Status of Nikhef activities

Matteo Alfonsi

Martin Fransen

Harry van der Graaf

Fred Hartjes

Wilco Koppert

Gijs Hemink

Anatoli Romaniouk

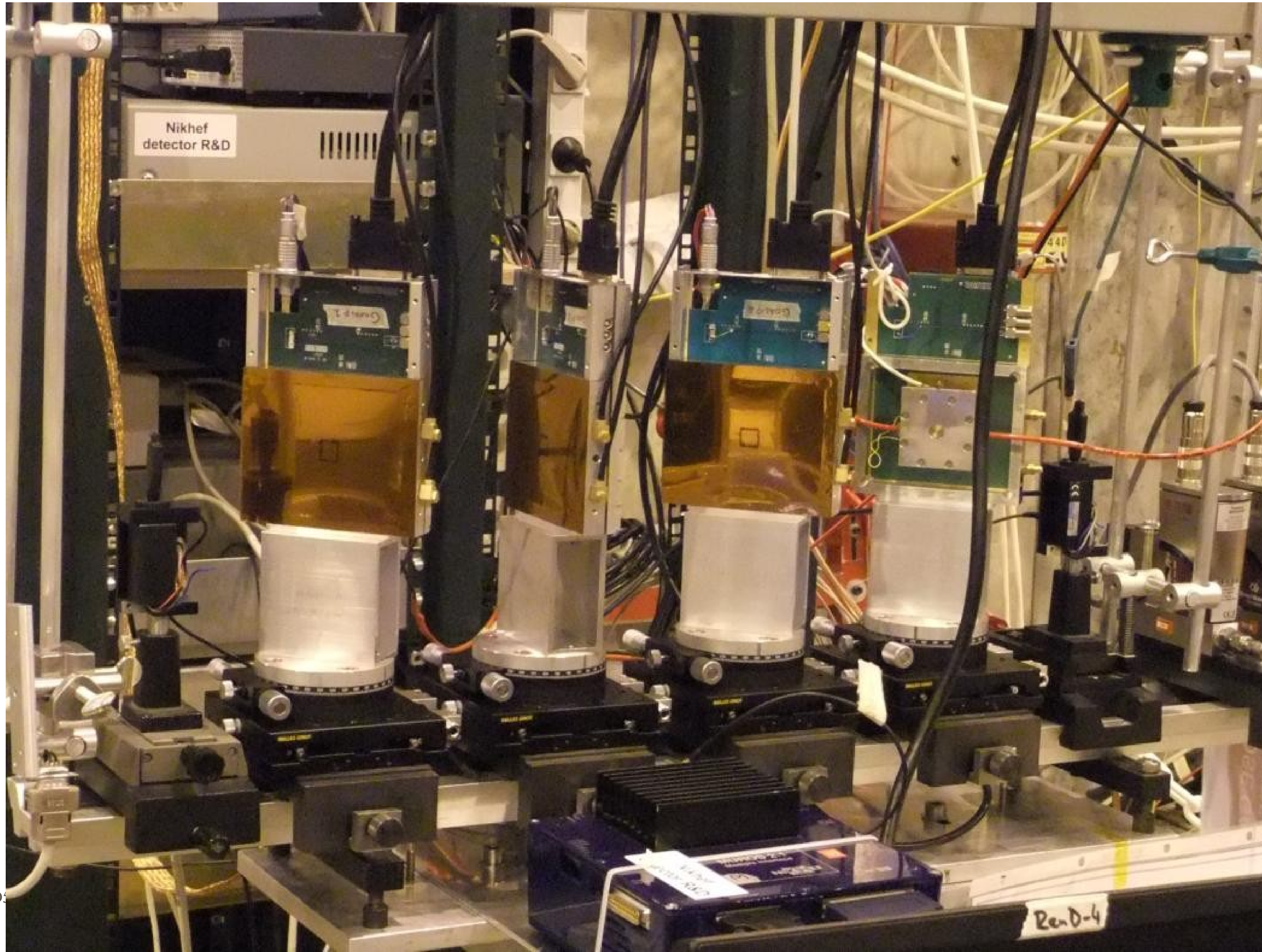
Rolf Schön

Rob Veenhof

- **Analysis August 2010 testbeam**
  - **Performance Gossip/GridPix**
  - **Drift velocity and diffusion**
  - **GridPix as L1 trigger in Atlas**
    - **Particle ID**
- **Other subjects**
  - **Photoelectric GridPix**
  - **GridPix production**
  - **GridPix R.O. (ReLaXd)**
  - **Xenon WIMP search**
  - **Polapix (polarized X-rays)**
  - **Status mini HV unit**

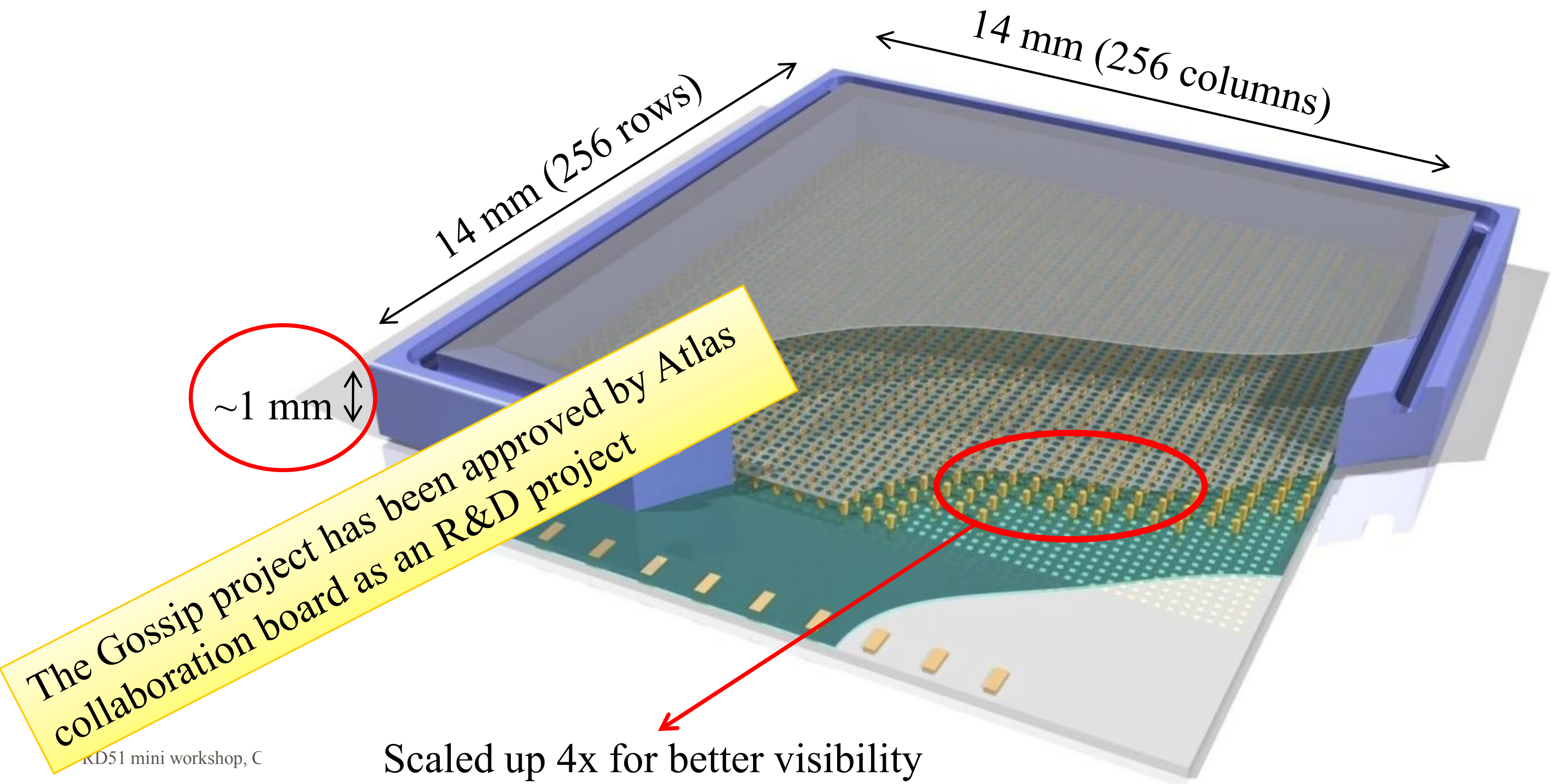
RD51 mini workshop, CERN, January 18, 2011

Gossip testbeam August 12 – 22 , 2010



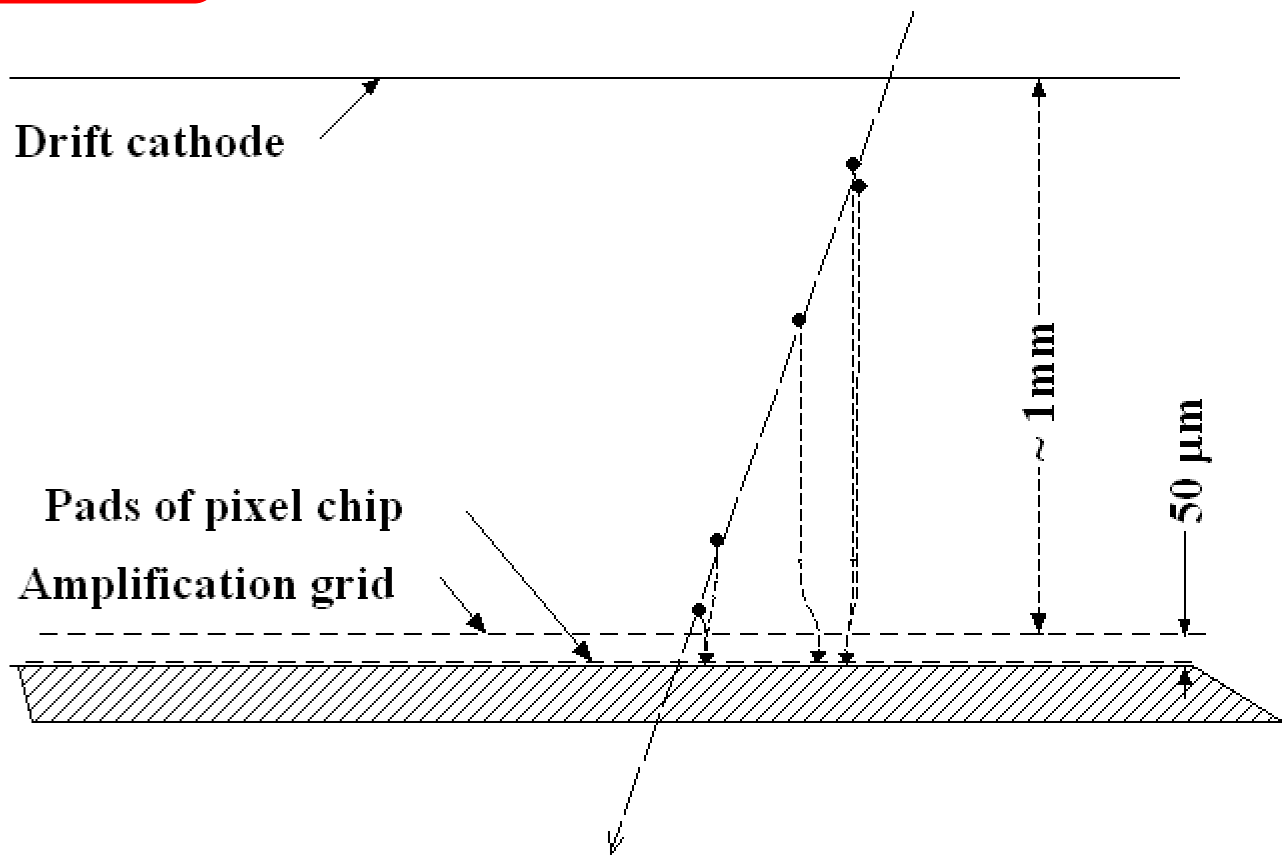
Principle of Gossip

- **High granularity** pixel chip
  - Cell pitch 55 – 60 µm in X and Y
  - Thinned to 50 – 100 µm (not for this testbeam experiment)
- Detection medium: **drift gap ~ 1 mm high**
- Signal (~6 primary electrons) enhanced by **gas avalanche** from a grid
  - Gas gain 5000 - 10000



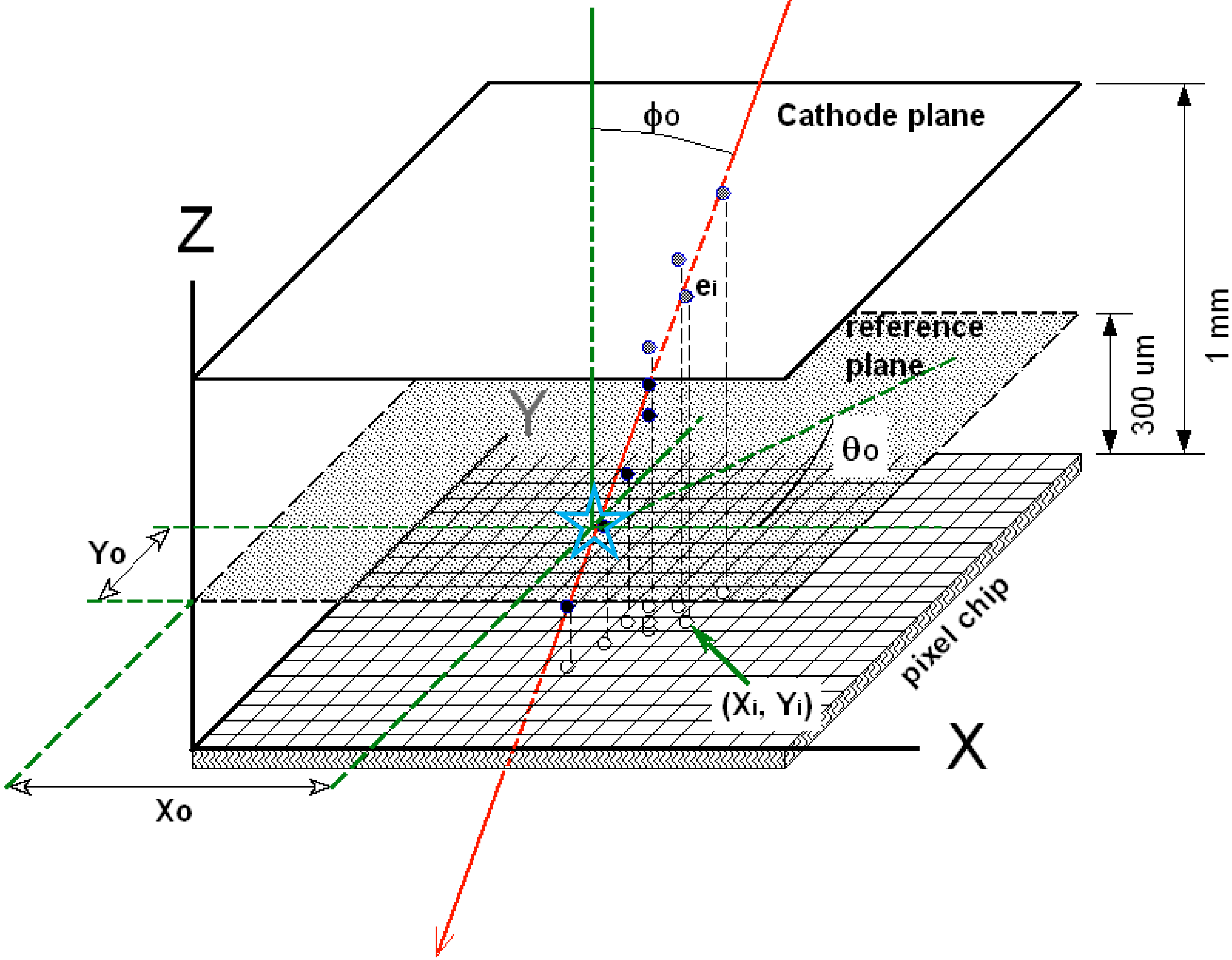
Gossip functioning

- Pixel chip with integrated Micromegas (InGrid)
- Drift gap height 1 mm
  - Getting > 95% track detection efficiency
- Often detecting **individual electrons**
- Track segment characterized by
  - **Crossing point**
  - **Direction**



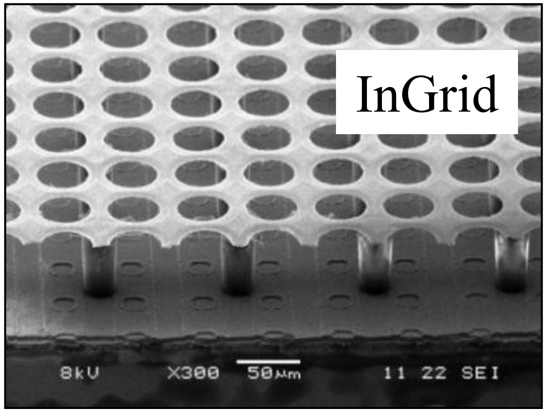
Reconstructing track segment

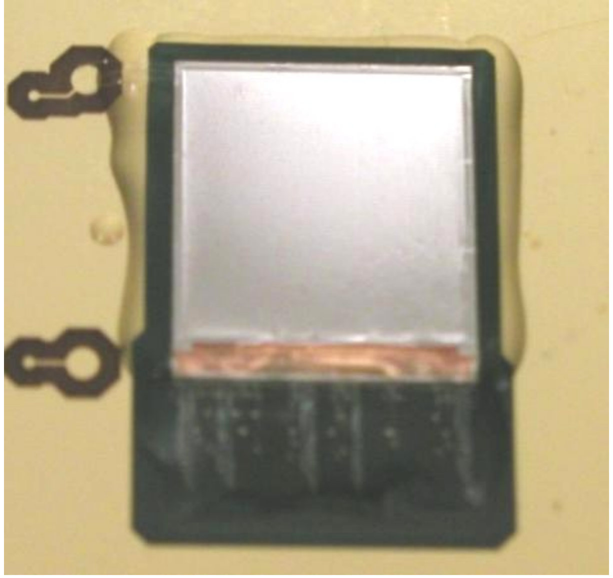
- Track characterized by φ, θ and the crossing point (X, Y) with the reference plane



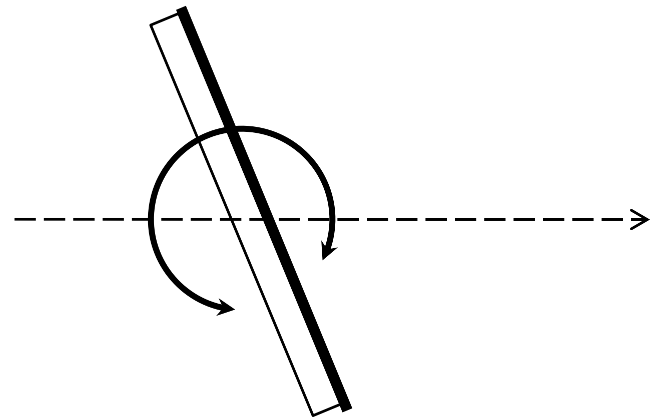
Timepix as a pixel chip

- TimePix
  - Derived from MediPix (X-ray detection)
  - Matrix of 256 x 256 pixels
  - 55 µm pitch
  - => 14.08 x 14.08 mm^2 sensitive area
  - Common clock (100 MHz) to measure drift time for each pixel
  - Also Time-Over-Threshold (TOT) mode to measure charge signal spectrum
  - **Not optimized for time measurements => much time walk**
- Postprocessing
  - 7 µm Si doped Si_3N_4 for **spark protection**
  - **Amplification grid** (InGrid) on TimePix

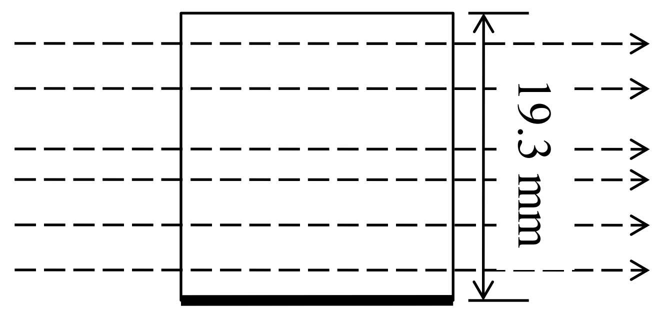




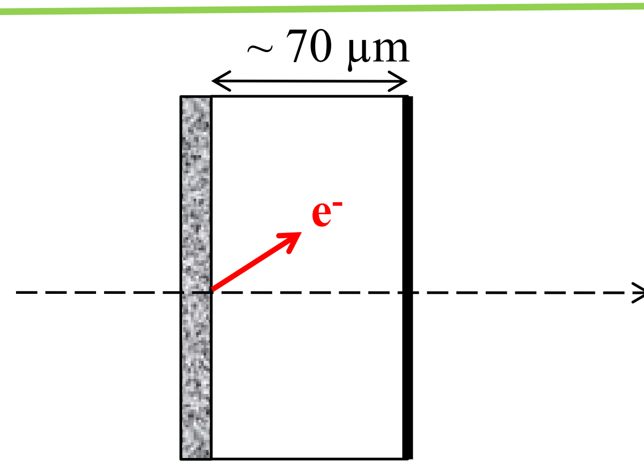
Aim of the Gossip testbeam experiment in August 2010



1. **Gossip performance**
   - Position resolution
   - Angular resolution of track segment
   - Track detection efficiency
   - Dependence on gas gain (V_{grid})
   - Double track separation



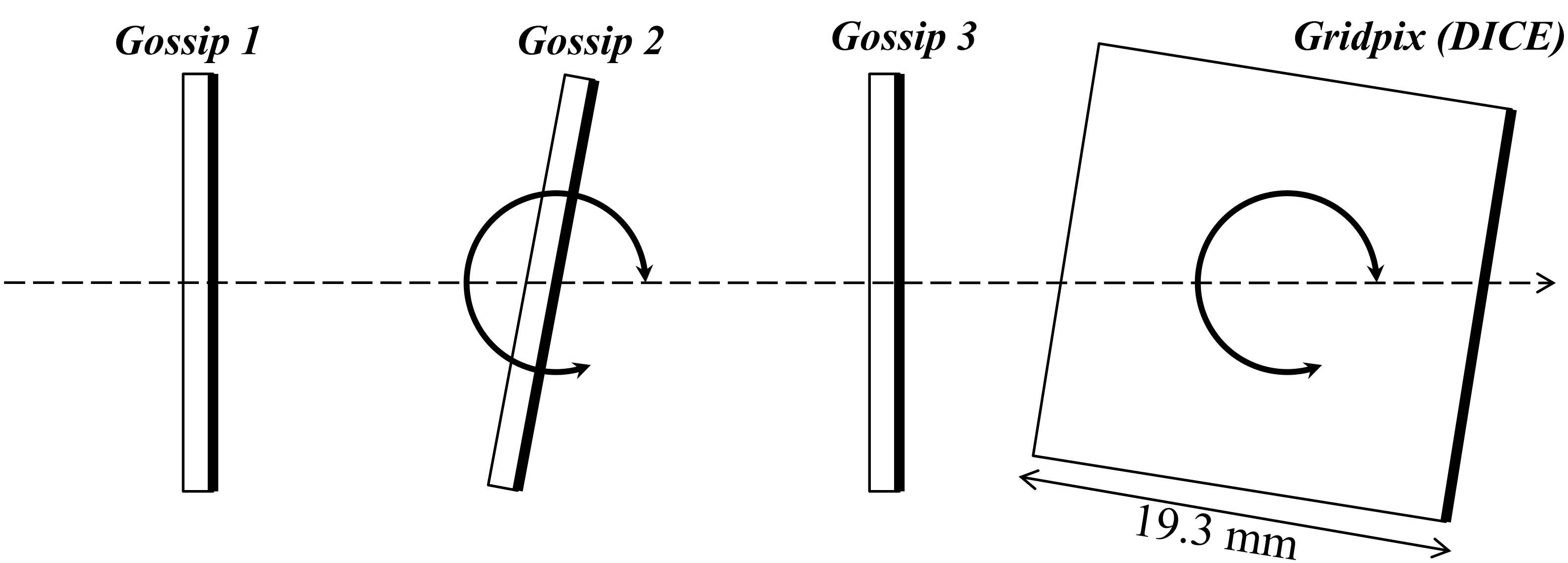
2. **Characterisation** of DME/CO_2 50/50 mixture
   - Primary ionisation/cluster density
   - Drift velocity
   - Transverse diffusion



3. **Cathode emission**
   - Detecting knock-off electrons from cathode surface

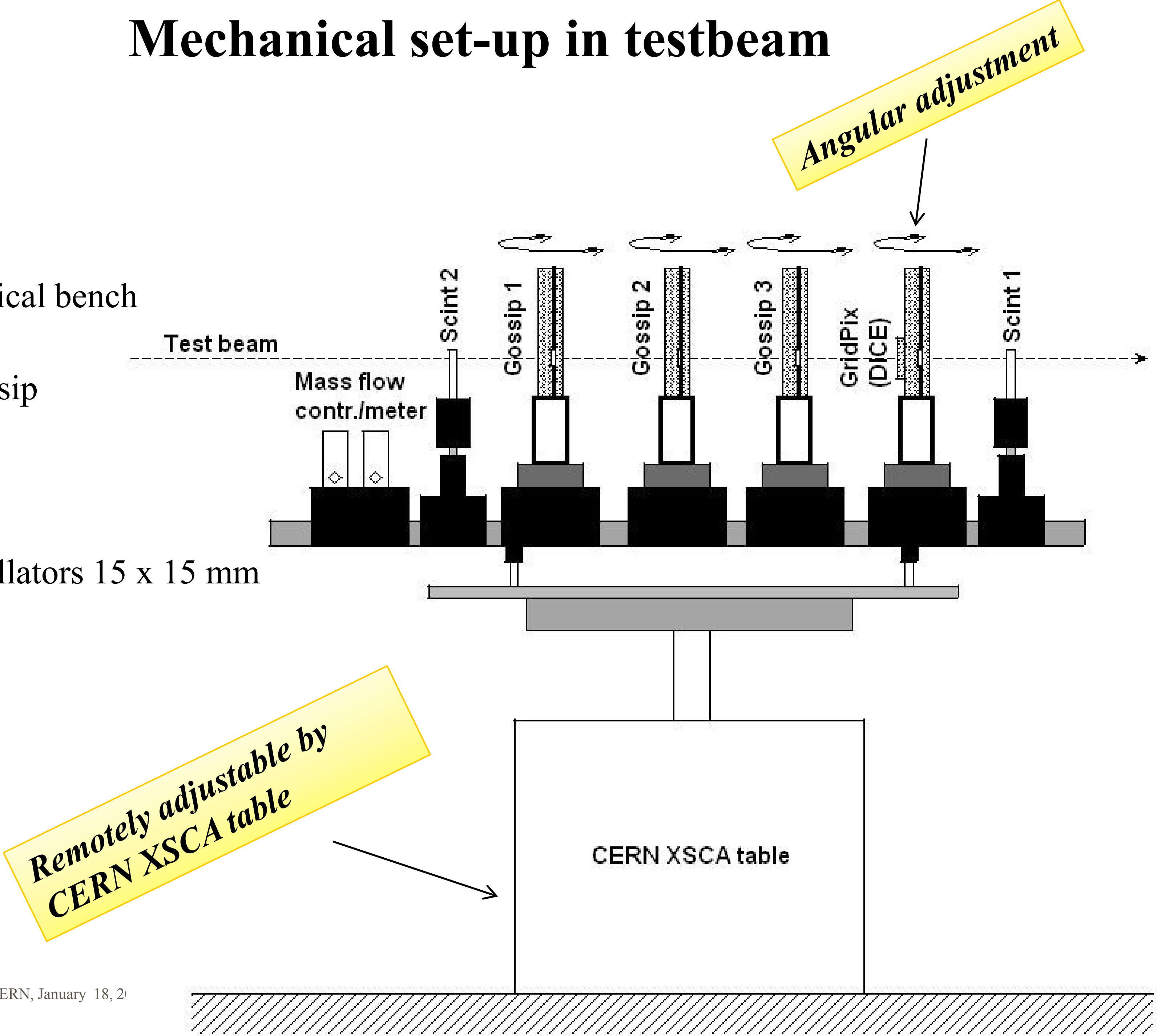
Using Gossip/GridPix telescope as a reference

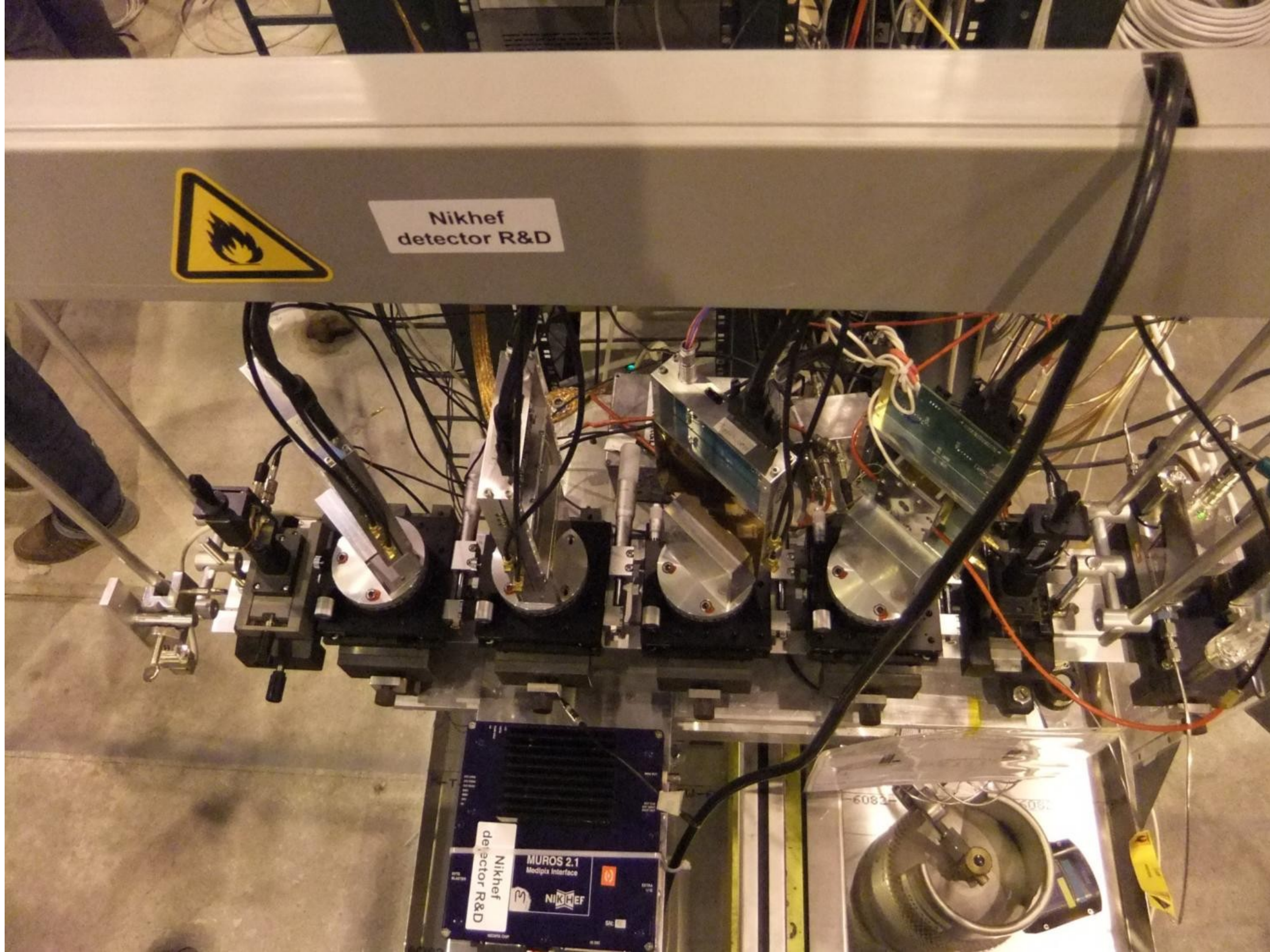
- Measurements done with Gossip 2 (1 mm gap)
- Define track with Gossip 1 and 3 (1 mm gap)
- Reject bad events using the Gridpix detector (19.3 mm drift gap)
  - Wrong angle (background tracks)
  - Outside fiducial volume
  - Multiple tracks (showers)



Mechanical set-up in testbeam

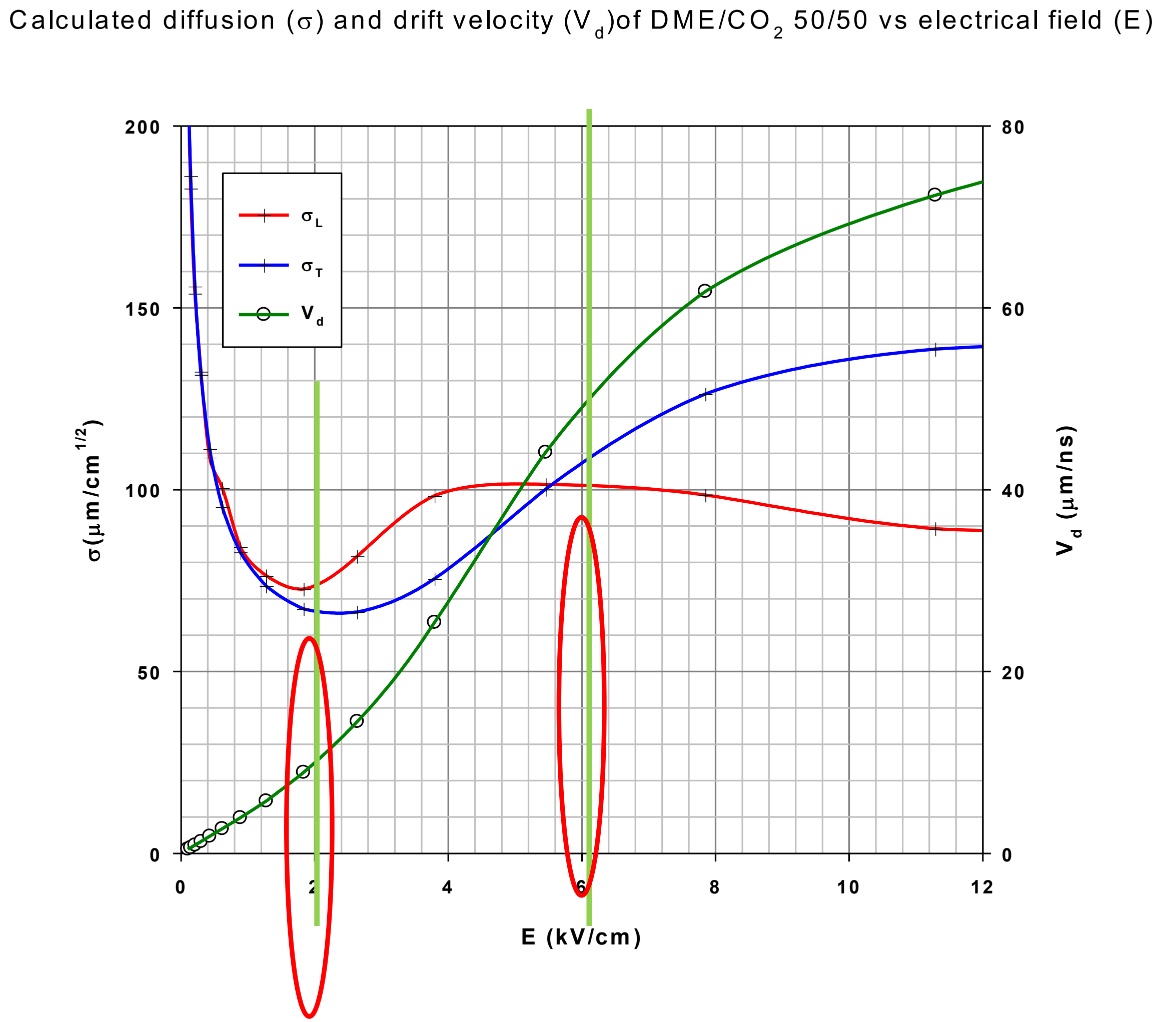
- 1 m optical bench
- 3 x Gossip
- GridPix
- 2 Scintillators 15 x 15 mm




Nikhef
detector R&D
Nikhef
detector R&D
MUROS 2.1
Medipix Interface
NIKHEF

Chamber gas: DME/CO_2 50/50
Garfield simulations

- DME/CO_2 50/50
  - Very slow and "cool" gas
  - High drift field required
  - Very low diffusion
  - Suited for TPC
- Drift fields used in Gossips
  - **2 kV/cm** (lowest diffusion)
  - **6 kV/cm** (Vd = 50 μm/ns)
    - LHC tracking



Analysis of the August 2010 testbeam

- Wealth of useful data
- **Analyzed**
  - Angular resolution of Gossips and GridPix
  - Drift velocity and diffusion for DME/CO_2 mixture
  - Position resolution at 0º
- Related effects: **Time-walk**
- **Not yet done**
  - Position resolution at angles # 0º
  - Primary ionization and possible electron attachment
  - Parallel tracks in one Gossip
  - Double track resolution from showers by upstream experiment (thick GEM tracker)

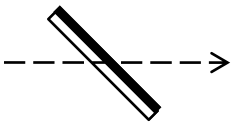
- In total 60 runs containing ~250k events
- Almost all done with DME/CO_2 50/50 and 150 GeV muons
- Last 4 runs with Ar/iC_4H_{10} 80/20
  - 46k events
  - ~3k of them were hadrons

Run overview Gossip beam test August 2010

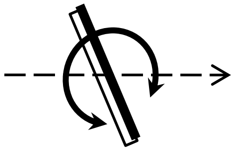
run#	start time	start date	# of event	Vg1	Vg2	Vg3	Vg4	Vf Gossip	Vguard	Vf DICE	α1	α2	α3	α4	gas	Analysed?	
1	19:41	12-8	273	580	580	580	500	780	540	2000	45	0	45	45	DME/CO2		
2		12-8	1696	580	580	580	500	780	540	2000	45	0	45	45	DME/CO2		
3		12-8	654	580	580	580	500	780	540	2000	0	0	0	0	DME/CO2		
4		13-8	1463	580	580	580	500	780	540	2000	0	0	0	0	DME/CO2		
5		13-8	1023	580	580	580	500	780	540	2000	0	0	0	0	DME/CO2		from ev 322 tests beam tuning
6		13-8	1024	600	600	600	530	800	630	4390	0	0	0	0	DME/CO2	X	
7		13-8	788	450	450	450	450	650	600	4310	45	45	45	45	DME/CO2		run in TOT mode
8		13-8	1340	450	450	450	450	650	600	4310	45	45	45	45	DME/CO2	X	
9		13-8	773	450	450	450	450	650	600	4310	45	45	45	45	DME/CO2		
10		13-8	714	470	470	470	470	670	620	4330	45	45	45	45	DME/CO2		run in TOT mode
11		13-8	1026	470	470	470	470	670	620	4330	45	45	45	45	DME/CO2	X	
12		13-8	4026	470	470	470	470	670	620	4330	45	45	45	45	DME/CO2		
13		14-8	770	490	490	490	490	690	640	4350	45	45	45	45	DME/CO2		repair timing + rot. DICE, TOT
14		14-8	1022	490	490	490	490	690	640	4350	45	45	45	45	DME/CO2	X	
15		14-8	1017	490	490	490	490	690	640	4350	45	45	45	45	DME/CO2		
16		14-8	741	510	510	510	510	710	660	4370	45	45	45	45	DME/CO2		run in TOT mode
17		14-8	1612	510	510	510	510	710	660	4370	45	45	45	45	DME/CO2	X	
18	14:19	14-8	1388	510	510	510	510	710	660	4370	45	45	45	45	DME/CO2		peak at 90 ns hopefully cured
19		14-8		530	530	530	520	730	670	4380	45	45	45	45	DME/CO2		run in TOT mode
20	17:40	14-8	4362	530	530	530	520	730	670	4380	45	45	45	45	DME/CO2	X	
21		14-8		550	550	550	530	750	680	4390	45	45	45	45	DME/CO2		run in TOT mode
22	20:28	14-8	2188	550	550	550	530	750	680	4390	45	45	45	45	DME/CO2	X	
23		14-8		570	570	570	530	770	680	4390	45	45	45	45	DME/CO2		run in TOT mode
24	22:12	14-8	2059	570	570	570	530	770	680	4390	45	45	45	45	DME/CO2	X	
25	23:27	14-8	17728	590	590	590	530	790	680	4390	45	45	45	45	DME/CO2	X	Run overnight until 8:06
26	10:32	15-8	339	590	590	590	530	790	680	4390	45	45	45	45	DME/CO2		run in TOT mode
27	10:55	15-8	348	600	600	600	540	800	690	4440	45	45	45	45	DME/CO2		run in TOT mode
28	12:19	15-8	2275	600	600	600	540	800	690	4440	45	45	45	45	DME/CO2	X	
29	14:52	15-8	2192	610	610	610	550	810	700	4450	45	45	45	45	DME/CO2	X	
30		15-8	824	610	610	610	550	810	700	4450	45	45	45	45	DME/CO2		run in TOT mode
31		15-8	694	620	620	620	560	820	710	4420	45	45	45	45	DME/CO2		run in TOT mode
32	19:40	15-8	2251	620	620	620	560	820	710	4420	45	45	45	45	DME/CO2	X	
33		15-8	2898	620	620	620	560	1220	710	4420	45	45	45	45	DME/CO2	X	
34		15-8	4270	620	620	620	560	1220	710	4420	10	45	10	10	DME/CO2		
35		16-8	5839	620	620	620	560	820	710	4420	10	45	10	10	DME/CO2		DICE trip
36		16-8	4015	620	620	620	560	820	710	4420	10	0	10	10	DME/CO2	X	
37		16-8	4596	620	620	620	560	1220	710	4420	10	0	10	10	DME/CO2	X	
38		16-8	4569	620	620	620	560	1220	710	4420	10	5.75	10	10	DME/CO2	X	
39		16-8	17919	620	620	620	560=> 550	820	710	4420	10	5.75	10	10	DME/CO2		DICE trip problems
40		16-8?	4084	620	620	620	520	1220	670	4380	10	11.5	10	10	DME/CO2		DICE reduced after trips
41		17-8	4306	620	620	620	530	820	680	4390	10	11.5	10	10	DME/CO2		broad beam, low intensity
42		17-8	5001	620	620	620	540	820	690	4390?	10	23	10	10	DME/CO2		~ 10x more particles
43		17-8	5307	620	620	620	540	1220	690	4440	10	23	10	10	DME/CO2		
44		17-8	30855	620	620	620	540	820	690	4440	0	0	0	90	DME/CO2	X	
45		18-8	6442	620	620	620	540	820	690	4440	0	0	0	90	DME/CO2	X	gasflow to 65 ml/min
46		18-8	7097	620	620	620	540	820	690	4440	0	0	0	90	DME/CO2	X	lower thresh. DICE
47		18-8	1940	620	620	620	540	820	690	4440	0	0	0	10	DME/CO2		Vf of pos2 at 0V
48		19-8	9854	620	620	620	540	820	690	4440	0	45	0	10	DME/CO2		Vf of pos2 at 0V
49		19-8	8358	620	620	620	540	820	690	4440	0	45	45	10	DME/CO2		Vf of pos2 at 0V
50	11:44	20-8	4440	620	620	620	540	820	690	4440	45	45	45	0	DME/CO2		Vf of pos2 at 0V
51	14:50	20-8	2410	620	0	620	540	820	690	4440	45	45	45	0	DME/CO2		PillarPix dead, P3 sparky
52	16:26	20-8	292	620	0	620	540	820	690	4440	45	45	45	0	DME/CO2		Hadr.;SCXA:106;306=>092;366
53	16:38	20-8	3832	620	0	620	540	820	690	4440	45	45	45	0	DME/CO2		Hadrons, no field on P3 and P2
54	18:07	20-8	2744	620	0	620	540	820	690	4440	45	45	45	0	DME/CO2		sheet missing
55	11:27	21-8	3381	620	620	620	540	820	690	4440	0	0	0	10	DME/CO2		
56	12:48	21-8	5314	620	620	620	540	570	450	3245	0	90	0	10	DME/CO2		SC2 5.5 to PC, SC1 2.5 oppos.
57	18:19	21-8	634	420	420	420	350	570	450	3245	0	0	0	10	Ar/iC4H10		150 GeV hadrons
58	18:32	21-8	4314	420	420	420	350	570	450	3245	0	0	0	10	Ar/iC4H10		Hadrons => muons
59	19:50	21-8	34348	420	420	420	350	570	450	3245	0	0	0	10	Ar/iC4H10		
60	9:30	22-8	11804	420	420	420	350	570	450	3245	0	11.5	0	10	Ar/iC4H10		

What has been measured?

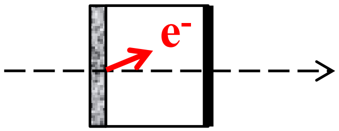
- 50k events for Gossip under 45°
  - Grid voltage scan from -510 to -620 V
  - Mostly at field 2 kV/cm
  - 2.8 k events at 6 kV/cm
    - 25 ns charge collection => LHC timing



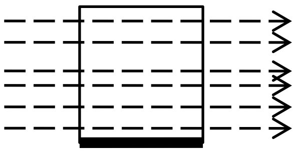
- 10k events under 4 other angles
  - 0; 5.75; 11.5 and 23°
  - Both at drift field of 2 and 6 kV/cm



- 25k events with secondary emission detector (PillarPix)

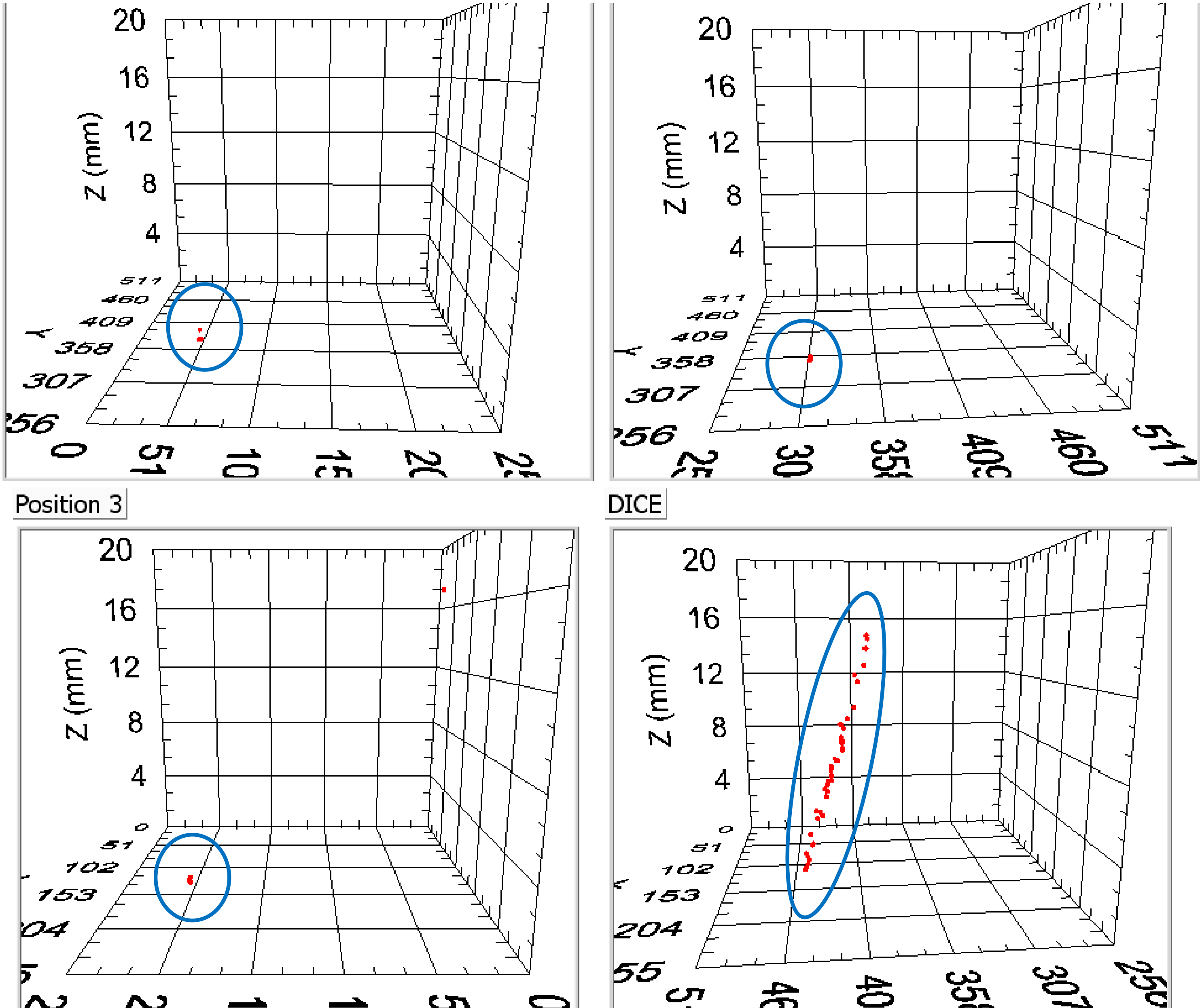


- 44k events in GridPix under 90°



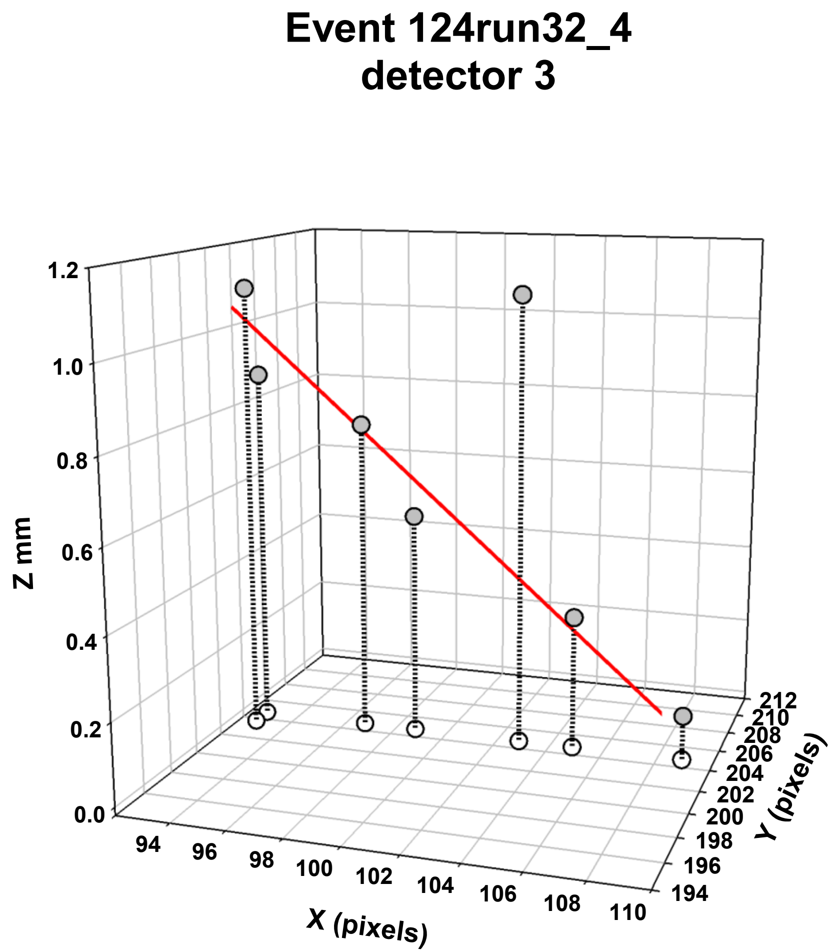
- 5k events with parallel tracks in Gossip

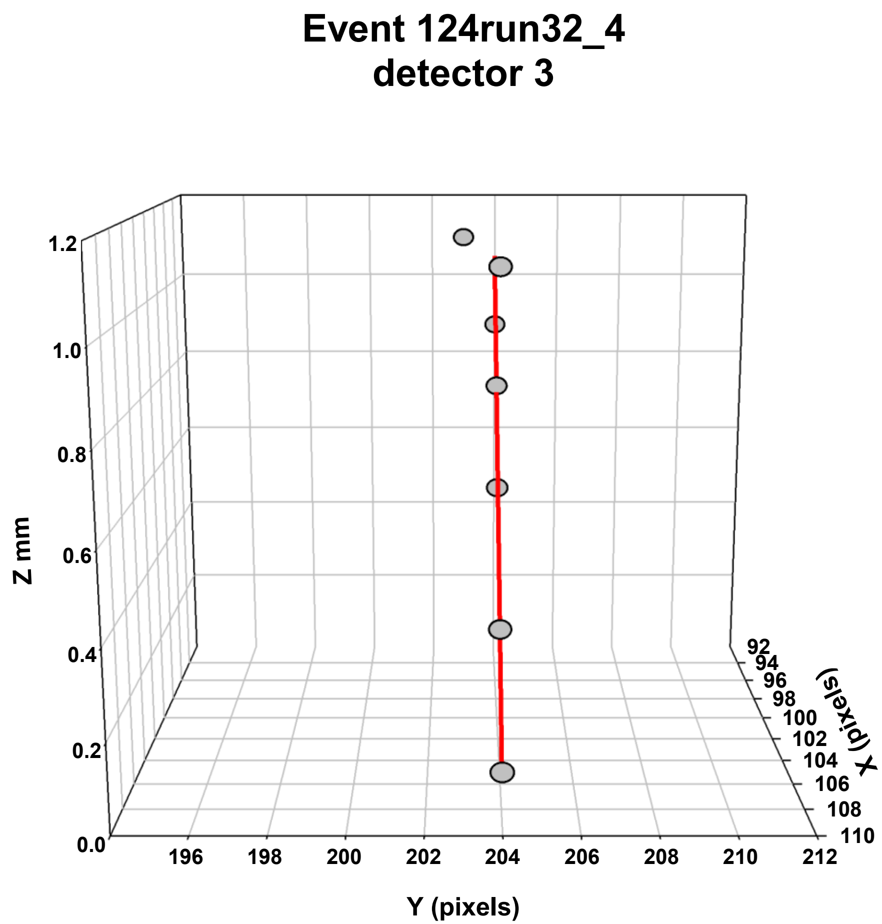
Typical event in all 4 detectors (angle 10°)



Typical track in Gossip 3
45° in X-Z plane

55 x 55 μm pitch



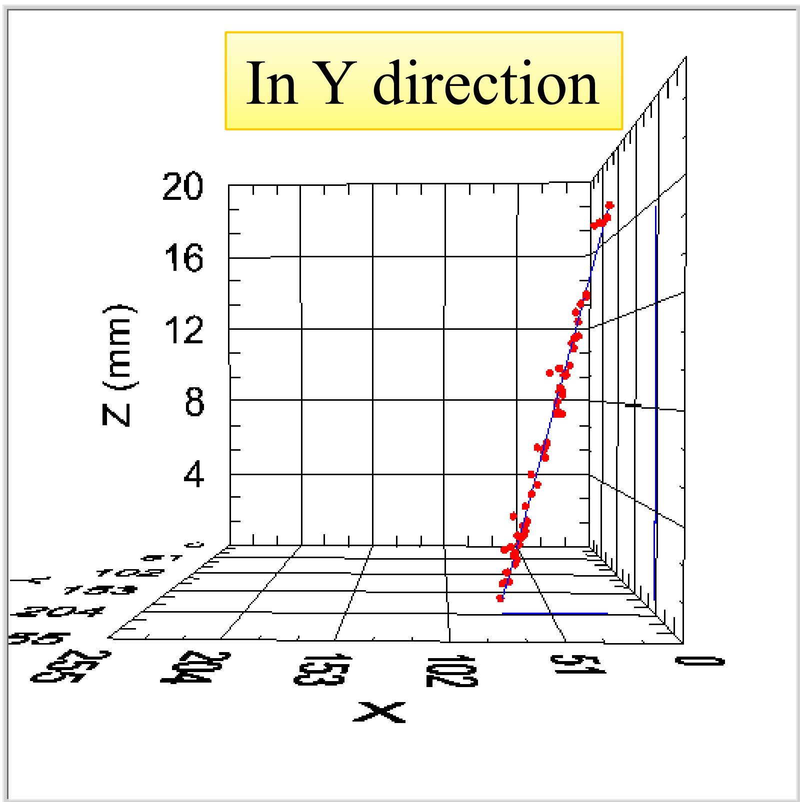


Comparing DME/CO_2 to Ar/isobutane

Tracks under 10°

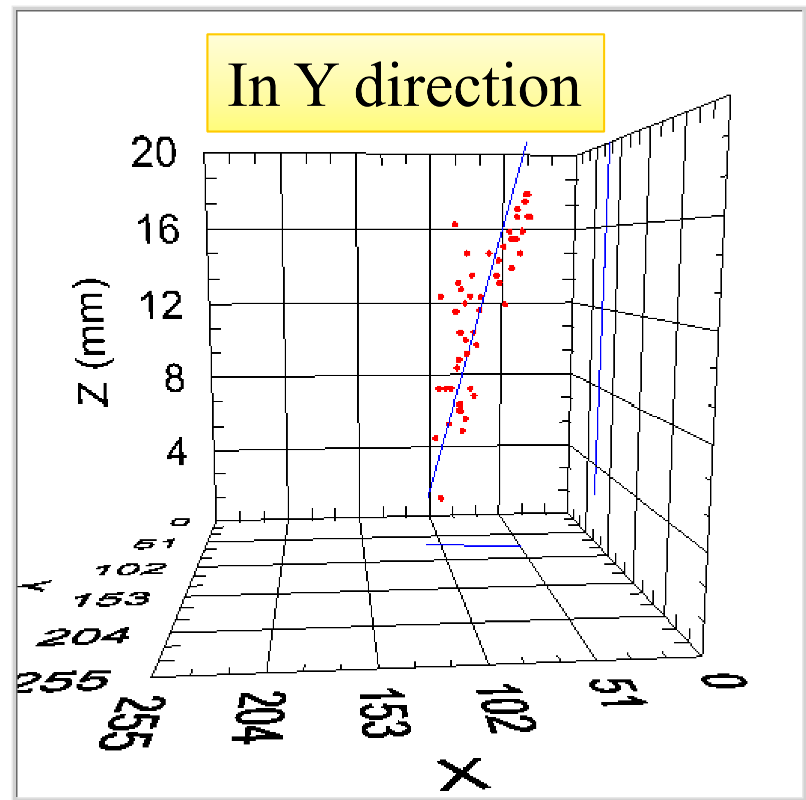
DME/CO_2 50/50

TimePix



Ar/iC_4H_{10} 80/20

TimePix



Data cuts

- **Cuts** on each detector individually
- Cuts on fitted tracks
  - Slope
  - Intercept Z=0
  - Fit residue
- Cuts on pixel hits
  - Fiducial area
  - Maximum drift time

Fit Cut Matrix

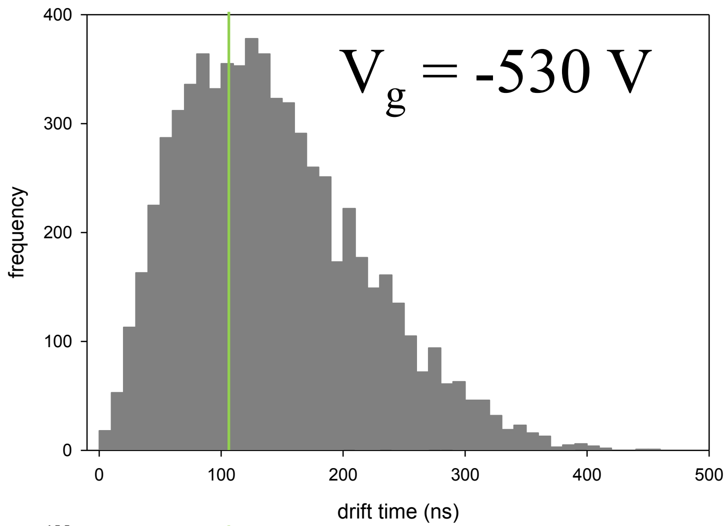
#	Gossip 1	Gossip 2	Gossip 3	GridPix	
0	1	1	1	-0.85	Max Z-X slope
1	-1	-1	-1	-1.1	Min Z-X slope
2	0	0	0	1	**Z-X slope enable**
3	0	0	0	0.03	Max Z-Y slope
4	0	0	0	-0.03	Min Z-Y slope
5	0	0	0	1	**Z-Y slope enable**
6	0	0	0	13	Max X intercept (Z=0, mm)
7	0	0	0	2	Min X intercept (Z=0, mm)
8	0	0	0	1	**X intercept enable**
9	0	0	0	11	Max Y intercept (Z=0, mm)
10	0	0	0	1	Min Y intercept (Z=0, mm)
11	0	0	0	1	**Y intercept enable**
12	0	0	0	1	Max X-slope residue
13	0	0	0	1	**X slope residue enable**
14	0	0	0	0.02	Max Y-slope residue
15	0	0	0	1	**Y slope residue enable**

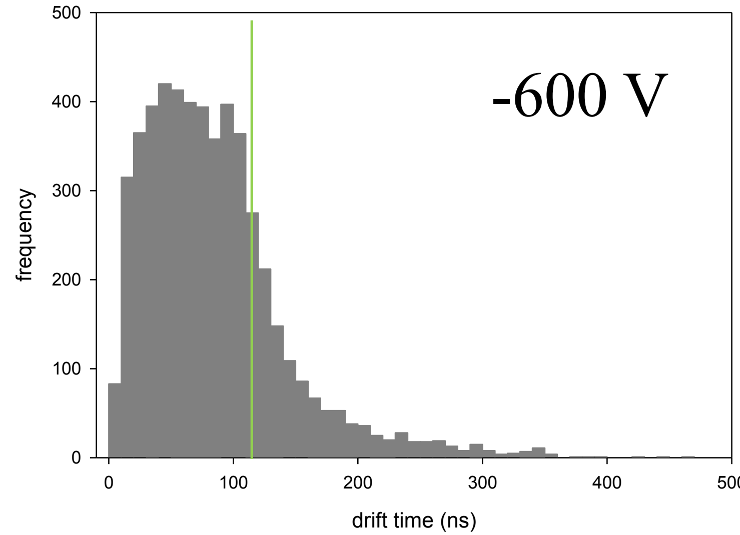
Pixel Cut Matrix

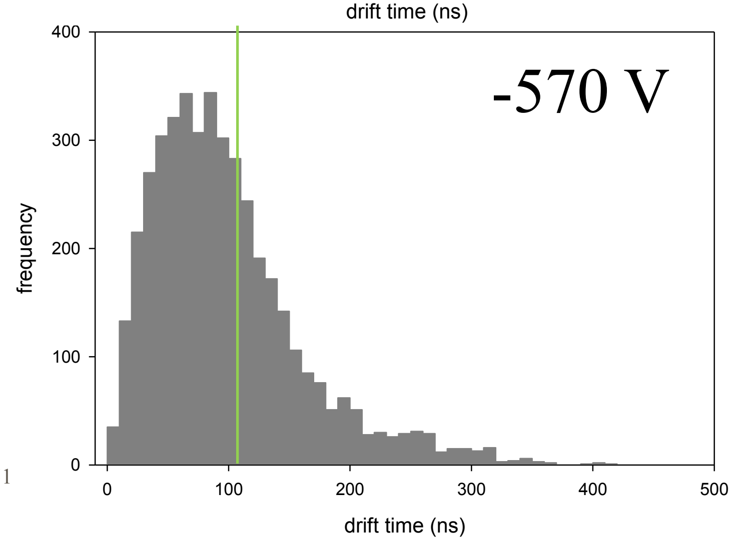
#	Gossip 1	Gossip 2	Gossip 3	GridPix	
0	245	245	245	245	X upper limit (pix)
1	10	10	10	10	X lower limit (pix)
2	1	1	1	1	**X fid enable**
3	245	245	245	245	Y upper limit (pix)
4	10	10	10	10	Y lower limit (pix)
5	1	1	1	1	**Y fid enable**
6	2	2	2	2	# of hits
7	0	0	0	1	**# of hits enable**
8	111	111	111	0	Max drift time (ns)
9	1	1	1	0	**Max drift time enable** (1: cut; 2: coerce)

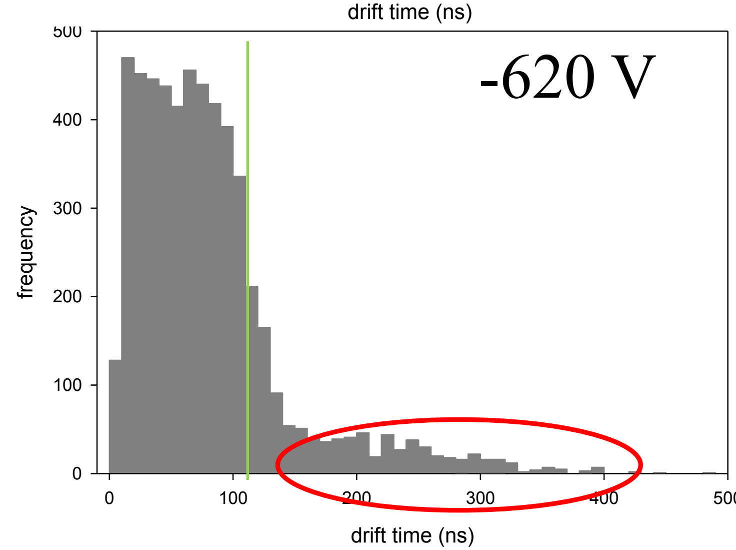
Gossip drift time spectra

- Should be ~ 100 ns wide
- TimePix chip suffering from **time walk** => extending for hundreds of ns
- Less dominant at high gain, **but do not disappear**





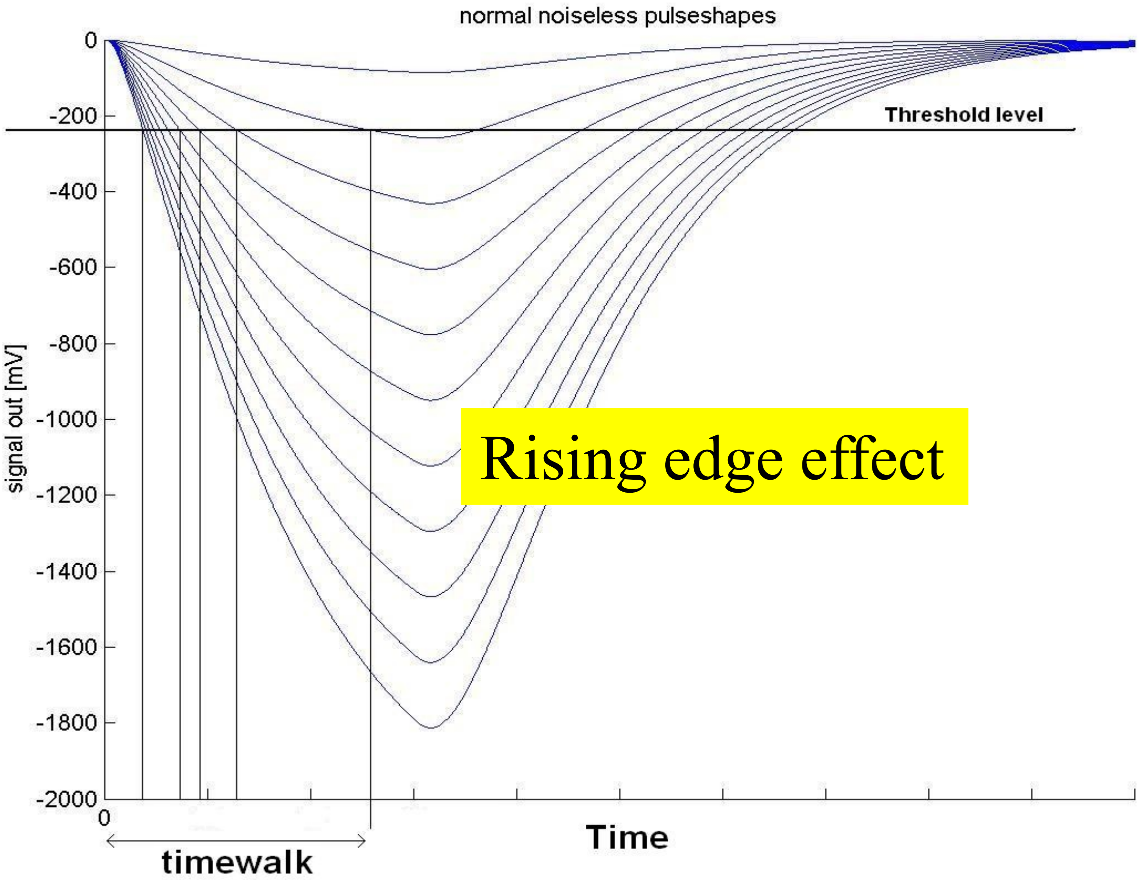




Time walk leading to excessive arrival times

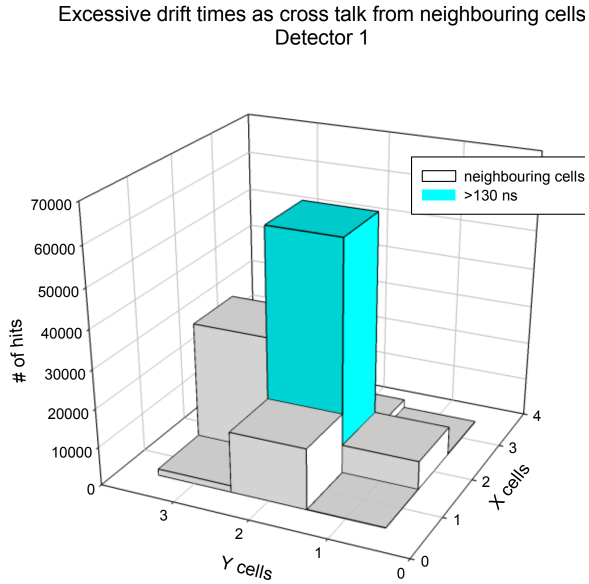
- Rising edge effect: up to 50 ns delay
- Discriminator overdrive
  - Certain charge >0 is needed to let the discriminator fire

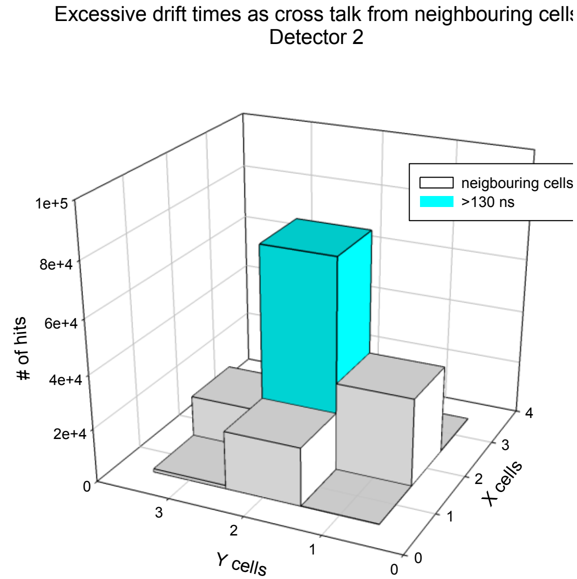
Hundreds of ns time walk possible

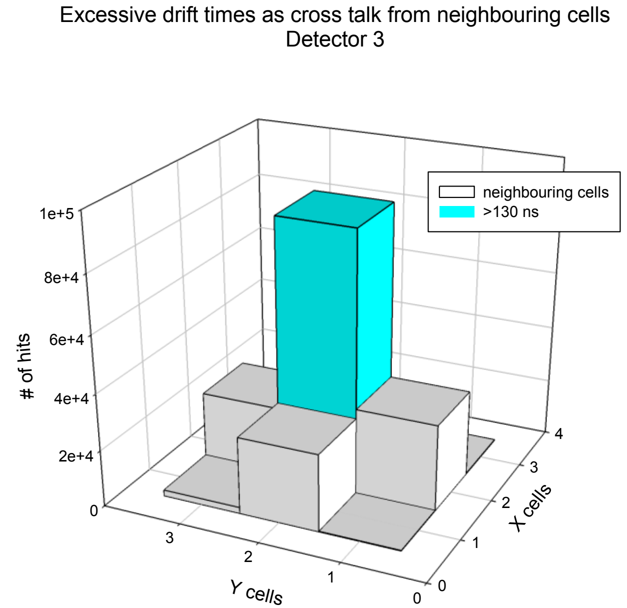


Excessive arrival-time hits at high gain <u>possibly</u> from cross talk by neighbours

- Excessive time-walk hits (> 130 ns) normally accompanied by hit in neighbouring cell



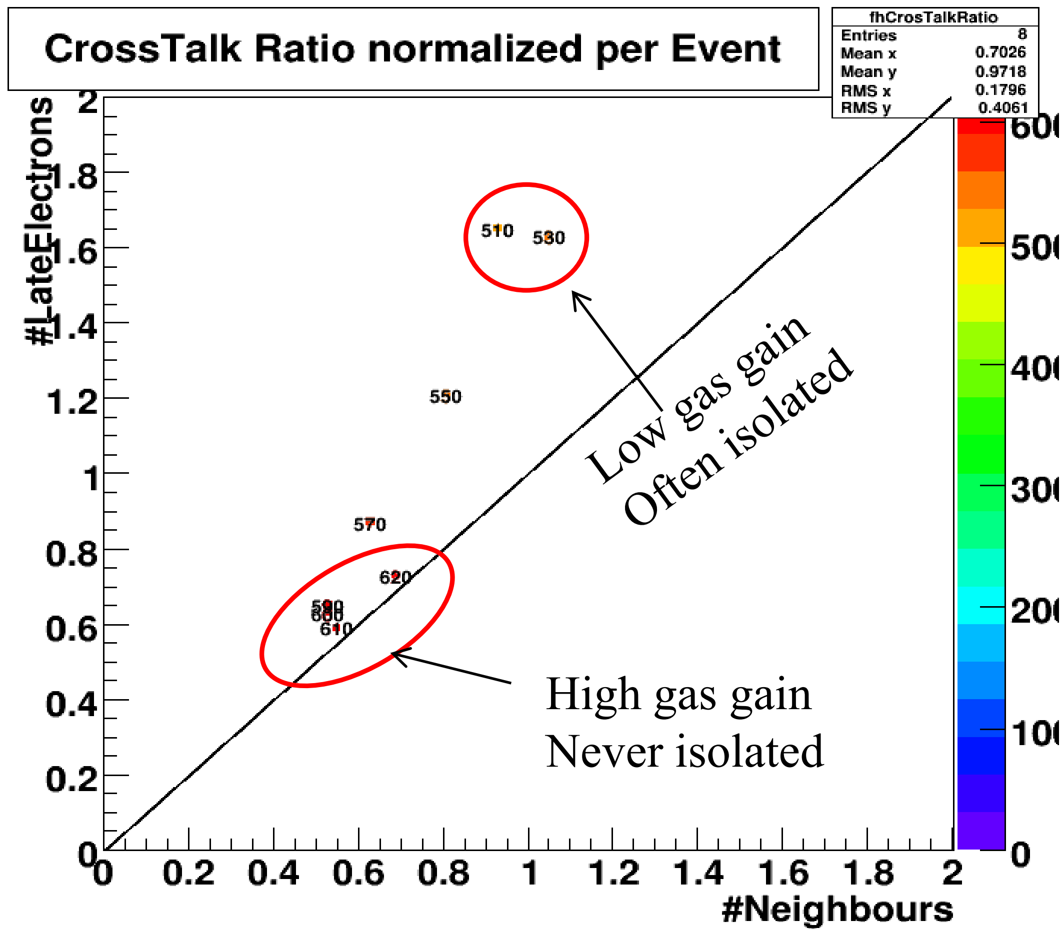




Isolation of excessive arrival-time hits

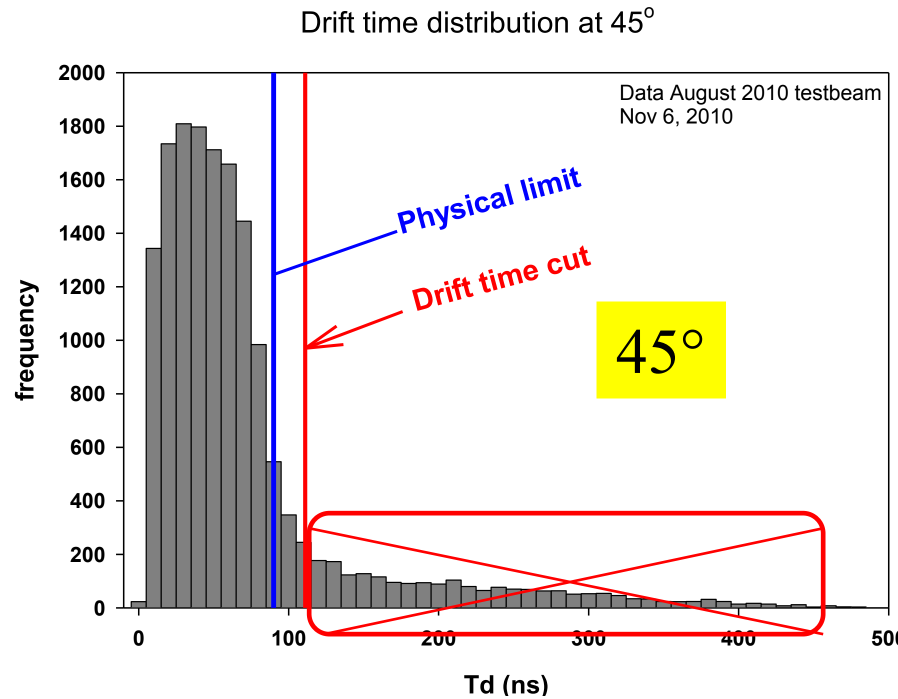
- **Often** isolated at low gas gain (V_{grid} = -510, -530 V)
- **Never** isolated at high gas gain (V_{grid} = -590 to -620 V)

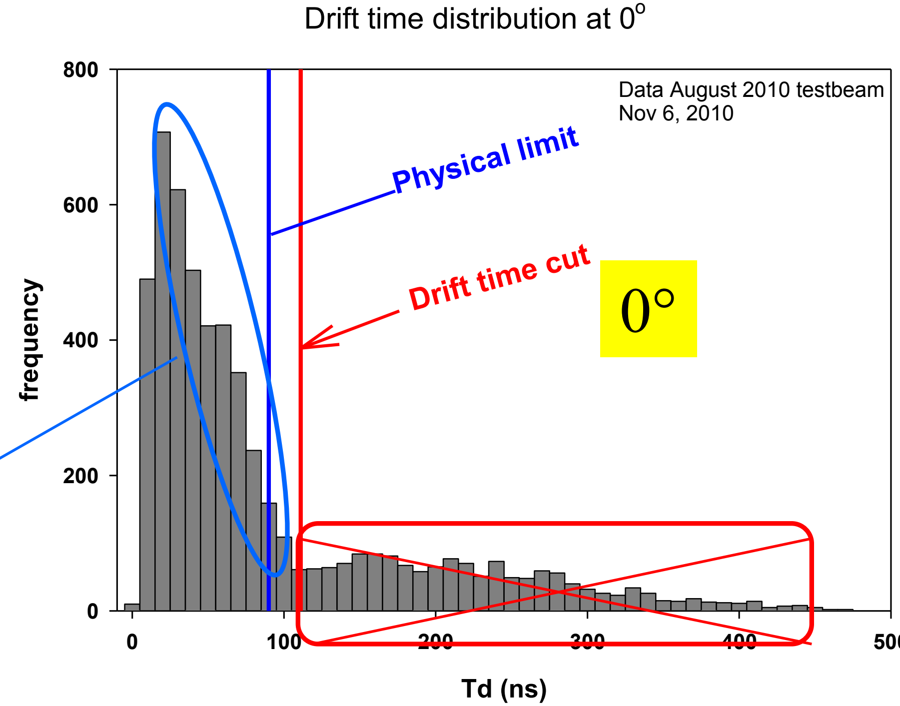
Gossip 2



Angular dependence of drift time spectrum in Gossip

- **Tail** with drift times longer than given by drift space
  - Cross talk signal just passing the threshold => long arrival time from poor time walk properties of TimePix chip
  - => out of range drift times removed in analysis
  - **Drift time cut at 111 ns**
- **Pile up** effect at 0°
  - => **Two or more** electrons collected by the same pixel
  - => at 0° longer drift times are under-populated

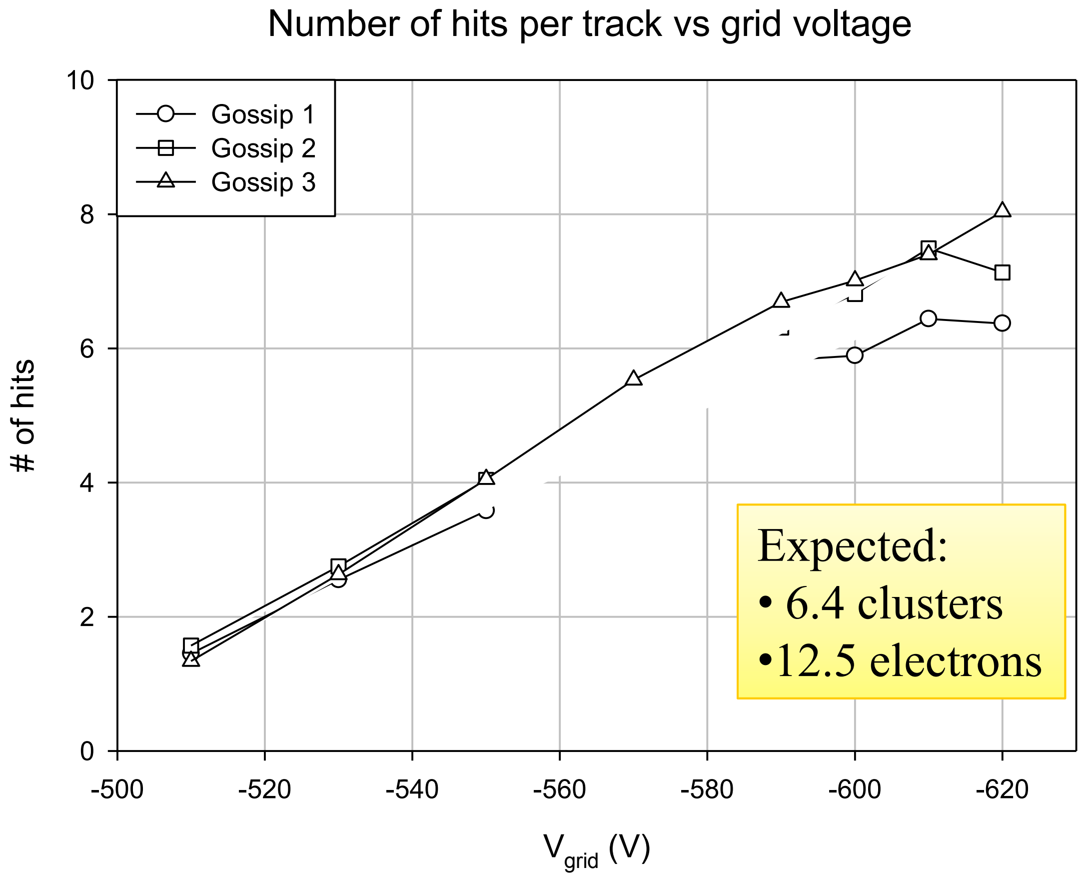




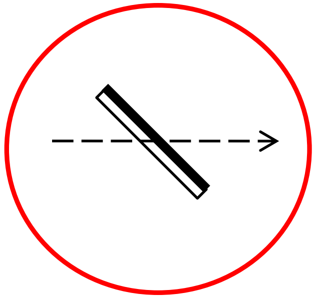
Number of hits per track in Gossip vs grid voltage

- Excessive arrival times (> 111 ns) have been cut

Tracks under 45°

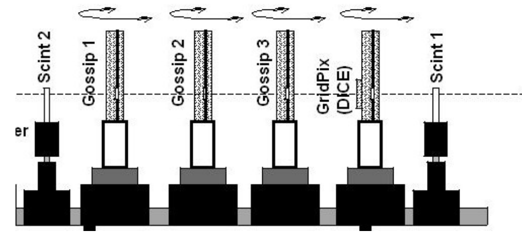


Expected:
• 6.4 clusters
•12.5 electrons



Cut matrix for hit plot

- Using **GridPix** as a reference for good tracks
- Rejecting
  - Empty events
  - Multiple track events
  - Background tracks
  - Large drift time electrons in Gossips (> 111 ns)



Fit Cut Matrix

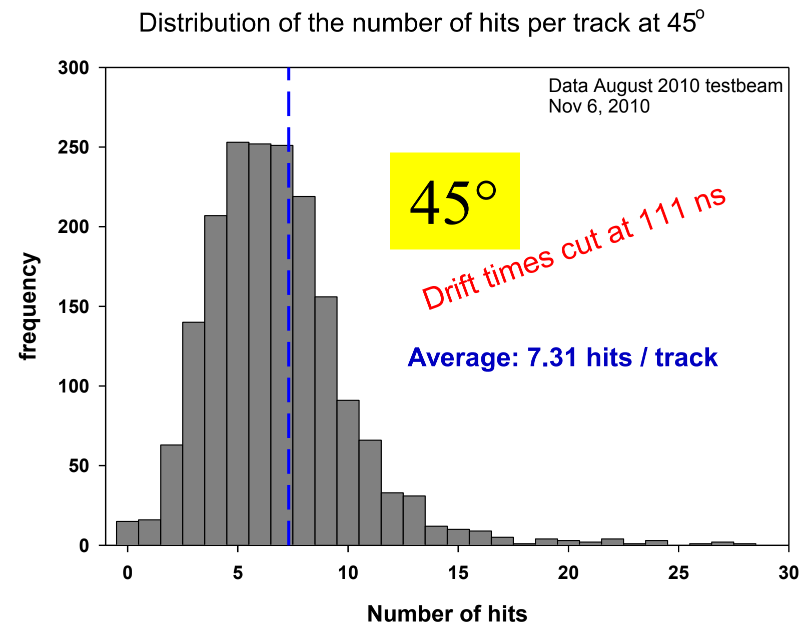
	Gossip 1	Gossip 2	Gossip 3	GridPix	
0	1	1	1	-0.85	Max Z-X slope
1	-1	-1	-1	-1.1	Min Z-X slope
2	0	0	0	1	**Z-X slope enable**
3	0	0	0	0.03	Max Z-Y slope
4	0	0	0	-0.03	Min Z-Y slope
5	0	0	0	1	**Z-Y slope enable**
6	0	0	0	13	Max X intercept (Z=0, mm)
7	0	0	0	2	Min X intercept (Z=0, mm)
8	0	0	0	1	**X intercept enable**
9	0	0	0	11	Max Y intercept (Z=0, mm)
10	0	0	0	1	Min Y intercept (Z=0, mm)
11	0	0	0	1	**Y intercept enable**
12	0	0	0	1	Max X-slope residue
13	0	0	0	1	**X slope residue enable**
14	0	0	0	0.02	Max Y-slope residue
15	0	0	0	1	**Y slope residue enable**

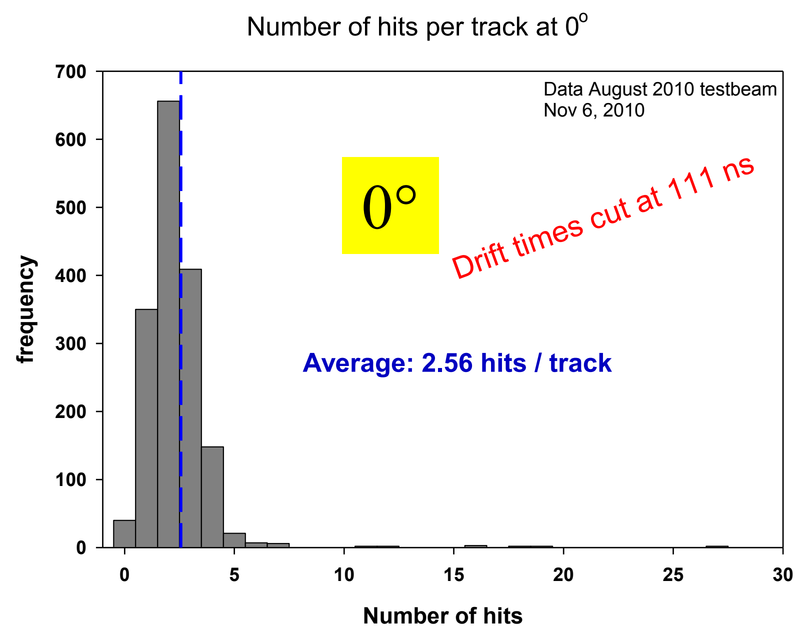
Pixel Cut Matrix

	Gossip 1	Gossip 2	Gossip 3	GridPix	
0	245	245	245	245	X upper limit (pix)
1	10	10	10	10	X lower limit (pix)
2	1	1	1	1	**X fid enable**
3	245	245	245	245	Y upper limit (pix)
4	10	10	10	10	Y lower limit (pix)
5	1	1	1	1	**Y fid enable**
6	2	2	2	2	# of hits
7	0	0	0	1	**# of hits enable**
8	111	111	111	0	Max drift time (ns)
9	1	1	1	0	**Max drift time enable** (1: cut; 2: coerce)

Angular dependence of number of hits per track

- **Pile up** effect at 0° causing factor 2 decrease of hit pixels

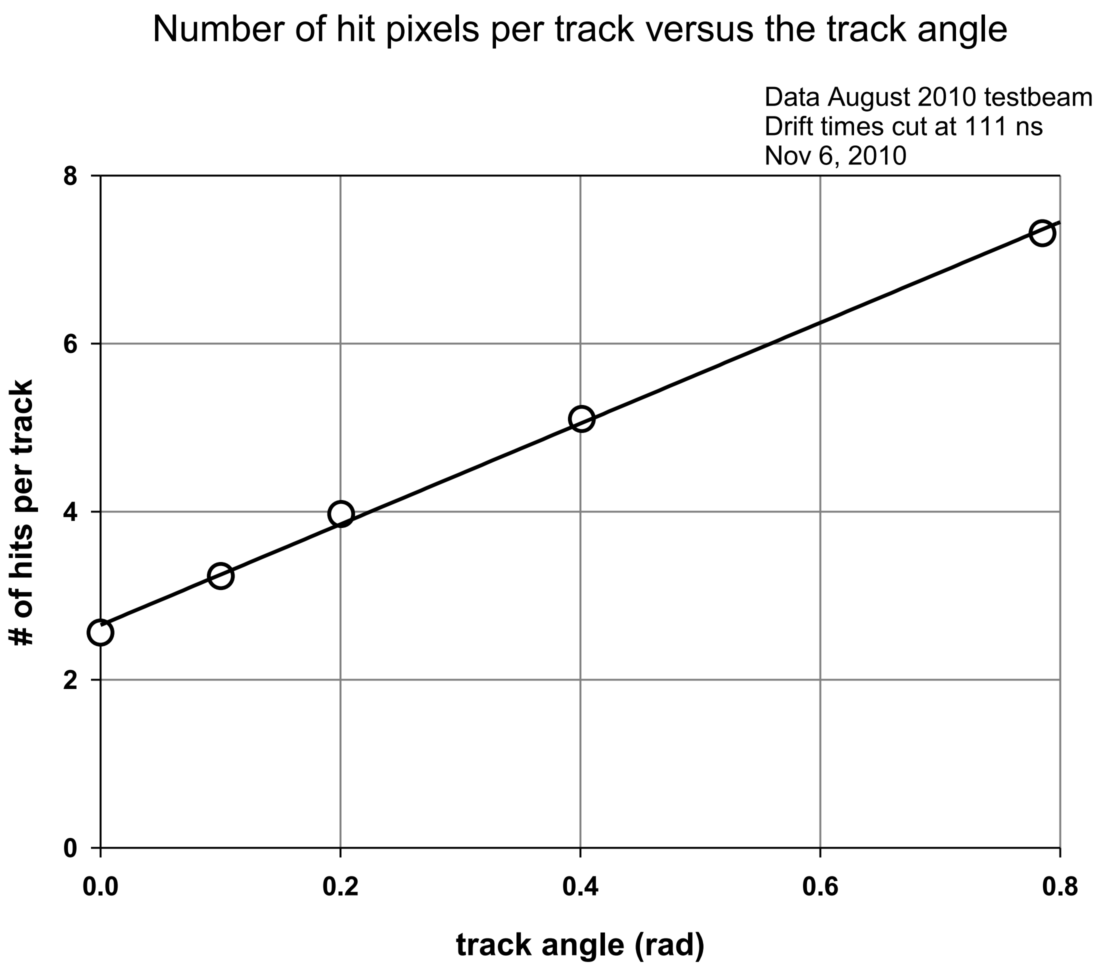




Number of hits per track versus angle of incidence

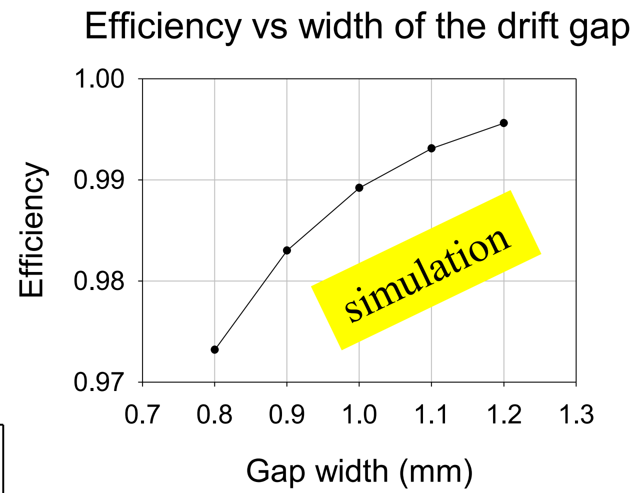
- Steady rise from decrease of **pile up**

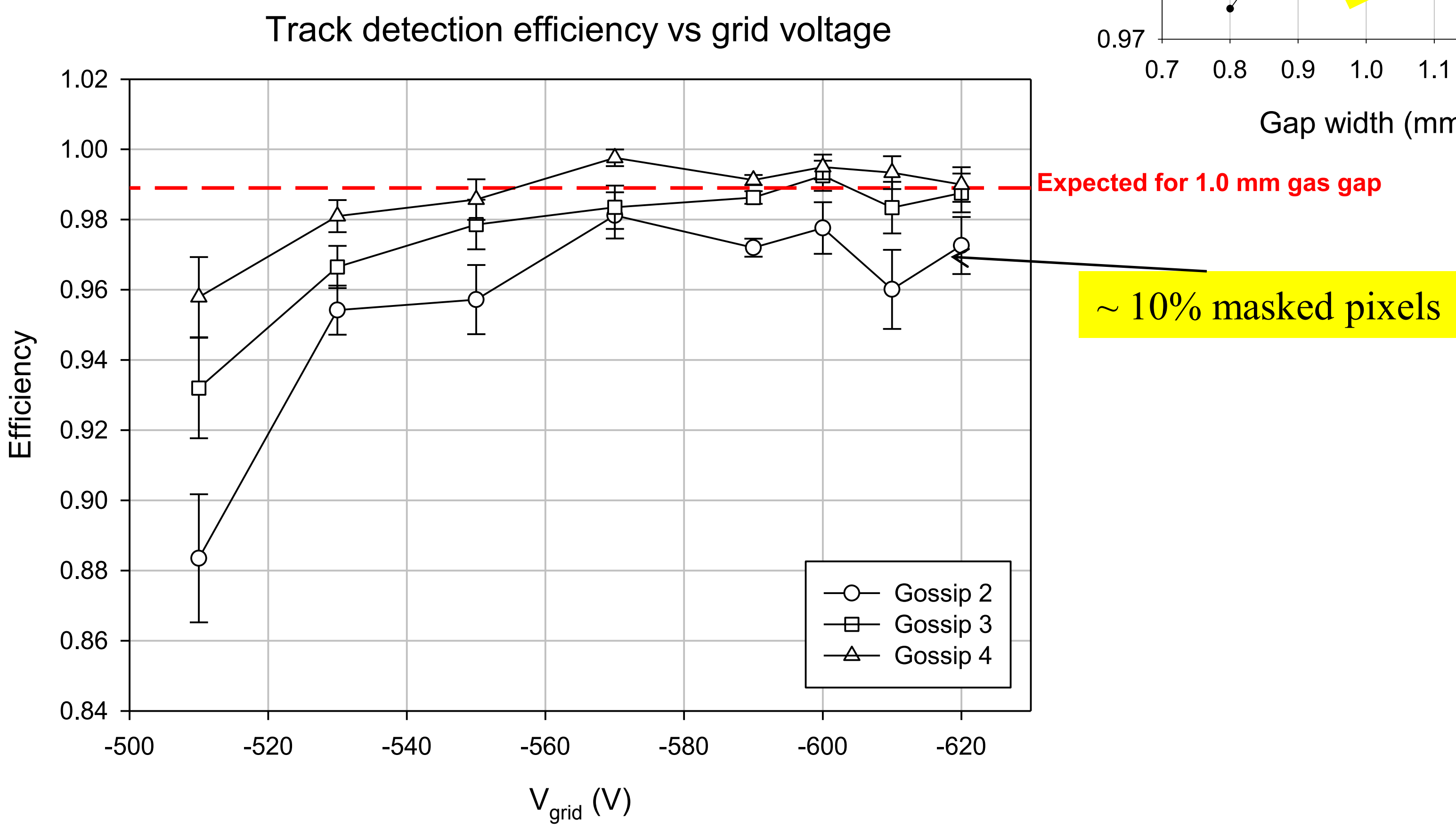
- Cannot explained by the increase of the ionization



Track detection efficiency

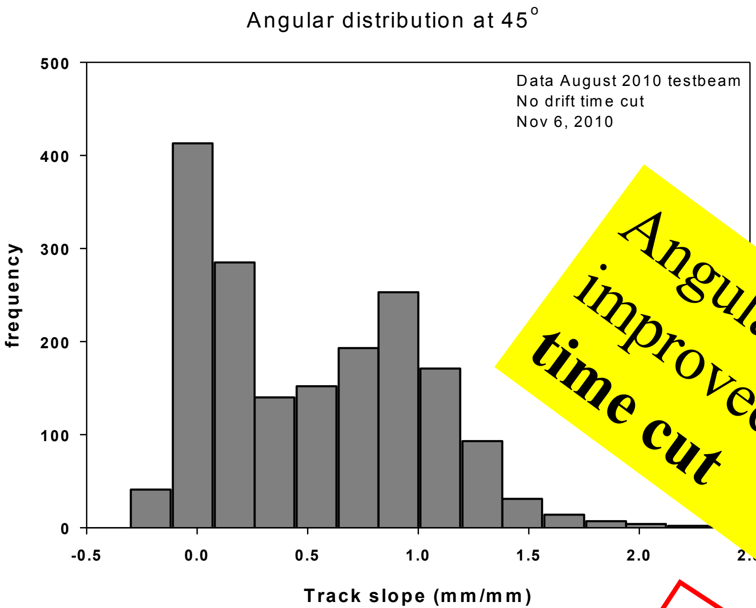
- Tracks selected by GridPix detector
- Completely flat plateau from ~ -570 V on
- Expected for 1.0 mm DME/CO_2: 98.9%



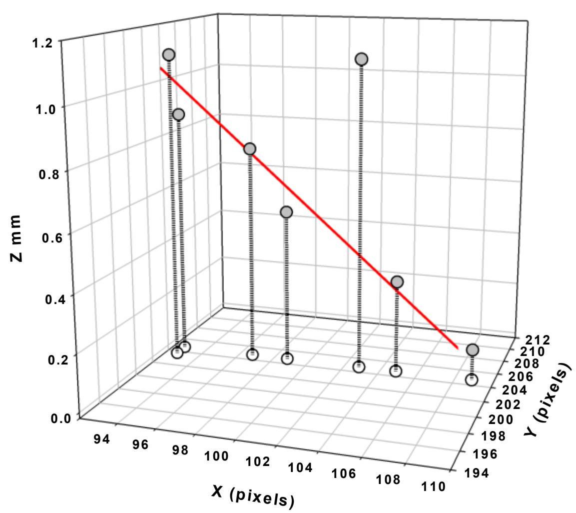


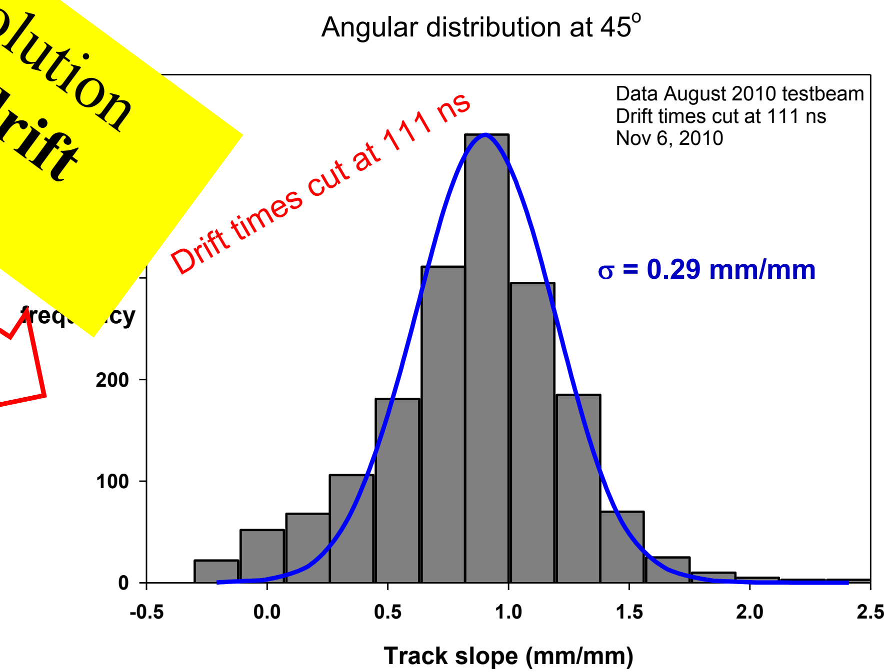
Angular resolution at 45°

- Also for 1 mm of gas one may deduce the angle of the traversing track



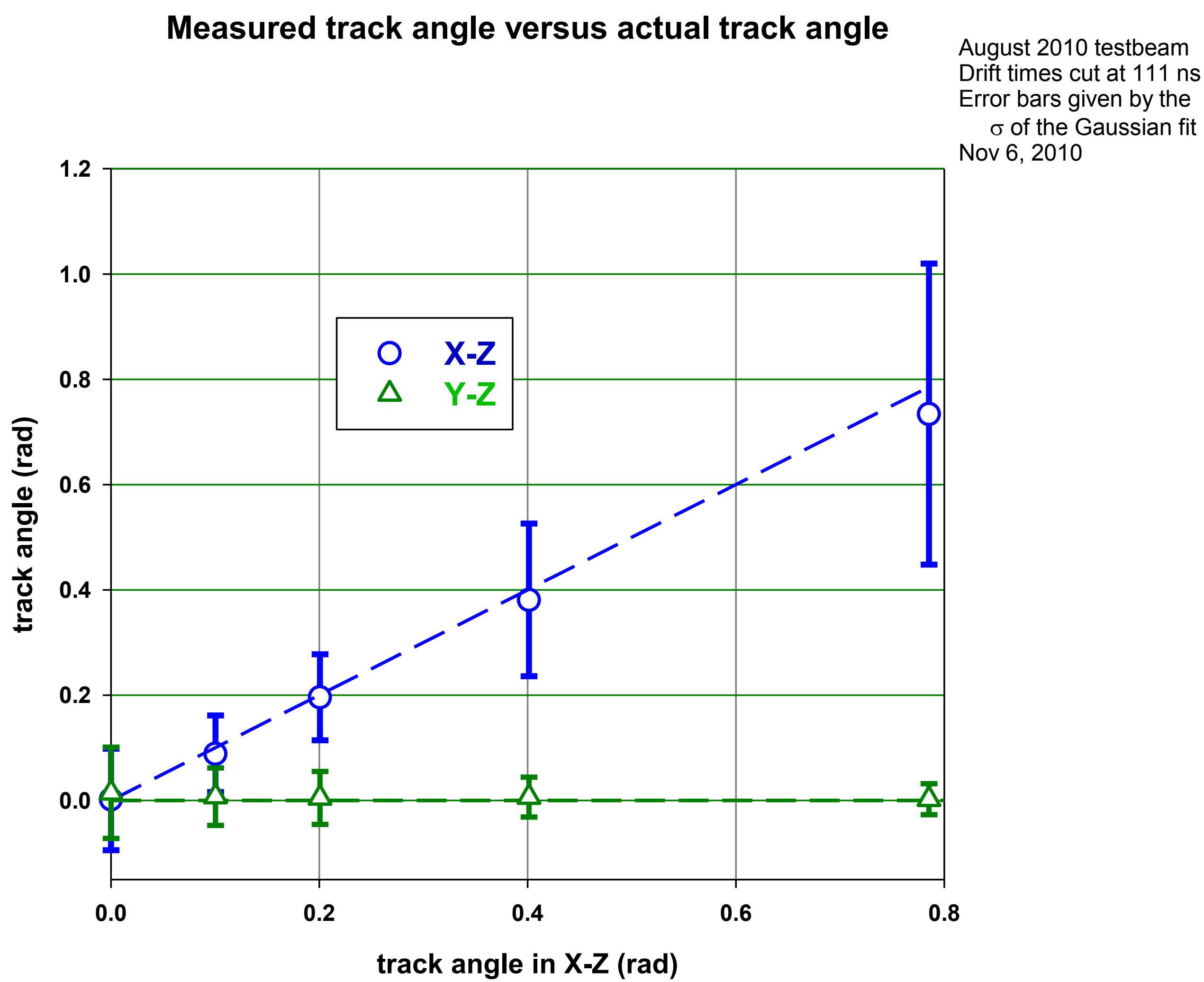
Angular resolution improved by drift time cut





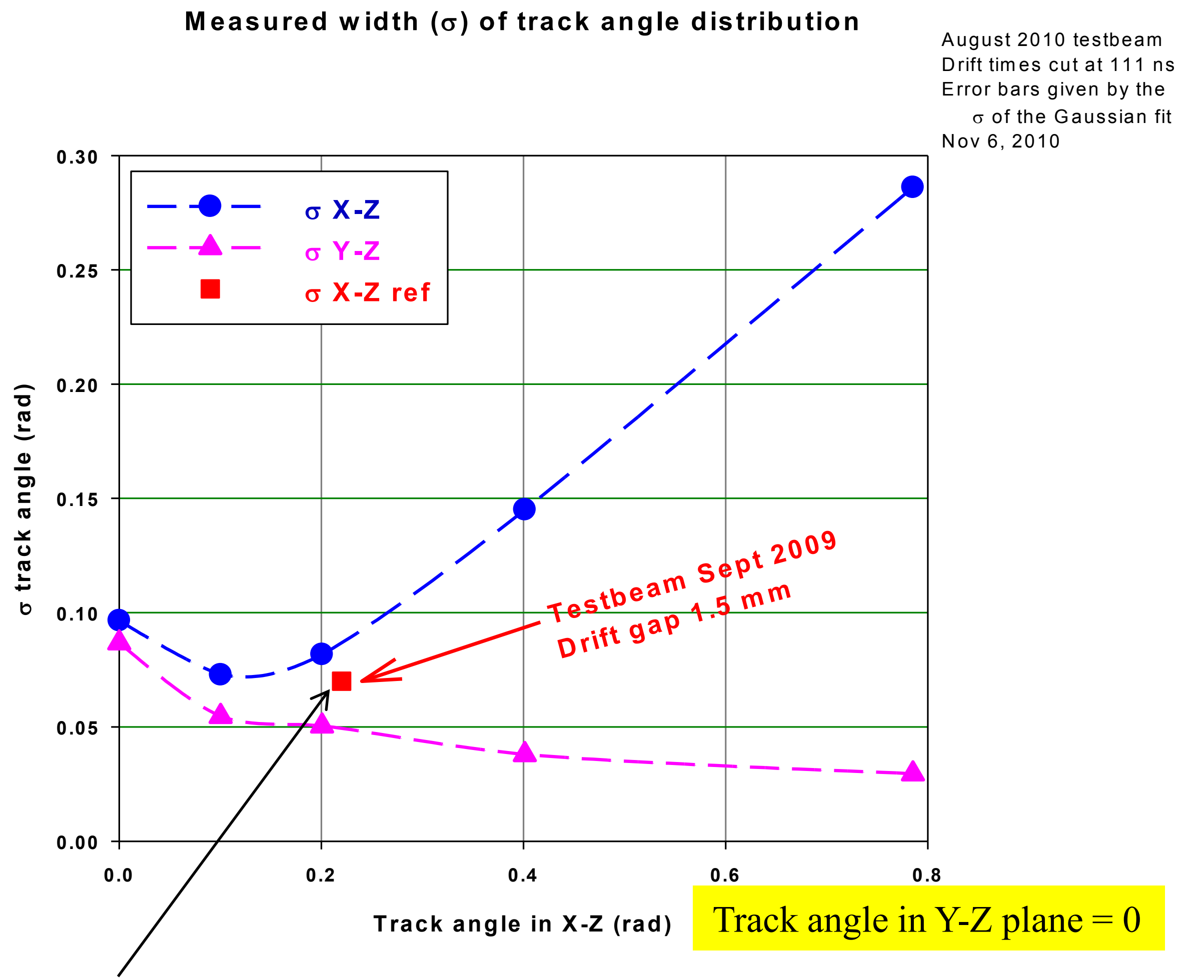
Measured track angle versus angle of incidence

- Angular resolution in X-Z plane still limited by time walk, minor ionization and small lever arm
- In Y-Z plane accuracy gets better with increasing X-Z angle (better electron statistics)
- Increasing the drift gap 1.2 mm would give better performance



Angular resolution versus angle of incidence

- Angular resolution in X-Z plane deteriorated by **limited timing properties** of the TimePix chip
- In Y-Z plane accuracy gets better with increasing X-Z angle (better statistics)
- Increasing the drift gap to **1.2 mm** would give better performance

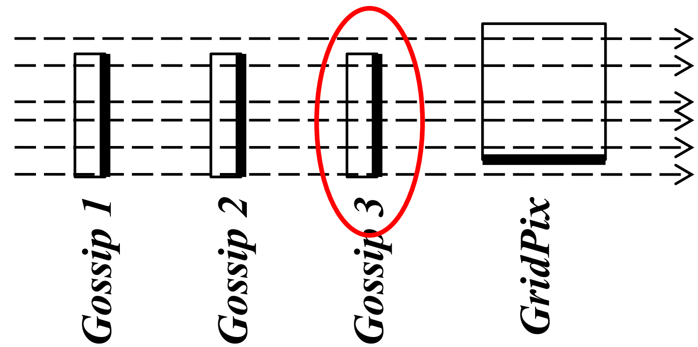


Track angle in Y-Z plane = 0

ref: ***Y. Bilevych et al., submitted to the proceedings of the 12th Topical Seminar on Innovative Particle and Radiation Detectors, Siena, Italy, June 7 -10, 2010***

Parallel tracks in GridPix

- GridPix under 90°
- Gossips under 0°
- 44k events



- Presently only using Gossip 3 as a reference

Pixel Cut Matrix

	Gossip 1	Gossip 2	Gossip 3	GridPix	
0	245	245	245	245	X upper limit (pix)
1	10	10	10	10	X lower limit (pix)
2	1	1	1	1	**X fid enable**
3	245	245	245	245	Y upper limit (pix)
4	10	10	10	10	Y lower limit (pix)
5	1	1	1	1	**Y fid enable**
6	2	2	2	2	# of hits
7	0	0	0	1	**# of hits enable**
8	111	111	111	0	Max drift time (ns)
9	1	1	1	0	**Max drift time enable**
					(1: cut; 2: coerce)

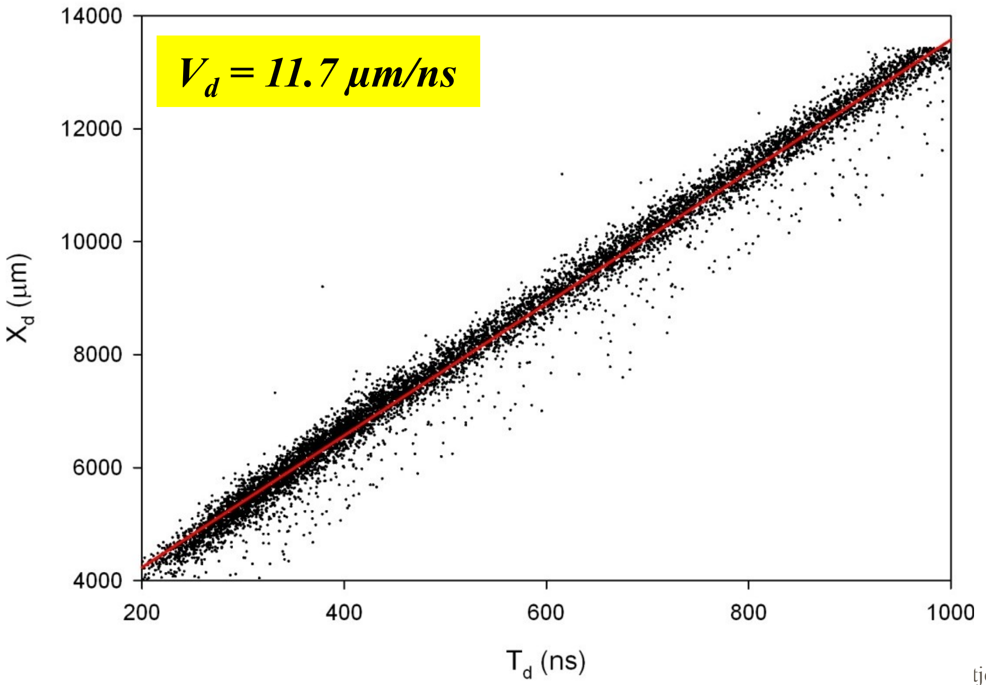
Horizontal Fit Cut Matrix

	Gossip 1	Gossip 2	Gossip 3	GridPix	
0	1	1	1	0.05	Max X-Z slope
1	-1	-1	-1	-0.05	Min X-Z slope
2	0	0	0	1	**X-Z slope enable**
3	0	0	0	0.03	Max X-Y slope
4	0	0	0	-0.02	Min X-Y slope
5	0	0	0	1	**X-Y slope enable**
6	0	0	0	10	Max Z intercept (X=0, mm)
7	0	0	0	2	Min Z intercept (X=0, mm)
8	0	0	0	0	**Z intercept enable**
9	0	0	0	13	Max Y intercept (X=0, mm)
10	0	0	0	1	Min Y intercept (X=0, mm)
11	0	0	0	0	**Y intercept enable**
12	0	0	0	0.3	Max X-slope residue
13	0	0	0	1	**X slope residue enable**
14	0	0	0	0.01	Max Y-slope residue
15	0	0	0	1	**Y slope residue enable**

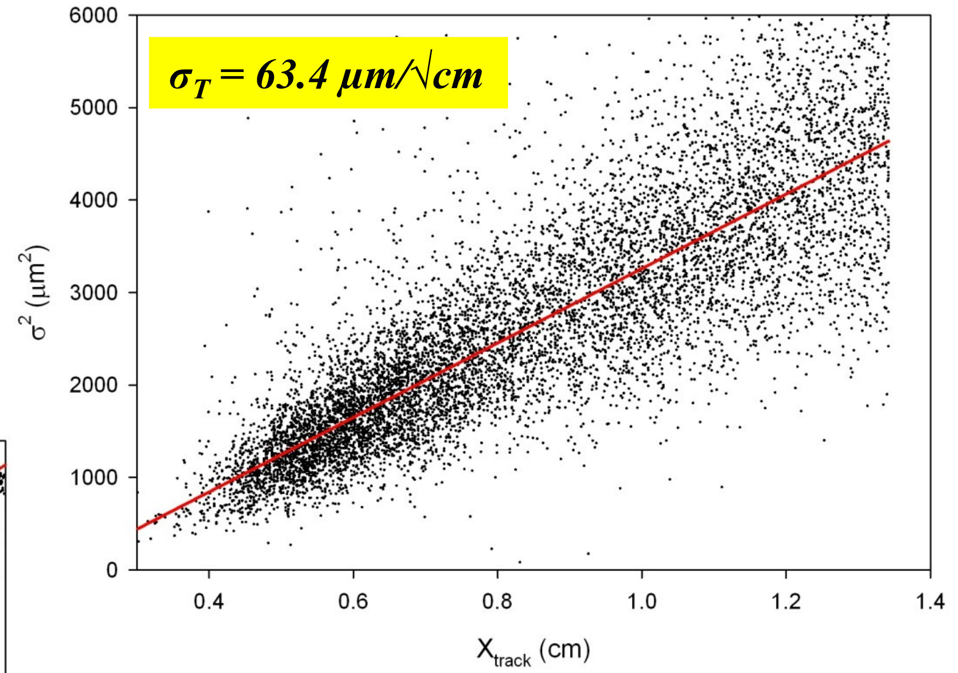
Diffusion and drift velocity

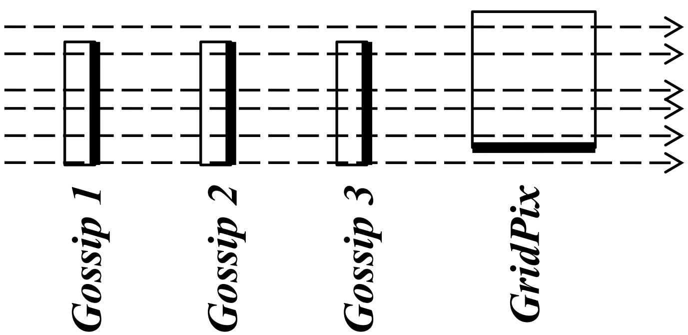
- E_d = 2.08 kV/cm
- Reference detector: Gossip 3
  - RMS < 2 pixels
- σ corrected for pixel size

Drift distance (X_d) vs drift time(T_d) in GridPix



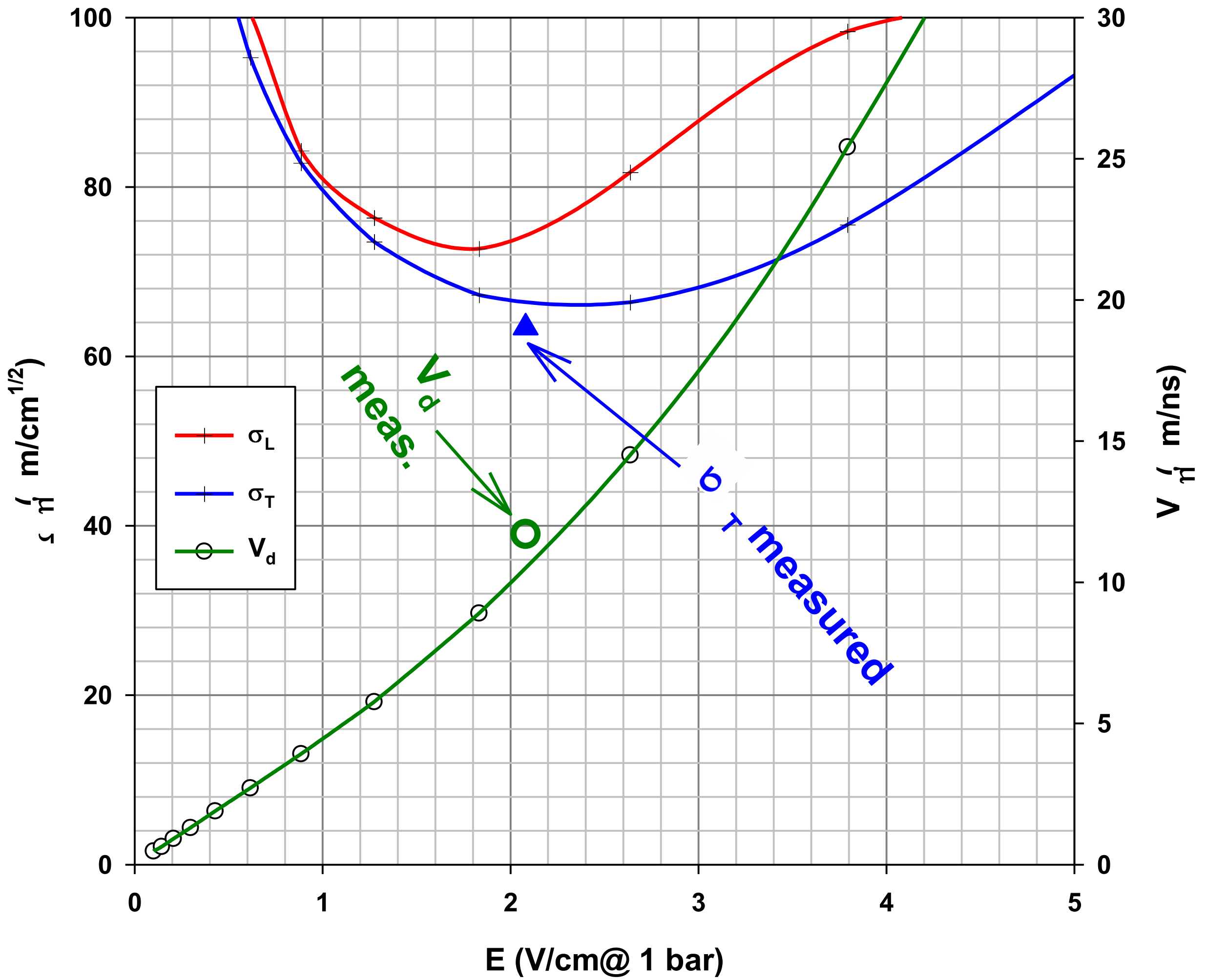
Diffusion vs drift distance in GridPix





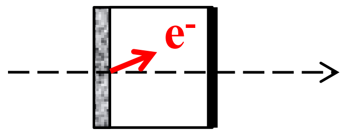
Compared to Garfield simulation

Calculated diffusion (σ) and drift velocity (V_d)of DME/CO_2 50/50 vs electrical field (E)

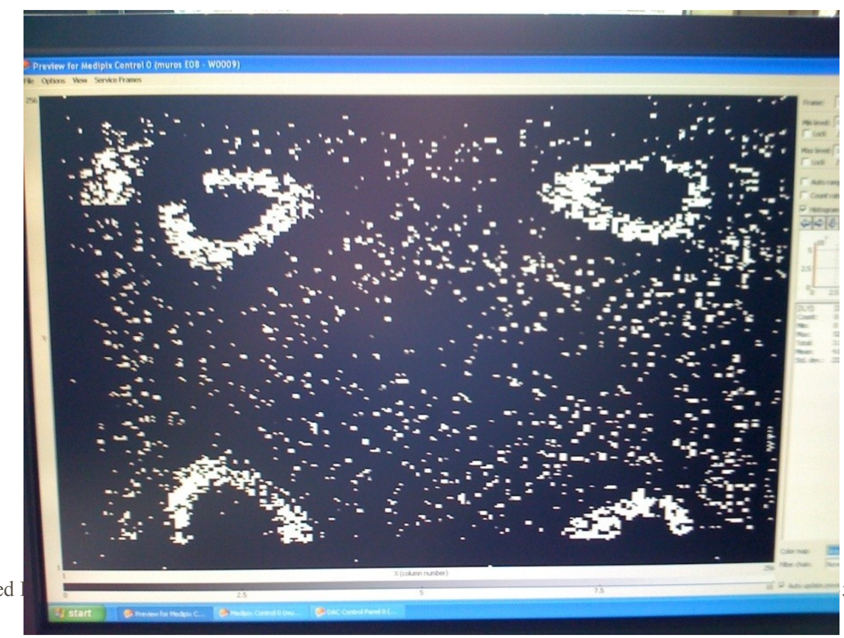


Secondary emission test

- 3 different surfaces on grid of one Gossip detector
  - **doped diamond**
  - **Cu**
  - **Al**

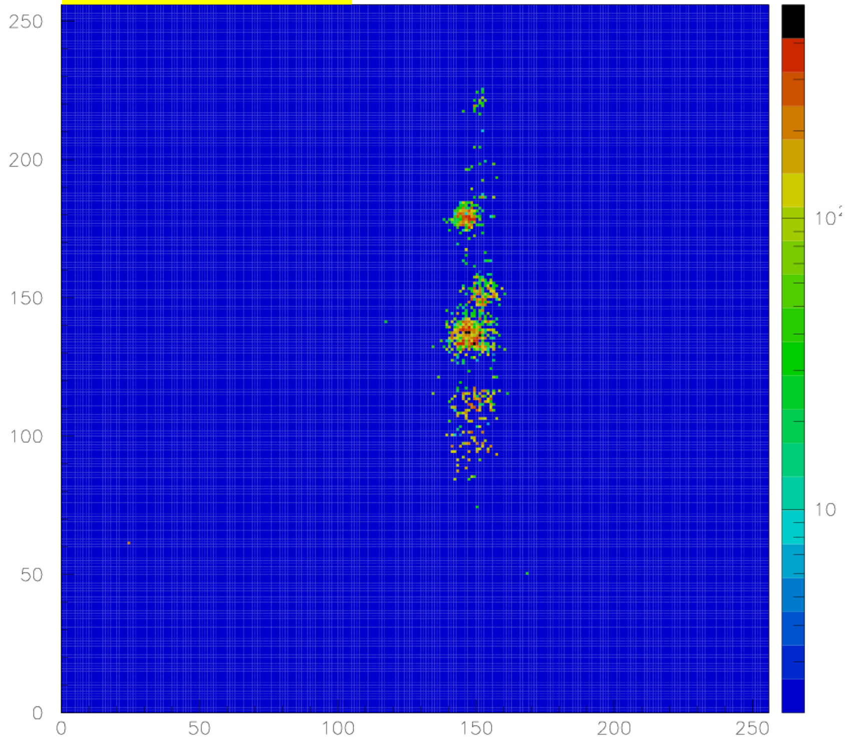


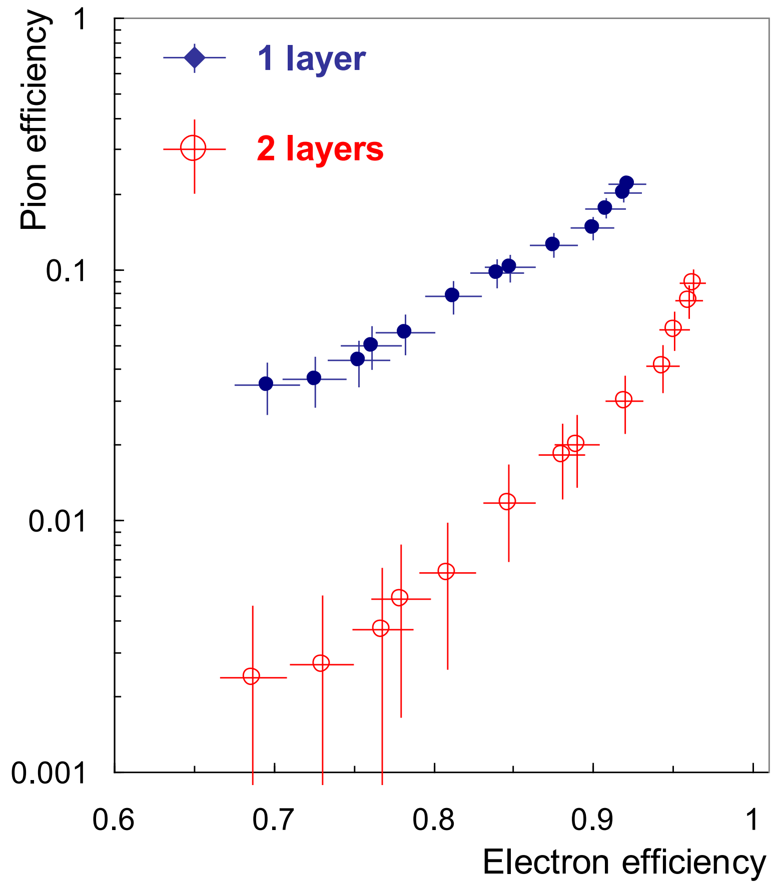
- Result: no significant effect seen so far, only discharges near pillars



Test beam results: Particle Identification

2008 testbeam





Two method were used

1. Total energy deposition
2. Cluster counting technique

Pion registration efficiency as a function of electron efficiency for 1 and 2 layers of the detector. Cluster counting method.

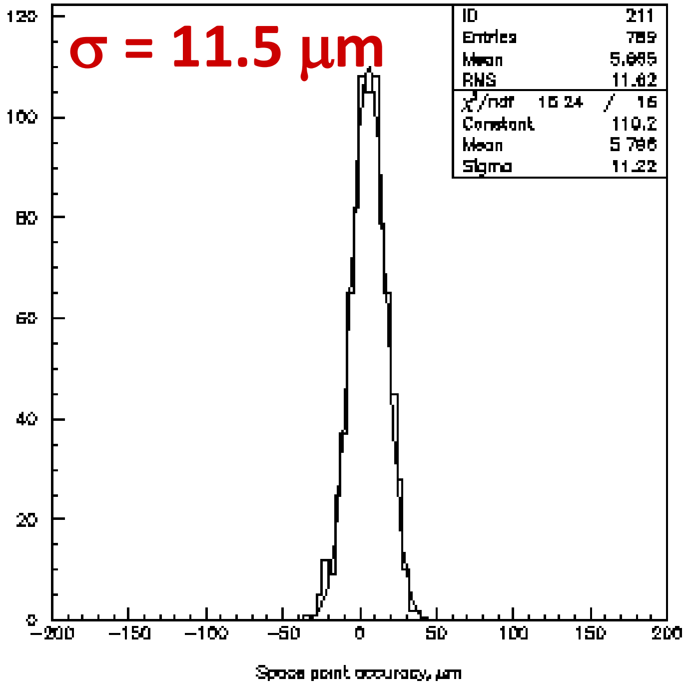
Analysis by Anatoli Romaniouk

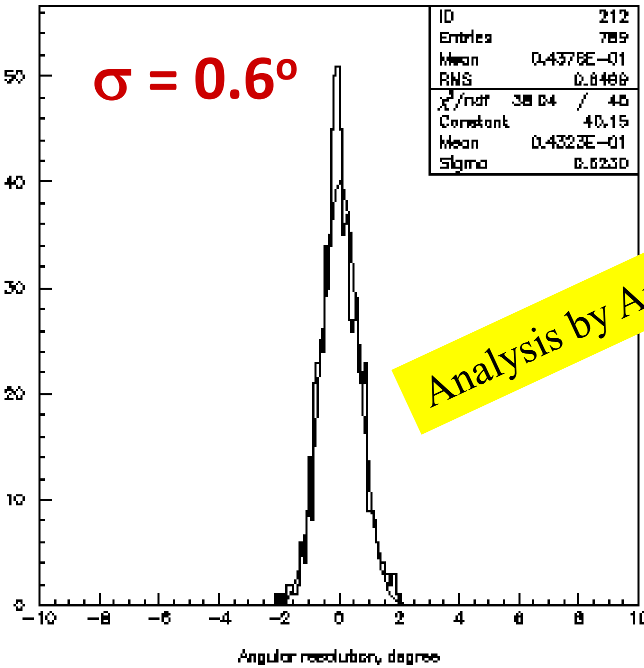
TRD with two detector layers (total thickness ~ 40 cm) allows to achieve rejection factor of **~ 50** for 90% electron efficiency.

GridPix Tracking: Low diffusion gas (result August 2010 test beam)

DME/CO_2 (50/50), 19.3 mm drift,

Incident angle of **10°**.





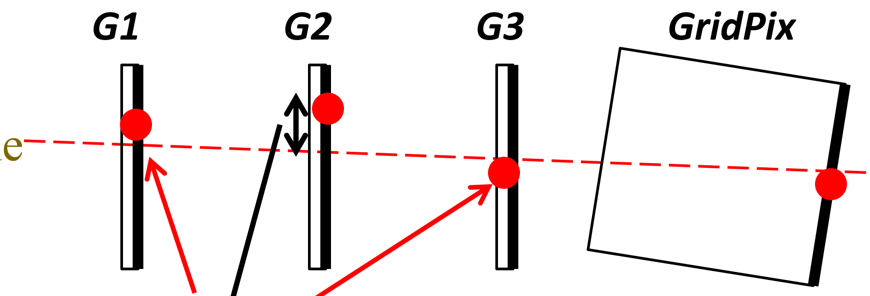
Analysis by Anatoli Romaniouk

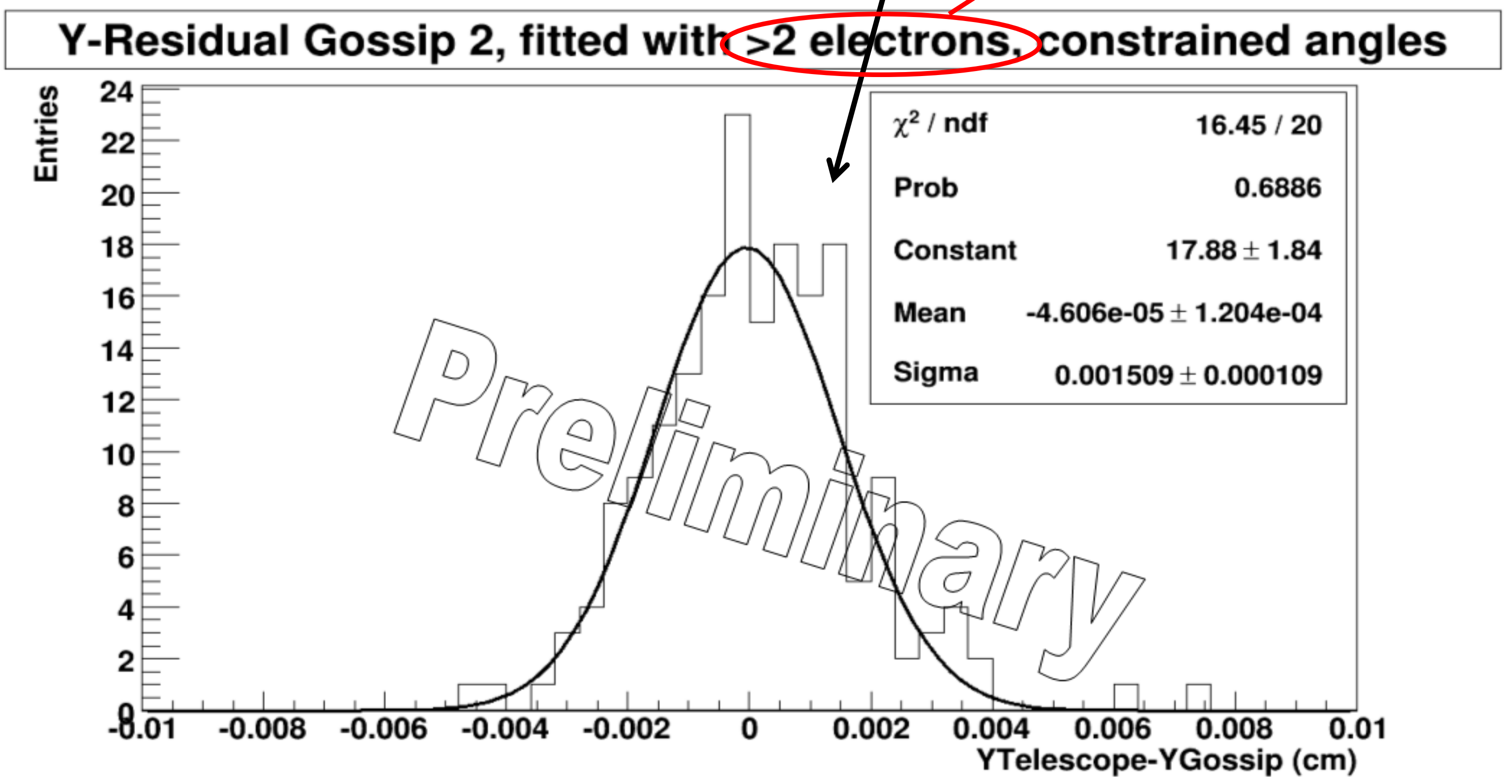
*At **10°** incident angle an angle measurement accuracy of **0.6°** for the track projection would mean:*

***15%** momentum measurement accuracy for P_t of **40 GeV** with one layer of a GridPix tracker/L1 trigger!*

Position resolution

- Fit through G1, G3 and GridPix → residuals G2
- 0 degrees → ~15µm
  - Value still affected by finite accuracy of the track detection of the reference detectors





Conclusions on analysis of August 2010 testbeam

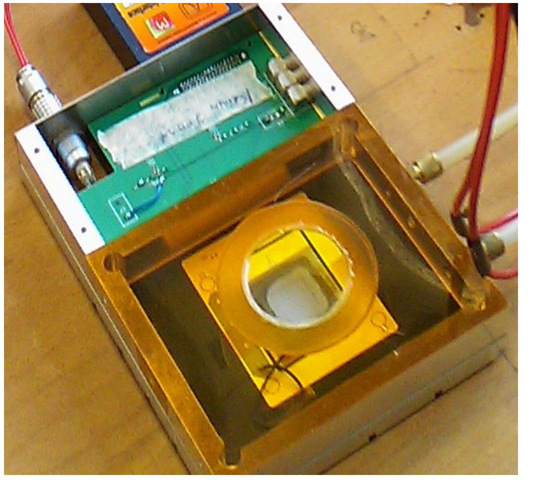
- Running experience
  - All Gossips were operating reliably without any HV problem at high gain
  - The (older) GridPix (mostly running at -560 V) had less good gain, but still rather good single electron efficiency
  - Profited Infrastructure of remote control of HV and gas
    - Settings can be modified without asking for access
    - Values permanently logged
- Analysis results
  - Time walk probably caused by the (weak) cross talk signals just passing threshold
  - Angular resolution of Gossips determined for 5 different angles
    - Gas gap of 1.2 mm would give better result
  - Angular resolution for GridPix very good
    - 0.6º for track over < 20 mm
  - Gossips have excellent track detection efficiency (~ 99%) from -570 V on
  - Drift velocity and diffusion are close to Garfield simulation
    - Diffusion DME/CO_2 mixture very advanteous
  - Position resolution of 15 μm agrees with simulation
    - After correction for finite accuracy track definition

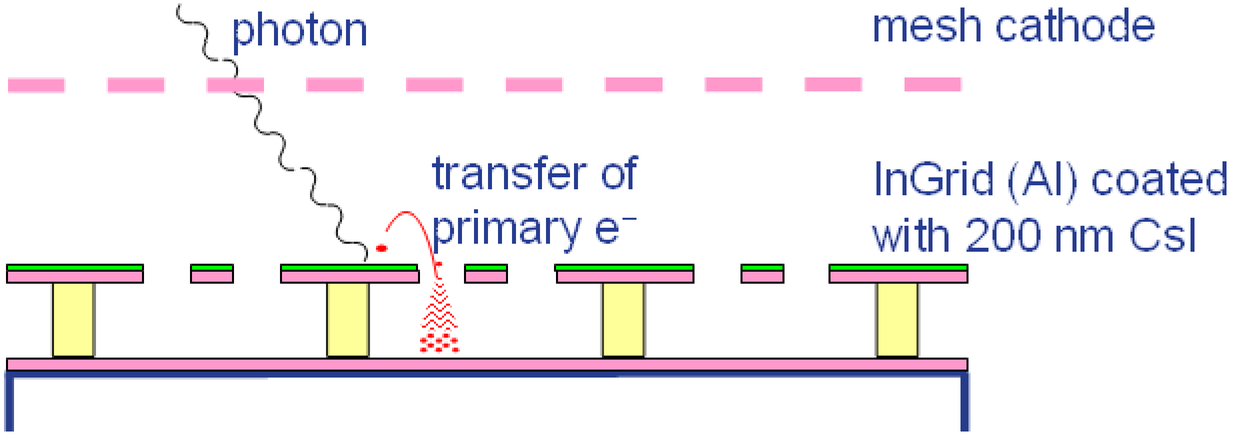
Other MPGD related research at Nikhef

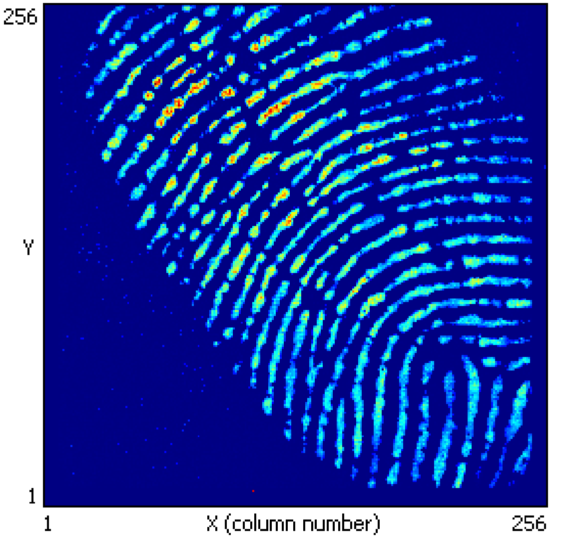
- Photosensitive GridPix detectors
- ReLaXd R.O. replacing MUROS
- Industrial production of GridPix
- Xenon experiment (WIMP search)
- PolaPix (polarized X-rays from space)
- MiniHV (small remotely controlled HV supply for laboratory use)

Photo sensitive GridPix

- CsI layer on grid
- Collection efficiency > 90%





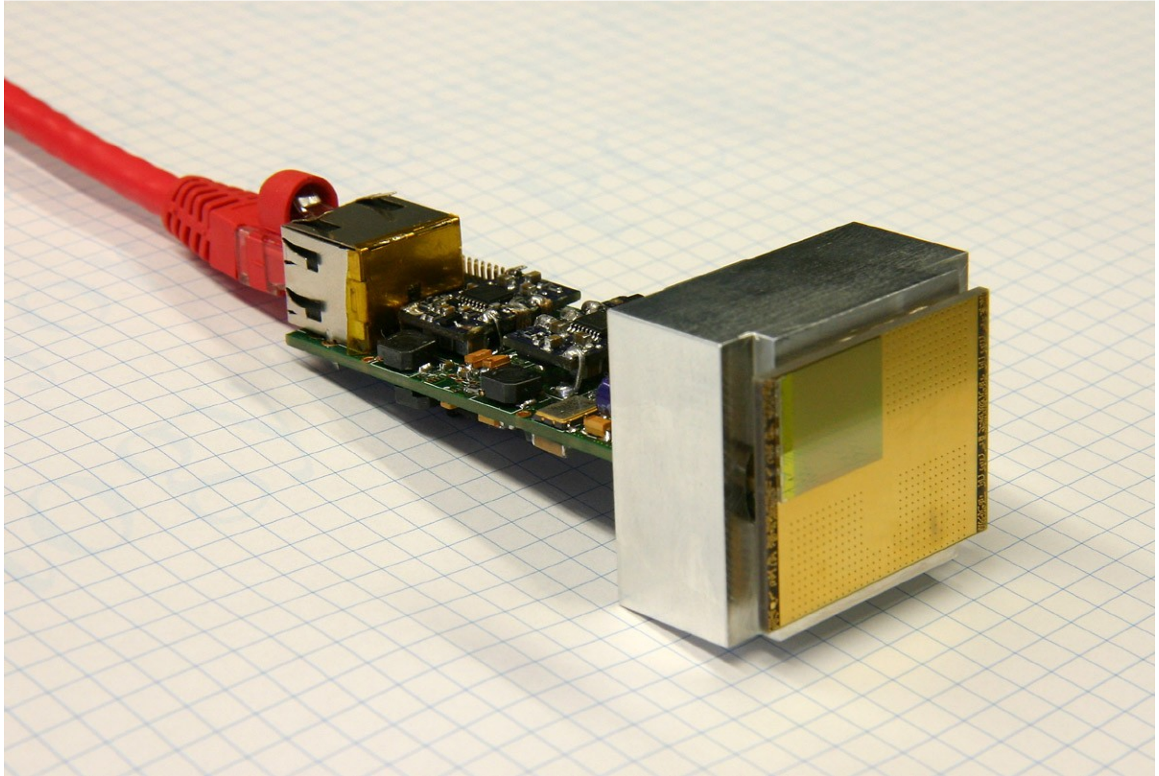


Thesis Joost Melay, Univ. Twente, MESA+
Jurriaan Schmitz' STW project 'There is plenty of room at the top'

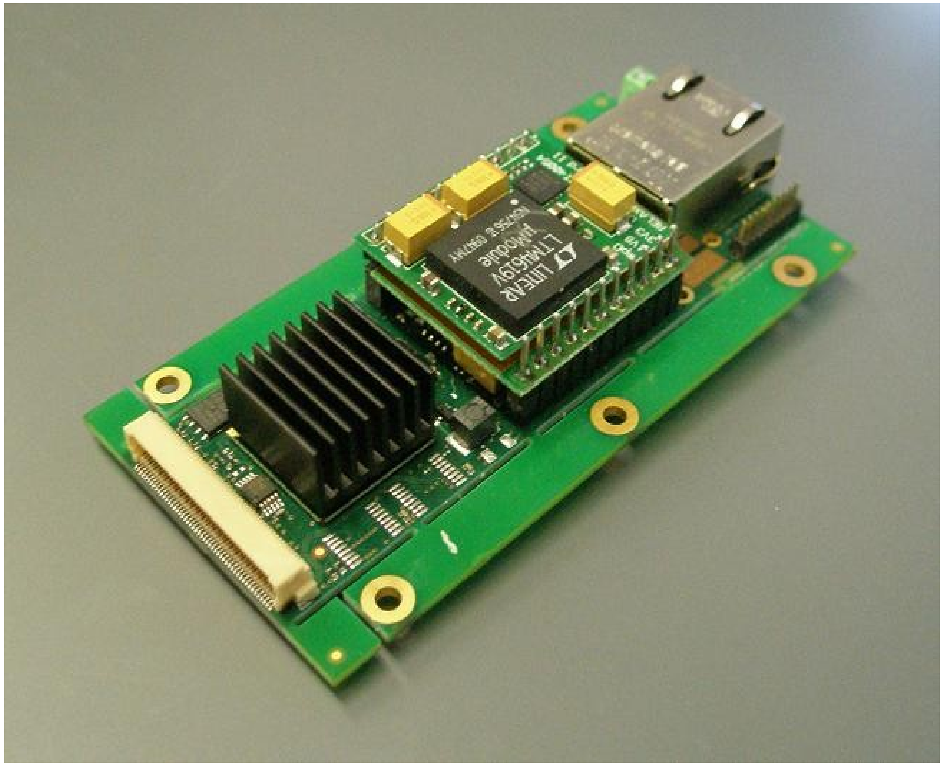
Collaboration with Amos Breskin, Weizmann Institute of Science in Rehovot, Israel

ReLaXd read out

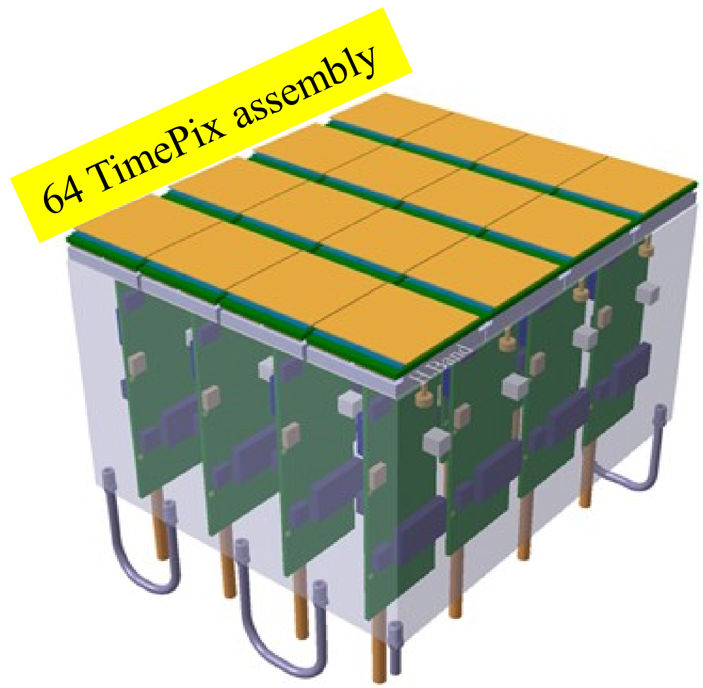
- Rapid DAQ of TimePix chip
- Replacing MUROS (R.O. rate ~ 3 Hz for 4 chips in series)
- Addressing many chips in parallel
- R.O rate of 2.8 kHz achieved in August testbeam (test detector)



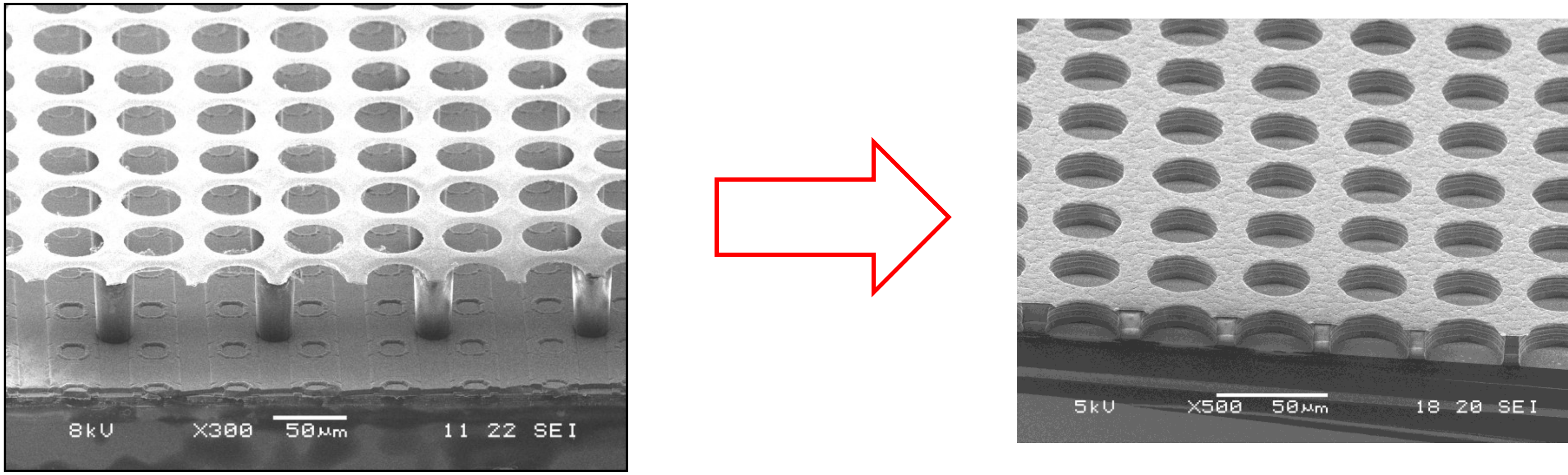
ReLaXd readout board



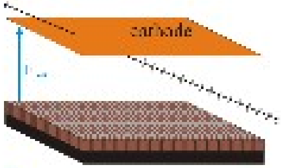
- Features:
- Onboard power supply
- 4 chips parallel readout
- Debug terminal
- Gigabit Ethernet interface
- External triggering
- Temperature sensor



Status industrial GridPix production

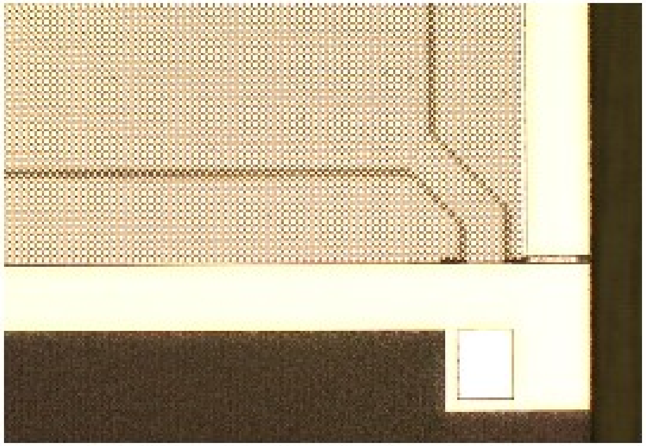


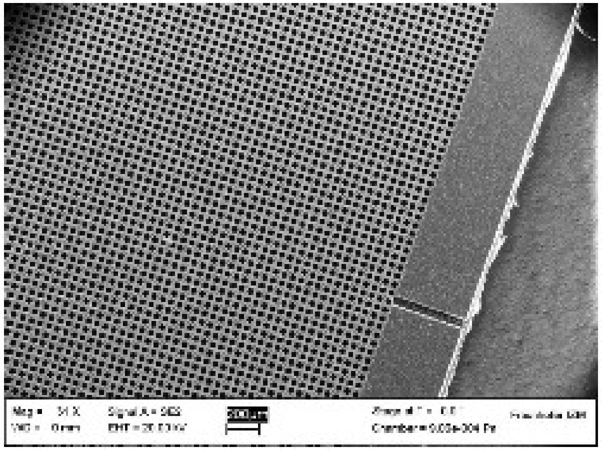
- Changing technology InGrid => GEMgrid
  - Creating “pillars” by heavy over-etching
  - Getting rid of the insulated surface in the hole
- Technology transfer to SMC, Edinburgh: failure
- Technology transfer to IZM-Berlin: first working GEMGrids
- VERY good progress with first GEMgrids on 8” wafers
- Goal: to make robust, lasting GEMgrids
  - 8” TimePix wafers
  - Low price

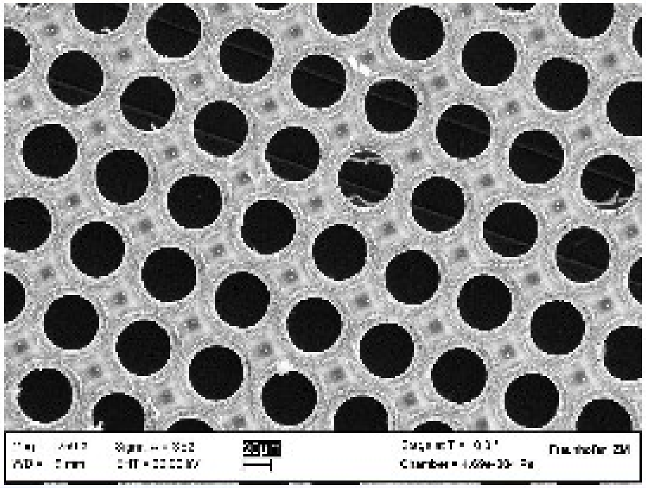


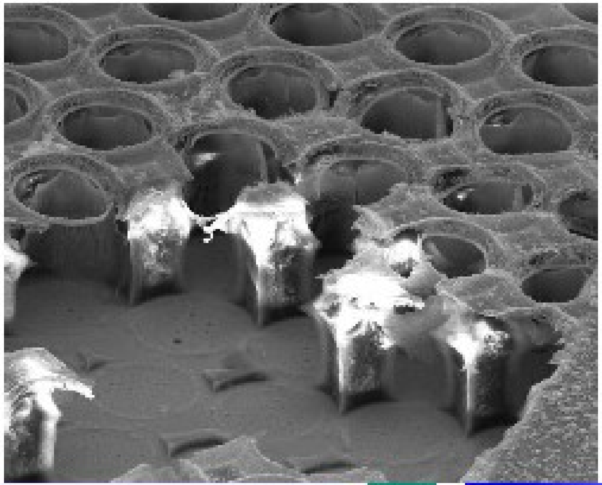
Processing of GEMGrid Test Chip (II)

GEMGrid Test Chip after BCB Dry Etch





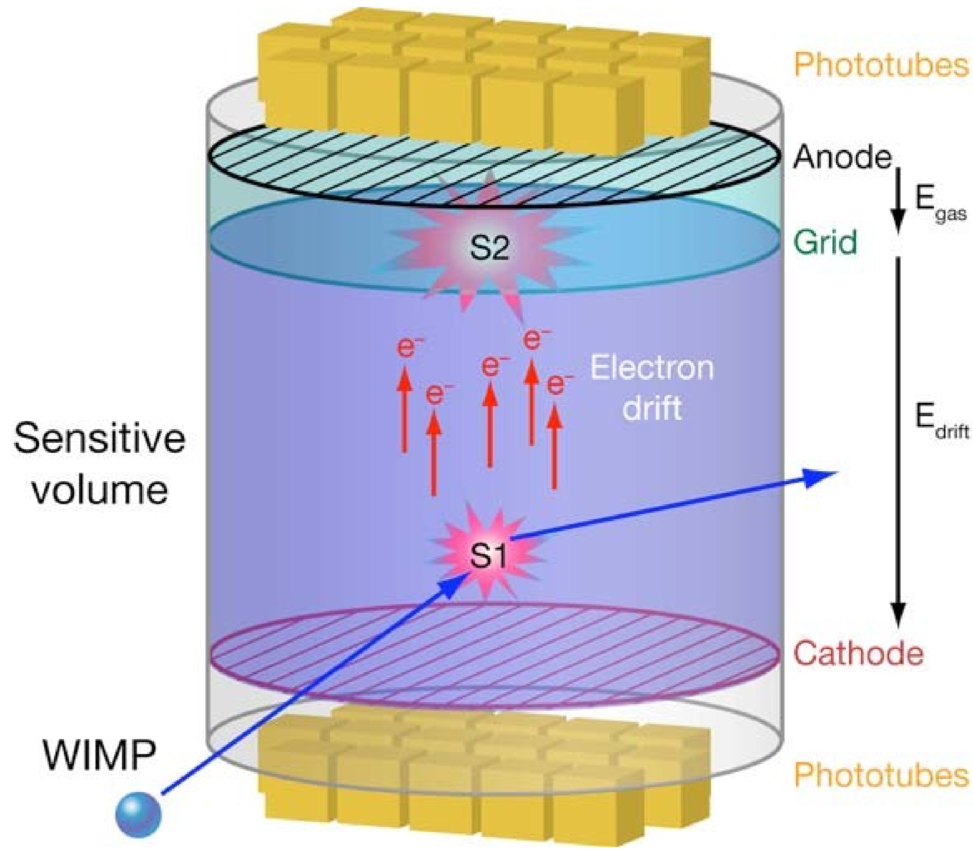




universitätbonn

WIMP search, bi-phase Xenon

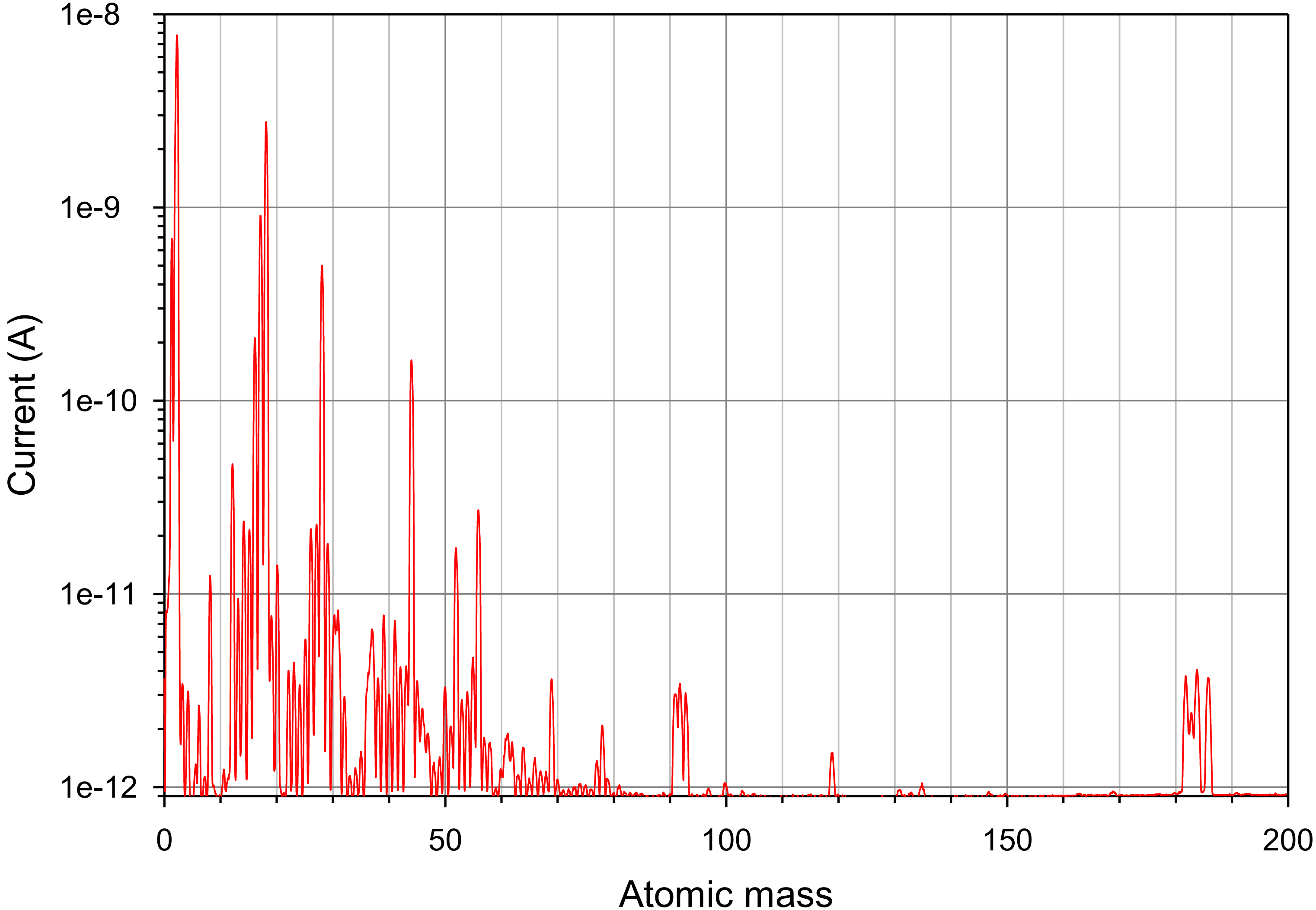
- GridPix TPC as WIMP / DBD detector
- Placing GridPix detectors in the gaseous phase, interleaved with PMs

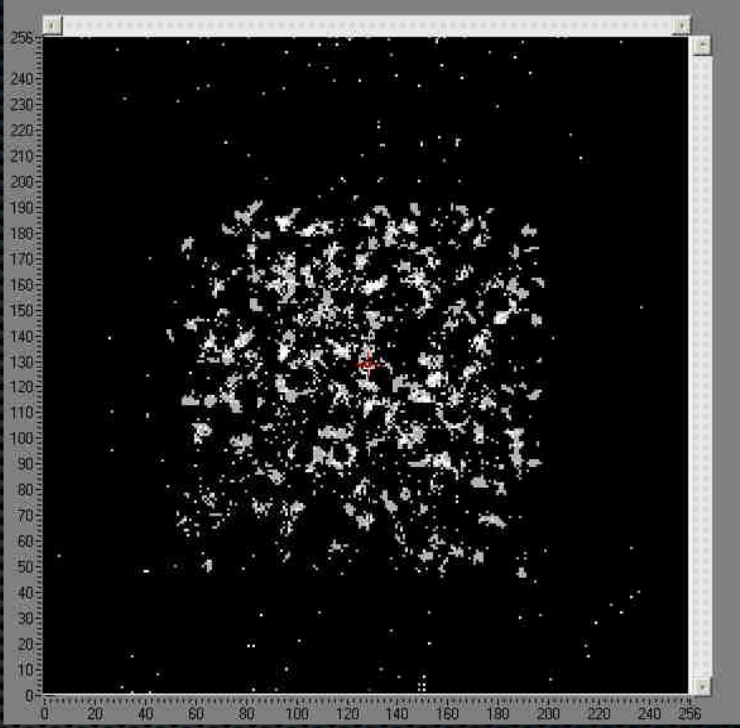


Source: Direct Searches for Dark Matter, Elena Aprile, EPS - HEP, July 21 2009, Krakow, Poland

Measuring impurities in Argon

Mass spectograph TimePix chip + InGrid

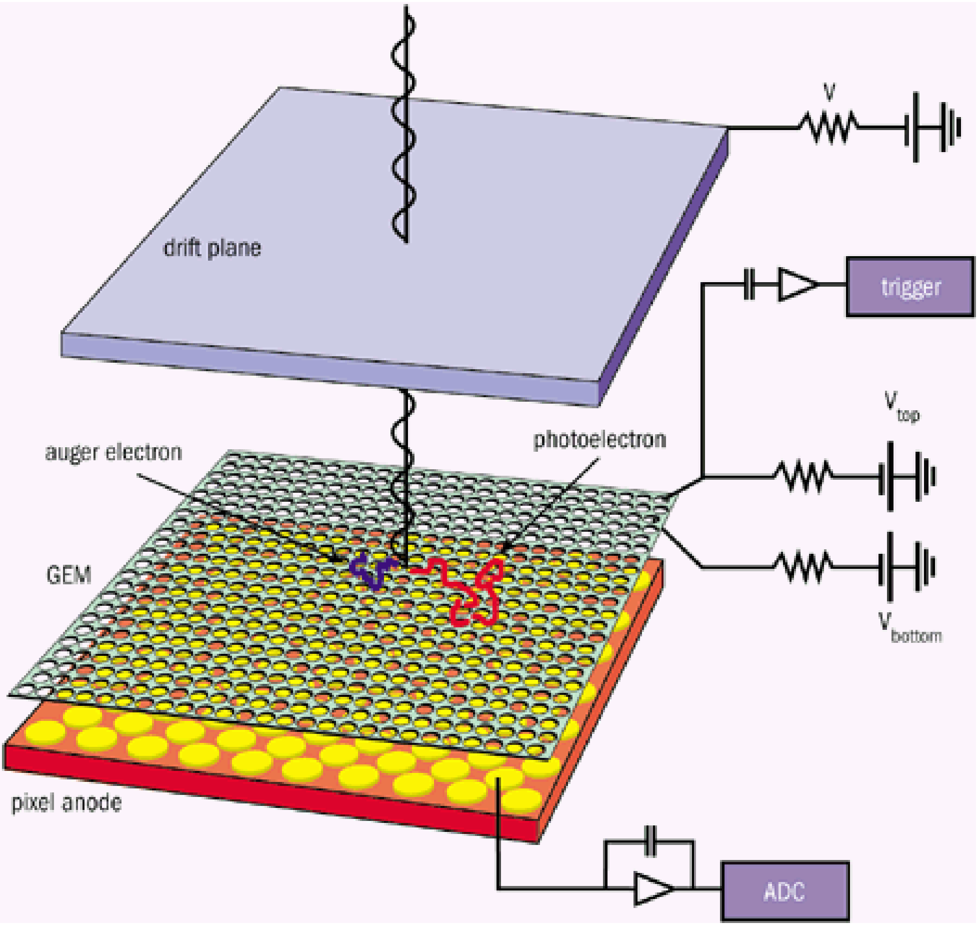


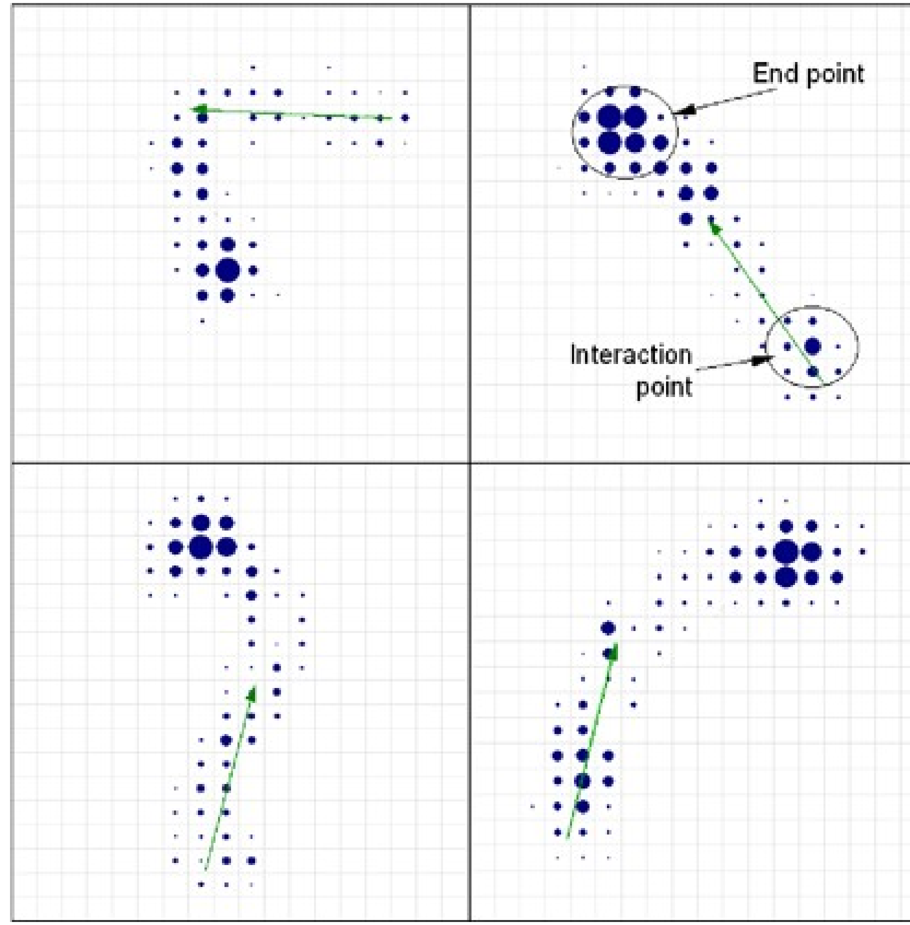


PolaPix

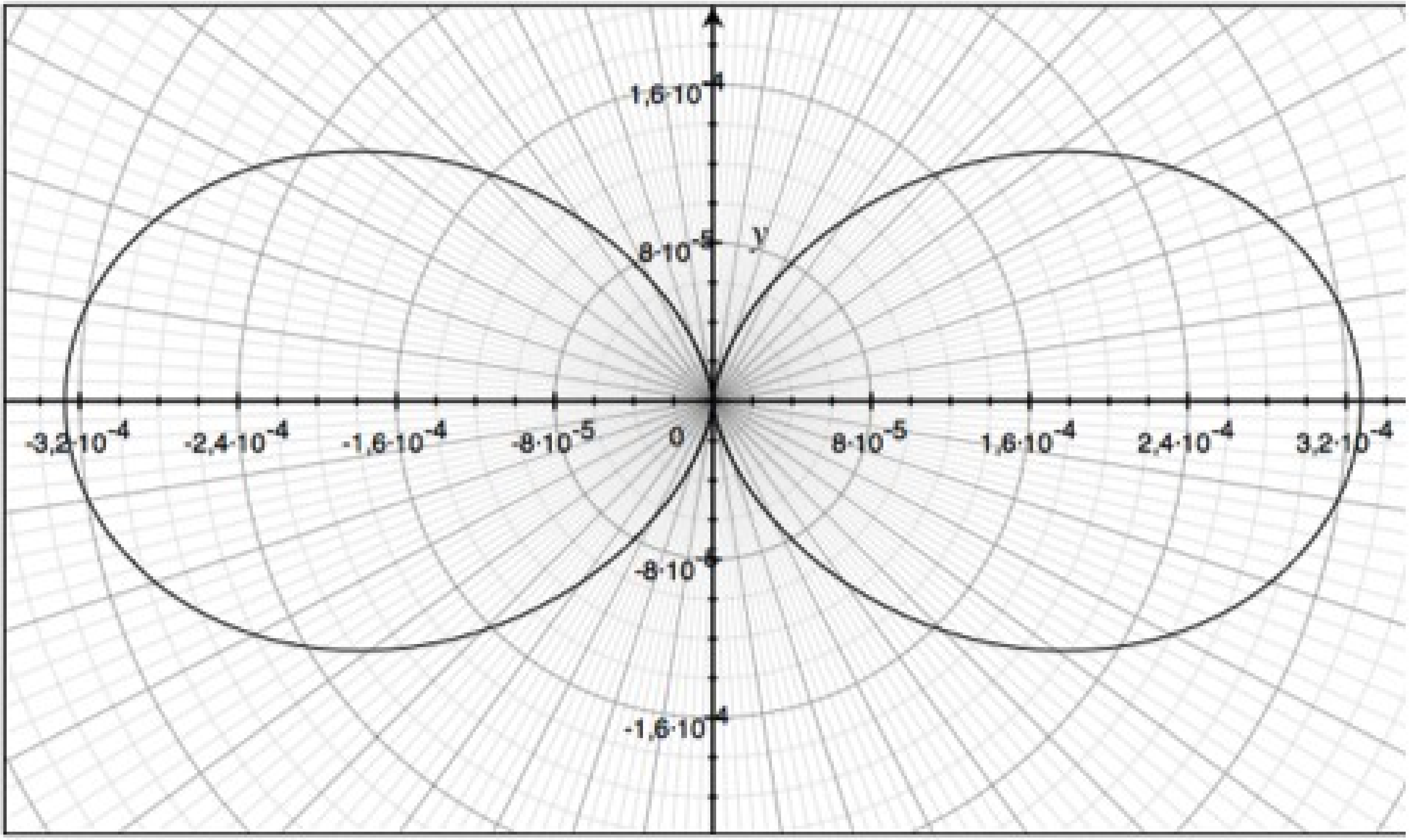
Using a GridPix detector for the 3D detection of polarized X-ray photons

Sjoerd Nauta - Nikhef





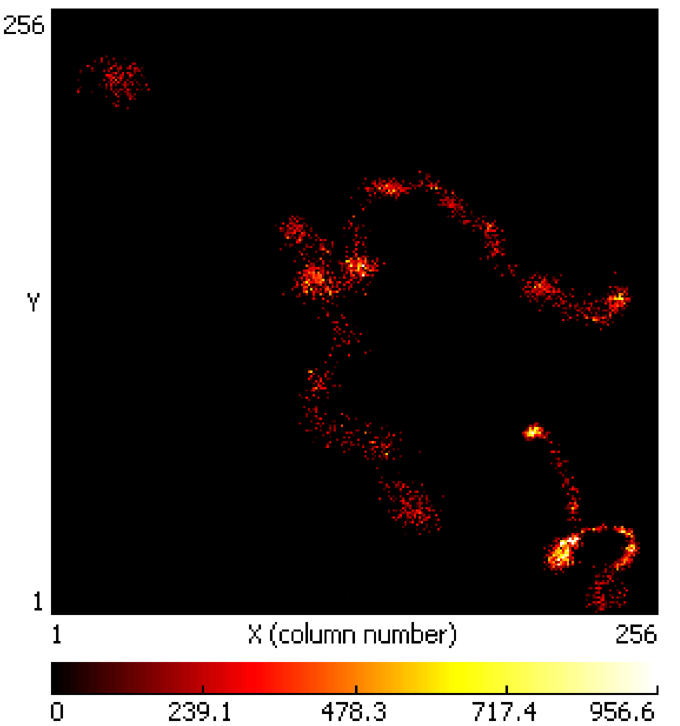
X-ray Polarimeter proposed by R. Bellazzini



Distribution of direction of photo-electron of (fully) polarised X-rays

Collaboration with ECAP/University Erlangen

- GridPix as (gas-filled) photon detector for applications in space observatories
- Tracking photo-electron or Compton-electron.
- Measurement of 1 – 511 keV photons
  - Photon energy
  - Photon direction
  - Polarization



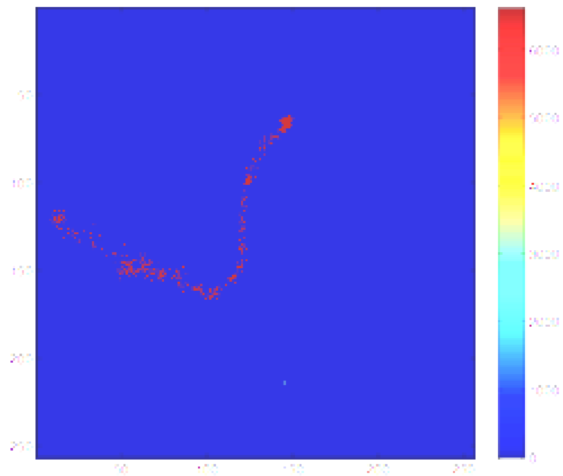
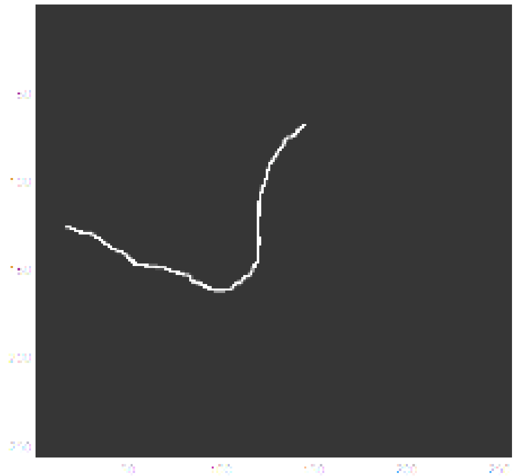


Photo-electron
after photon interaction



Reconstructing
trajectory

Figure 4.11: An example of a skeletonized trace. On the left, the original measurement is shown, on the right the skeletonized version of the same trace is shown. This picture has been made by the group at the university of Erlangen.

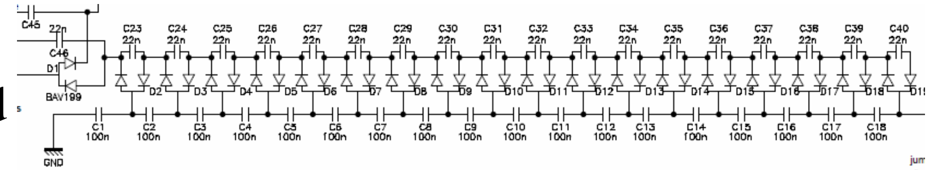
Status mini HV development version 2

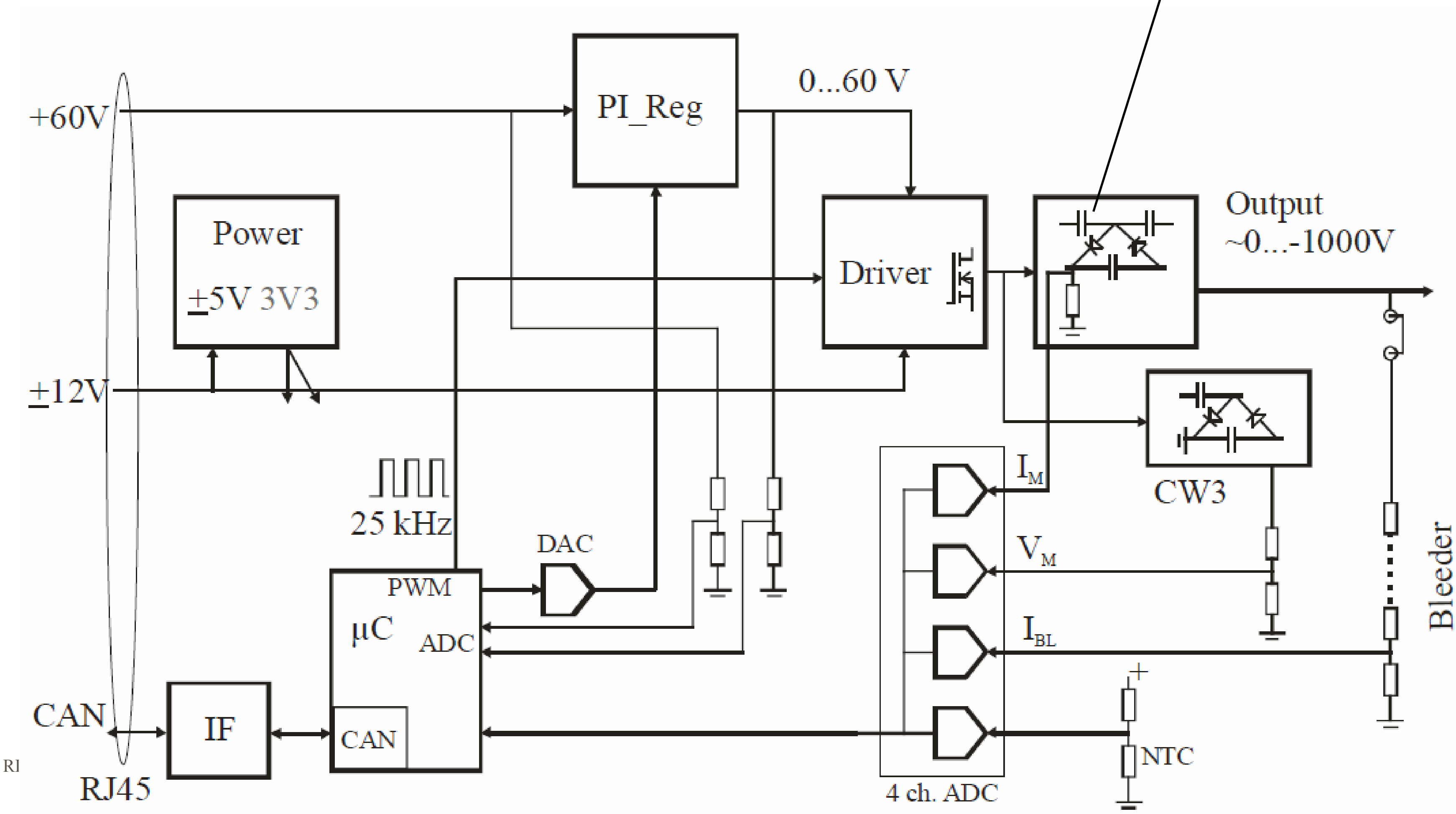
Based on prototype studies, to be updated with final version

- Intended to supply gaseous detectors in th laboratory
- Output ~ -3 to -1000V @ -5 μA
- Standard negative output
  - **Positive** output in principle possible using same PCBs
- Current measurement in < 100 pA units
- HV stabilisation by feedback from measured current using local processor
- Ripple ~ 100 mV p-p @ -0.5 μA and -500V
- Sophisticated ramping and trip

Status mini HV development

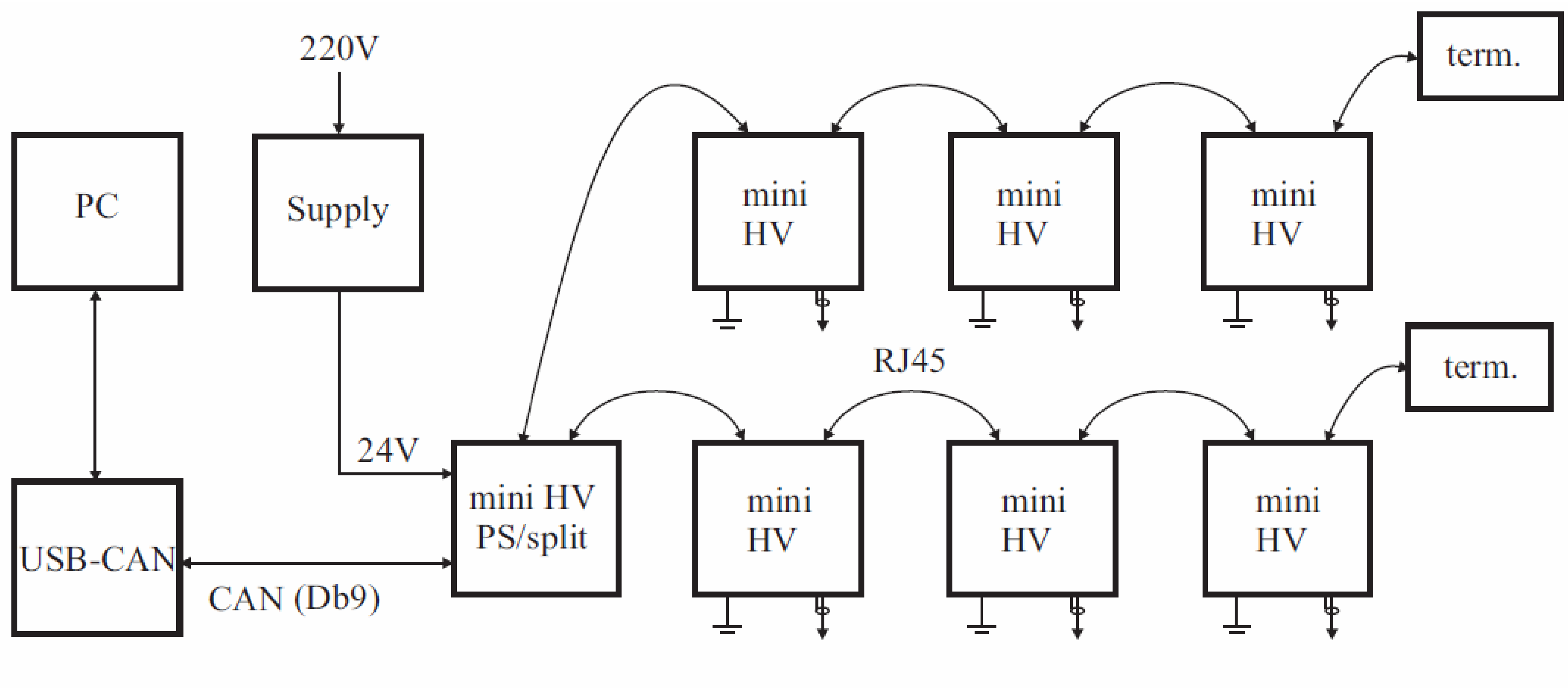
- 60 V input voltage regulated and chopped
- High voltage (N x V_{in}) generated by **Cockroft Walton circuit**





CANopen communication to multiple mini HVs

- Two RJ45 cables to supply up to 8 miniHV units



Status mini HV development

- 5 prototypes built
- We are not as far as hoped
- Project delayed by
  - PCB assembly
    - Delivery time
    - Assembly errors
  - Frequent breakdown of the processor
    - Protection added now