Review of the Machine Protection System in the PS complex

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thanks to
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R.Steerenberg

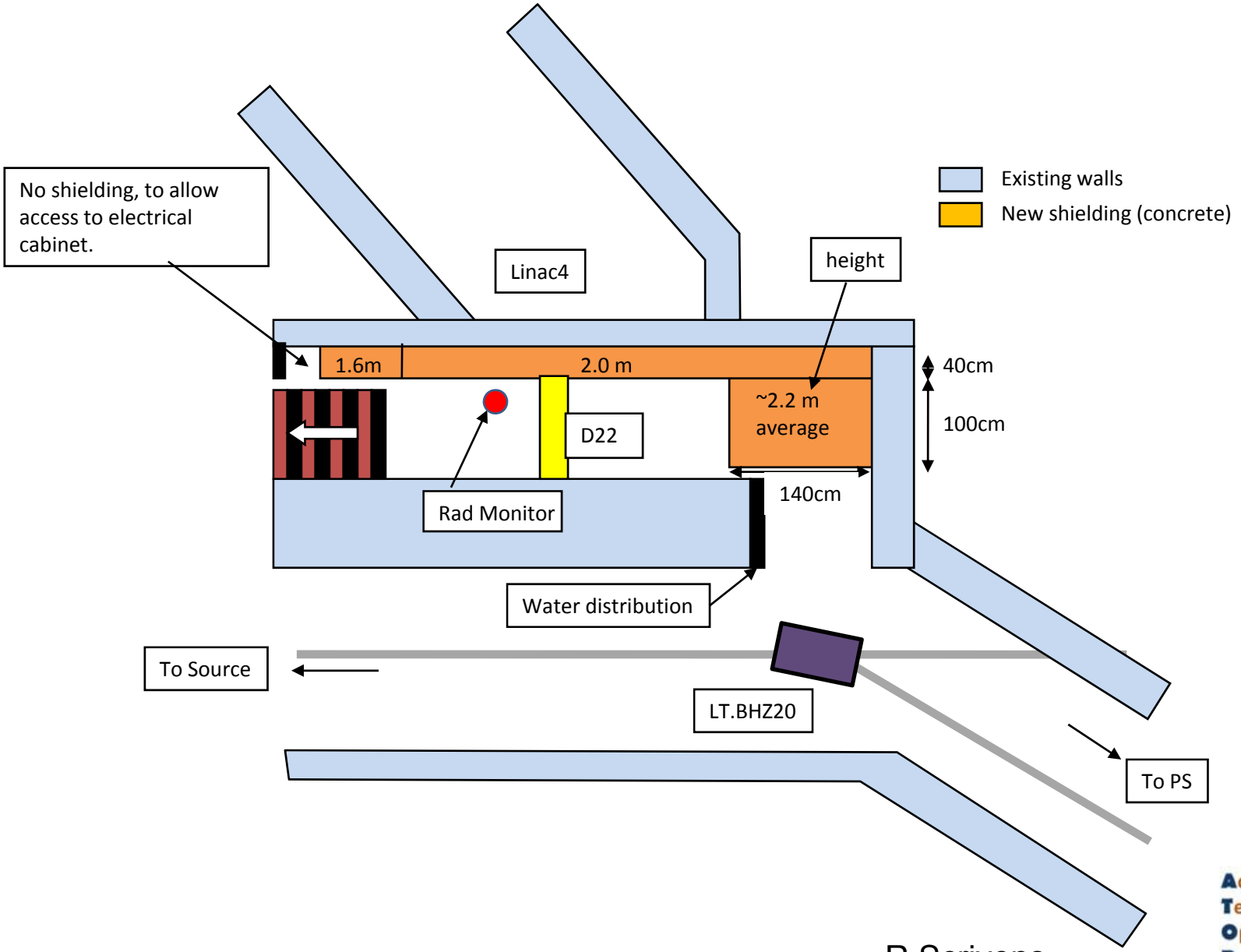
Linac2: General

Interlocks work basically well, sometimes it is difficult to tell that the external condition interlock has been activated on a beam (can this be improved, e.g. on the Vistar?).

The Linac watchdog is only compatible with the FESA BCTs by using the FESA2GM backwards compatible class.
CO is in the process of rewriting the watchdog to be fully compatible with modern standards, also in view of Linac4. First tests are planned for 2009.

In 2009, and for the foreseeable future, there will be a radiation monitor in the access safety chain for Linac 2, to protect the Linac4 work site.

Protection of Linac4 Construction Site



R.Scrivens

Protection of Linac4 Construction Site

The civil engineering work for Linac4 requires some protection measures to protect the workers (public) from radiation during Linac2 operation.

- improved shielding
- installation of a Radiation Monitor (PAXS_22) in Linac2 klystron gallery between Linac2 line and Linac4 construction site

PAXS_22 triggers the Linac2 safety chain (cutting the beam in case of losses toward Linac4 construction site – linac source timing and stopper).

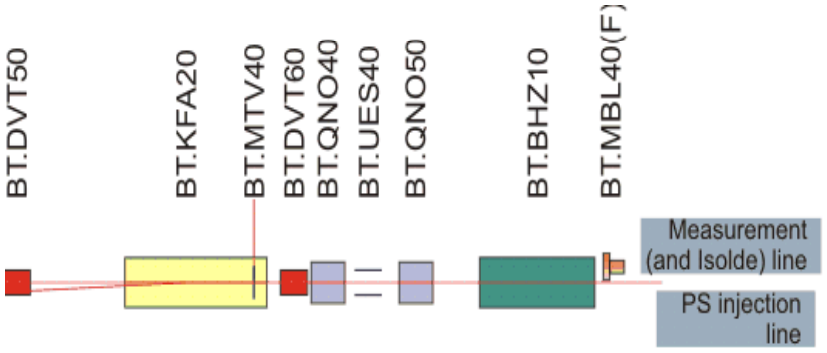
Operations procedure in case of beam cut by PAXS_22 in the process of being written

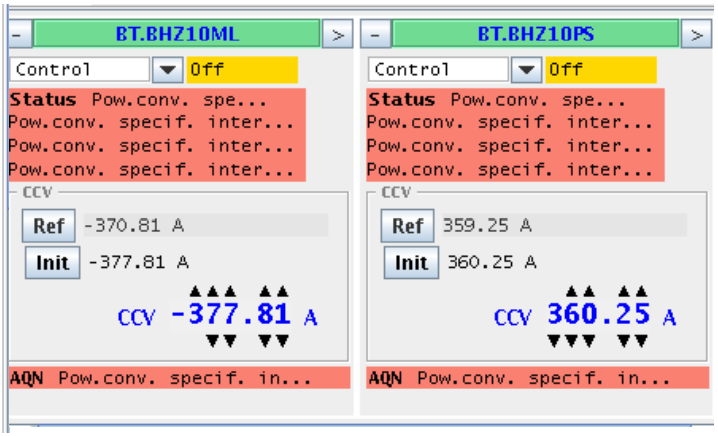
Booster 2008: Wrong Destination

On 23/04/2008, a timing problem caused a trip of about 28 DSCs and resulted in a mis-pulsing of BT.BHZ10 (switching magnet between PS/ISOLDE); the magnet stayed with its last setting.

Even though the beams with destination PS were cut, ISOLDE beam with destination DUMP was sent into the PS and lost at injection of the PS.

This case is presently not interlocked, beam was stopped by the BLM (after a couple of shots).

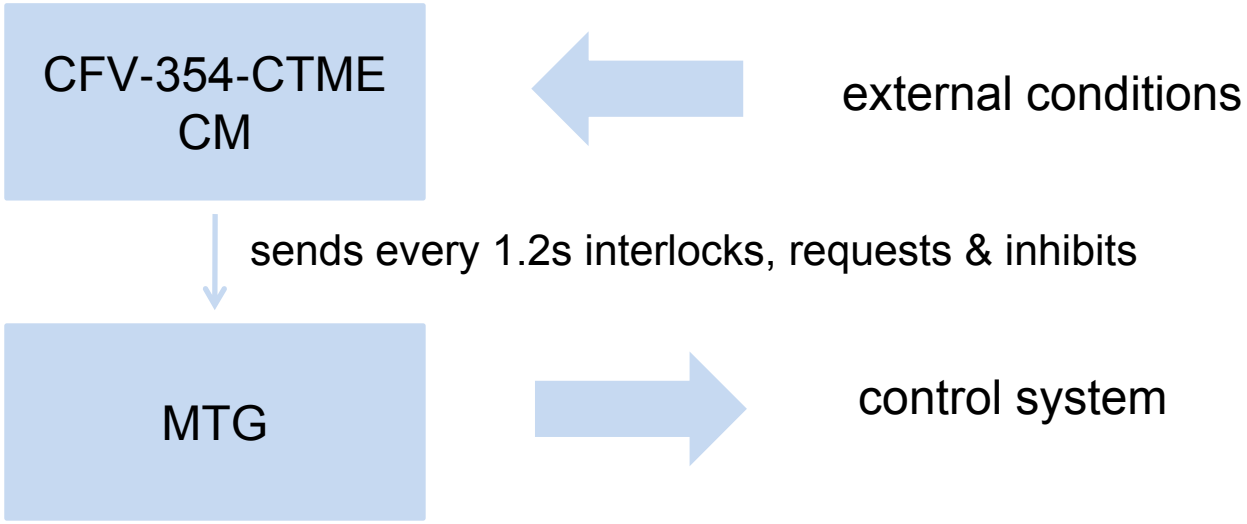




Booster 2008: Beam to ISOLDE while Request OFF

Following re-start of the PSB after an emergency stop on Monday, 28 July 2008, beam was sent to ISOLDE while the proton request was OFF.
It was found by the piquet CO that the VME crate for the external conditions was OFF. After switching it back on, the proton request worked again as it should.

The VME crate for the external conditions houses the front-end CFV-354-CTMECM. All external conditions enter in this crate as cables (hardware). The information on the conditions, including request ON/OFF, is sent every 1.2s via reflective memory to the MTG in the CCR (CFV-CCM-CTMMAINA/B). The status of the conditions is read from a work station in the CCC via a front-end called CFV-CCR-CTMEMM, which accesses the MTG.



Booster 2008: Beam to ISOLDE while Request OFF

The system is designed such that beam is inhibited if either the request is set OFF or the front-end CFV-354-CTMECM is not powered, which was the case on Monday 28 July. This second condition was not taken into account correctly, and beam was sent to ISOLDE although the crate was not powered.

A software bug in the system was identified and fixed by CO, the system was tested and confirmed to work correctly.

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    Resolution: Fixed

Work done:
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The check executed int the mtgrt task to test if the hardware external conditions which
were sent through Xmem shared table, was not well  done. A fix has been done. The task has
been installed and the Mtgs rebooted.

Test executed:
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To simulate the problem, I stopped the timing on cs-ccr-ctmecc that initiates the send of
the Xmem shared table which contains hardware external conditions. The consequence are :
1/ A error  message is now produced on the MTG consoles each basic periods 2/ All hardware
conditions from cs-ccr-ctmecc are set to 'inactive'. This can be seen through the web link
http://wwwpsco.cern.ch/cgi-bin/mtg/showeqtV2?L+ExtCond+SPS+cfv-ccr-ctmemm


After an enable of the timing, the situation is well restored .
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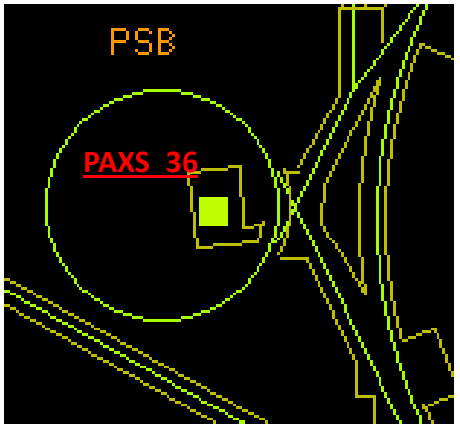
Booster 2009: New Lift Interlock

High radiation level on PAXS_36 during PSB beam operation



SC/RP recommendation:
forbid access under floor -2 during beam operation

- respect of the SC/RP recommendation
- maintain the Booster availability
- keep the Booster lift functional for safety and building needs

solution proposed:
interlock triggers the Booster safety chain if somebody goes down under the -2 floor using either the stairs or the lift.

status:
- stairs signal: OK
- lift signal: a study with EN-HM is ongoing.
  The idea is to modify the lift automation and to integrate the new constraints.

In case the final solution cannot be implemented for the Booster start-up, a temporary solution will be applied (block the lift).

ISOLDE: 2008 Incidents

A number of occasions where the ventilation system had problems with a broken belt (ABOC and ISOLDE tech meeting 28/10/08).

The air flow went below a certain threshold which then triggered an (radiation!) alarm in the CCC, and the operators stopped the beam.

However the measurement of the air flow is not interlocked and not considered part of the safety chain. It was suggested at the time by RP that the system itself should have an interlock.

23/05/08:
BTY.DVT324 in fault and causes beam on target instead of converter. This was not Interlocked (but will be).

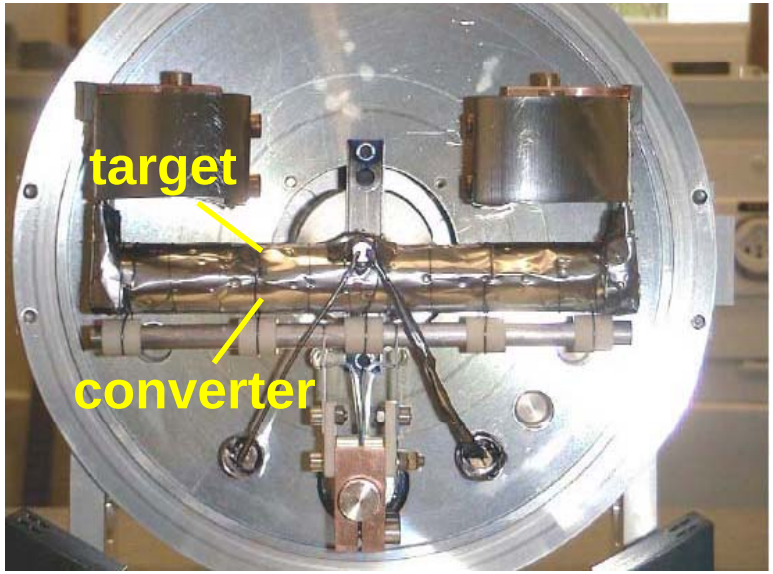
06/10/08:
BTY.QDE151 power supply tripped, causing beam loss in the BTY; beam was stopped by the BLMs;
not interlocked, and not included in the new interlocks

ISOLDE: Wrong Beam

In previous years (before 2008) on several occasions ISOLDE received beam with wrong focusing, steering or intensity.

This happened e.g. when the focusing of the last quadrupoles in the BTY changed spontaneously due to re-loading archives, which could change the settings of these magnets as they are non ppm. In the course of 2007, these non-ppm quadrupoles were separated from the normal working sets. In order to change them, you need to explicitly ask for it; no such cases reported in 2008.

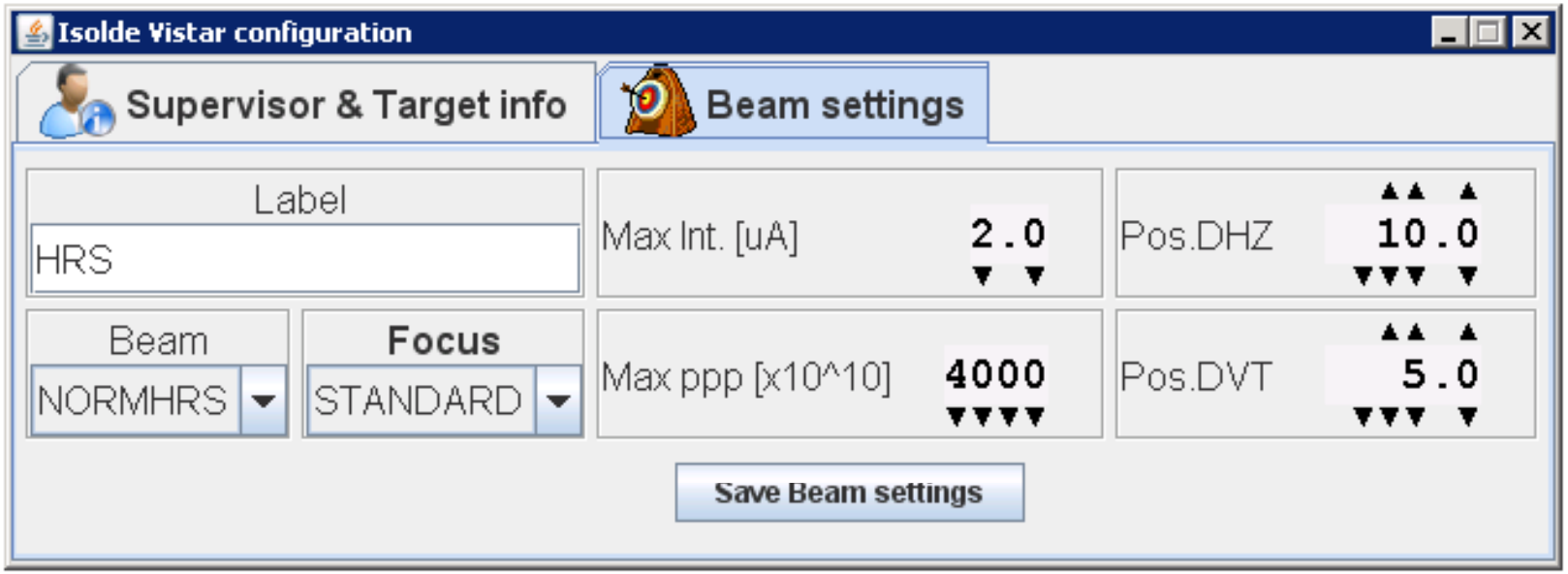
However, the need for a real interlock became apparent



ISOLDE 2009: New Interlock

focus/steering interlock: parameter window set by ISOLDE machine supervisor
AQN must be within this range

Intensity interlock:
AQN ≤ set maximum value

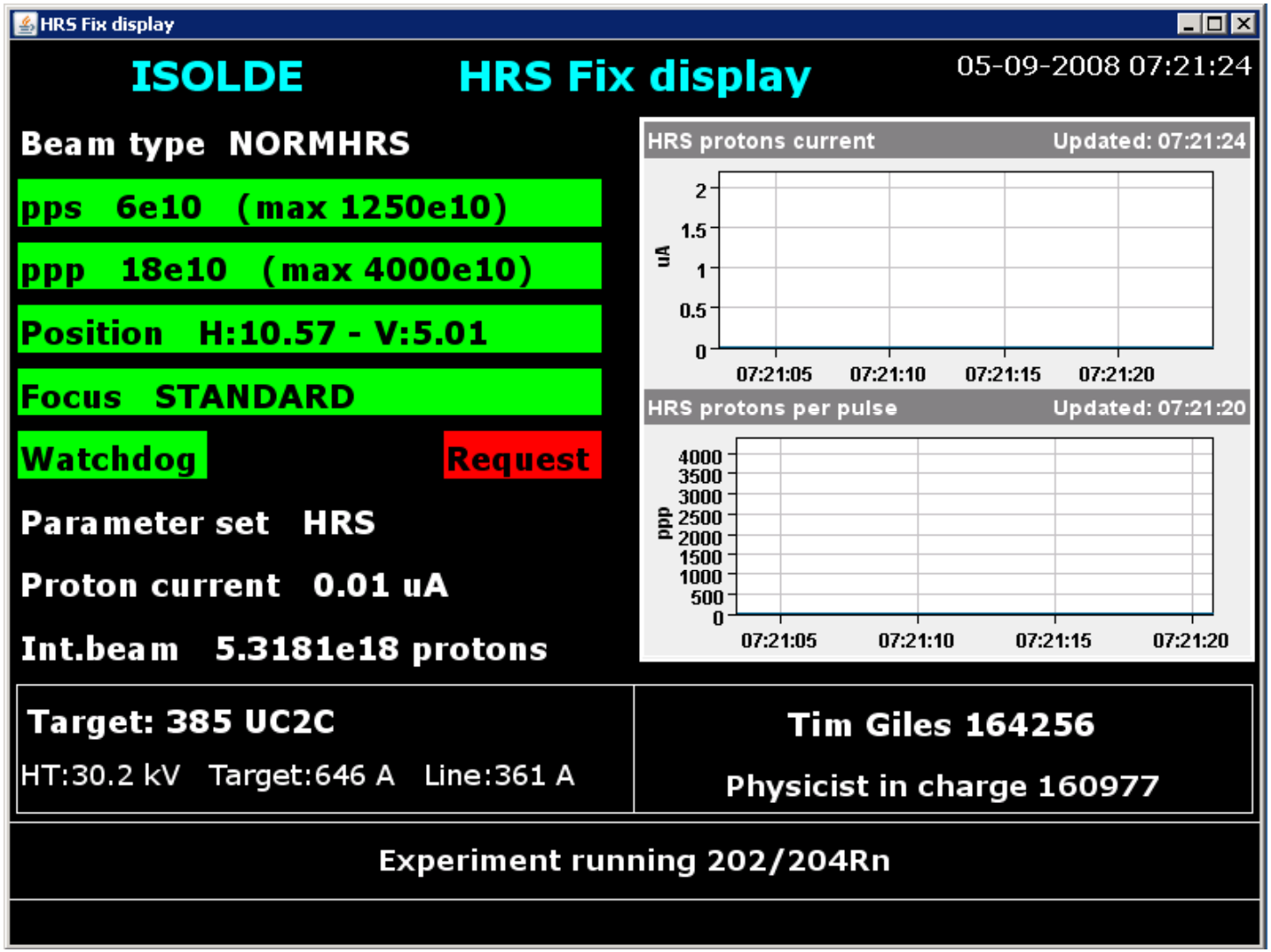


E.Piselli

"supervisor GUI"

ISOLDE 2009: New Vistar

HRS and GPS Vistars permanently displayed in ICR and CCC



E.Piselli

PS

Machine protection system worked well and did not pose any problem in 2008

In the framework of INCA the external conditions and their actions are being reviewed.

The main aim is to get more transparency on the action of external conditions and more flexibility up to a certain level to make specific definitions.

This work has just started, not much can be concluded yet.

AD

No problems or issues with AD protection.

When FTA.BHZ6024 broke down during the 2008 start-up (in the target area), the ground fault detection worked as expected.

No modifications for 2009.

Conclusions

In most cases the interlock and machine protection for the PS complex worked well

Some improvements of the existing interlocks can be imagined, notably the ISOLDE ventilation.

Main worries were centered around the Booster-ISOLDE interface
With the new Vistar/Interlock system, to be deployed for the 2009 start-up, the situation should be as safe as it can be

A number of new interlocks (Linac4 work site protection, Booster lift) will be put in place in 2009; need operational procedures.