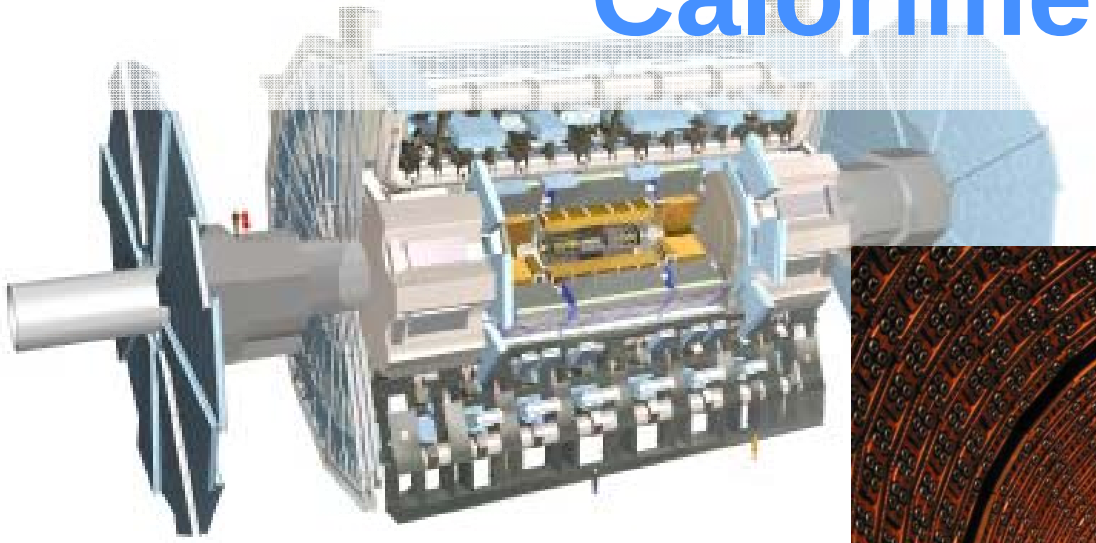
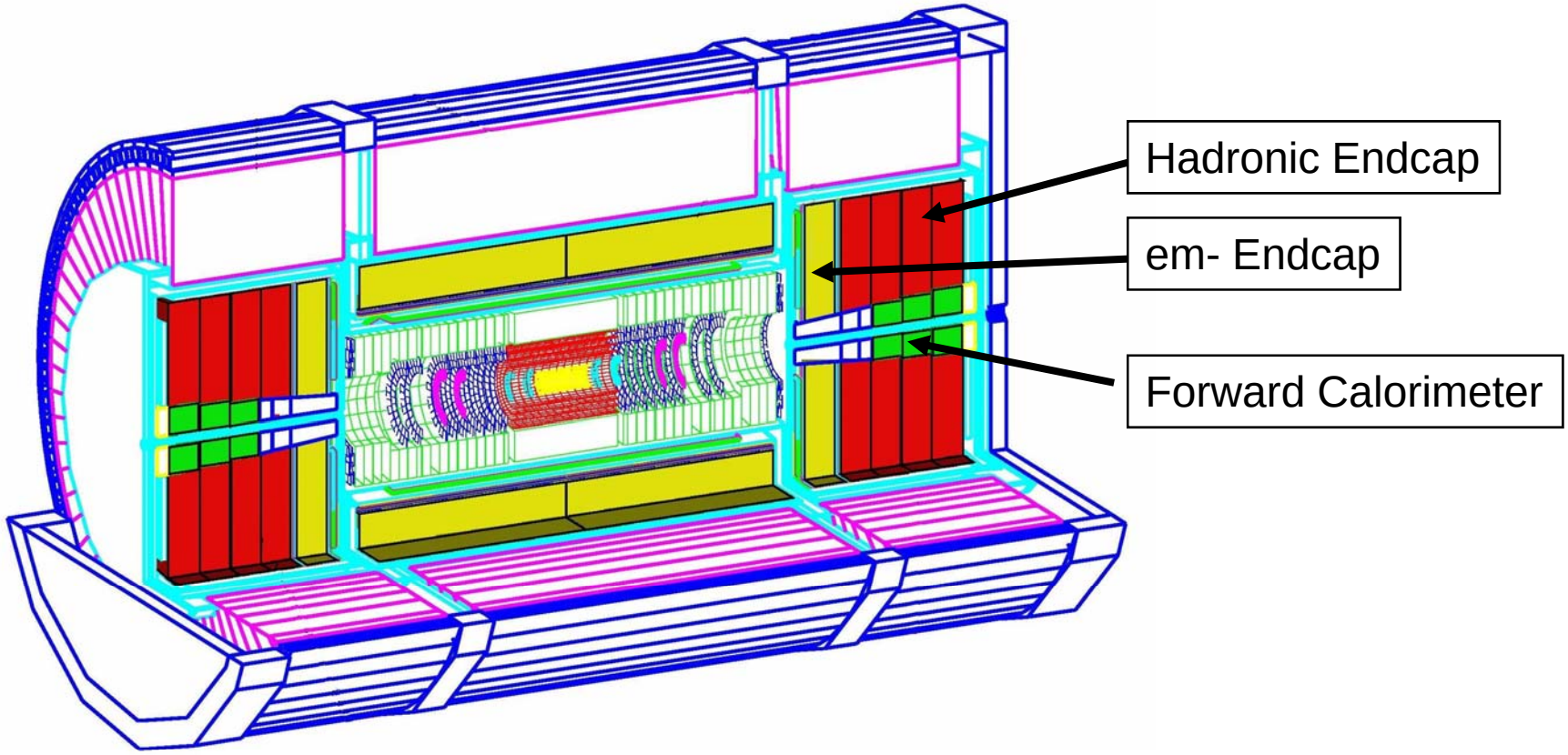
ATLAS LAr Forward Calorimeters



C. Zeitnitz (Universität Wuppertal)
for the ATLAS LAr Community

Forward Calorimeter Overview

- Endcap consists of three LAr Calorimeter



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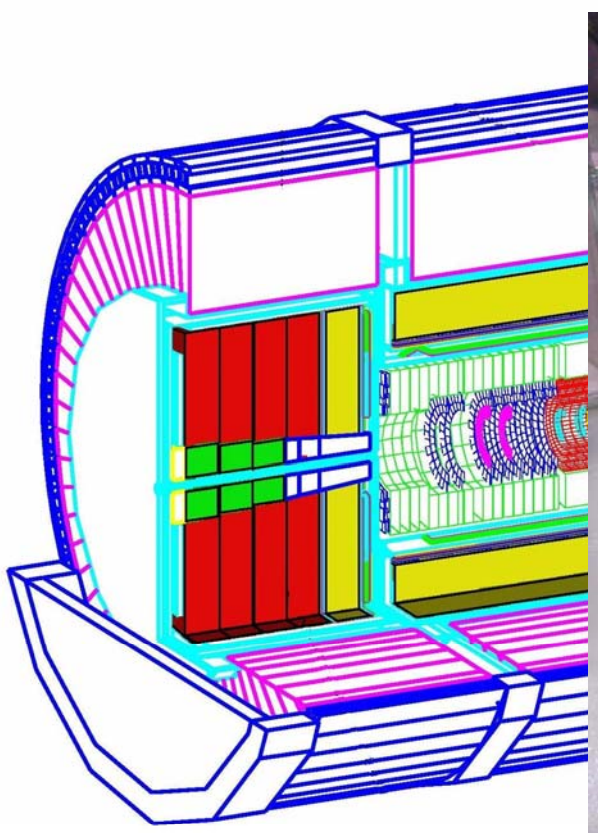
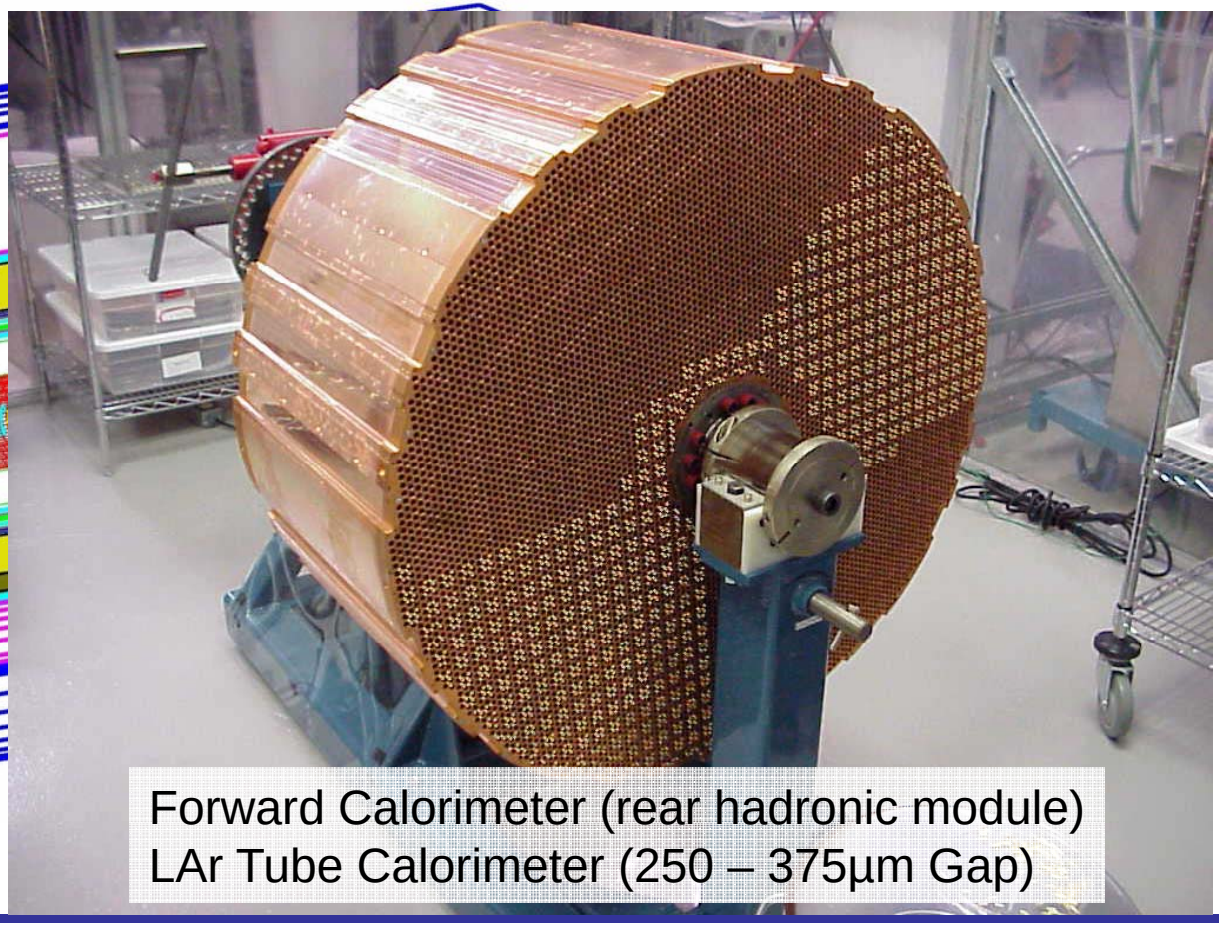




Forward Calorimeter (rear hadronic module)
LAr Tube Calorimeter (250 – 375µm Gap)

sLHC Issues

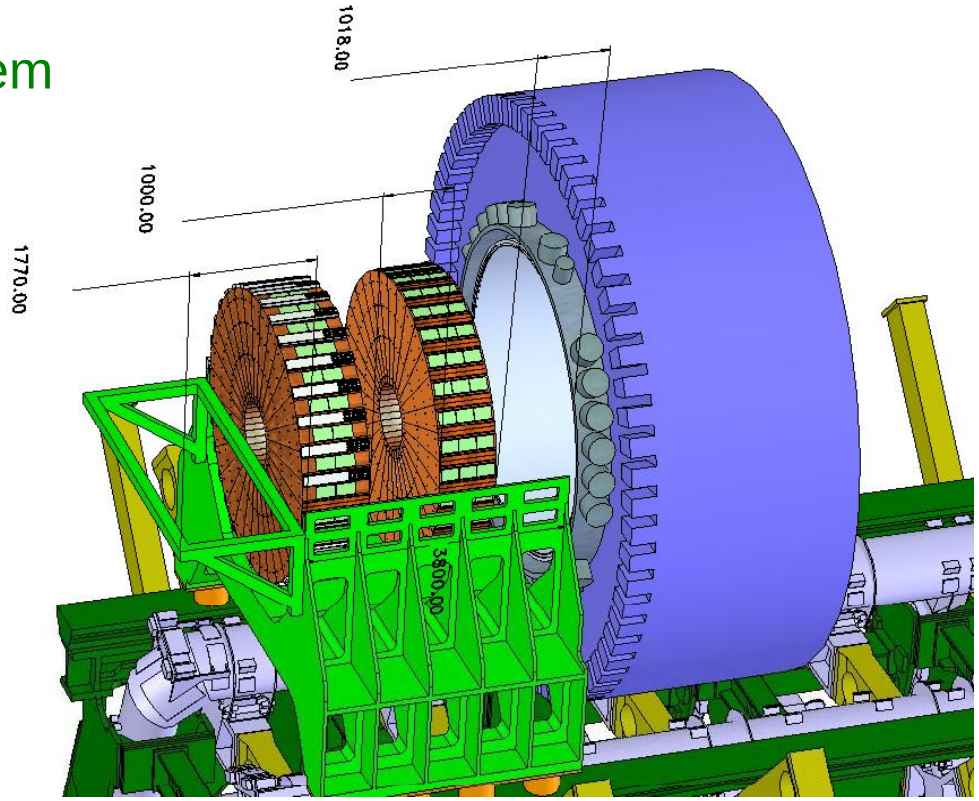
- Energy deposition in Forward Calorimeter
  - Heat-up of the modules and risk of boiling of the LAr
  - Increased current through LAr gap (voltage drop over series resistor)
- Ion Build-up in LAr will cause problems
  - Slow drift velocity of Ar-Ions lead to space charges
  - Shielding of High-Voltage leads to signal degradation
  - Forward Calorimeter will be unusable @ sLHC
  - Calorimeter “remembers” the last 10-20ms
- Front-End Electronic
  - Radiation damage
  - Adaption to sLHC machine parameters
- Might want/need higher granularity for triggering
  - Changes to Read-out, trigger tower building and trigger
- Radiation damage of cold electronics of Hadronic Endcap Calorimeter
  - Depends on actual radiation level

Some Solutions

- Impact of High Ionization rate on endcap calorimeters not clear
  - High Intensity Beam test at Protvino
- Shield forward region by additional warm calorimeter
  - Endcap cryostat bore could house a warm, dense calorimeter
    - Impact on inner detector should be small, BUT has not been studied so far
    - Currently simulation are performed ➔ Reduction in energy deposition etc.
- New Forward Calorimeter
  - Requires a substantial reduction in the gap width (250µm to 100µm) at least in the first (EM) compartment ➔ Protvino Beam test
- Replacements of Hadron Endcap cold electronics (if necessary)
  - Need measurement of radiation background (2010 ?) to estimate lifetime
  - Opening of endcap cryostats and wheel extraction required

Some Solutions (2)

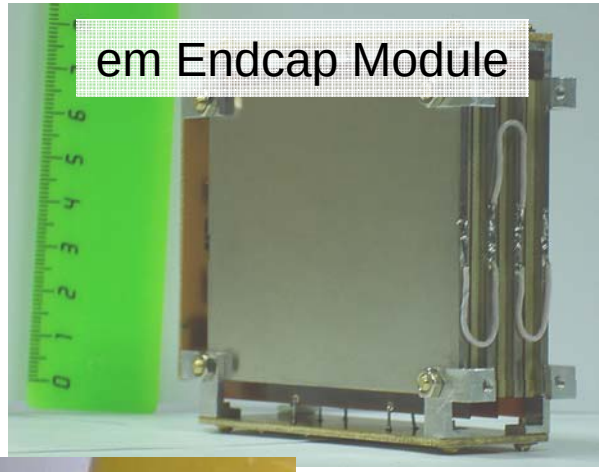
- Engineering studies of replacement are ongoing
  - Required tooling
  - Radiation background problem
  - Space and time constraints



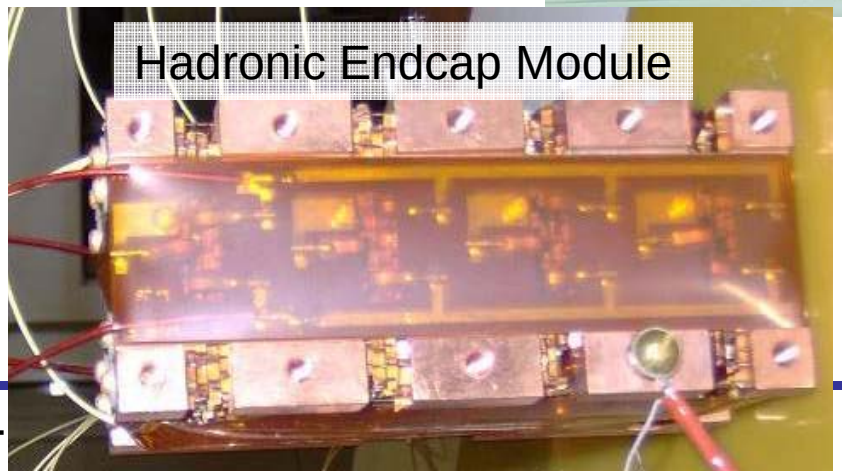
- New FE-Electronics required
  - Adapt to machine parameters (bunch-crossing-time) and rate

Protvino High Intensity Beam

- Study response of Endcap Calorimeters in high intensity beam
  - INTAS Project at Protvino 2007 - 09
  - 50GeV Proton Beam with up to 10^{12} protons per spill
  - Three small test modules for EM, Hadronic and Forward Calorimeter have been produced

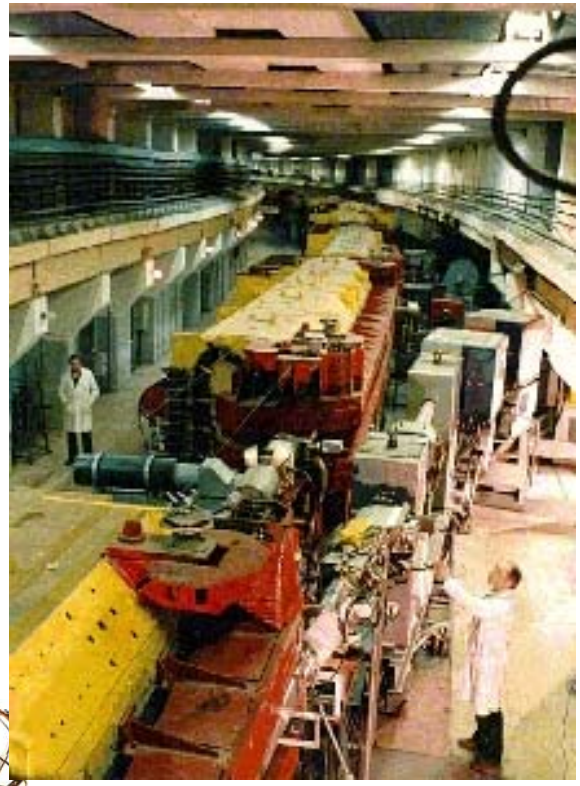

em Endcap Module

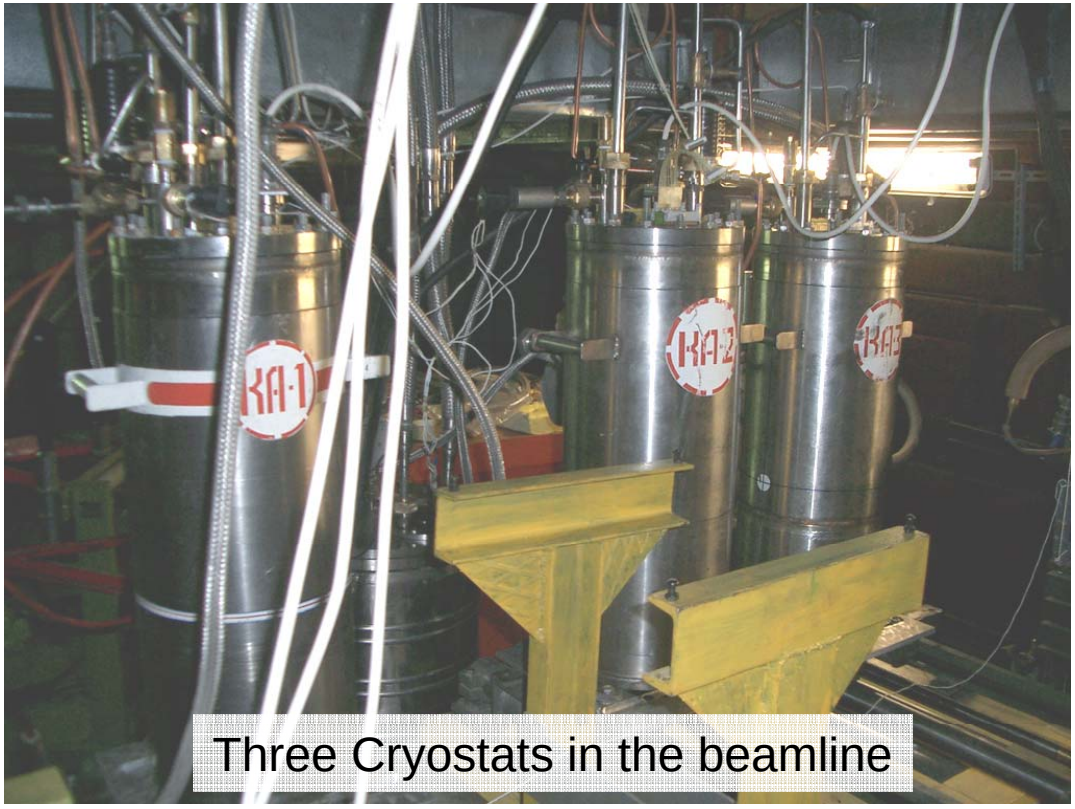

Forward Calorimeter Module w/ 100µm and 250µm


Hadronic Endcap Module

Protvino High Intensity Beam (2)

- Schedule
  - First technical runs in Sept. and Nov. ‘07
  - First serious beam run in April ‘08
  - Next run in Nov. ‘08
  - Analysis of first data has started

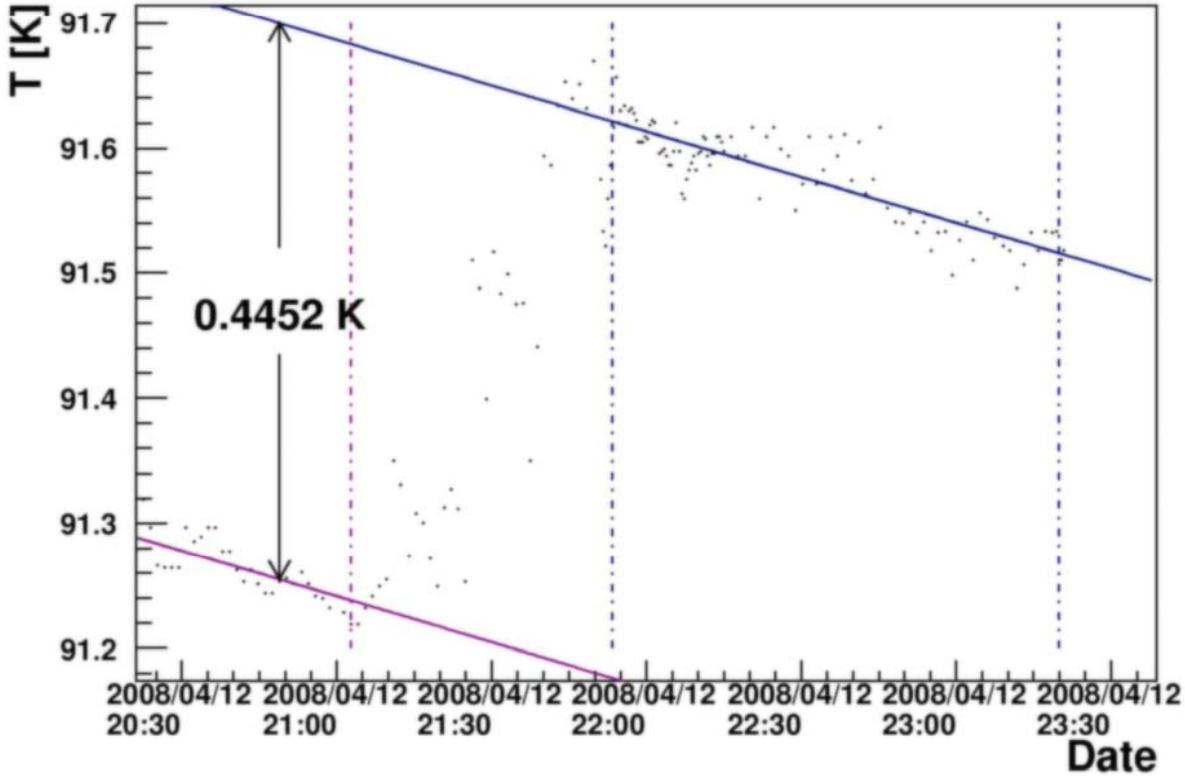




Three Cryostats in the beamline

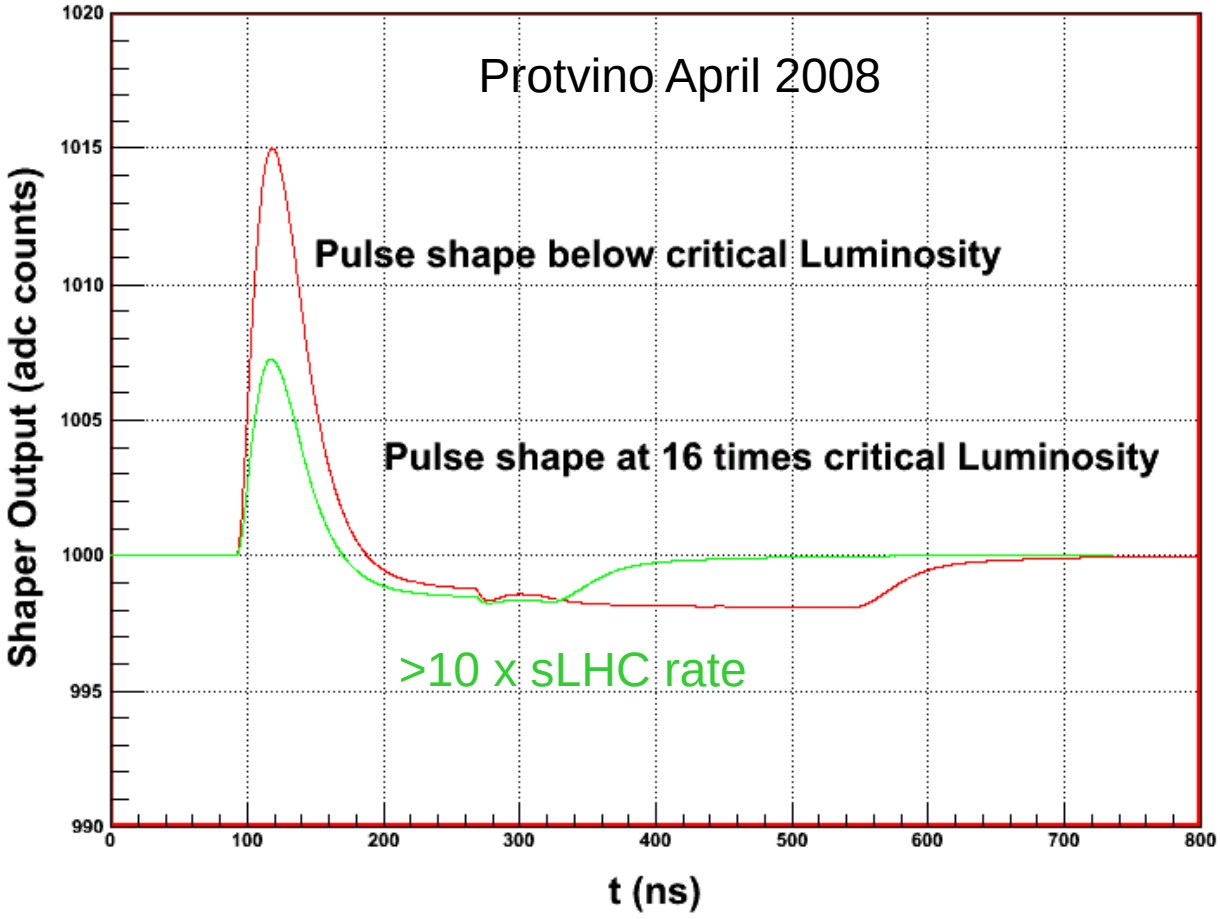
First Online Plots

- A “Real” Calorimeter
  - Beam induced temperature rise in the Forward Calorimeter Module



First Online Plots (2)

- Signal degradation at high Luminosity
  - Signal after shaping (Hadronic Endcap)



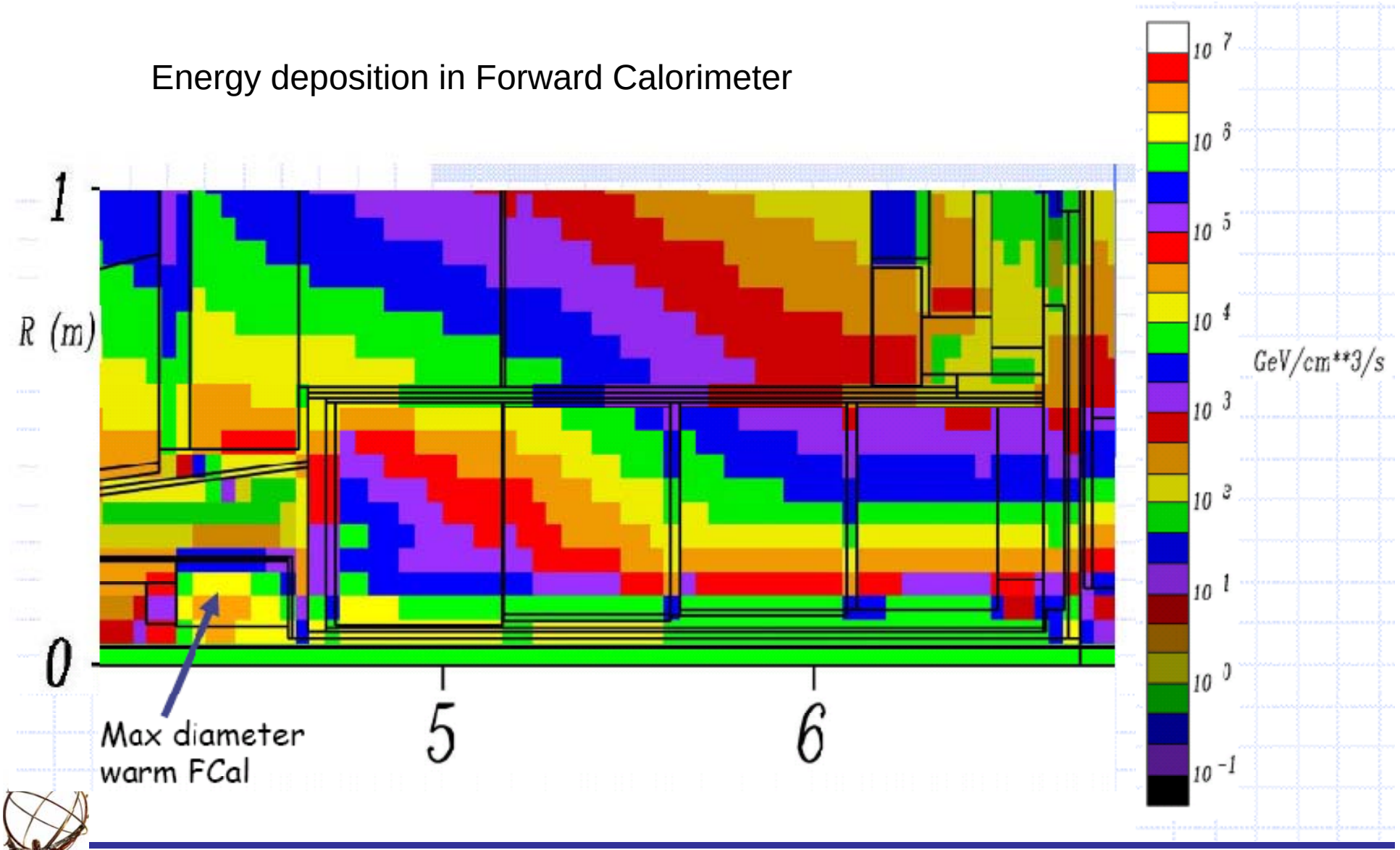
Summary and Outlook

- Finish Protvino test and obtain reliable estimate for the operation range of the LAr-endcap calorimeters
  - First results hopefully available beginning of next year
- Study warm calorimeter solution for high radiation environment
  - Possible solutions: diamond/ sapphire based readout
- Engineering studies for opening cryostats in the Pit
  - Limited space
  - High radiation environment
  - New tooling required for calorimeter extraction and handling
  - Interference with other subdetectors
- Develop new FE-Electronics
  - First developments have started
- Organizational structure for upgrade within the LAr-Calorimeter group will be established very soon
- Plan Workshop in Fall/Winter together with Tile Calorimeter

BACKUP

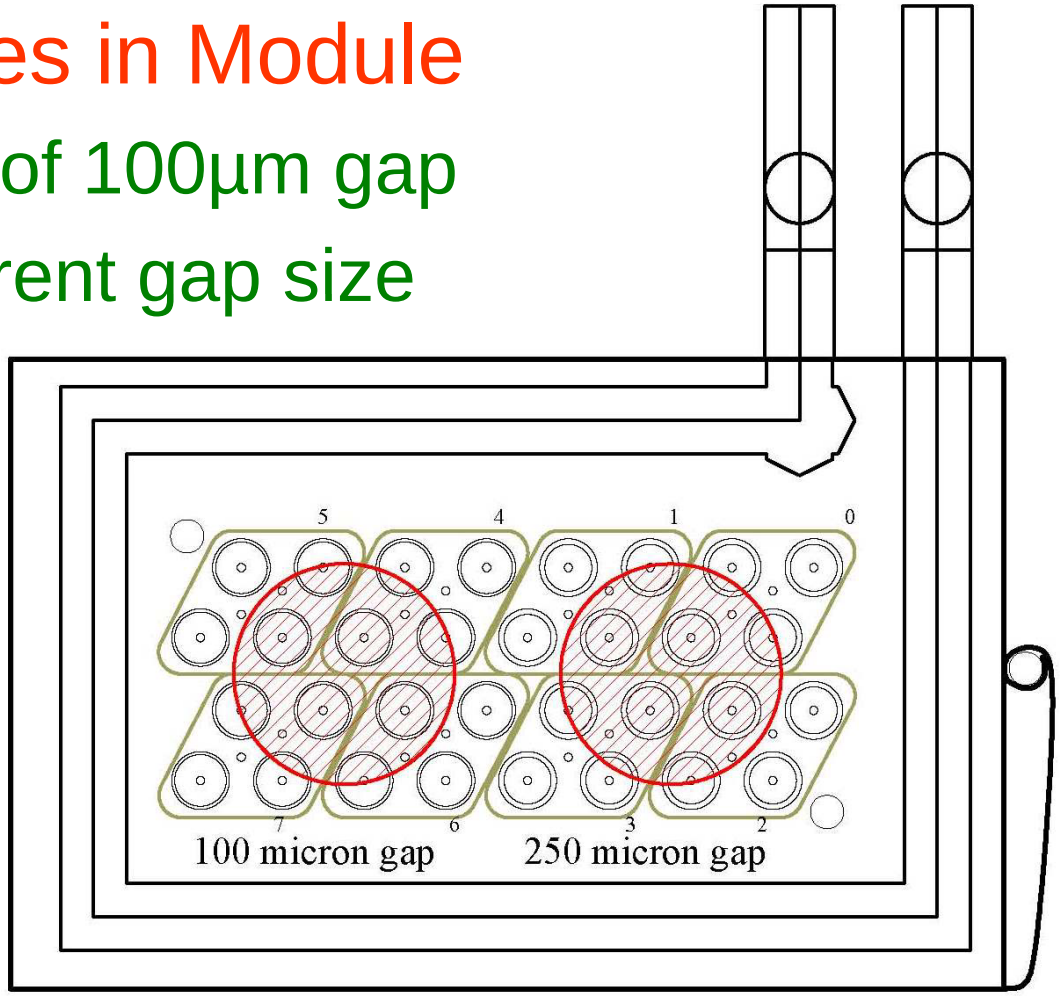
Endcap Cryostat w/ warm calorimeter

Energy deposition in Forward Calorimeter



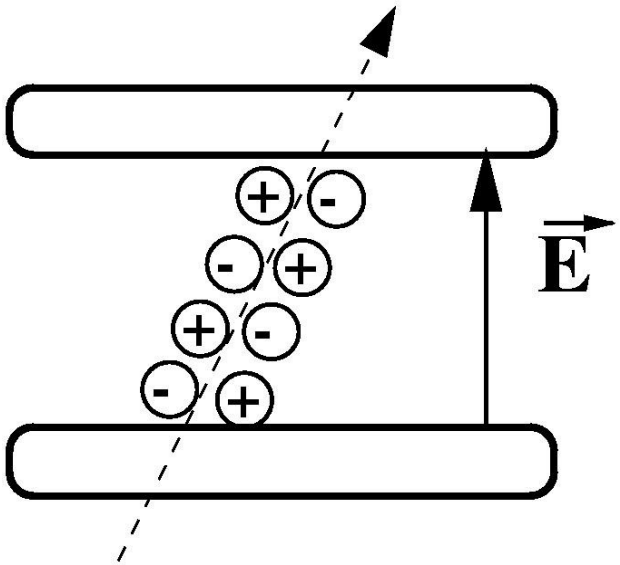
Protvino Forward Calorimeter Module

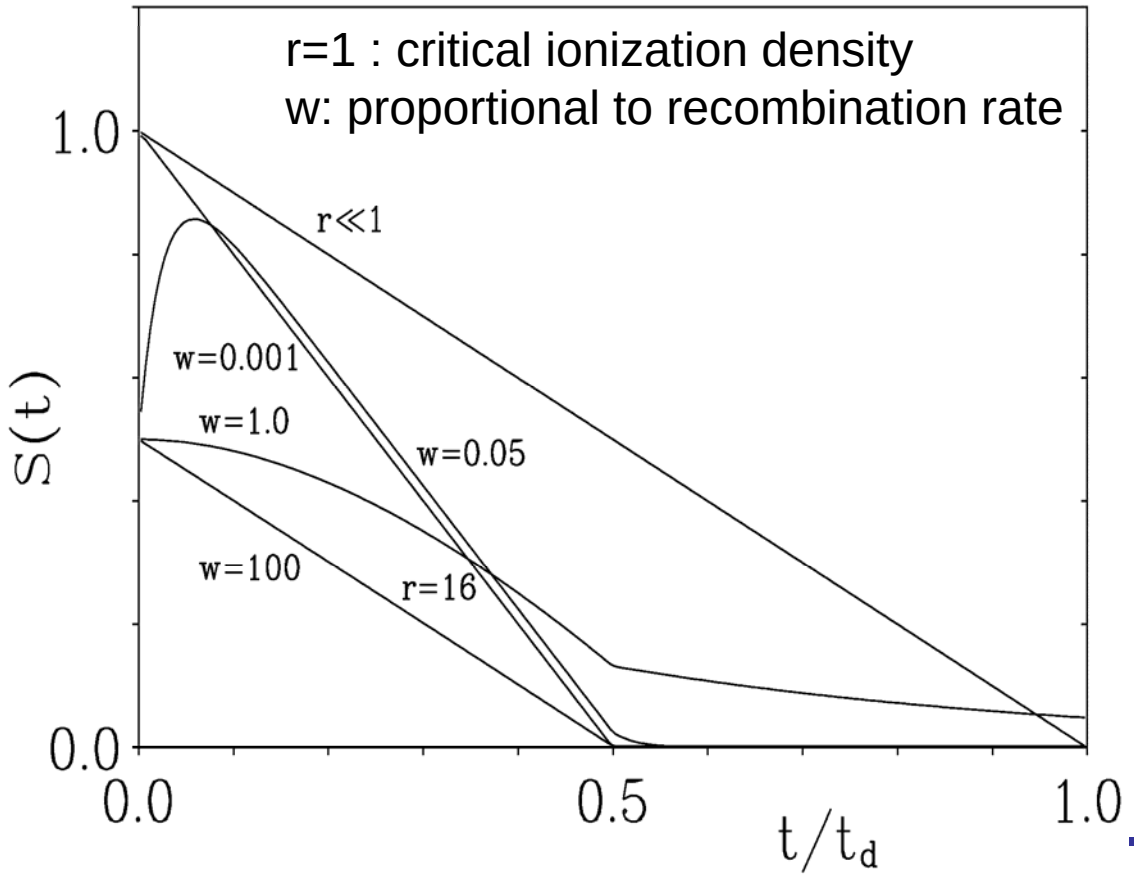
- Different Gap sizes in Module
  - Study feasibility of 100µm gap
  - Compare w/ current gap size



Pulse Shape

- Critical Ionisation Density and Signal Shape
  - Ion Build-up reduces effective voltage/gap
  - Current pulse gets shorter



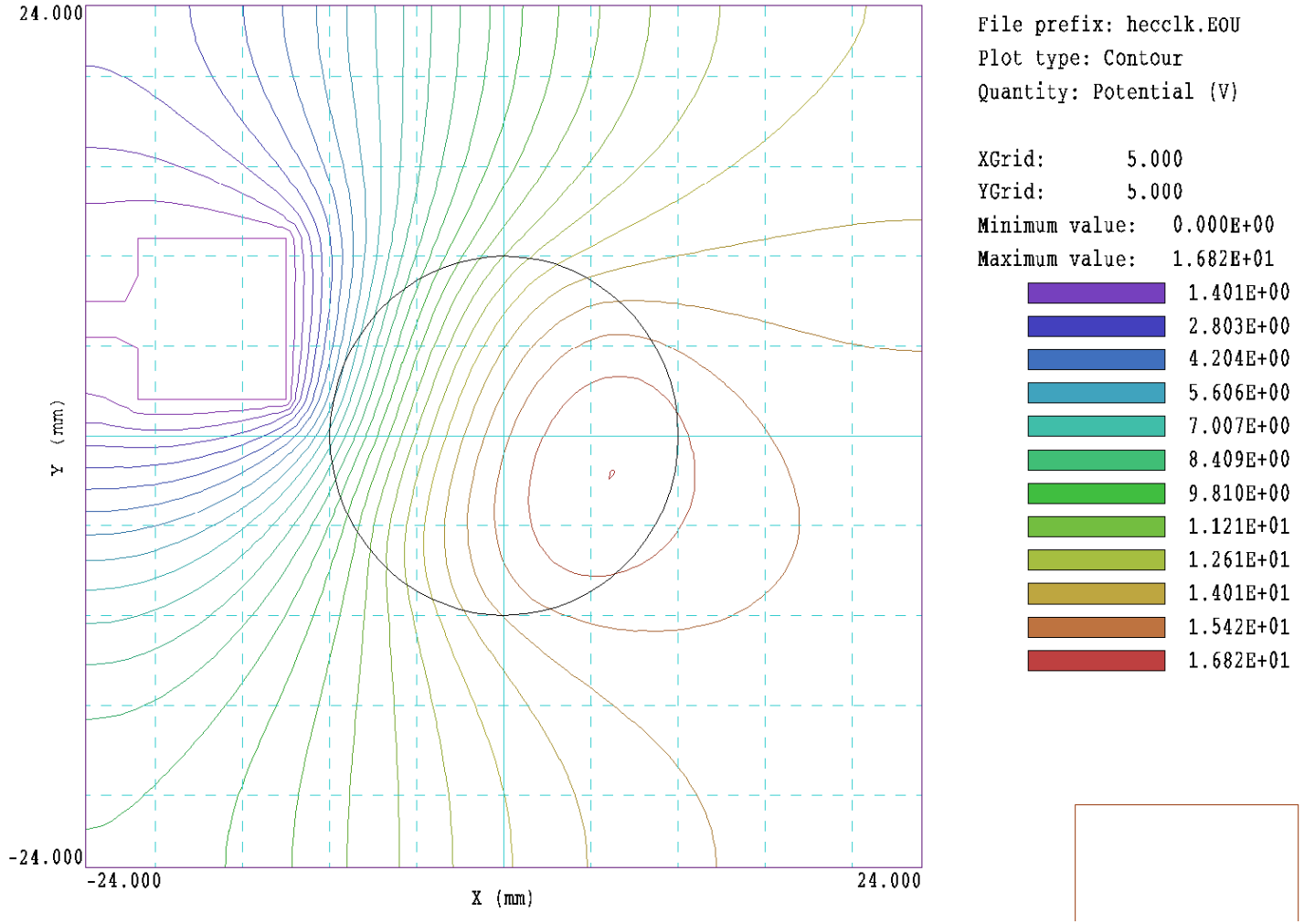


Hadronic Endcap Issues

- Cold Electronic might not survive the radiation at $10^{35} 1/cm^2 \cdot s$
  - Can only be replaced by opening the endcap cryostats
    - Calorimeter Wheels have to be extracted from the cryostats
  - Radiation level will only be known once we have sufficient luminosity to compare background simulation with data (mid to end 2010)
- High Voltage applied via High Resistive Coating (Carbon Loaded Kapton)
  - Coating limits locally the current at high ionization rate
    - High Voltage drop depends on distance to HV connector

Hadronic Endcap Issues (2)

- High Voltage map calculated for Protvino setup



Front-End Electronics

- Study radiation hard processes
- Current Base Design