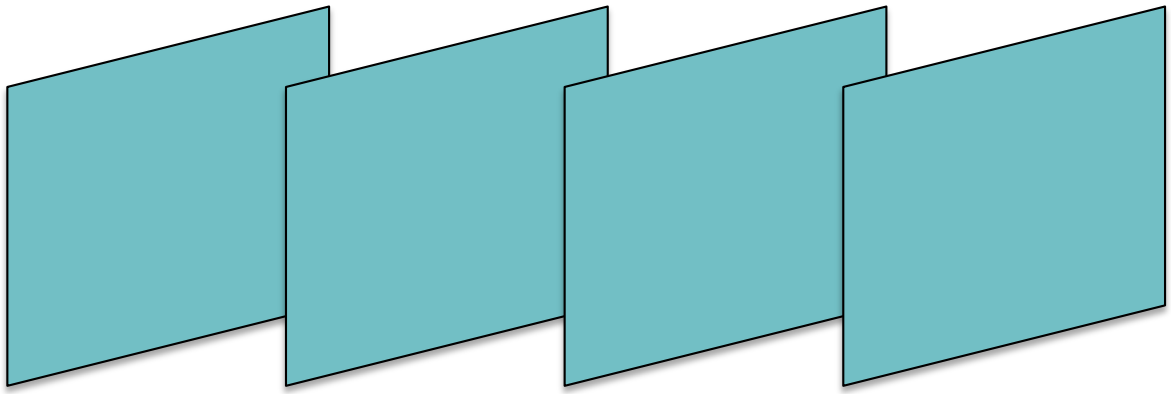
- Our DAQ system supports 4 ATLASPix3.
- We will make
  - 2 “tracking stations”
  - DUT station
  - Space for additional DUTs
- No need for trigger system: each sensor provides hits and time stamps.
  - Can synchronize the reset signal.





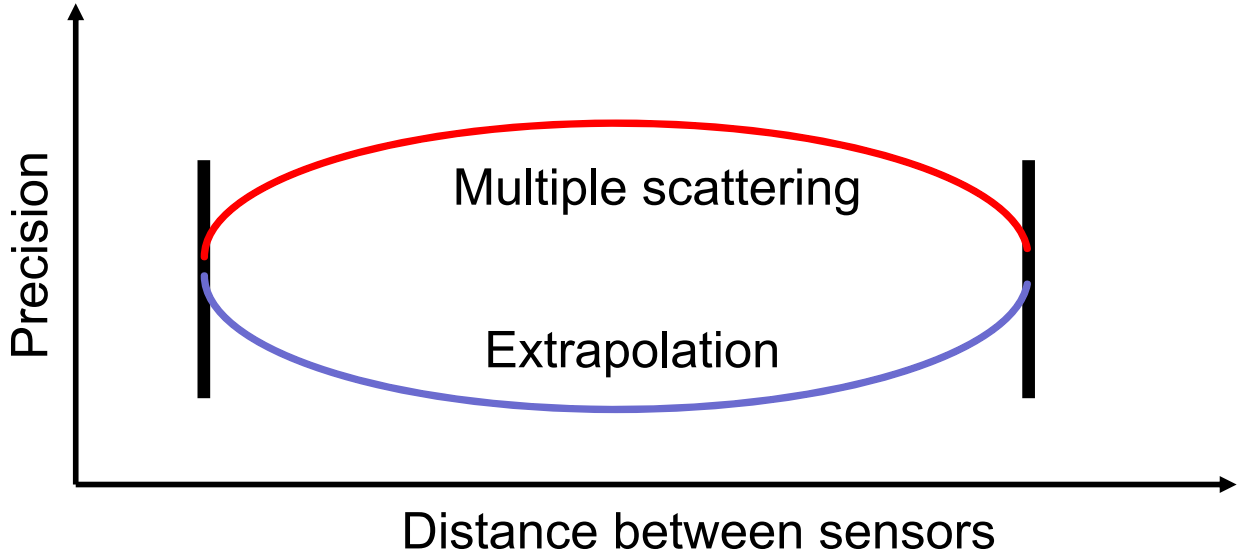
Tracking stations

- The tracking stations will contain 4 ATLASPix3 chips.
- The two stations will provide track segments.
- Key issues
  - Spacing
  - Orientation



Tracking stations

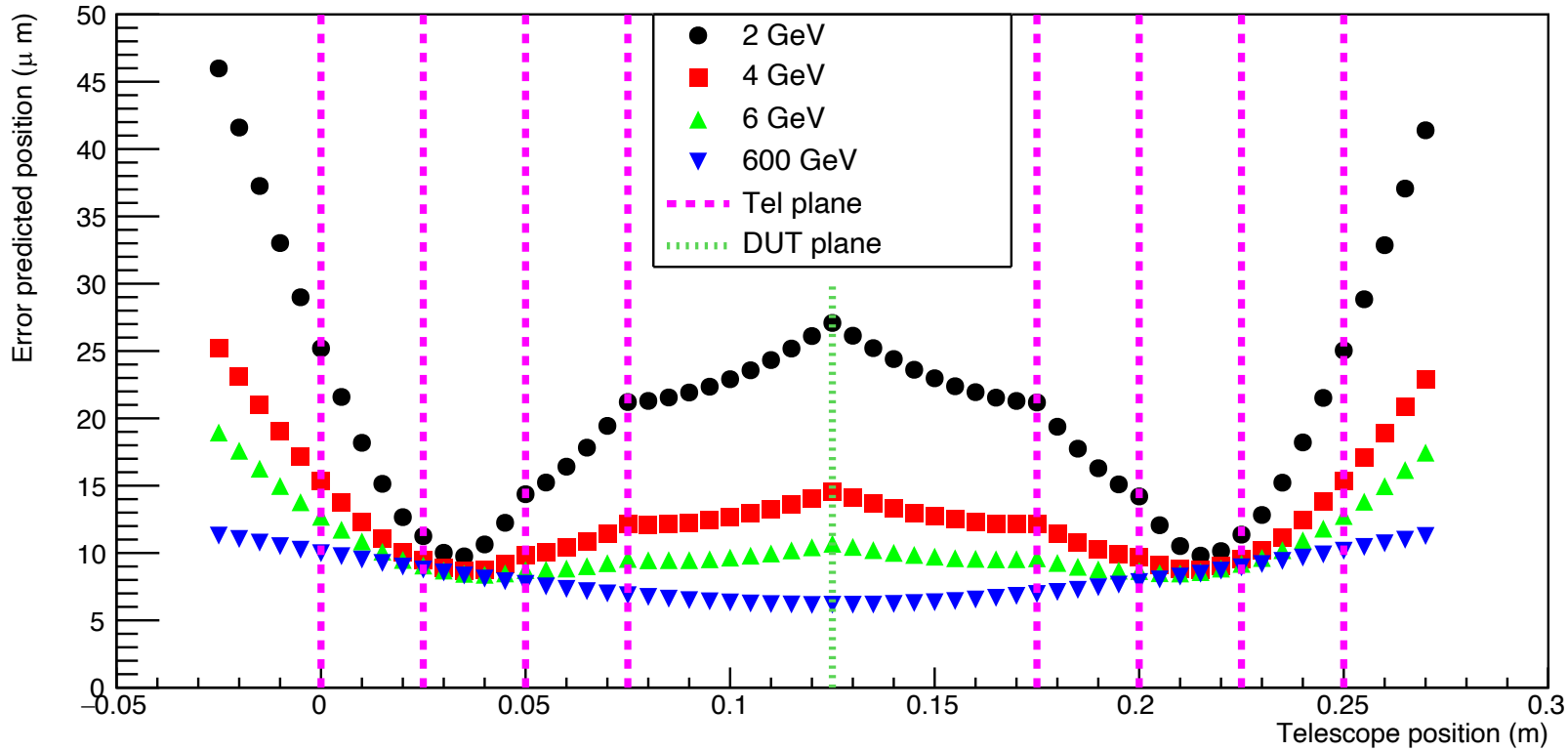
- Key role is to provide precise tracking.
- Ideal spacing depends on beam energy and hit precision.



- Complication: ATLASPix3 is much larger in 1 direction.
  - Should we rotate half the planes?
  - Can even have tilted planes if we can make the mechanics work.
- Need MC study.

Expected precision

- Very preliminary simple MC
  - 500 micron thick detectors, 17 micron resolution for telescope plane
  - 2.5cm between planes, DUT not in fit, 5cm DUT spacing
  - 6 GeV electrons give 10.6 micron precision on DUT.
  - High energy limit 6.0 micron

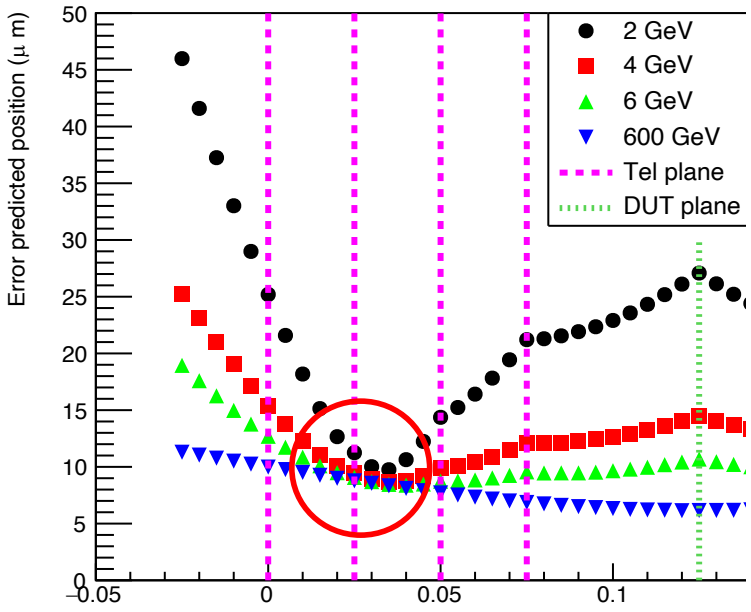


Expected precision

- Can still optimize a bit.
- Minimum for 6 GeV is 8.39 micron.
- Bringing in telescope closer to DUT helps.

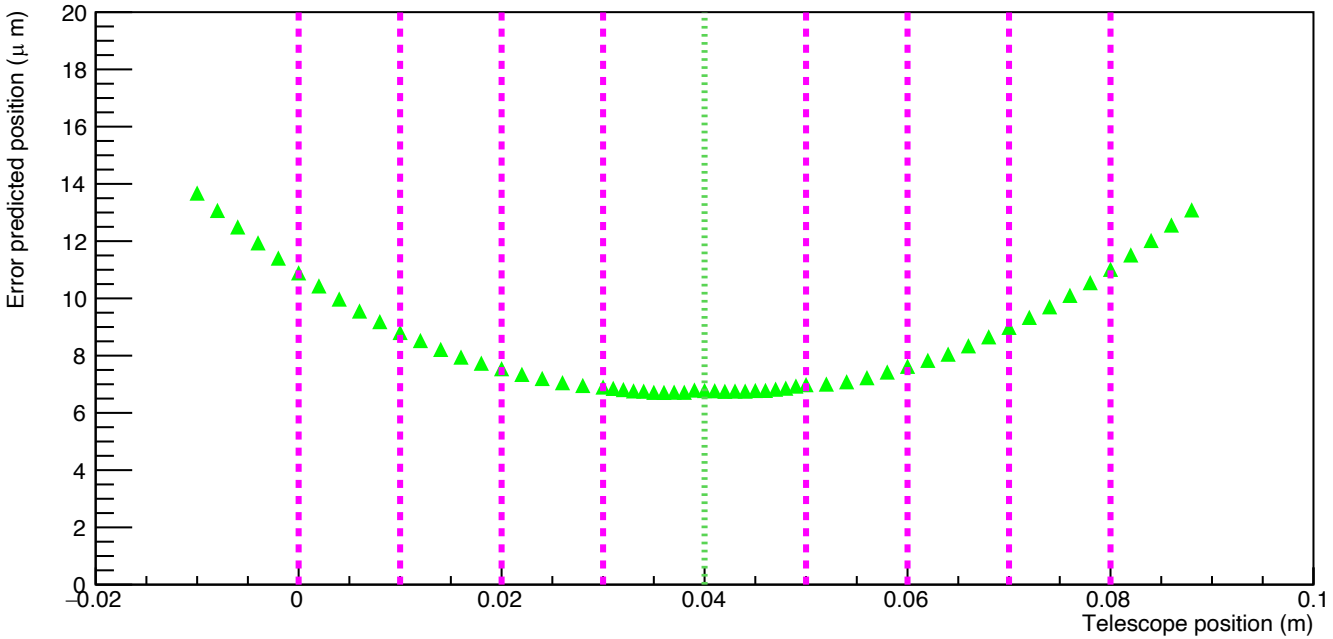
- Need more study:
  - Rotate planes?
  - Tilt planes to lower error on track?

- Current uncertainty:
  - Expect slightly lower than 50/√12=14.4 micron, so on the edge.
  - In-pixel studies: can bin reliably 5x15 using symmetry. Needs ~10 hours of data taking.
  - Integration with existing telescope? Might be worth it for CERN, but not now.



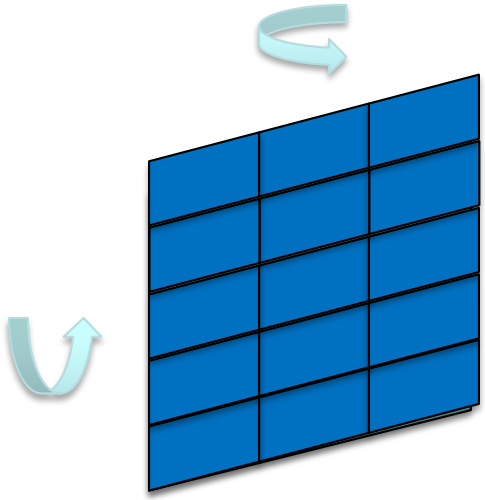
Expected precision

- Need critical look at required and achievable precision.
  - With 1cm spacing at 6 GeV, get 6.8 micron.



DUT station

- One device on rotation stage.
- Need to rotate around two axes.
- Can install a Quad as well



Additional DUT station

- The additional DUT station is useful if we can have
  - irradiated sensors.
  - MightyTracker prototypes

Measurement plan

- Tracking stations will give great statistics on efficiency, purity and position resolution under standard settings.
- DUT studies
  - Bias voltage scans
  - Angle scans
  - Edge scans
  - (In-pixel studies, but the statistics required and expected uncertainty on the hit position make this less interesting.)
- Quad
  - Performance of interface regions

What do we need?

- Minimum requirement
  - Mechanical support structure
    - XY-rotation stage (got one on Bristol)
  - Readout stations
    - Power supplies (HV & LV)
    - DAQ computer(s) (3!)
      - Working setups in Bristol, Lancaster, Edinburgh & RAL ☺
- Very nice to have
  - Synchronization signal or trigger
- Nice to have
  - More sensors (minimum is 9)
  - Quad modules
  - Irradiated sensors
  - MightyTracker prototypes
  - Trimming stations

Things to do

- Preparation phase
  - Test sensors and get things together
  - More Monte Carlo study to optimize configuration
  - Mechanical support structure
  - Develop Data Quality Monitoring software
  - Irradiate sensors
  - Trouble shoot multiple sensor DAQ
    - Do we need clever solutions to connect remotely to DAQ PCs?
- During test beam
  - Install system and debug
  - Do shifts (can be remote)
- After test beam
  - Data analysis
  - Write paper(s) ☺