Power distribution for the Mu3e experiment

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 $10^8 \mu$ /s DC muon beam stopped on a double cone mylar target





50 μ m thin active pixel sensors (MuPix), mounted on a polyimide support

The Mu3e experiment

- Search for the lepton flavour violating decay $\mu^+ \rightarrow e^+ e^+ e^-$
- SM branching ratio of 10⁻⁵⁴, search for new physics
- Current limit on the BR: $< 10^{-12}$ from SINDRUM (1988)
- Phase I experiment aims for a $2 \cdot 10^{-15}$ single event sensitivity
- Stopping 10⁸ μ^+ /s DC beam at π E5 (PSI)
- Tracker with excellent time, vertex, and and momentum resolution to

differentiate <u>signal</u> from background



- Low mass e^{-/+} tracker in a IT magnetic field based on
 - High Voltage Monolithic Active Pixel Sensors (HV-MAPS)
- Scintillating tile and fibre detector with a time resolution of 50/300 ps
- Triggerless readout, track reconstruction on GPU filter farm (see poster N. Berger)

2844 MuPix sensors each needing I.I-I.6 W



Power requirements

- Power hungry ASICs require 6.5 kW at low voltages (1.1-3.3V)
- DC-DC conversion in magnetic field with >75% efficiency
- Low mass power distribution in active detector region
- Converters compensate for voltage drops and extra power losses after conversion

II2 Frontend board with ArriaV FPGA consuming I3W





Power distribution system

- 120 *power partitions* with a single connection to a common virtual ground plane inside magnet bore
- Slow control power independent from main detector power
- 20VDC for each partition provided by Wiener MARATON supplies
- Frontend board has integrated DC-DC converters
- Dedicated power crate for MuTrig and MuPix ASICs
- LV power distribution through Cu bars and flex prints







388 MuTrig (SiPM readout chip)

each needing I.2 W

	Number	Device	vout (v)	Current (A)	
	112	Frontend board	1.1	2	
DC-DC converters	112	Frontend board	1.8	2	
	112	Frontend board	3.3	2.5	
	112	Detector ASIC	2.2	10-27	

- Buck converters based on a commercial chip + custom air coils
- **3** versions for frontend board, I *power board* for the detector chips
- \Box Each detector power partition requires 20A, 2V and < 10 mV Pk-Pk ripple
- Compact design with secondary LC filter, requiring minimal filtering
- downstream 2A, I.8V prototype

∿ ^Bw:250M



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20A, 2.2V prototype



Toroid aircoil for 20A, I MHz f_{sw}



voltage drop

input V: 18 V

input V: 19 V

9.0

10.0

load current

9.5

10.5

input V: 20 V

0.885 -

0.880

0.875

0.870 -

0.865

8.5



Significant reduction of EMI noise:



A C1 / 2.0mV Triggered Auto Dun Sam

Cluster of Excellence PR^îSMA⁺

Precision Physics, Fundamental Interactions and Structure of Matter



