

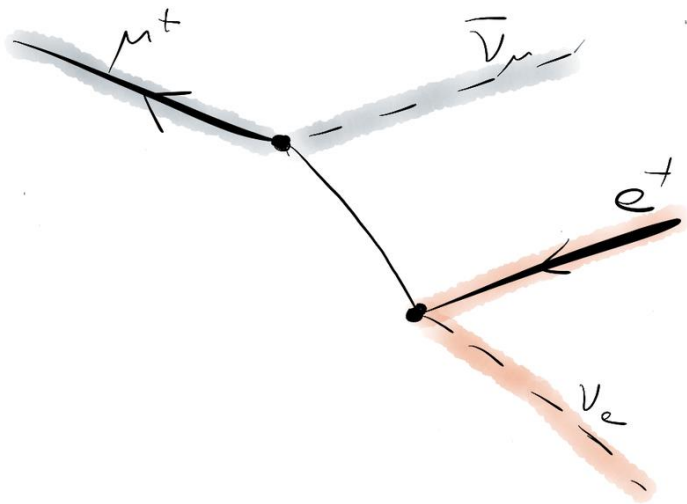


DEVELOPMENT OF A DC-DC CONVERTER FOR THE MU3E EXPERIMENT

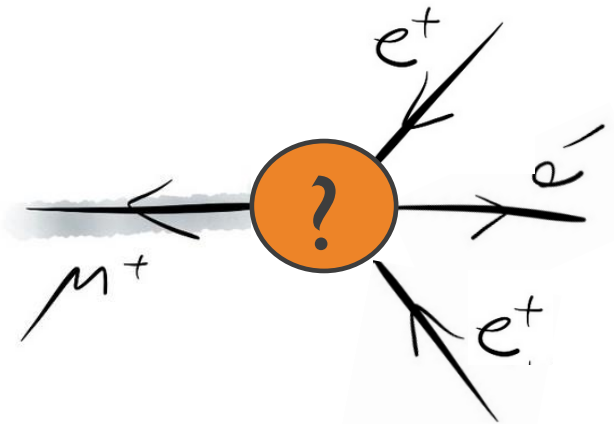
SOPHIE GAGNEUR FOR THE MU3E COLLABORATION

JOHANNES GUTENBERG UNIVERSITÄT, MAINZ


MOTIVATION



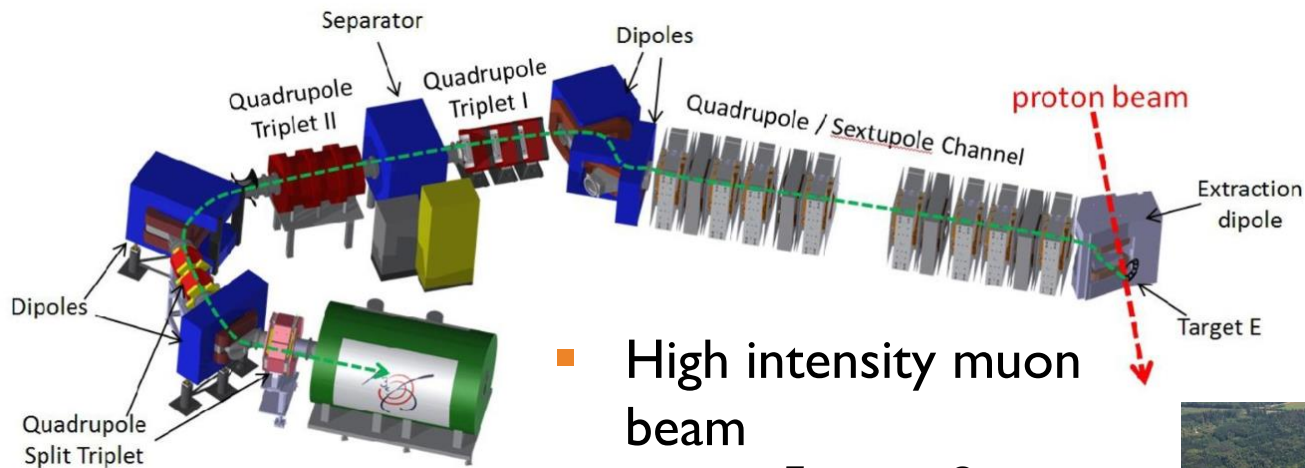
Theories of physics beyond the standard model



Michel decay

- Branching ratio nearly $\sim 100\%$
 - $\mu \rightarrow eee$ suppressed in the standard model
-  lepton flavour violation

THE EXPERIMENT

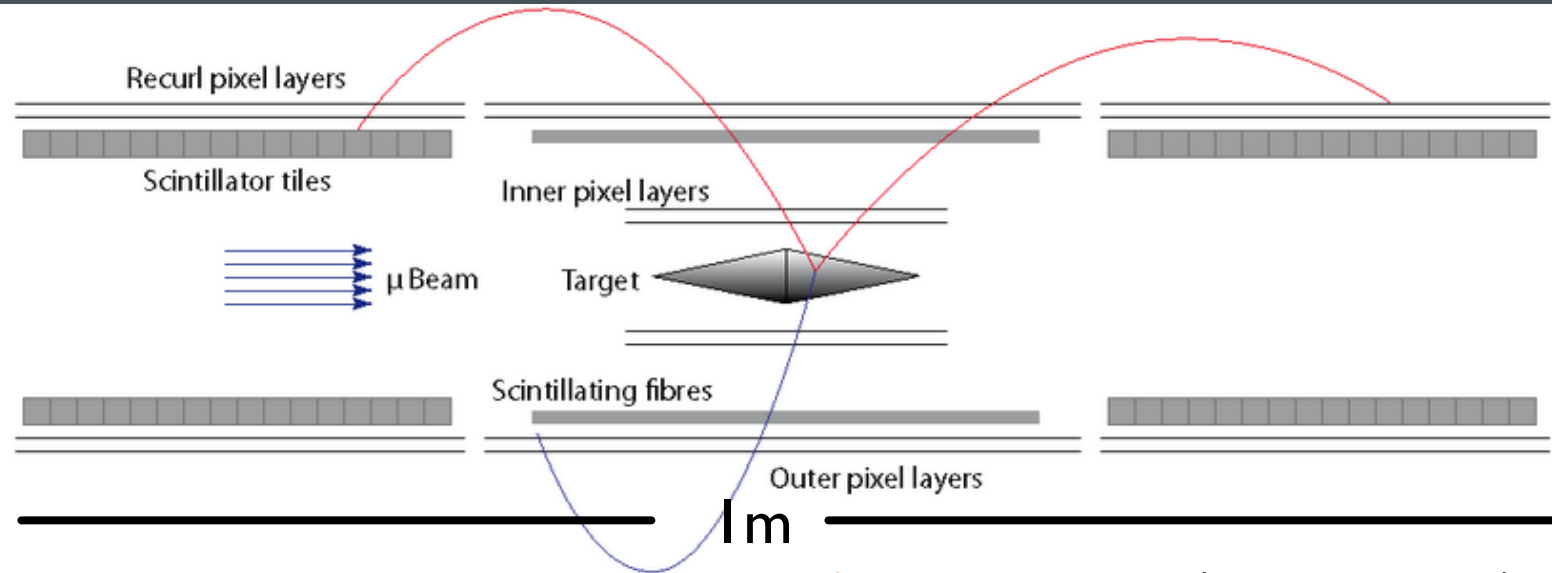


- High intensity muon beam
 - $10^7 - 10^8$ muons/seconds
- Sensitivity goal:
 $B(\mu \rightarrow eee) \leq 2 \cdot 10^{-15}$

Paul Scherrer Institute,
Villigen, Switzerland



THE MU3E DETECTOR

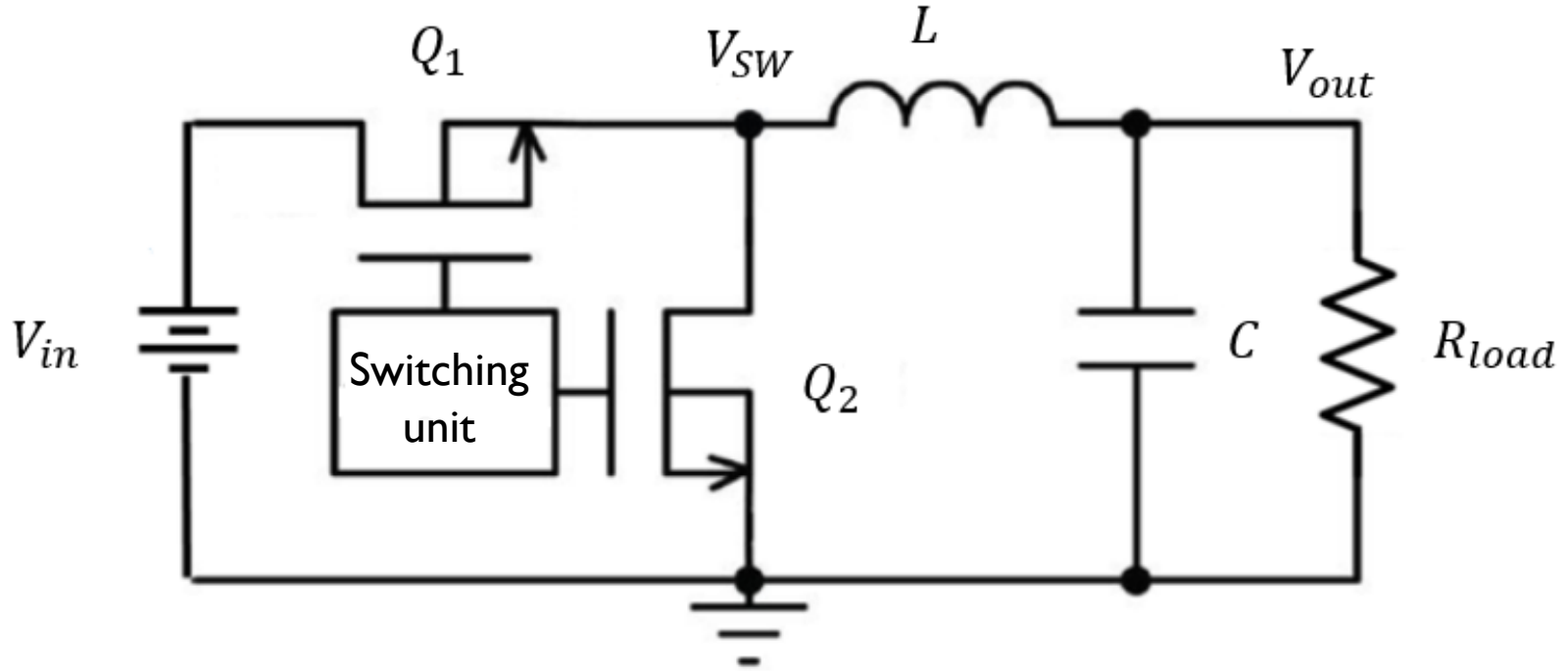


- Placed inside a 1 T strong magnetic field
- Three detector subsystems

- Pixel detector (MuPix sensors)
 - Accurate track and vertex reconstruction
 - Scintillating fibres
 - Scintillating tiles
- } Exact timing measurements

POWER REQUIREMENTS

- Relatively low voltages required by the detector components (1-3.3V)
- Cables are very long \Rightarrow high losses through the cables
- Thicker cables are not possible due to size
- Solution: DC-DC converters close to the detector parts step a 20V input power down to the required value
- 126 DCDC converters for the whole experiment
 - \Rightarrow provide more than 9kW power in total



WORKING PRINCIPLE

WHAT TO CONSIDER



External conditions



Quality of the output signal



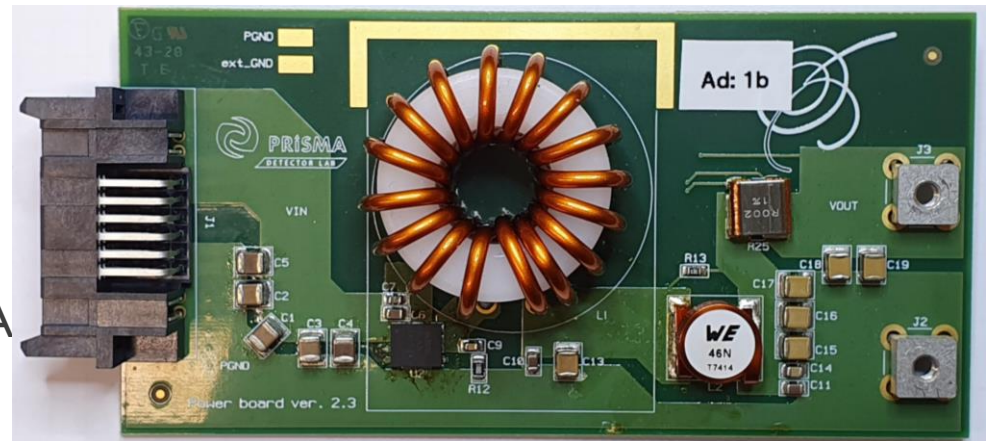
Are interlock systems needed?



Other systems for the functionality of the detector

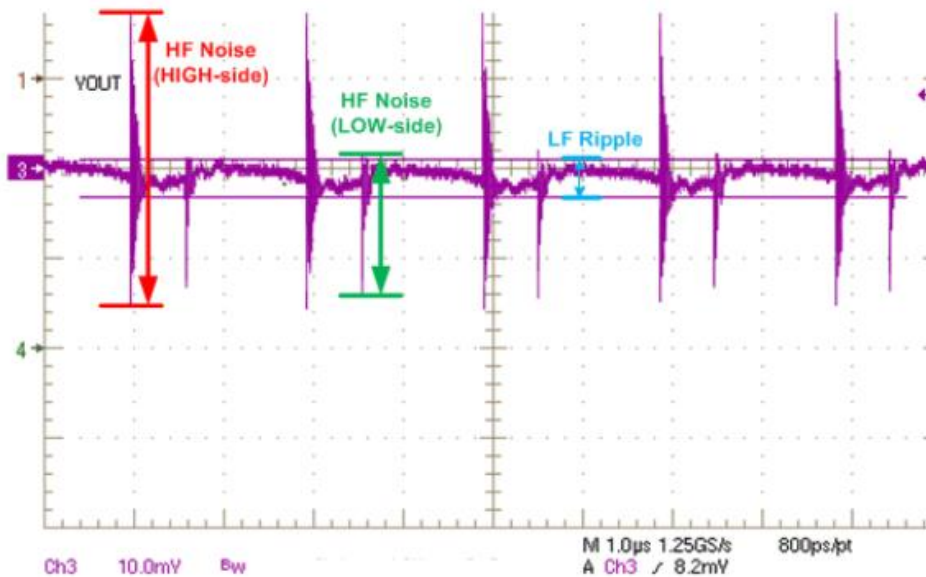
EXTERNAL CONDITIONS FOR THE MU3E EXPERIMENT

- Required output voltage: 2.1 V
- High signal quality is needed
- High output current needed: 20A
- Must work in a magnetic field
 - ➔ no commercial coils usable
- Space is very limited



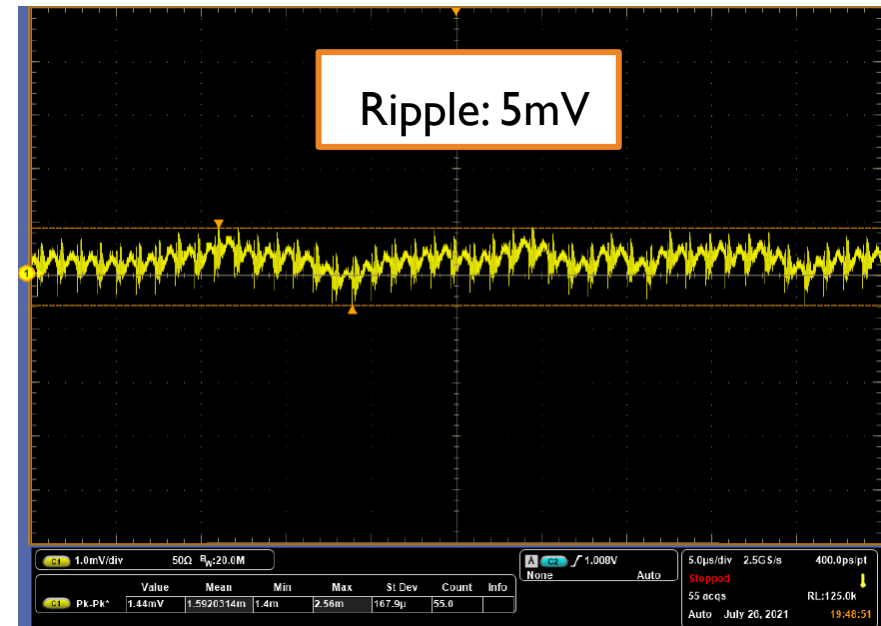
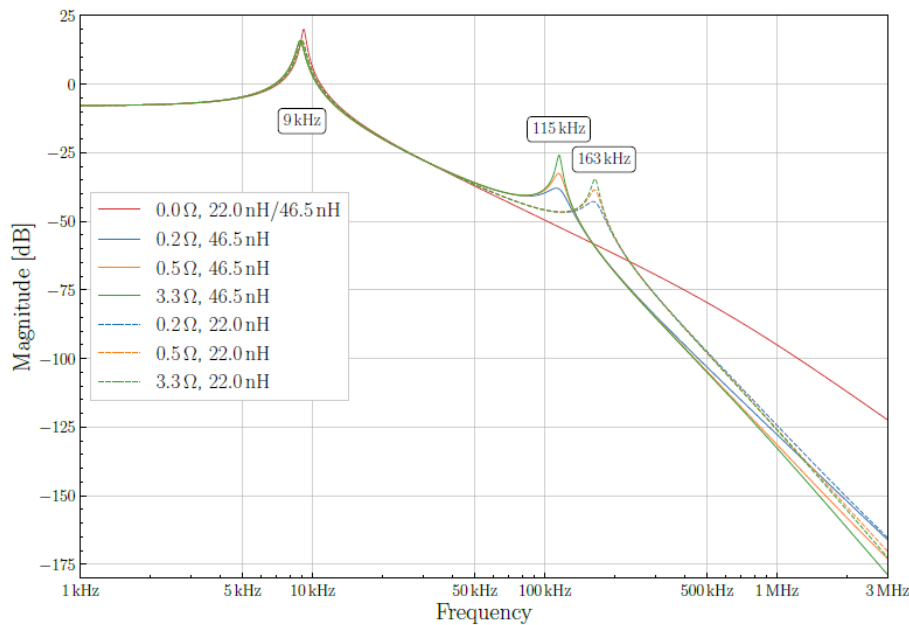
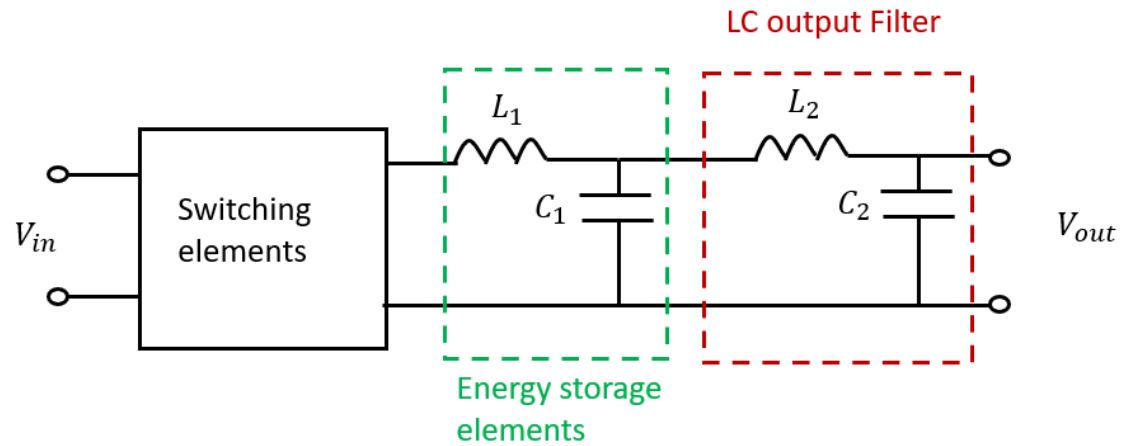
- Air coil: $0.55\mu\text{H}$
- $f_{\text{switch}} = 1\text{MHz}$
- Efficiency: 87.0% at 10A

OUTPUT SIGNAL QUALITY



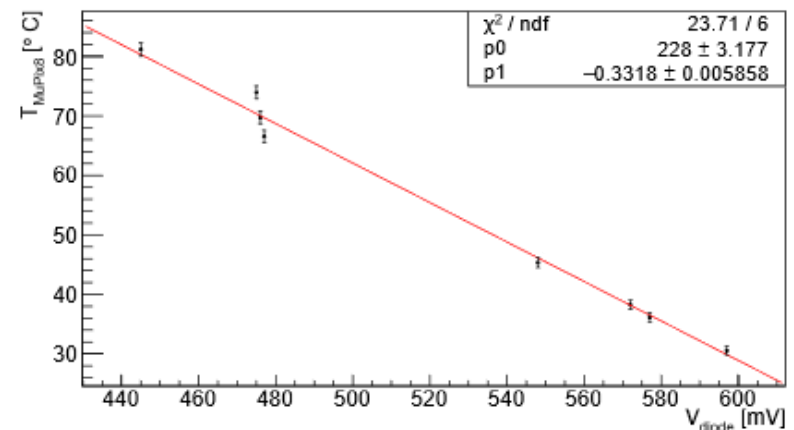
- HF noise
 - can be reduced via a good PCB design
- LF ripple
 - can be adjusted by a second stage filter

LC FILTER



INTERLOCK SYSTEM

- High power means strong heat development
- Complete detector must be cooled
- System to make sure the detector is running only when the cooling system is on
- Pixel detectors have an integrated temperature diode



Conclusion

- What is required?
 - Signal height
 - Quality
 - Additional features
- PCB Design
- Mechanical integration
 - Shielding
 - Cooling
 - Cabling

