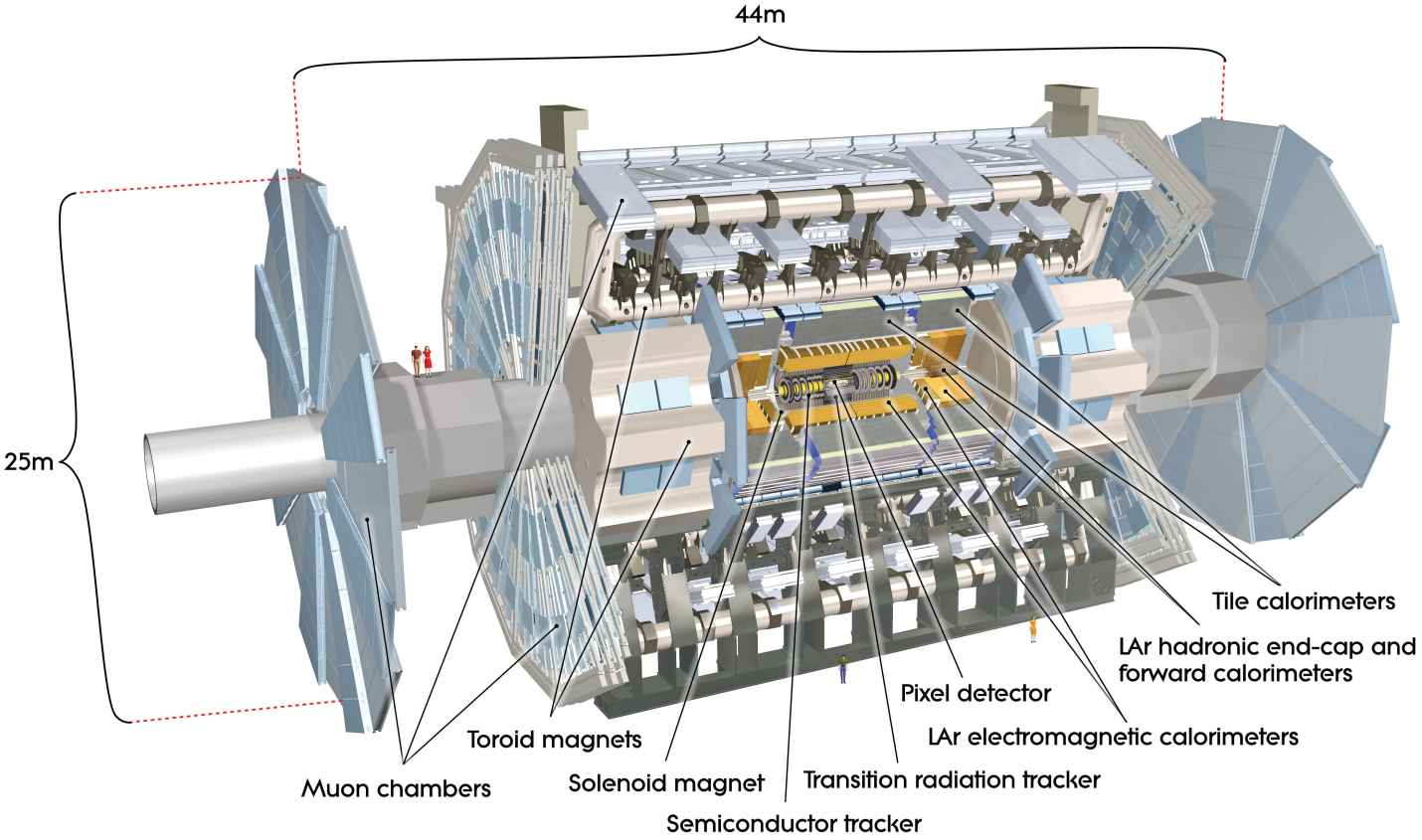
Overview of the ATLAS powering requirements



Philippe Farthouat, CERN

26 Feb. 2019

Outline

- Current Atlas experiment
- Upgrade program
- Basic requirement for new powering scheme

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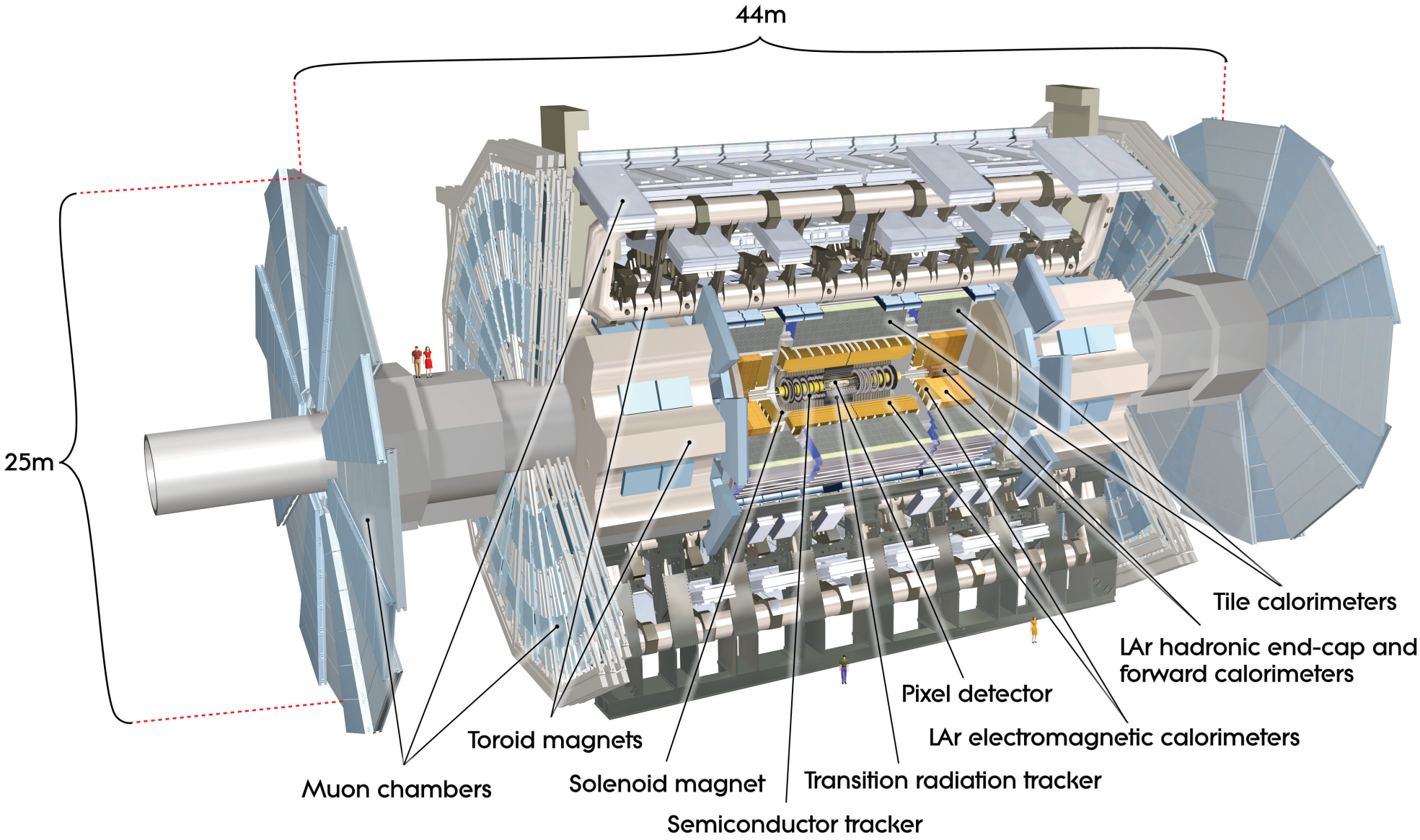
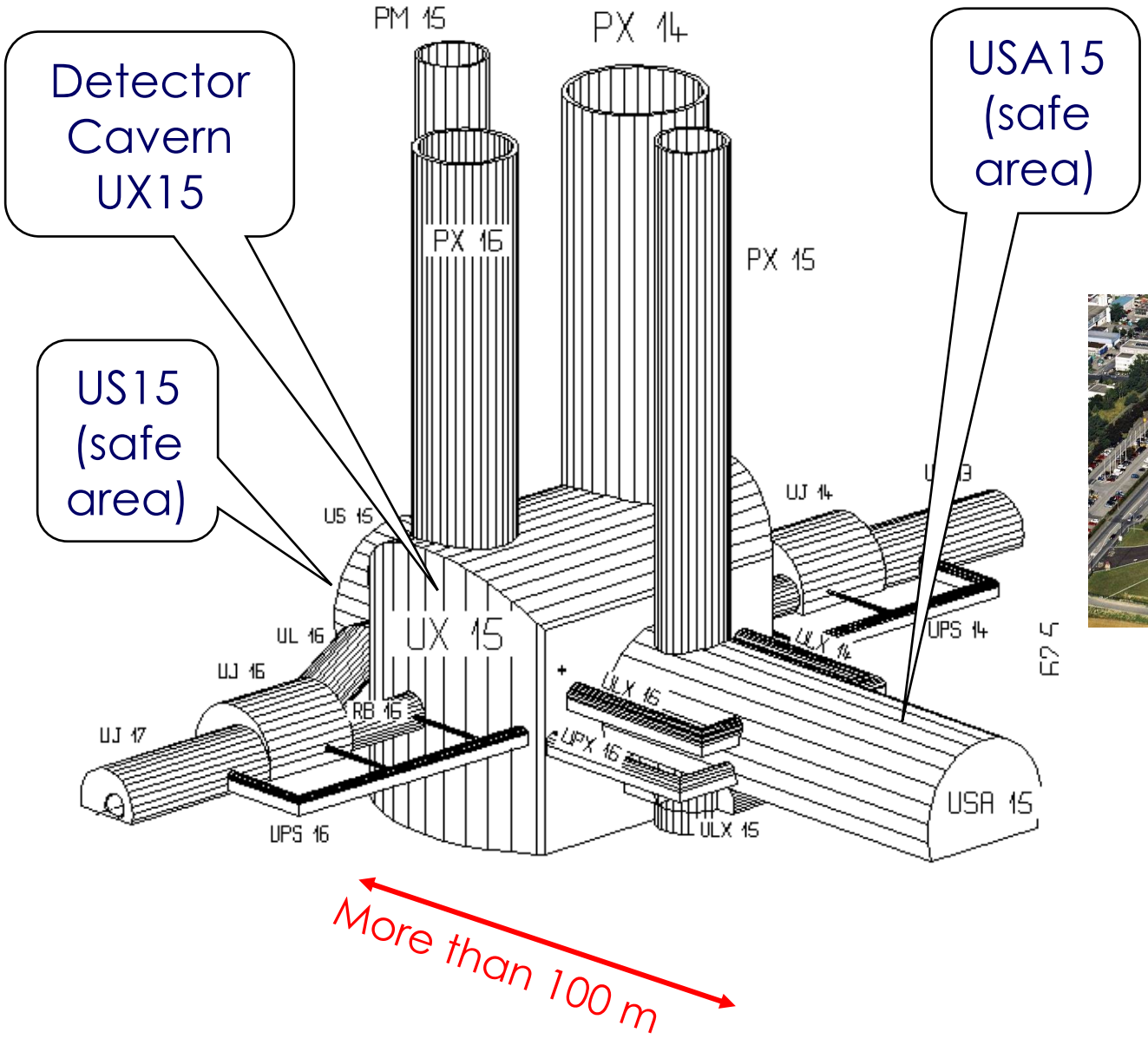
ATLAS (A Toroidal Lhc ApparatuS)

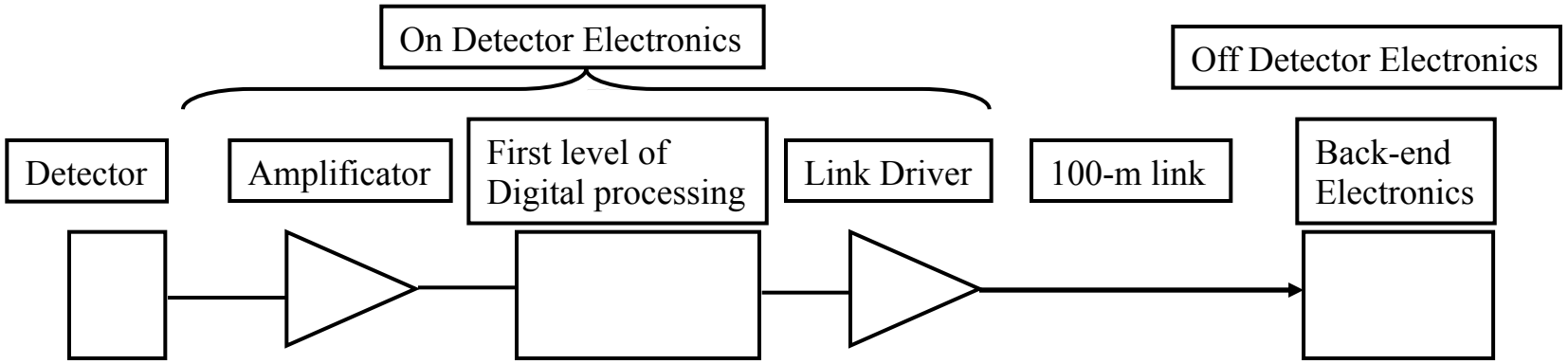


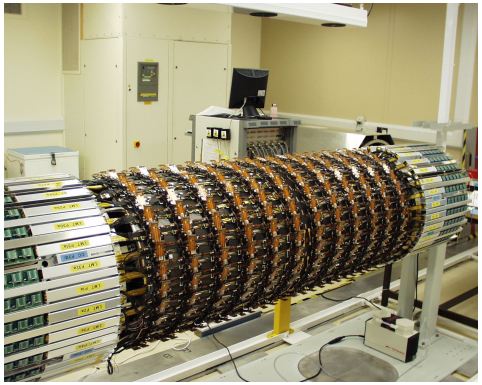
Weight: 7000 t

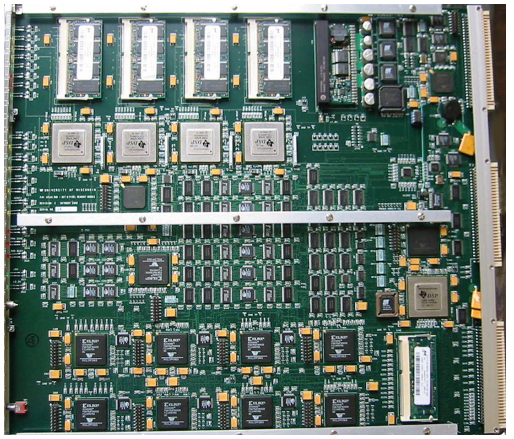
ATLAS experimental area



Read-out Electronics

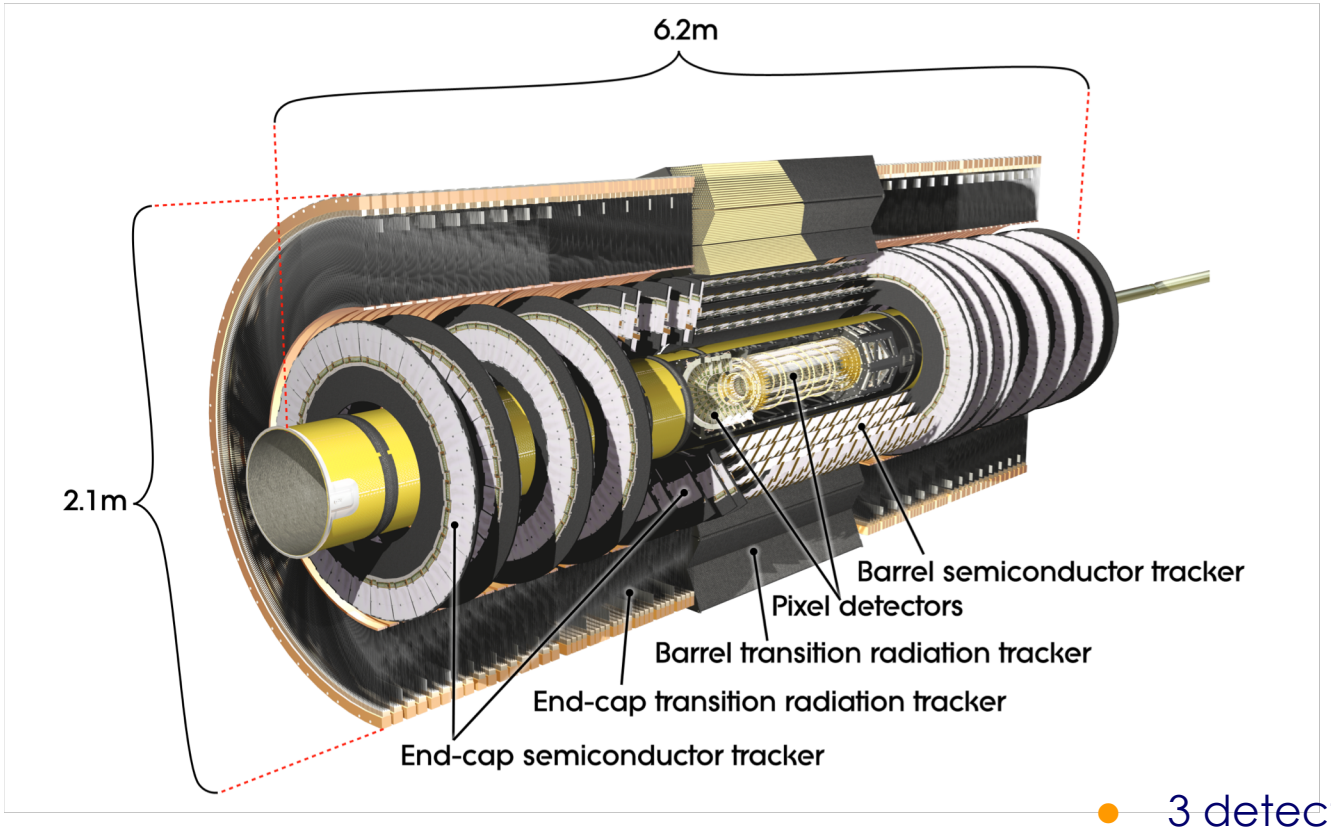






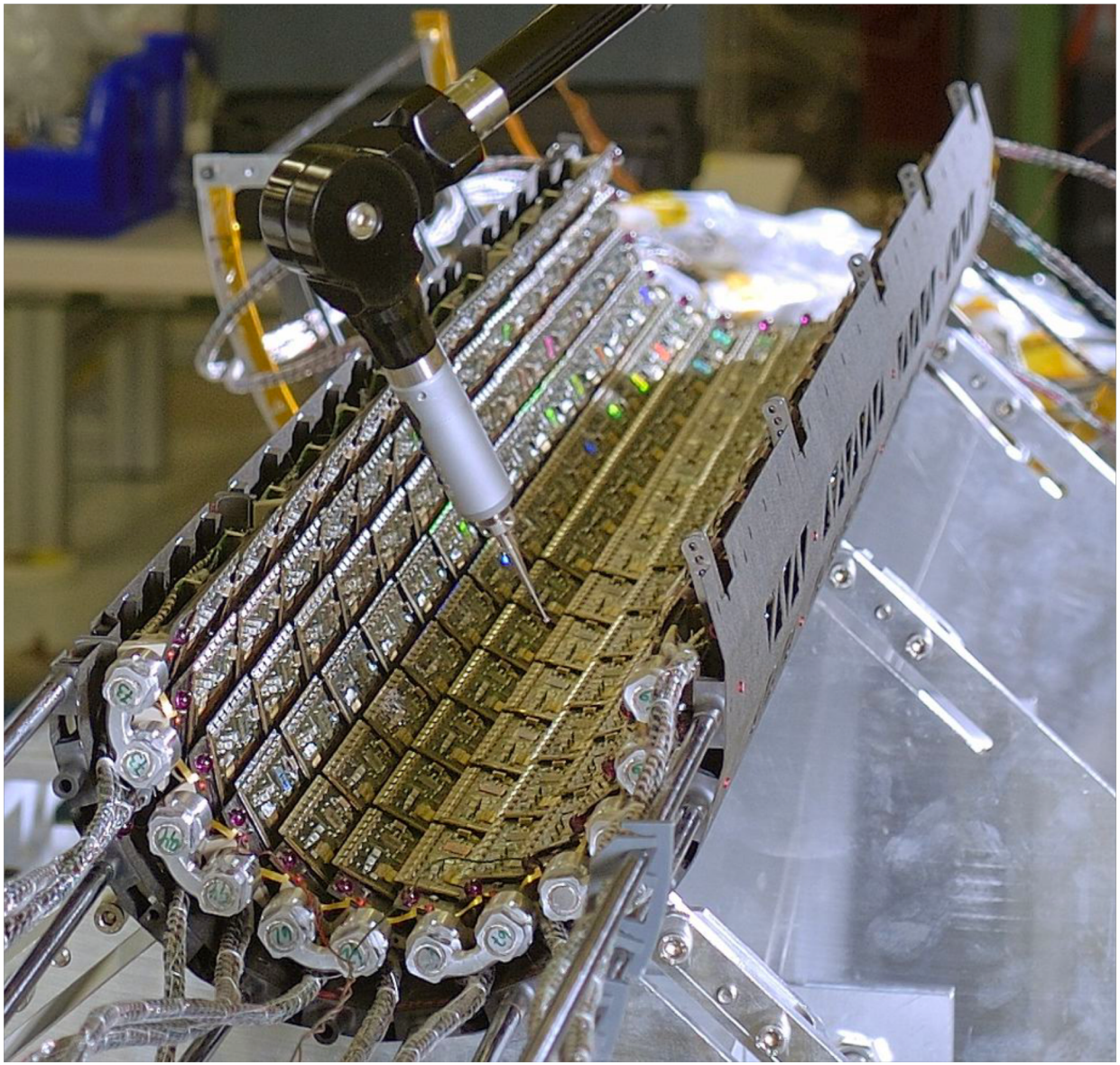
- Power for front-end
  - Custom
  - Environment uneasy (radiation and magnetic field)
- Power for back-end
  - Racks, crates, …

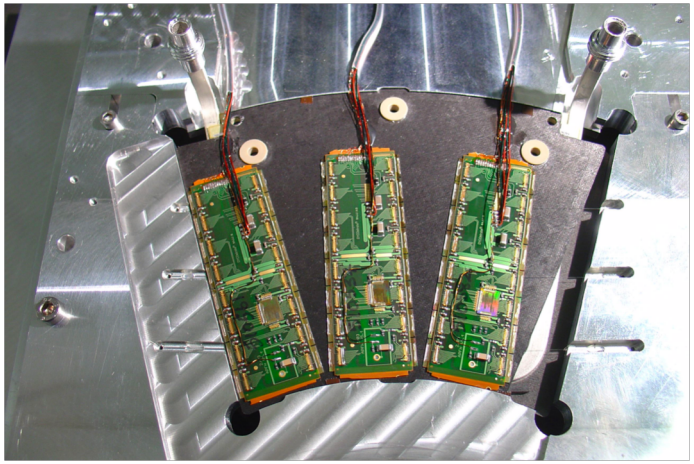
Inner Tracker



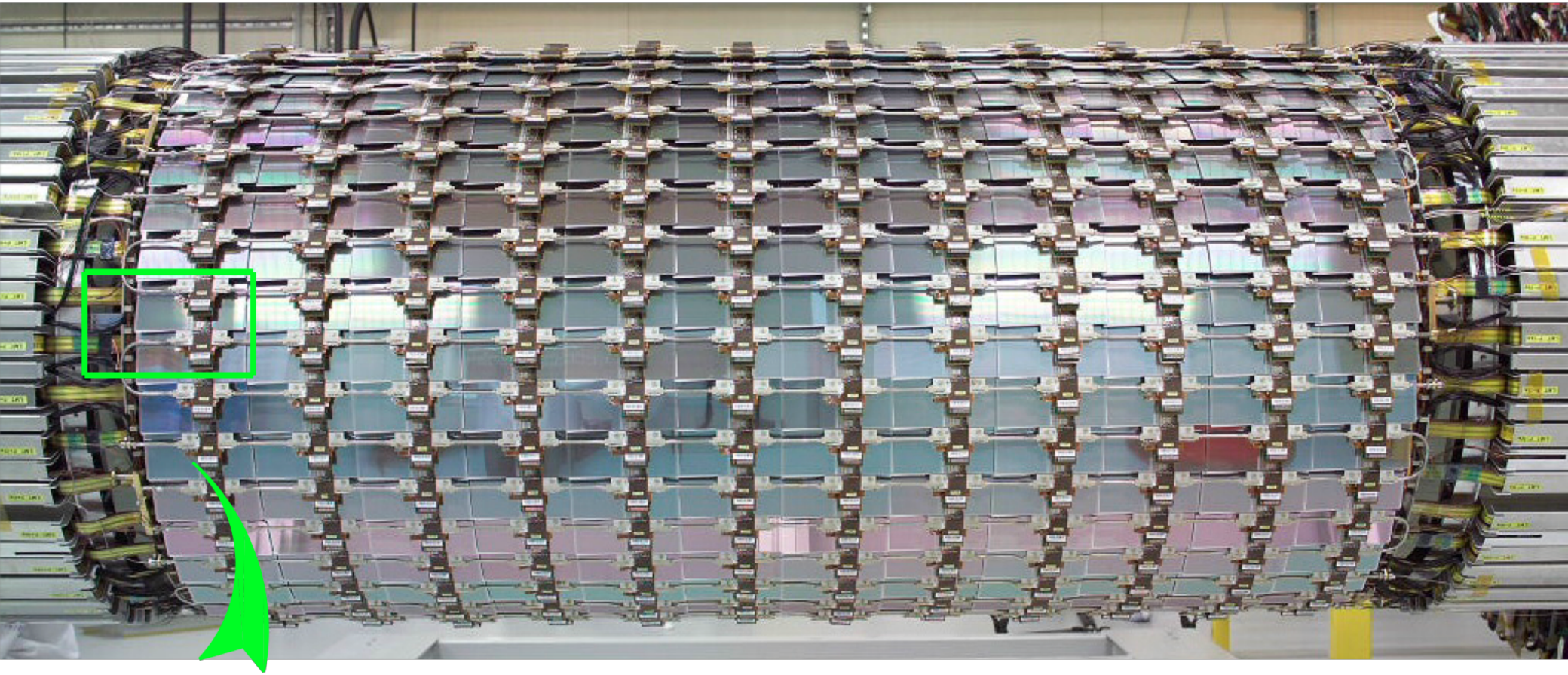
- 3 detectors:
  - Pixel
  - Semiconductor tracker (SCT)
  - Transition radiation tracker (TRT)

Barrel and end-cap pixel



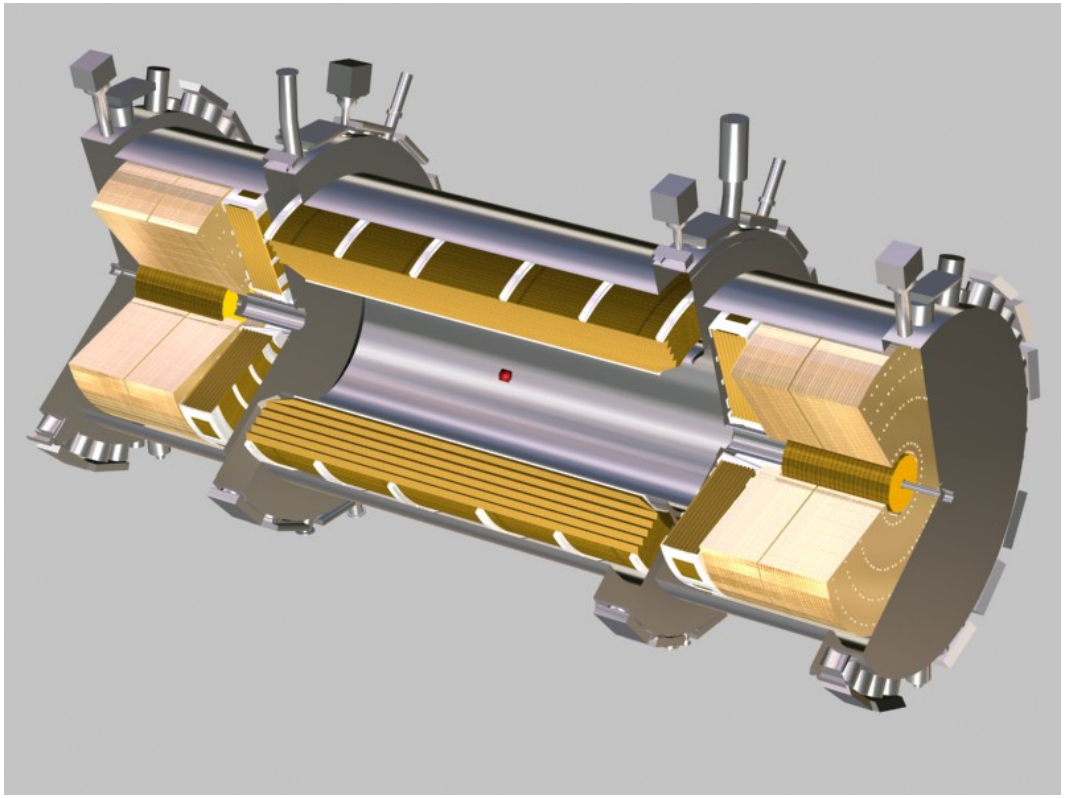


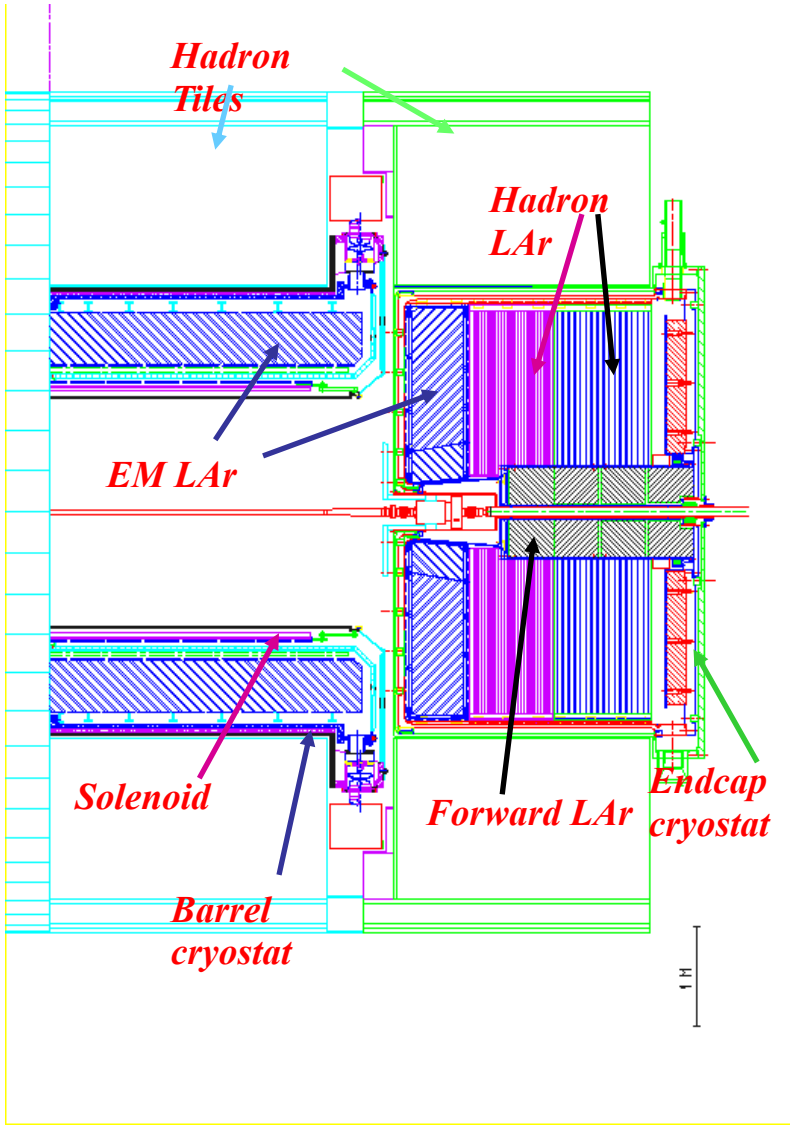
SCT Detector

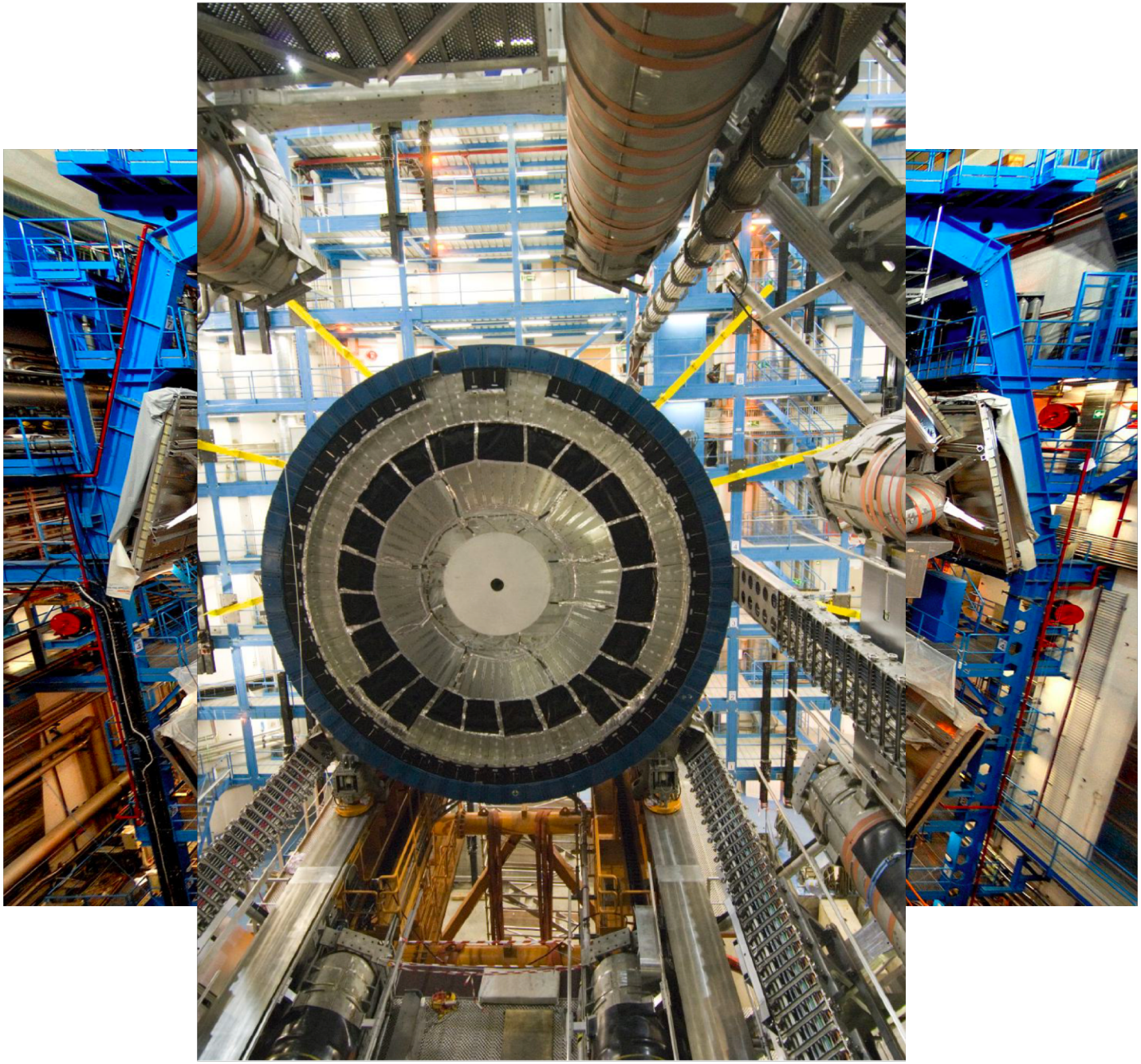


Calorimeters

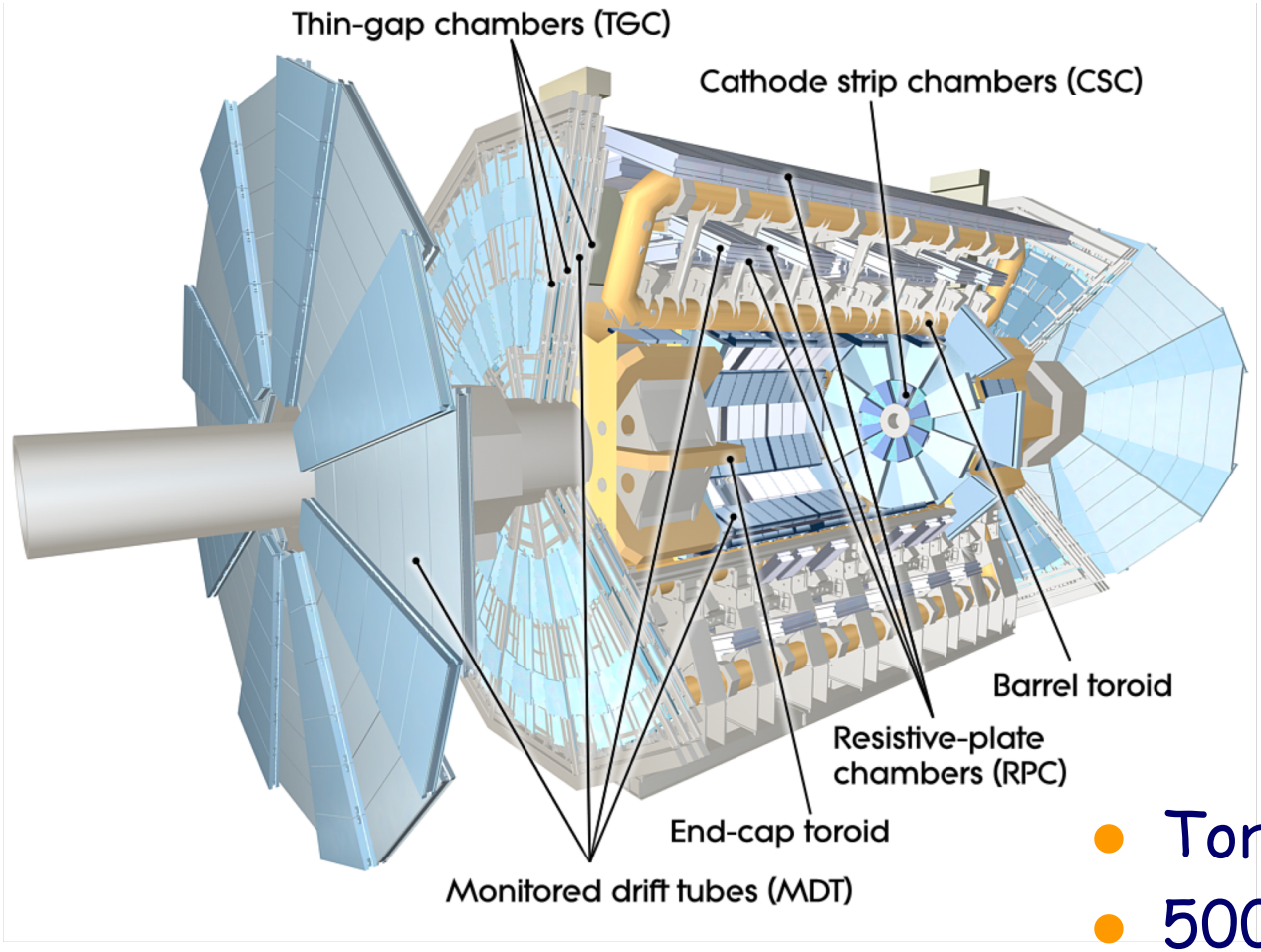
- Two types:
  - Liquid argon (EM & hadronic). 200000 channels
  - Scintillating tiles (hadronic). 10000 channels





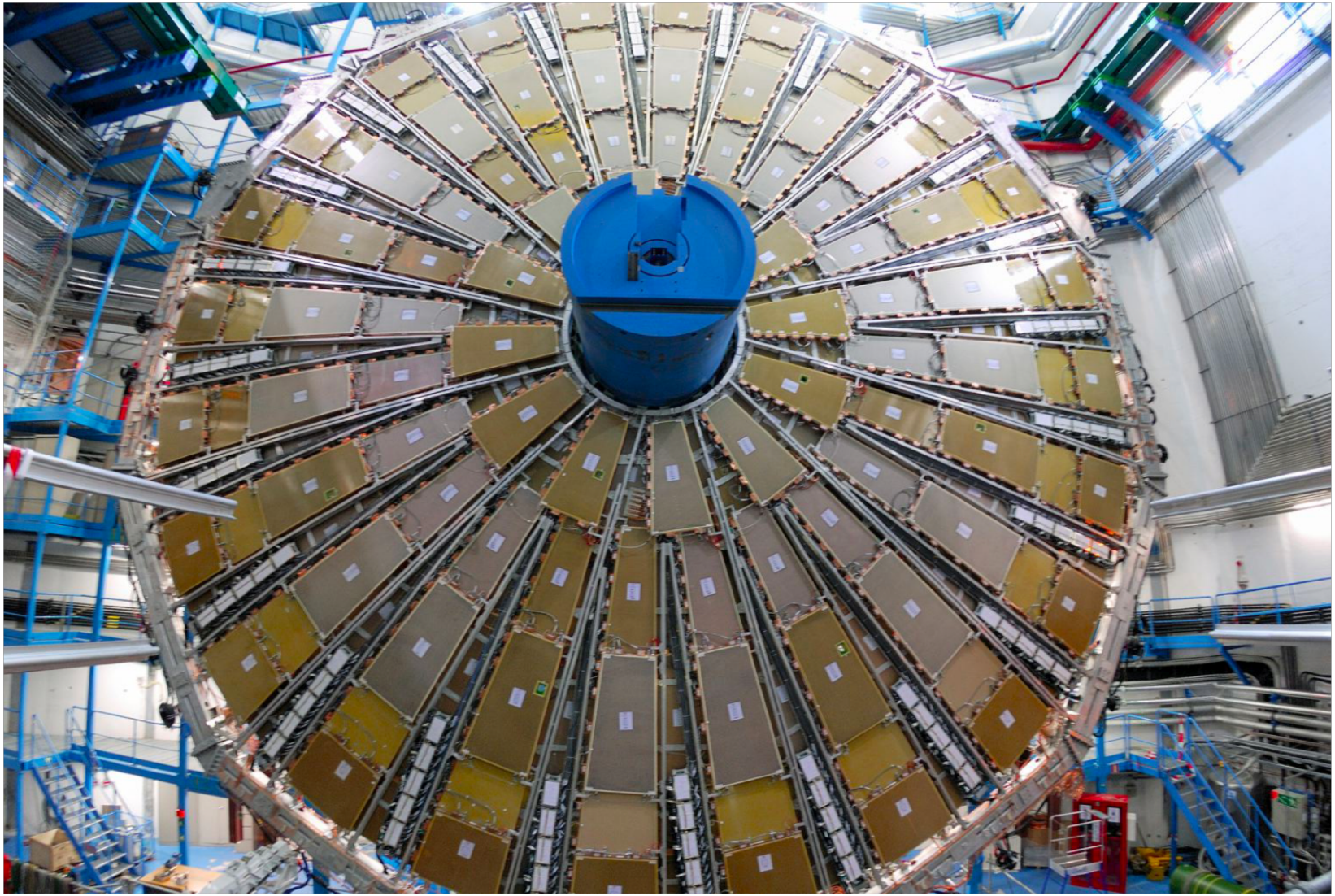


Muon spectrometer



- Toroidal field
- 5000 m2 of chambers
  - 420000 channels
  - ~100 μm spatial resolution

Muon end-cap: Big-Wheel



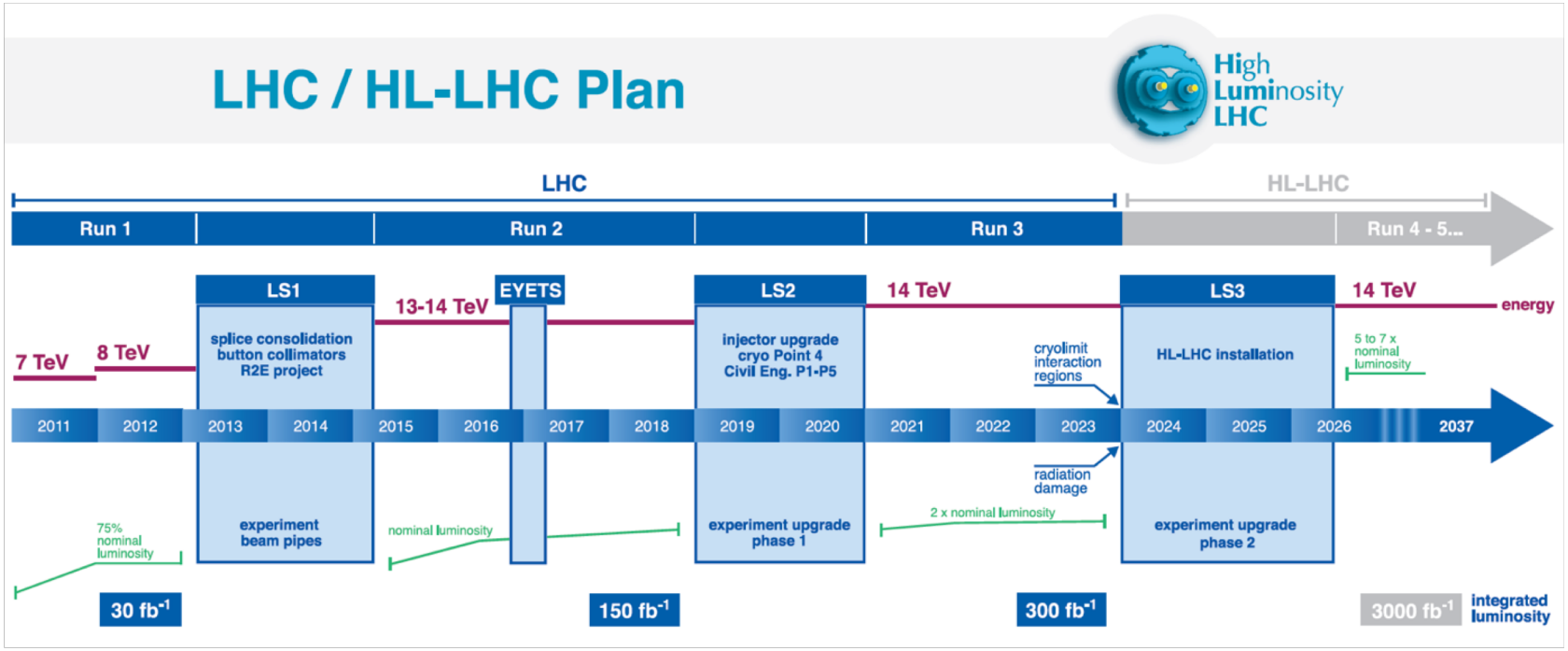
Power per sub-detector (front-end)

- Inner tracker: ~70 kW
  - Several MRad and 10^{14} neutrons.cm^{-2}
  - 2 tesla
- Calorimeters
  - Electromagnetic: ~200 kW
  - Hadronic: ~50 kW
  - A few 10's of kRad and 10^{13} neutrons.cm^{-2}
  - Low magnetic field
- Muon spectrometer: ~150 kW
  - Low level of radiation
  - Several kGauss

Outline

- Current Atlas experiment
- Upgrade program
- Basic requirement for new powering scheme

Upgrade Schedule



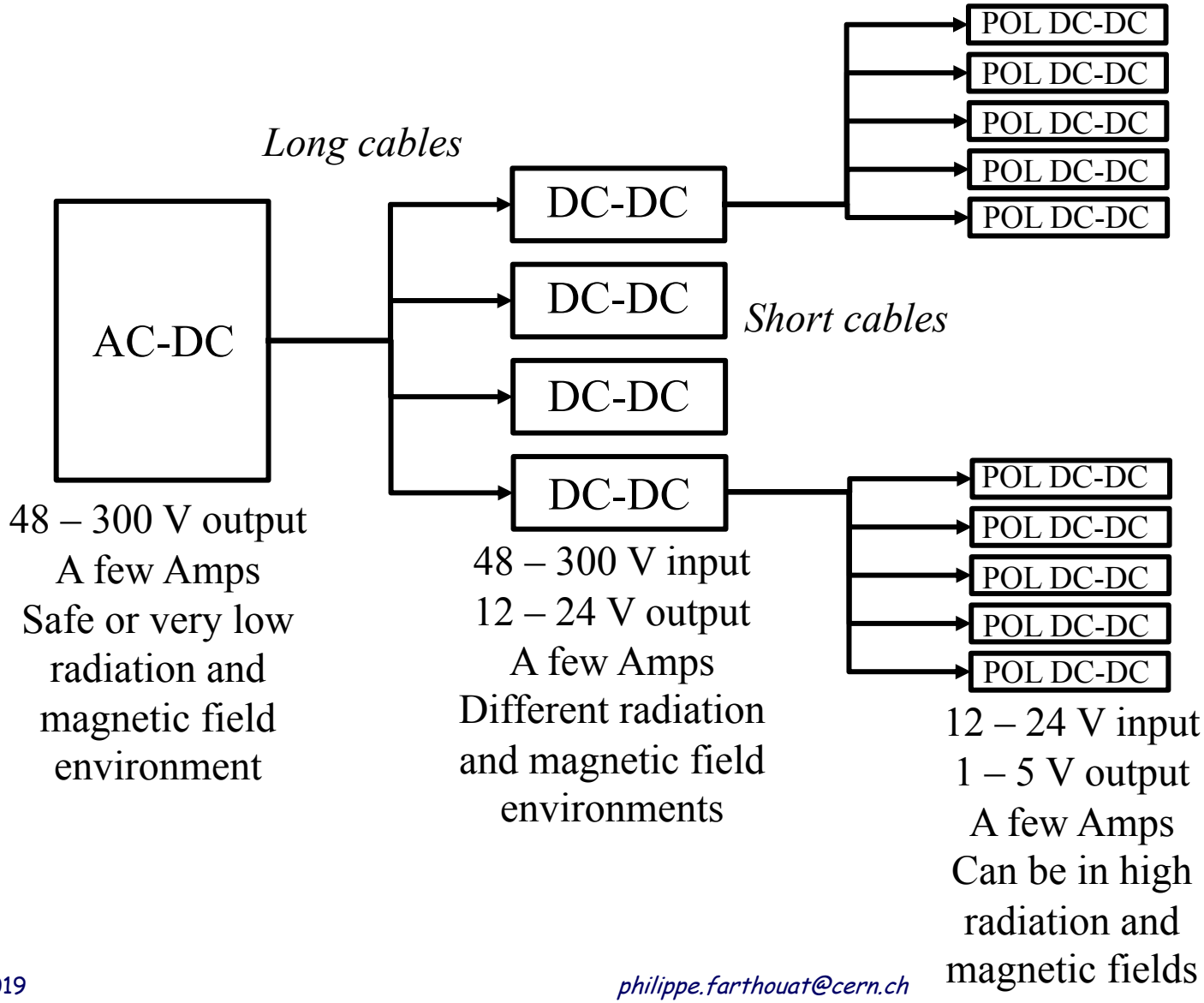
- Major upgrades during LS3
  - New Inner Tracker
  - Replacement of the front-end electronics of all sub-detectors

Impact of the Upgrade on Power

- More particles to be detected, more data to be readout
  - Granularity of the inner tracker increased
  - Readout of the other subdetectors at 40 MHz
- Total amount of power cannot dramatically change
  - Remain in the same ~500 kW ball park
- New technologies use less power
- But more current

- Intensive use of DC-DC converters
  - Or serial powering scheme from the inner part

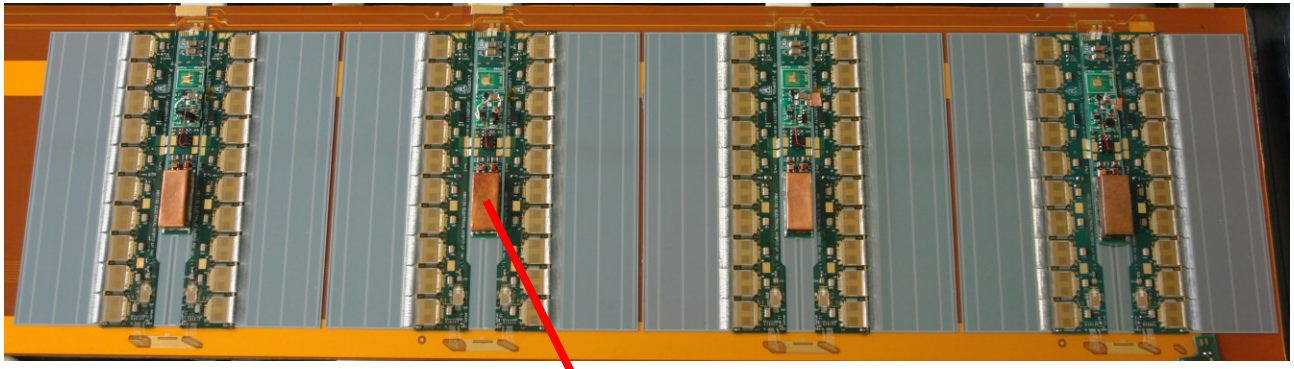
Powering Scheme – LV Generic View



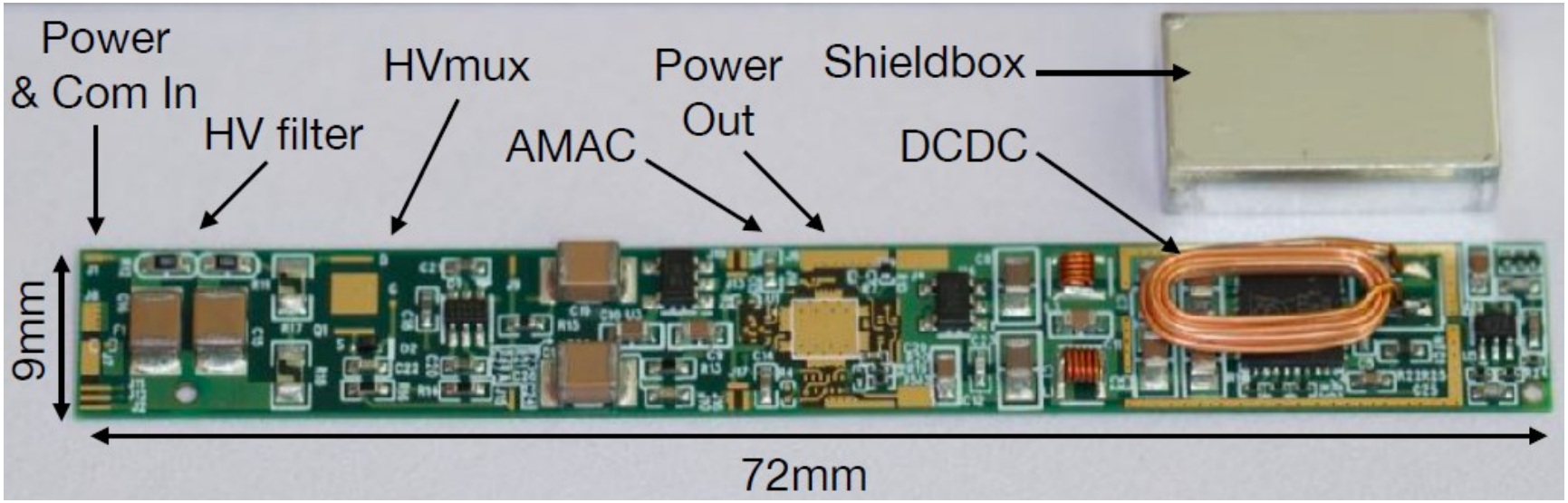
Outline

- Current Atlas experiment
- Upgrade program
- Basic requirement for new powering scheme

Inner Tracker – Strips



Prototype short strip modules on stave

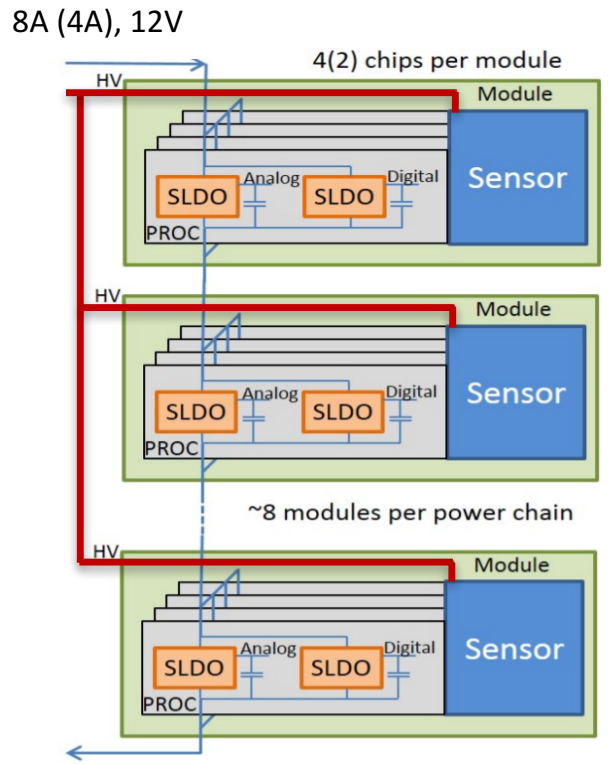


Inner Tracker – Strips

- LV power
  - AC-DC
    - 48 V out
    - 2 or 4 A
    - 1600 channels
    - No radiation and no magnetic field
  - DC-DC
    - 48 V in – 14 V out
    - 5 or 10 A (two versions)
    - Moderate radiation
      - 20 Gy – 3 10^{11} 1 MeV neq
    - 6 kGauss
    - About 1600 channels
- HV power
  - 500 V – 8 mA max
  - 3600 channels
  - No radiation and no magnetic field
- AC-DC and HV power in 19" racks with vertical air flow cooling
- DC-DC in custom crates water cooled
- Control
  - Remote ON-OFF
  - V – I monitoring
  - Max I and V setting
  - Interlocks

Inner Tracker – Pixels

- Inner most part of the detector
- Strong restrictions on the material quantity
- LV
  - Serial powering scheme
    - To minimize the cables volume
  - Requires constant current sources (8 A)
    - One source per Serial Power (SP) chain
    - About 1000 SP chains
    - No radiation and no magnetic field
- HV
  - 800 V – 1.5 mA
  - About 1000 channels
  - No radiation and no magnetic field
- Complex control and interlock between the LV and the HV



Lar Calorimeter

- LV power
  - AC-DC
    - 280 V out
    - 12 A
    - 58 units
    - No radiation and no magnetic field
  - DC-DC
    - 280 V in – 12, 24 or 48 V out
    - 3 kW to be delivered
    - Location not finalised
      - A. Moderate radiation (20 Gy – 3 10^{11} 1 MeV neq
      -) and 6 kGauss
      - B. Larger radiation (1 kGy – 2 10^{12} 1 MeV neq) and low magnetic field
    - About 58 units
- HV power
  - 2500 V – 3 mA max
  - 4500 channels
  - No radiation and no magnetic field
- AC-DC and HV power in 19" racks with vertical air flow cooling
- DC-DC in custom crates or boxes water cooled
- Control
  - Remote ON-OFF
  - V – I monitoring
  - Max I and V setting
  - Interlocks

Muon Detector

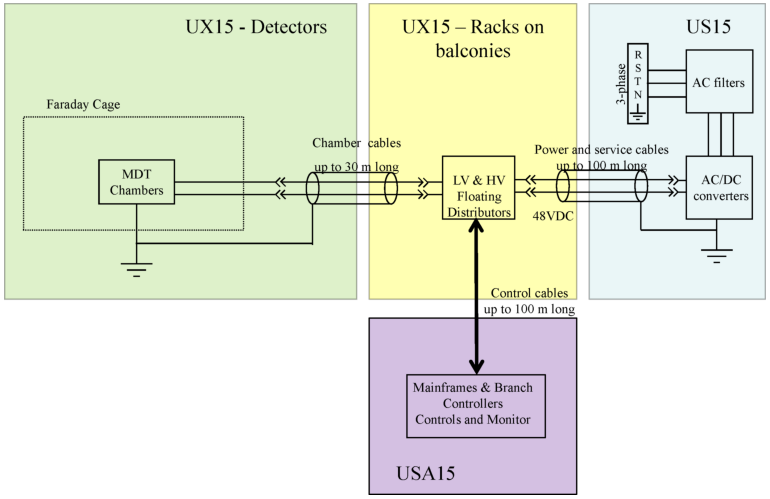


Figure 10.1: Simplified scheme of the HV and LV systems for the MDT detectors.

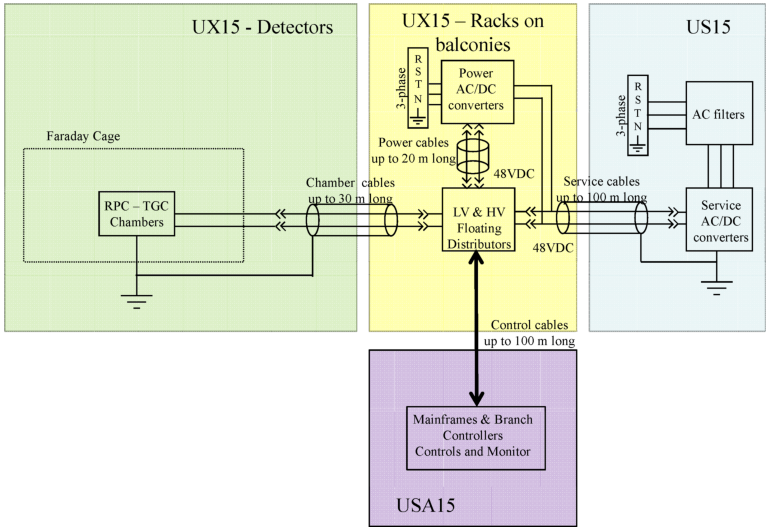


Figure 10.2: Simplified scheme of the HV and LV systems for the RPC and TGC detectors.

- Current system is using more than 1500 modules of different sorts
  - Radiation (~100 Gy) and magnetic field (up to 1 kGauss)
  - DC-DC for LV

    Multiple Vout and I
  - HV module

    12 kV – 1 mA

    4 kV – 1 mA
- Upgrade plan not yet finalized
  - Adiabatic change considered
  - Specs in 2019, prototypes in 2020, pre-production in 2021 and production 2022-2025

Summary

- Short presentation of the ATLAS requirements
- Detailed specifications to be finalized in 2019 – 2020
- Specific invitations to tender for each system
- Production to be finished in 2025