

# Measurement and characterization of LumiCal sensors in the TAU lab

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# Outline

The clean room and measurement system

Capacitance and current measurements

Some results

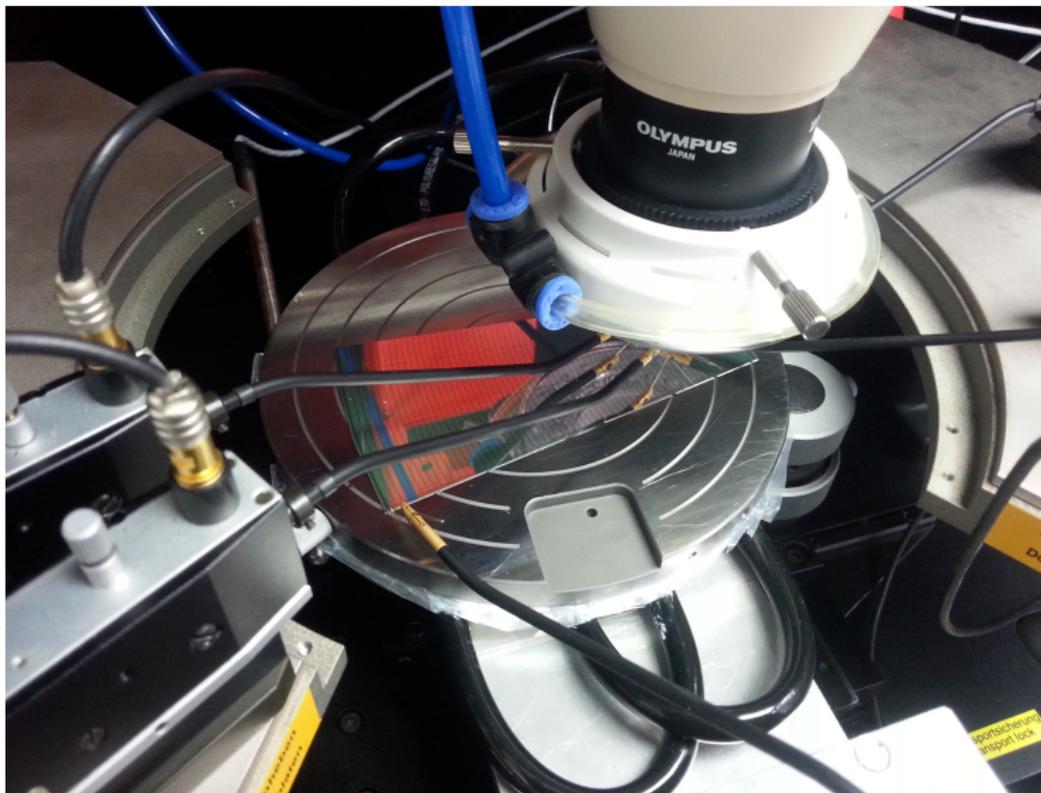
The broken sensor

Conclusion

# The clean room

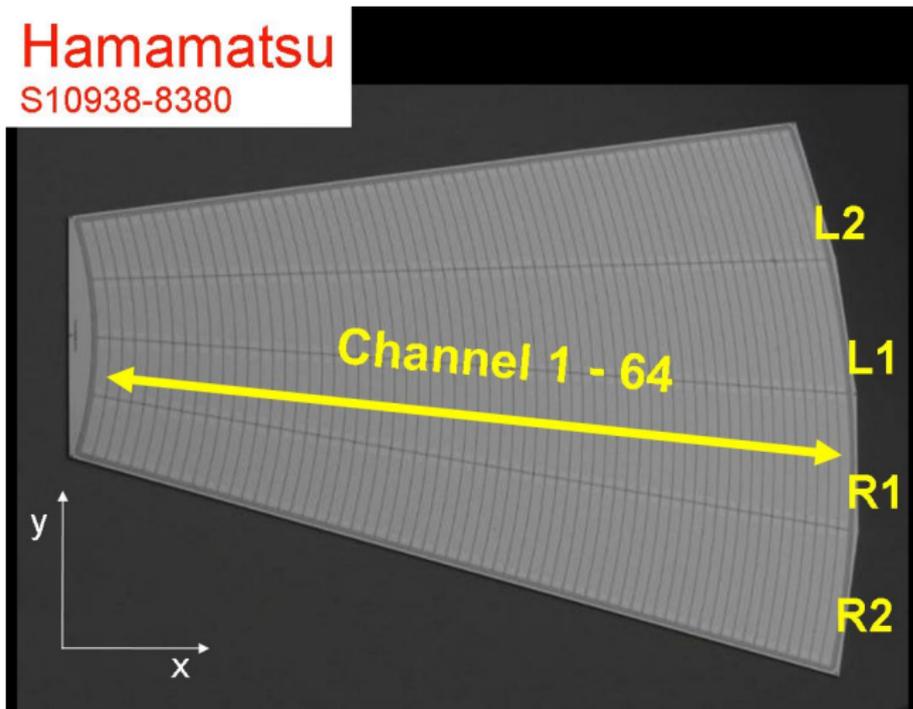


# The system



# Sensor Layout

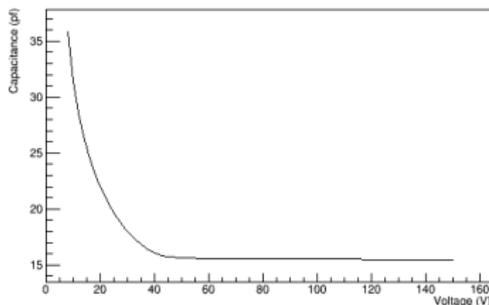
**Hamamatsu**  
S10938-8380



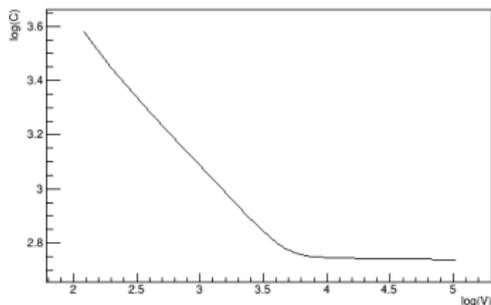
# Capacitance measurements

Expected two behaviors in two voltage regions:

1. For  $V < V_d$        $C(V) \sim V^{-0.5}$
2. For  $V > V_d$        $C(V) \sim \text{const}$



(a) C vs V plot

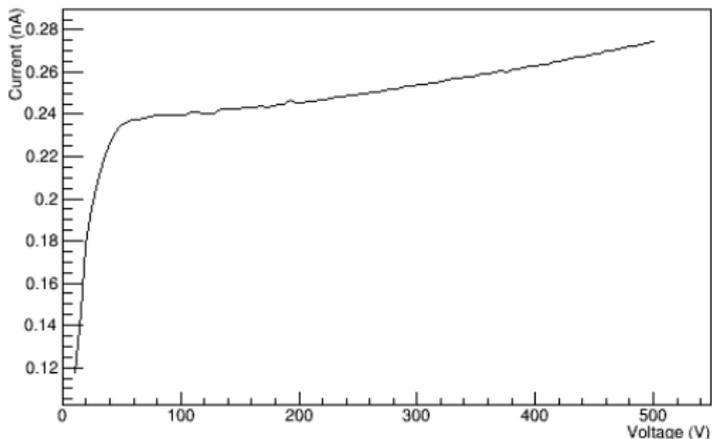


(b)  $\log(C)$  vs  $\log(V)$  plot

## Current measurements

Expected two behaviors in two voltage regions:

1. For  $V < V_d$        $I(V) \sim \sqrt{V}$
2. For  $V > V_d$        $I(V) \sim \text{linear}$



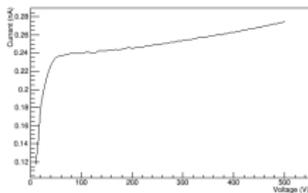
## $I(V)$ measurements - recent change

Previously, current at high voltage seemed constant (rather than linear in voltage).

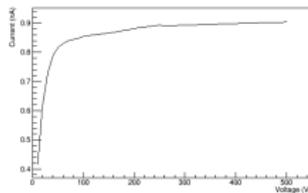
The reason: voltage box used for the  $C(V)$  measurements was limiting the voltage to 250V.



Since this was found out, the box is bypassed during current measurements.



(a) w/o box



(b) with box

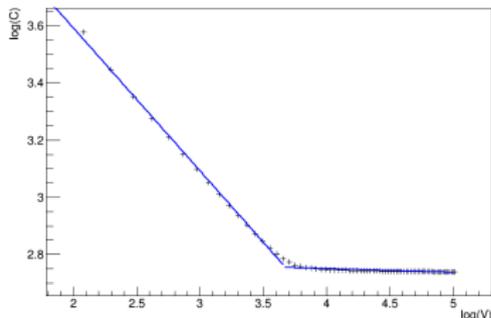
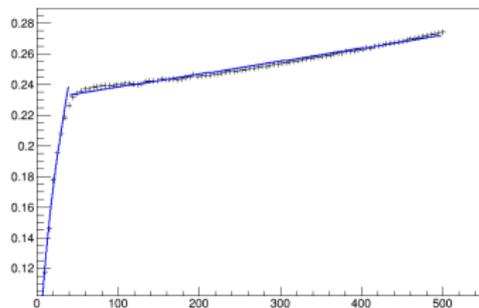
## Progress of measurements

- Sensor 16 was fully measured before it was glued to the board for the TB (was spare sensor)
- Sensor 14 was almost fully measured before it broke :(
- Sensor 17 is  $\approx 80\%$  measured. Measurements will be completed in the following weeks

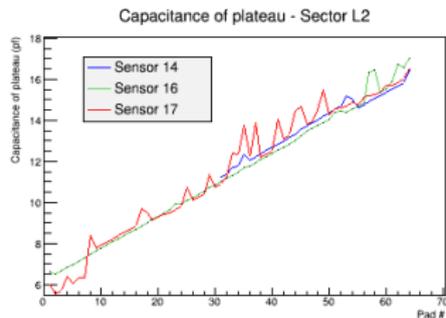
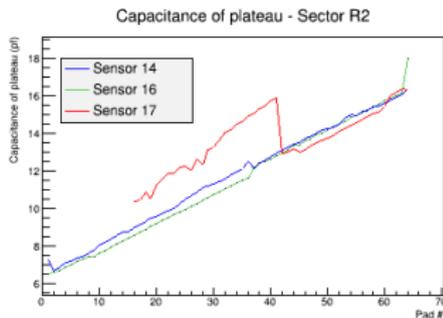
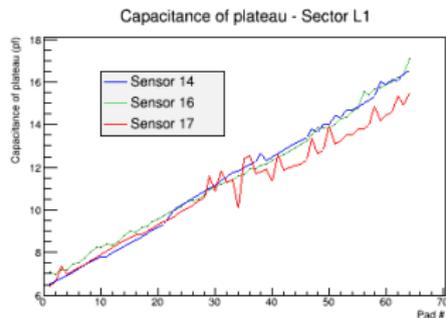
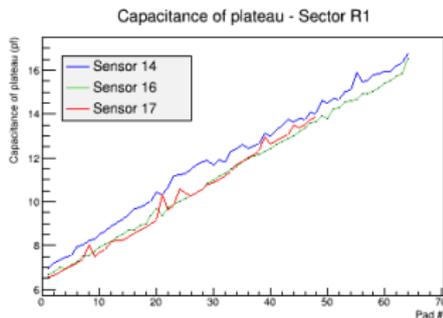
This means that we now have enough data to compare between different sensors!

# Results

One can fit the  $C(V)$  logarithmic curve and find the depletion voltage and the constant capacitance in the high voltage region. Similarly, one can find the average level of current for the linear part of the  $I(V)$  curve.

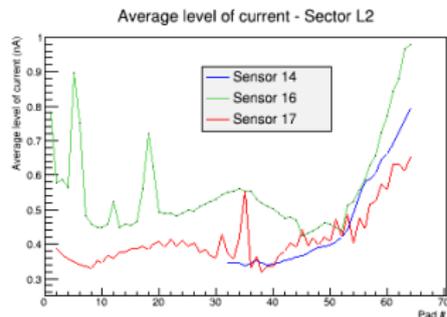
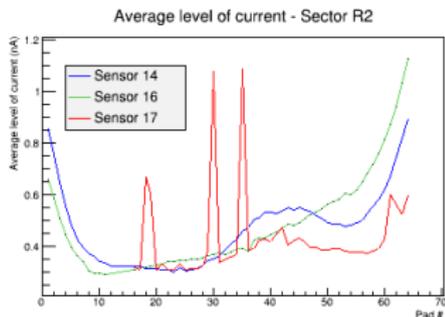
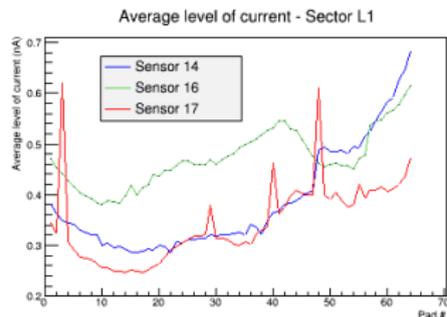
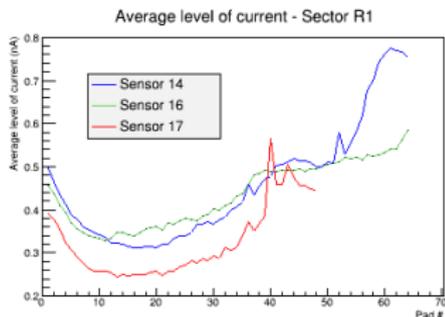


# Results



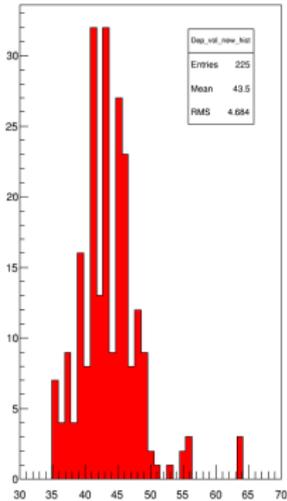
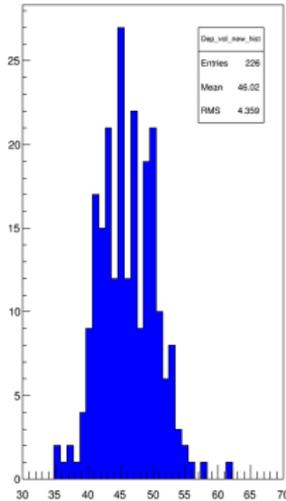
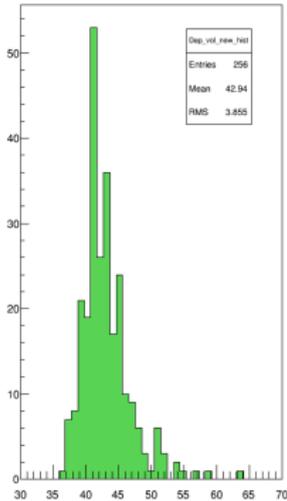
Capacitance is linearly dependant of pad number (i.e. pad size)  
and is independent of the sector or of the specific sensor  
(geometrical quality)

# Results



Current values display (roughly) the same dependance on pad number in different sensors, for a given sector

# Results



Depletion voltage of all pads lies in a rather small range of values, regardless of the specific sensor/sector/pad

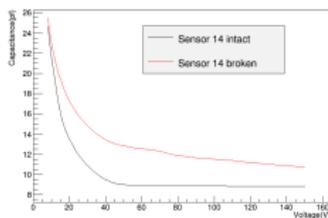
## The broken sensor



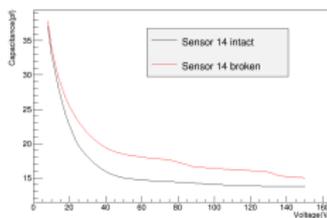
Selected intact pads were measured from both parts of the sensor

# The broken sensor - $C(V)$ measurements

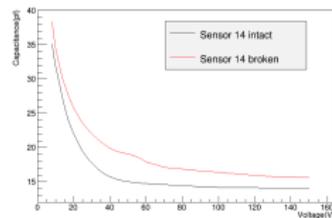
Most of the measured pads showed regular behavior, but comparison to the old measurements shows an increase in capacitance



(a) Sector L1 pad 18



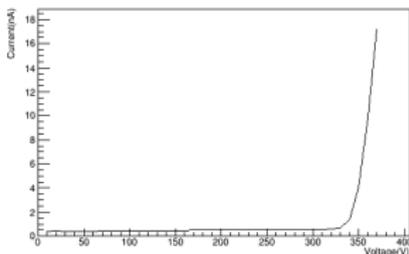
(b) Sector R2 pad 49



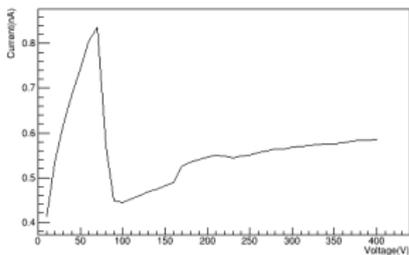
(c) Sector L2 pad 50

## The broken sensor - I(V) measurements

Many of the pads are breached and show a very large increase of current:



Some of the pads display normal behavior with an addition of a "spike" at low voltage:



Will this sensor be useful in tests for new electronic boards?

## Conclusion

- Electrical measurements of sensors are ongoing in the TAU lab
- Data collected from three different sensors suggests that behavior is rather uniform among the different sensors
- Depletion voltage of all pads is in the 40V-55V range
- Broken sensor is (obviously...) damaged, but some pads still show almost normal behavior