Laser measurements on single chip module

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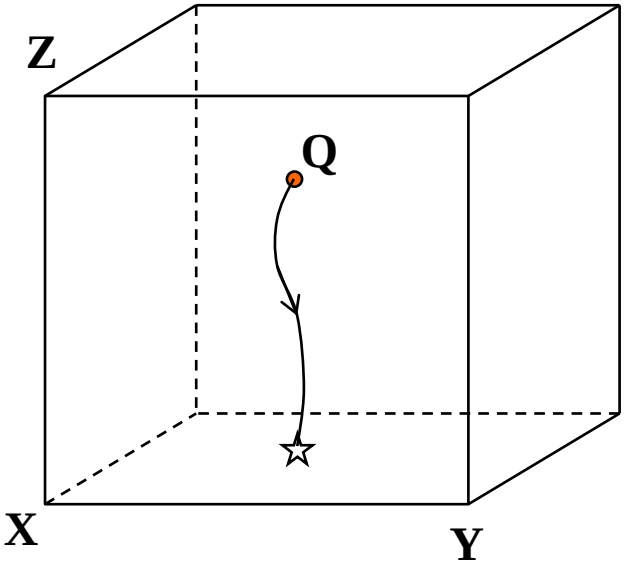
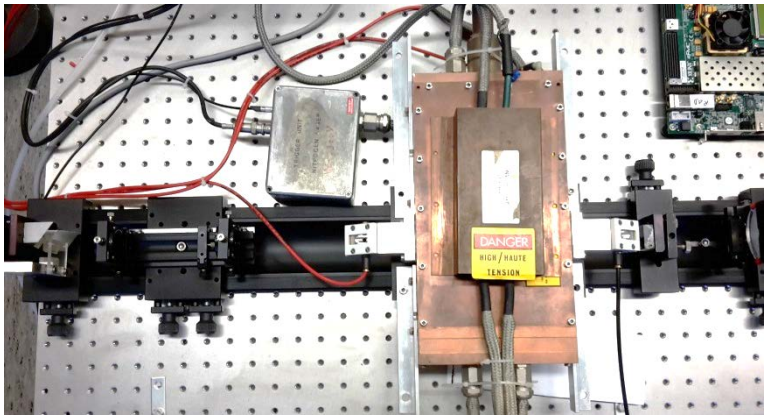
Why laser measurements?

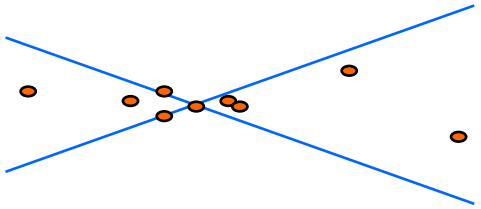
- Fundamental method to measure drift paths and drift velocities in a drift volume in 3D
- Classical electrostatic problem
  - Create a point charge **Q** in a parallel E-field at a given position in space and at a given time
  - Measure the travel time and hit position at an XY plane
- By doing an XYZ scan across the whole drift volume, we get a direct measurement of the drift trajectories and local drift velocities



Making laser ionization

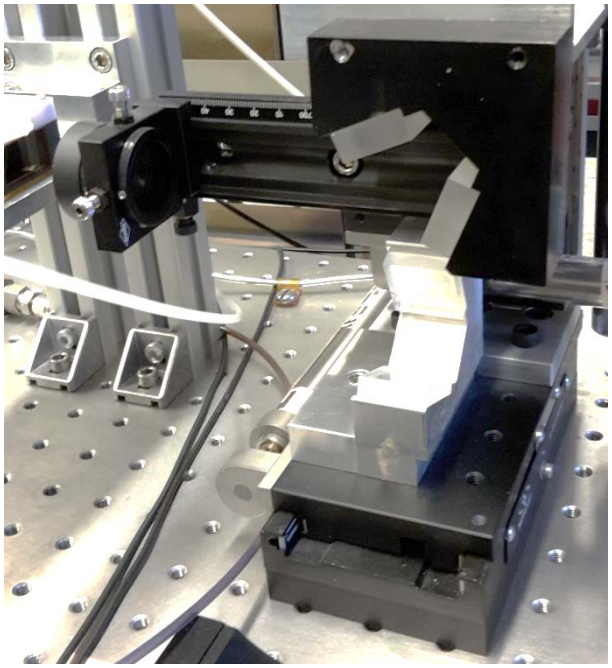
- Using focused beam pulsed UV nitrogen laser (Nikhef type IA)
  - Near UV: 337 nm (3.7 eV)
  - < 1 ns duration
- Pulse frequency ~ 3 Hz
  - MOPA setup => near diffraction limit
  - Beam diameter ~10 mm, focused at 60 mm focal length
    - Achromatic composite lens to avoid spherical aberration
- Ionization in chamber gas by **double photon** process
  - Proportional to square of light intensity
  - 2 * 3.7 = 7.4 eV
  - Tetra-Methyl-Phenylene-Diamine (TMPD) as ionizing compound
  - Concentration << 1 ppM
- => highest ionization density (e^-/cm) in focal area





Beam management

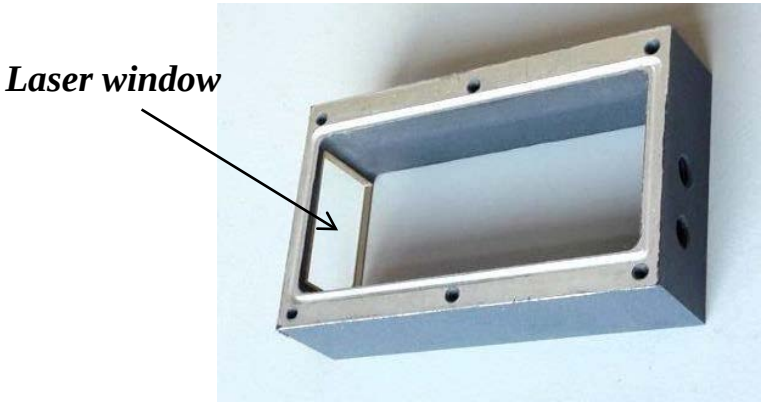
- Detector kept on fixed position, scanning with focal point
- Position of focal point exclusively determined by two parameters
  - Position of focussing lens
  - Direction of incoming beam
- Lens mounted on remotely controlled XYZ stage system
  - Allowing precise positioning with sub μm resolution
- Beam direction stabilized by two pentamirror systems
- Ionization tuned by neutral density wedge filter

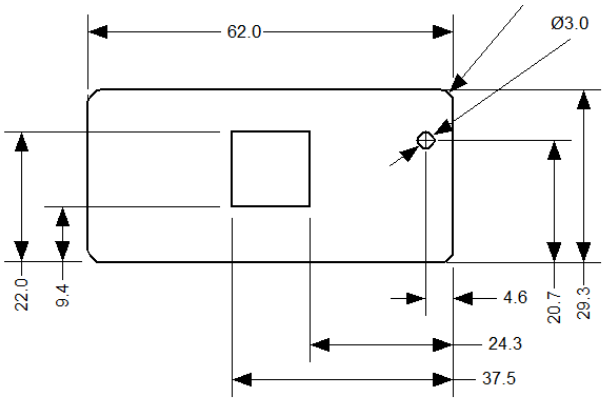


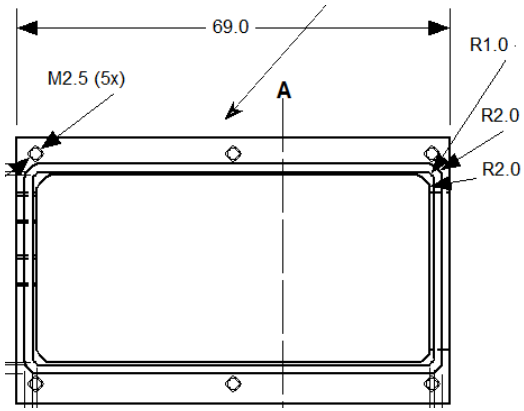
Stages with two pentamirror sets + focussing lens

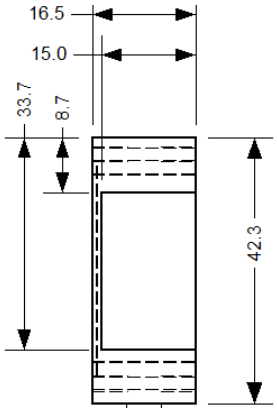
Single module setup

- Using TPX3 with InGrid from Yevgen
- Field cage from conductive plastic
  - Semitron ESD 490 HD
  - Top and bottom edge made conductive by silver paint
- Drift length ~15.5 mm
- Guard aperture 13.2 * 12.6 mm
  - Cutting part of active pixels
    - 12.6 of 14.1 mm







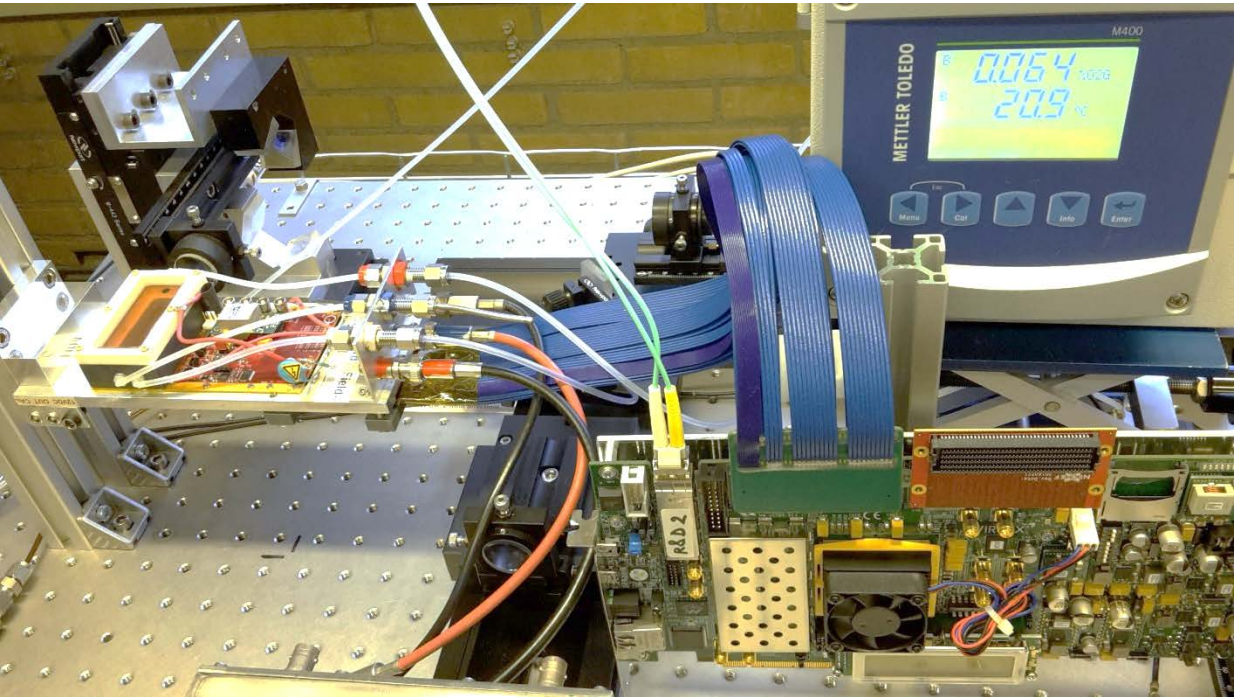


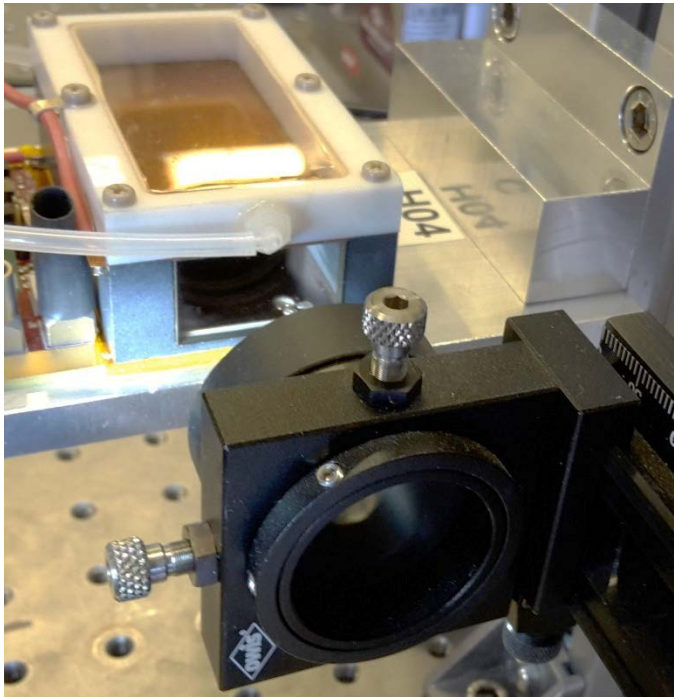
Coppered kapton 50 um

Status

- Detector assembled and installed
  - Chip H4 (class C)
- Services connected
  - Gas, HV, SPIDR board, stages

- Commissioning in progress
  - Remote control XYZ stages
  - Optical measurement of height of grid, guard electrode, cathode foil
  - Verifying voltage distribution along field cage
  - Entering the trigger time (fast photodiode) in SPIDR

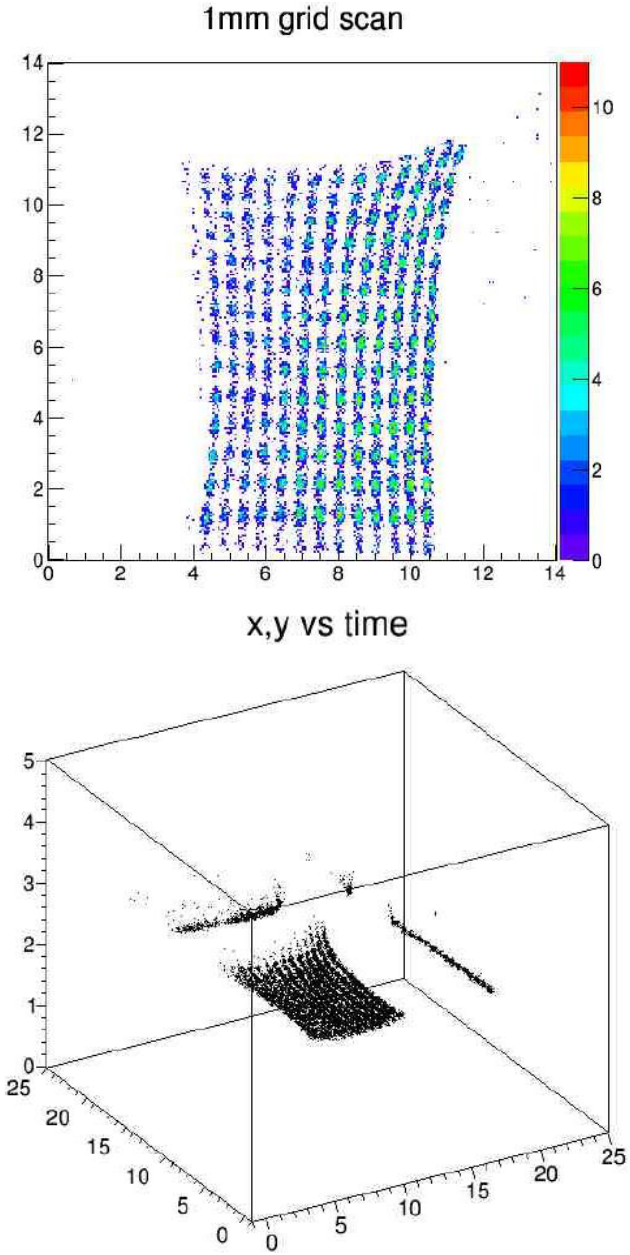




Running conditions

- Tune gas gain to SE hit efficiency > 80%
- Tune laser intensity such that hit efficiency per pixel per laser shot < 10%
  - => double electron hits < 5% of total hits on that pixel (Poisson statistics)
- Collect 50 laser shots on same position
  - Use the hits to calculate a master point (centre of gravity)
- Move one stage to next position (over 1 mm or so) and take another 50 shots

- Example of 3D run
  - Collecting data from XYZ matrix of 1 * 1 * 1 mm step across 15 * 15 * 15 mm
  - => 3375 master points
  - => 168750 laser shots
  - => 15.6 hour running



Earlier measurements of Harry's QUAD focus chamber by Wouter Bos

SPARE

List of parameters

- In progress/ under discussion
- Going from one chip to another on same carrier
  - 3 pixels sacrificed
- Going from one chip to another on neighbouring carrier
  - 4 pixels sacrificed
  - 28.6 => 28.435

First approach, to be updated
Put this on a Nikhef server with read access to everybody (incl Bonn)

Mechanical									
Item	**Values (um)**			**Angle (mrad)**		**Reference**			**remarks**
	X	**Y**	**Z**	**hor. Plane**	**vert. plan**	**X**	**Y**	**Z**	
position InGrid of chips	± 20	± 20	± 20	1	1	PCB ref marks	PCB ref marks	foot T	
chip to chip distance	60								
last pixel Ch1 1st pixel CH2	165								
chip to chip distance mod 1 to mod 2	115								
last pixel mod1 to 1st pixel mod 2	220								
module to module pitch	28435								
position PCB ref marks	± 20	± 20	± 100	1	1	carrier edge	carrier edge	carrier foot	
Top guard electrode	± 50	± 50	500± 20	10	1	carrier edge	carrier edge	chip dyke	
chip edge to PBC		100							
chip dimension edge to edge		14130							
Electrical	**Value**								
Grid potential Vgrid (V)	~-400± 4								
Grid supply resistor (Ω)	100M								each chip
drift field E (V/cm)	-100								
Guard potential (V)	Vgrid + E*Zguard								
Guard supply resistor (Ω)	100M								

Assembly / alignment method

- Mount PCB on carrier
  - Refer to two carrier edges using jig with reference marks
  - AND refer to reference marks on PCB
- Mount chips on carrier
  - 2 chips on one side simultaneously
  - XY: refer to grid hole pattern
    - rough alignment using bonding pads (N x 55 µm)
  - AND refer to reference marks on PCB
  - Z: refer to grid (fixed height of alignment jig)
- Mount guard electrode
  - XY: refer edges to reference marks on PCB (tolerance 100 µm)
  - Provide a 1 mm hole at the PCB reference marks
  - Z: let sides of the guard rest on dykes
    - Guard should fabricated bit hollow
- Module to module
  - XY: refer to PCB reference marks

dykes

- Sides
  - 2 x 3 pixels lost
- Top
  - No pixels lost
- Bottom
  - No pixels lost