MM Electronics Power Concepts

D.Amidei, J. Ameel
University of Michigan

with
V. Polychronakos (BNL)
K. Johns, W. Hart (Arizona)
J. Huth, J. Oliver (Harvard)
U. Landgraf (Freiburg)

MM electronics power

- VMM power required

item	Power (W)	counting
channel	0.008	
chip	0.512	64 channels
FE board	4.10	8 chips
layer	65.5	16 boards
doublet	131	2 layers
quadruplet	262	4 layers
sector	524	8 layers
wheel	8.3K	16 sectors
system	16.7K	2 wheels

- the whole power:
  - will have ~ 70% transmission efficiency
  - will be x1.3 (?) to include trigger/readout
- example: one sector = 524*(1/0.7) * 1.3 = 973 W

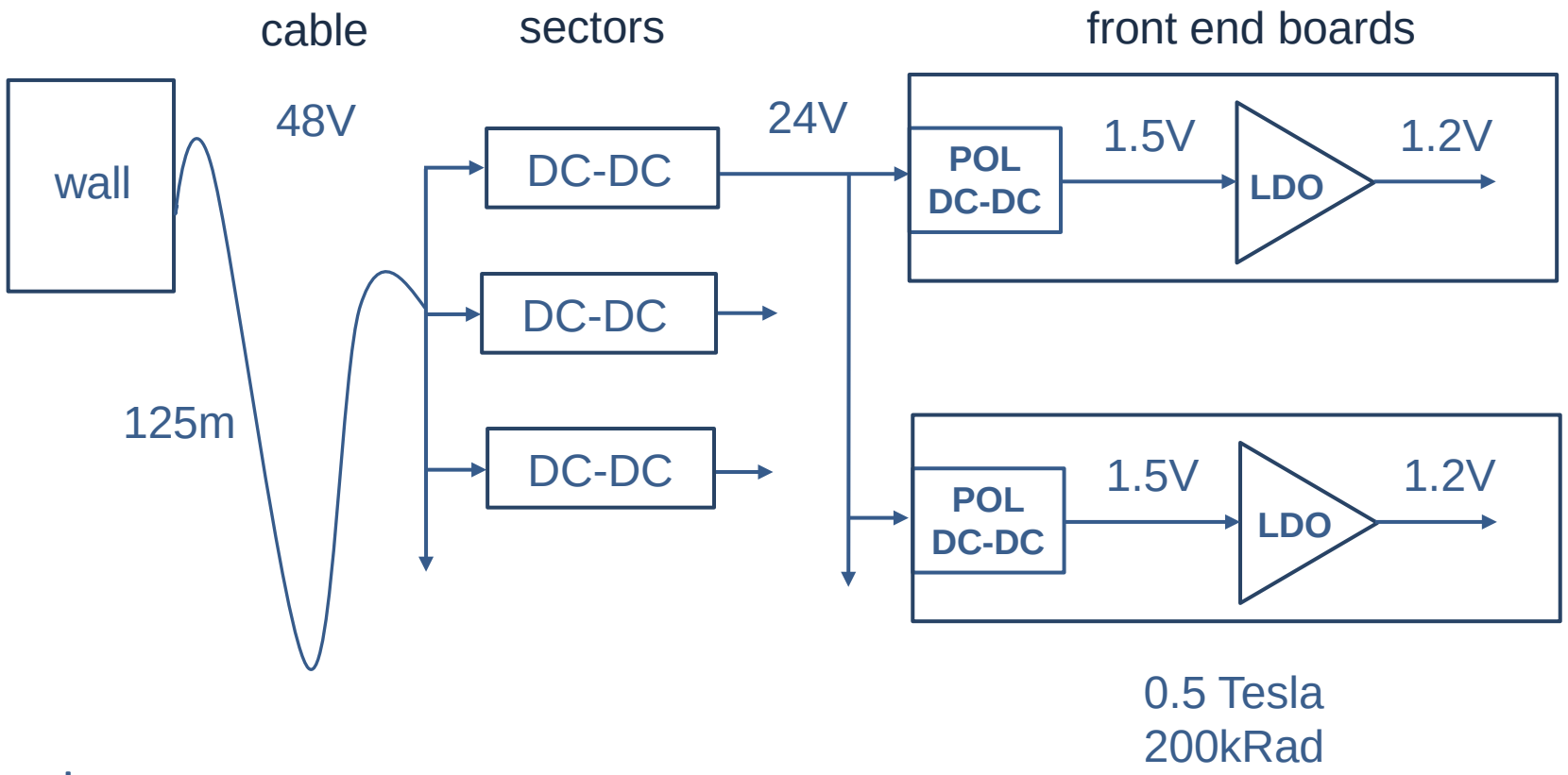
power delivery

- rad hard VMM operates at 1.2V
- one sector: 973W at 1.2V → 810 Amps

- problem is being solved for Phase1-Phase 2 tracker upgrades
- solution: high voltage transmission using point-of-load DC-DC conversion

- see e.g.
  - S. Michelis "Status of DC-DC Components" ATLAS Upgrade Week, 18/11/2012
  - K. Klein et al "DC-DC Powering for the CMS Pixel Upgrade", 13th Vienna Conference on Instrumentation, 11/2/2013.

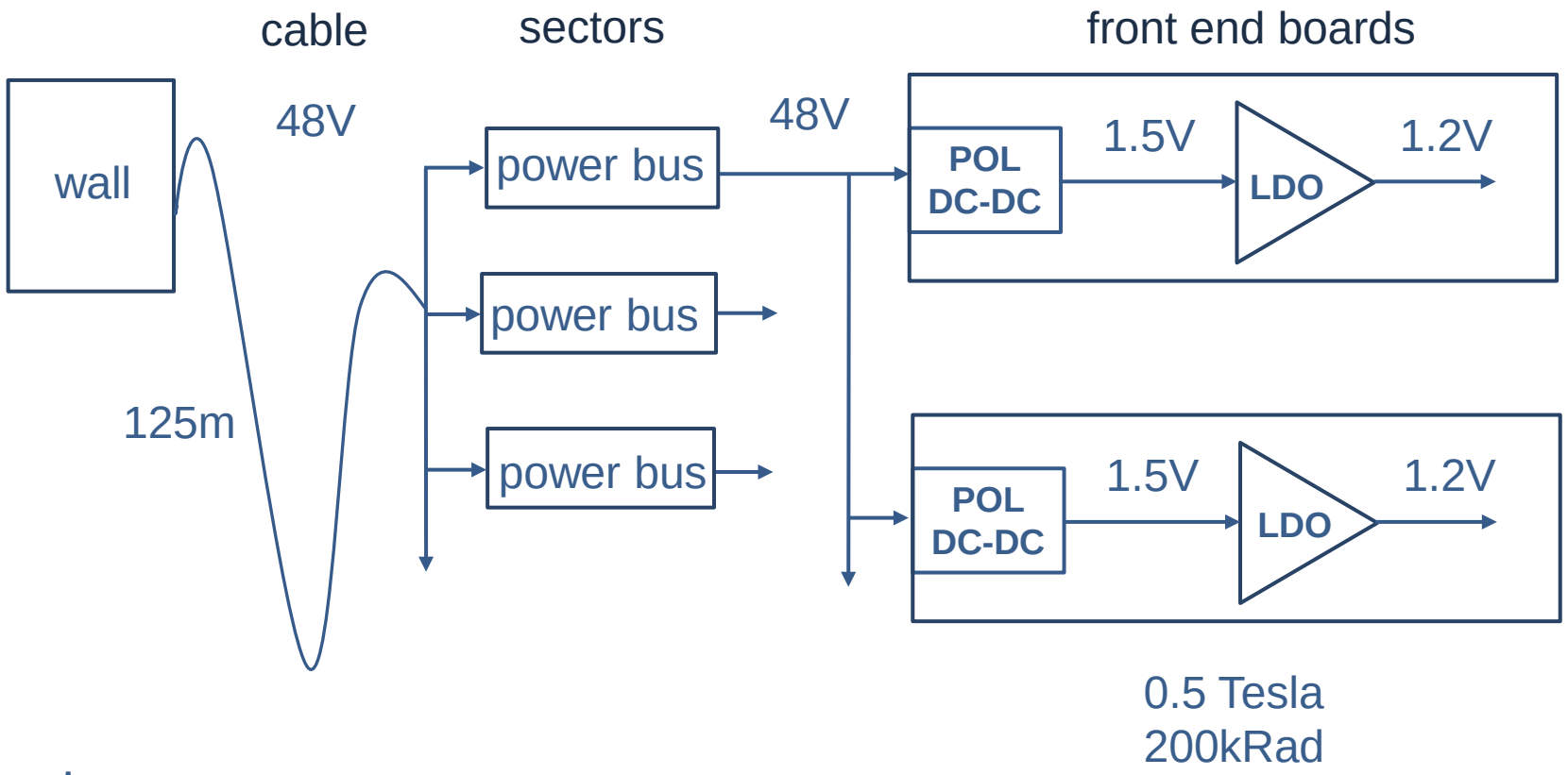
two-step followed by linear regulator



n.b.

each stage costs efficiency ~ 0.8-0.9

one-step followed by linear regulator



n.b.

each stage costs efficiency ~ 0.8-0.9

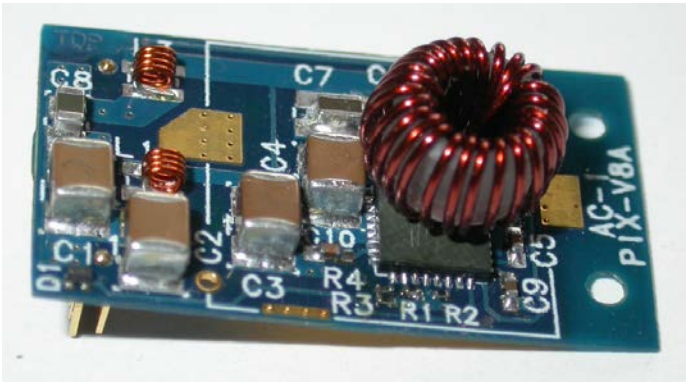
if find a 48V-1.5V POL converter, do this in **one step**

DC-DC conversion

- LTM4619V
  - 26V in, 1.5-5.0V out
  - survives 350 kRad

- ASQ4815
  - 48V in, 1.8V out
    - one step design
  - 2”x1” board
  - space qualified

- Aachen/CMS custom
  - 10V in, 2.4V out
  - rad hard, B tolerant



Qualify DC-DC converters and linear regulators

test

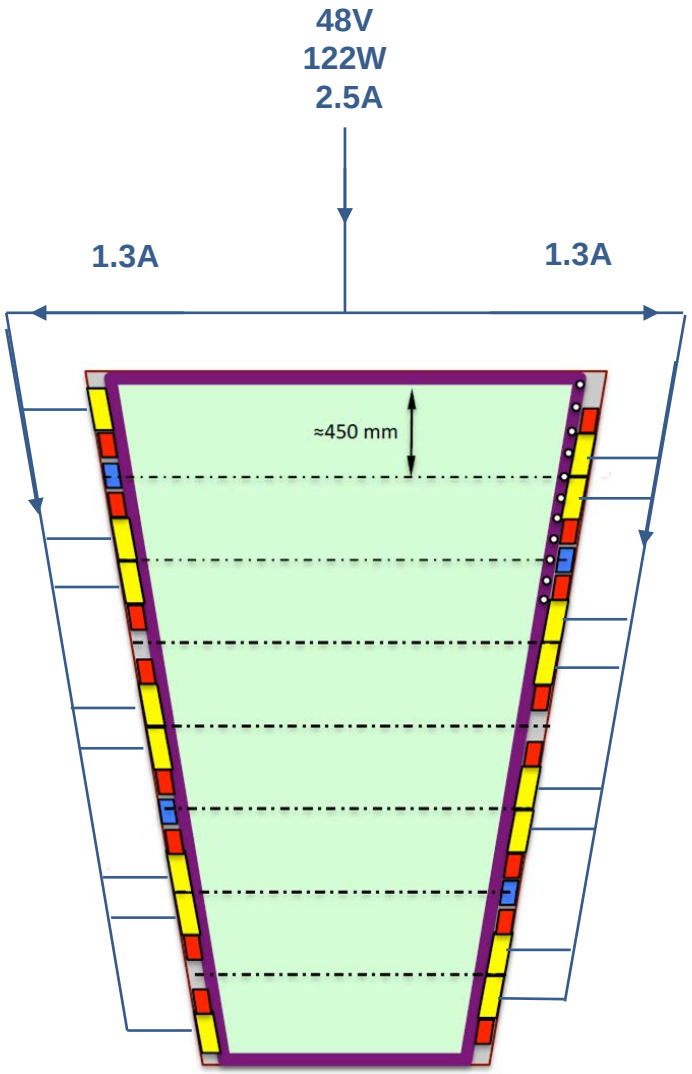
- efficiency, noise, heat, EMI, etc

as a function of

- radiation
  - 200kRad
  - BNL Semiconductor Gamma Radiation Facility
- magnetic field
  - 0.5-1.0 T

settle device choice this Fall

back-of-envelope for one layer



Assume a one-step 48V design

Per layer :

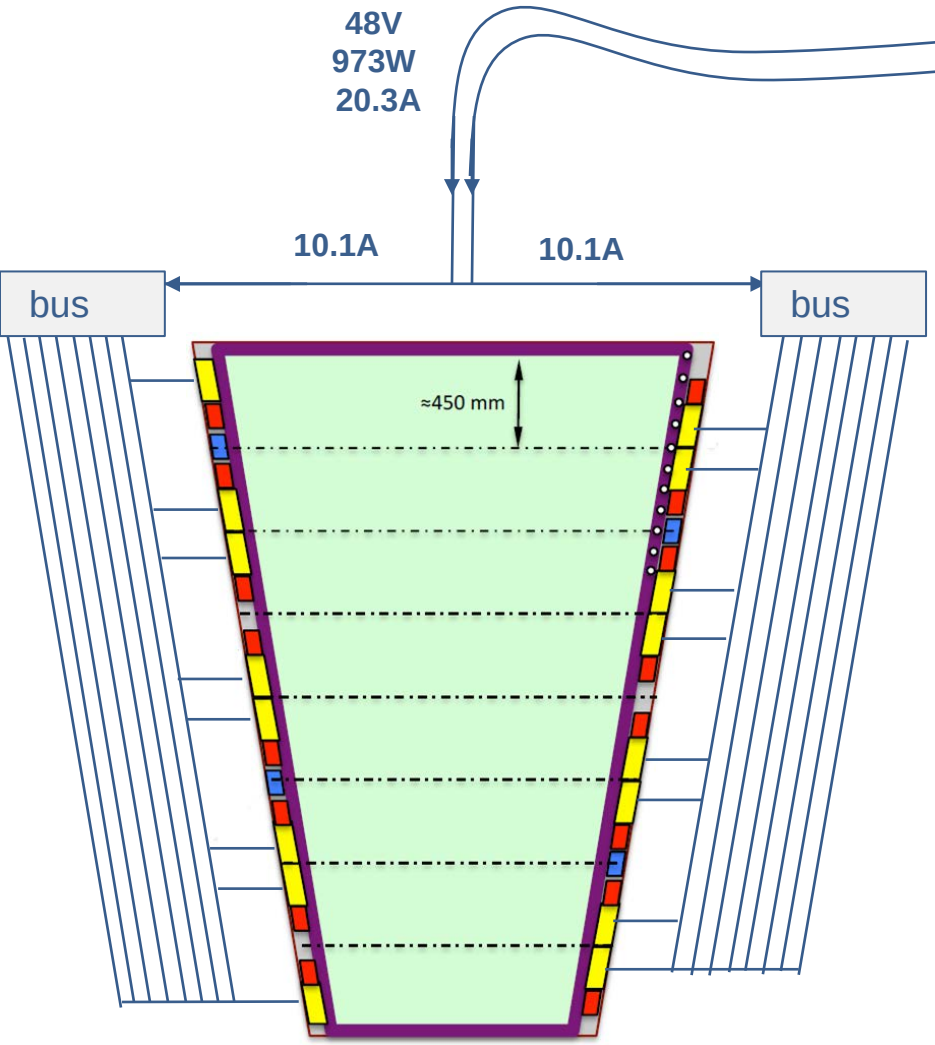
- 16 boards @ 7.6W★
- 122 W
- 2.5A @48V

Deliver ½ current to each side:

- 1.3A @ 48V
- cable:
- 22 AWG d = 0.6mm
- 5meters:
  drop 0.3V
  lose 1.7W

★ FE board power
4.1W * (1/0.7) *1.3 = 7.6W

back-of-envelope for one sector = 8 layers

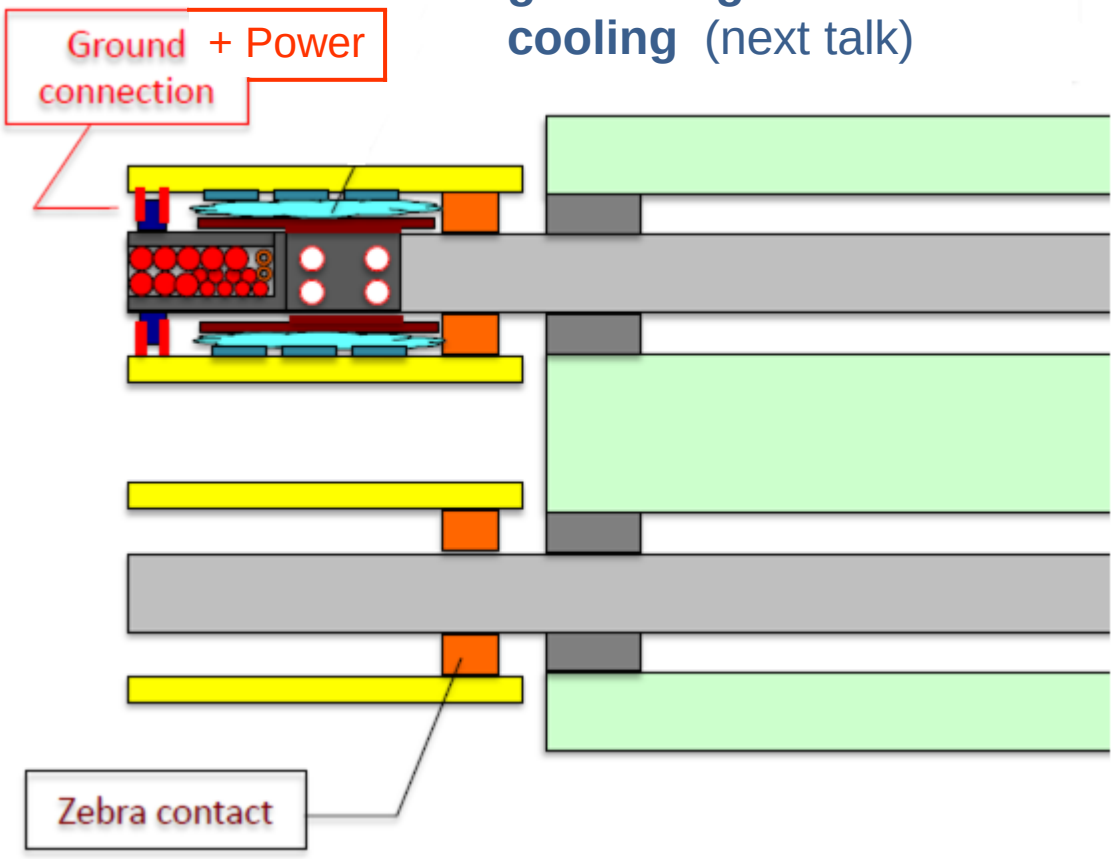


Per layer :

- 128 boards @ 7.6W[1]
- 973 W
- 20.3A @48V

- cable:
  2 x 8 AWG d = 3.3 mm
- 125 m
- on each
  - 10.1 A
  - 2.5V drop
  - 25W lost

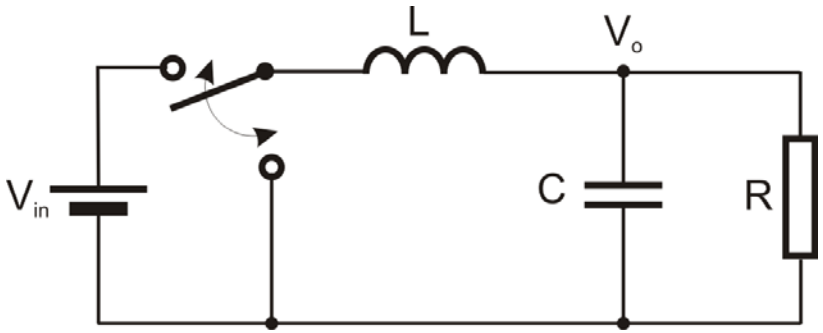
TBD:
power connections
wire size
ganging scheme
grounding
cooling (next talk)



summary

- FE electronics power ~ 1kW/sector
- transmit as close to 48V as possible
  - using POL DC-DC conversion
- developing concept
- identify/test DC converters, regulators
- understand layout issues
- closely coupled to cooling
- TDR section coming

DC-DC conversion



- Example: Linear LT46119
  - works at 150KRad
    - Wide Input Voltage Range: 4.5V to 26.5V ($EXTV_{CC}$ Available for $V_{IN} \leq 5.5V$)
    - Dual 180° Out-of-Phase Outputs with 4A DC Typical, 5A Peak Output Current for Each