Using the LHC Control System –
2016 Retrospective and Short Term Plans

Guy Crockford

BE/OP/LHC

Many thanks for discussions with…

Kajetan Fuchsberger, Laurette Ponce, Matteo Solfaroli, Delphine Jacquet, Georges-Henri Hemelsoet, Michi Hostettler, Giulia Papotti, Jorg Wenninger, Markus Albert, Roman Gorbonosov,, Marine Gourber-Pace, Grzegorz Kruk

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2016 Retrospective
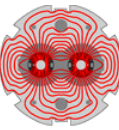
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2016 Retrospective – User View

- The LHC Control System very stable in 2016

- Suite of applications, fixed displays & feedbacks have evolved & matured over 5 full years of LHC beam operation

- Early problems of database slowness in regenerating settings for BP mitigated

- Still room for some improvements

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Priorities from Evian 2015

Kajetan's talk, "Controls - an OP perspective", revised

1. Improved Filling Diagnostics

2. Improve integration of QPS/PIC/Equipstate

3. Improved Automation of Sequencer, Scripting

4. Know the State of the machine at a given time

   - Important to improve robustness of PC interlock system

   - First step towards a real state machine

5. Improve Window Management on Consoles

   - Startup scripts implemented to configure default applications and their window positioning (for upper tier fixed display screens)

- Non-exhaustive list! More "nice to have" requests

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Improved Filling Diagnostics
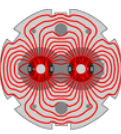
- Quick analysis of injections problems between SPS & LHC
- Uses a generic analysis framework which can be used by other applications
  - Used in the next version of the BIS

Sequencer: multi-tasking
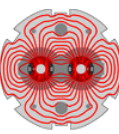
- Heavily used and working very well

- Manual option for parallel execution of sequences

- Time savings possible if this could be automated

- But still keep shift crew "in the loop"

- Example:

  Prepare Ramp…

  Move out injection

  protection collimators

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Luminosity Scan Client/Server
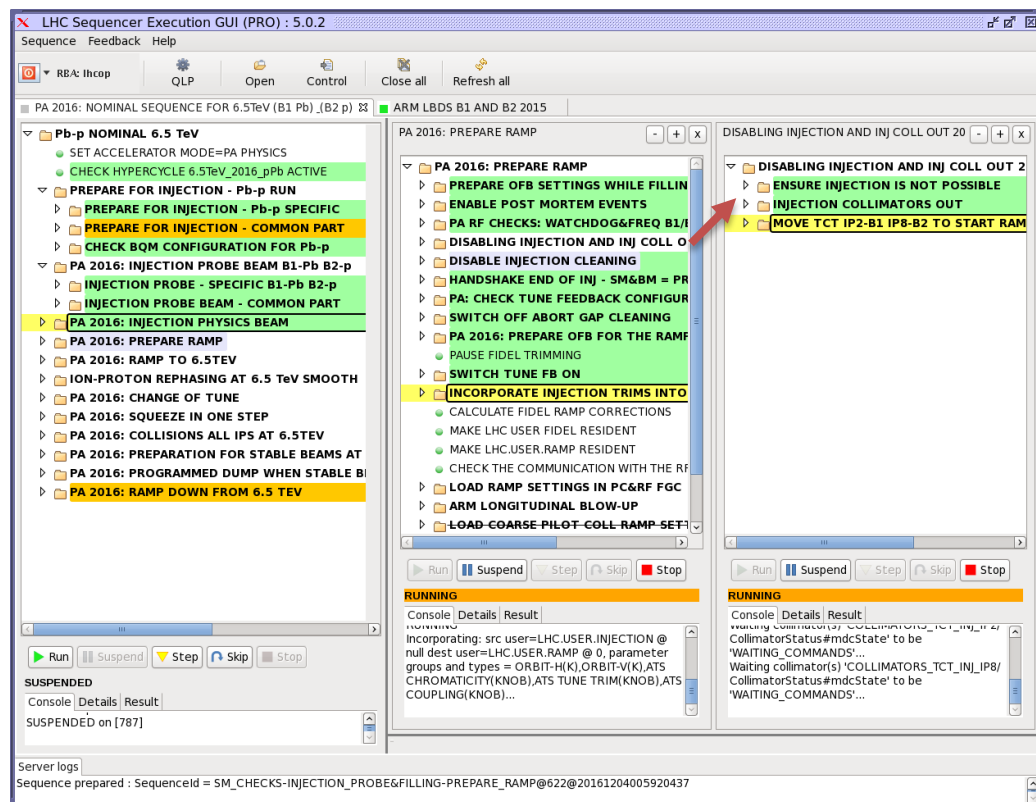
- Very nice tool for luminosity optimization & Emittance scans
- Proper reservation management via server, avoid conflicts
- Used intensively during physics fills
- New features for VdM scans
- Reliable and robust
- Further developments planned for EYETS
  - Levelling

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Tune &Chromaticity Estimate
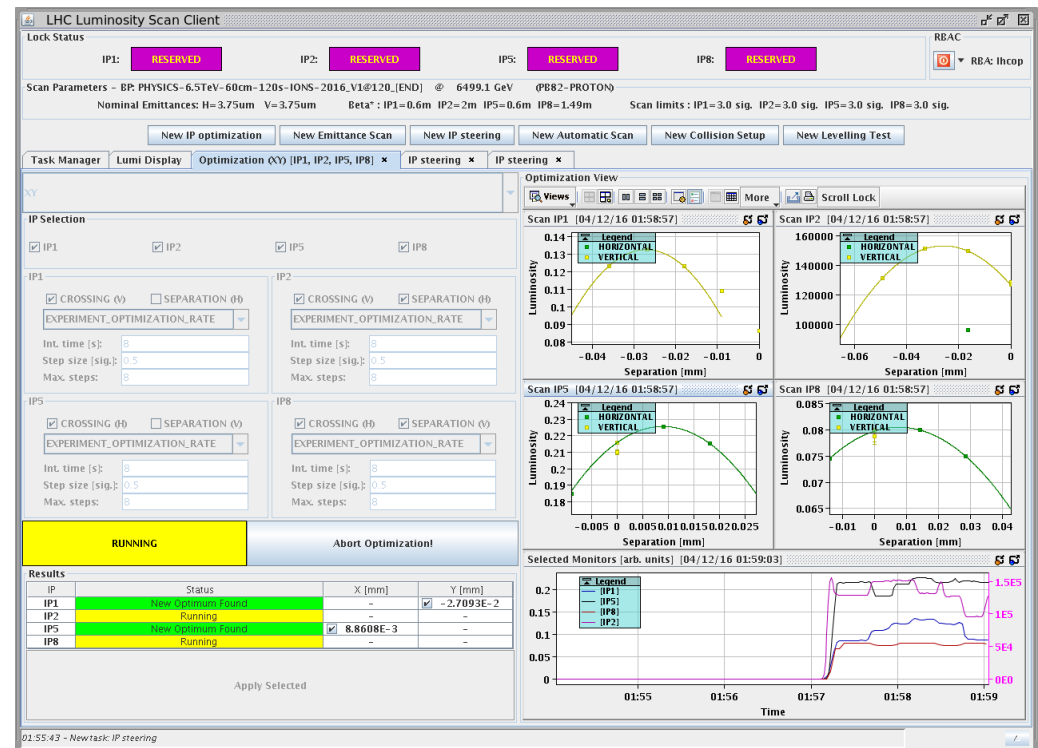
- Convenient tool to quickly measure and correct Tune and Chromaticity

- Time saving on routine trims during filling process

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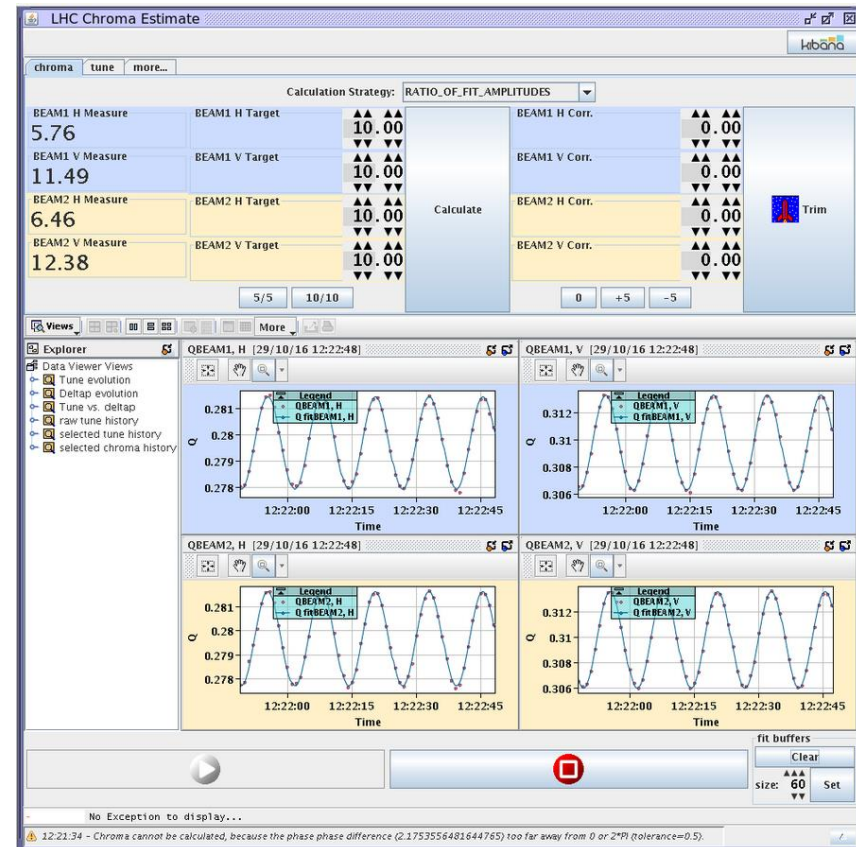
Power Converter Interlock

- Checking Power converter currents within tolerance
- Connected to SIS interlock
- Also a useful display of time remaining in Beam Process
  - Ramp, Squeeze, etc

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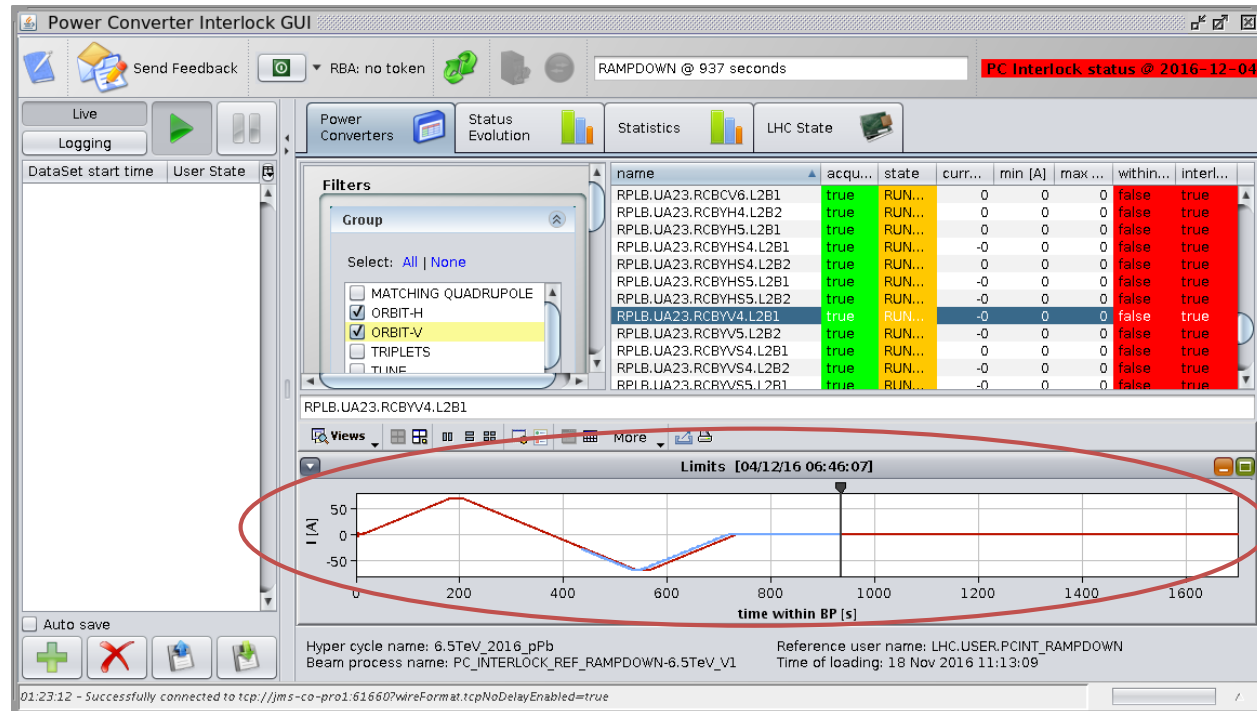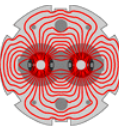
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Human Error & Controls 1

- Human variability is a force to harness (especially at 4AM)

- Ask why the control system defenses did not catch the (human) error (rather than blame the individual)

- Machine Protection defenses proved to be very robust

  - All cases caught by clean beam dumps

- Downtime due to human error could be improved

- 52 events "Ops Mistake"

  - 63% Injection

  - 17% Ramp + prepare

  - 10% Squeeze

  - 10% Stable Beams

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Foto: FOX
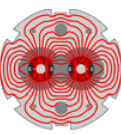
Human Error: Some examples

- Beam bumps with PM, Category "Operational Mistake"

- Errors mostly during MD and Beam Commissioning

- Errors on override of SBF with setup beam

    - Unintentionally forced to SBF false

    - Errors with masks, hidden interlocks

    - Intensity over threshold wrt energy

- Incorrect sequence execution

    - Switch on ALICE Dipole instead of Solenoid

- Errors in MD Setup/recovery from MD

    - E.g. Coarse collimator setting without BETS-TCDQ mask

- Preparing Hypercycle change with circulating Beam
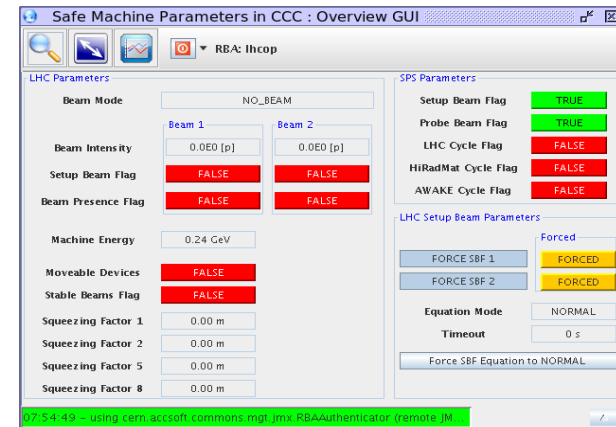
Human Error & EquipState

- Recovery from PC faults, frequent occurrence
- Risk to switch off a sector by mistake
  - Cost: At least 1 Precycle, 40 minutes
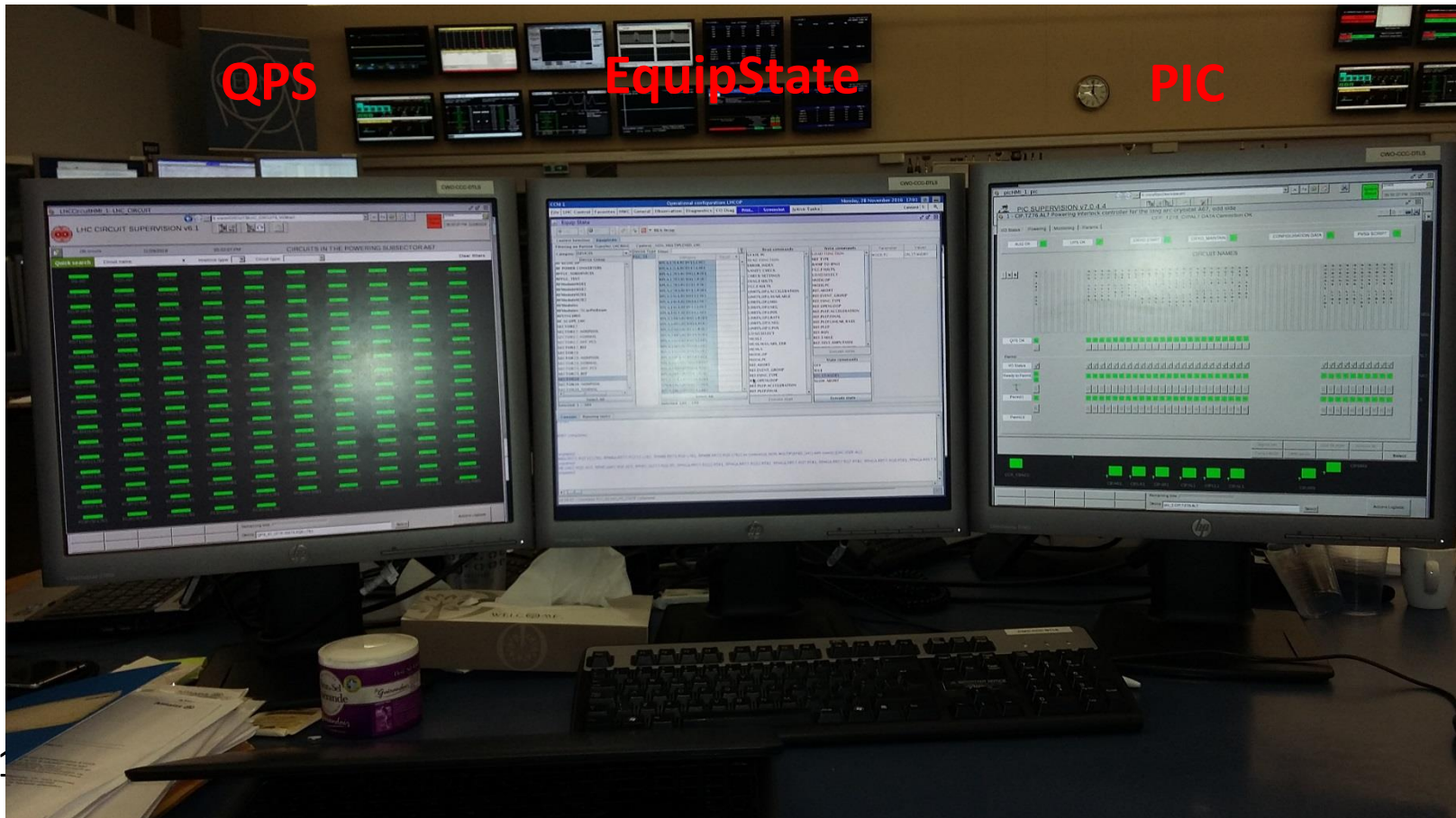
Human Error: Defences

- Popup confirmation on global execution commands (eg EquipState)

- Improve SBF override checks
    - Possibly via improved state machine

- MD pre-planning detail and tidy up after

- Mitigation measures already added to SIS or Sequences following some operational errors

- Keep 2 sets of eyes on tasks

even seemingly trivial

(Especially at 4AM!)

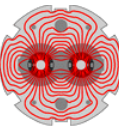Guy Crockford

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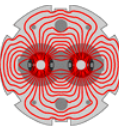
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EYETS Controls Schedule

- 5 days CO maintenance from 5 – 13 January

- CO core services frozen by 30th January (LHC last to start)

- CBNG build tool (CommonBuild replacement) Tests in progress
  - Training for application developers in February

- See: https://wikis.cern.ch/display/SUWG/EYETS+2016-2017

Controls Operation requests during EYETS – Q1 2017
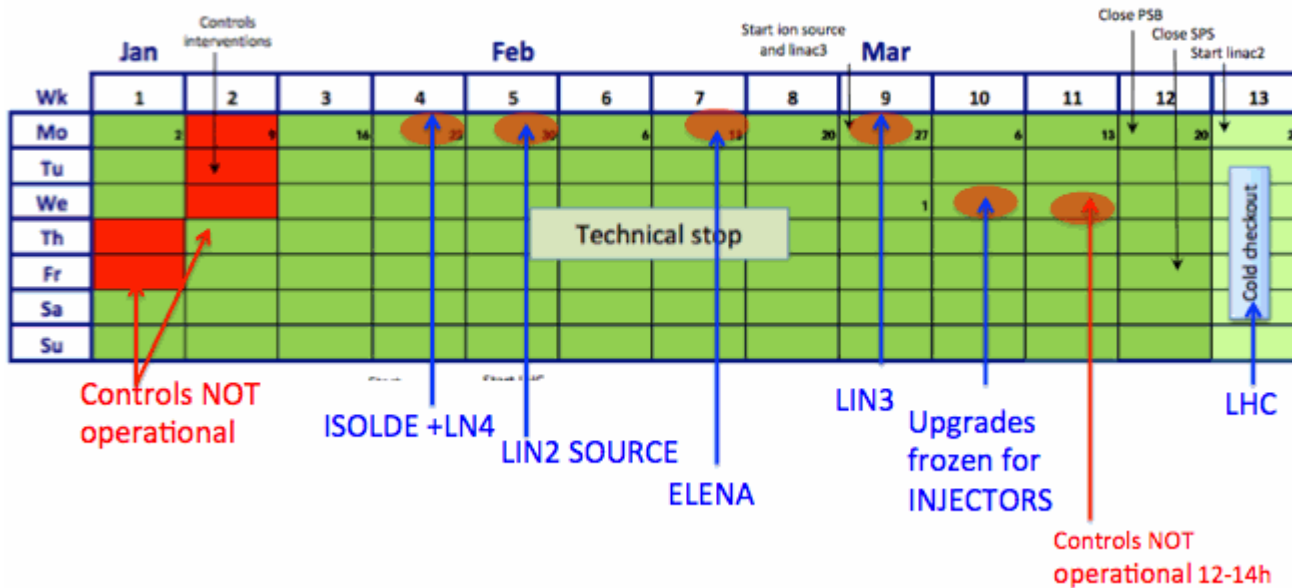
Courtesy
Marine Gourber-Pace

EYETS work, LSA team
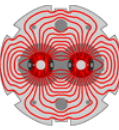
- Function & Function List Type (FESA3, CMW, FGCs)

- Better Settings Archiving
  - Problems with Cache size early in the run
  - Clone BPs at beginning of run (with Trim History)

- Consolidate LSA Suite
  - Eventual eradication of individual LSA applications

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LSA Suite Consolidation

- Work in progress between OP (requirements) and CO (implementation)
- Essential functionality needs to be incorporated into LSA Suite
- BUT OP also need to keep an open mind to changing working habits
- In both CO and OP interest to operate the machine from LSA suite in 2017
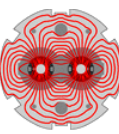- Liberate CO from maintaining duplicate applications
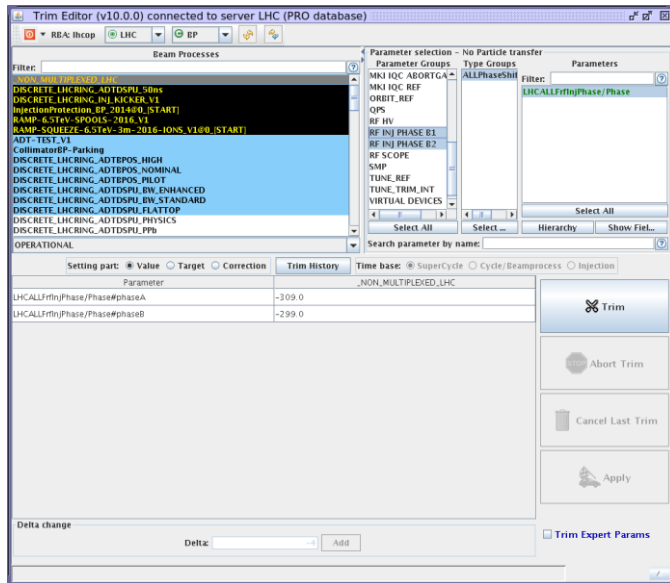
Trim Application

LSA Suite Trim

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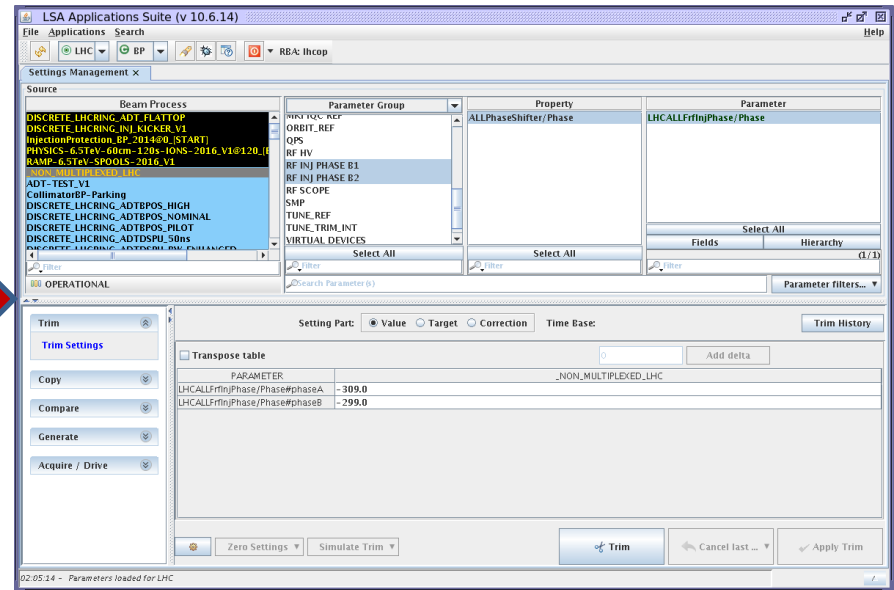
EYETS OP Team projects

- Luminosity Scan Client improvements, Levelling

- Separation plane levelling first

- Followed by Crossing Angle levelling

- Preparing the way for Beta* Levelling (later)

- Complex software implementation

  - LSA Expertise help required

  - Close collaboration
    with CO/APP planned

- Eradicate old Lumi scan
 application

OP soft teamwork approach
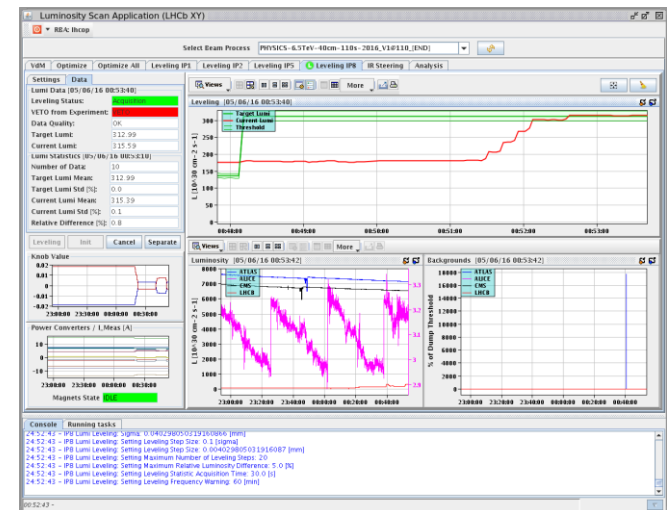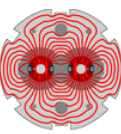
- OP Team trying a teamwork approach to software development
- (other OP members also developing LHC software outside the team)
- Slow to get started using new approach, but payoff in long term
- Team meet-ups hampered by shiftwork duty
- Heavy burden to maintain software following authors departure
- This problem is alleviated by a teamwork approach

- Room for more volunteers in the team!

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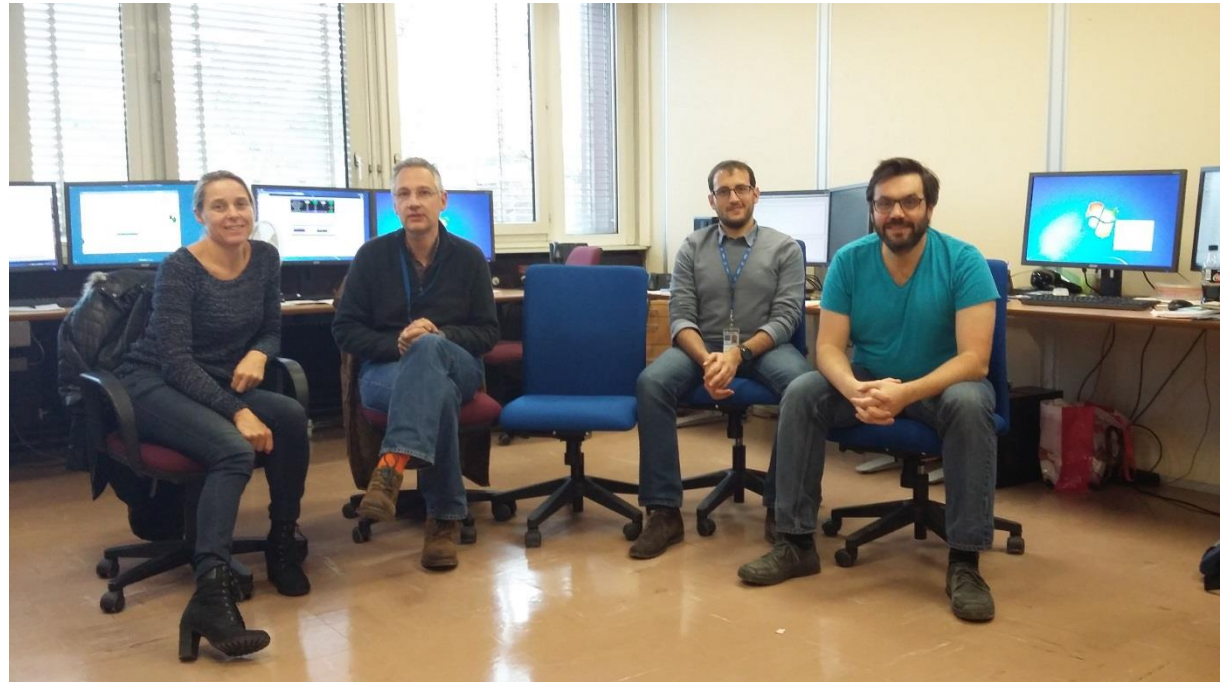
Teamwork software approach
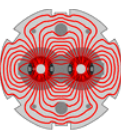
Still navigating in a complex environment
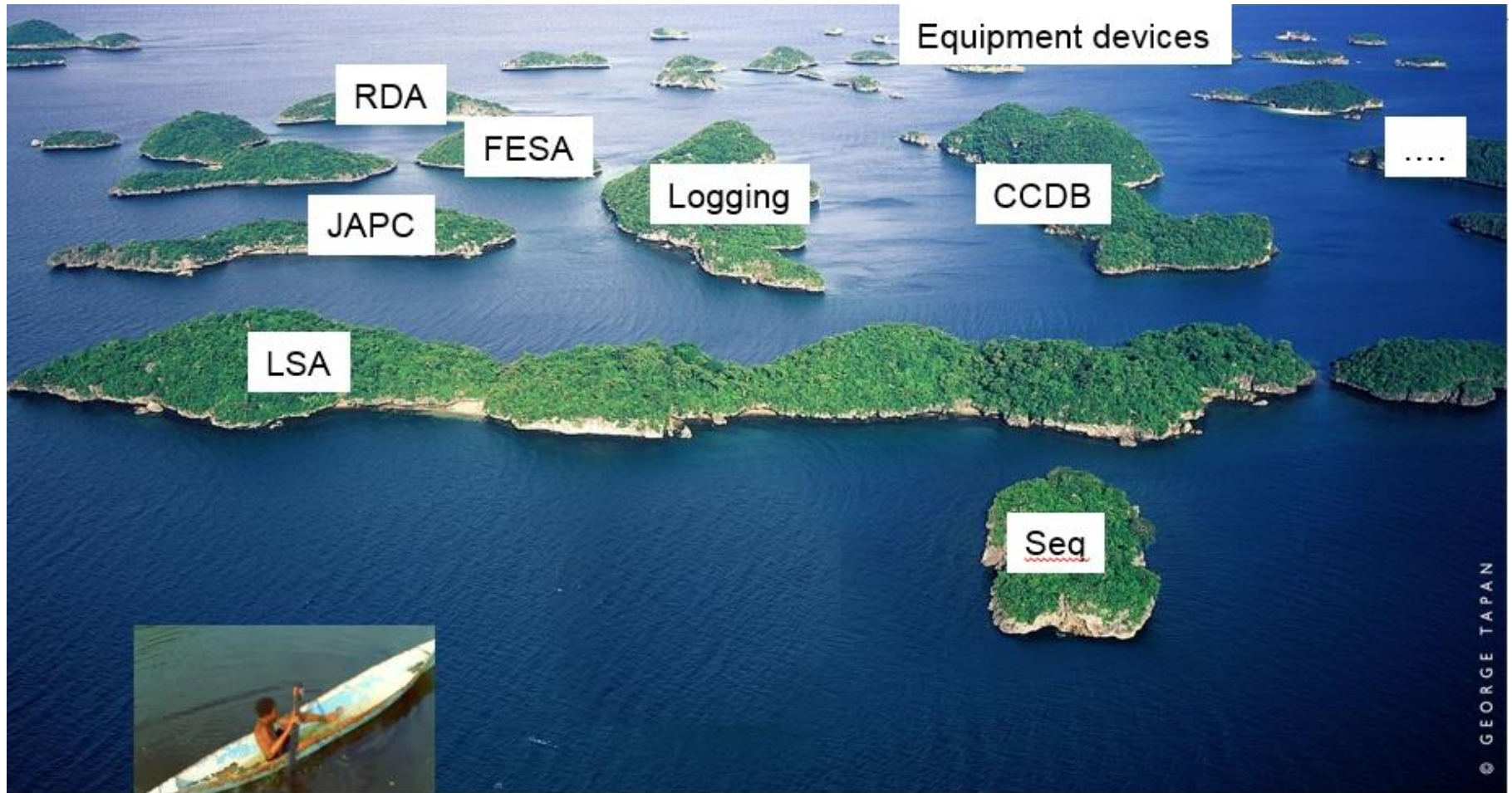
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Summary

- The LHC Control System has reached an excellent level of stability and efficiency in 2016

- New tools are contributing to fast and efficient operation

- Keep in mind the Human factor, and try to catch the errors

- Teamwork on software development projects, the way forwards

- EYETS is not so "Extended" for Controls

- Plenty of work-in-progress during EYETS in preparation for the 2017 startup: CBNG, LSA Suite, Lumi Levelling etc

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Photo courtesy of Daniel Valuch

Thanks for Your Attention!

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