



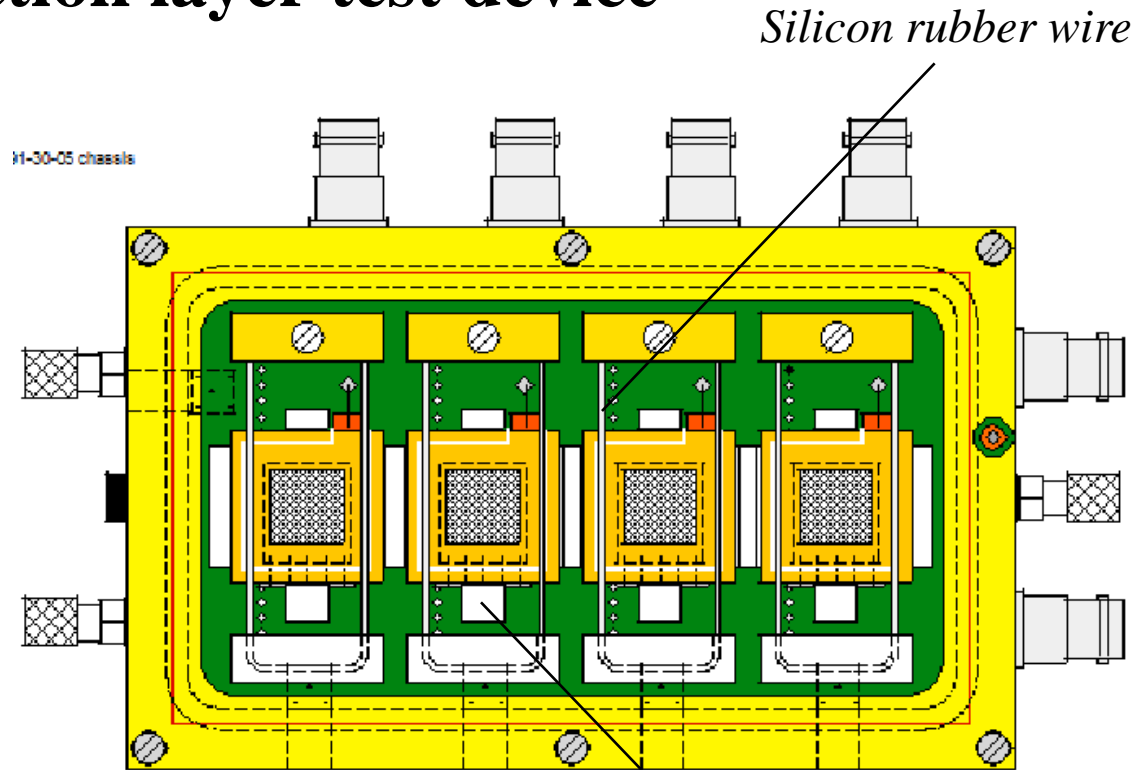
InGrid spark test at CERN

Fred Hartjes
NIKHEF

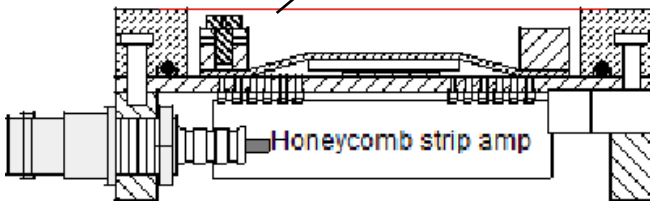
LepCol meeting
October 10, 2016

Protection layer test device

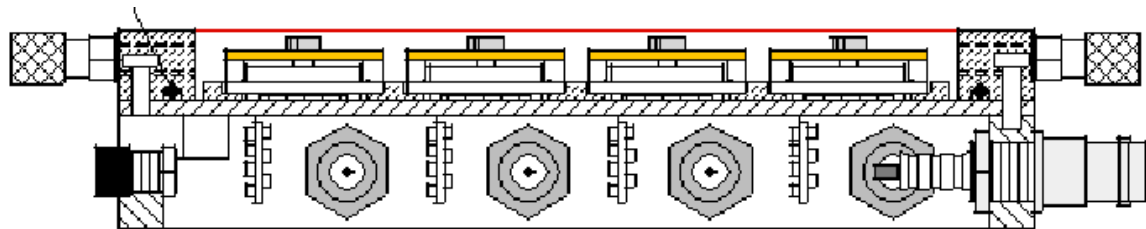
- ❑ 4 channels
- ❑ PCB sandwiched by insulating gas envelope and aluminium connector frame

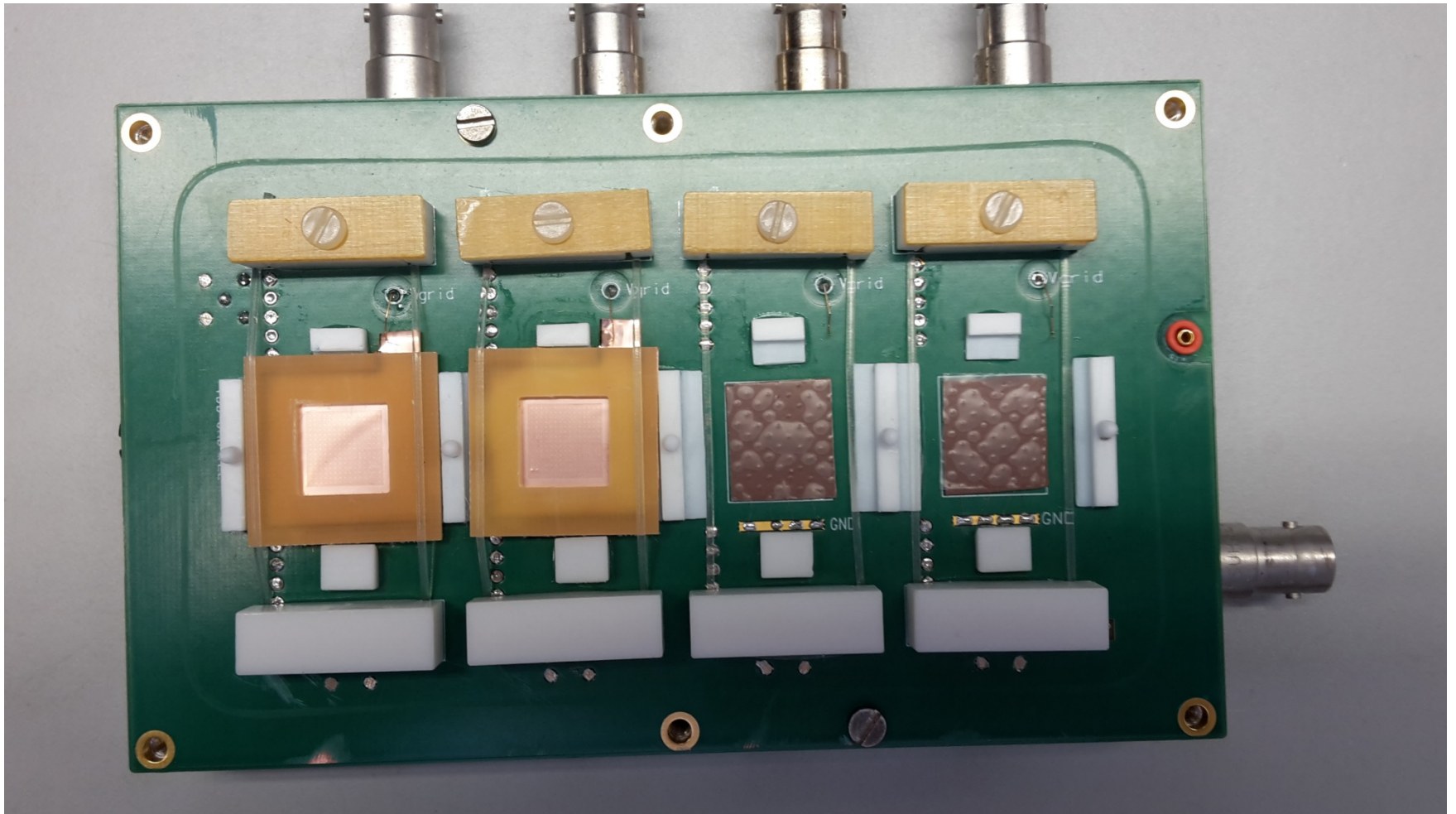


Coppered kapton cathode



Plastic blocks to guide the Micromegas





Registering sparks

- ❑ Designed for dummy substrates with loose Micromegas
- ❑ **But can also be used for TPX3 chips with InGrid**
- ❑ 4 channels per assembly
 - ❑ Each channel has individual HV control
 - ❑ Nikhef miniHV
 - ❑ Currents measured in sub nA resolution
 - ❑ Currents registered at 5 Hz rate
 - ❑ Two alarm levels
 - ❑ **Warning: register discharge (presently 50 nA)**
 - ❑ **Trip: shut off HV (presently 3 x 1 μ A in succession)**
- ❑ Grid coupled to Honeycomb strip amplifier
- ❑ Normally currents and voltages are only logged once a minute
- ❑ At spark discharge (exceeding warning limit) currents of few minutes before and after discharge are stored



Sparks automatically detected and registered

4 CH main HV control Protla.vi

File Edit View Project Operate Tools Window Help

HV control protection layer setup

Grid1 Grid2 Grid3 Grid4 **Field**

Ramp parameters

ramp speed (V/s): 3.0
% from line to exp (0 - 100): 80
Min. ramp speed (ADC cnts/s): 10
~15 DAC cnts = 1 V

Trip parameters

Control loop interval (s): 0.50
Warning limit (nA): 50
Trip limit (nA): 1000
Current limit count: 3
Limit zero => no trip active

record length: 2000 Record#: 8511

ObjHandle out: 52

Emergency shut off

Emergency

<Escape>

STOP

CH1	CH2	CH3	CH4	CH5
Node CH1: 2	Node CH2: 22	Node CH3: -1	Node CH4: -1	Node CH A/B: 100
Required CH1: -560	Required CH2: -560	Required CH3: 0	Required CH4: 0	Required CH5: -1500
CH1 [V]: 560.5	CH2 [V]: 559.0	CH3 [V]: 0.0	CH4 [V]: 0.0	Out of range
Current (nA) 2: -0.48	Current (nA) 3: 1	Current (nA) 4: 0.00	Current (nA): 0.00	
Req. voltage [V]: 560.3				

Voltage graph

Y-axis: Voltage (V) [0 to 600]
X-axis: Time [09:46:00 to 10:08:11]

Graph shows voltage rising from ~200V to ~560V between 09:50:00 and 09:56:00.

Current graph

Y-axis: Current (nA) [-1 to 10]
X-axis: Time [09:46:00 to 10:08:11]

Graph shows current spikes up to ~8 nA between 09:50:00 and 09:56:00.

Remark

Give non-existing channel a negative node number (-1)
Give Field channel node number 100 or 101 (A and B resp)

Error in loop		Error out	
status	code	status	code
✓	3FF62009	✓	0

source: NI-CAN Read Network Interface Object (ncReadNet.vi)

RH (%): 0 Temperature: 0.0 barometer pressure (mbar): 776.8

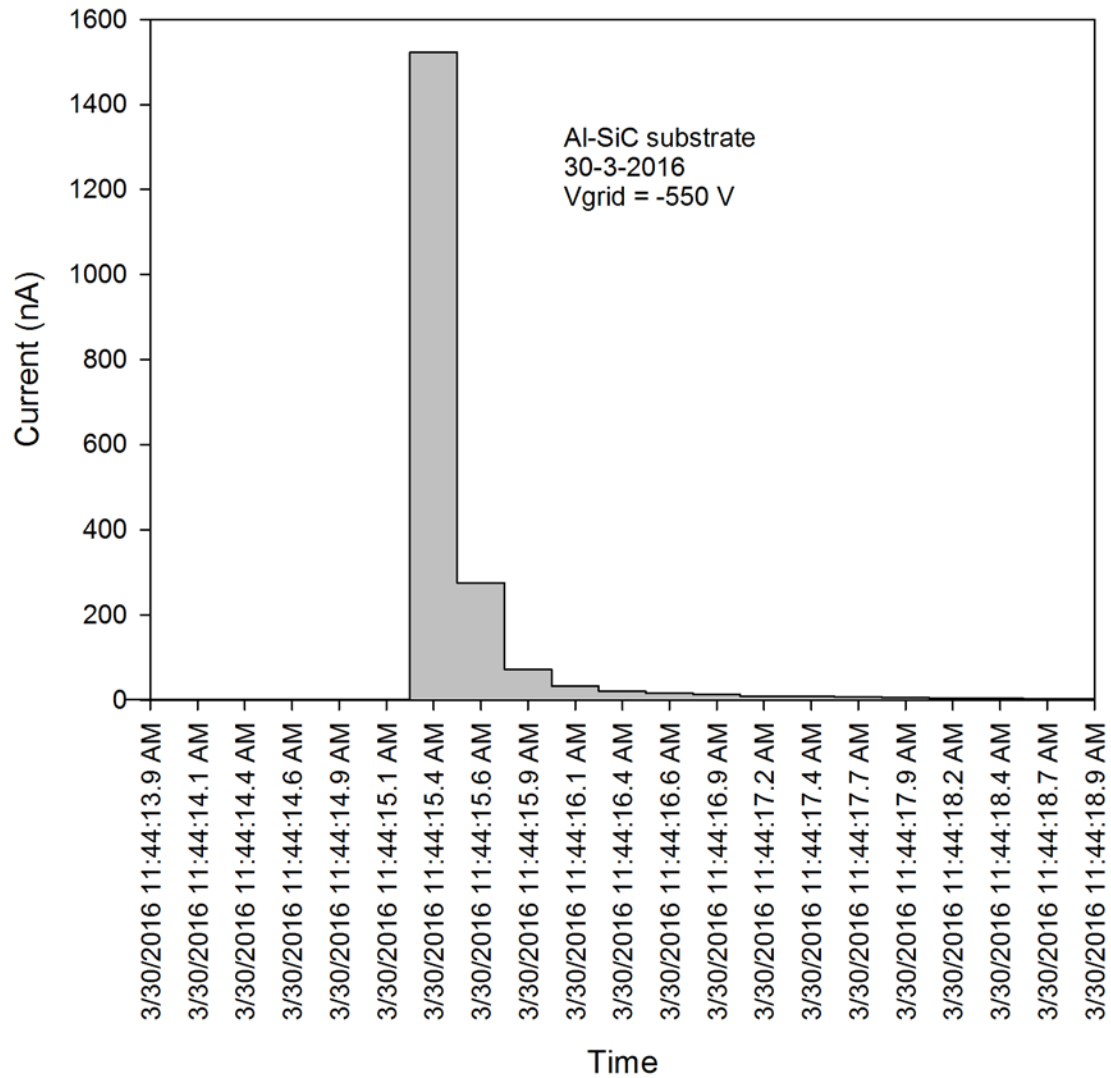
Enable Sensirion Envir. error: ✓

- CH1: [red line]
- CH2: [red line]
- CH3: [green line]
- CH4: [blue line]
- CH5/10: [yellow line]

Print warning set: [green dot]

Typical spark discharge

Typical spark event



Testbeam at CERN

- ❑ High rate ($> 1 \text{ MHz/cm}^2$) hadron beam at SPS
- ❑ => many awkward high ionization phenomena
 - ❑ Showers
 - ❑ Converting gammas
 - ❑ Converting neutrons
- ❑ Rather limit ($\sim 10^7 e^-$) frequently exceeded
 - ❑ Many sparks expected



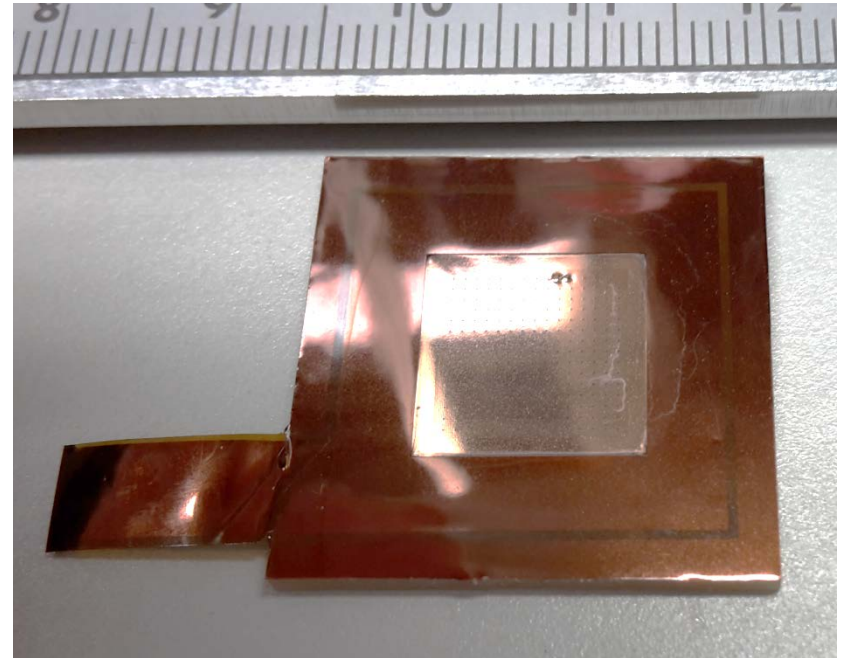
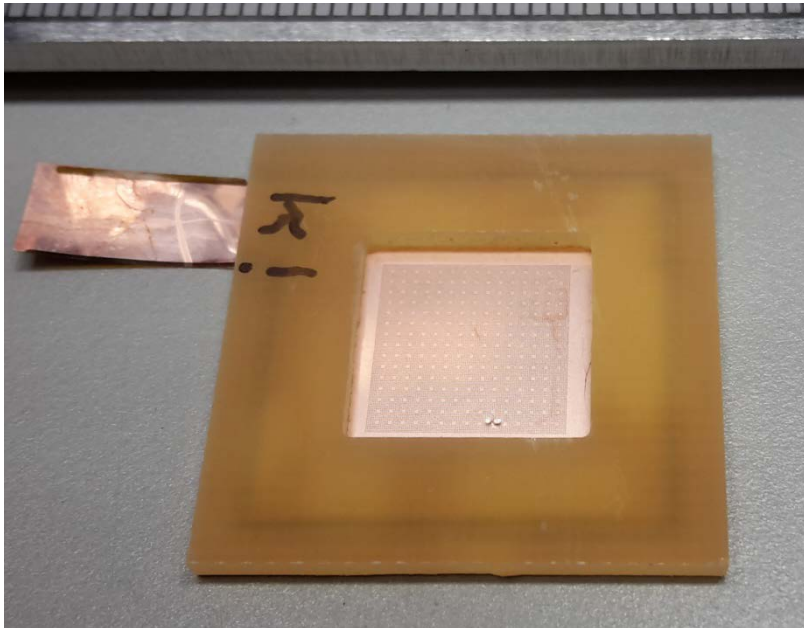
- ❑ Two test modules
 - ❑ => 8 chips may be tested in parallel
 - ❑ But we still need some 4 chips (electrically broken, but good grids)
- ❑ Planned Nov 2 – Nov 9 in T4 H8 (LHC-B), parasitic
 - ❑ Crew: Stergios, Kevin?, Fred,



SPARE

Test device based on dedicated Micromegas board

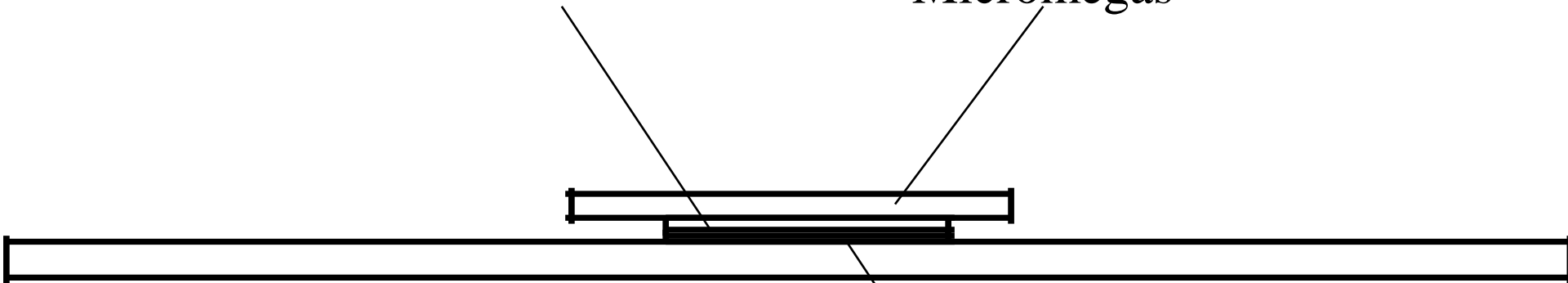
- ❑ Designed by Harry
- ❑ Mounted on glass fibre epoxy frame
 - ❑ 25 x 25 mm
- ❑ Pitch 80 μm , gap 50 μm
- ❑ Fabricated at CERN (Rui De Oliveira)



Laid down on (dummy) chip

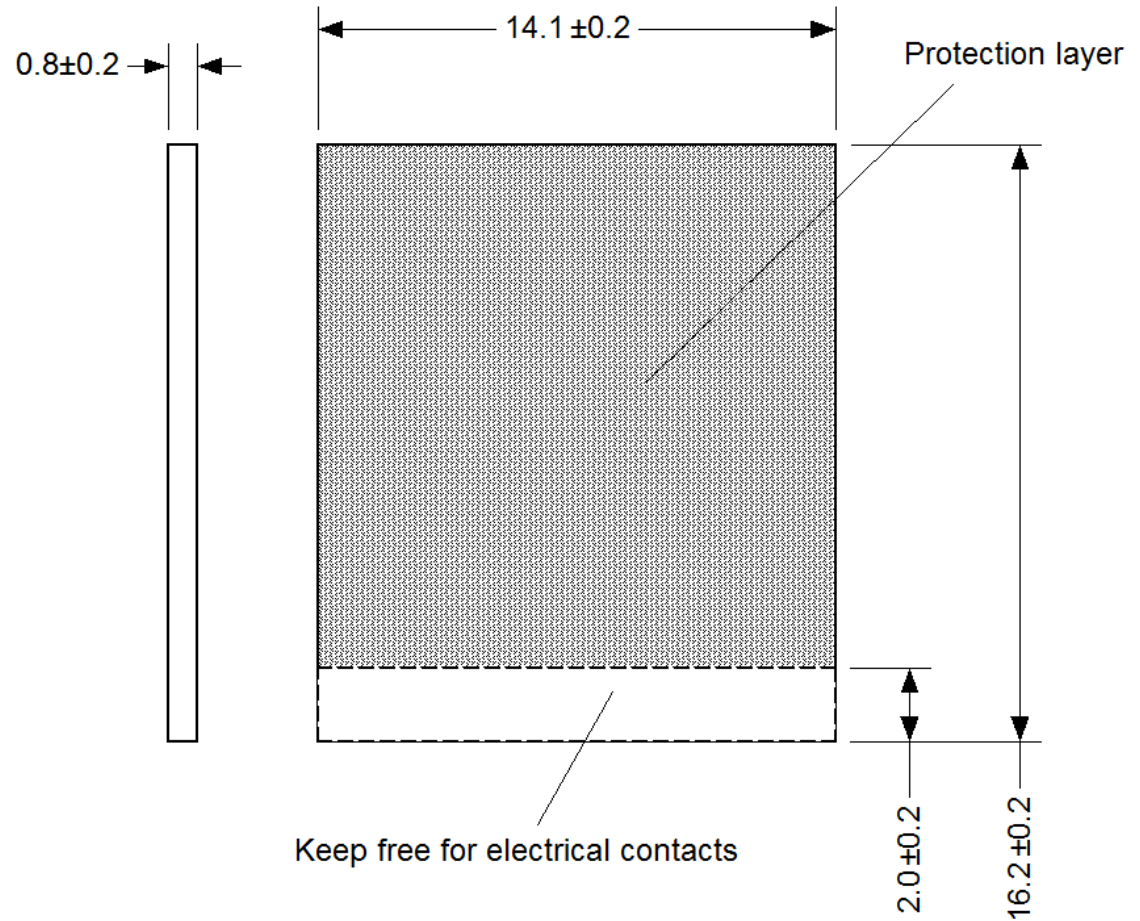
Test substrate

Micromegas



- ❑ Pressed down by silicon rubber wires
- ❑ Electrical spring contact made by W-Au wires
 - ❑ 200 um (Micromegas)
 - ❑ 30 um (dummy chip)
- ❑ Micromegas voltage by MiniHV
- ❑ Field voltage by Wenzel
- ❑ All controlled by LabVIEW

Joop's double sticky tape



Protection layer test device
Sample requirements

4-12-2015, Fred Hartjes

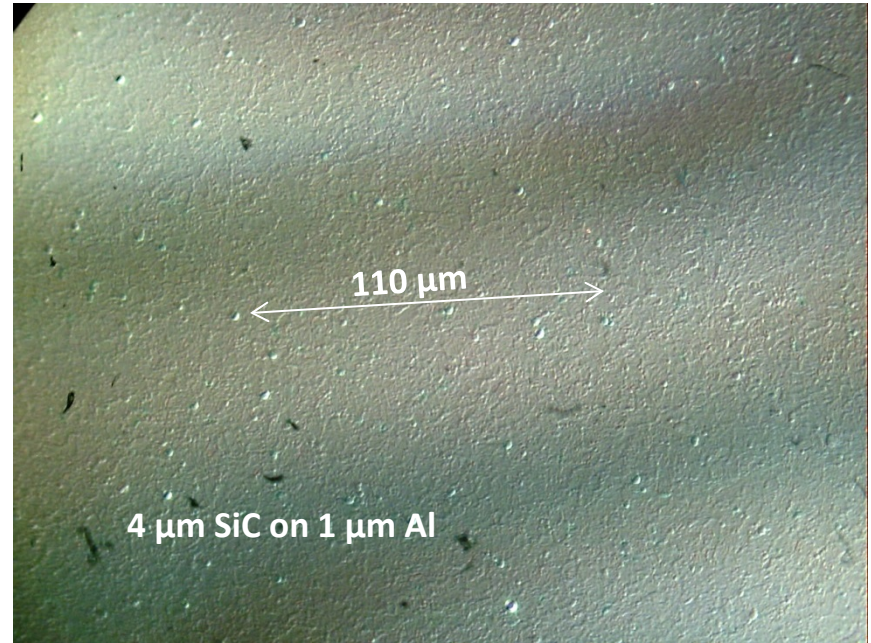
Scale: 5:1
 Units: mm
 Material: silicon



Two substrate types tested

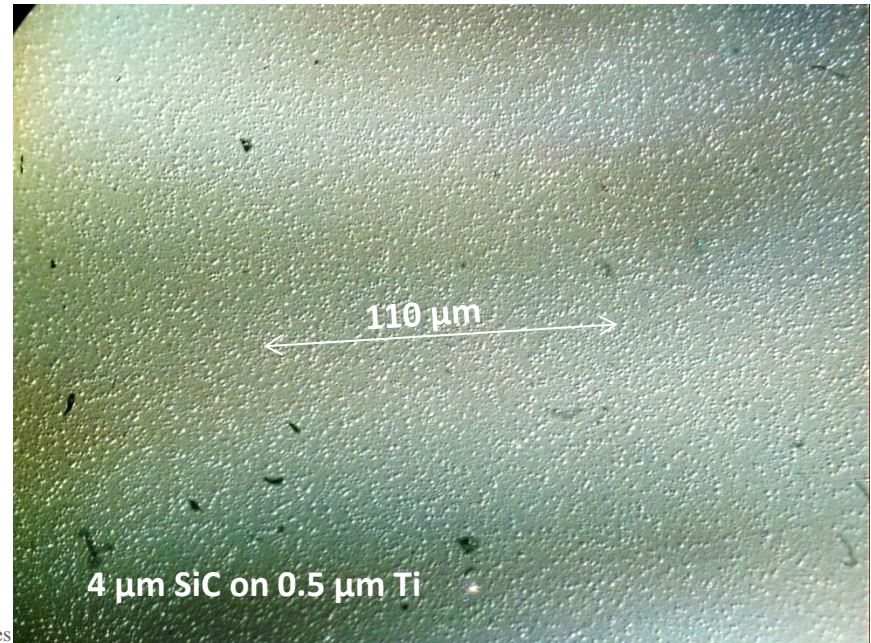
◆ 4 μm SiC on 1 μm Al

- Produced/cut on 17-3-2016
- #138



◆ 4 μm SiC on 0.5 μm Ti

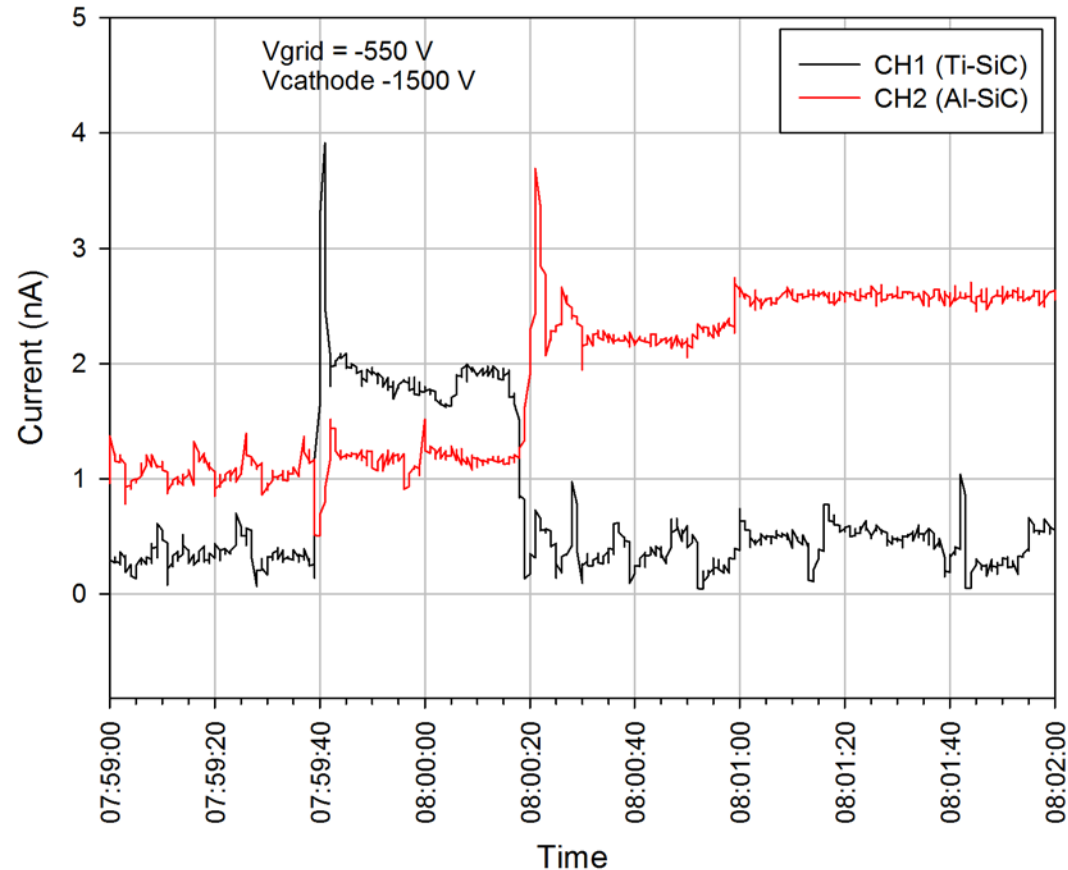
- Produced/cut on 17/21-3-2016
- #078



- ❑ Gas: DME/CO₂ 50/50
 - ❑ O₂ level 100 – 150 ppM
- ❑ Gas directed through two Thorium socks
 - ❑ => Alfa track every 4 s
 - ❑ Big pulses easily developing to spark discharge
- ❑ Using ⁵⁵Fe source
 - ❑ Assuming 220 e-/conversion
- ❑ Low rate gain (approximate), needs verification
 - ❑ ~1500 at -550 V grid
 - ❑ ~6000 at -600 V grid
- ❑ Gain drops down by factor > 4 at high rate
 - ❑ Gain is restored in ~30 s after removal source
 - ❑ To be measured precisely => calculation of SiC resistivity

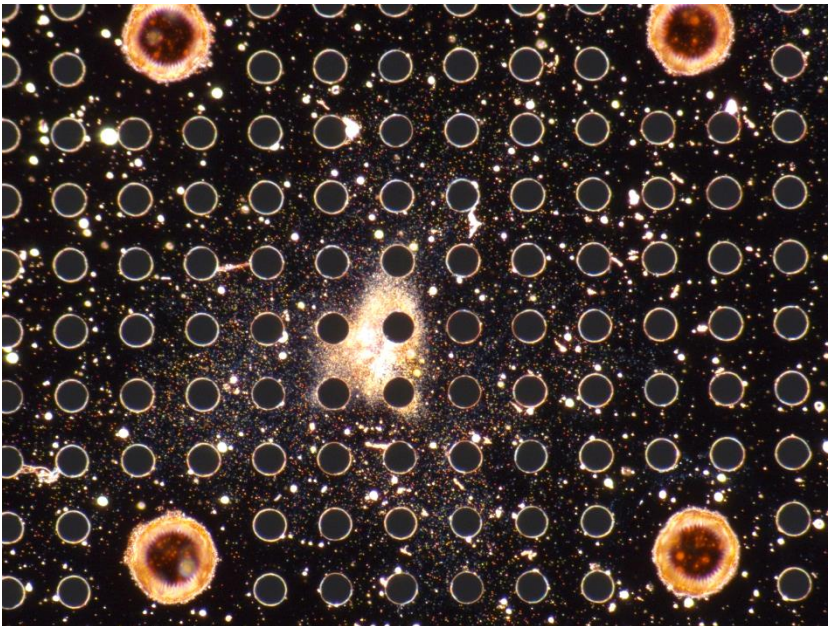
Gas gain

Induced current from ⁹⁰Sr source



Spark test with Al-SiC substrate

- ❑ Several typical discharge points
- ❑ SiC layer has been burst
- ❑ Discharge also visible at the backside of the grid



Fred Hartjes

Spark test with Ti-SiC substrate

- ❑ Three substrates tried, cut from the same wafer

- ❑ **At -550 V**
 - ❑ no discharge observed

- ❑ **At -600 V**
 - ❑ One substrate gave many sparks
 - ❑ Only at a single edge, substrate cut too short

 - ❑ Two other substrates gave occasional discharges
 - ❑ Tested during ~140 h
 - ❑ 36 discharges on ch 1
 - ❑ 6 discharges on ch 1

- ❑ Both substrates examined under the microscope
 - ❑ Only few dust particles observed, no single damage point on the SiC layer