

IV+CV results of Rounds 5-6 LD sensors

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HGC Si characterisations at CERN



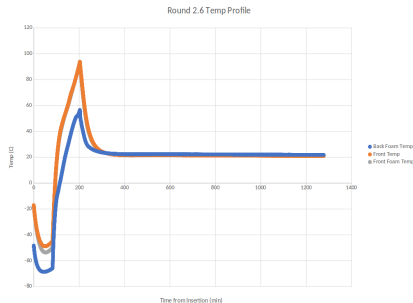
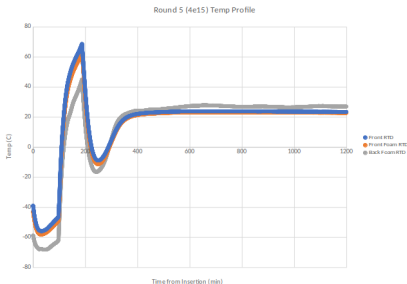
Outline

- 1 Introduction
- 2 Annealing effect on IV results
 - N4790_21
 - N4790_09
 - N4792_07
 - IV Hexplots
- 3 Annealing effect on CV Results
- 4 Temperature effect
- 5 Alpha plot
- 6 Leakage current vs. fluence behaviour
- 7 Next steps



RINSC irradiation, overview

	Round 5	Round 6
Date	19.01.2022	26.01.2022
Target fluence [neq/cm ²]	4.00E+15	5.50E+15
Annealing time in the reactor at 60 ^{°C}	16.1 min (Front: 48.8 min, Back: 9.2 min)	115.4 min (Front: 961.5 min, Back: 18.6 min)
Order (back to front)	N4790_08, N4790_09, N4790_21	N4792_09, N4790_08, N4792_20



¹ More Info about the the profiles.

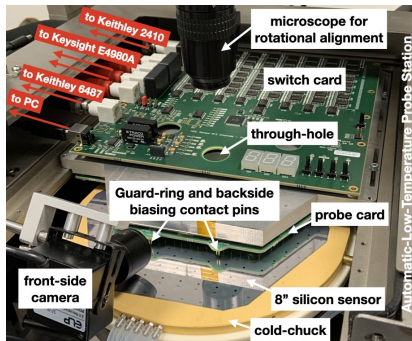
Sensor list and annealing step

sensor	annealing steps post raditation	IV grading	CV grading
N4790_09	27.6min + 31.8min	all passed	inclusive
N4790_21	10.9min + 11.7min + 11.4min + 9.6min + 11.5min + 19.9min + 11.4min + 17.2min	all passed	inclusive
N4792_7	30.9min + 31.0min	0 passed , 30 analysis not run, 60 passed	inclusive
N4790_08	no additional annealing	passed	inclusive
N4792_09	no additional annealing	passed	inclusive
N4792_20	no additional annealing	analysis not run	inclusive

Table: Annealing steps

- Sensor N4792_08 could not be located, instead the sensor N4792_07 was found in the stack

Measurement Setup: ALPS



- Sensors placed directly on chuck (no backside protection)
- Temperature: -40°C ; humidity: 4% – 8%
- Voltage provided through the HV pin to the frontside; voltage up to **-850V**
- Annealing at 60°C (chuck), target time of 115 mins
- Sensors from Round 5 were annealed to the total time of 115 min at CERN
- Sensors from Round 6 were not further annealed



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Annealing effect on IV (N4790_21)

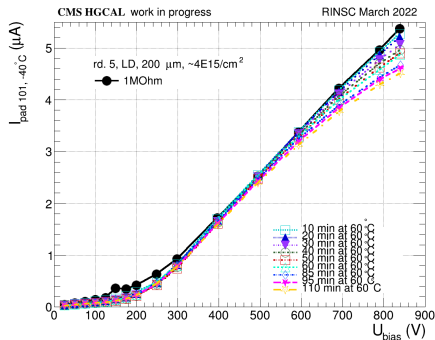


Figure: Annealing effect on IV of pad 101

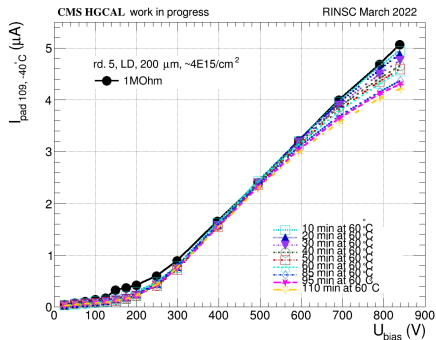
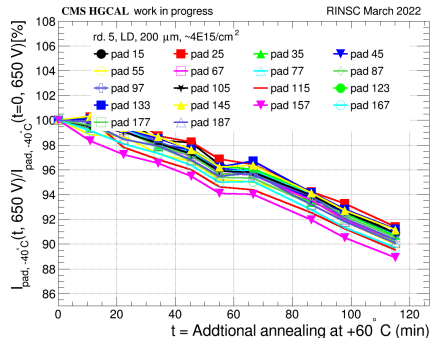
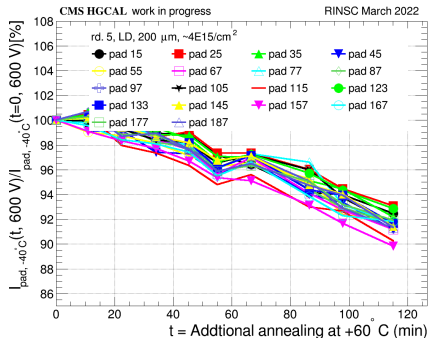


Figure: Annealing effect on IV of pad 109

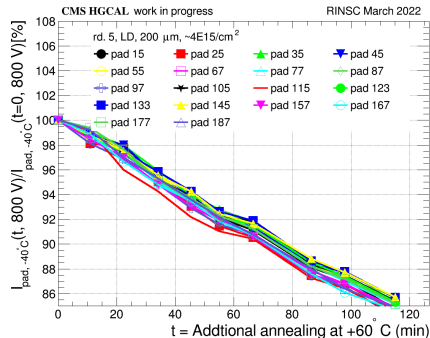
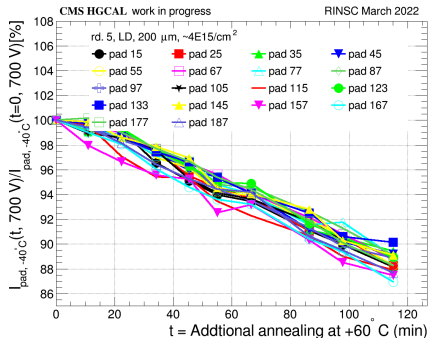
- We do see annealing effect on current
- Annealing on IV results of other channels all consistent([backup](#))



Current vs annealing time for 600V and 650V



Current vs annealing time for 700V and 800V



Annealing effect on IV results(N4790_09)

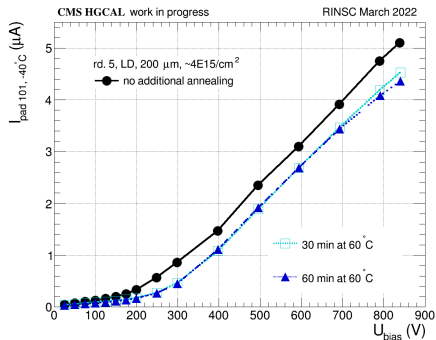


Figure: Annealing effect on IV channel 101

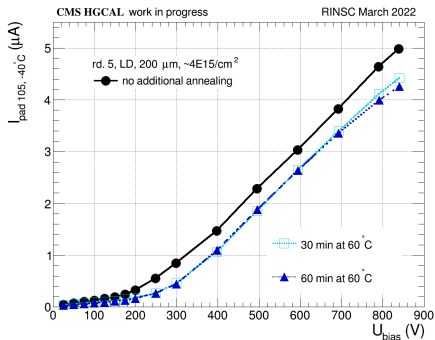
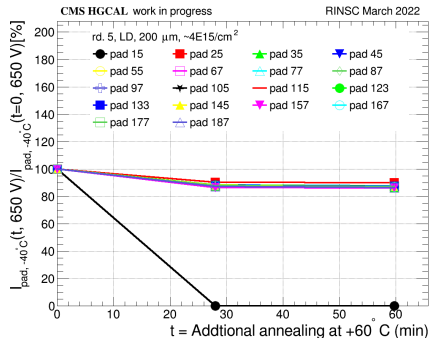
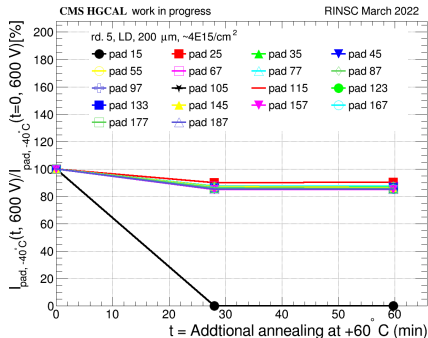


Figure: Annealing effect on IV channel 105

- Reached the limit at around 60 mins
- Other channels all have consistent plot(exceptions exist!)

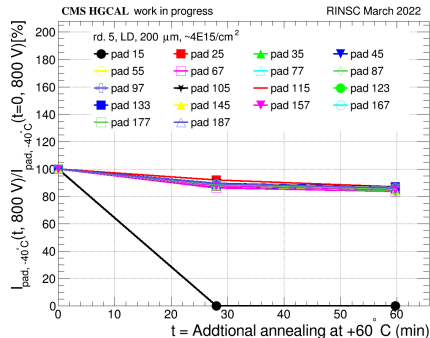
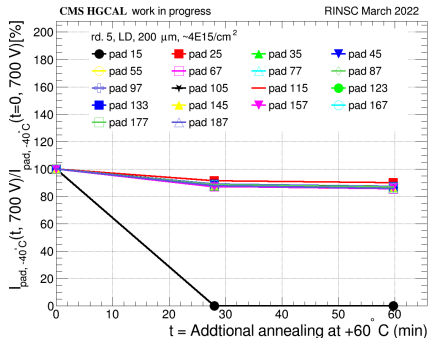
Current vs annealing time for 600V and 650V



- Channel 15 seems to be masked at 30 and 60 annealing measurement
- Only drawing 18 channels, there could be more abnormal channels like 15
- Need to further investigate this



Current vs annealing time for 700V and 800V



Annealing effect on IV channel 15

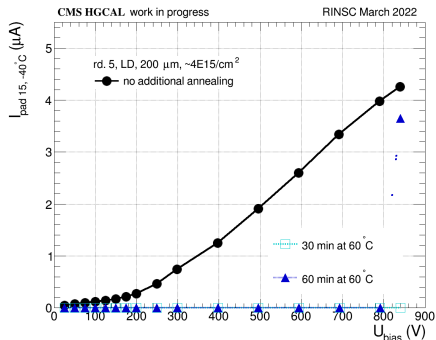


Figure: Annealing effect on IV channel 15

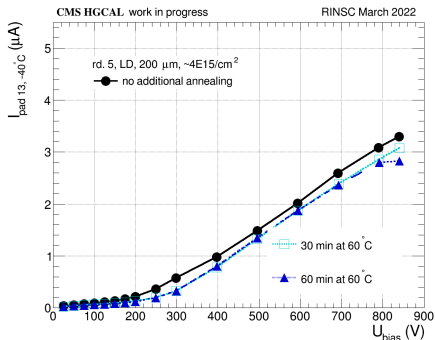


Figure: Annealing effect on IV channel 13

Annealing effect on IV results(N4792_07)

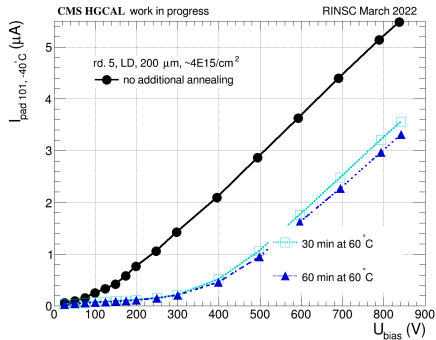


Figure: Annealing effect on IV channel 101

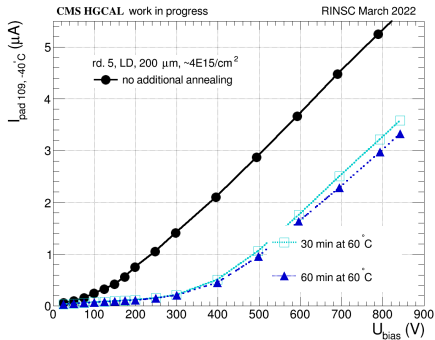
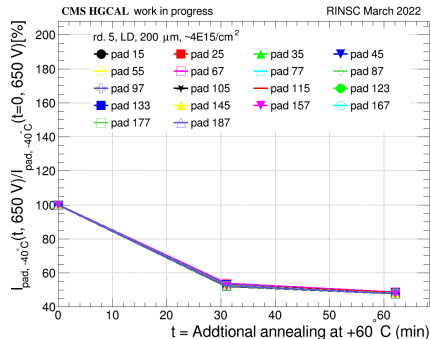
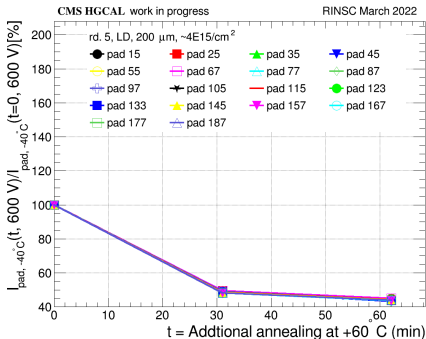


Figure: Annealing effect on IV channel 109

- Current drop is significantly higher than for other sensors
- Maybe reached the limit at around 60 mins
- Other channels all have consistent plot



Current vs annealing time for 600V and 650V



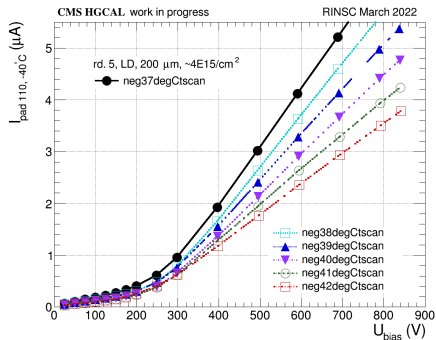
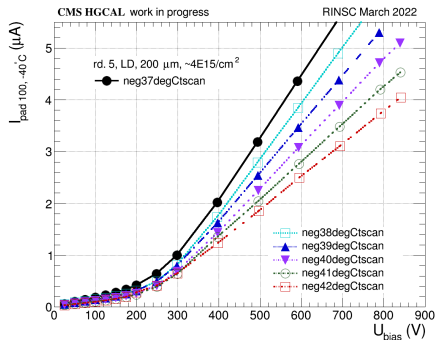
● seems too good?

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Temperation effect on IV measurement



IV HexPlots

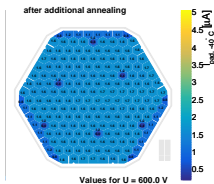


Figure: Round5, N4792_7

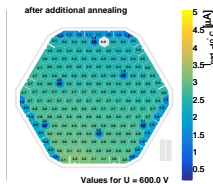


Figure: Round5, N4790_09

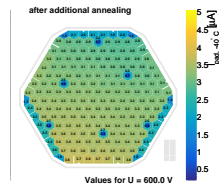


Figure: Round5, N4790_21

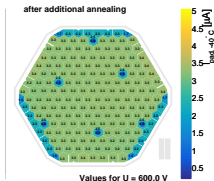


Figure: Round6, N4792_09

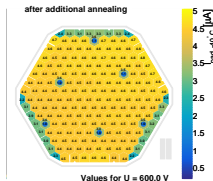


Figure: Round6, N4790_8

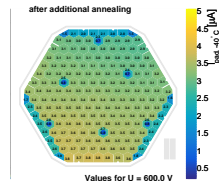


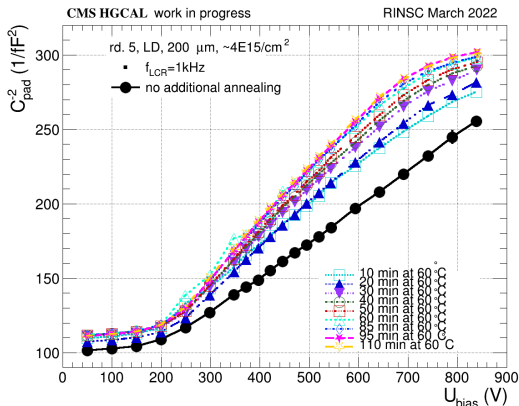
Figure: Round6, N4792_20

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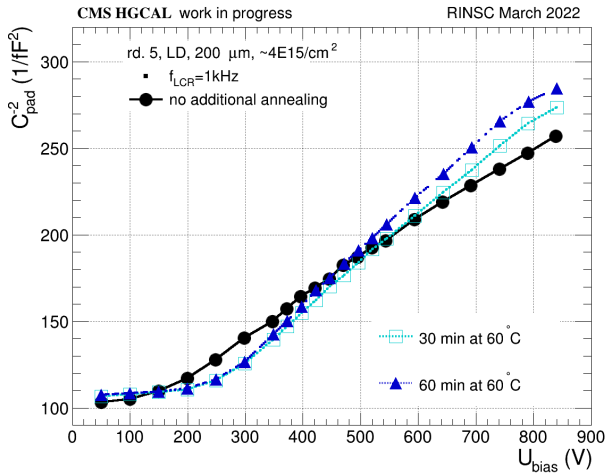
CV results, N4790_21



- We do see annealing effects
- Reached the limit of reversed annealing at around 60 min
- Depletion voltage not reached



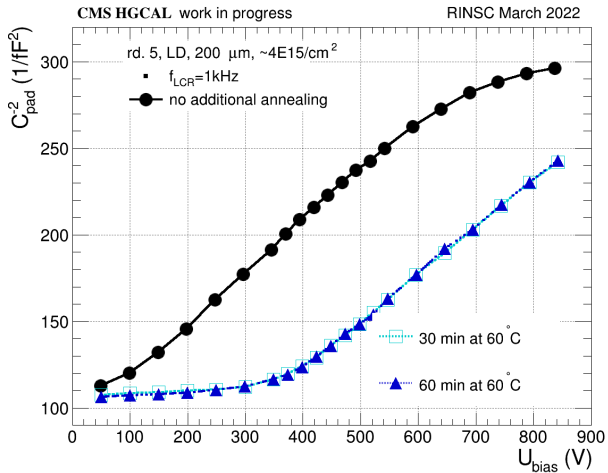
CV results, N4790_09



● CV curves



CV results, N4792_07



● CV curves



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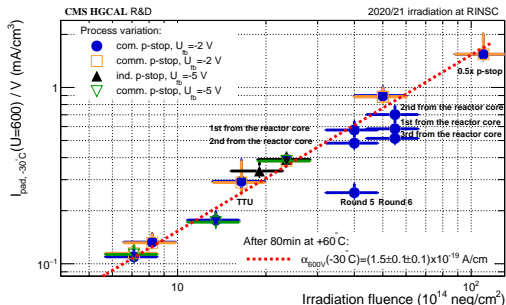


Outline

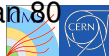
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Proto-A: example CV results



- Round 5 and 6 sensors in general follow the current damage rate from previous campaigns
- Round 5 the sensor N4792_7 seems to have received more annealing during the irradiation
- Round 6 has probably been annealed significantly more than 80 mins (values for the other sensors)



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Summary

- Clarify the irradiation setup with Nick to better understand the annealing during the irradiation
- Measure and analyze Round 7 & 8 sensors



Backup slides



RINSC irradiation, Round 5

RINSC irradiation round	Target fluence (neg/cm ²)	Sensor ID	Scratch pad ID	Oxide type	Thickness	P-stop	Current location	Pre-irrad. IV+CV Institute	Estimated arrival date at Brown	Irradiation date at RINSC (one per week)	Irradiation status (Done/scheduled)	Wafer location from reactor core (1st, 2nd, 3rd)	Puck material
5	4.00E+15	N4792_08	200094	C	200	com	CERN	FSU	18/1/22	19/1/22	Done	3	
5	4.00E+15	N4790_09	200077	B	200	com	CERN	FSU	18/1/22	19/1/22	Done	2	PEEK
5	4.00E+15	N4790_21	200083	D	200	com	CERN	FSU	18/1/22	19/1/22	Done	1	

Figure: Round 5, sensors, N4792_7 instead of N4792_8

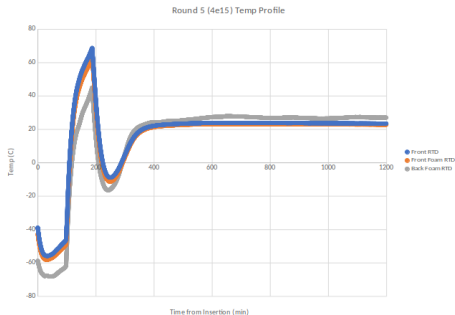


Figure: Round 5, temperature profile



RINSC irradiation, Round 6

RINSC irradi. round	Target fluence [neg/cm ²]	Sensor ID	Scratch pad ID	Oxide type	Thickness	P-stop	Current location	Pre-irrad. IV+CV institute	Estimated arrival date at Brown	Irradiation date at RINSC (one per week)	Irradiation status (Done/ scheduled)	Wafer location from reactor core (1st, 2nd, 3rd)	Puck material
6	5.50E+15	N4790_08	200076	B	200	com	CERN	FSU	18/1/22	26/1/22	Done	2	PEEK
6	5.50E+15	N4792_09	200095	C	200	com	CERN	FSU	18/1/22	26/1/22	Done	3	
6	5.50E+15	N4790_20	200082	D	200	com	CERN	FSU	18/1/22	26/1/22	Done	1	

Figure: Round 6, sensors

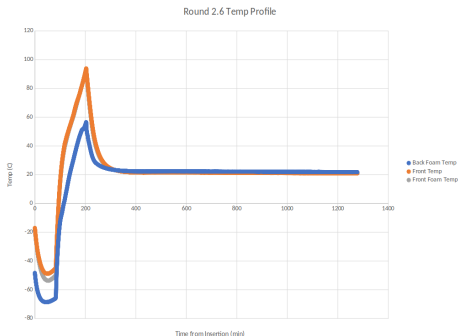


Figure: Round 6 temperature profile