Plans for Integrated Cooling of the AHCAL

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JG|U

NEED FOR INTEGRATED COOLING

ILC environment:

- power consumption managed through power pulsing (1 millisecond bunch trains at 5 Hz)

FCC-ee requirement:

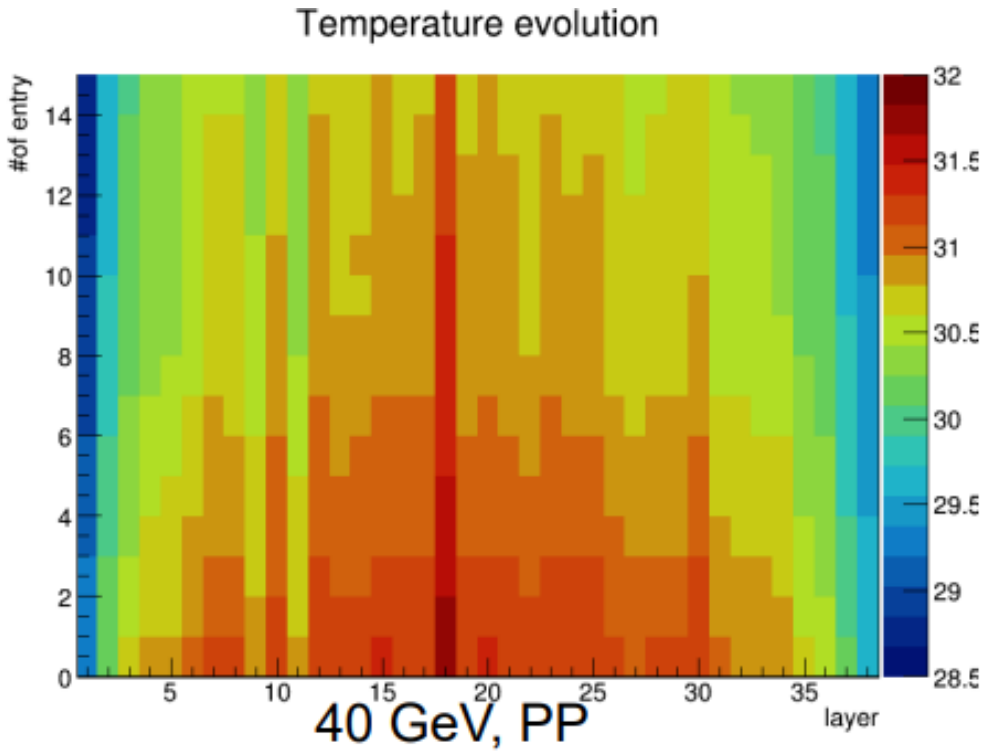
- higher interaction rate

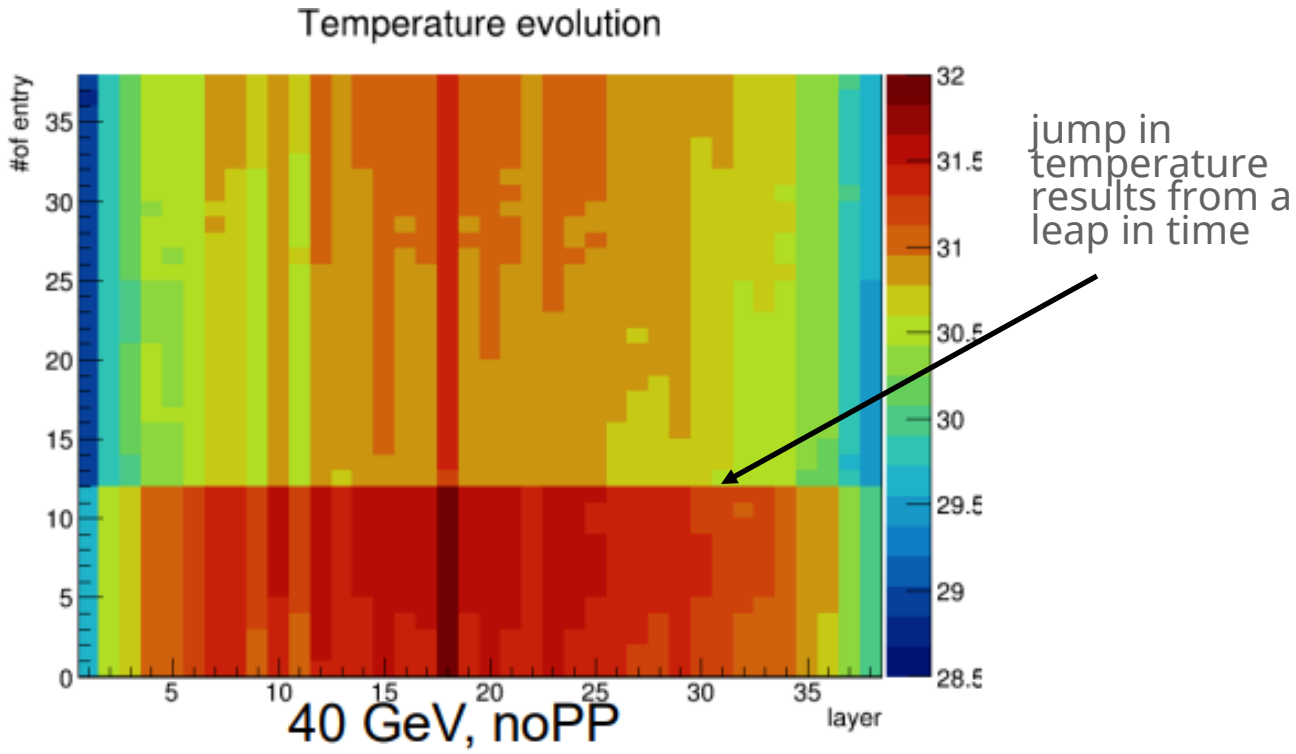
➢ electronics need to remain continuously powered

-> Need for integrated cooling

EFFECTS OF POWER PULSING

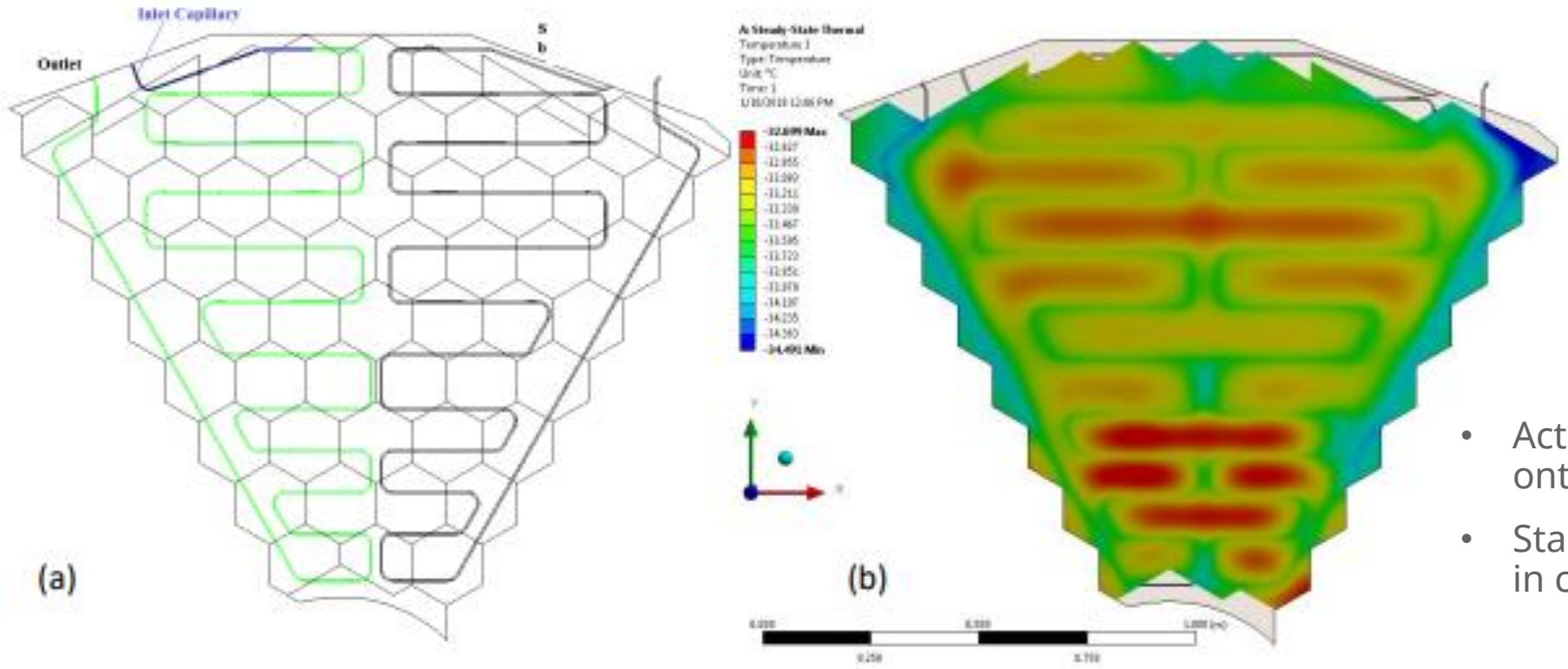
Cooling with power pulsing, heating without power pulsing





Plots taken from Anna Rosmanitz (2018)

CMS HGCAL COOLING



- Active elements mounted directly onto copper plates
- Stainless steal tubes embedded in copper plates

Plot taken from: The Phase-2 Upgrade of the CMS Endcap Calorimeter - CERN Document Server

FIRST PLANS

Build a dummy HBU using resistors to mimic the power consumption

Approach 1 (together with the Heidelberg group):

- Use power consumption information from the electronics
- ASICs: 3.34mW/Channel -> 120mW/chip
- Power Boards: $\mathrm{P_{powerboard}} = (4\mathrm{V} - 1.8) * \mathrm{I_{HBUs}}$
- -> Simulation needed

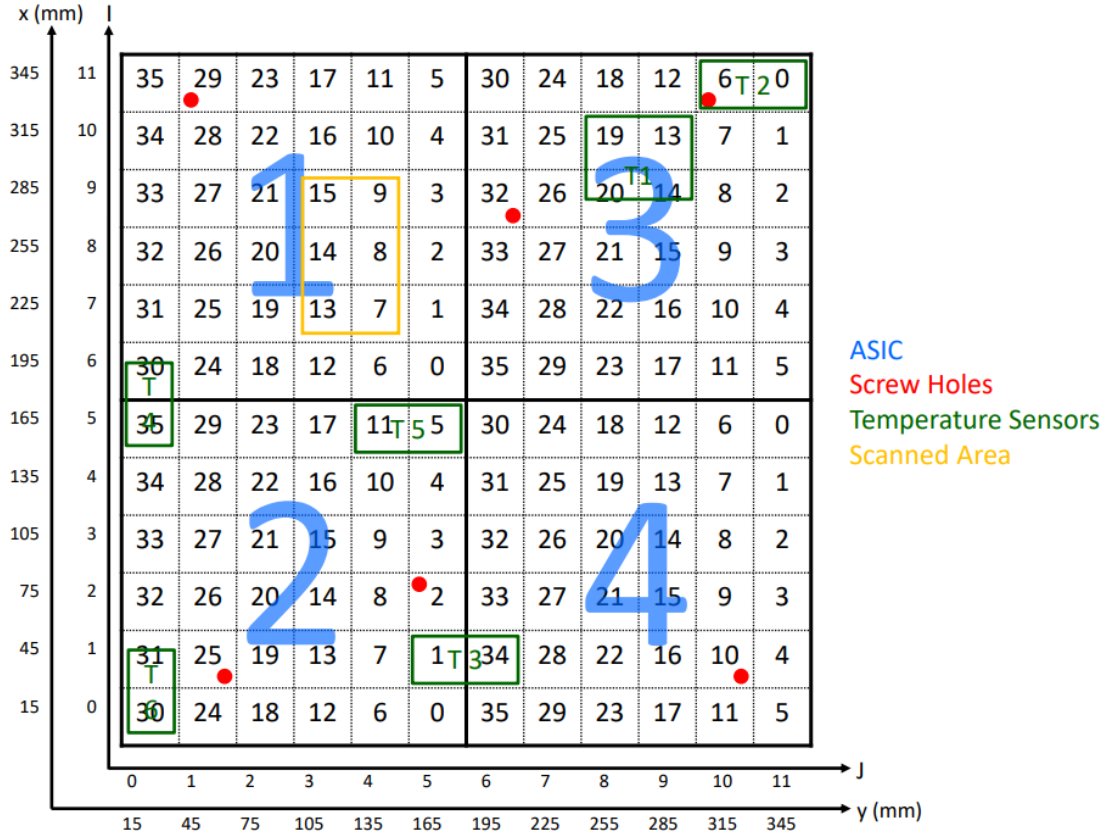
FIRST PLANS

Build a dummy HBU using resistors to mimic the power consumption

Approach 2:

- Using test beam data
- Temperature distributions on the HBUs
- Using gain of SiPMs as temperature measurement

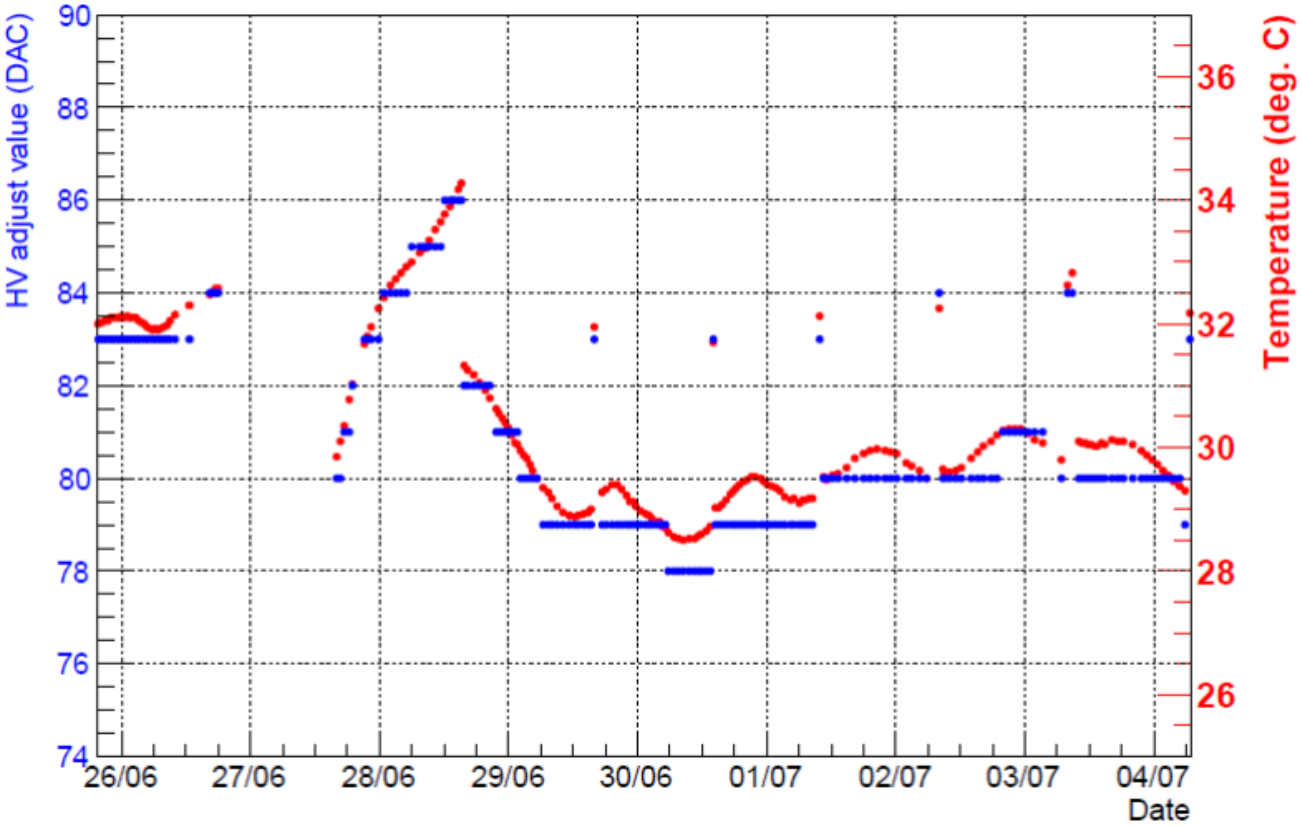
TEMPERATURE DISTRIBUTION ON THE HBU'S



Plot taken from Anna Rosmanitz

- Direct temperature measurement
- 6 temperature sensors distributed across each HBU

TEMPERATURE DISTRIBUTION ON THE HBU'S



Plot taken from Daniel Heuchel "Particle Flow Studies with Highly Granular Calorimeter Data" (2022)

- Indirect temperature measurement
- Using gain of each SiPM as temperature measurement

REQUIREMENTS FOR THE AHCAL

What should the operating temperature be?

How much space do we have? Does the absorber need to be cooling?

Can we use plain copper plates cooled on one side, or do we need tubes inside the copper plates?