Phase 2 Power Supplies Requirements

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- Only LV power supplies are considered in this presentation

- Serial powering is not treated
  - Pixel only
  - Coordination within RD53 assumed

A bit of History (1)

- Current ATLAS detector
  - Tracker
    - Pixel: voltage regulators at PP2 powered by WIENER PL512
    - SCT: one power supply channel per module. Direct powering (with a clamp in PP3). Home made system
    - TRT: voltage regulators at PP2 powered by WIENER MARATON
  - Calorimeters
    - Lar: complex DC-DC converter on the detector (each box containing 27 DC-DC). Voltage regulators on the FEBs
      - First version failed and was replaced by a WIENER design
    - Tile: complex DC-DC converter in the drawers. Direct powering of FE
      - Two versions done
  - Muons
    - Large system mainly based on CAEN EASY system populated with different DC-DC modules

A bit of History (2)

- A number of devices are radiation and magnetic field tolerant
  - WIENER MARATON
  - CAEN devices
  - Calorimeters DC-DC
- Similar situation in the other LHC experiments
- The special environmental requirements limited strongly the number of companies able to deliver
- The load for the two usual culprits was extremely high
  - Some delays experienced just before the LHC start
  - "Crash coordination" program between the experiments for the delivery

- *We should try and anticipate a very likely similar situation for phase 2*

Point of Load DC-DC

- All the detectors (except pixels) plan to use POL DC-DC
- Assume we'll get a radiation hard enough version (air core inductance for B)
  - upFEAST and DCDC2S
- COTS may be considered for outer layers (e.g. calorimeters and muons)
  - Could allow higher input voltage
  - A lot of testing required for validation…
  - If one found OK, it should be advertised

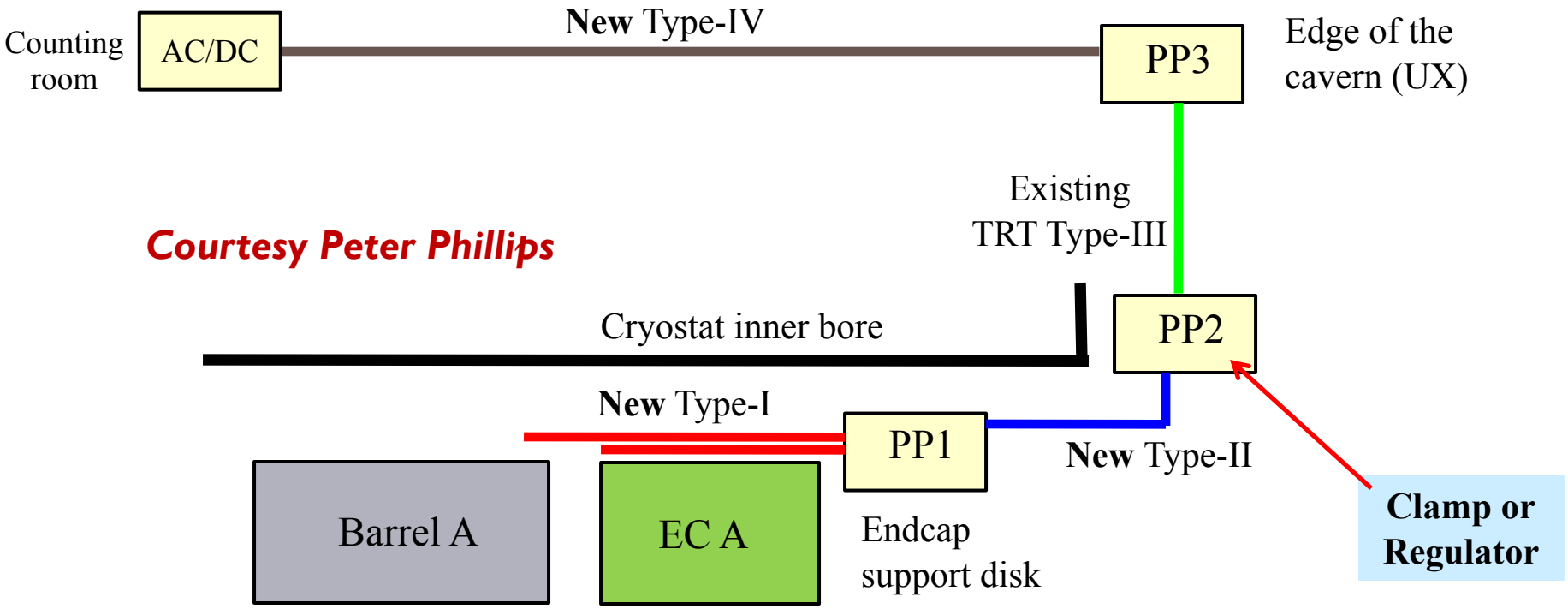
- The requirements on the power supplies feeding these devices are much lighter than in the current systems
  - One or two different voltages
  - Less constraints on regulation etc.

Silicon Strips

- POL DC-DC to be used on the front-end
- Reuse of some existing cables
- Several schemes being considered to power them
  - Power directly from the service cavern (~15V source)
  - Intermediate DC-DC either at PP3 (periphery of detector) or PP2 (inside muon detector; High B)

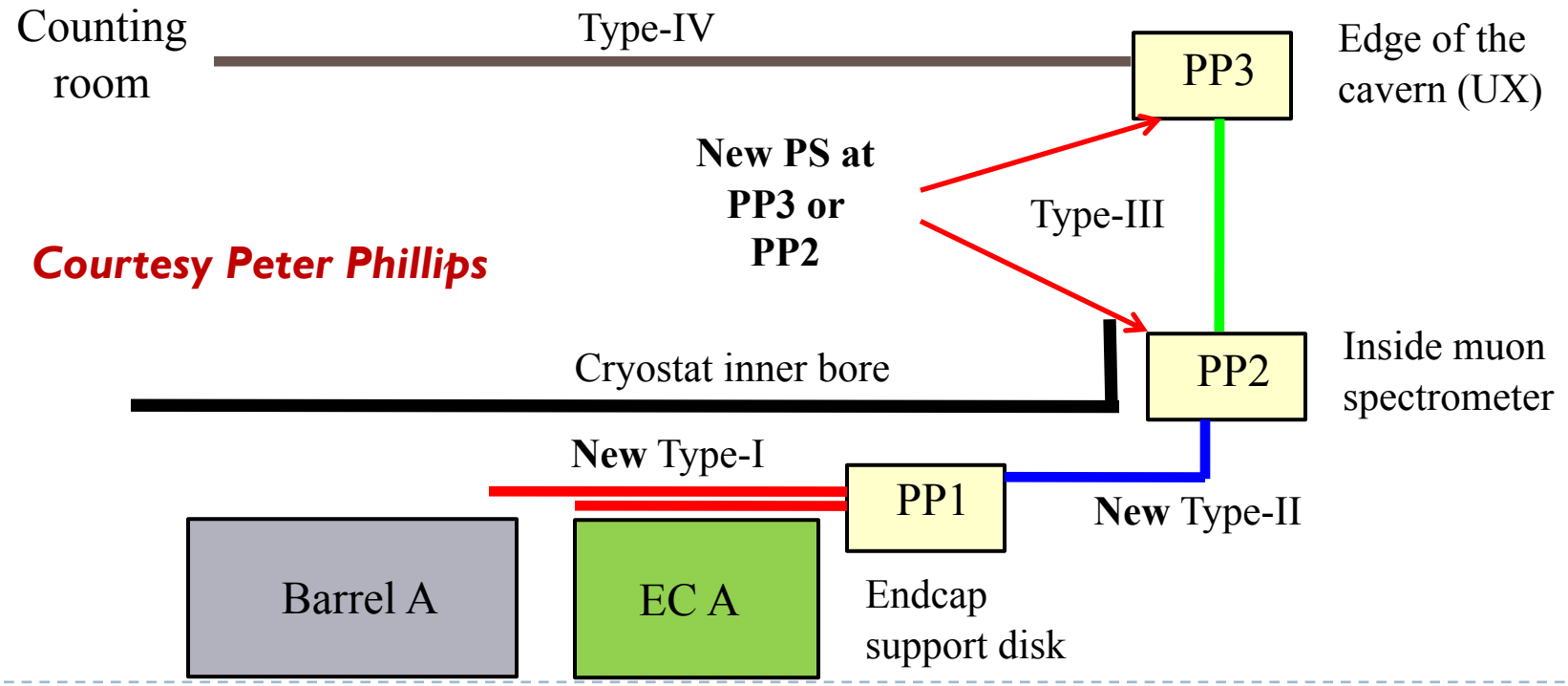
Silicon Strips: Single Stage DC-DC

- COTS LV in US(A)15?
  - No need for radiation tolerant bulk supplies
  - Is there enough space in the service cavern?
- If turn off all the modules on SS stave, maximum ∂I ~12A. Must control ∂V to avoid damage!
- Radiation Hard voltage clamp or regulation at PP2 and/or clever control at the source



Silicon Strips: Dual Stage DC-DC

- AC-DC in US(A)15 delivering 48 V or more
- Radiation Tolerant power supply at PP3 or PP2
  - Essentially a second DC-DC converter stage delivering 12–14 V for the POL DC-DC
- If turn off all the modules on SS stave, maximum ∂I ~12A. Must control ∂V to avoid damage!

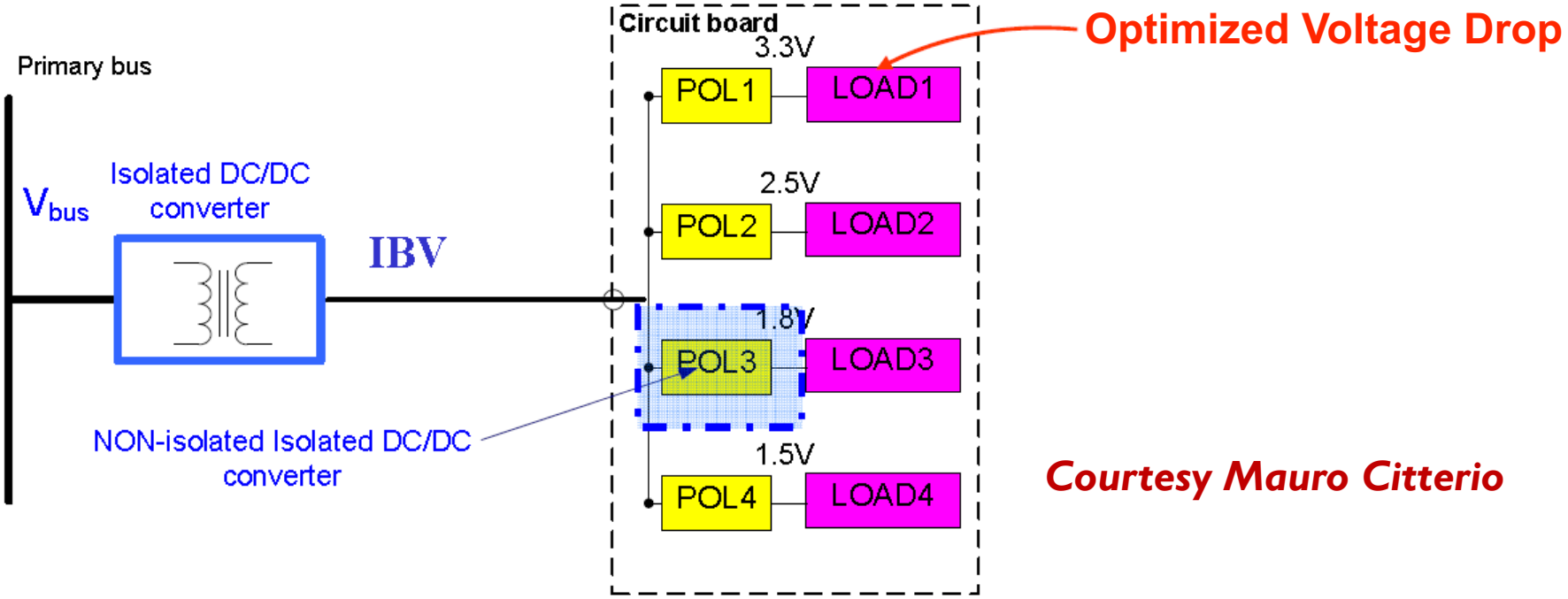


Calorimeters

- POL DC-DC to be used on the front-end
- A tile drawer or a LAr front-end crate requires a substantial amount of power in a limited place
  - E.g. ~3–4 kW for a Lar crate
- Direct powering from the service caverns might be difficult
  - Large current needed at 12 V if upFeast used
  - Higher voltage could be used but not with FEAST as POL
- Both Lar and Tiles plan to use another level of DC-DC close to the FE crates/Drawers
  - Similar to existing system but with less complexity
  - Mechanical constraints

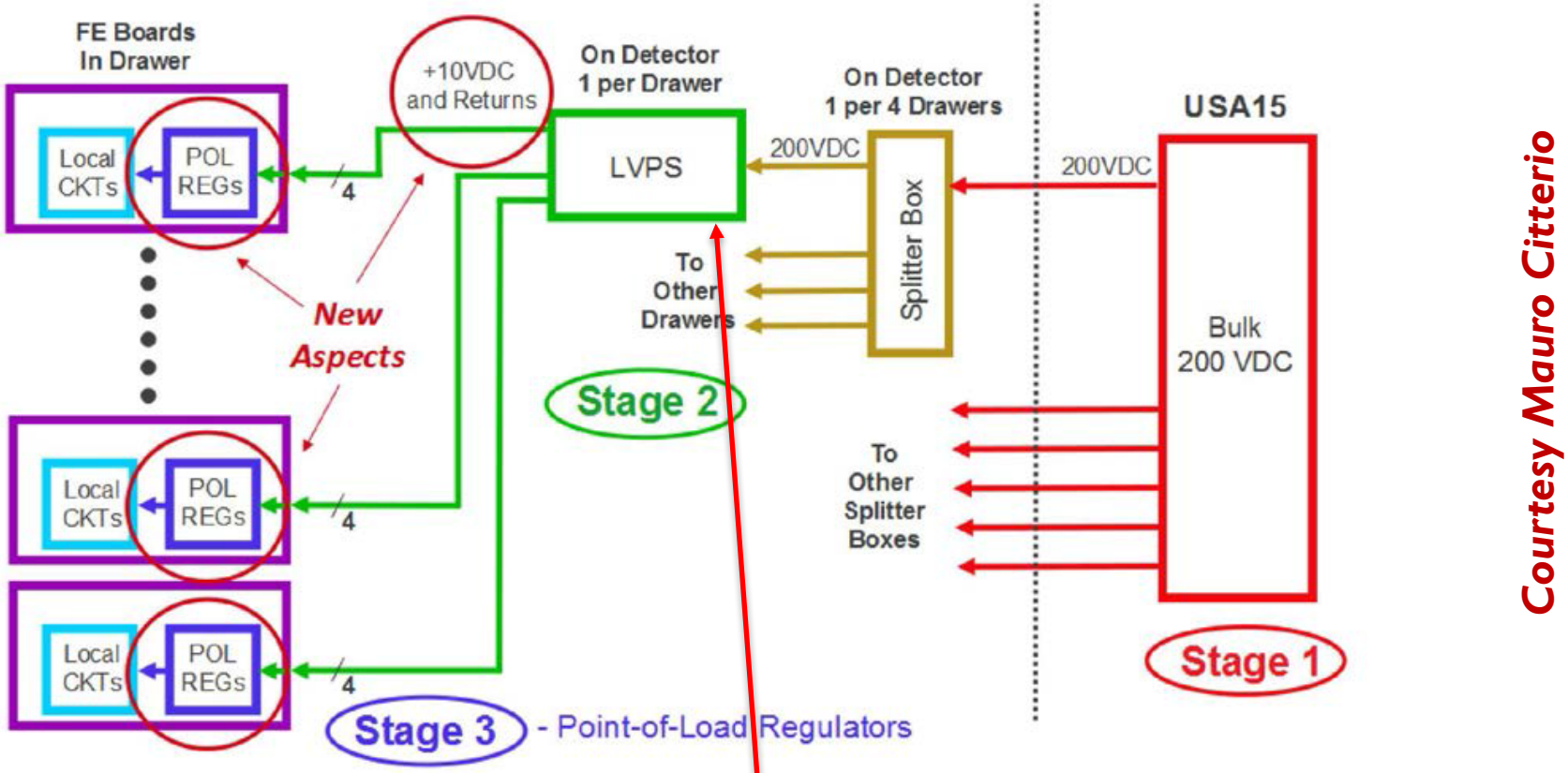
LAr Calorimeter

- Phase II upgrades require new electronics with lower supply voltages
  - LDO regulators replaced by NON-Isolated DC-DC converters
- Distributed Power Architecture (DPA) replaces the centralized power distribution
  - A single intermediate DC bus (+48Vor+12V) is generated by a main converter



Courtesy Mauro Citterio

Tile Calorimeter



- The LVPS system consists of +10 V feeder supplies located at the ends of the barrel
  - Total power is ~ 300 Watt/unit

Muons

- POL DC-DC to be used
- Existing services constraint a lot the upgrade path
  - New system likely to stick to the existing granularity/geometry
- Dramatic changes (e.g. moving the power supplies in the service caverns) are not envisaged
- Adiabatic change preferred
  - Installed DC-DC modules have enough power to feed the POL of the new electronics and the cables are good enough (lower current because of the POL DC-DC)
  - Replacement by more optimised (and simpler) modules over several years

A3016B (MDT)	6 ch	8V/16A/90W
A3025B (LVL1)	4 ch	8V/25A/150W
A3009 (RPC & LVL1)	12 ch	8V/9A/45W

Used devices (excluding CSC which are using MARATON

New Small Wheels

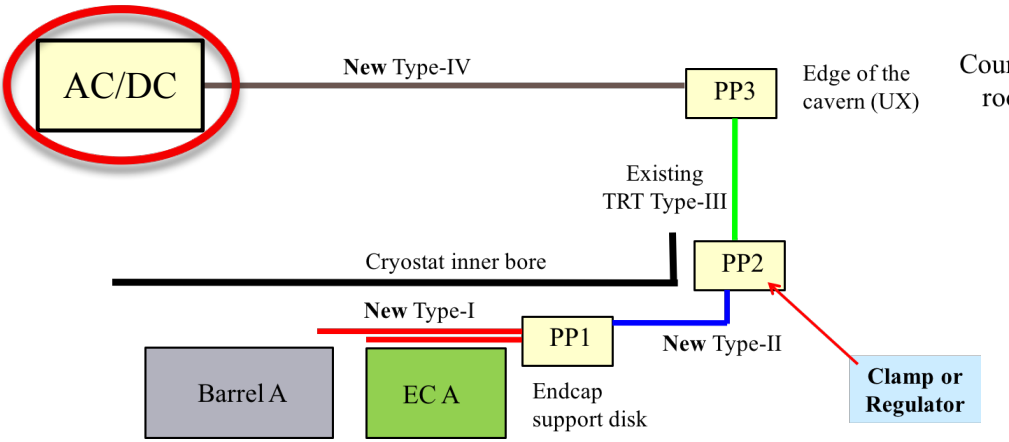
- Installation during LS2
- Front-end using POL DC-DC (FEAST)
- No way to power individually the front-end boards
- Intermediate DC-DC on the chambers RIM
- Very similar architecture as the calorimeters

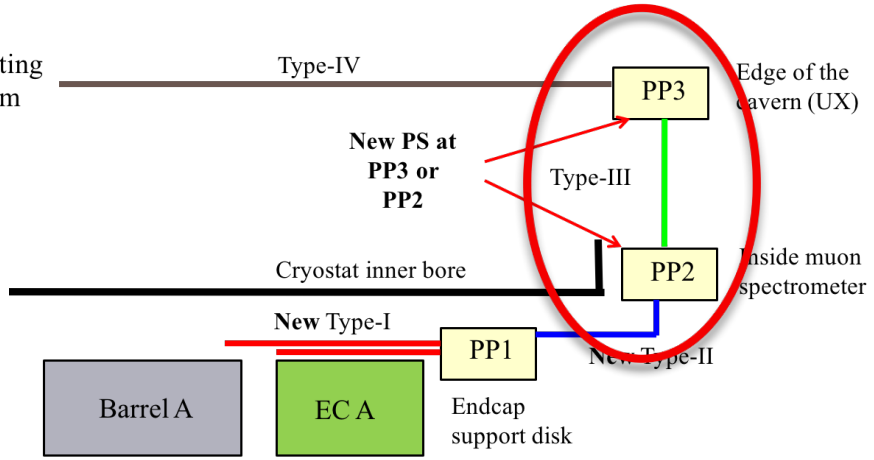
ACES 2016

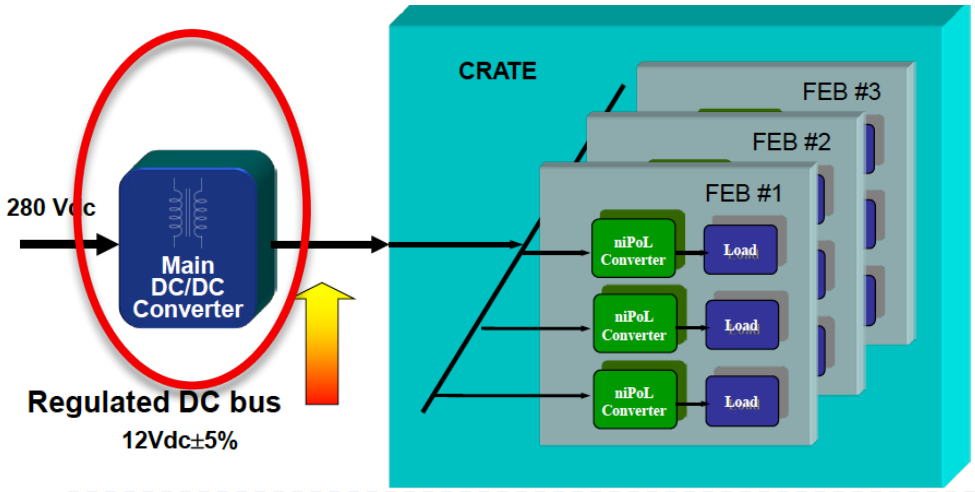
- Proposal made at joint ATLAS-CMS Electronics workshop, ACES-2016
  - Common developments
    - Establish Requirements
    - Build Demonstrators with industrial partners
    - Run System Tests
    - Run Qualification Tests
- Common procurement
- Common maintenance and logistics
- DC-DC powering common project
  - Differentiate between Calorimeter-type and Tracker-type systems
  - Slow progress
    - System aspects to be understood first
    - Strained resources and more urgent priorities

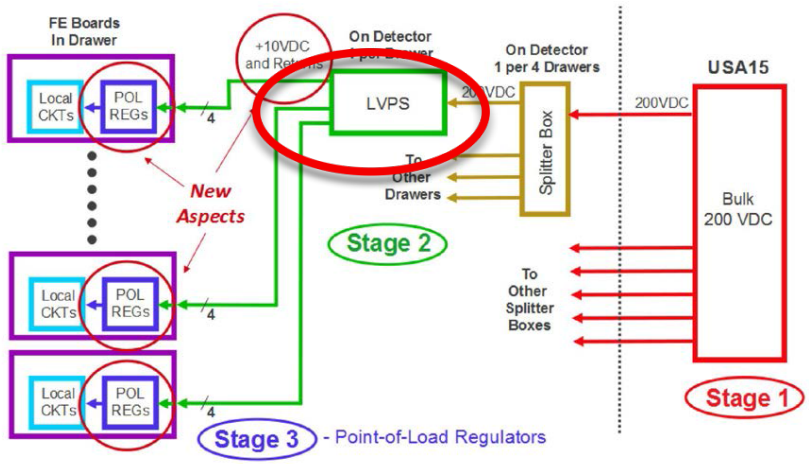
First Steps: Silicon Strips and Calorimeters

- Rough requirements of what is needed









First steps: Muons

- Replacement plan for the existing converters
- Rough specs of the new ones
- Specs of the NSW DC-DC

Next Steps

- See whether commonalities can be found within ATLAS
  - Could be at the level of "building blocks"
    - e.g. DC-DC component, control
- Do the same in CMS
- Reduce diversity (ATLAS/CMS) as much as we can
  - e.g. avoid 50 different types of modules for the muon detectors
- Build demonstrators, preferably with industrial partners
- Put in place procurement and maintenance contracts

Practicalities

- Define working groups per type:
  - (Serial powering (under RD53 umbrella to start with))
  - Trackers
  - Calorimeters
  - Muon spectrometers
- Representatives per experiment and representative(s) from CERN electronics group
  - From the list detailed needs → possible specs
  - Refine the designs/concepts

Summary

- Rough requirements for each system to be made available
  - So far I only got promises
- Similar exercise in CMS
- Look at reducing diversity