Machine Protection System PETRA III

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PETRA III - Machine Protection System

29/08/2012

HELMHOLTZ ASSOCIATION

DESY

Overview

- Rough specifications
- MPS – An Overview
- MPS - Integration in the PETRA Machine
- Alarm Handling and Dumping of the Beam
- Fast Interlock and Distribution with FPGA
- Summary

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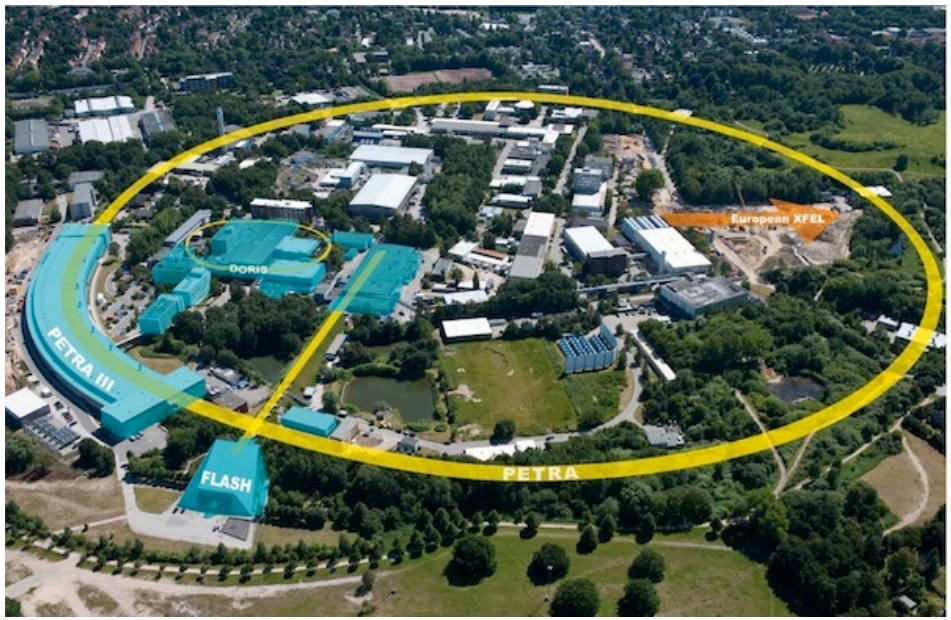
PETRA III



Facts and figures

- Ring accelerator for electrons and positrons
- Length: **2304 metres**
- Commissioning: 1978
- 1978-1986: particle physics
- 1987-2007: pre-accelerator for HERA and X-ray radiation source
- Since 2009: most brilliant **storage-ring-based X-ray source** in the world
- Start of user operation: 2009
- **14 experimental stations** with up to 30 instruments

http://www.desy.de

Specifications for the MPS

- Detect and transmit a dump trigger within 100 µs
- Flexible logical combination of alarm inputs
- Flexible individual beam current threshold for each alarm input
- Flexible minimum number of active alarms inputs
- Detect the alarm(s) which fullfilled the dump condition first (fast localisation of the cause)
- Post Mortem Trigger for triggering other systems (i.e. BPM) after an event (dump or beam loss)

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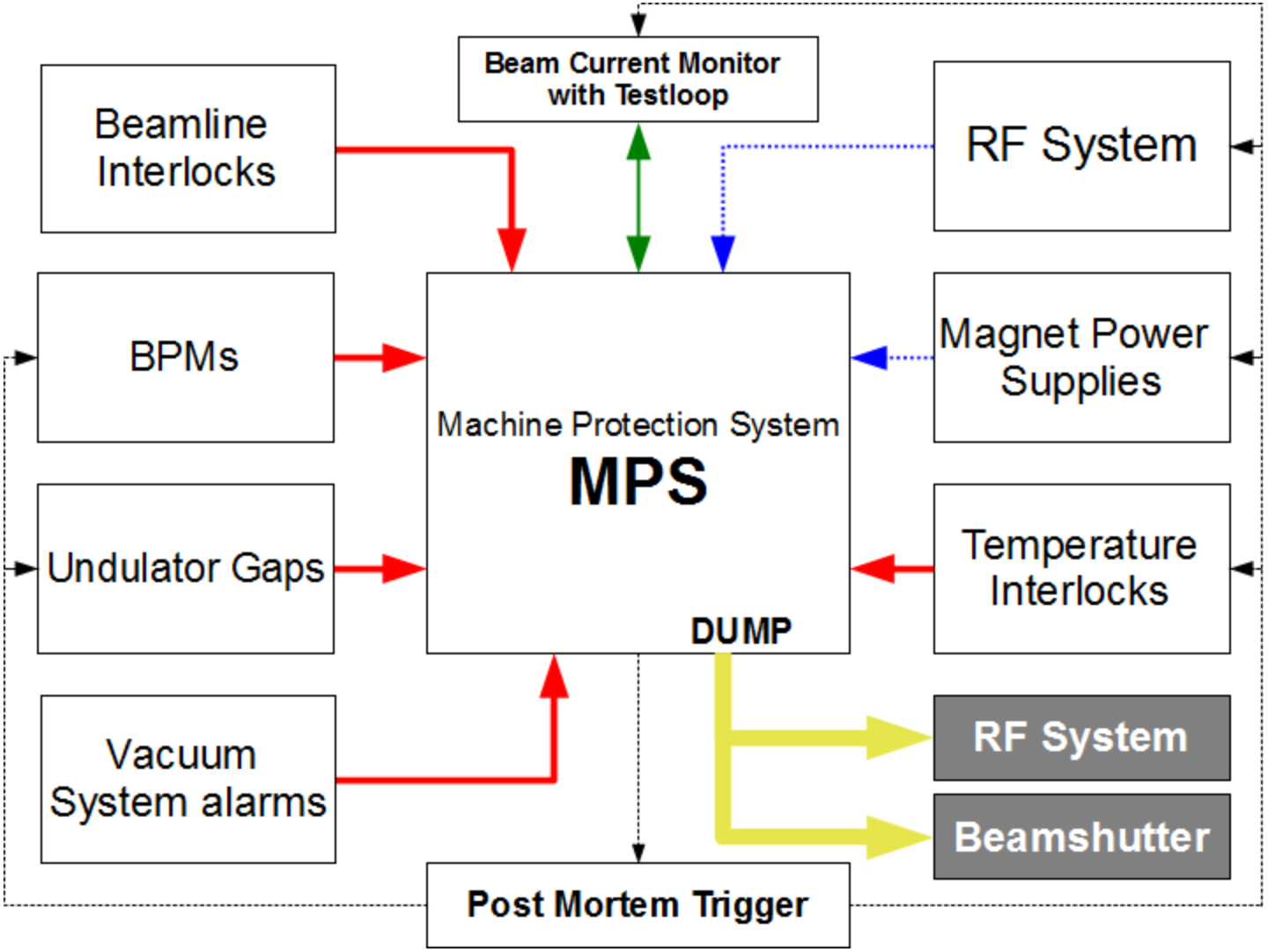

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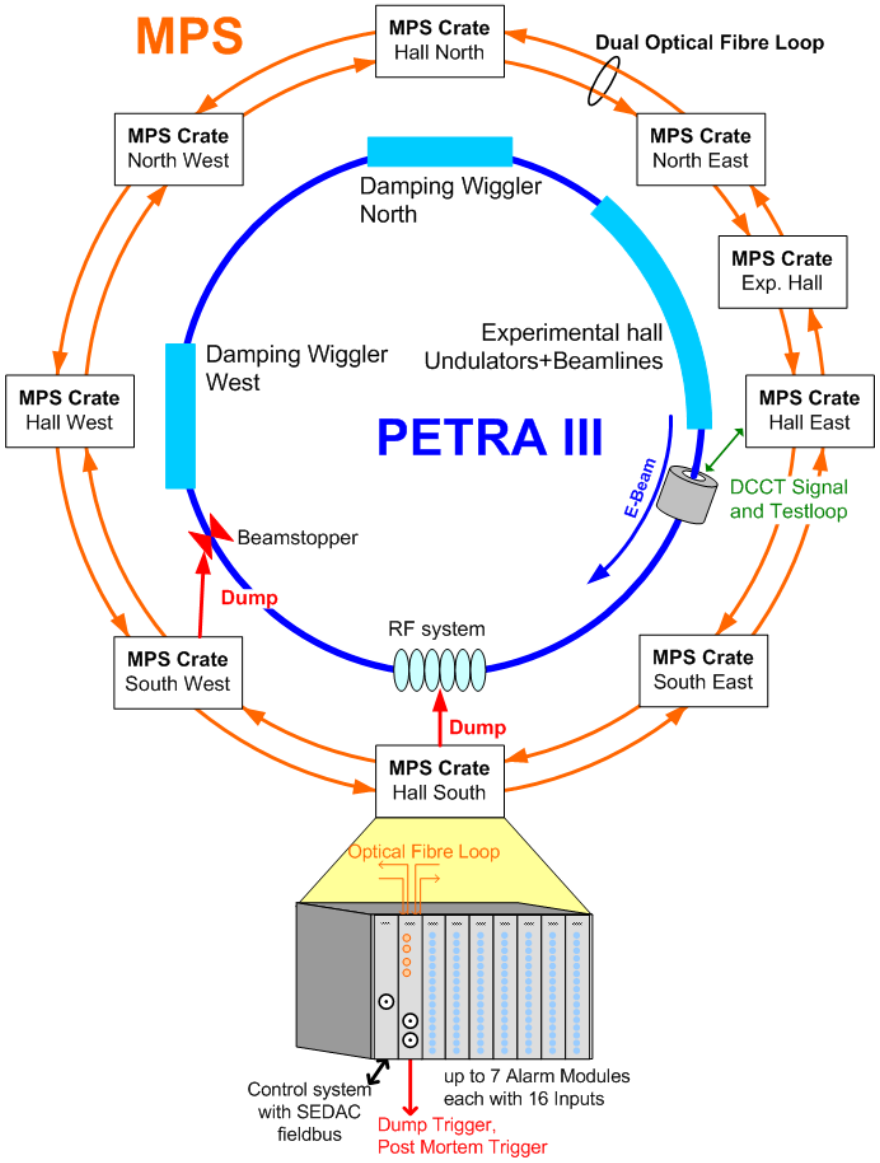
MPS - Integration in the PETRA Machine



- Distributed system
  - 10 crates in 9 PETRA halls
  - Each crate can have up to 112 alarms and is connected to the optical loop
- Redundant optical fibre between modules for transmission of
  - Beam current
  - Post Mortem trigger
  - Dump trigger
  - Synchronisation of modules
- Measure beam current with dedicated DCCT

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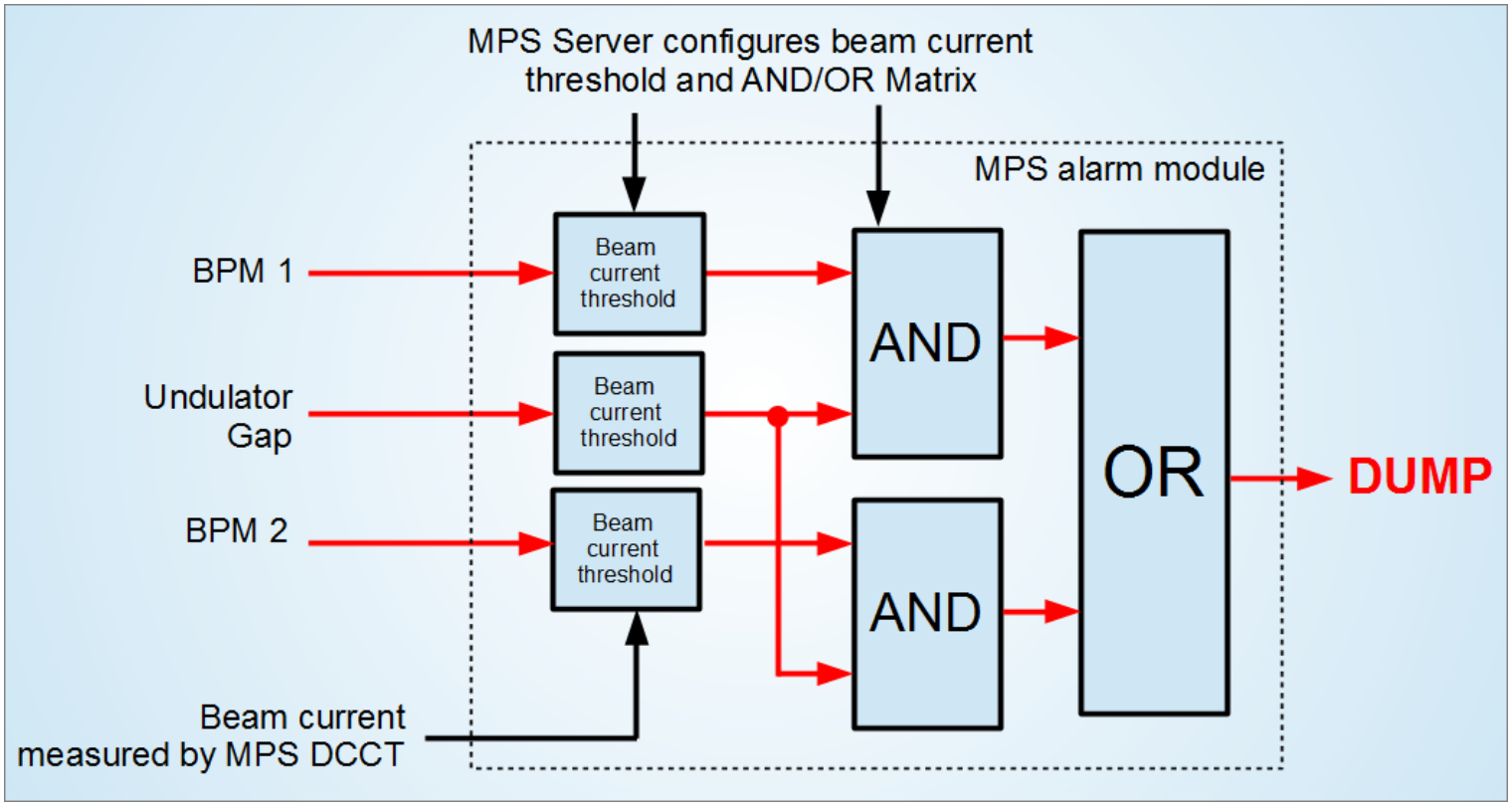
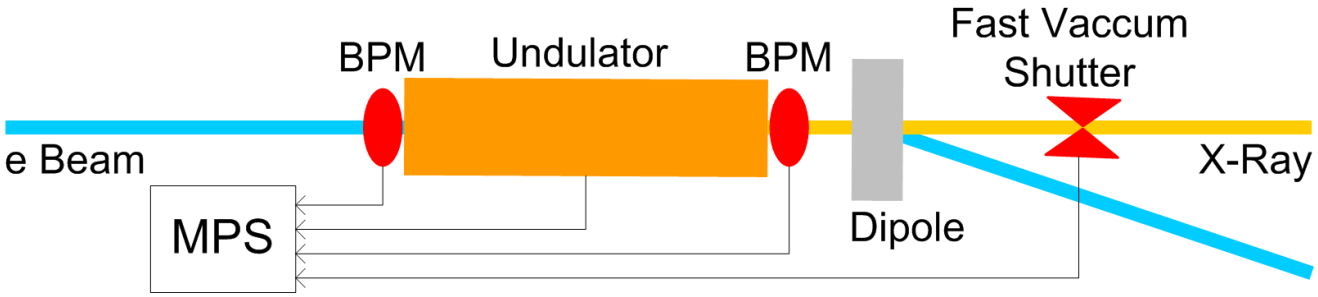
Alarm Handling





How to get rid of the beam?

- Switch off RF power for 5 ms
  - fast, ca. 400µs

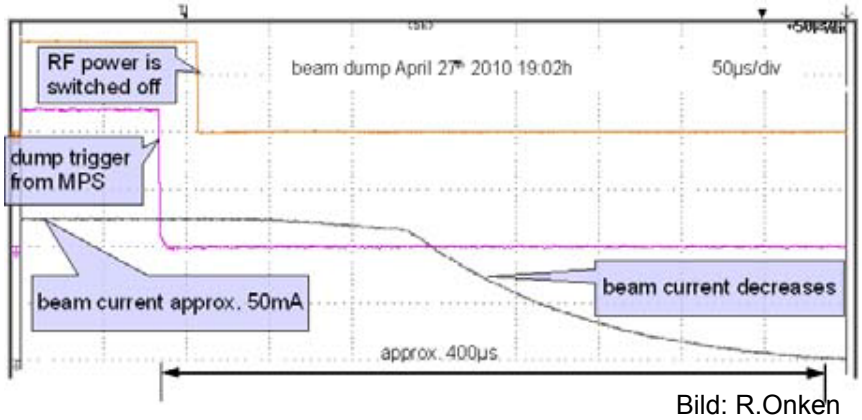
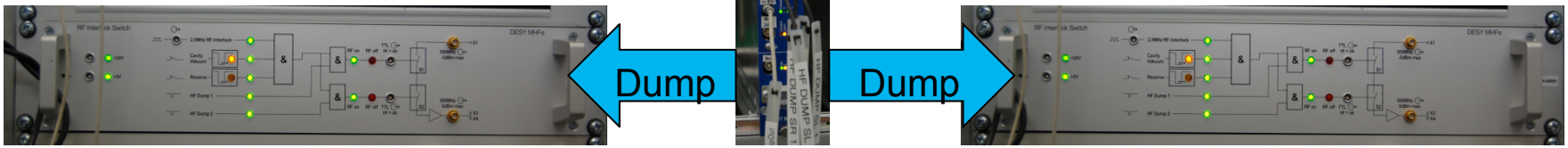


Bild: R.Onken



RF Interlock Receiver 1 | MPS Dumpmodule | RF Interlock Receiver 2

- „Backup“: beam stopper
  - slow, ca. 200ms
  - → this is also a beam inhibit mechanism!

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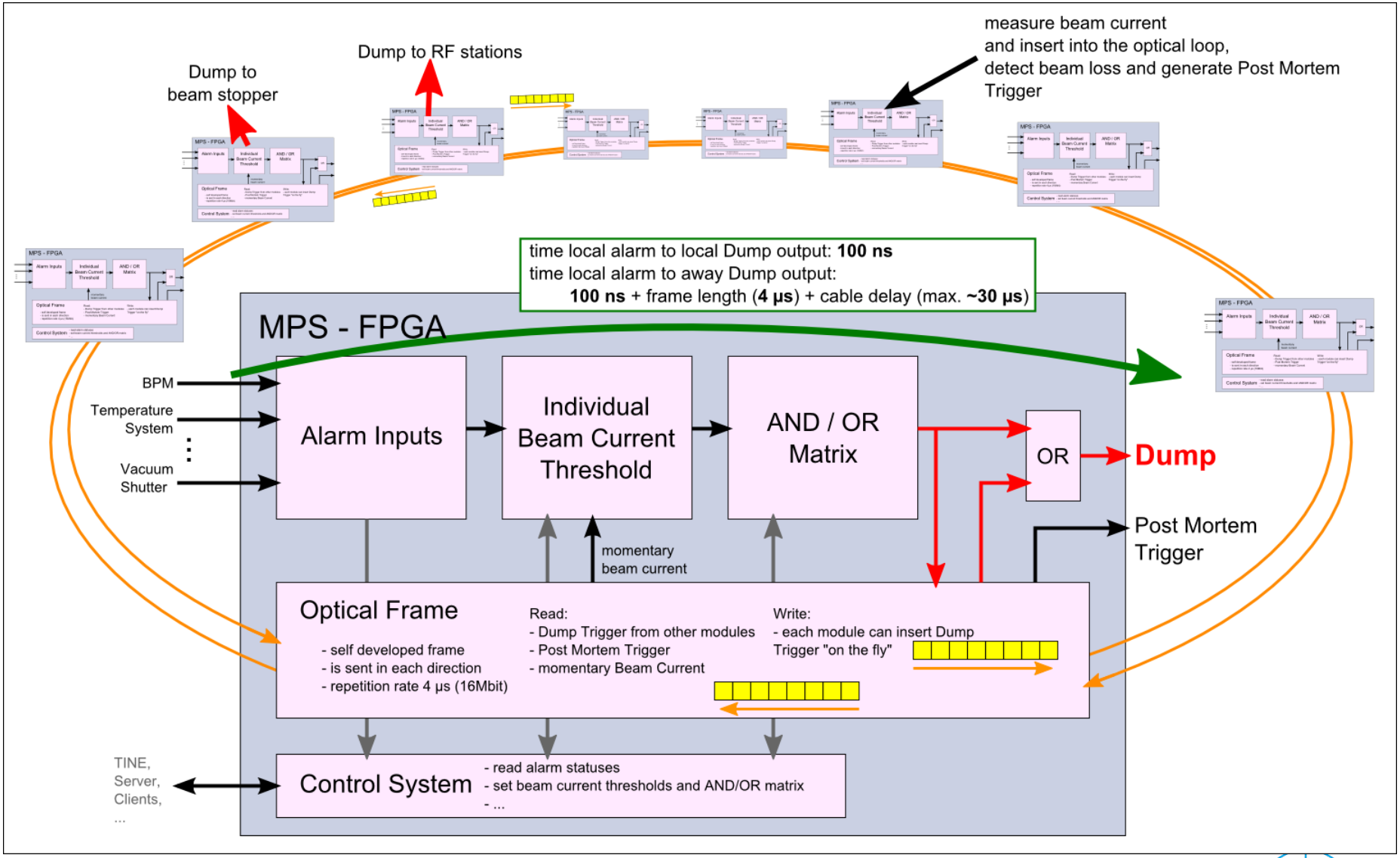
Fast Interlock and Distribution with FPGA



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Summary

- distributed system, connected internally through optical link
- Dump trigger: decision 100ns, distribution in ~35µs, get rid of the beam ~400µs
- Fast reaction and high flexibility due to use of FPGAs (AND/OR Matrix, optical frame, …)

We have also …

- Analyzing beam losses with synchronous Post Mortem trigger
- Software based rule system helps operator to understand beam losses

Thank you for your attention.

MDI6
Matthias Werner
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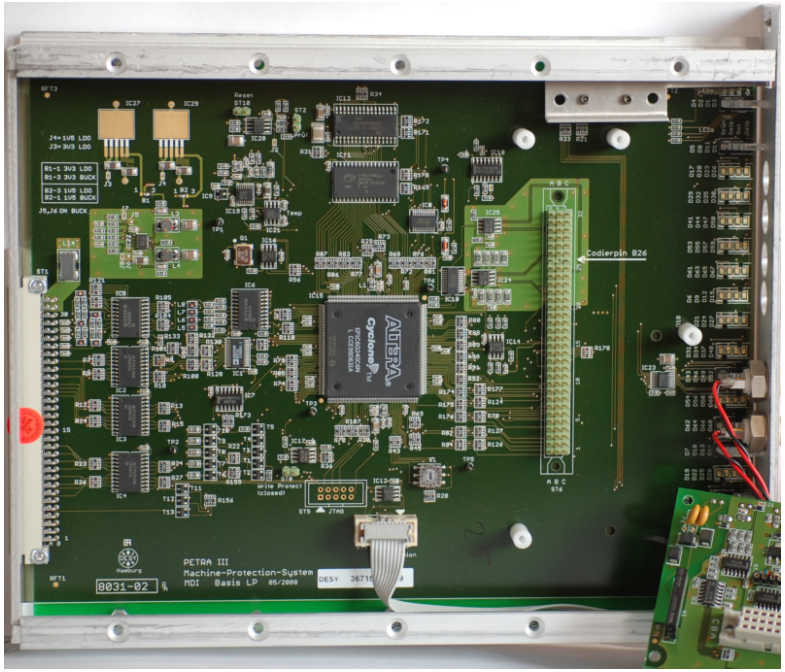
Timmy Lensch

MCS (MPS Software)
Yuri Netchaev
Victor Soloviev
Marcus Walla
Winfried Schütte

Hardware Developed for the MPS

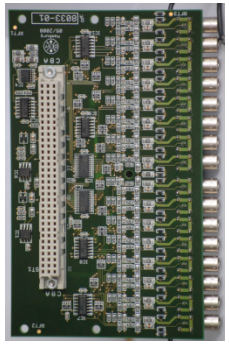
Basis Digital Carrier Board

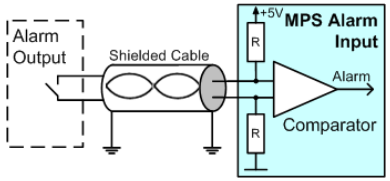
- Interface to the control system (SEDAC)
- Power converters, LEDs on the front, …
- Usable with different piggy backs, core functionallity is defined in the FPGA firmware



MPS Alarm Module (MPSA)

- 16 differential inputs
- „inherits“ from Basis Board
  - Interface to control system
  - Communication over backplane with controller module
- 25 modules are working in PETRA

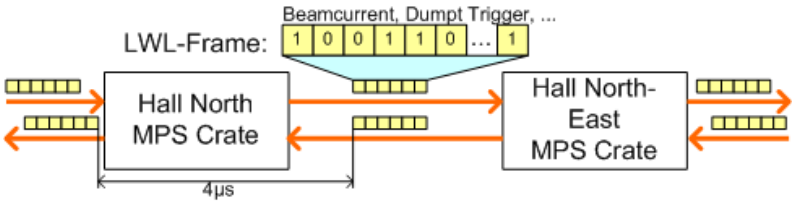




Hardware Developed for the MPS

MPS Master Module (MPSM)

- „inherits“ from Basis Board …
- Master of optical interface, frame repetition rate is 4µs
- Synchronisation of all MPSCs
- Beam current measurement
- 1 module in PETRA



MPS Controller Modul (MPSC)

- „inherits“ from Basis Board …
- Optical interface to neighbour crates, can add information to optical frame (dump trigger)
- Post Mortem output
- Collects MPSA information from backplane
- 10 modules in PETRA (1/Crate)

MPS Dump Module (MPSD)

- Receives dump command and transmitts it redundand to the RF systems
- 1 module in PETRA