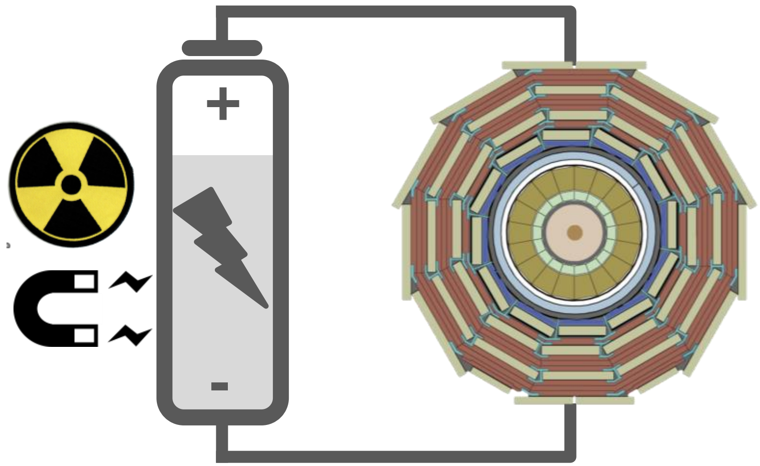


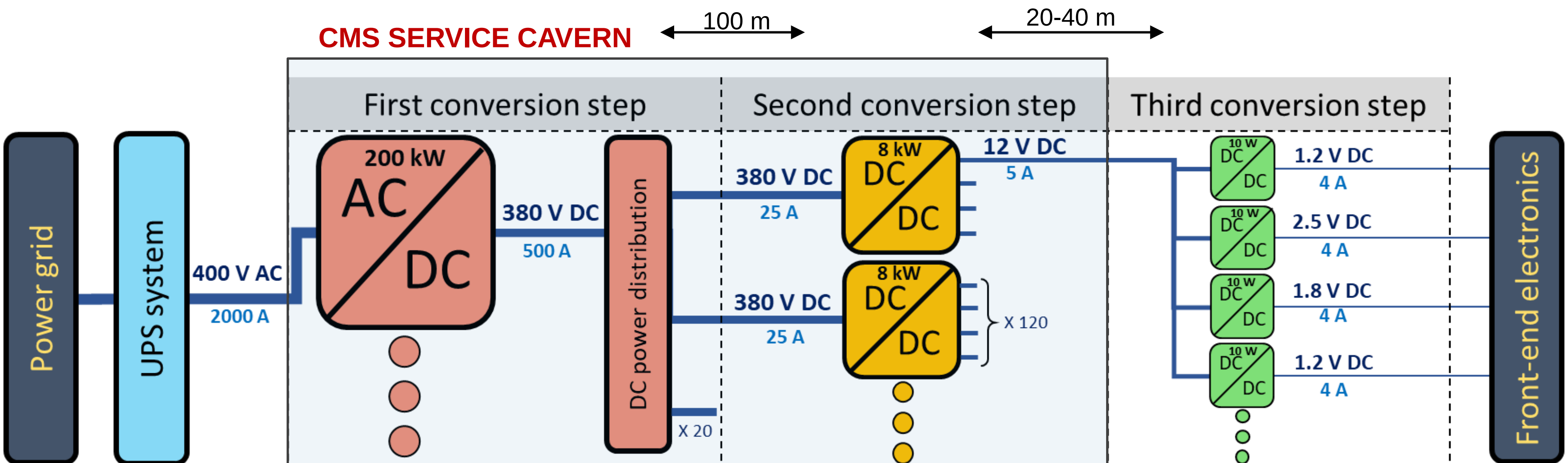
LVPS – Low Voltage Power Supply for the CMS detector

Use of magnet for environmental qalification test.

Krzysztof Stachon

26/11/2024

CMS power conversion chain

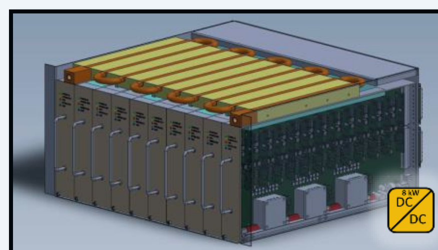


- **400 V AC => 380 V DC**
- **Non-hazardous environment**
- Up to 140 m away from front-end electronics

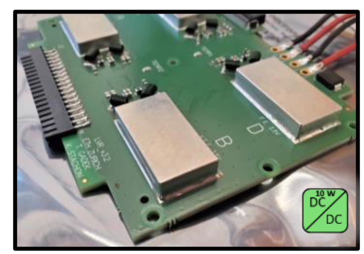
- **380 V DC => 12 V DC**
- **Moderately hazardous environment**
- Up to 40 m away from front-end electronics.

- **9 - 12 V DC => 1.2 – 2.5 V DC**
- **Highly hazardous environment**
- At the point of load

A small scale prototype of the first conversion step. It is composed of: a a power cabinet (right) and a distribution cabinet (left).



Visualization of radiation-tolerant implementation of the second conversion step. This device will be located in experimental cavern, where radiation is present. .



A photo of the PCB acting as the third conversions step in EB subdetector. It hosts four radiation-hard DC-DC converters called bPOL12V.

LVPS: Magnetic field tollerance testing

- 2-3 November 2023 – full system-level magnetic field test at Goliath magnet.
  - Results: did not pass. More info: next slides.
- Repetition of the test desired: preferably: 5 days within 20 January – 7 Febuary 2024 due to manpower availability these dates.
- Requirements:
  - Up to 160 mT in 20 mT increments
  - Minimum aperture size to test in 3 orientations: 650 mm
  - Electrical needs:
    - 1 x 3-phase 16 A (32 A socket would also be good) with max consumption of 1 kW
    - 1 x 230V standard socket, 10A
    - One table for laboratory equipment
  - Full access to the magnet (no beampipe in the aperture)
  - Optionally: magnetic field probe to cross-check magnetic field value.

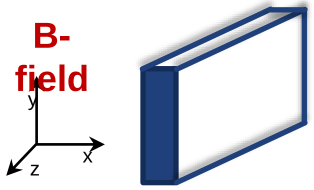
Results

Efficiency
- Output power / Input power
- Calculated from measured input and output voltages
- V_{in} = 380V
- Correct for idle current: 0.078A

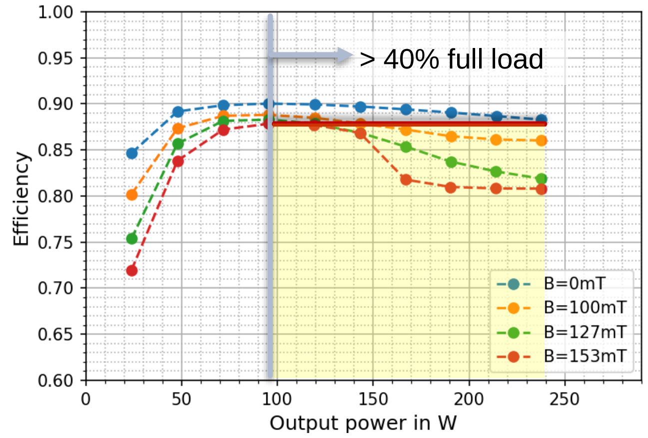
Module
- M6 120W
- 2-channels aggregate = 1 LLC
- Output power = 240W

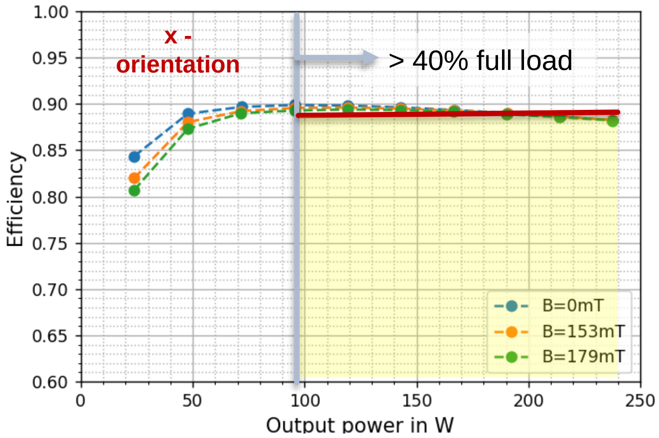
Requirement
- >88% at > 40% of full load = 96 W

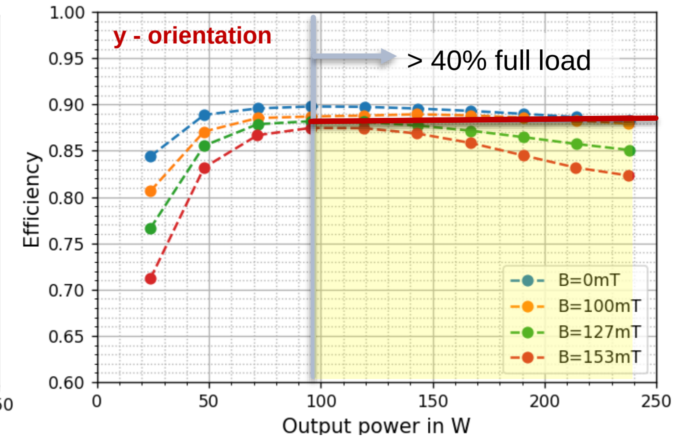
B-field



z - orientation







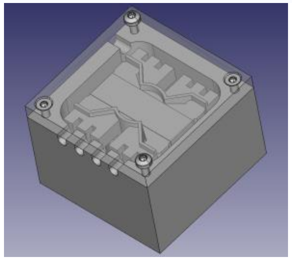
Results
- x: ok
- y: not ok (B >~ 90mT)
- z: not ok (B >~ 90mT)

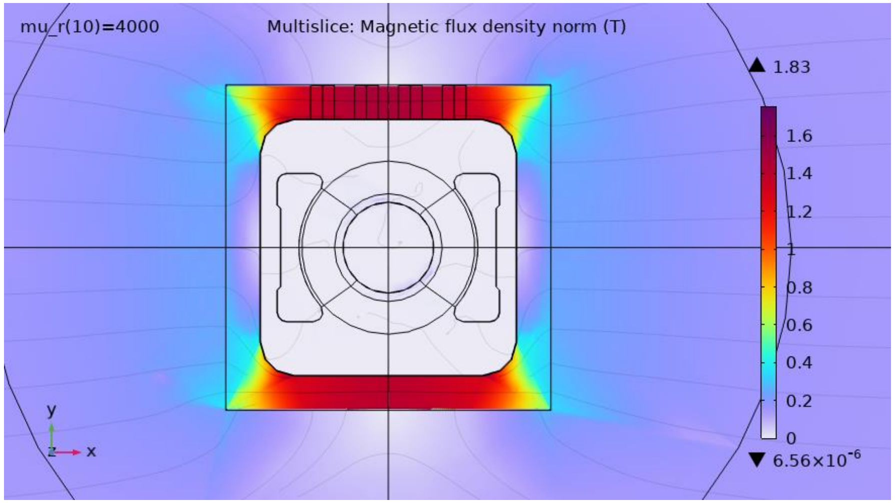
Study supported with computer simulations.

COMSOL Multiphysics used for simulation

Shield – saturation? ➔ NO

- **5mm thick high purity iron**
- **Peak flux density ~1.8T at ~120mT external field**





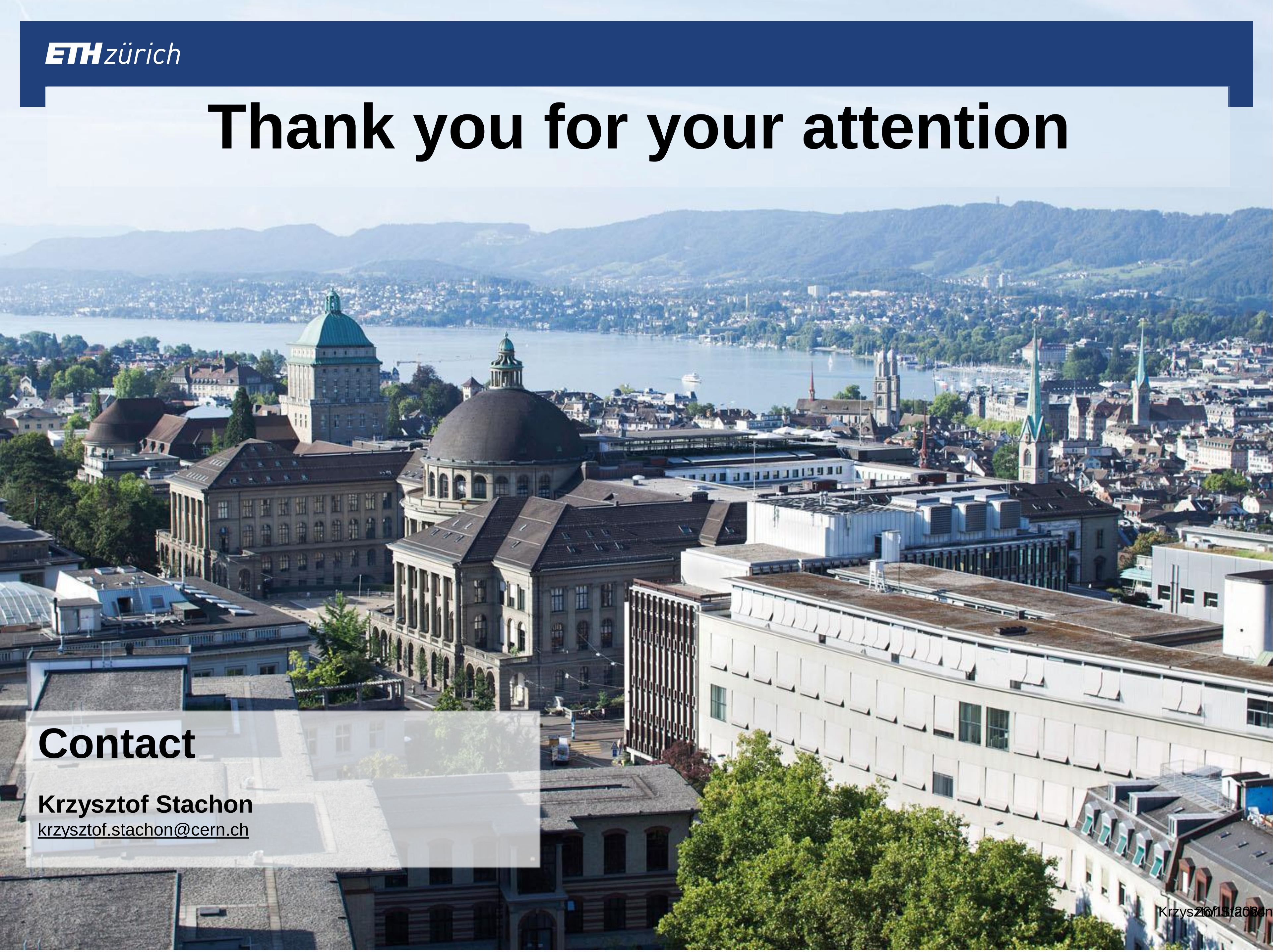
Flux penetration into inductor core? ➔ YES

- **Core relative permeability: μ_r ~ 3000**
- **Shield no annealing: μ_r < 2500**

Mitigation

- Thermal annealing of the shield
- Extended duty-cycle range of the PWM circuitry preventing oscillations.

Thank you for your attention



Contact

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