Overview

The synchrotron lightsource PETRA III
• Circumference 2.3 km
• Operates at 6 GeV
• 100 mA beam current (200 mA planned)
• Experiments at 14 undulator beamlines

Machine Protection System
• distributed system without central unit
• 10 crates, located in 9 PETRA halls
• crates linked together with a redundant optical fibre loop
• dump trigger and post mortem trigger available in each crate
• approximately 230 alarms are connected to the MPS

Connections to and from the MPS
• Remote Control
• BPMs
• Machine Protection System
• Vacuum System
• RF System
• 120 Hz frequency signal

MPS Outputs

Dump Trigger
• for a fast dump the RF system is switched off
• after ~400µs the beam is lost on a dedicated scraper

Time delay from dump trigger to beam loss:

Post Mortem Trigger
• MPS detects fast beam current drop and creates post mortem trigger
• distributed to several systems (e.g. BPM)
• allows time correlated analysis

Connections to and from the MPS

Time delay from dump trigger to beam loss:

Improvements of the MPS

Software
• each alarm input is represented by an icon
• red icons caused a dump – the first alarm(s) are highlighted
• post mortem data of the MPS beam current monitor is displayed if a beam loss occurred

Firmware
beam current measurement:
• averaging of 100ms - to increase accuracy at small beam currents
• dynamic averaging – fast tracking if a beam loss was detected
• post mortem data analysis of MPS beam current measurement

first alarm detection:
• system wide first alarm detection

redundancy of the optical loop:
• MPS continues operation even if one loop breaks

Post Mortem data analysis of the MPS beam current monitor

• beam loss detection by a fast drop in the measured beam current
• in the MPS console program a detailed information of time relation between dump and beam loss is given
• black vertical bar: time, where a beam loss is detected in the MPS hardware
• red bar: time where a dump trigger is generated

A beam loss occurred without a dump before or after.

A beam loss occurred (e.g. by RF fail) and a dump is generated (e.g. by BPM alarms due to inwards circulating beam).

A dump generated by the MPS results in a beam loss.

A partial beam loss (RF station 1 failed)* occurred; due to BPM alarms after, the beam is dumped anyway.

* PETRA III operates with 2 RF stations which are both switched off by the MPS for a beam dump.

Future Plans

• using the testloop for permanent check of the beam current monitor
• time synchronisation to achieve a synchronous post mortem trigger (resolution goal: 2µs)
• using timestamps for a detailed alarm analysis

Permanent check of the beam current monitor

looking for the 120Hz frequency: if found → monitor ok
else → monitor defect

MPS Hardware
left: dump and post mortem output module; redundant optical fibre interface (1/take)
middle: alarm module with 16 inputs (up to 7/take)
right: beam current measurement module; optical fibre interface (1/system)

Post Mortem data analysis of the MPS beam current monitor

permanent check of the beam current monitor

A trapezoidal (0.5mA ss 120Hz) is sent to the testloop - measured beam current looking for the 120Hz frequency:
if found → monitor ok
else → monitor defect

Permanent check of the beam current monitor

looking for the 120Hz frequency: if found → monitor ok
else → monitor defect

MPS console program – Main GUI

MPS Hardware
left: dump and post mortem output module; redundant optical fibre interface (1/crate)
middle: alarm module with 16 inputs (up to 7/crate)
right: beam current measurement module; optical fibre interface (1/system)