Update in the DEPFET vertex detector for a future linear e+ e- collider

L. Andricek[1]
J. Dingfelder[3]
I. Garcia[2]
C. Lacasta[2]
C. Marinas[3]
D. Markus[3]
M.A. Villarejo[2]
M. Vos[2]

CLIC Detector and Collaboration Meeting
10-11 June 2014
CERN

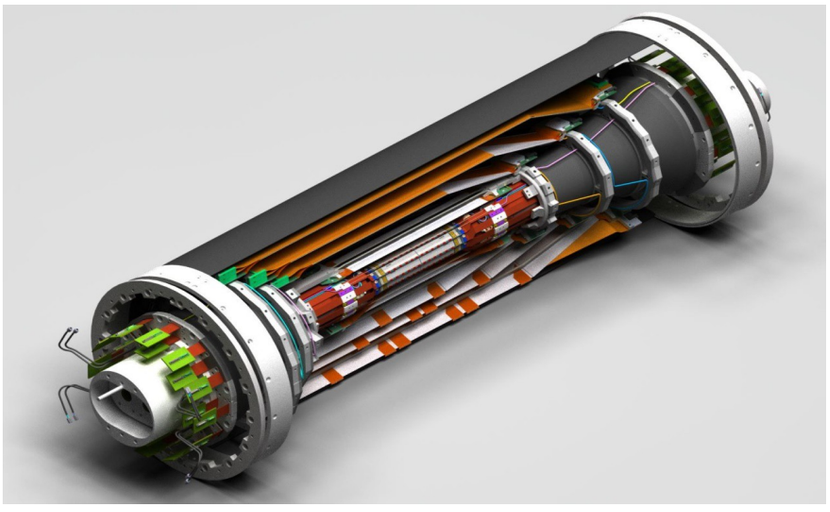
[1] MPG Semiconductor Lab
[2] IFIC- Valencia
[3] University of Bonn

Summary

- 0. DEPFET Overview
- 1. DEPFET Ladder cooling strategy
  - 1.1 Power Pulsing
  - 1.2 Microchannel cooling
- 2. DEPFET Petals status and future work
- 3. Conclusions

0. DEPFET Overview

- One of the candidates for LC vertex detector because
- Currently used in the Belle-II
- Detector requeriments:



	Belle II	ILC
Occupancy	0.4 hits/μm²/s	0.13 hits/μm²/s
Radiation	2 Mrad/year	< 100 krad/year
	$2 \cdot 10^{12}$ 1 MeV n_{eq} per year	10^{11} 1 MeV n_{eq} per year
Duty cycle	1	1/200
Frame time	20 μs	25-100 μs
Momentum range	Low momentum (< 1 GeV)	All momenta
Acceptance	17°-155°	6°-174°
Material budget	0.21% X_0 per layer	0.12% X_0 per layer
Resolution	15 μm (50x75 μm²)	5 μm (20x20 μm²)

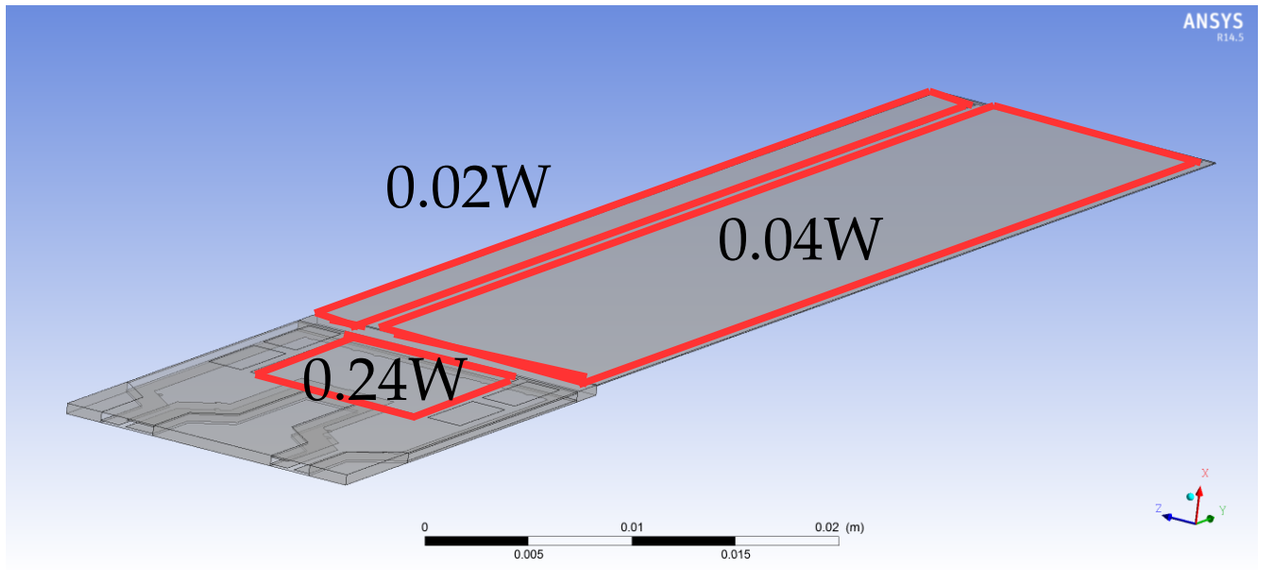
Real challenge

http://arxiv.org/pdf/1212.2160.pdf
http://digital.csic.es/handle/10261/64311

1.1 DEPFET Ladder Cooling Strategy: Power Pulsing

Advantages:

- Less power dissipation
- Cooling could be not necessary (natural convection with air)
- Lower material respect to microchannel cooling

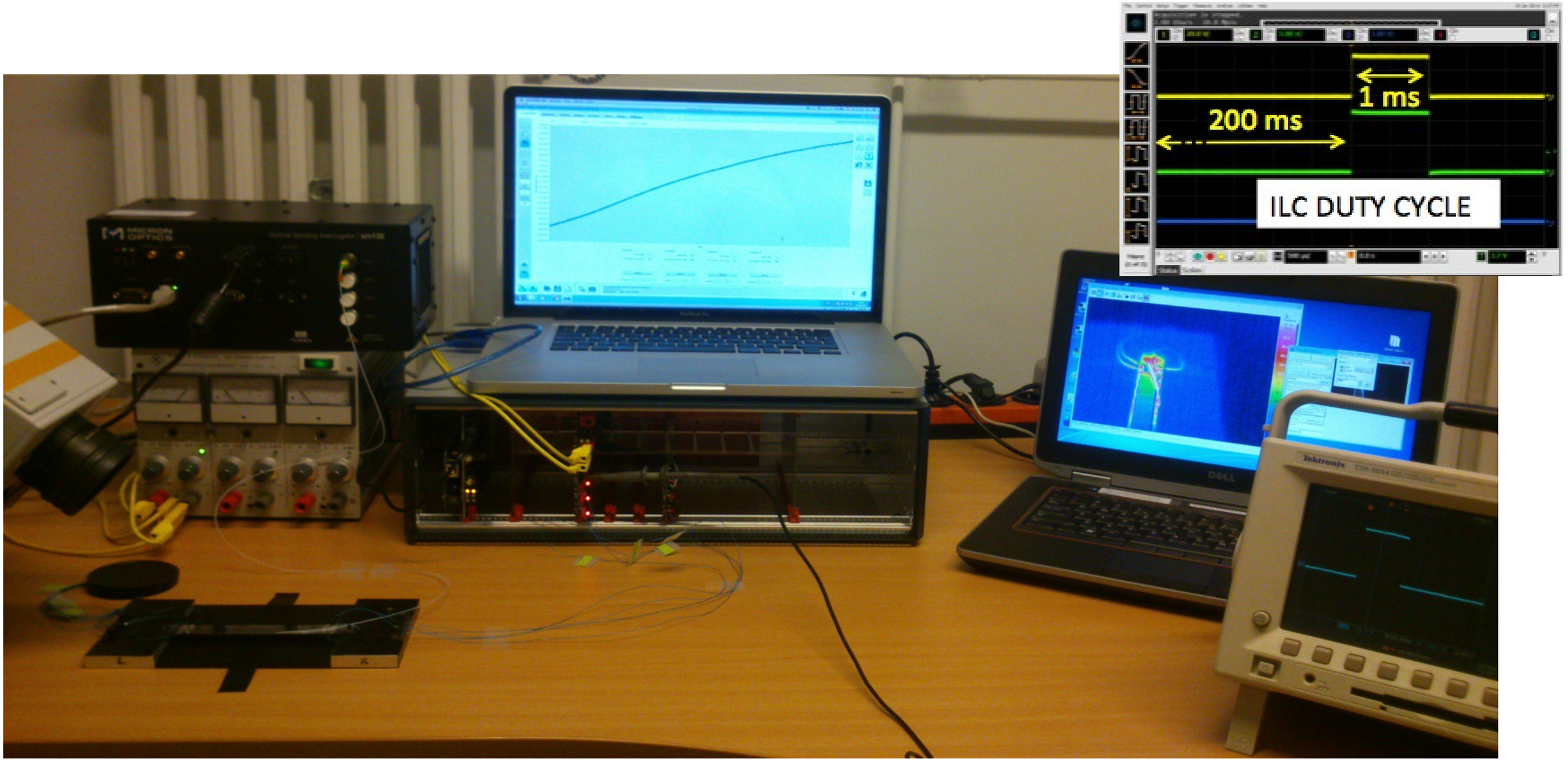


Disadvantages:

- Complex setup
- Higher possibility failure

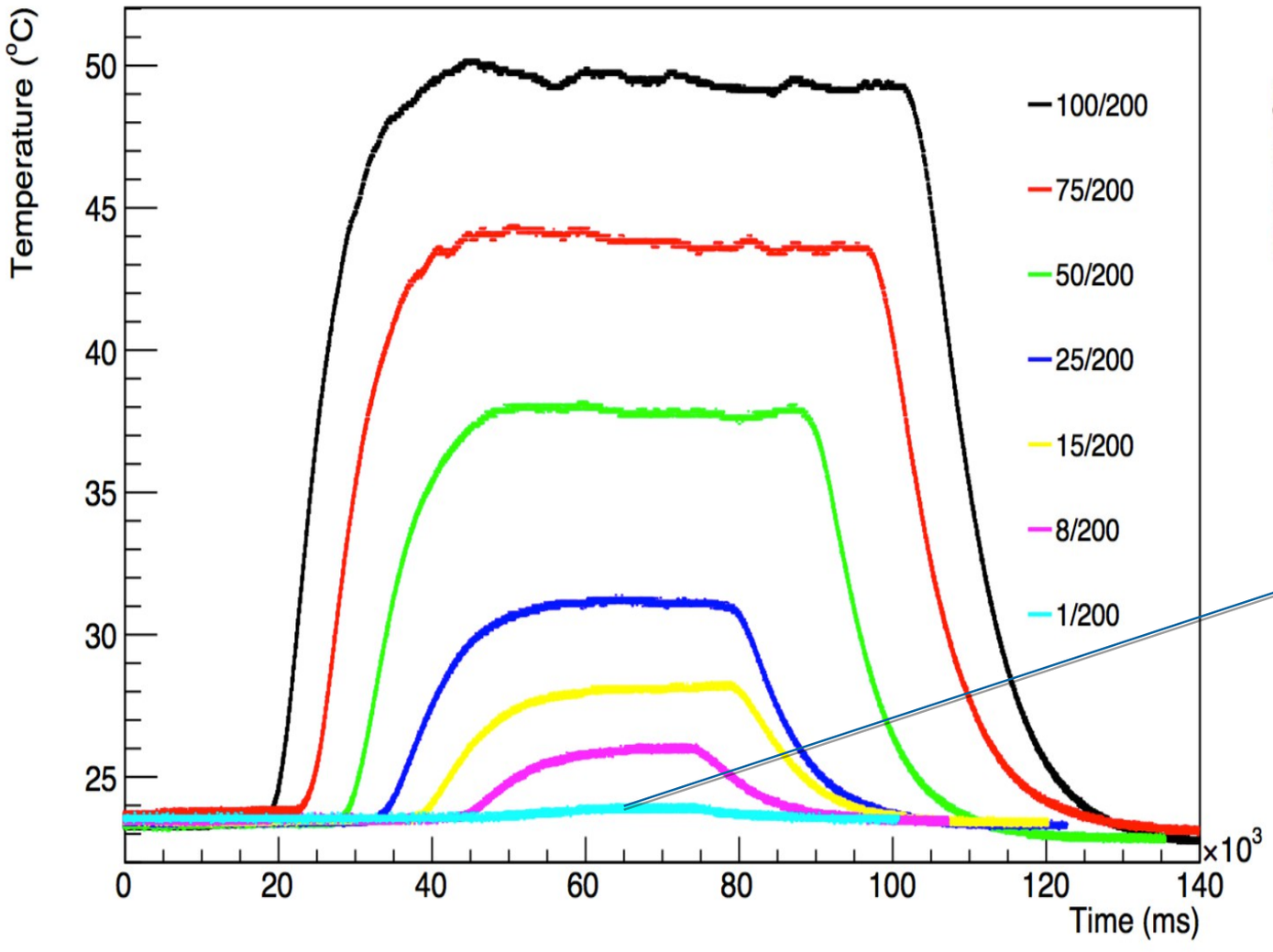
1.1 DEPFET Ladder Cooling Strategy: Power Pulsing

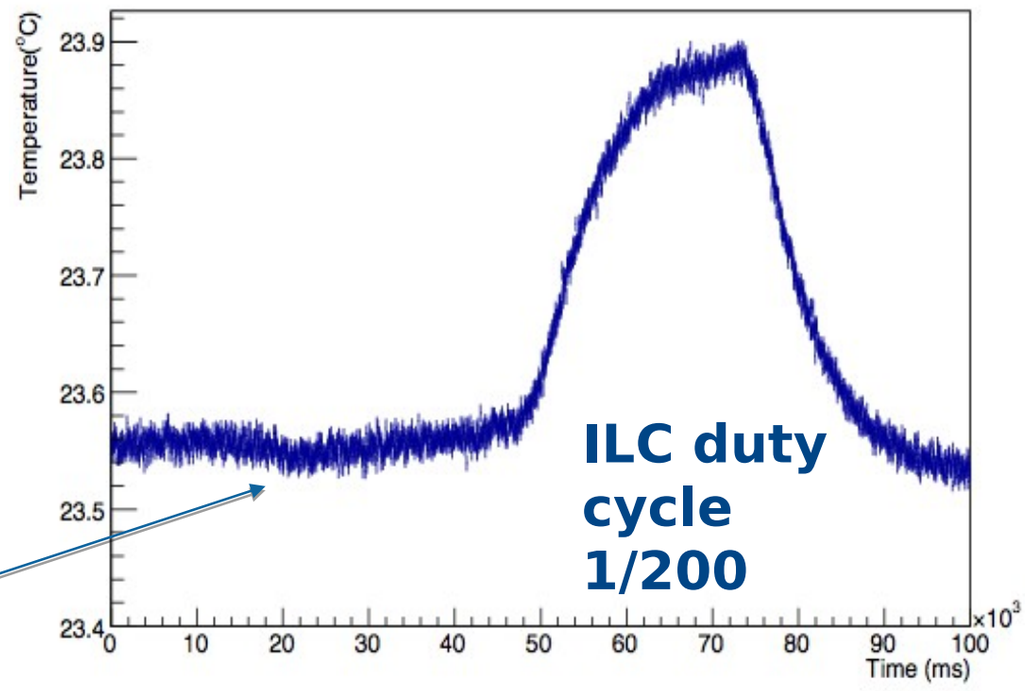
Tests made: Power Pulsing Thermal tests



1.1 DEPFET Ladder Cooling Strategy: Power Pulsing

Tests made: Power Pulsing Thermal tests





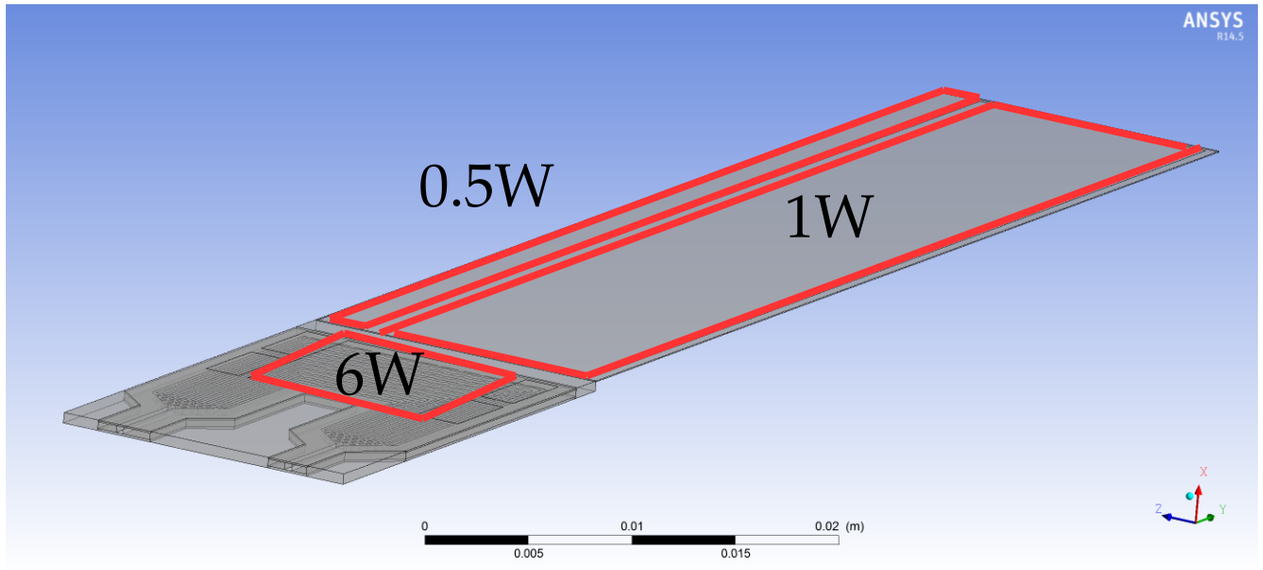
1.2 DEPFET Ladder Cooling Strategy: Microchannel cooling

Advantages:

- Detectors operating full-time
- Technologically easier
- Constant T-> better alignment

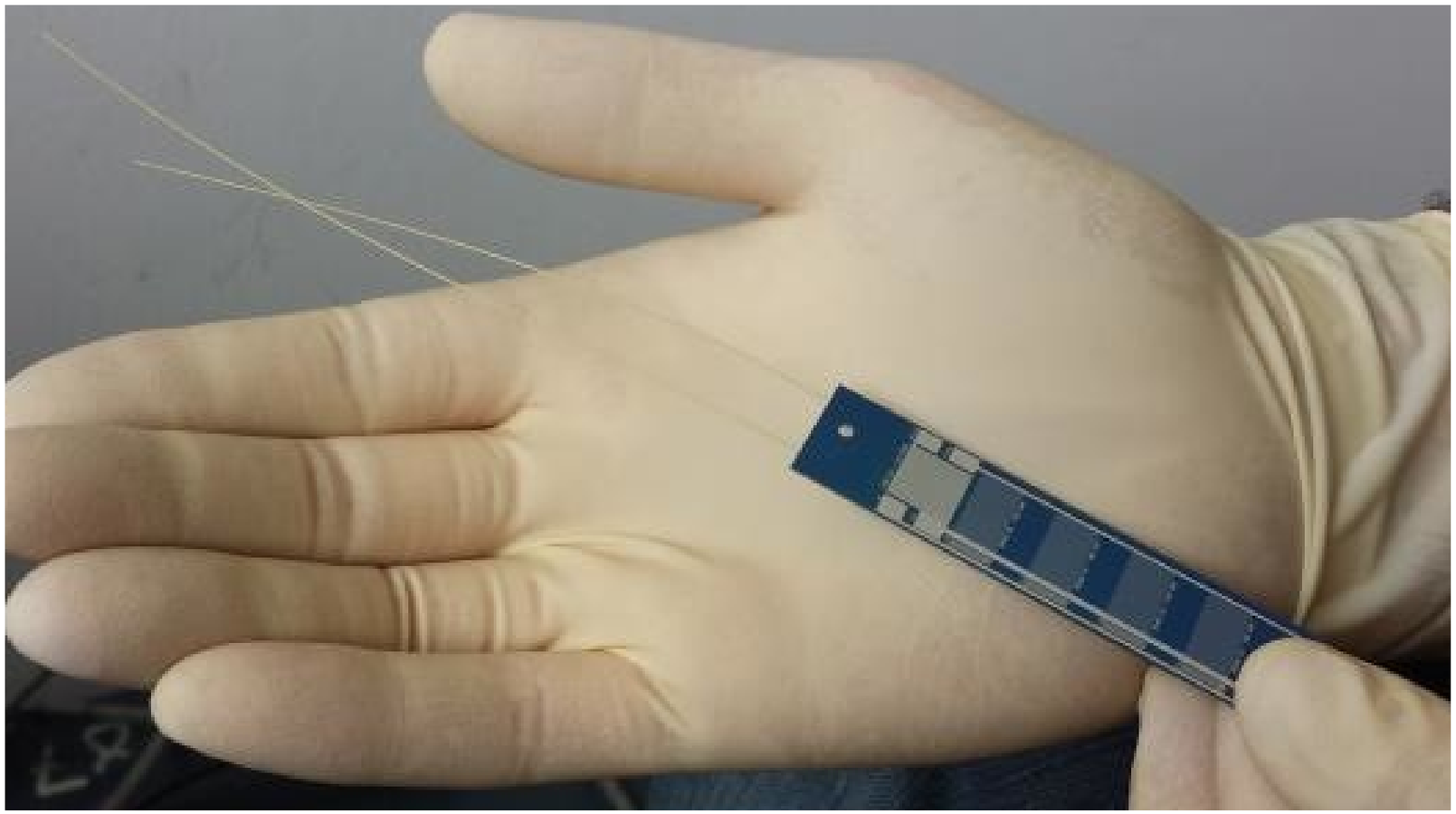
Disadvantages:

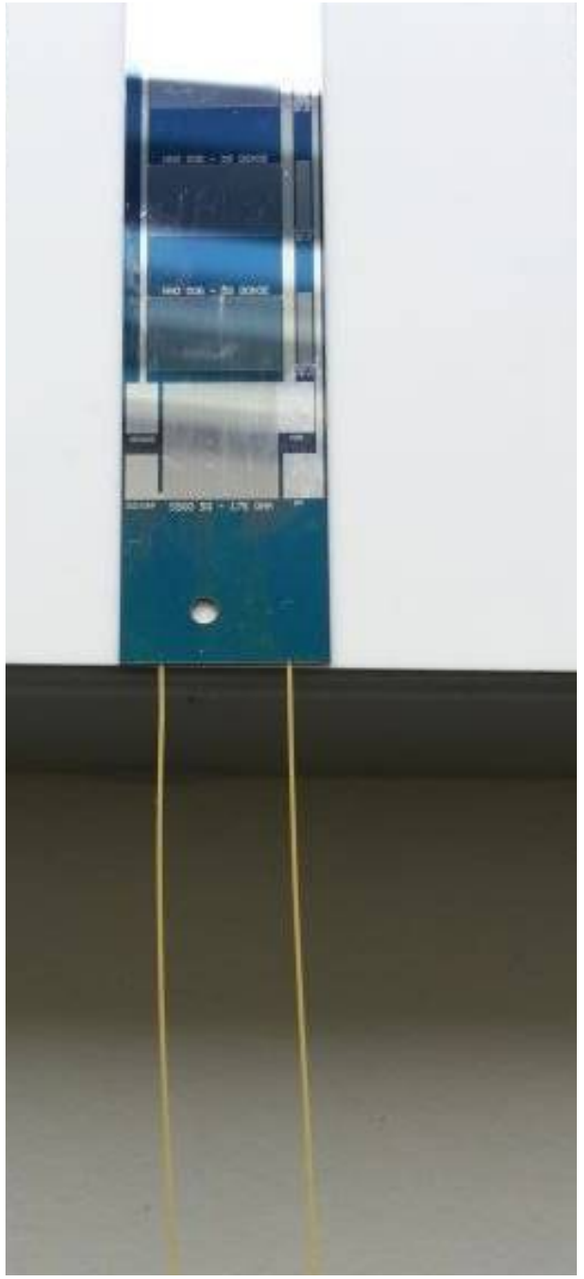
- Increase of the material budget
- Criogenics



1.2 DEPFET Ladder Cooling Strategy: Microchannel cooling

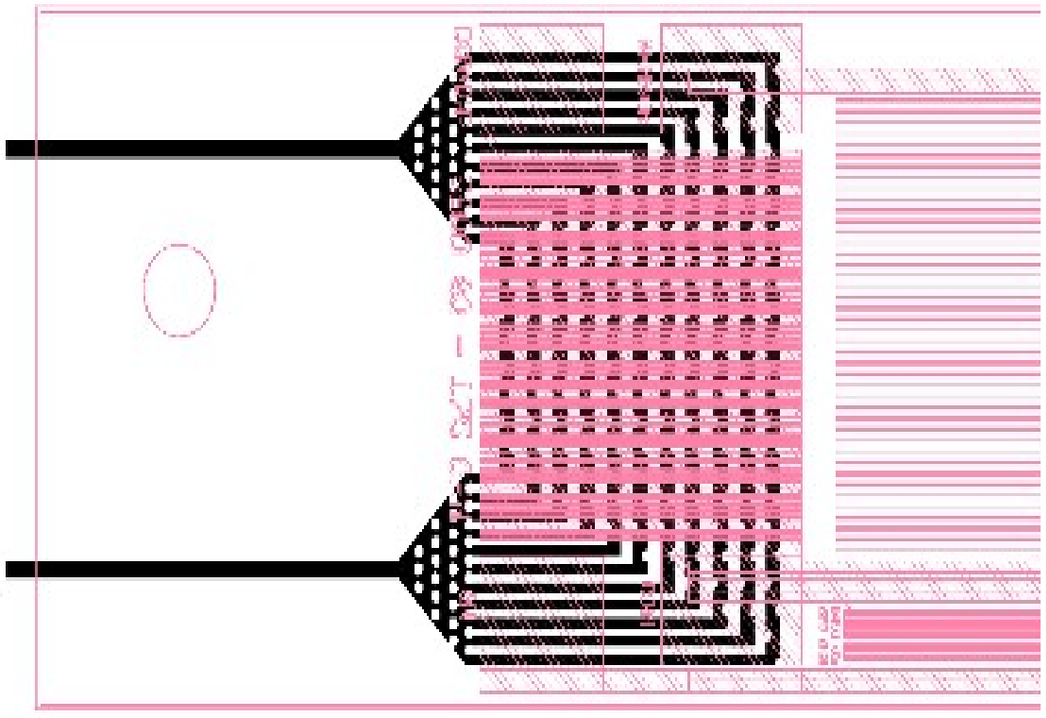
Tests made: water cooling



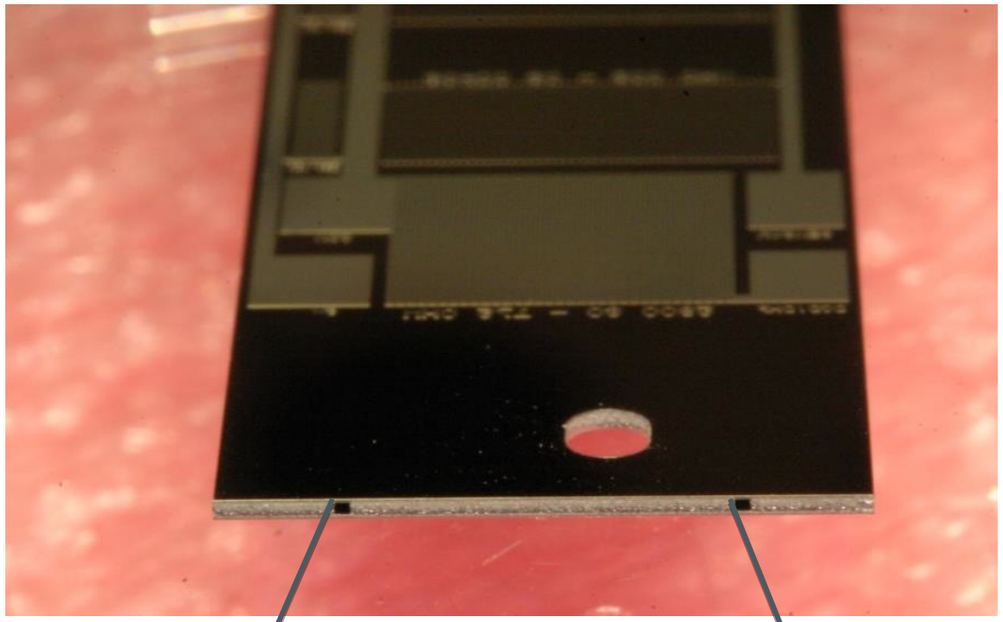


1.2 DEPFET Ladder Cooling Strategy: Microchannel cooling

Tests made: water cooling

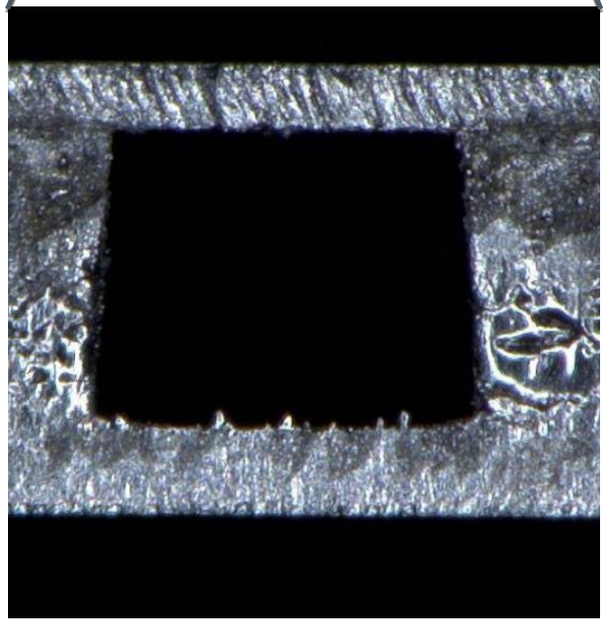


4mm



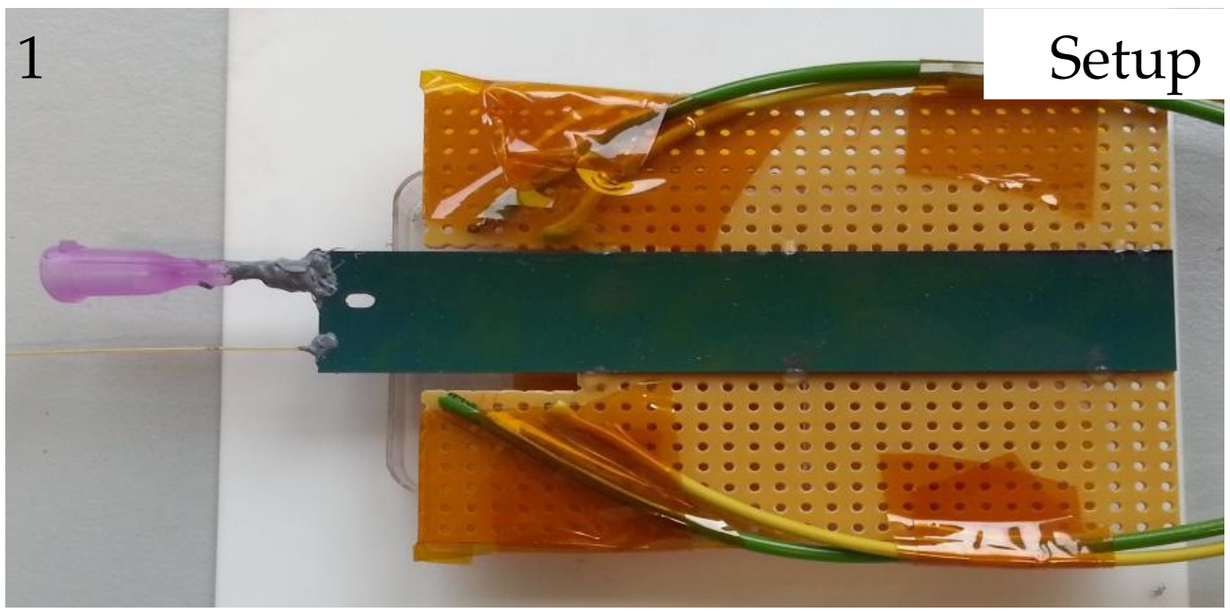
340µm

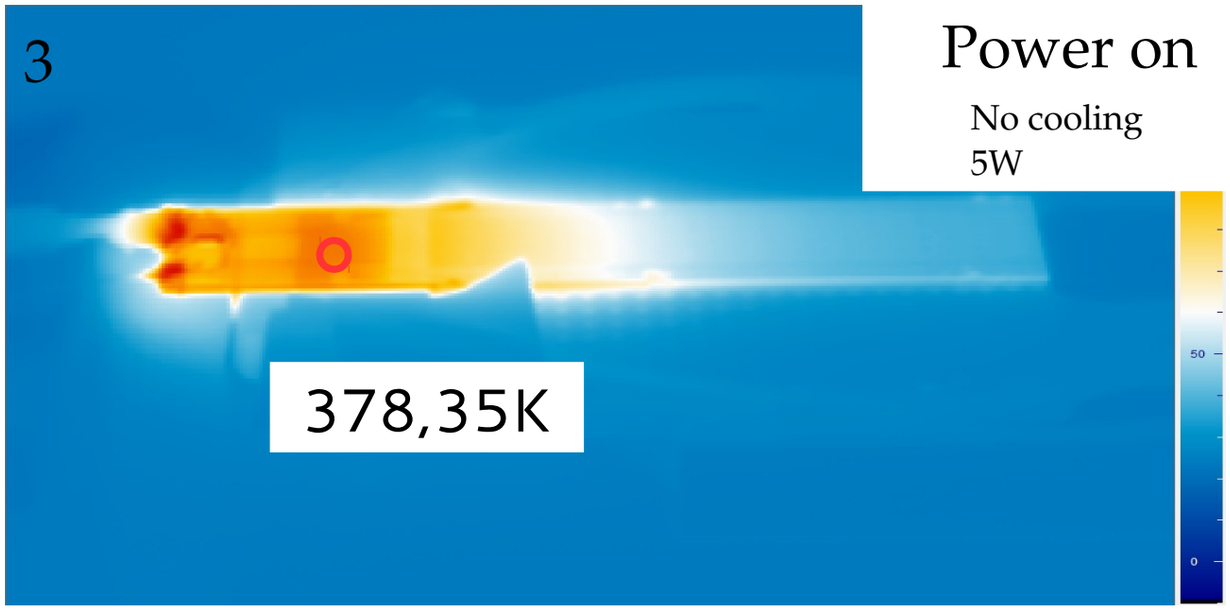
380µm

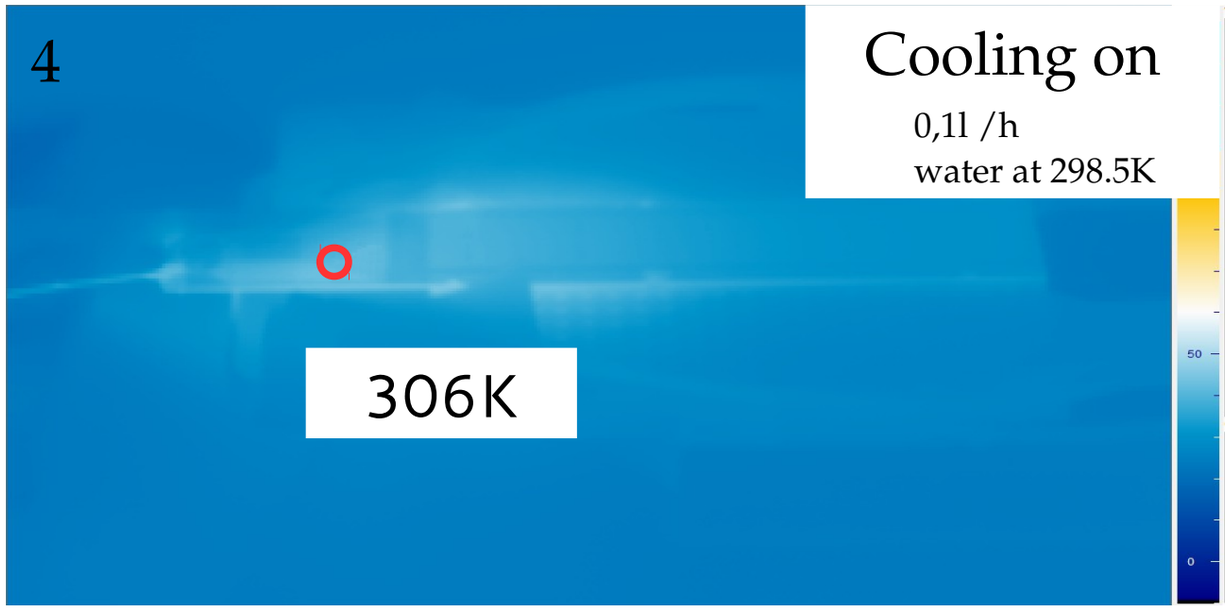


1.2 DEPFET Ladder Cooling Strategy: Microchannel cooling

Tests made: water cooling

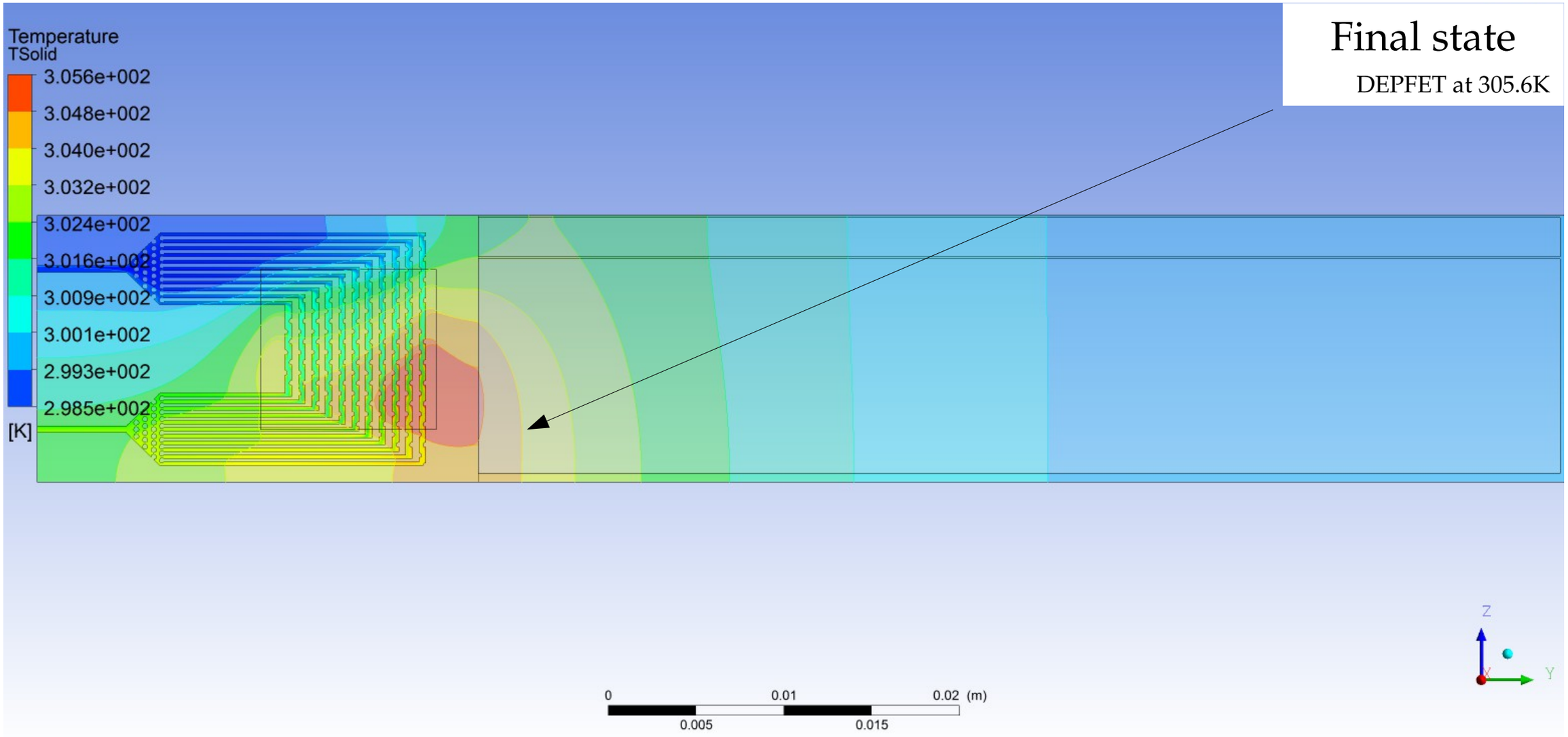






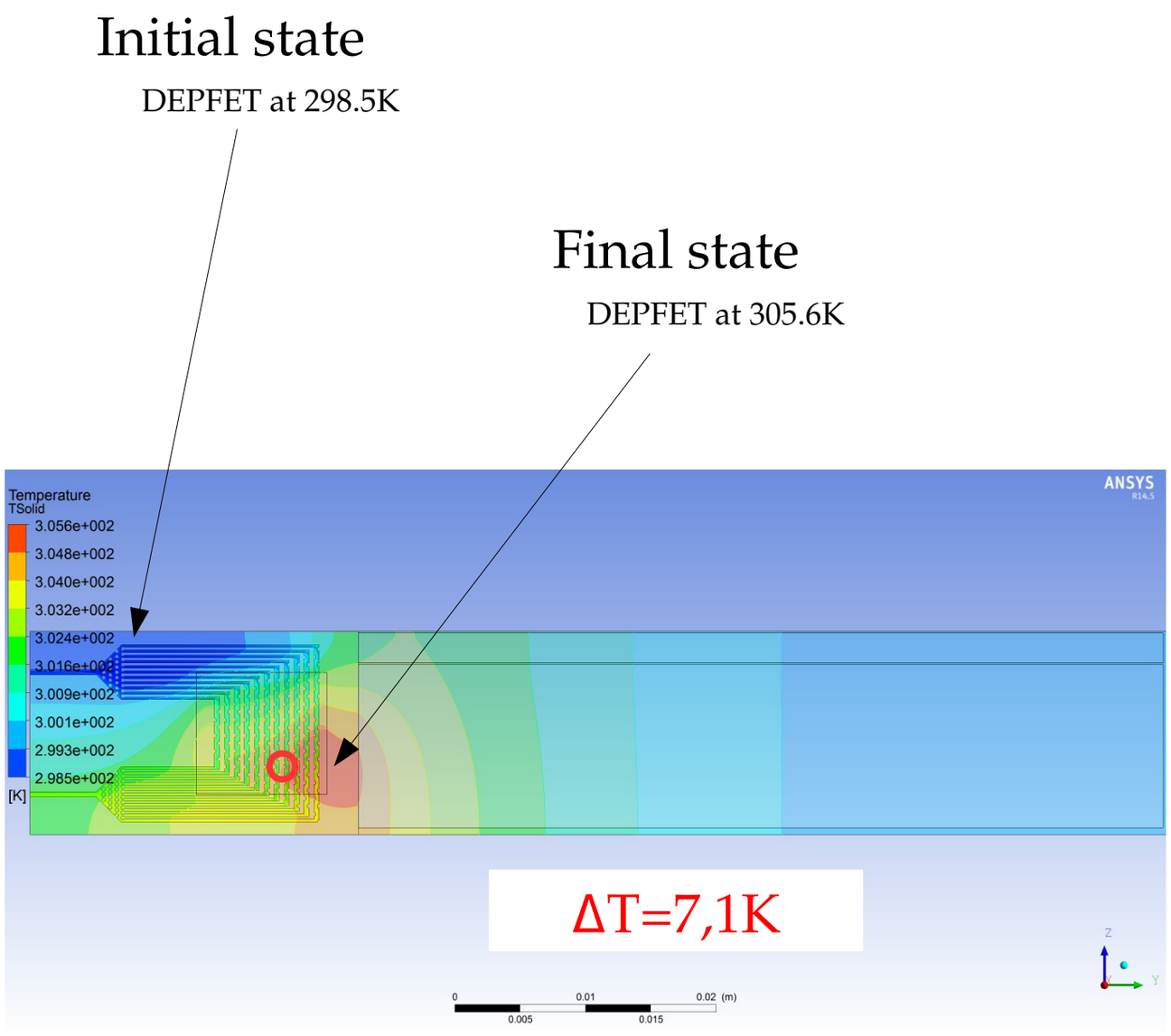
1.2 DEPFET Ladder Cooling Strategy: Microchannel cooling

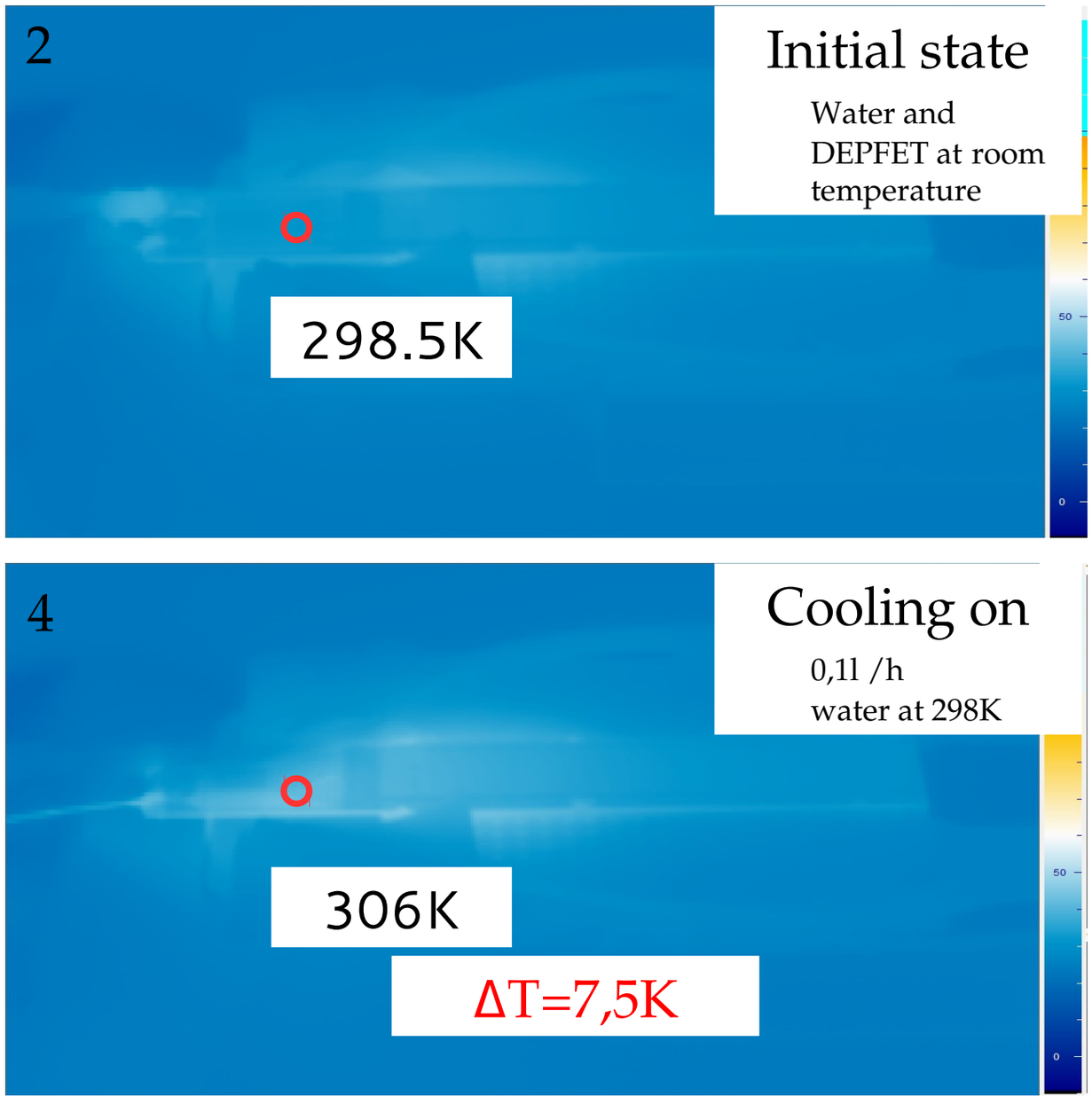
Tests made: water cooling



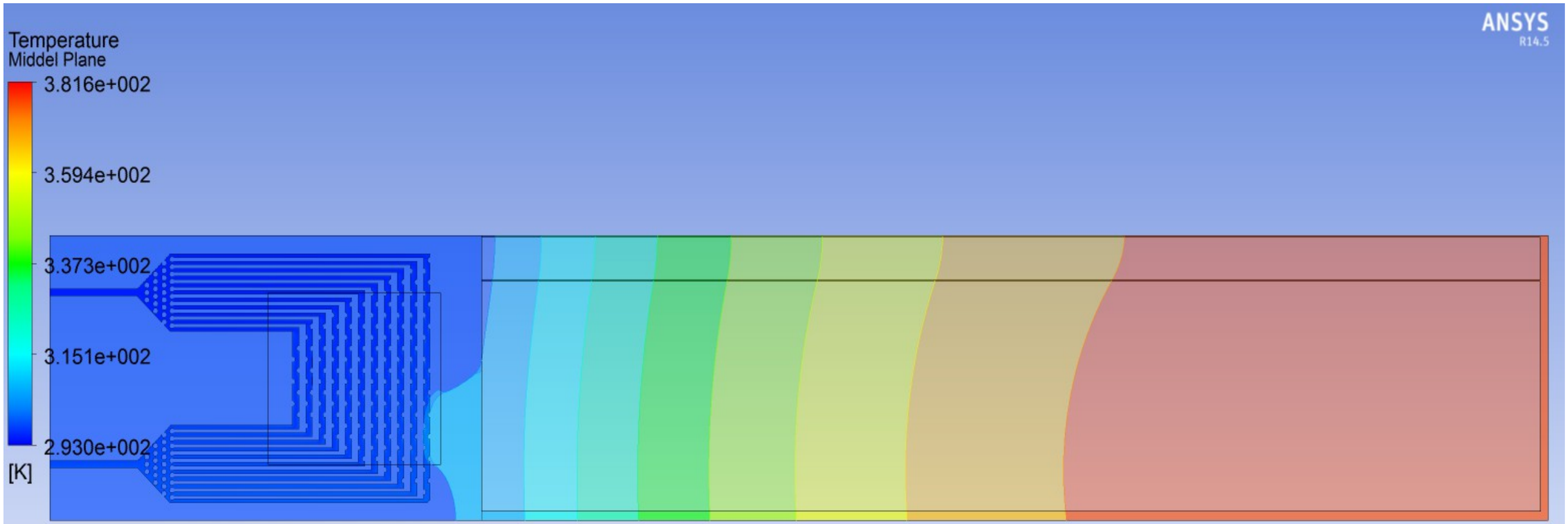
1.2 DEPFET Ladder Cooling Strategy: Microchannel cooling

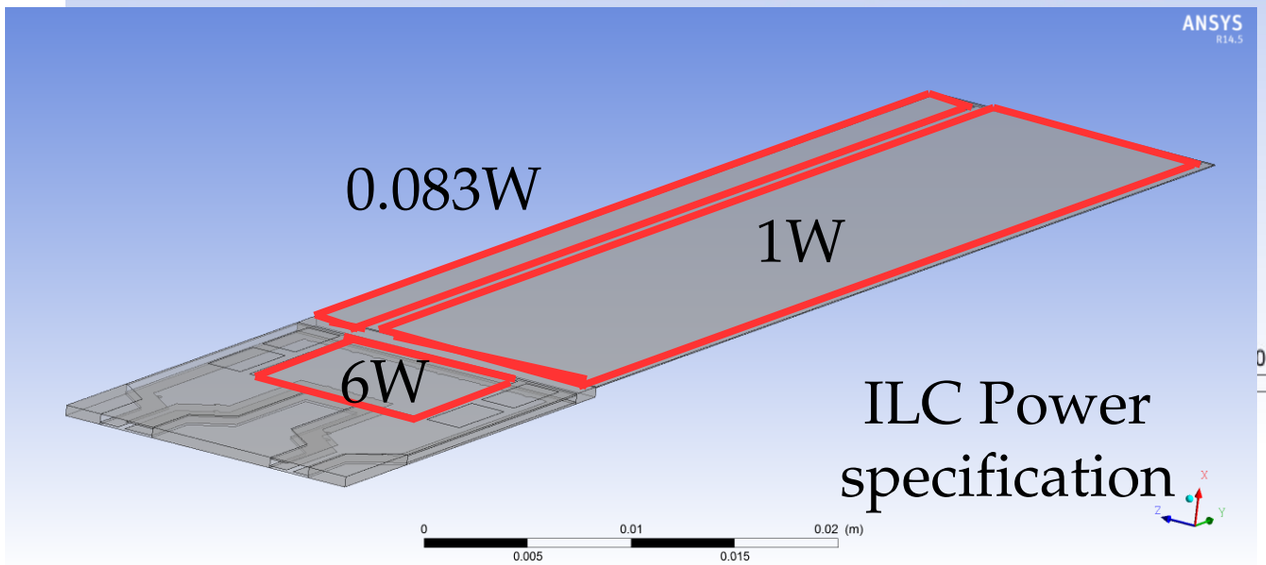
Tests made: water cooling



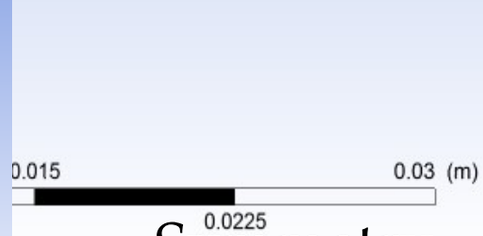


1.2 DEPFET Ladder Cooling Strategy: Microchannel cooling



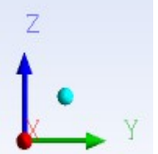


ILC Power specification

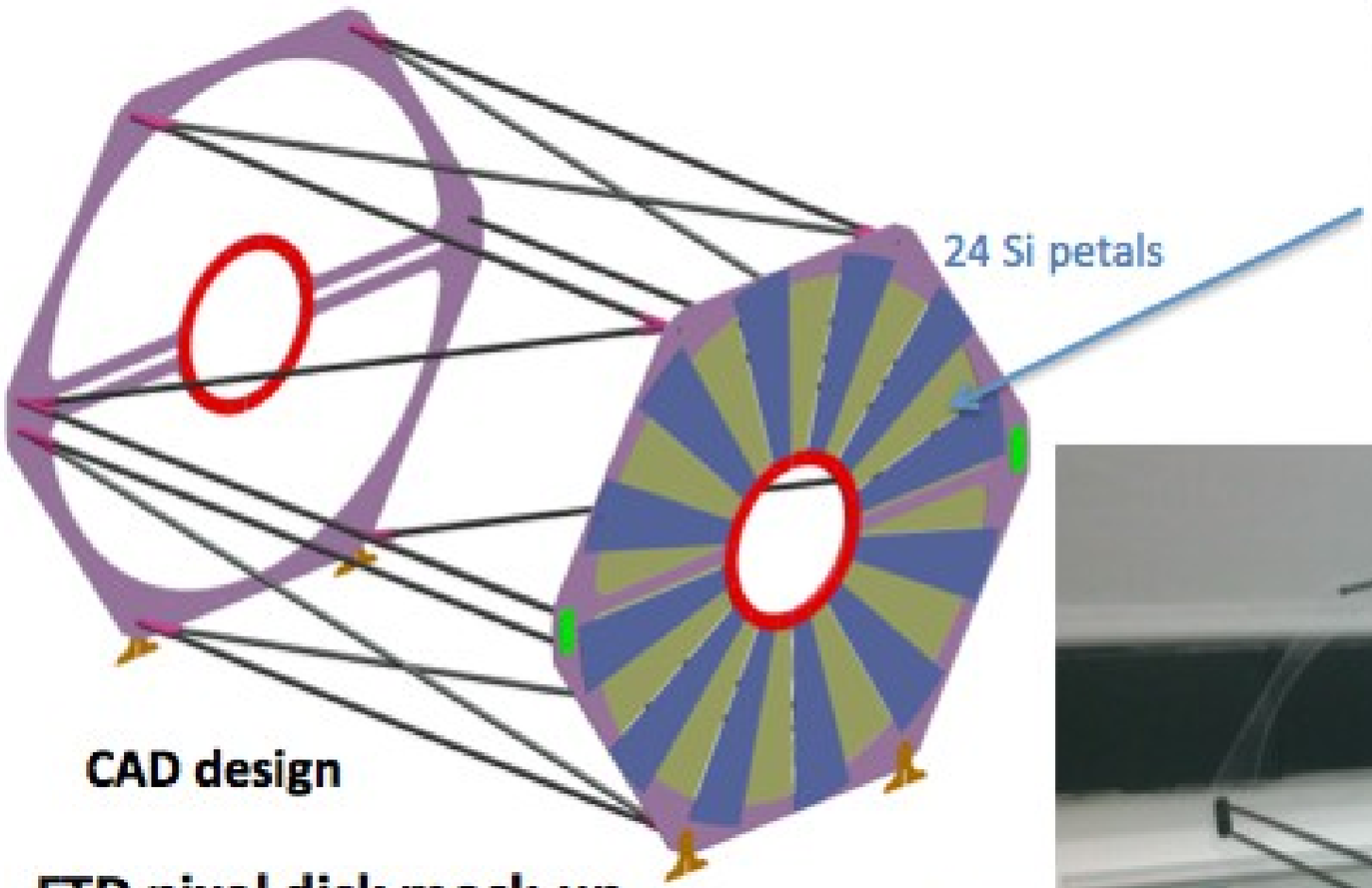


Symmetry

Radiation effects not simulated



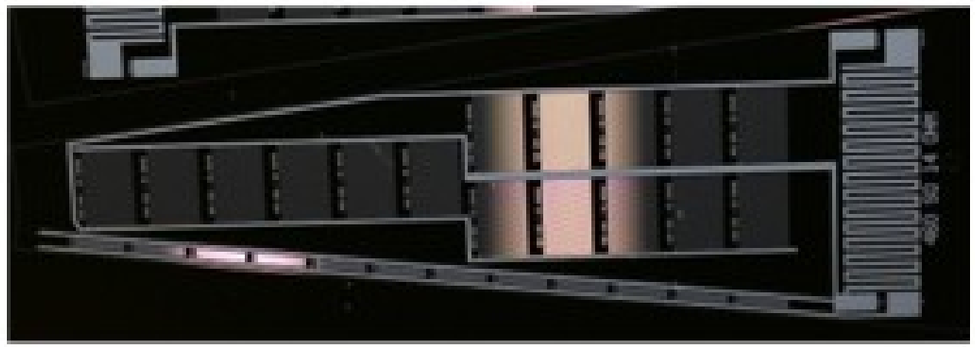
2.DEPFET Petals status and future work



CAD design

FTD pixel disk mock-up

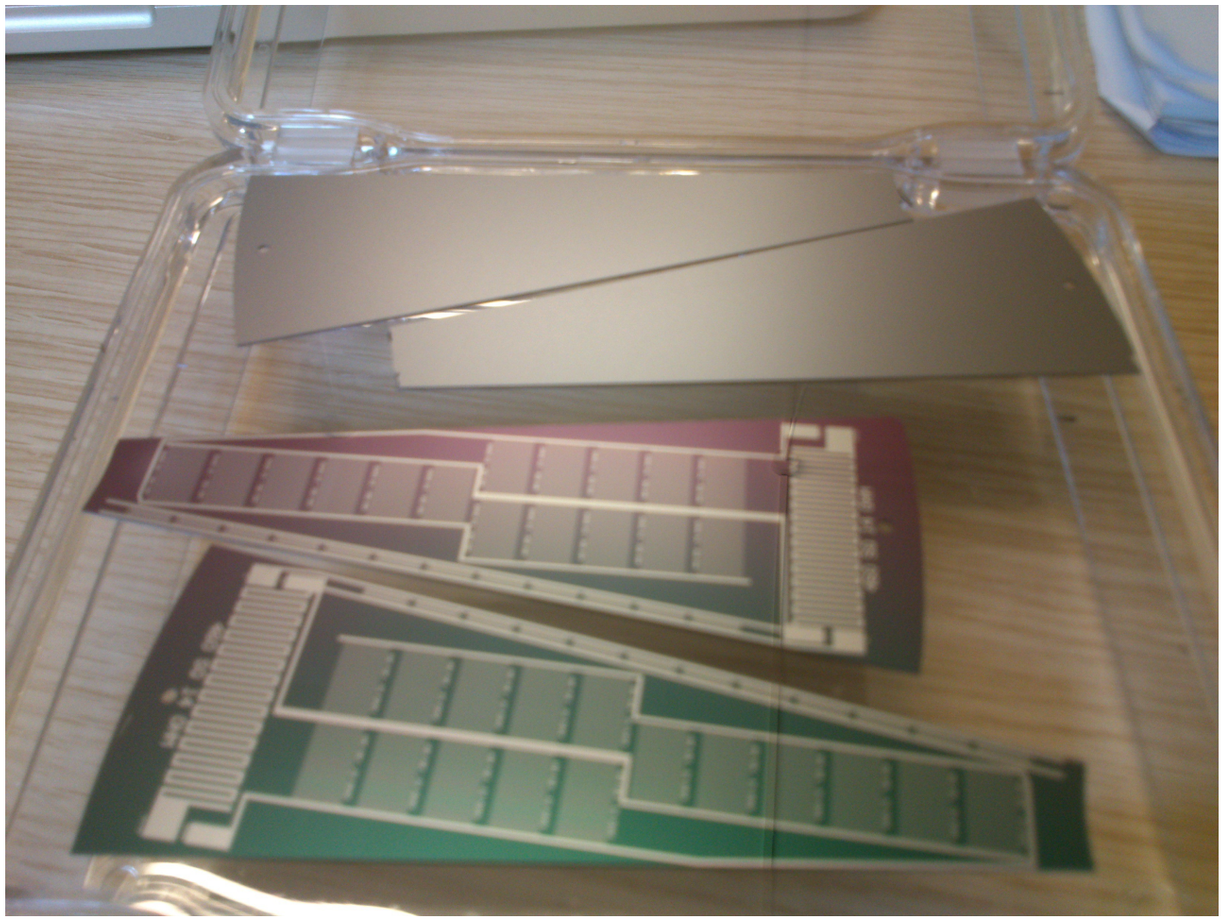
- DEPFET mechanical petals
  - 75 um Silicon (< 0.2% X0)
- Support disks
  - 1mm (0.09% X0 avg. area)
- CF connection tubes
- custom 3D printed joints

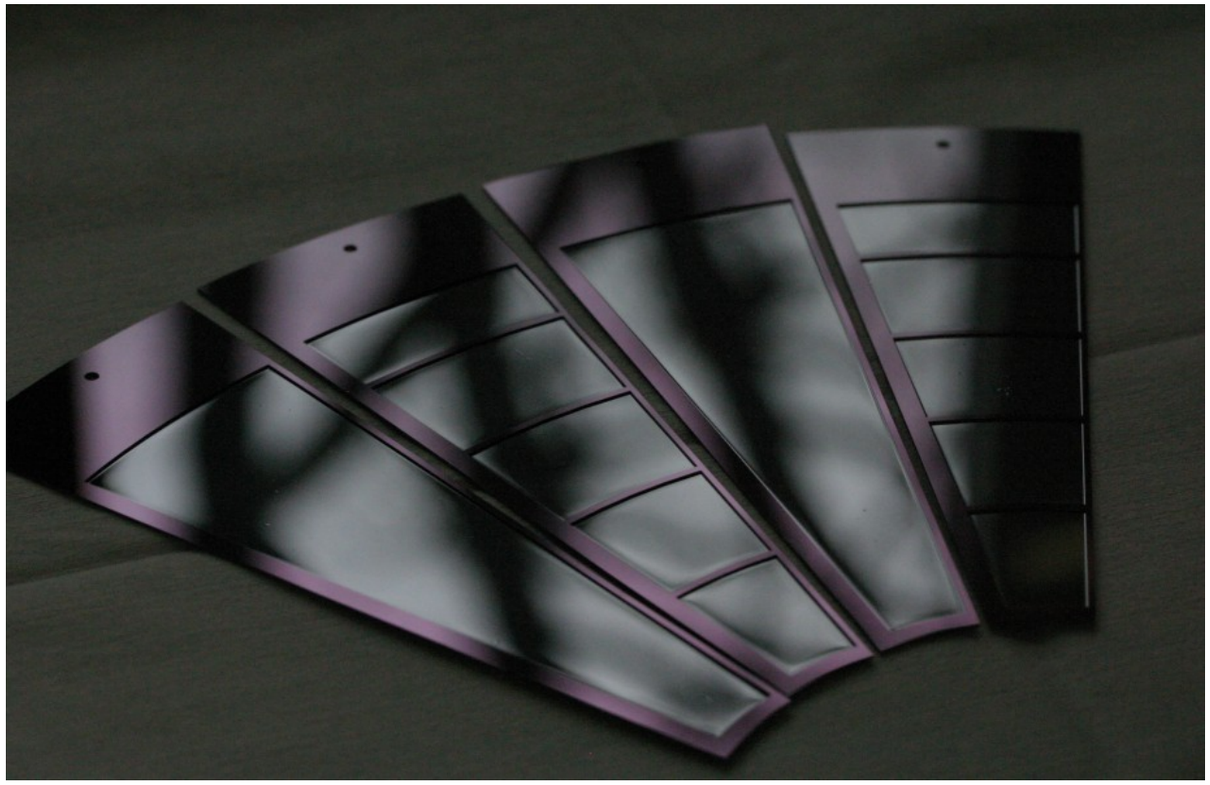


Mechanical support structure

2.DEPFET Petals status and future work

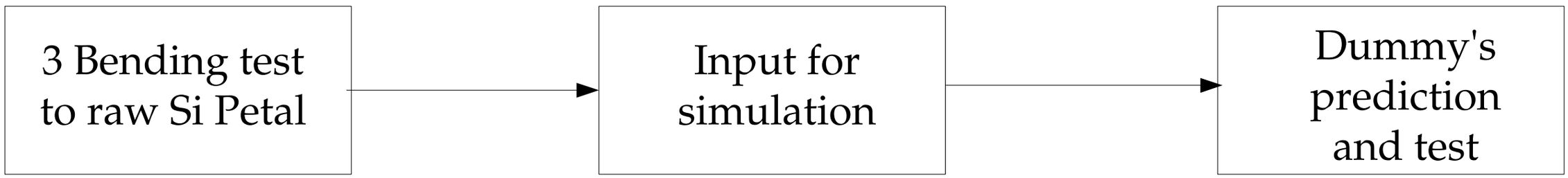
Tests made: dummy's characterization

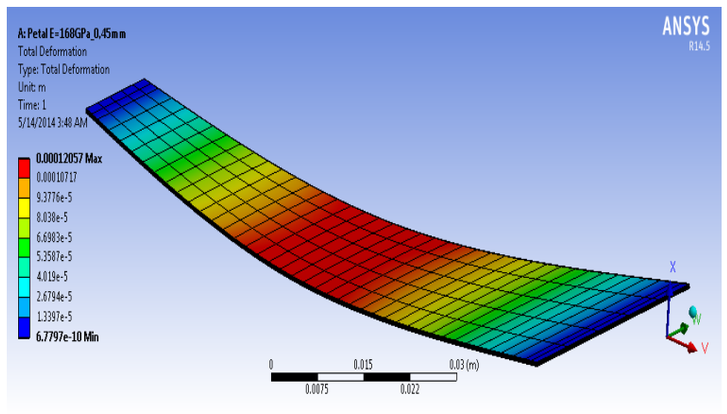


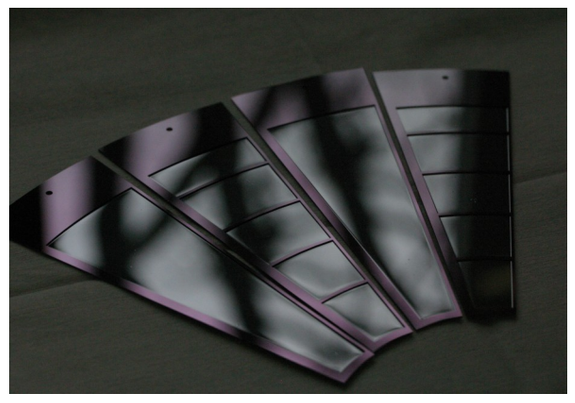


2.DEPFET Petals status and future work

Tests made: dummy's characterization

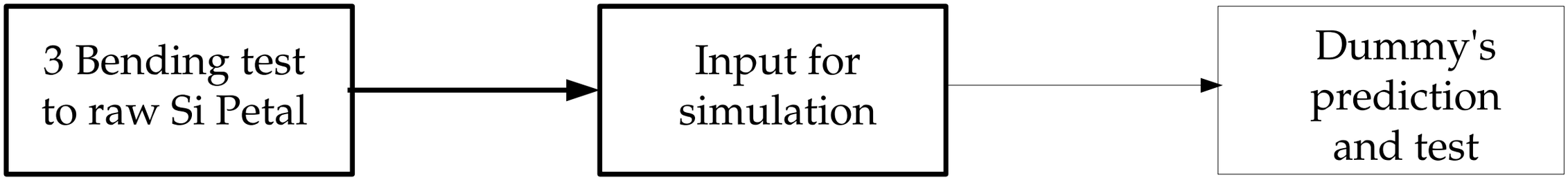


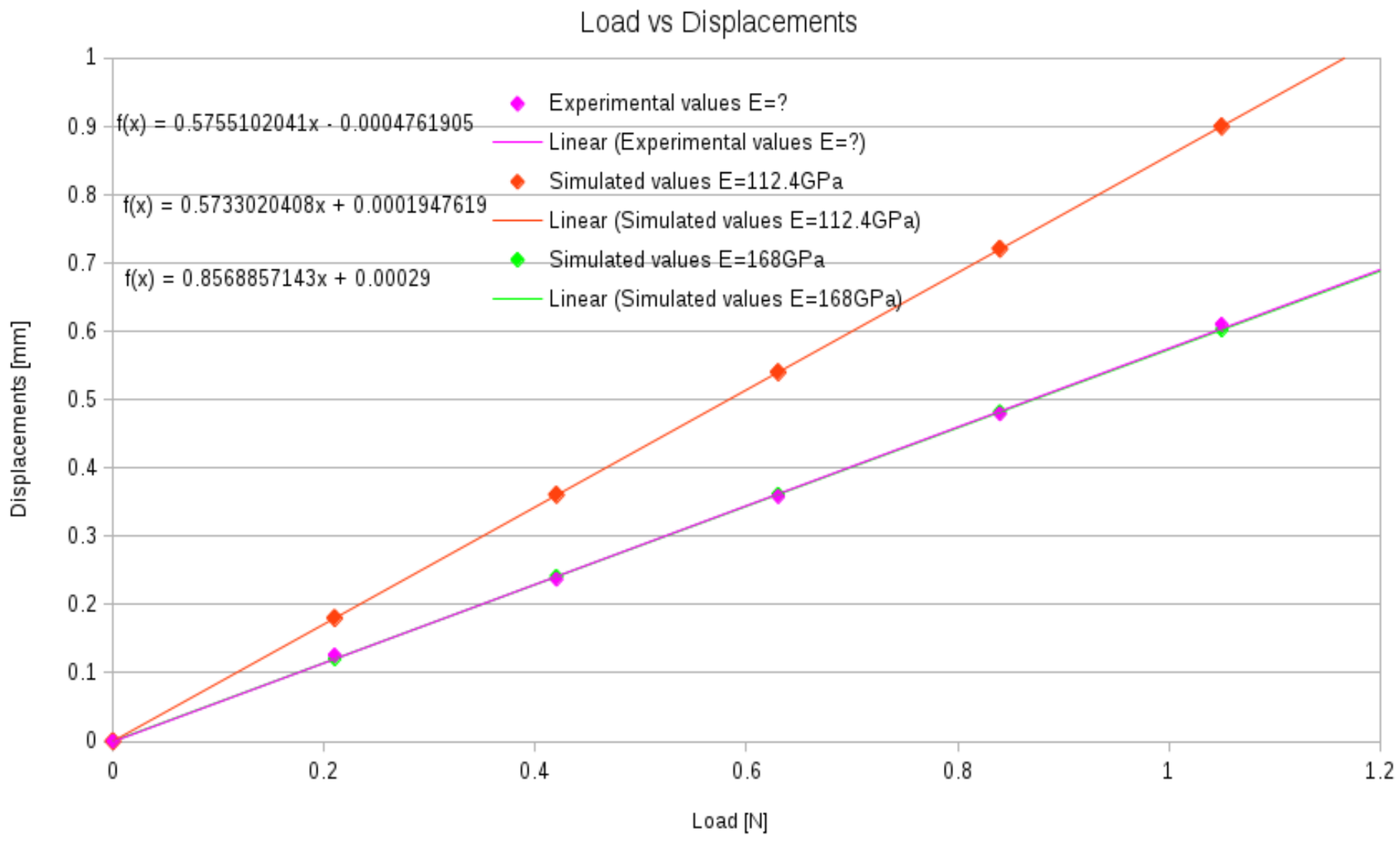




2.DEPFET Petals status and future work

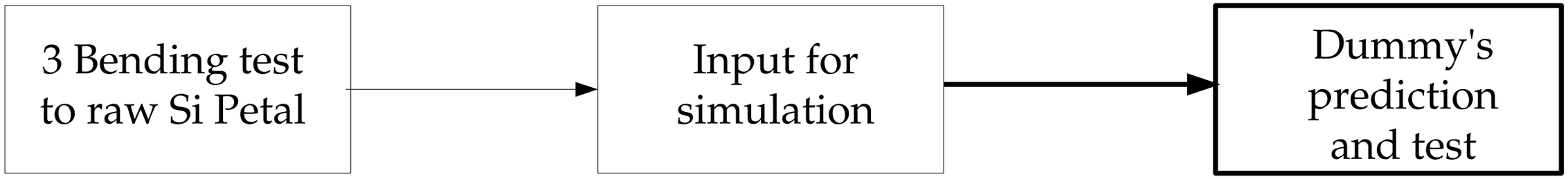
Tests made: dummy's characterization

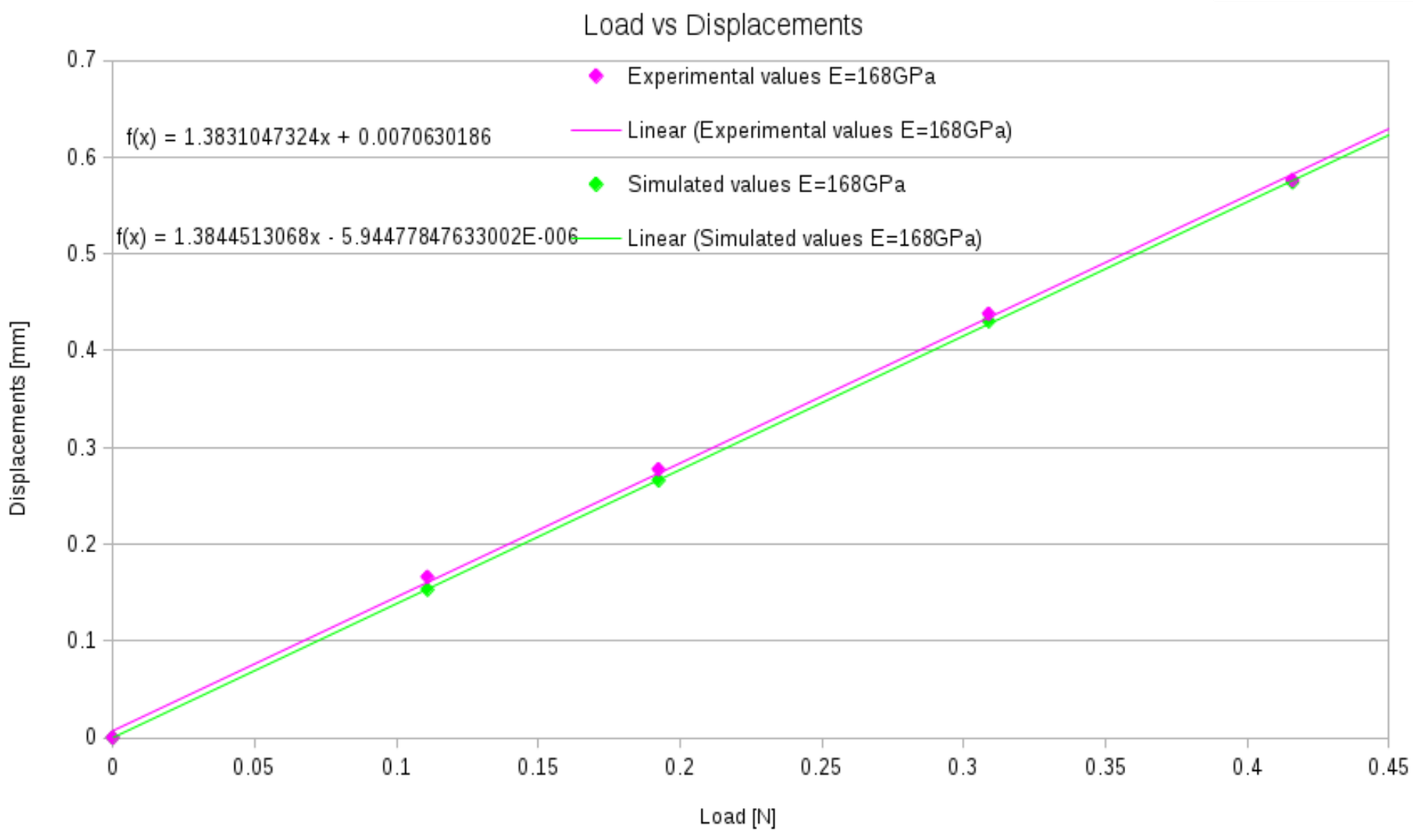




2.DEPFET Petals status and future work

Tests made: dummy's characterization





2.DEPFET Petals status and future work

- Analize and define petal's loads
- Optimize the structure
- Cooling test to petals
- Vibration test to petals
- Verify the design of the carbon fiber structure
- Multiphase CFD CO2 Simulations

3. Conclusions

- CFD simulations near to experimental tests
- Power Pulsing or constant Power?
- Microchannels are not enough
- Petals dummies machanicaly characterized

Thank you for your attention