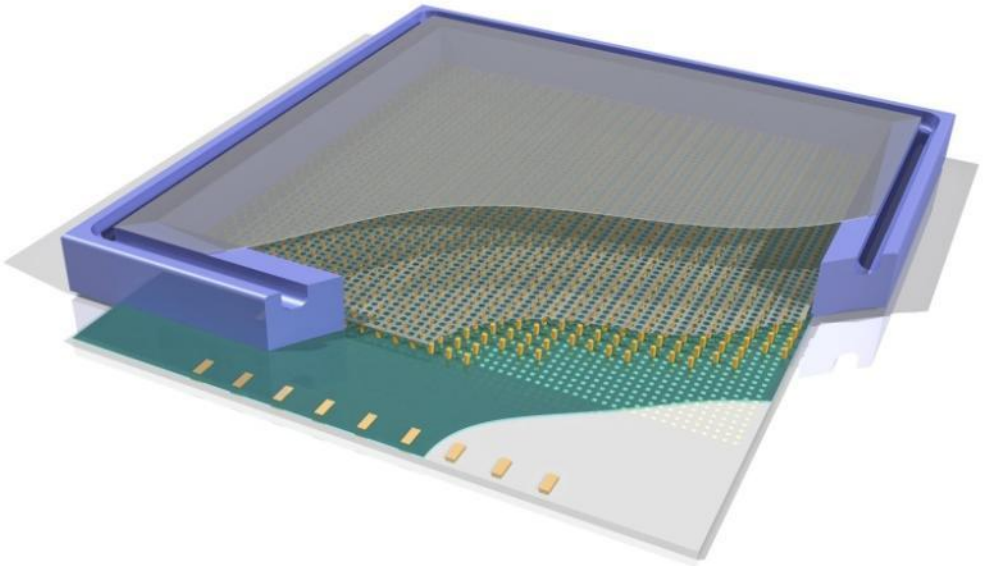
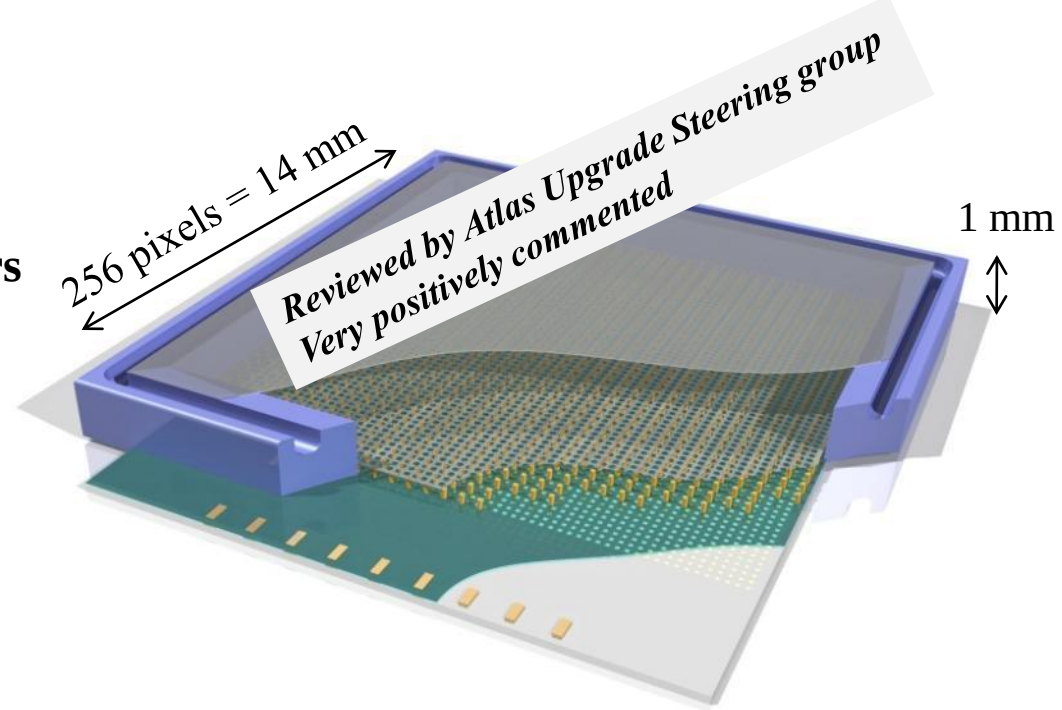
Gossip/GridPix testbeam experiment in SPS area T4-134 August 12 – 23, 2010



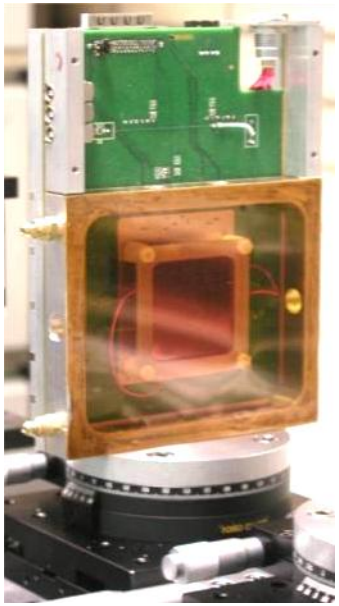
Maarten van Dijk, Martin Fransen, Harry van der Graaf, Fred Hartjes,
Wilco Koppert, Sjoerd Nauta

Aim of the beam test

- Characterisation of **Gossip detectors**
  - Gossip detectors are intended for tracking in the hottest parts (1 GHz/cm^2) at the sLHC
  - TimePix chip (55 x 55 µm)
  - Gas multiplication InGrid
  - Each pixel sensitive for single e^-
  - Reduced drift gap (~1 mm)



- Parameters to be measured
  - Position resolution
  - Angular dependence
  - Track detection efficiency



- Primary gas to be used: DME/CO2 50/50
  - Very low diffusion
  - Good primary ionisation

Properties of CO_2/DME 50/50

- "Cool gas"
  - $V_d \approx 10$ µm/ns @ 2 kV/cm
  - Very low diffusion: ~ 70 µm/√cm
  - Ref:
    - Ar/isobutane 80/20: ~ 250 µm/√cm
- We finally intend ~6 kV/cm
  - $V_d \approx 50$ µm/ns
  - Diffusion ≈ 100 µm/√cm
- High grid voltage needed to get sufficient gas gain
  - 400 V => 550 V
  - Discharges at edges (bond wires)
  - New detectors passivated by Gloptop

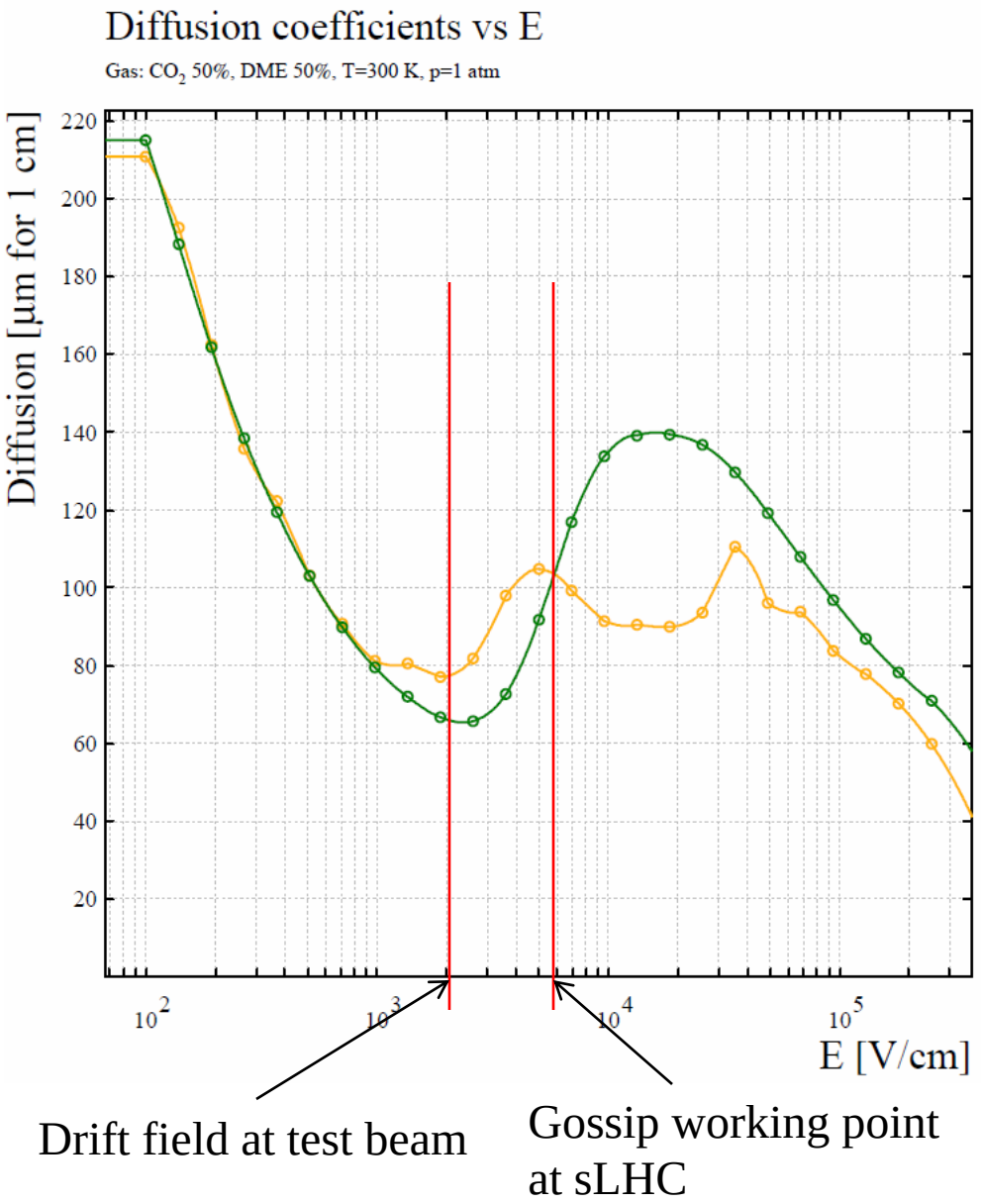
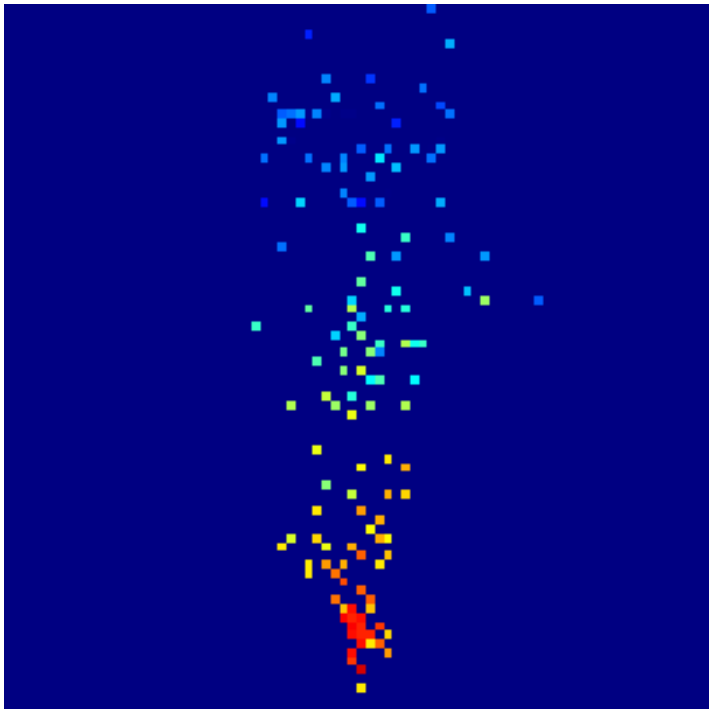


Illustration of DME/CO_2 properties

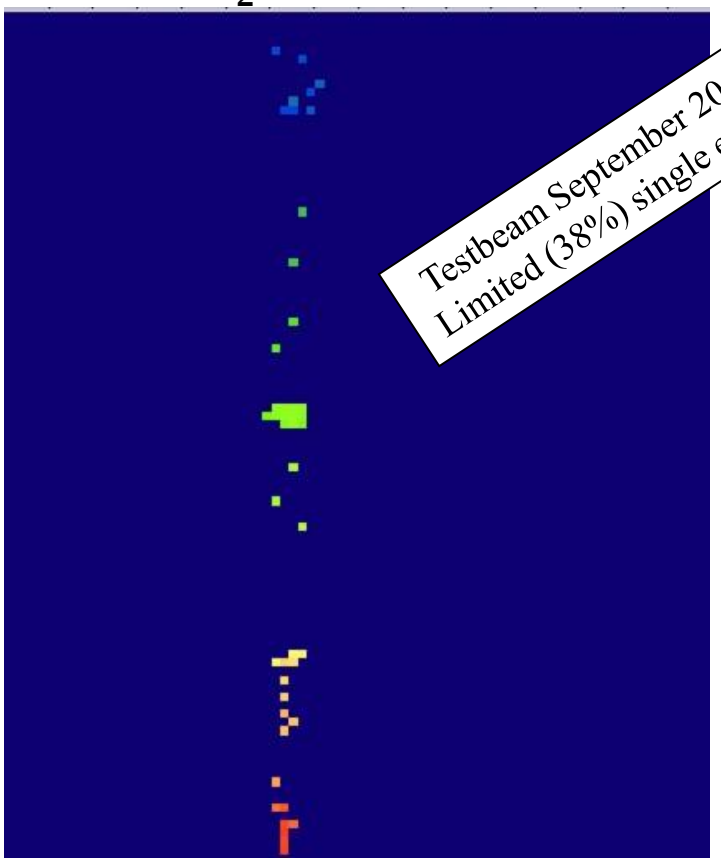
- Slanting tracks in same detector

Ar/iC_4H_{10} 80/20 (June 2009 testbeam)



80 pixels (4.4 mm)

CO_2/DME 50/50

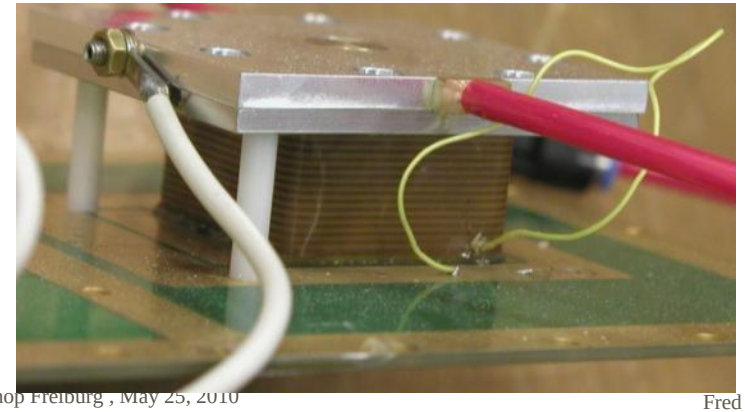


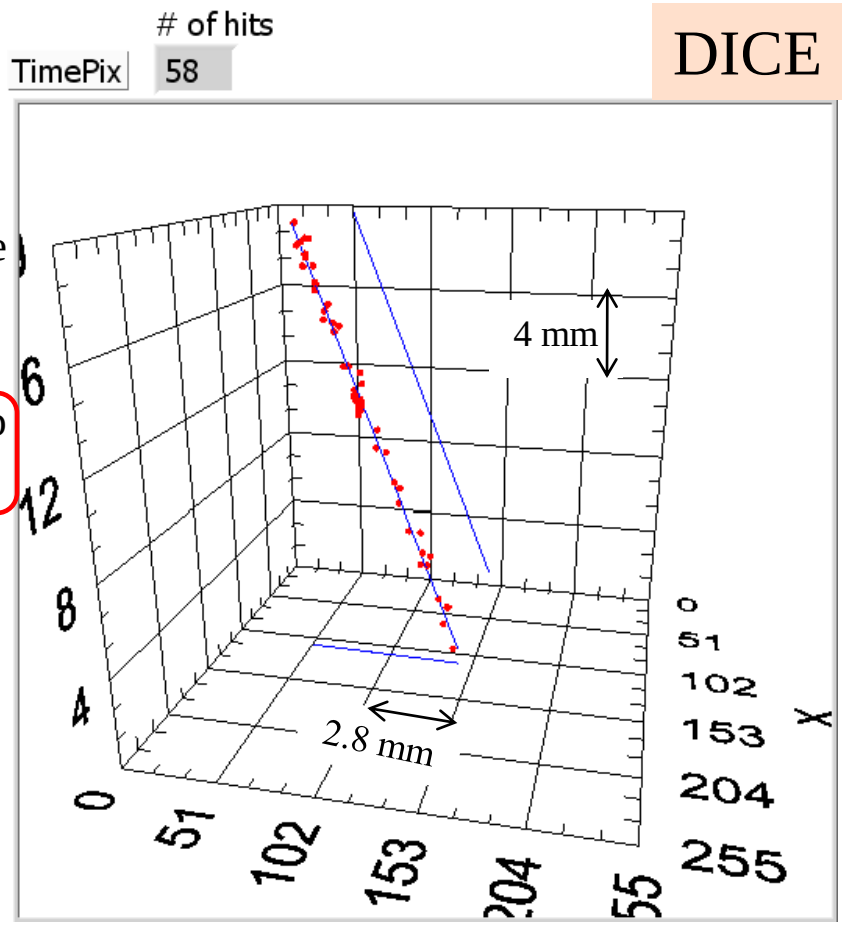
80 pixels (4.4 mm)

Fundamental properties of ionization and charge transport

- Primary ionisation
- Drift velocity vs field
- Diffusion
- Cluster density for MIPs
- Possible electron attachment in DME/CO_2

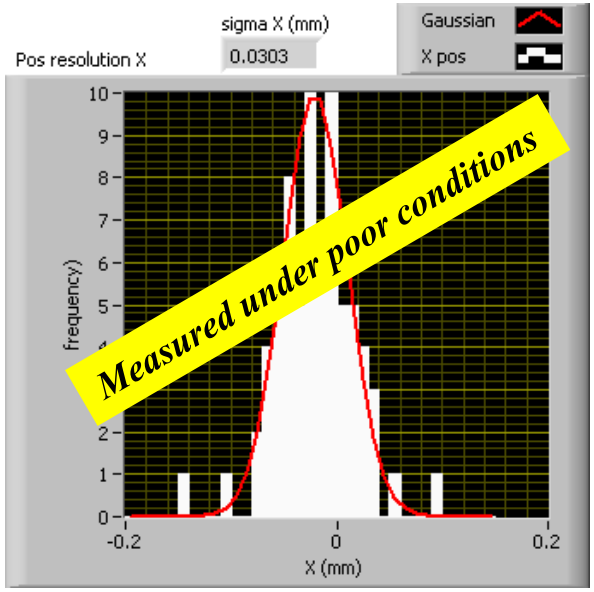
- Method
  - Measuring tracks **parallel** to pixel chip surface
  - Each pixel will have good efficiency (~ 90%) for single electrons
  - Apparatus: Gossip detector with large drift gap (19.3 mm)





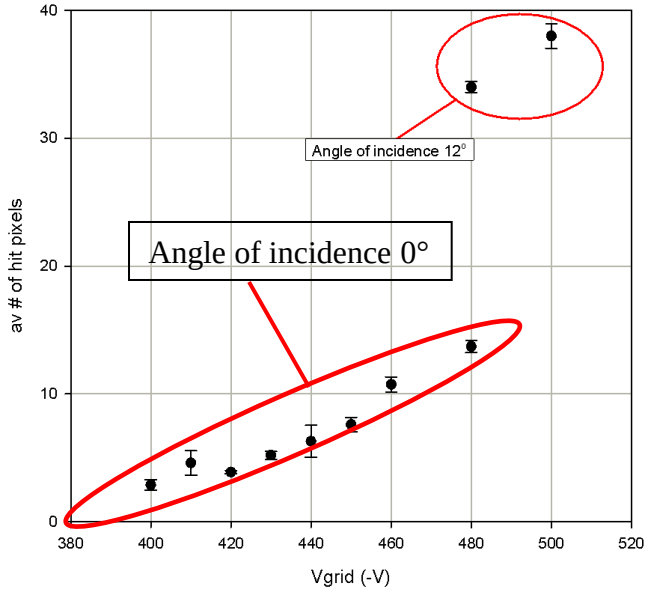
Expected performance of 1-mm Gossip

- Position resolution: 15 -20 µm expected from simulation (angular dependent)
  - => RD51 telescope cannot be used
  - For the time being a telescope from other Gossips will be used as a reference



# of pixels hit per event for DICE

- Pile-up
  - One pixel is hit by more than one electron
  - Strongly angular dependent
  - More prominent for DME/CO_2
    - Low diffusion

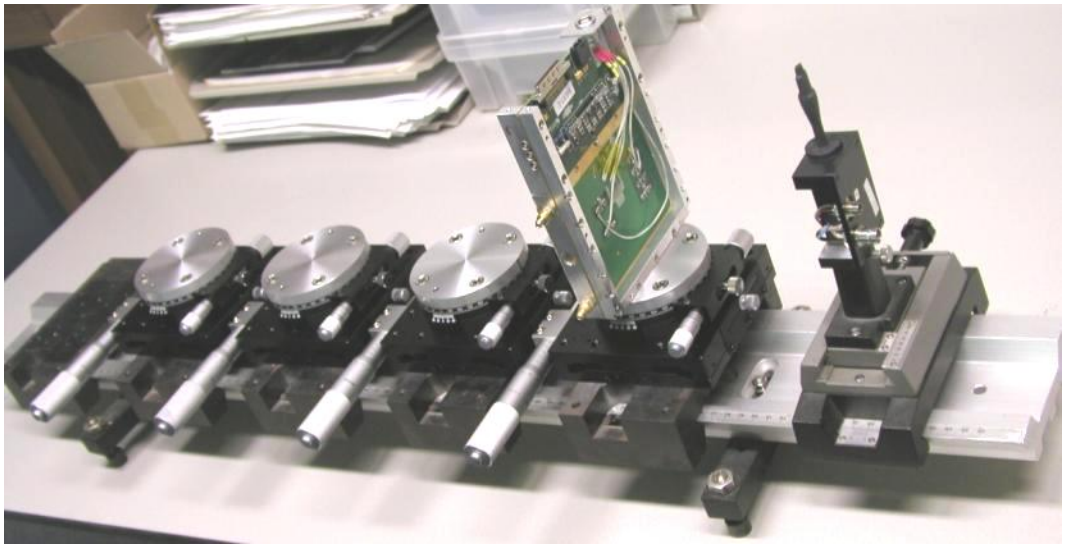


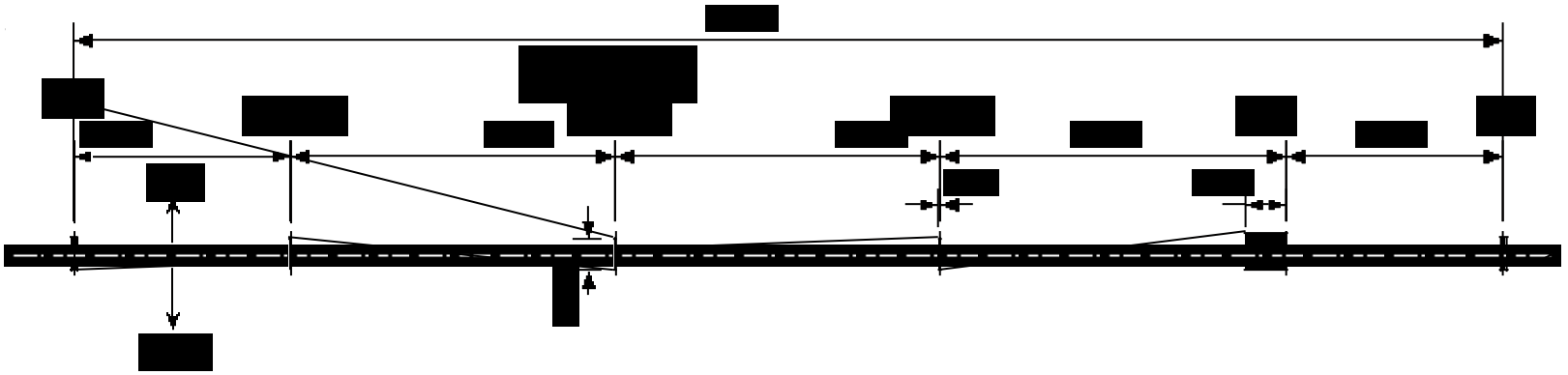
- => we have to do a lot of measurements at many different angles

Detector set-up

- Three 1.0-mm Gossips + one 19.3-mm Gossip (DICE)
- 2 miniature scintillators for triggering
- 1 optical bench 1 m long
  - 4 translation stages
  - 4 accurate rotary stages

- To be fixed as a whole onto a CERN movable table

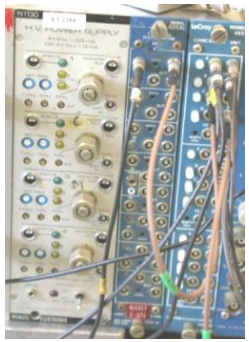


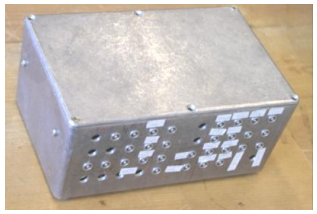


How much material do we put in the testbeam?

- Gossip test
  - Detectors: 4 Gossips, TimePix based, on PCB
  - Material budget
    - glass fibre epoxy with copper layers, 4 x 1.6 mm
    - silicon chips 4 x 0.7 mm
    - **Total 4 detectors 10.1% X/X_0**
  - 2 trigger counters 5 mm thick
    - **=> 2.0% X/X_0**
- **=> total material budget 12.1% X/X_0**

Services: self supporting





- Grid voltage
  - ISEG supplies (2 units of 2 CH each)
  - Remote control via RS232 by LabView on dedicated DCS PC
- Drift field by 4 ch NIM HV unit (Wenzel)
  - Remotely controlled by NI DAQ unit
- Triggering
  - Dedicated very fast trigger box from scintillator coincidence
  - NIM crate with trigger logic
- Low voltage: standard lab supplies
- DAQ
  - by MUROS unit using Pixelman software (MediPix)
  - Using dedicated DAQ PC
- Environmental
  - Recording temperature and atmospheric pressure in HV log file

Gas: also self supporting

- Gas system completely in beam zone including gas bottle
  - Using single premixed light weight SS bottle under low pressure
    - ≤ 20 bar
  - => **42 g H_2** eq for DME/CO_2 50/50 (10 bar)
  - => **29 g H_2** eq for Ar/iC_4H_{10} mixtures (≤ 20 bar)
  - Very well below the **400 g** limit of CERN Safety Class 1
    - Risk of small local flash fire or explosion
  - Leak check by measuring gas flow deficit

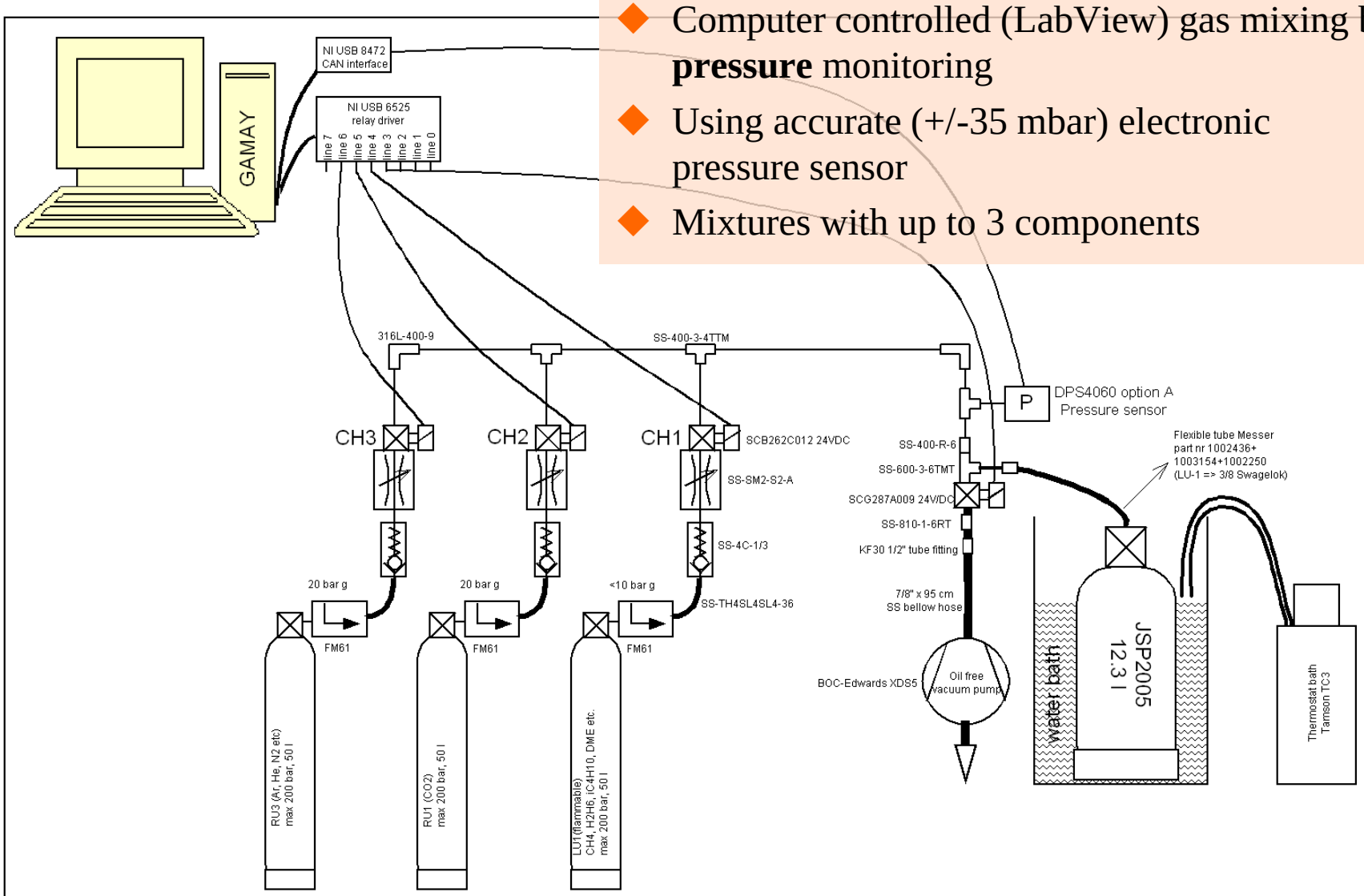
To be approved by CERN FGSO

- => many advantages
  - No gas mixing system
  - No long pipes
  - => rapid and easy installation

- Required gas flow ruled by inflow of oxygen by diffusion
  - 3.5 l/h required getting O_2 level < 30 ppM
    - Required for 19.3-mm drift Gossip
    - 1-mm Gossips no problem (< 500 ppM)
  - => we will using this flow only during data taking to save gas

Diagram Nikhef gas filling system

- Computer controlled (LabView) gas mixing by **pressure** monitoring
- Using accurate (+/-35 mbar) electronic pressure sensor
- Mixtures with up to 3 components

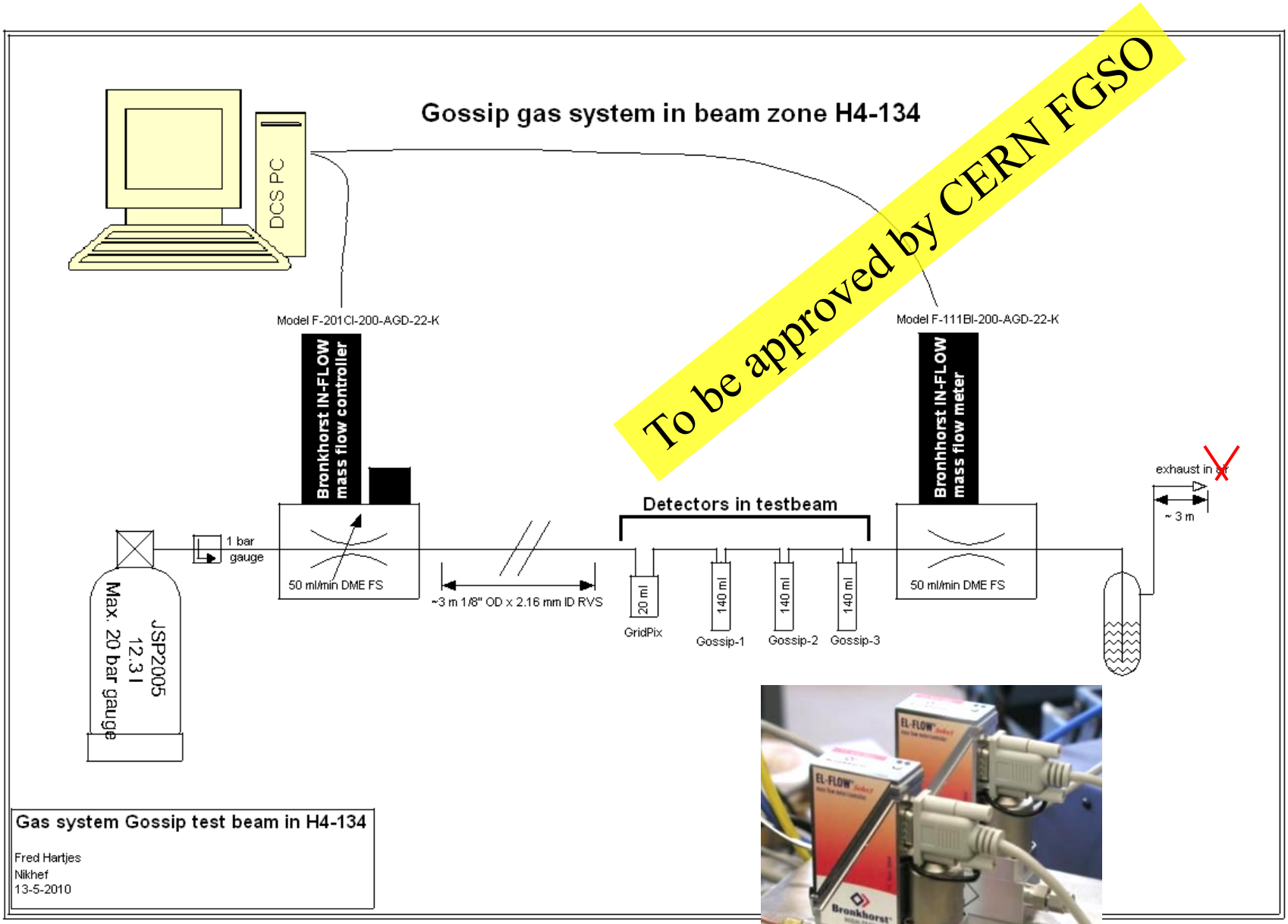


Nikhef gas mixing station

15-1-2010
Fred Hartjes

Gas from premixed Nikhef bottles

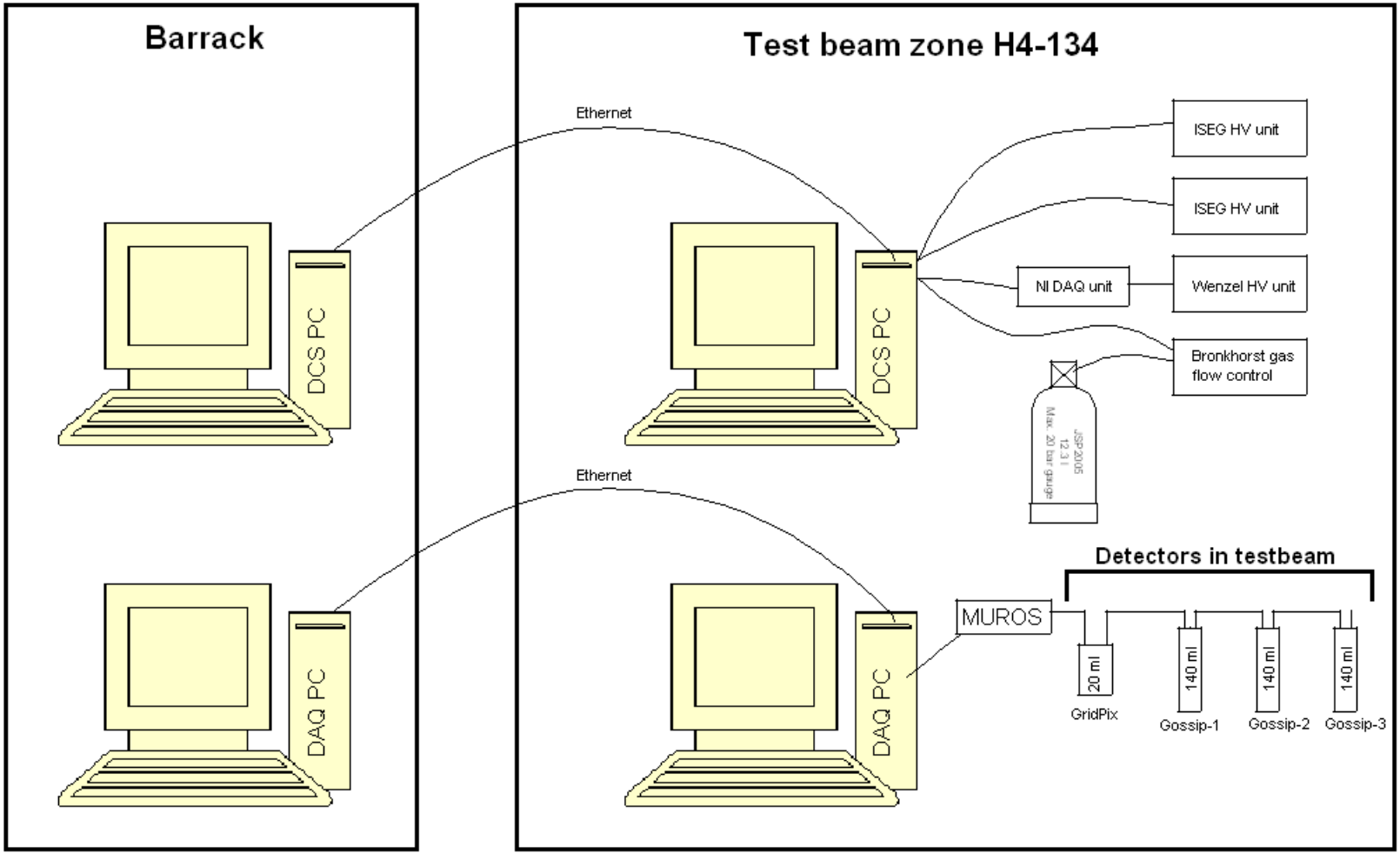
- Filling system now well operational
- Each bottle carries two self-sticky labels
  - Label with serial#
  - Label (automatically printed) with
    - mixture identification
    - Filling pressure (max 20 bar gauge)
    - Preparation date
- For each bottle a log file is automatically stored containing mixing data, place of use and name of user
- Bottles for external use will be formally certified by Nikhef director
- System will receive CE classification


Gossip gas system in beam zone H4-134
DCS PC
Model F-201CI-200-AGD-22-K
Model F-111BI-200-AGD-22-K
Bronkhorst IN-FLOW mass flow controller
Bronhhorst IN-FLOW mass flow meter
To be approved by CERN FGSO
Detectors in testbeam
exhaust in air
~ 3 m
1 bar gauge
50 ml/min DME FS
~3 m 1/8" OD x 2.16 mm ID RVS
20 ml
140 ml
140 ml
140 ml
50 ml/min DME FS
GridPix
Gossip-1
Gossip-2
Gossip-3
JSP2005 12.3 l Max. 20 bar gauge
Gas system Gossip test beam in H4-134
Fred Hartjes
Nikhef
13-5-2010

EL-FLOW
Bronkhorst
FLOW

Block diagram Gossip beam test

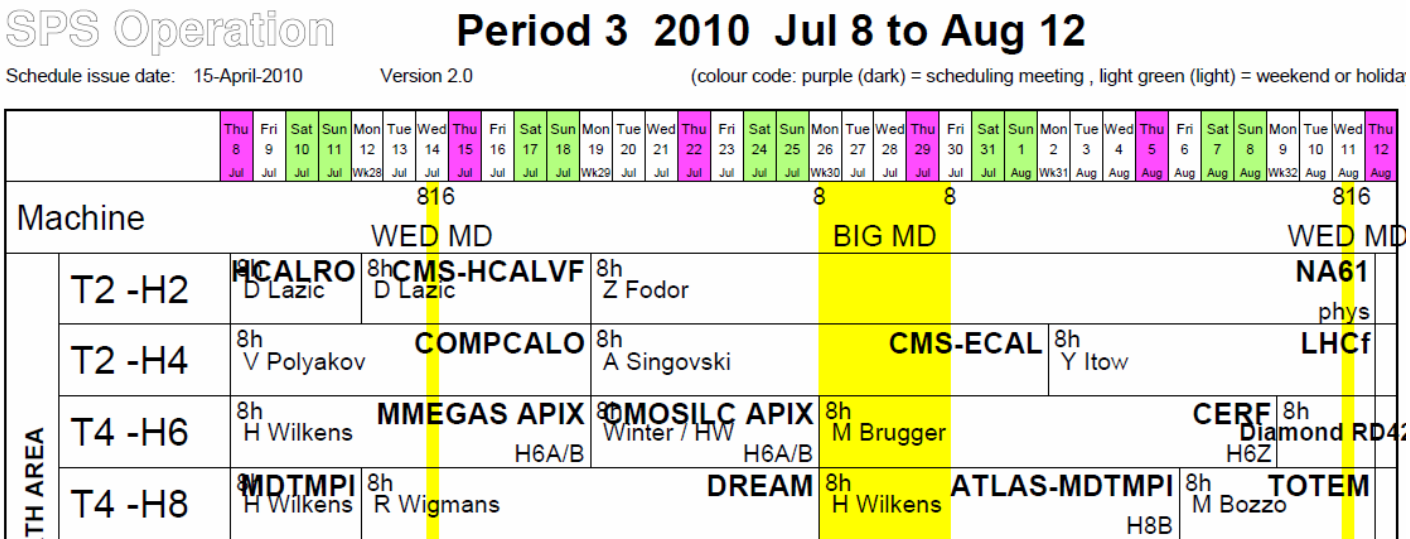
- **Completely stand-alone system including DAQ and gas**
  - Only **beam**, **230 VAC** and **movable X_Y table needed**
  - Computer control from barrack using Remote Desktop
  - Between barrack and experimental area: 2 Ethernet cables + 2-3 BNC cables



Installation schedule for August 12 testbeam

- MD period July 26 – 30
  - Laying Ethernet and BNC cables between testbeam zone and barrack
  - Make design for a support block on the movable table for mounting the optical bench with detectors

- August 12 (start testbeam period)
  - In testbeam area
    - Mounting optical bench with detectors onto movable table
    - Align detectors to beam
    - Install 2 PCs, DAQ box, trigger logic incl. NIM crate and gas system
  - In barrack
    - Install 2 PCs, some NIM logic



Measuring program in August testbeam

- Gossip characterisation
  - Single electron efficiency vs Vgrid (plateau curve)
  - Position resolution
    - Many different angles
  - Track detection efficiency
    - Low drift field, high gain

- DME/CO_2 parameters
  - Using parallel tracks (Gossips at ~ 0 deg, DICE at 90 deg)
  - Drift velocity vs E field
  - Diffusion/sqrt(cm) vs E
  - Electron absorption
  - Cluster density
  - Ionisation density

- Measure drift time spectrum at various gains
  - Time slewing TimePix