



Two weeks at CHARM

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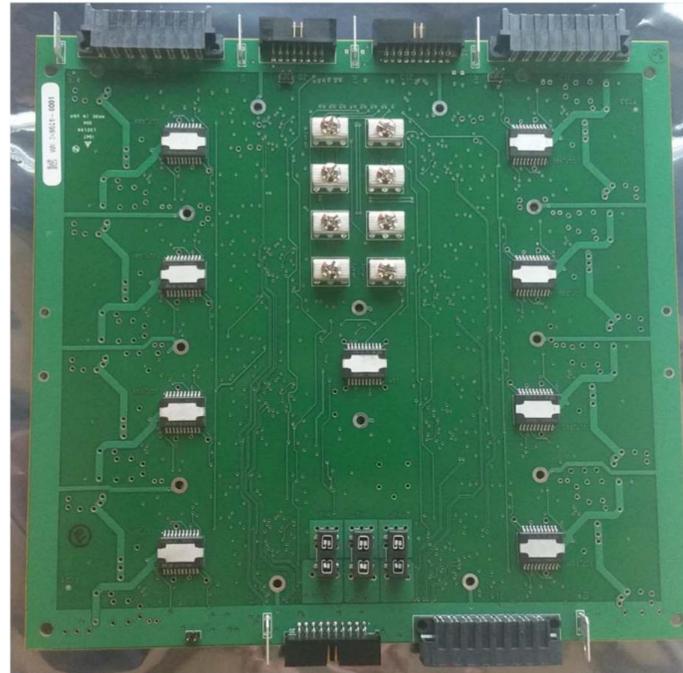
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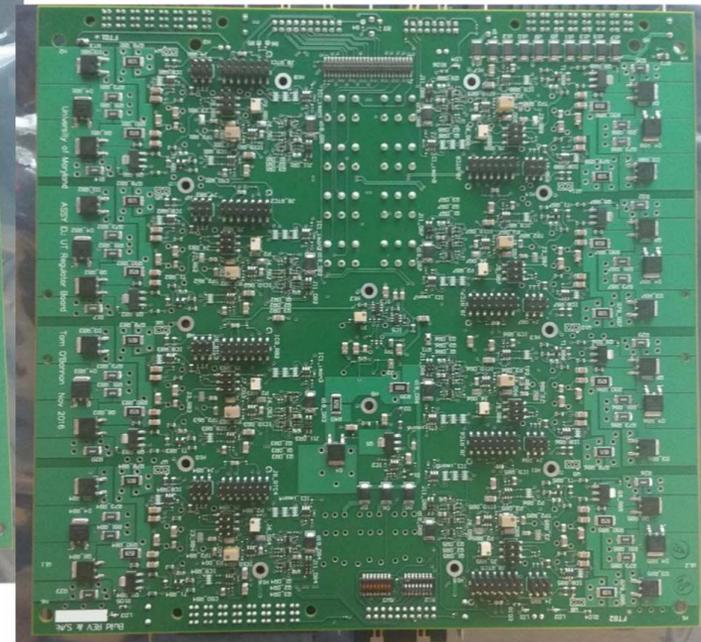
Test motivation

- UT project relies on custom remote LV power regulator circuits based around the LHC4913 chip with full differential remote sense
 - The first version of this design was characterized for SET at Mass. General Hospital 223 MeV p beam
- Additional features for gen2 as well as the mono-energetic nature of the first test motivates additional tests for latchup in a more realistic radiation environment
 - New features: aux current slave, FPGA timing and control (not shown)

Bottom Side (with 2 Piece heat sink removed)



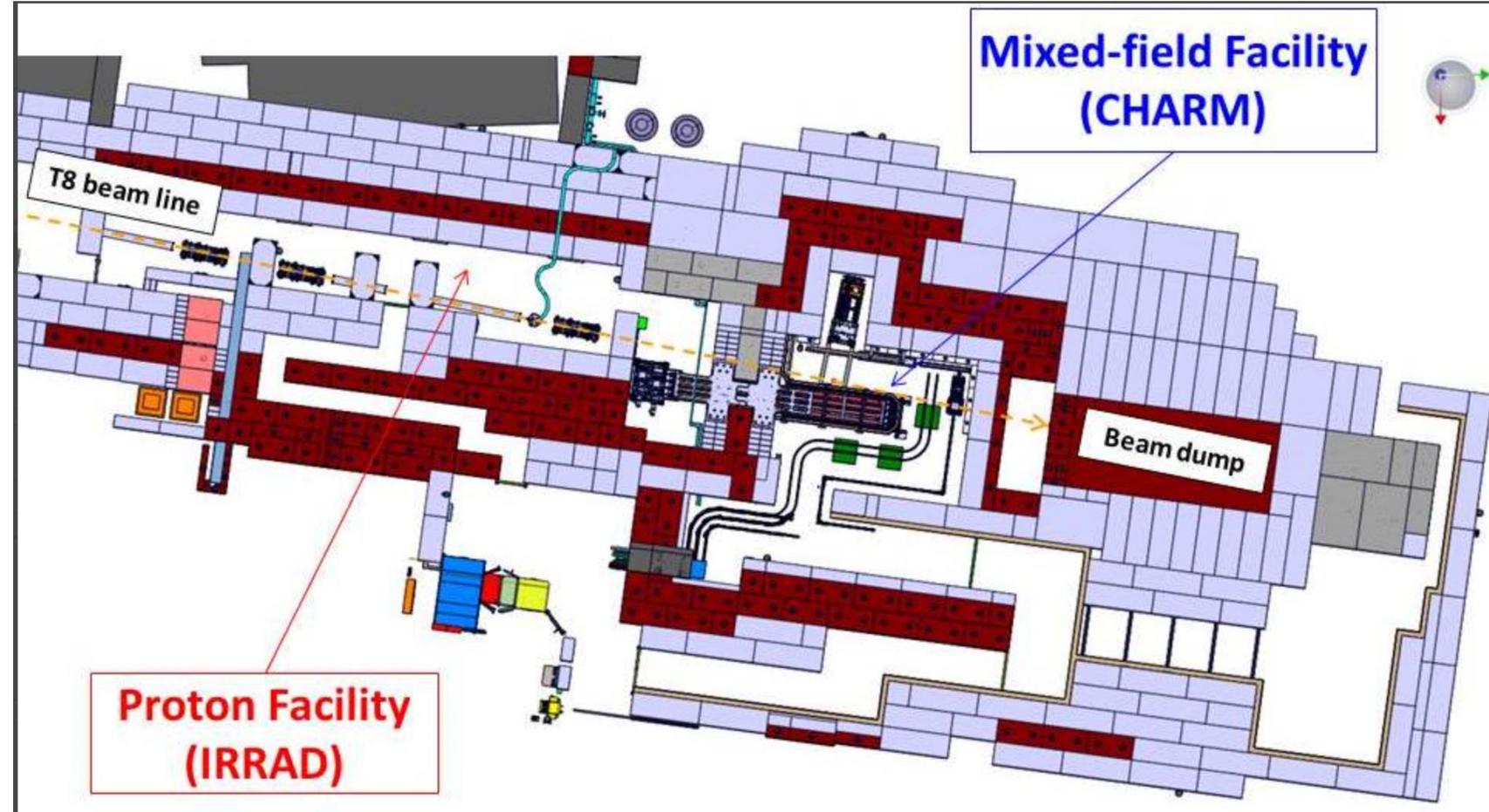
Top Side (with Wedgelocks removed)



SEL Test Conceptual Overview

- General plan:
 - Monitor Board input draw for signs of latchup in the form of a small-timescale excursion of the input current from the observed baseline
 - Holdoff for $\sim \frac{1}{2}$ second to capture some time behavior, then cycle power to clear
 - Board was instrumented to be able to narrow down what part of the board was latching
 - Prototype FPGA controller also be mounted with regulator board and monitored for problems
- Test Date: Week of May 31 – Dry run week of May 24
- Target high-energy hadron fluence - $1.6 \cdot 10^{11} \text{ cm}^{-2}$
- **Challenge: Organize this all across an ocean from the test site without all the true assets to be used!**
- **Made possible by the substantial assistance of Ken and James at CERN**

- New(ish) *mixed-field* irradiation facility
- Leftover IRRAD T8 beamline is spilled onto a target providing a large ambient radiation field
 - Handles to adjust details of dose:
 - Distance from target
 - movable shields
 - Can mock up a wide variety of environments
- Info we provided: want LHCb-cavern like environment, target HEH fluence
 - Position, target, shields etc decided by CHARM experts from there

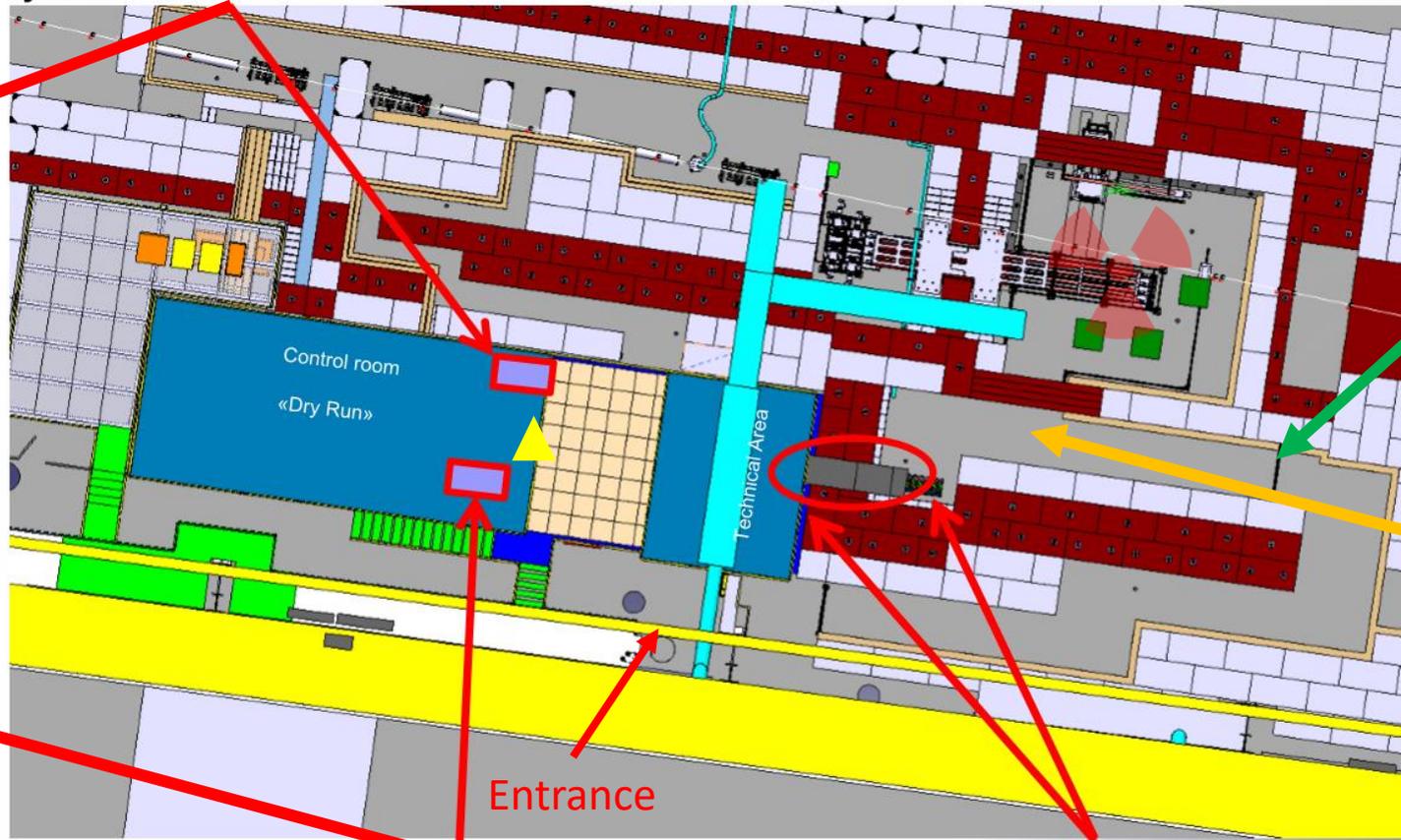




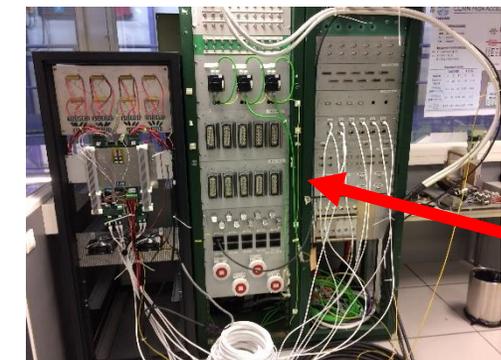
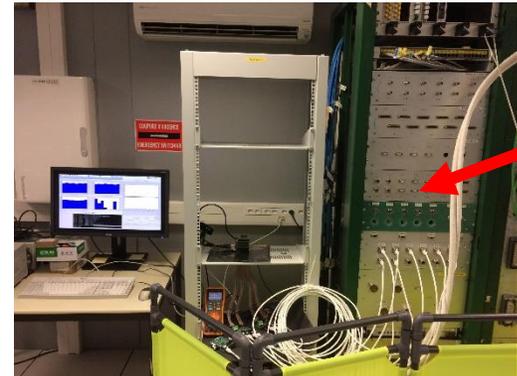
Facility Overview



Dry-Run: Patch Panel «IN»



Setup Area



Dry-Run: Patch Panel «OUT»

Test: Patch-Panel – Control Room Connection

New Irradiation Test Facility : CHARM

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June 12th 2014



- On the upper floor to the left is the dry run room / CHARM working space
- A pair of patch panels matching the “real deal” are on opposite sides of the room
 - Beware: sharpie marker markings on these guys do not necessarily appear on the patch panels for the real test! Be aware of your nomenclature/plan for connections
- Not sure how much others use their dry run week, but we found it extremely useful to shake out bugs and edge cases in our setup, and get organized regarding babysitting the logger

User rack (control)

- Wheeled racks with shelving provided for users to stock up their readout equipment on
- No reassembly required for moving from dry run to real deal – just unplug from patch panel mockup, push to control room, plug back in



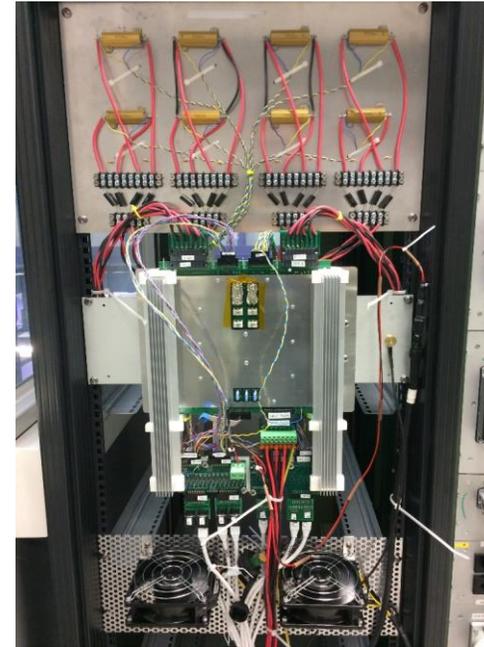
CHARM Radiation Area Access

- PPE: helmets, safety shoes, dosimeters
- Numerous safety trainings (all online)
- IMPACT from CHARM technical coordinator
- 3 hour access, but our part took ~30 minutes
- Able to bring in small items (e.g. laptop) for setup/test work



Test rack

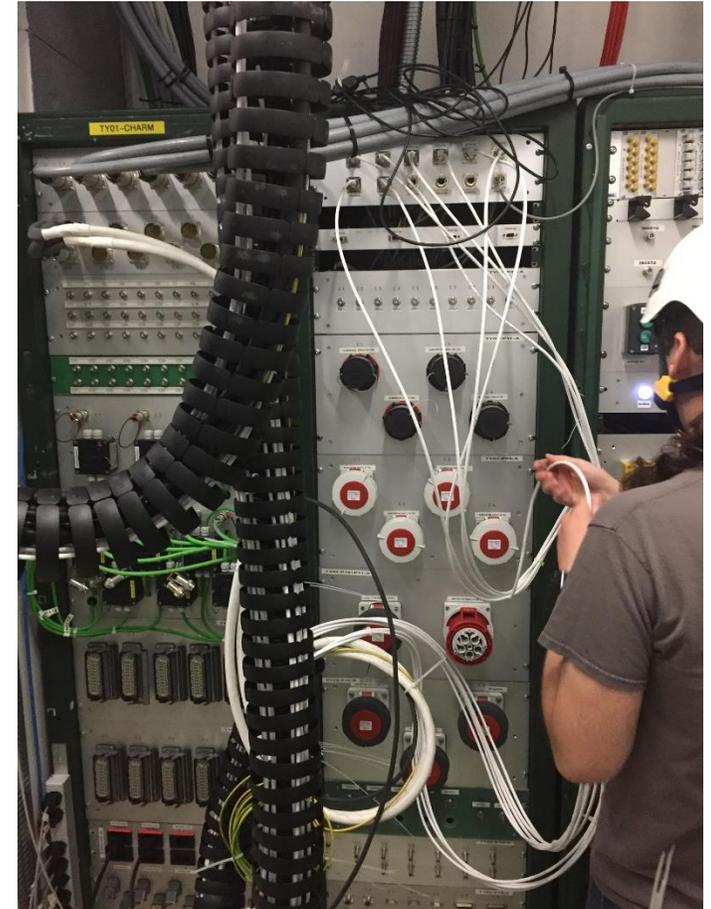
- 19 inch modular rack
 - Limited space, potentially multiple users
- Different racks for dry run and actual test
 - Be prepared for multiple setup/tear-downs
 - Assembly for real test takes place in buffer zones downstairs from the control room (bottom pic)
- Robot brings pre-assembled rack setup to final assembly point for you to cable
 - (right pic)
 - Very smooth ride
 - Cable chain fixed to rack assembly
- Perform final test before robot moves into irradiation position



Radiation Area Patch Panel

- Patch panel and rack are in/near line of sight of target
 - Work quick (~10 minutes)
 - Mandatory to have cables *well-labeled* *on both ends*
 - Thanks to Ken and James for the critical label-maker work

- Patch panel use must be coordinated between multiple users
 - A lot of your access time will be spent waiting for your turn to go work in this space



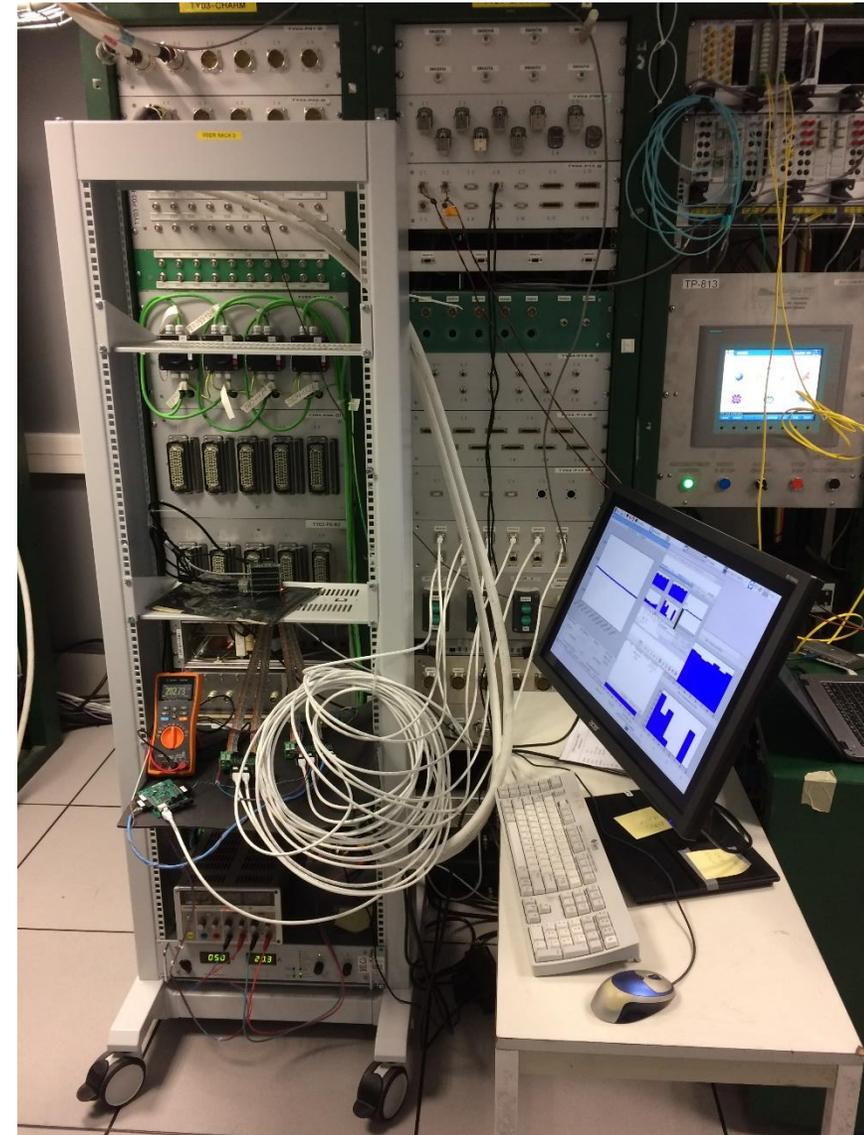
Cable management

- The literal worst
- Recommended to bring
 - Gloves
 - Chairs and table/cart
 - Grad students
- Cable chain runs along a track and is fixed to the rack assembly
 - Note! No similar fixing assembly at the patch panel – you'll have to tie it down well



Control Room

- Real control room is quite tight
 - If you can avoid large monitors like this it's for the best (we couldn't)
- During run: updates on approximate dose delivered by CHARM team
 - More details after run
- At end of run, need to be ready to move out as quickly as is reasonable
 - Minimize interference with next user



After Test

- Equipment rack moved to a cooldown space still inside CHARM
- User needs to submit TREC request re: what buffer zone it should be shipped to for further cool down and post-mortems
- User also asked to submit an EDMS document detailing their test and results for CHARM's record



Results

- Latchup detection code never tripped
 - Either no latchups happened, they were less than the threshold (3mA) or took more than 3ish seconds to move 3mA (not really single-event like at all)
- Several interesting features of data over long timecales yet to be understood
 - Slow input current rise (~5mA over 3 days) – TID ageing of DUT?
 - Weird ~1 hour cycle on input current after target removed (~1.5 mA)
- Instrumentation failure 1/3 of the way in
 - Extra information from board gone due to short in a board we were using to measure voltages on our DUT
 - Awaiting further post-mortem when there is further access to the setup
 - Being prepared for this scenario or at least robust against it is recommended: e.g. we still had a latchup rate test regardless of all these other features



Thanks to CHARM facility team
for a smooth and successful test