

# Initial Test Results for the Hamamatsu LumiCal Silicon Sensors

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**Iftach Sadeh** on behalf of

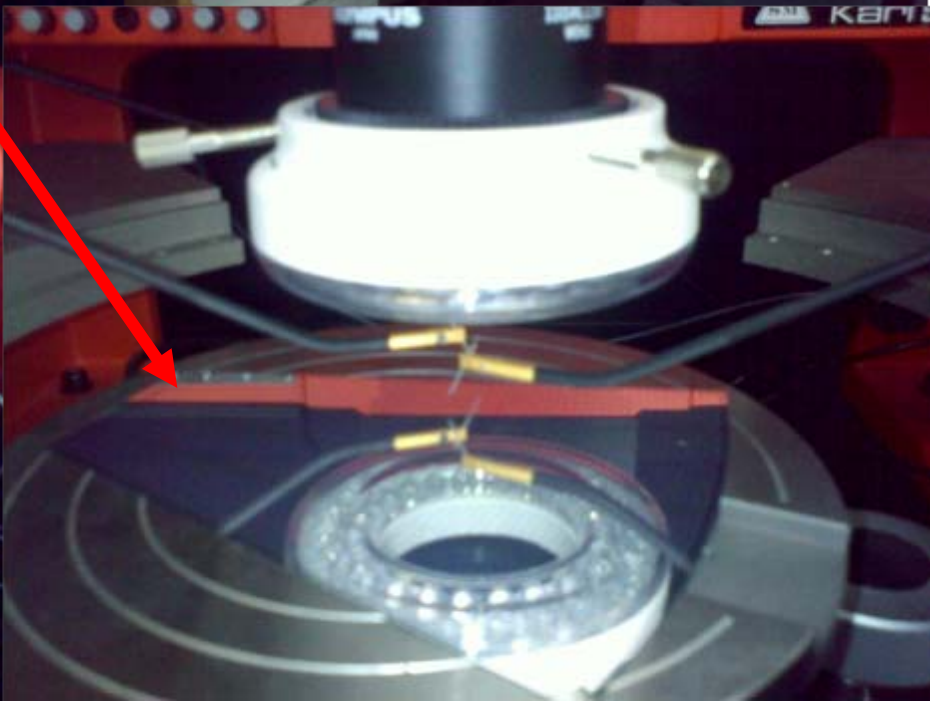
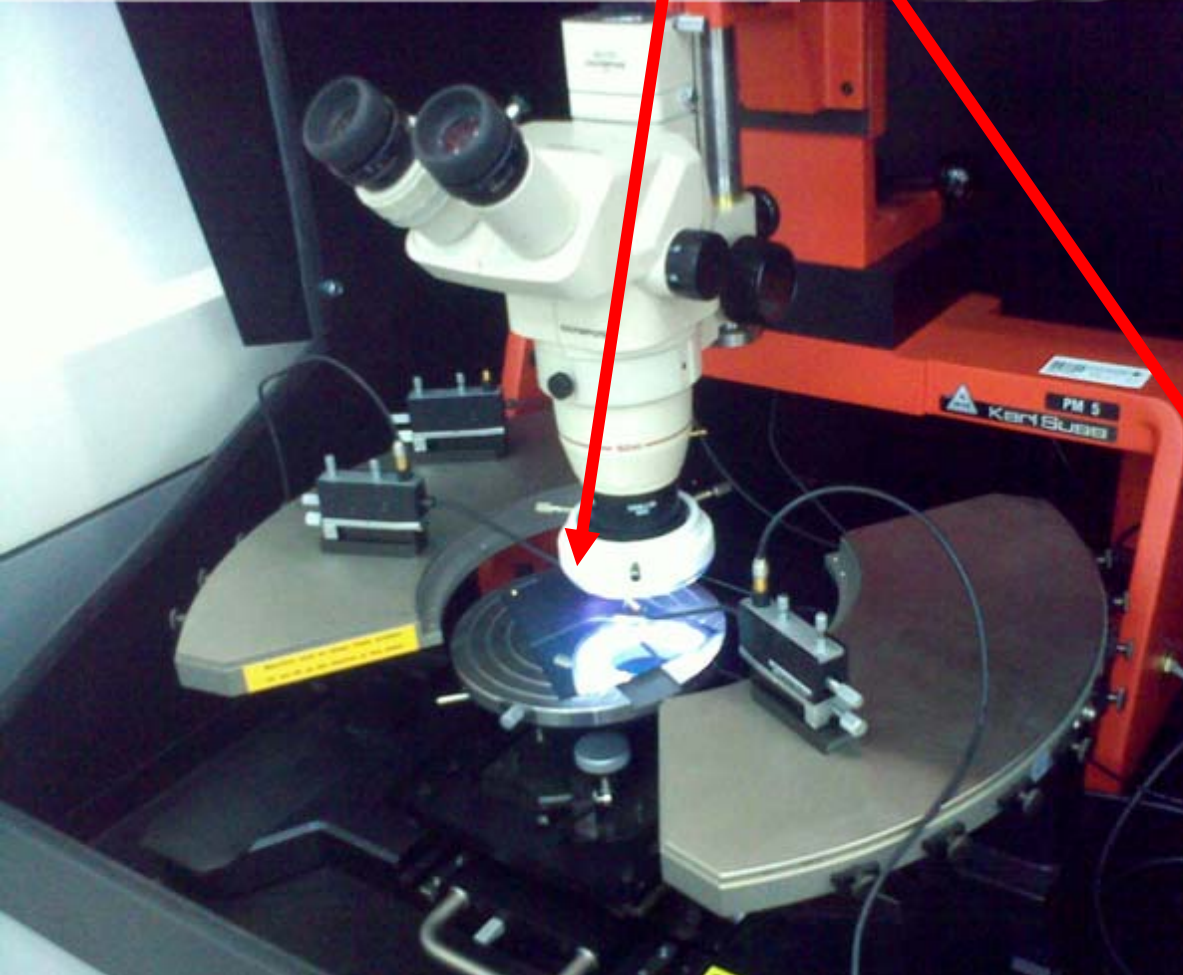
**Amir Stern, Rina Schwartz & Itamar Levy**

Tel Aviv University



Oct 19<sup>th</sup> 2009  
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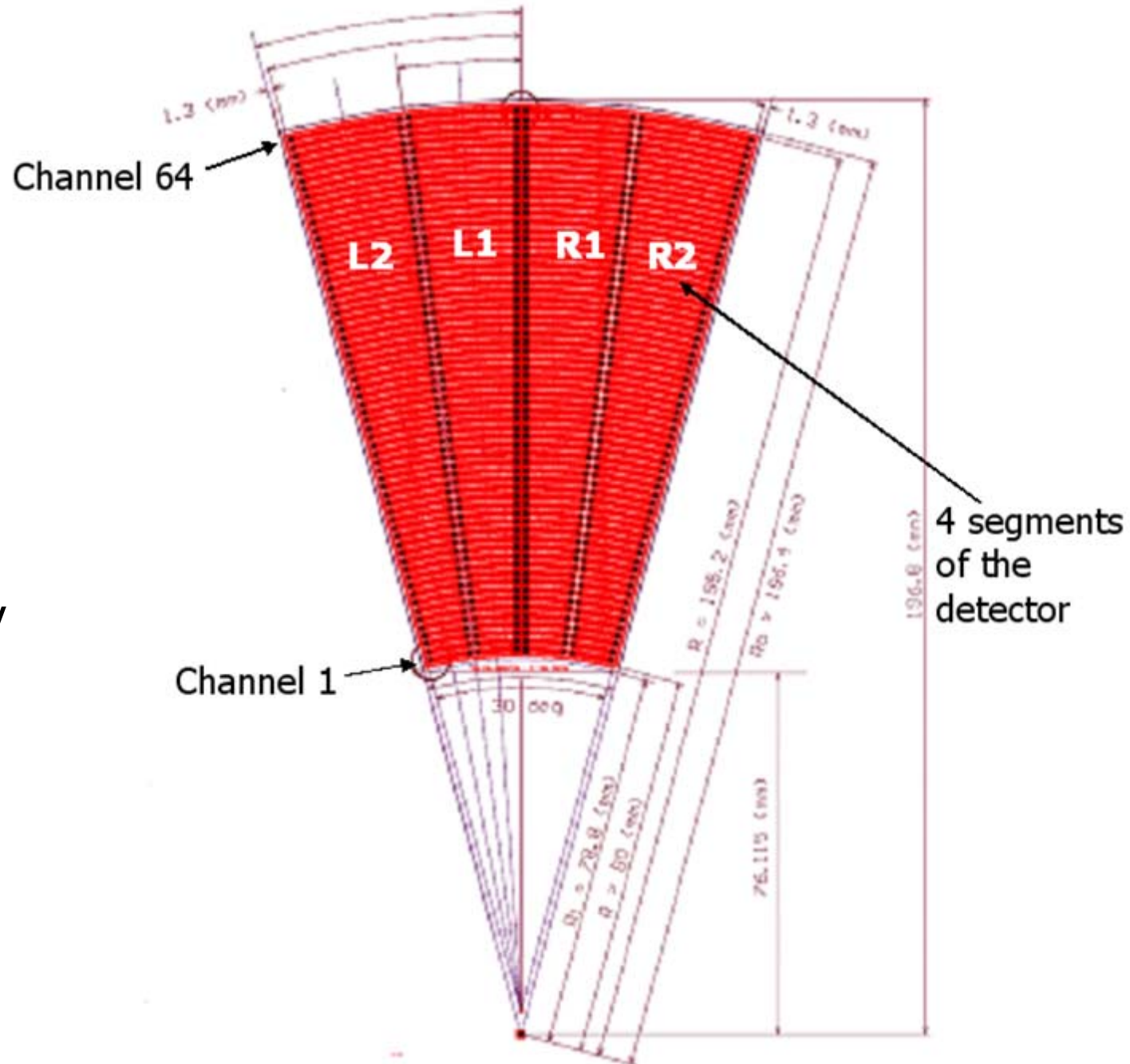
# Silicon sensor



# Overview

**Preliminary measurements were performed on the Hamamatsu silicon sensors:**

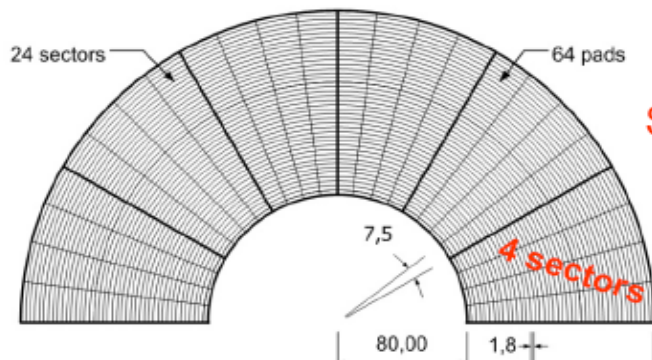
- Several pads from one sensor were tested.
- The tests included several kinds of I/V measurements as well as C/V measurements.



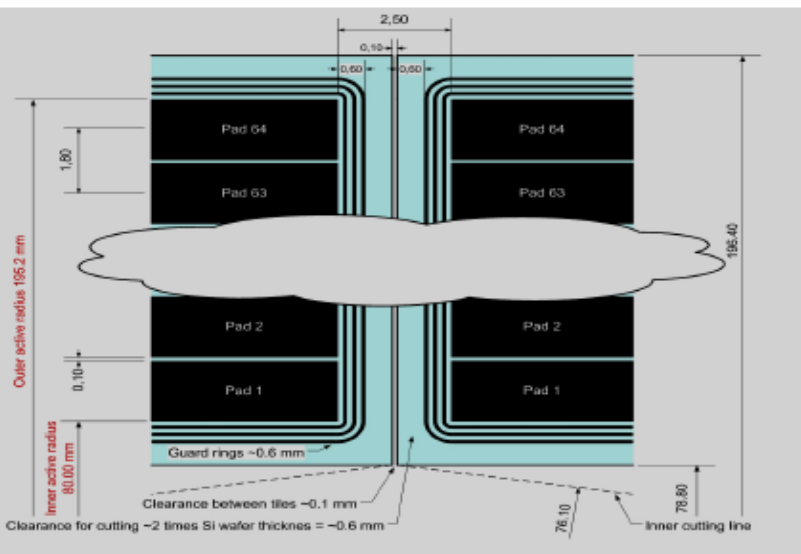
# Overview

At the design stage we take into account:

- results of Monte Carlo studies on angular resolution
- available (standard) silicon sensor technology
- requirement of FE electronics, number of channels and cost
- possible improvement of shower reconstruction accuracy by simple increase pads granularity (e.g. azimuth)
- remarks from Hamamatsu engineers

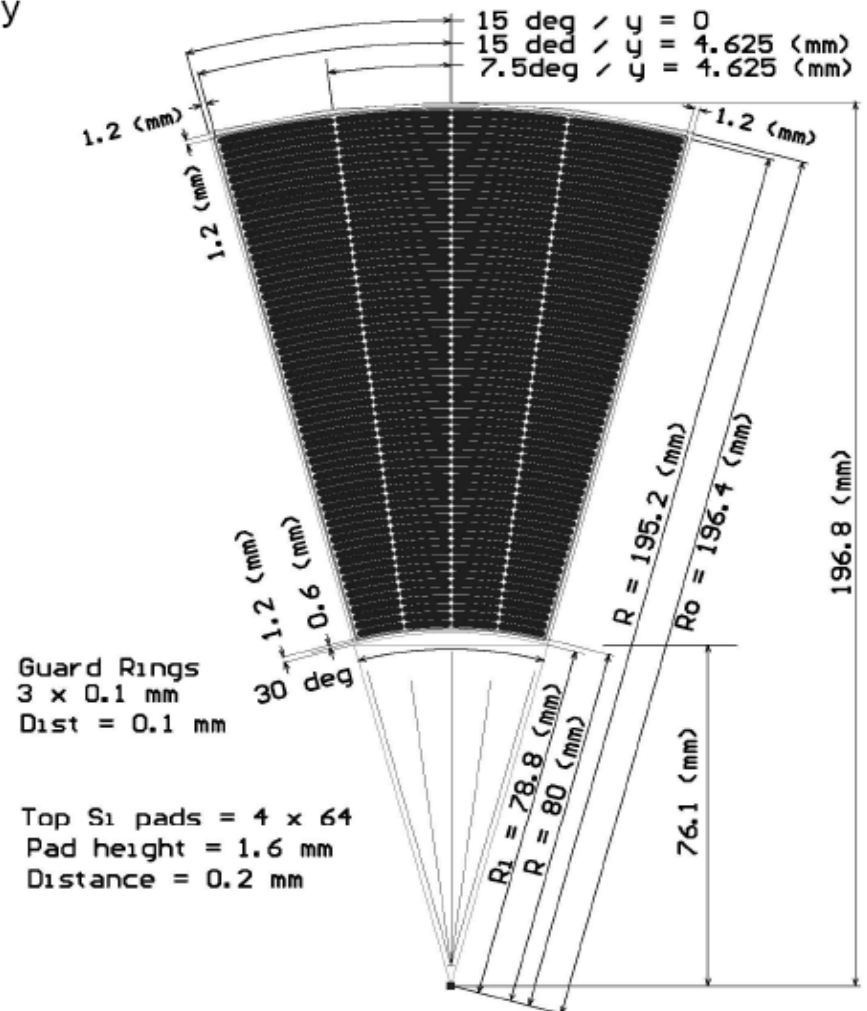


Silicon sensor  
half plane



Details of the structure: gap between tiles and guard rings

Top Layer & Dimensions

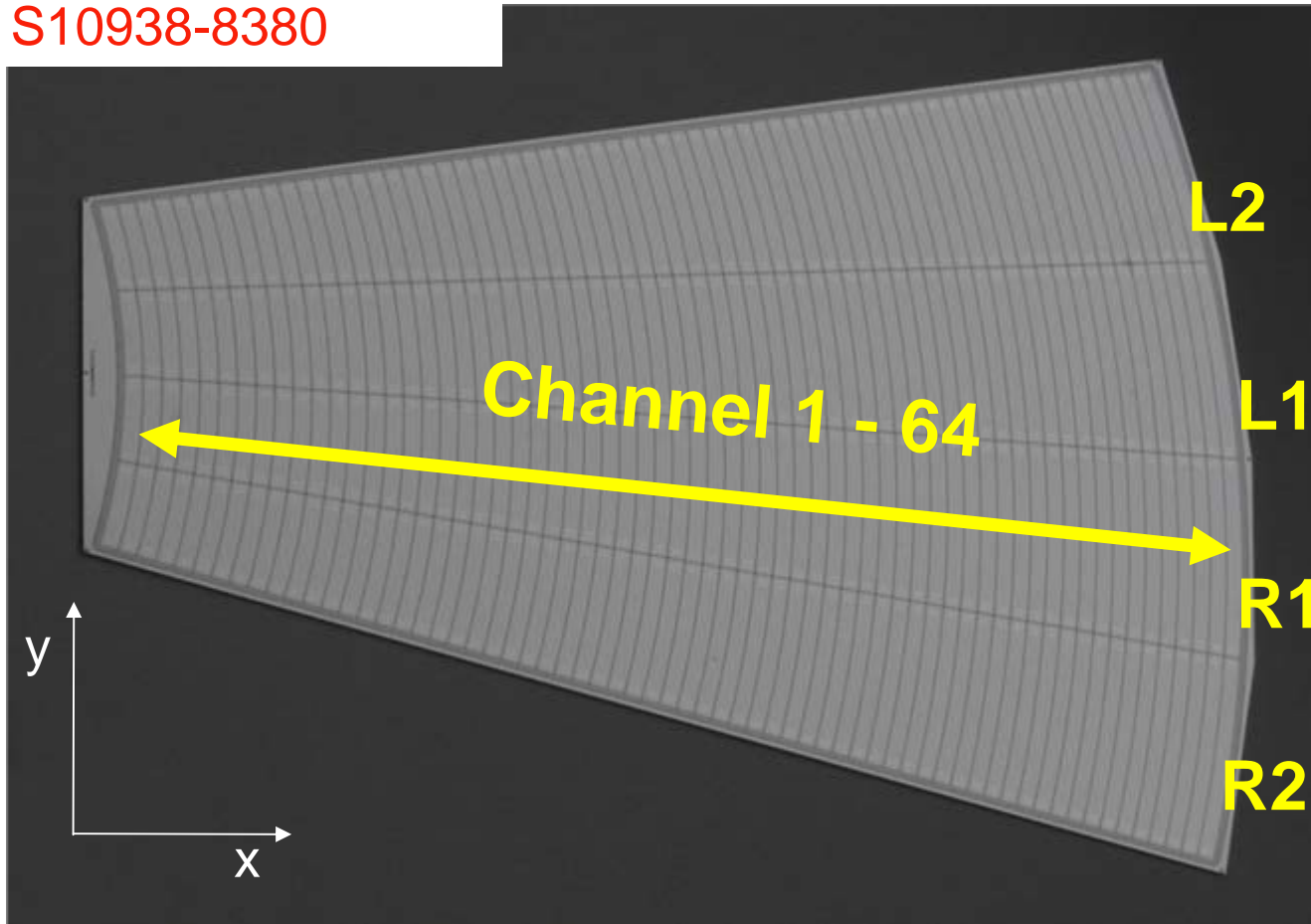


Segmentation of 4 sectors -  
they were produced by Hamamatsu

# Detector description

Hamamatsu

S10938-8380



“Cracow-Design”

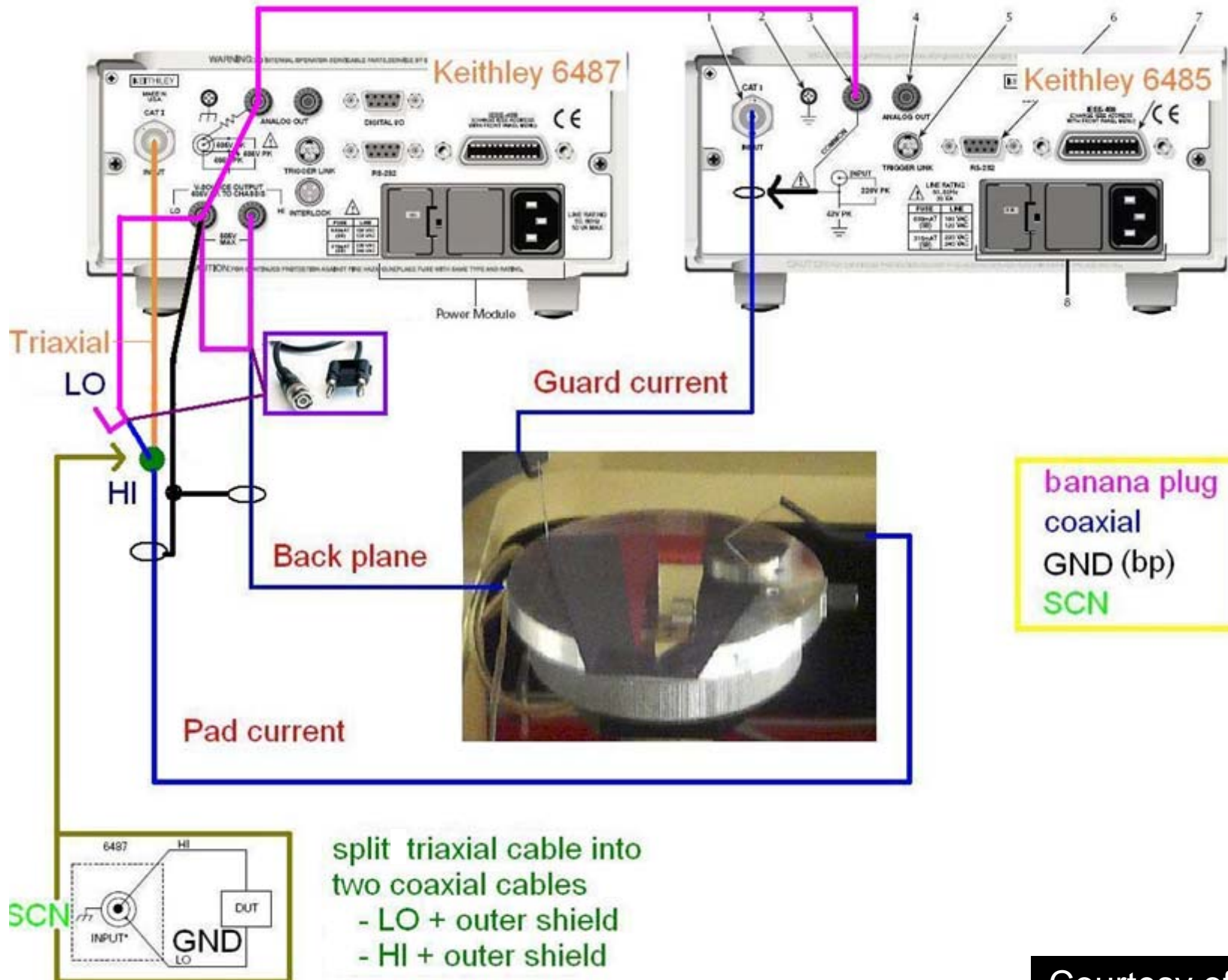
- High resistivity n-type Si
- 1,7mm p+ - strips with an Al-metallization
- Backplane: n+ implant and an Al-metallization
- 3 Guard rings

x-Size = 10,8cm

y-Size = 4...12cm

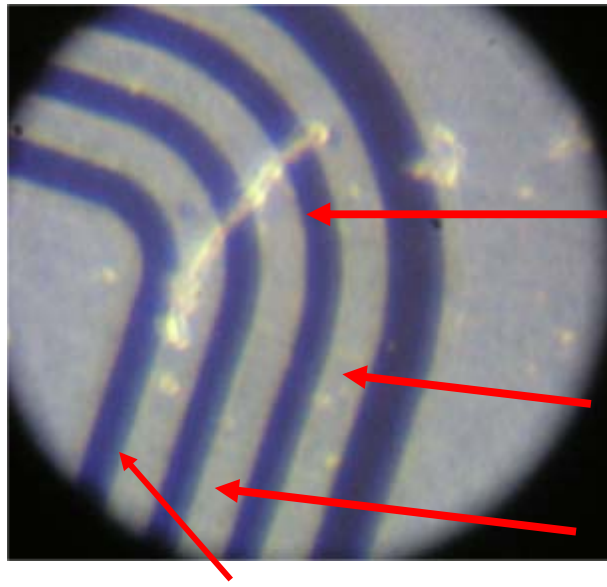
(6 Inch Wafers)

# I/V Measurements



# I/V curves - Sensor damage

- One of the Sensors was damaged during the measurements. The scratch in the area of the guard ring had **no affect on the pad-current**, but the **guard-ring current spiked**.

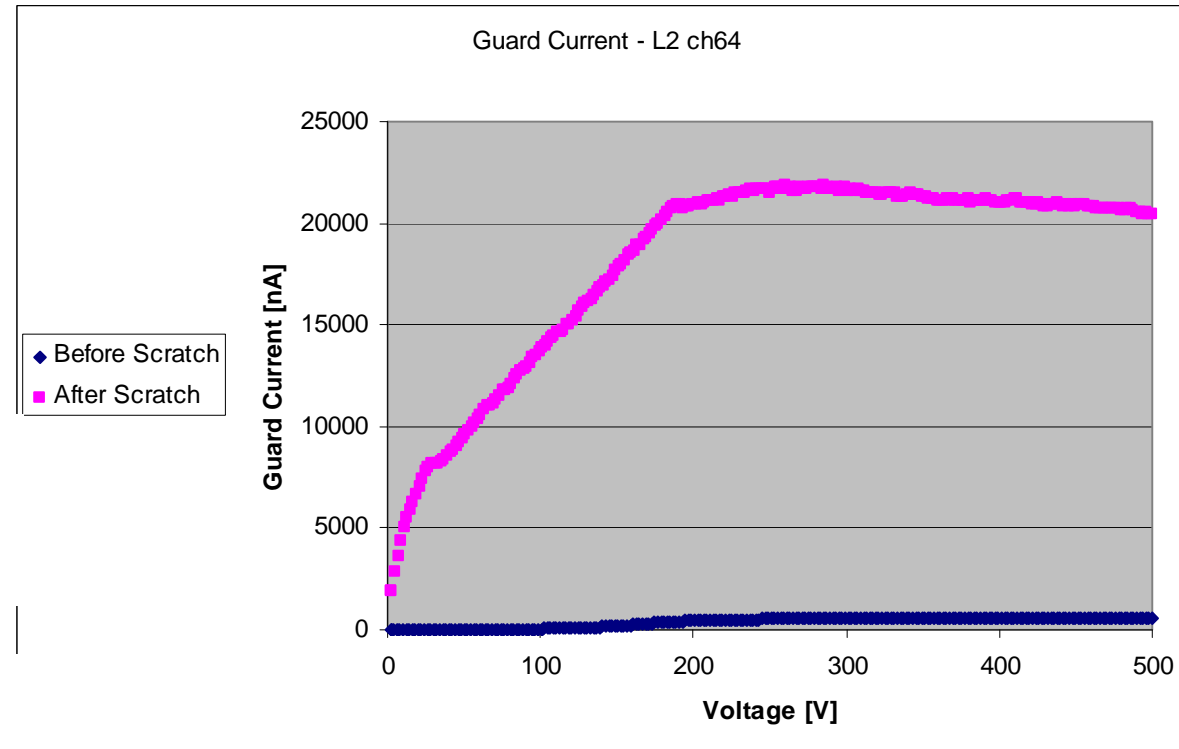
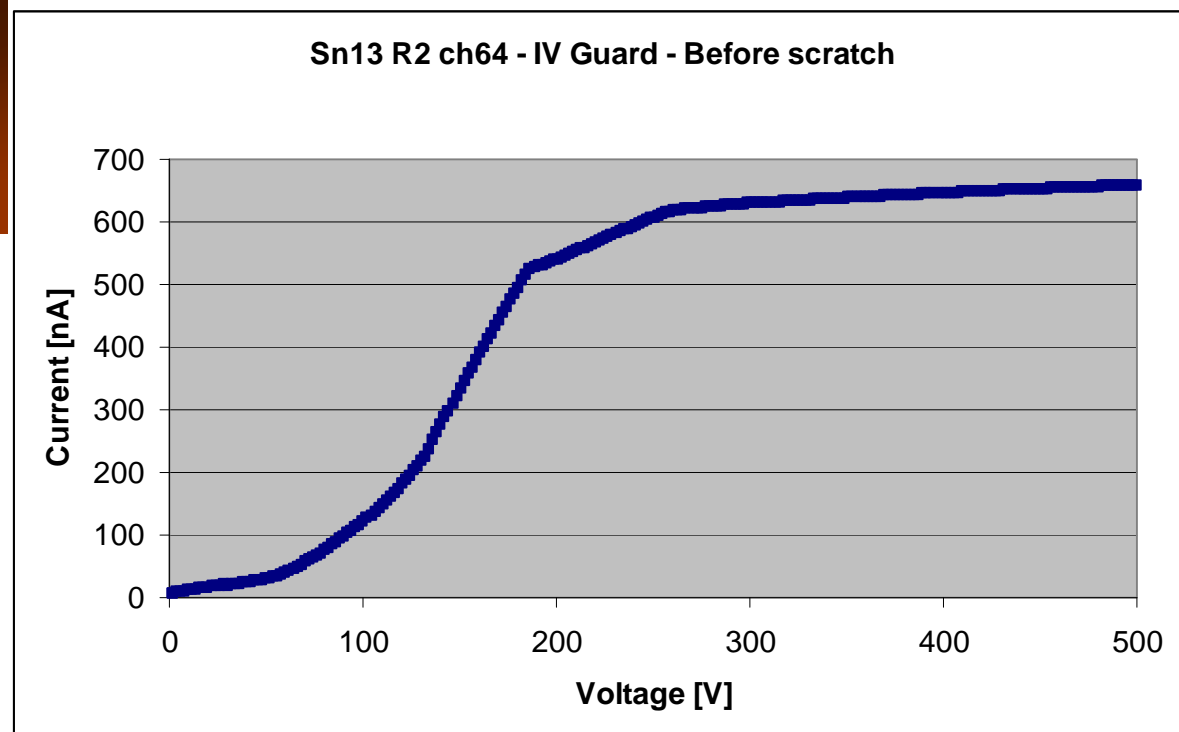


inner guard ring

scratch

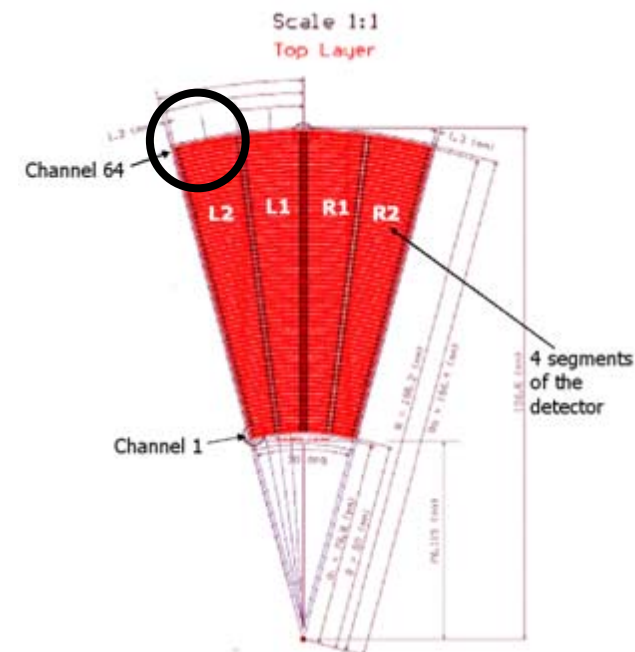
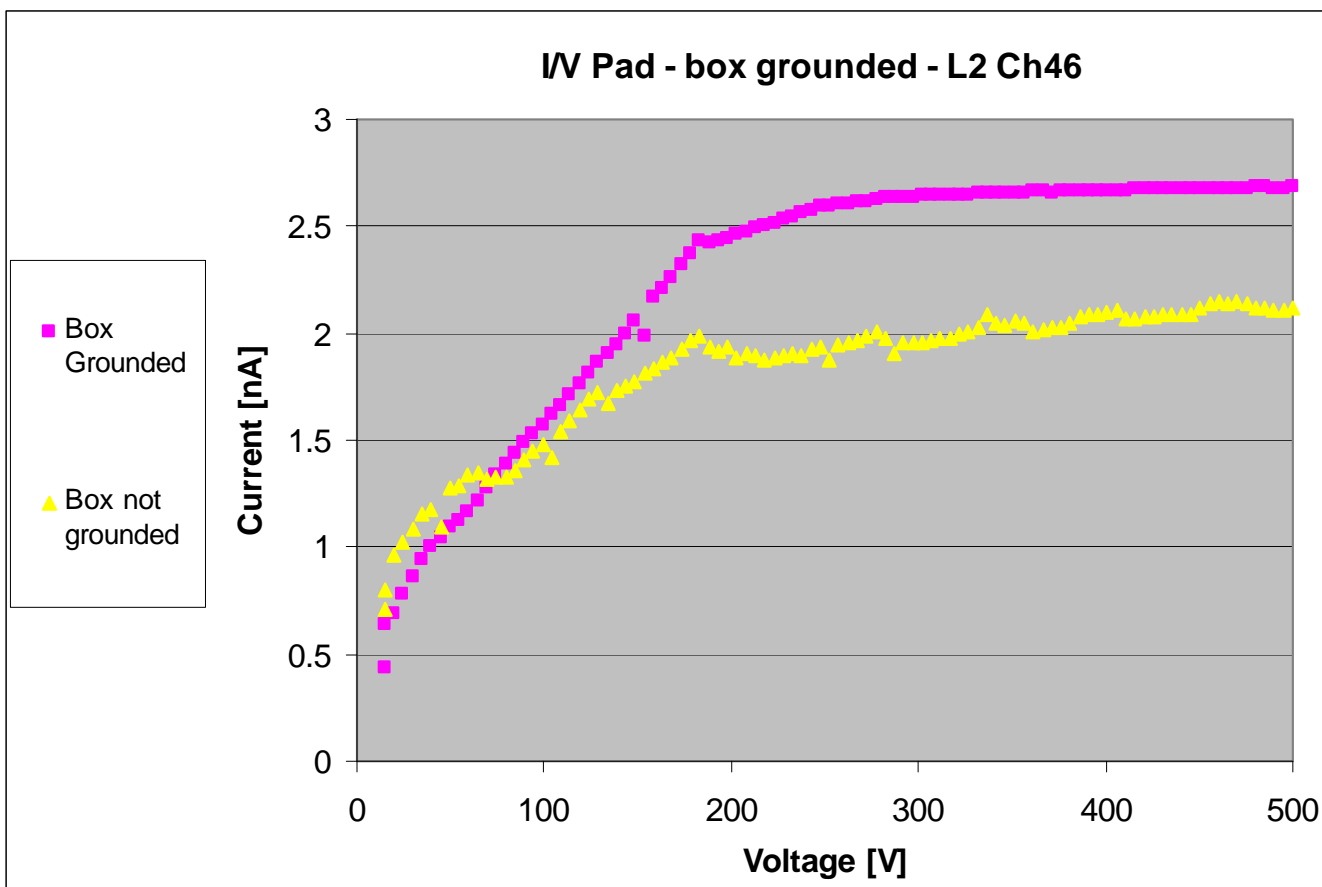
outer  
guard  
ring

middle  
guard ring



# I/V curves – Grounding issues

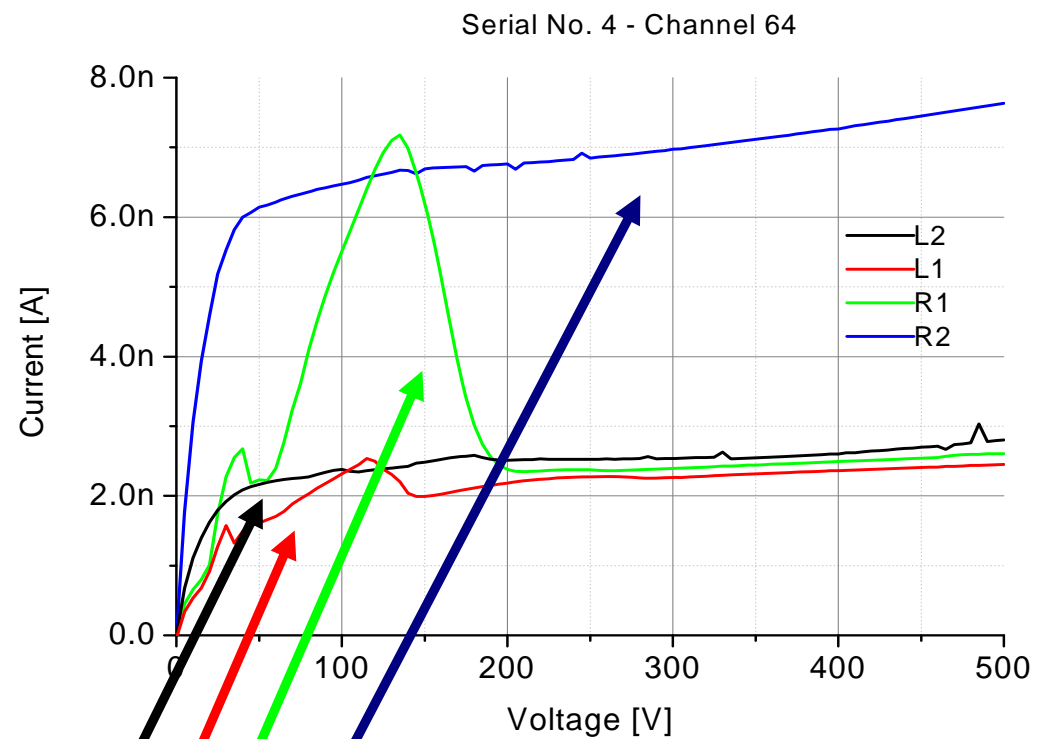
- The measurement setup is extremely sensitive to grounding.
- The plot shows an I/V measurement before and after grounding of the prob-station box



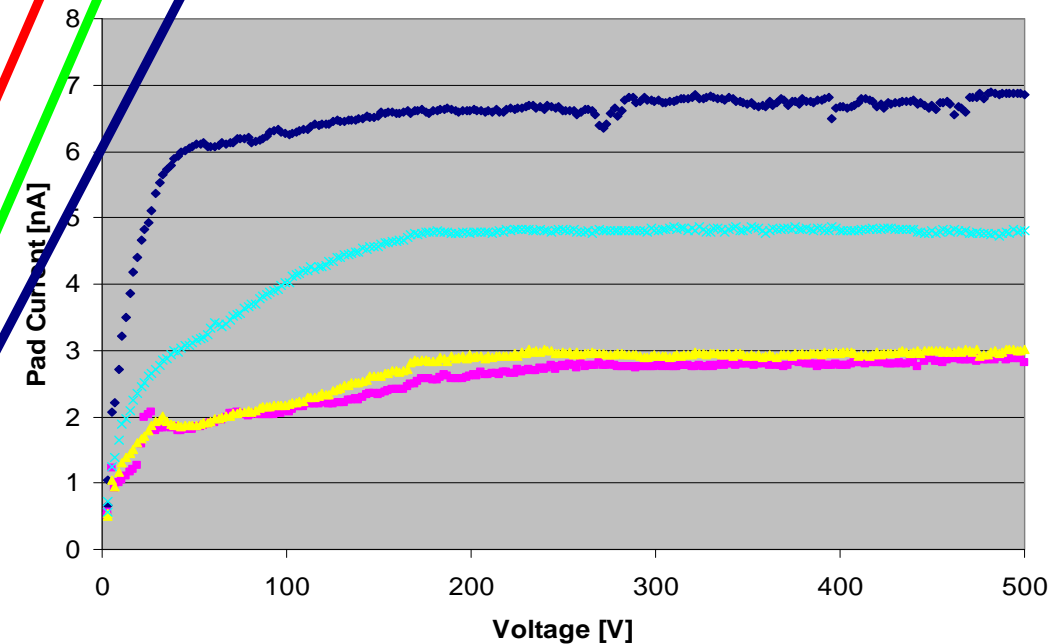


# I/V curves

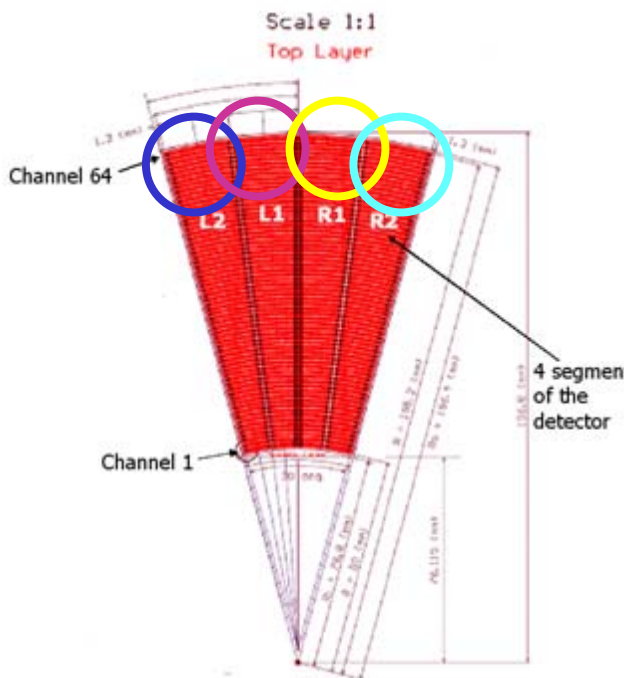
- Measurements were performed by our student both at DESY-Zeuthen (top right figure) and at Tel-Aviv (bottom figures) on different sensors, but on the same pads.



Serial No. 13 Channel 64



- ◆ L2 Ch64
- L1 Ch64
- ▲ R1 Ch64
- × R2 Ch64

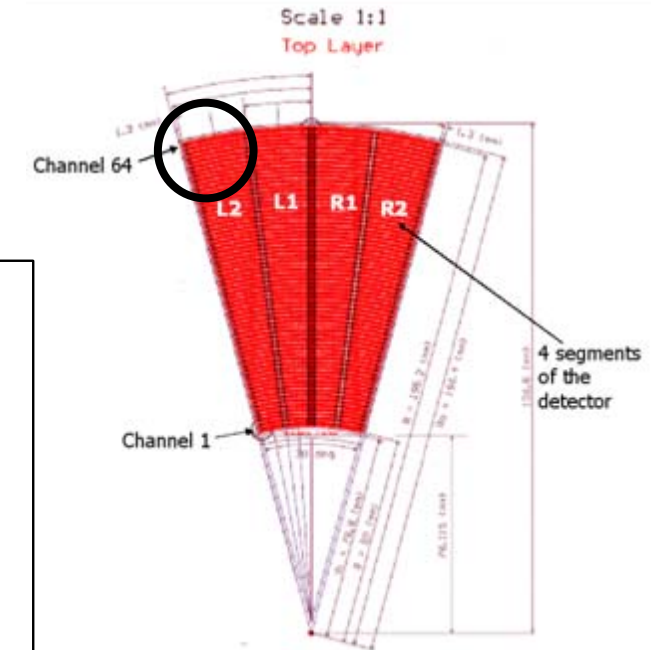
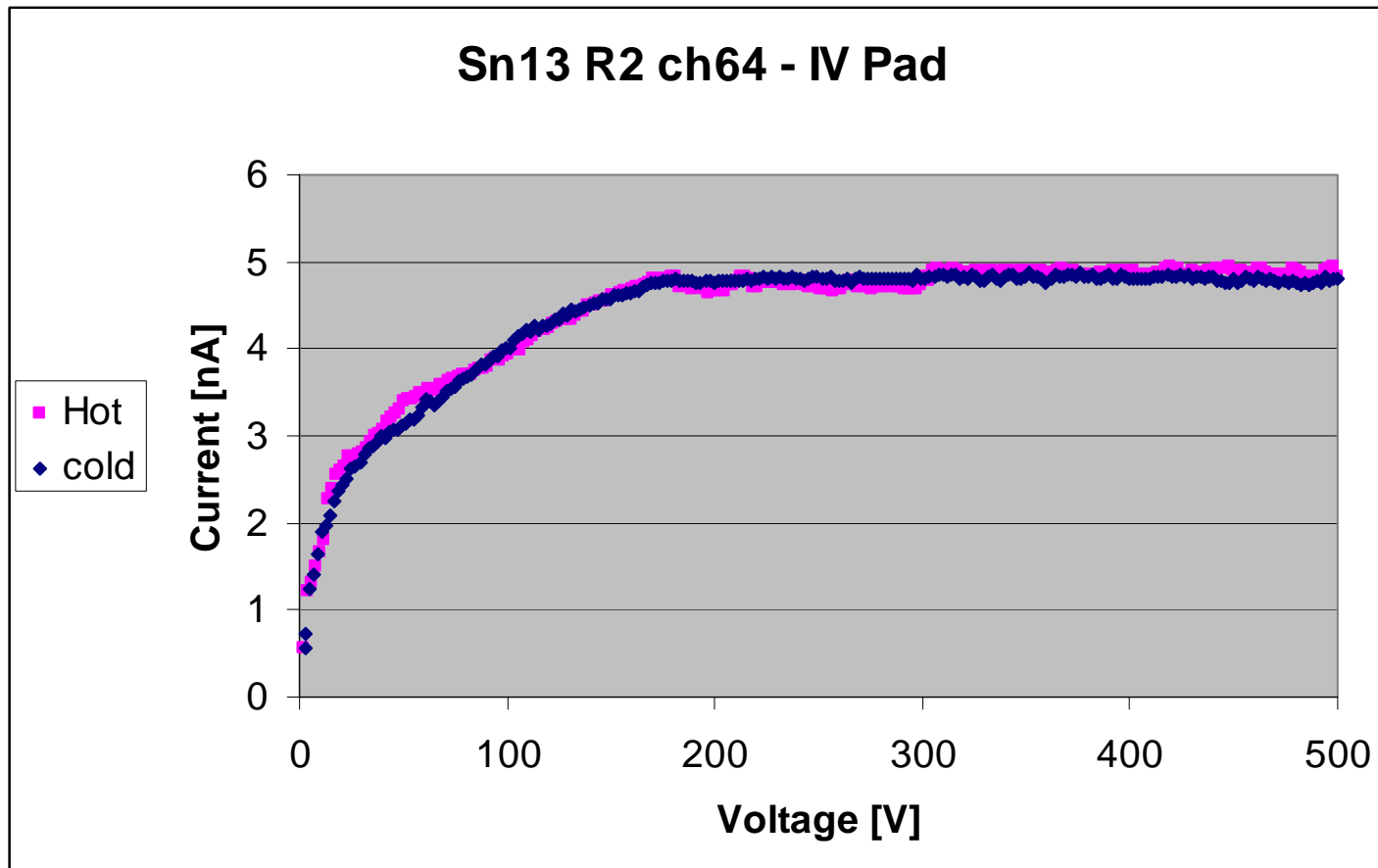


# I/V curves for different temperature & humidity

- Measurements were performed on the same pad with different external conditions, defined in the plot as:

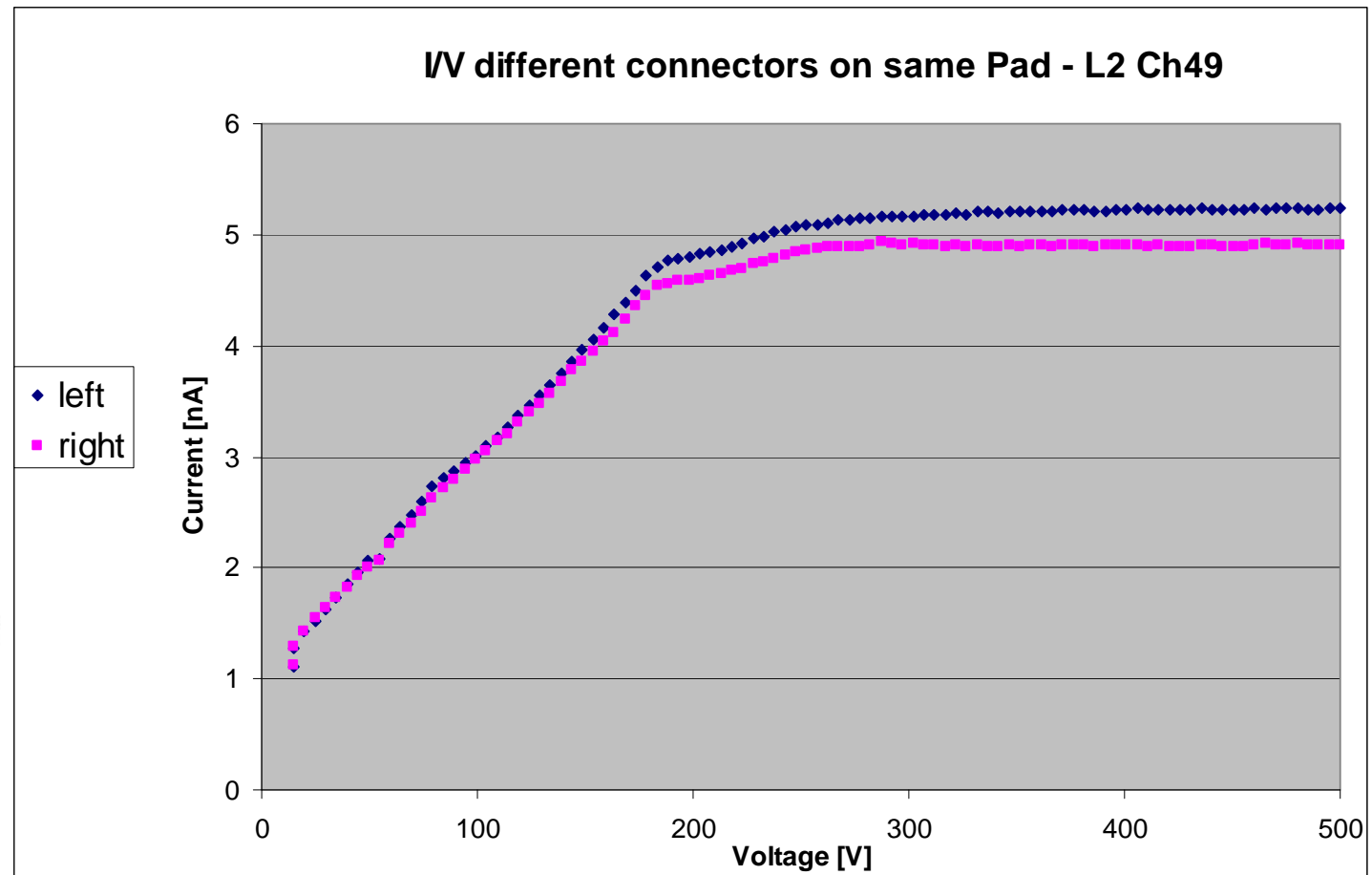
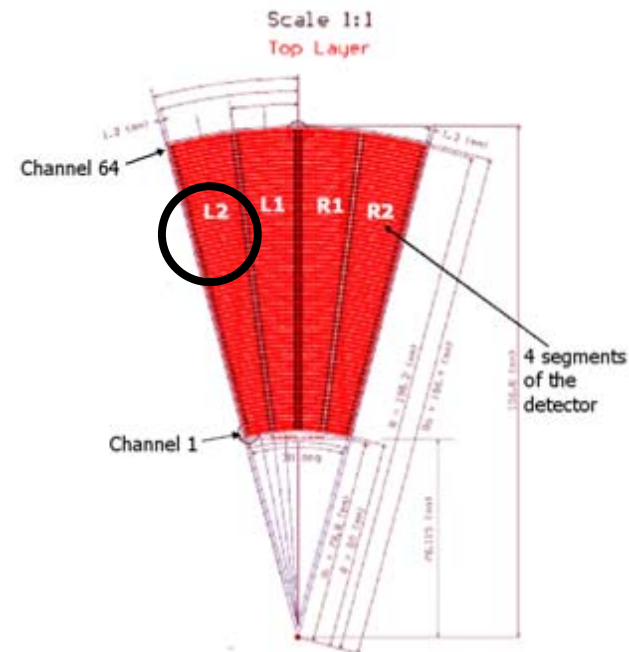
Cold == ~45% humidity, ~19°C

Hot == ~60% humidity, ~24°C.



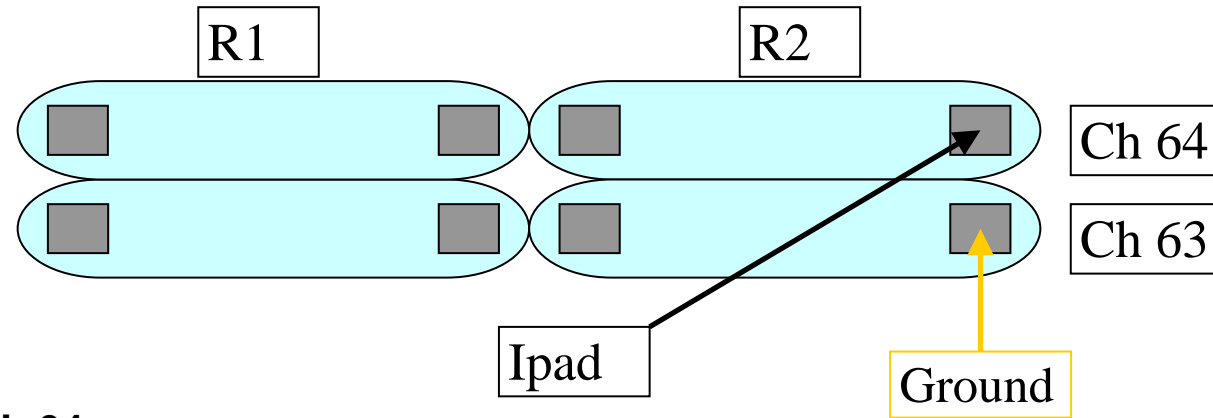
# I/V curves for different connection points

- Measurements were performed on the same pad on the two different connectors, showing slightly different results ( $\sim 0.3$  nA) between the **right** and **left** connectors.
- The difference may be due to the vicinity to the gourd ring.

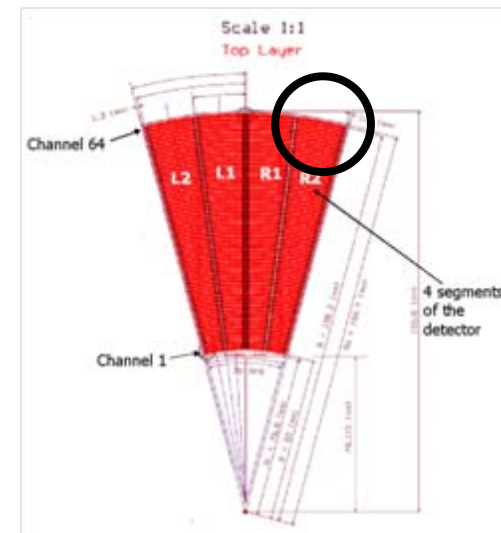
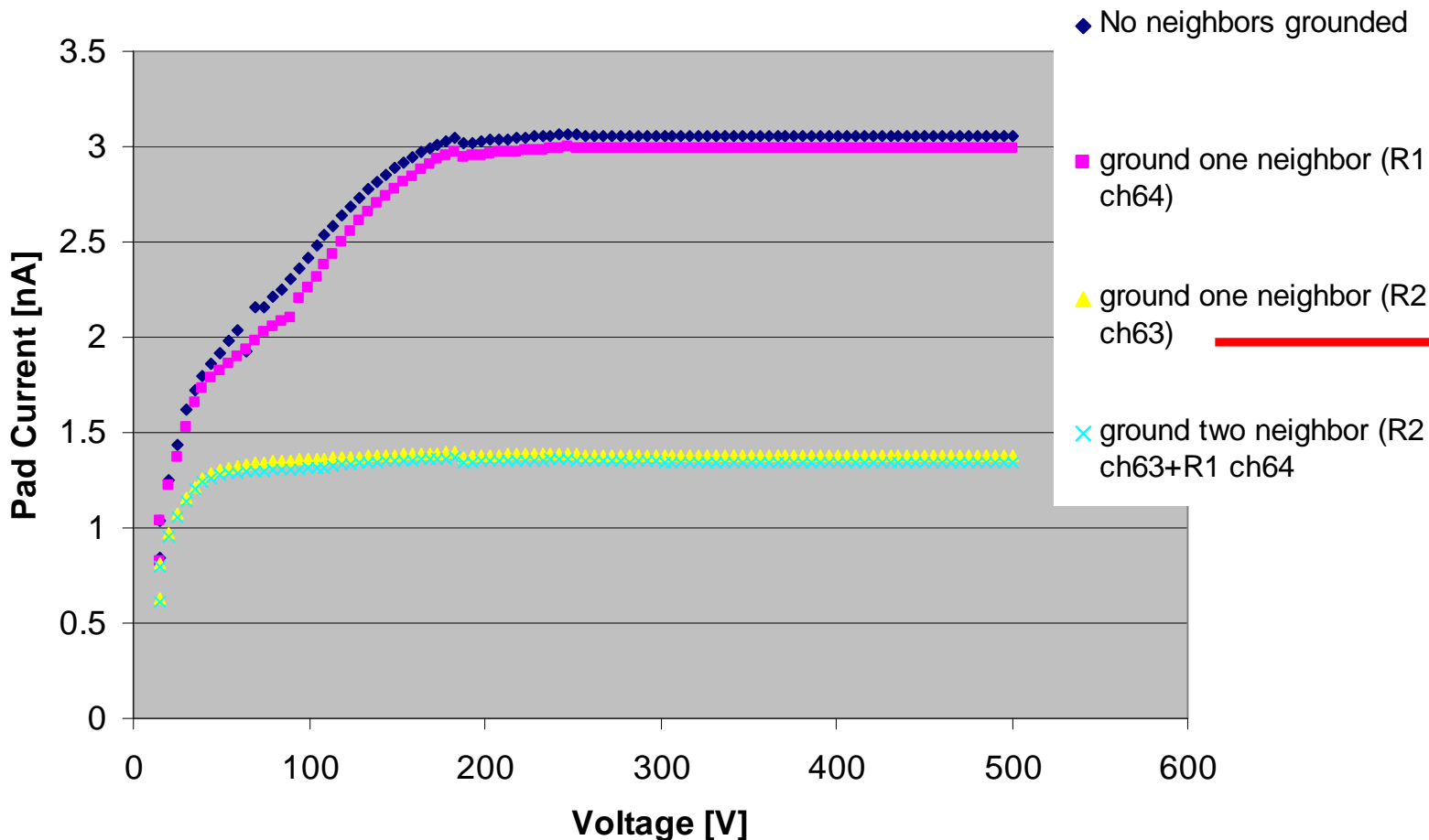


# I/V curves with one/two neighbors grounded

- Measurements were performed on pad R2 64 and one/two neighbors were grounded in different configurations.

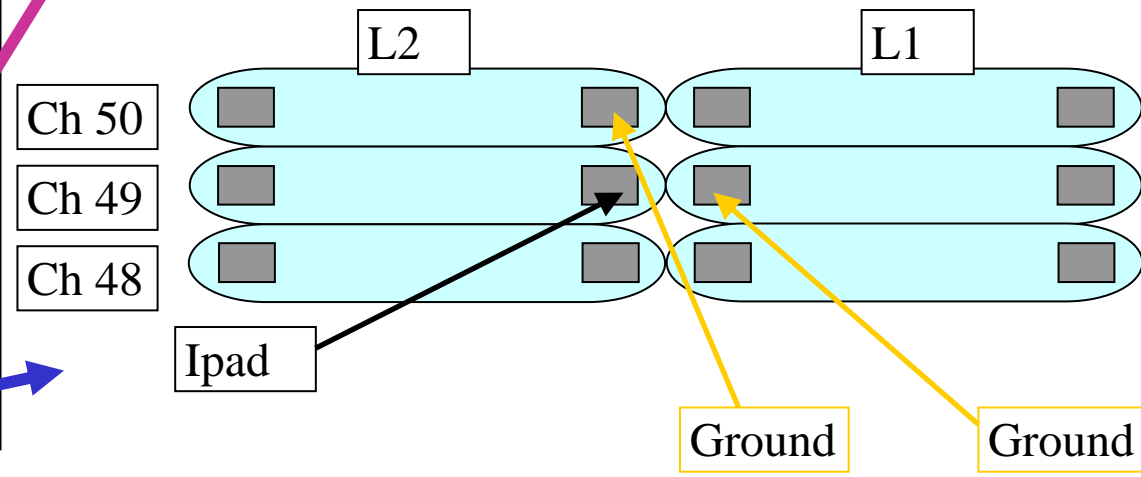
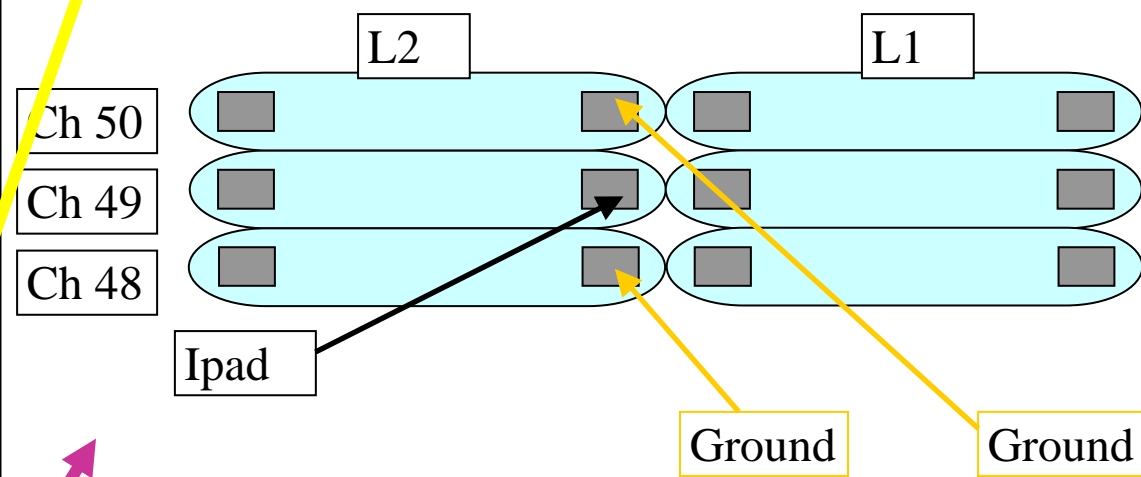
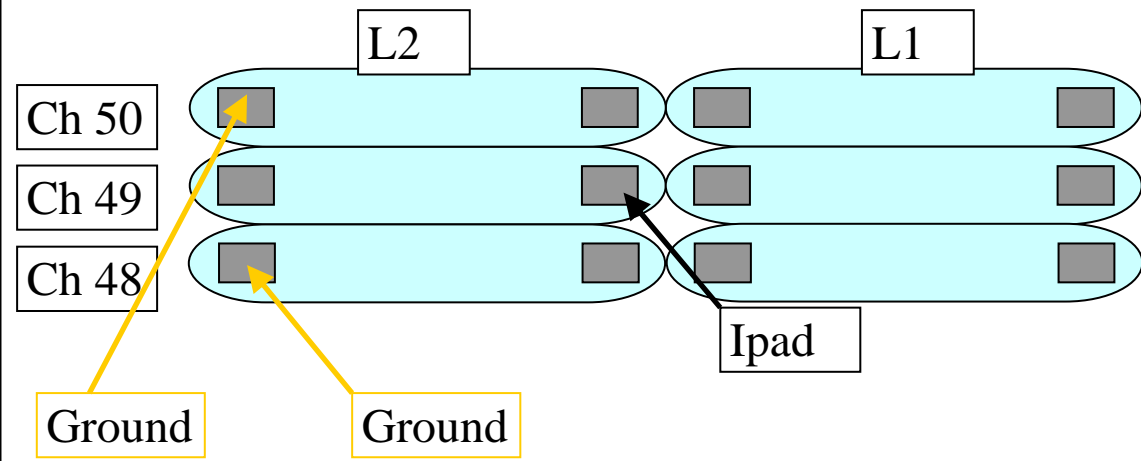
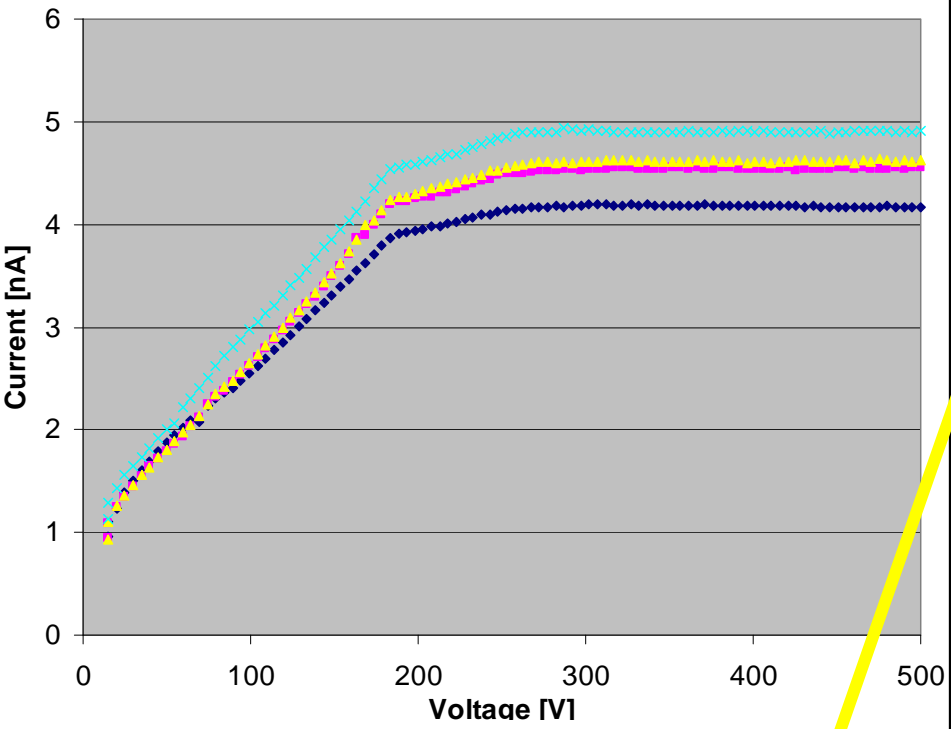


I/V Pad - Sn13 R2 ch 64



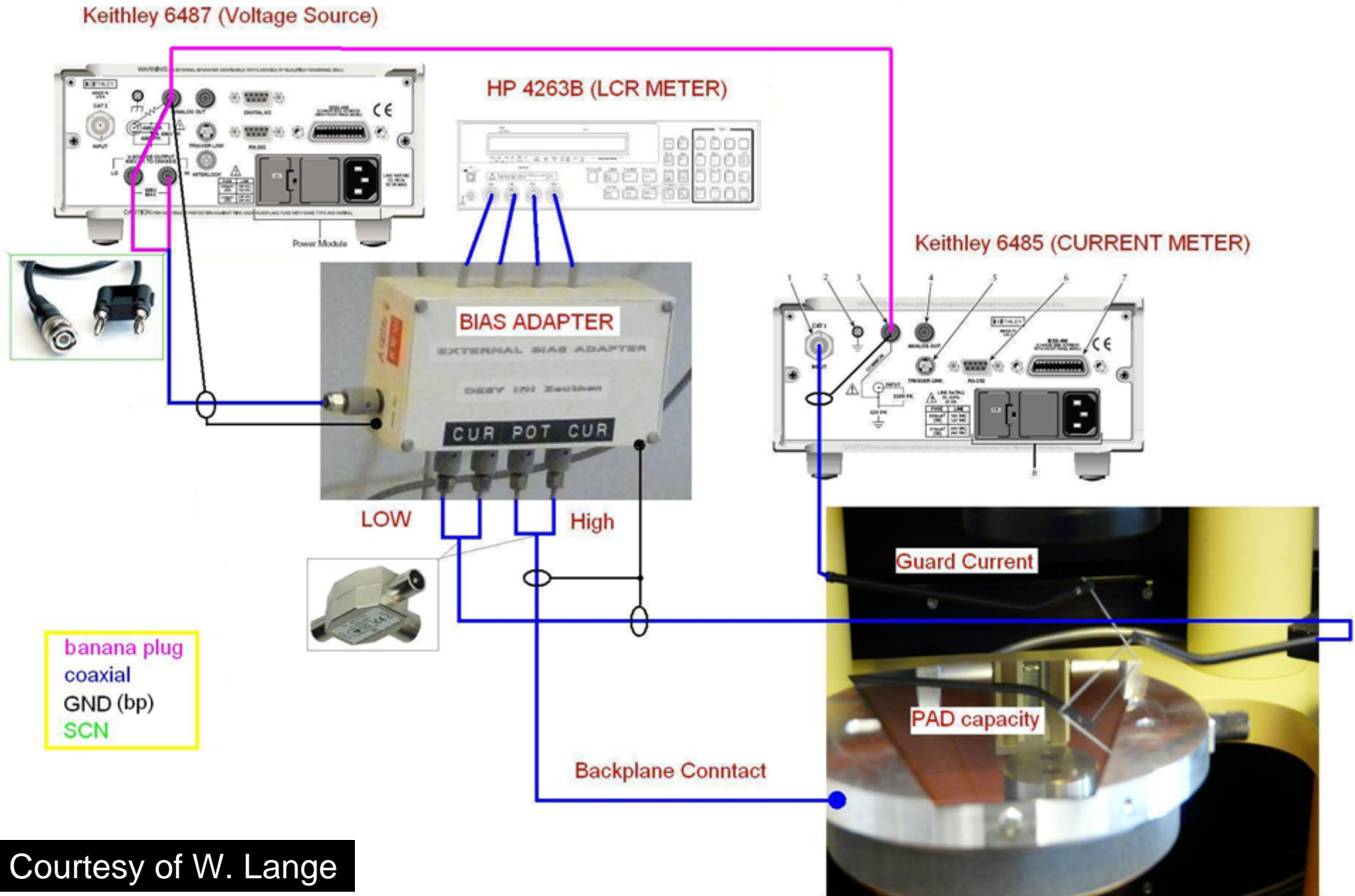
# 13 I/V curves with two neighbors grounded

I/V grounding different neighbors  
SNo13 L2\_Ch49

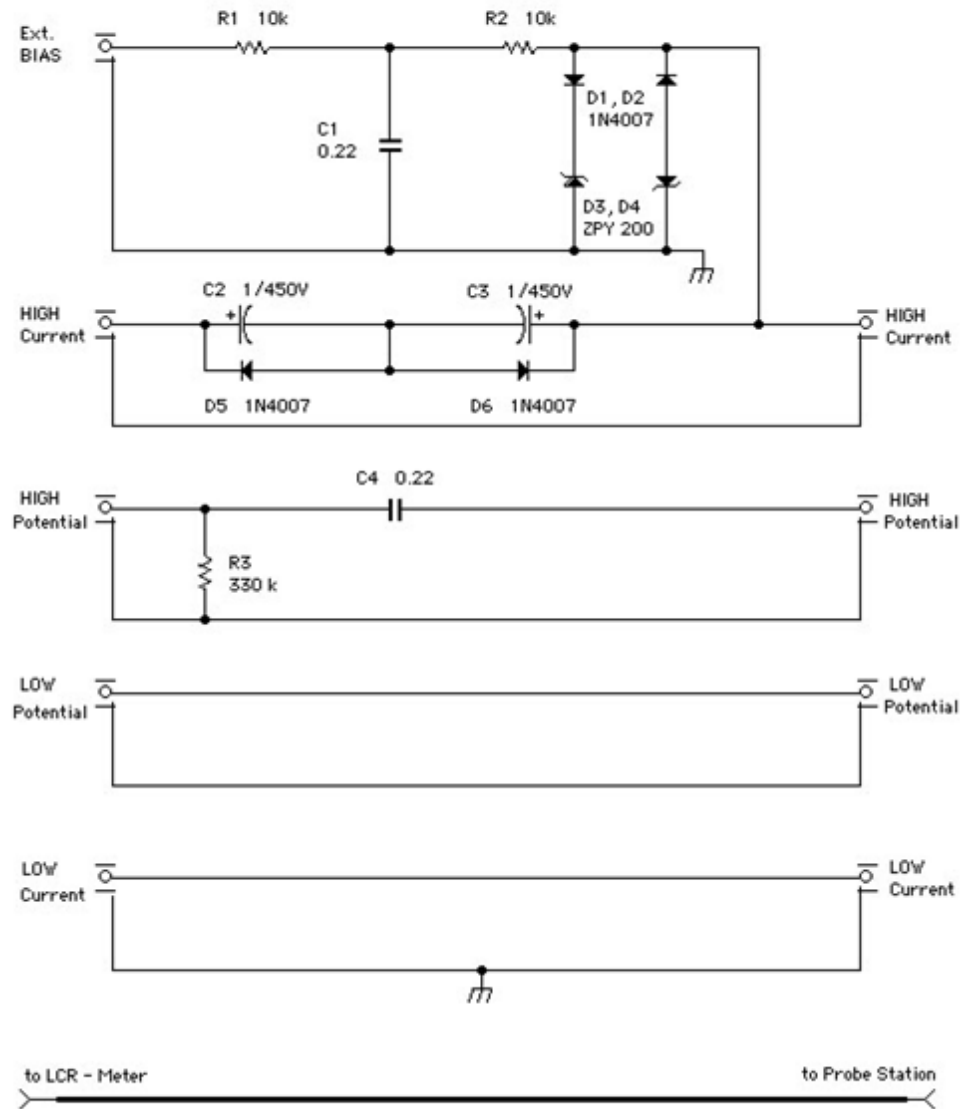


No grounding  
Ground on top & bottom (left)  
Ground on top & bottom (right)  
Ground on right & top

# C/V Measurements



# Bias Adapter Scheme



# C/V & Depletion Voltage Measurement

The full depletion voltage is determined by the voltage in which the capacitance saturates.

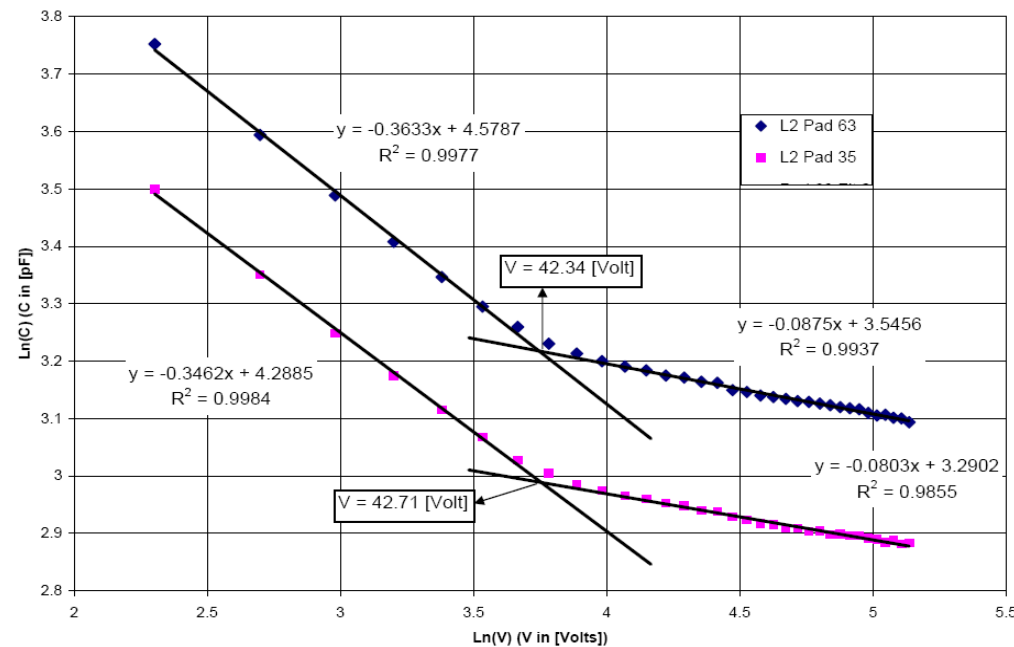
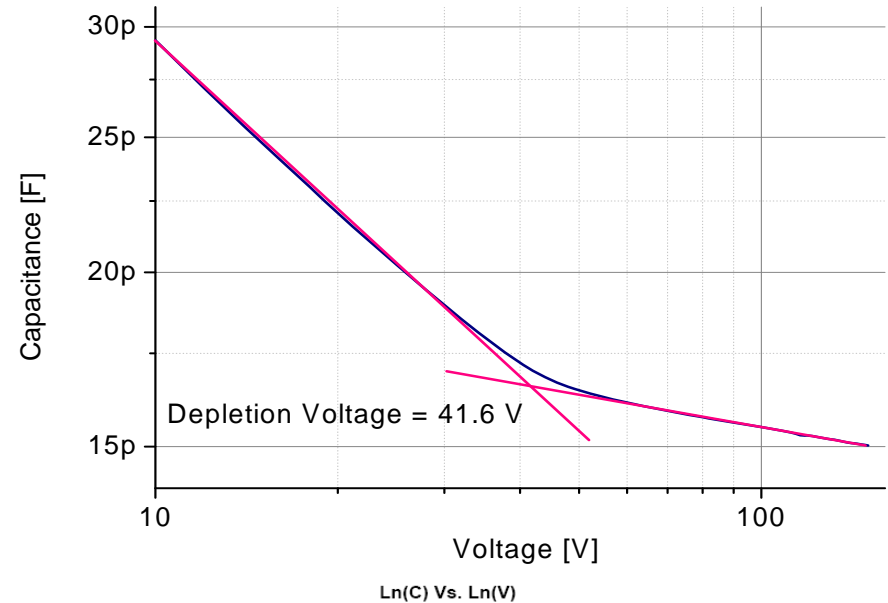
In these measurements the saturation is not full due to the fact that our sensor is not ideal. So the full depletion voltage is determined to be the cross point between two linear fits:

- one for the part of the curve where the capacitance decrease,
- the second for the “saturation” part of the curve.

Results in both labs give ~ 42 Volt as the depletion voltage

R. Schwartz at Desy-Zeuthen

Serial No. 3 - L2 Channel 30



At Tel-Aviv



# Summary

- The preliminary measurements produce similar results to the DESY-Zeuthen tests for the C/V measurement and for the I/V pad-current measurements.
- Grounding is a major issue; additional I/V measurements need to be performed with grounding of more neighboring pads.
- For the near future we plan:
  - A full set of tests on all pads in all sensor planes.
  - Comprehensive temperature and humidity dependant I/V curves.

We would like to thank W. Lange, H. Henschel, M. Bergholz (DESY), L. Linssen (CERN) and M. Idzik (AGH University) for the much needed technical advice and assistance.