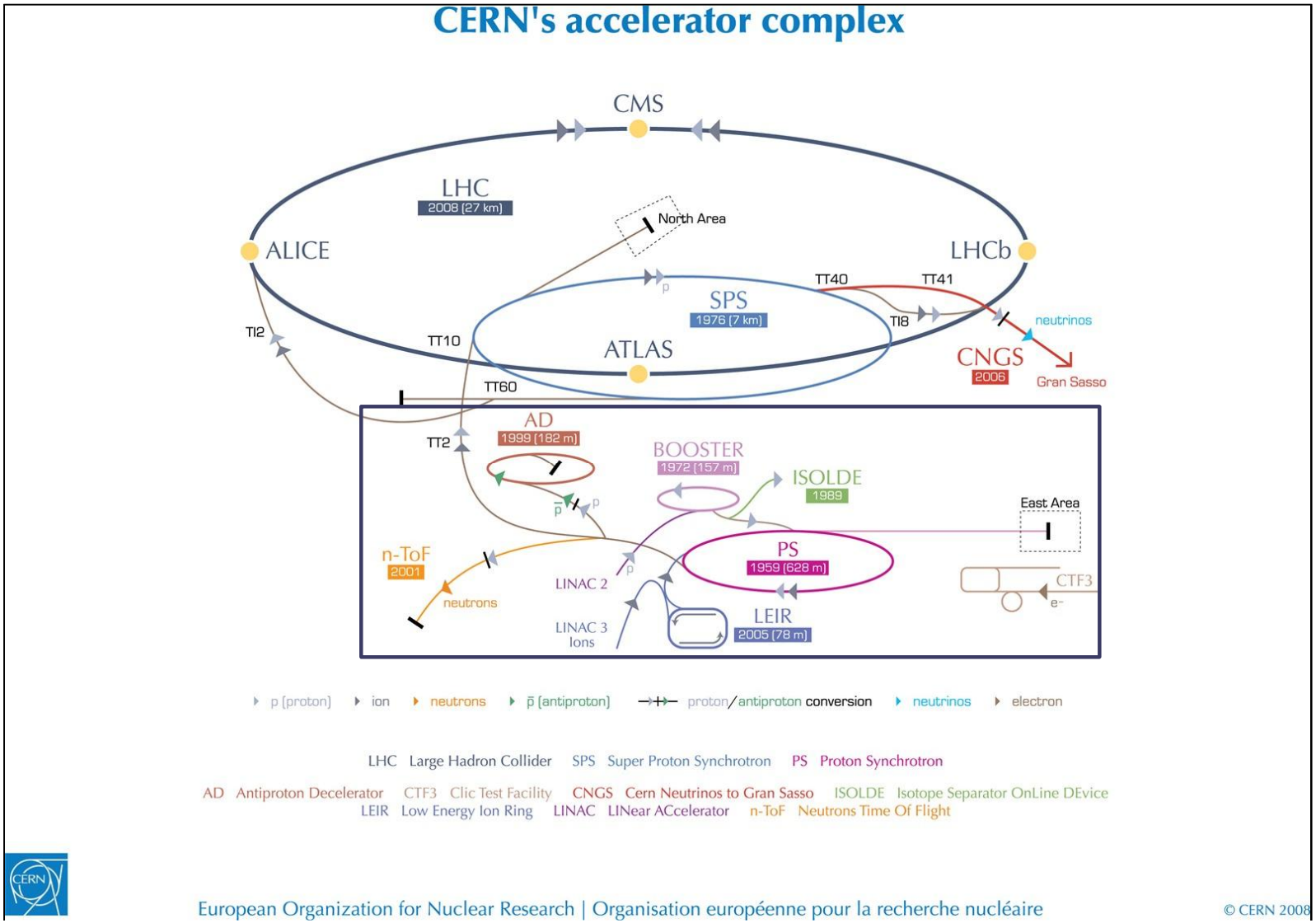
Marc Delrieux, CERN, BE/OP/PS

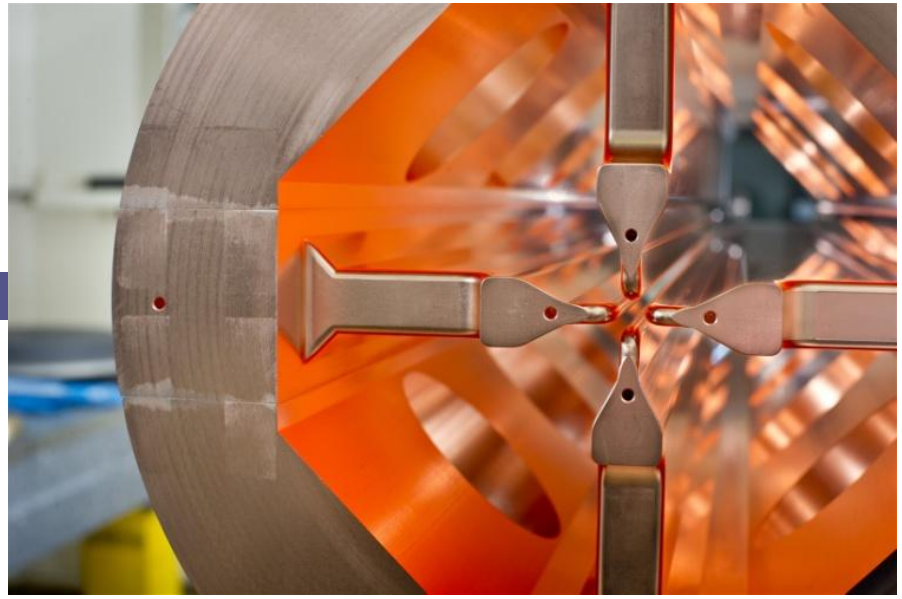
CERN'S PROTON SYNCHROTRON COMPLEX OPERATION TEAMS AND DIAGNOSTICS APPLICATIONS

- CERN's Proton Synchrotron (PS) complex
- How are we involved?
- Review of some diagnostics applications
  - examples of 3 possible scenarios for operations

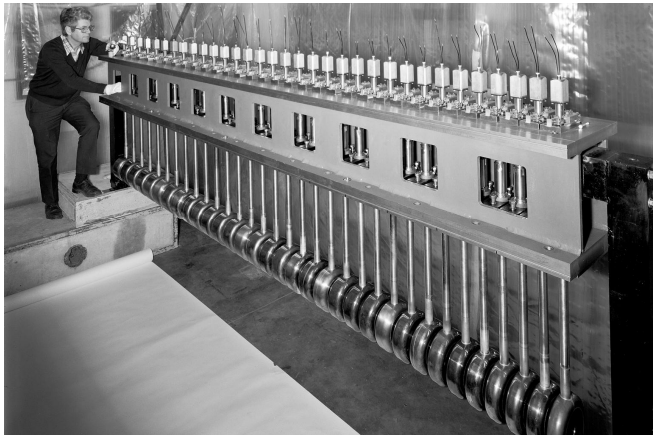
CERN's Protron Synchrotron complex (1/4)

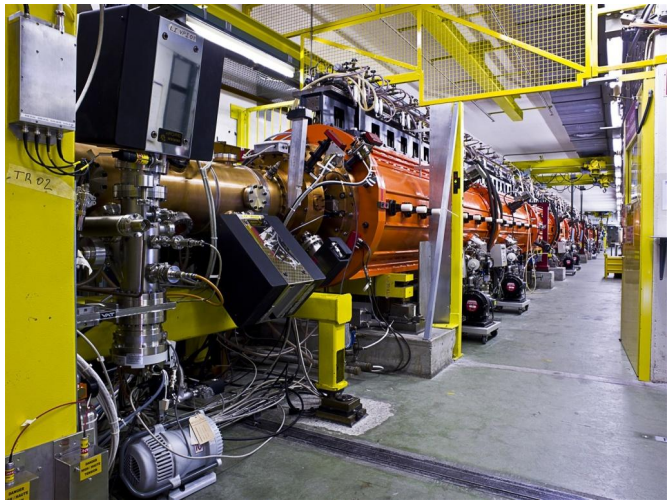


CERN's PS complex (2/4)

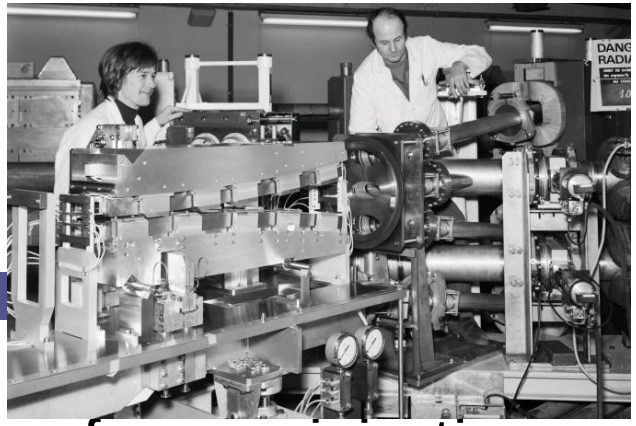


- Linac 2, 1978-?
  - Protons source
  - Radio-frequency quadrupole
  - 2 buncher cavities (and 1 debuncher)
  - 3 Alvarez drift tubes tanks
  - Bringing protons to a kinetic energy of 50 MeV, with a beam current up to 180 mA, each 1.2 s

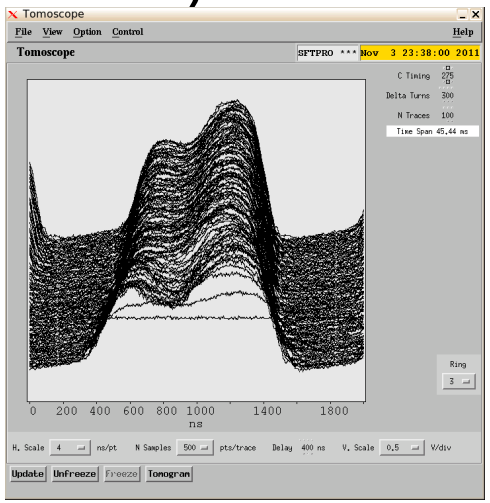




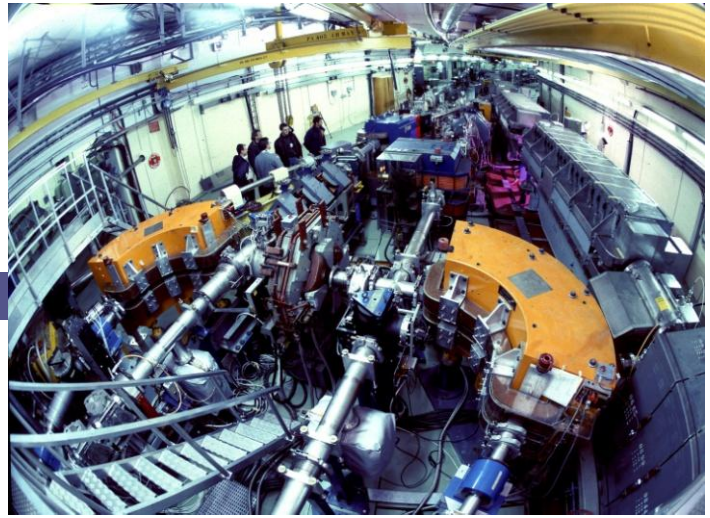
CERN's PS complex (3/4)

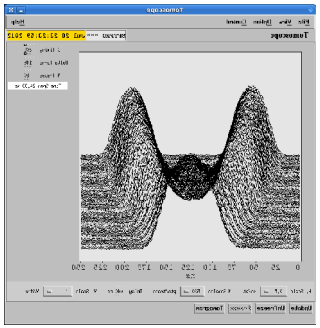


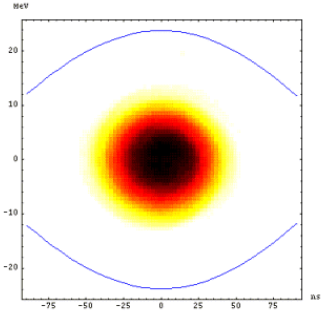
- PS booster, 1972-?
  - 4 superimposed synchrotrons of 157 m circumference, injecting a certain quantity of Linac 2's pulses via a multi-turns injection process
  - Captures 0, 1 or 2 bunches per ring, hence providing up to 8 bunches to the PS each 1.2 s, with a kinetic energy of 1.4 GeV
  - Wide intensity spread: 5E09-4E13 protons per cycle
  - A dedicated experimental area (ISOLDE), which consumes almost 40% of produced cycles (and a huge quantity of protons!)
  - Space charge effects, tune shift
  - Critical for intensity and transverse beam characteristics (hence LHC luminosity)



CERN's PS complex (4/4)

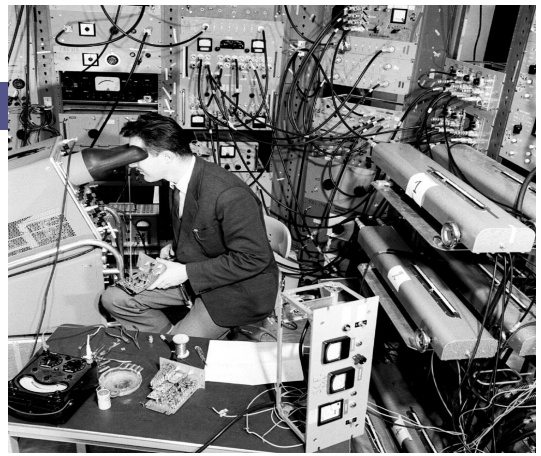




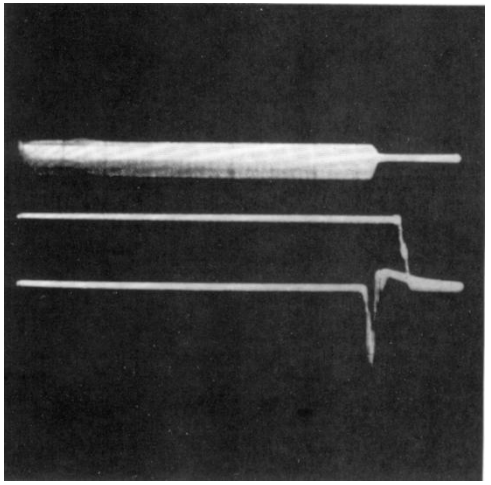


- Proton Synchrotron, 1959-?
  - Has accelerated/decelerated
    - Protons/antiprotons
    - Ions
    - Electrons/positrons
  - Combined-function magnets
  - Very versatile Radio-Frequency system
    - accelerating cavities (3.3-10 MHz)
    - "gymnastics" cavities (20, 40, 80, 200 MHz).
  - Wide harmonics range (h7 to h420), numerous manipulations
    - bunch splitting, bunch merging, batch compression, batch expansion, bunch rotation…
  - Various extraction energies (up to 26 GeV)
  - All operational beams cross transition (Transition energy 6.1 GeV).
  - Fast, slow, and multi-turn extractions (5 turns continuous transfer…)
  - Critical for longitudinal beams characteristics.
  - Dedicated experimental areas (East Hall, nTOF), and other client machine (Antiproton Decelerator)
- The ions LHC injectors chain also involves Linac3 and LEIR (Low Energy Ion Ring) but these are not operated by PS teams

How are we involved in applications?



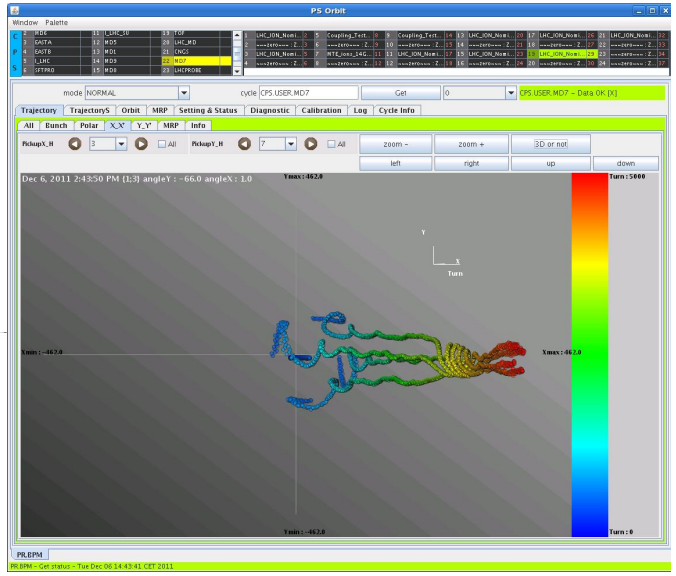
- Since 1959, some of our applications have slightly evolved…
- Groups developing applications
  - Controls
  - Beam instrumentation
  - Operation
- Each shift leader is linkman for a certain topic
  - Analogue signals observation
  - Beam intensity measurements
  - Longitudinal profile measurements
  - Beam losses measurements
  - Orbit measurements and corrections
  - Transverse profile measurements
  - Working point
  - Magnetic cycles
  - …and also: Controls system, power converters and magnets, beam documentation, Frequency domain measurements, Timing and sequencing, safety…

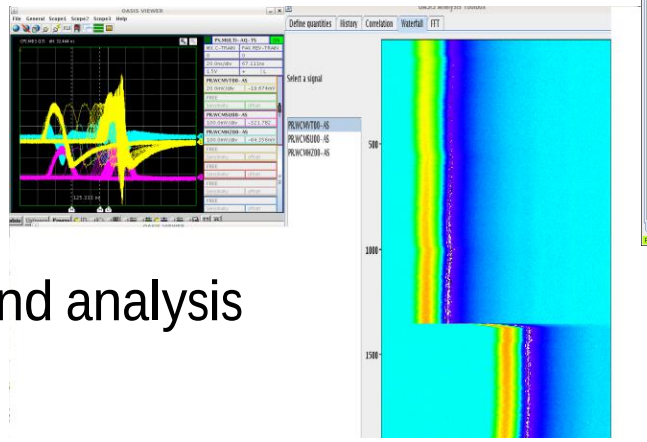


- A linkman's tasks: write specifications, test applications, report issues, follow-up, train fellow operators, ensure the applications fulfill expectations
- A tool for follow-up: from our e-logbook, "report OP issues"

1st (most frequent) scenario: let them do the job

- PS orbit (Beam Instrumentation)
  - 40 pick-ups, up to 200 000 measurements
  - Trajectories (turn-by-turn, bunch-by-bunch), orbits, mean radial position, phase space reconstruction
  - OP input permanently necessary
    - Succession of harmonics for gates
  - Very good reaction and follow-up
- Analog signals
  - >1800 signals
  - OP functionalities
    - Memory, survey…
    - Multi-triggering and analysis
  - Piquet service

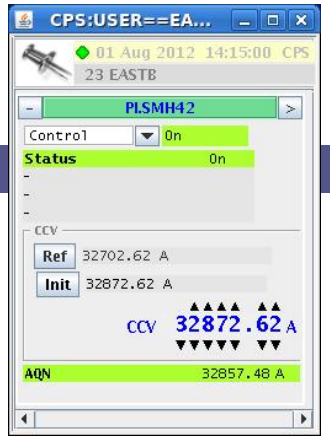


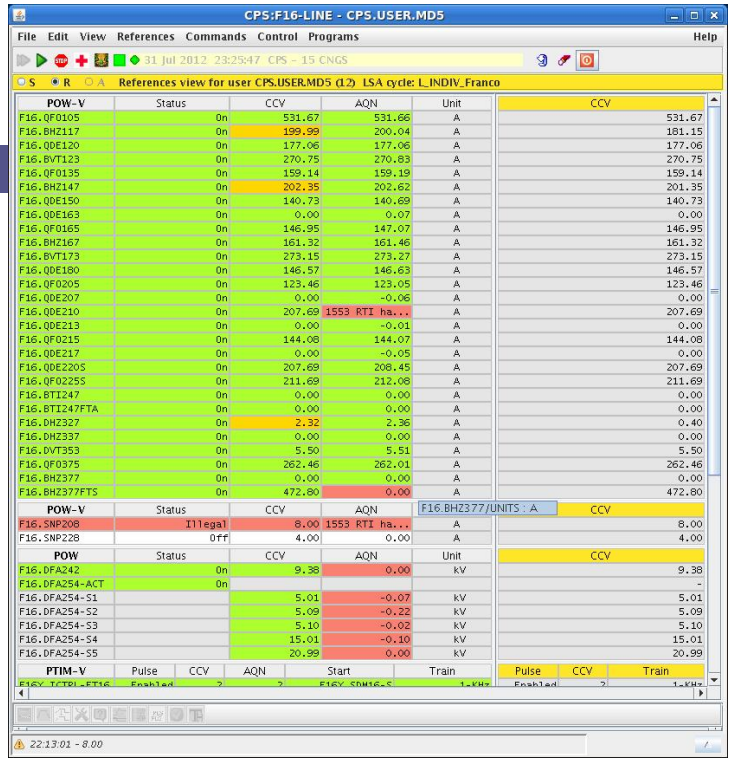


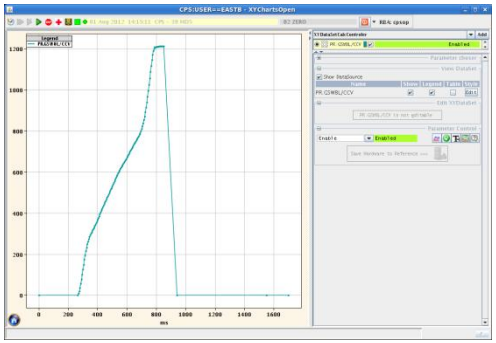
1st (most frequent) scenario: let them do the job

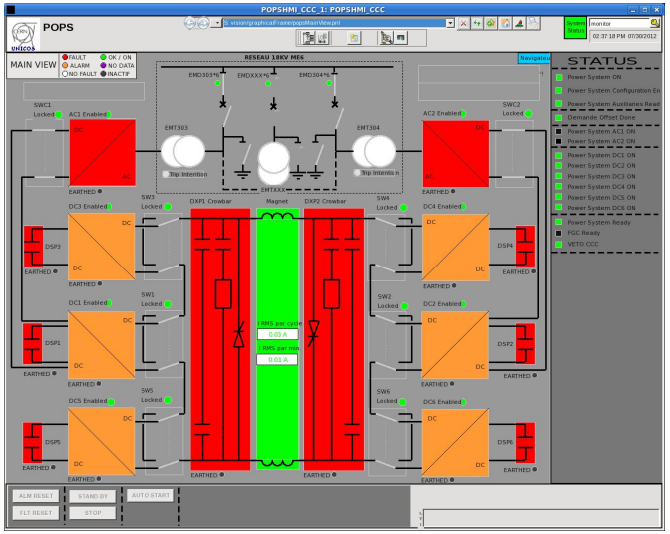
- Controls system
  - Knobs and working sets
  - Analog functions editor
- OP requirements
  - Piquet service
- Equipment groups
  - PS main power supply
  - Specialists application and interface

but adapted following OP requirements



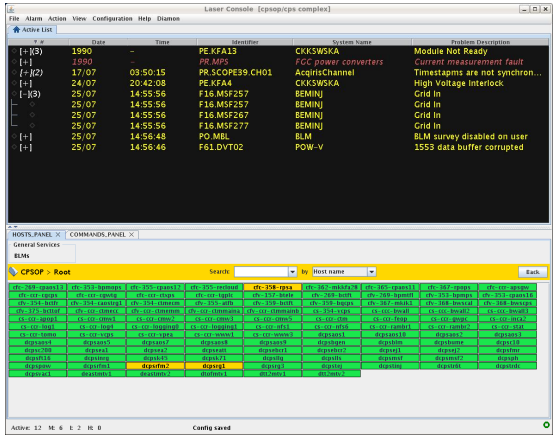


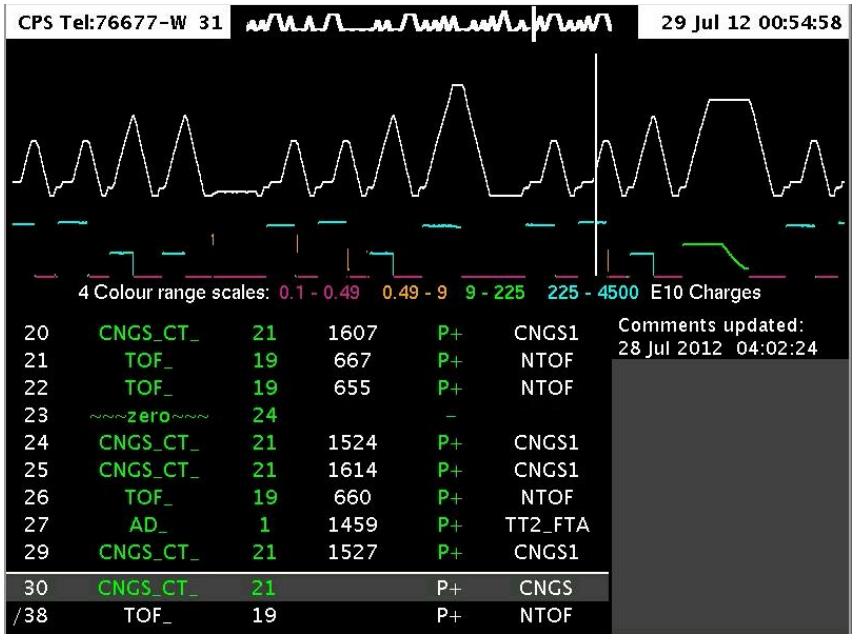




1st (most frequent) scenario: let them do the job

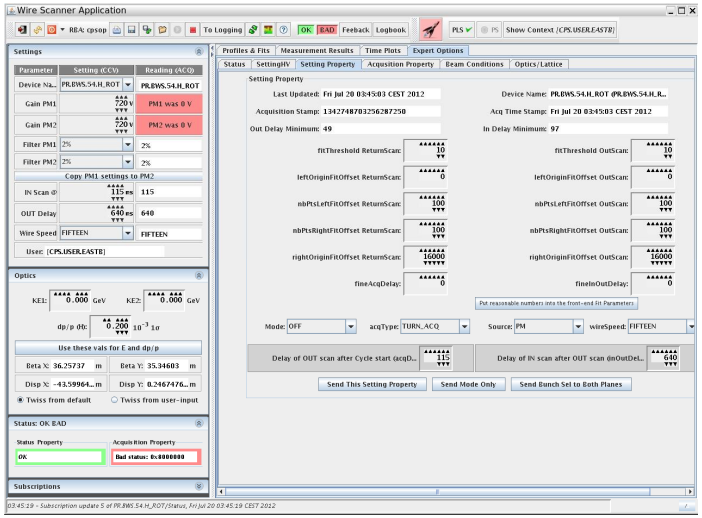
- Fixed displays
  - OP requirements to help fast diagnostics
    - Intensities, magnetic cycles, destinations, particles types…
- Alarms
  - Adapt an already existing program to PS complex
  - Integrate commands
  - Integrate frontends monitoring

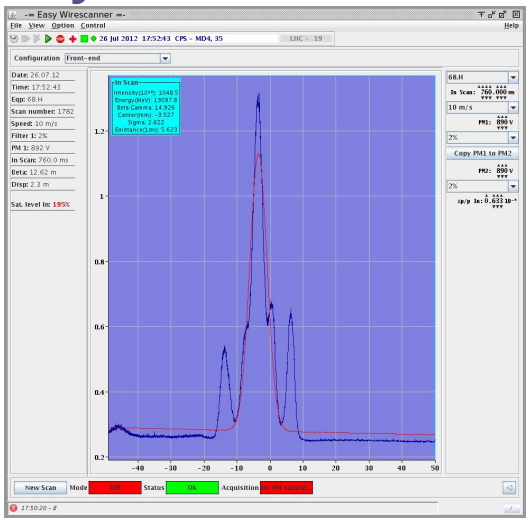




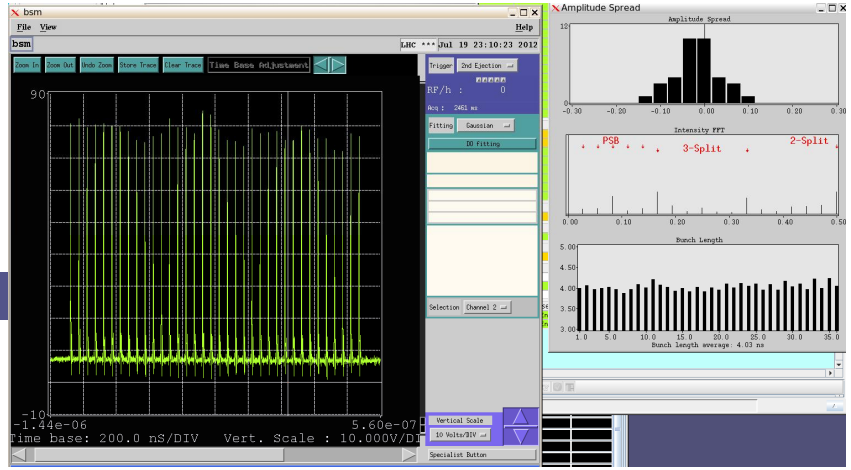
2nd scenario: adapt application to your needs

- In general CERN-(too)-generic applications
  - LHC is so different from our small pulsed accelerators!
  - Development for LHC is the priority
  - So many different beams = so many different settings
  - Exotic processes and manipulations
- Wire scanners, tune and chromaticity measurements…

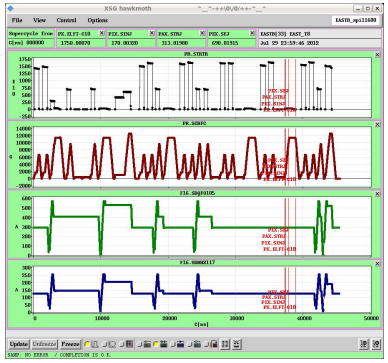


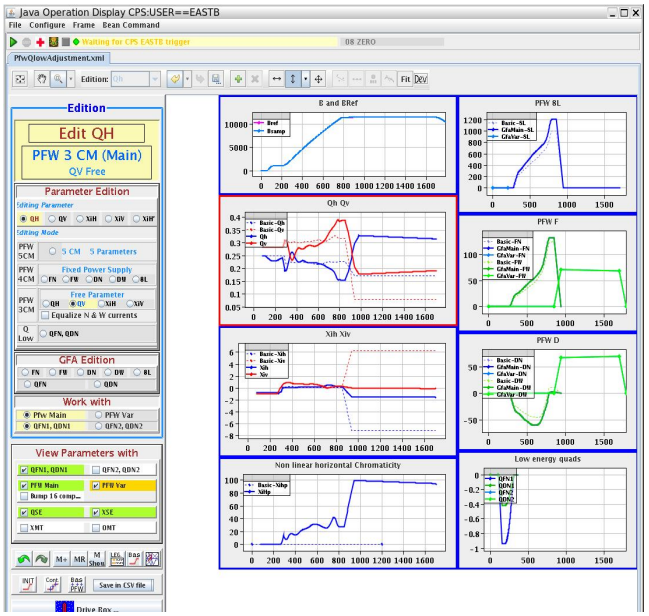


3rd scenario: do it yourself



- Specific, dedicated applications
  - RF gymnastics
    - Bunch shape measurements
  - Working point control
    - Combined-functions magnets
    - + additional windings
    - + low-energy quadrupoles
  - Pulsed accelerators
    - Samplers





- Requires heavy maintenance
  - In any case, you have to use controls tools and follow their standards

Conclusions

- If you have a dedicated controls/applications group
  - Try to get involved as early as possible
  - Write specifications
  - Find compromises
  - Make sure developers do what YOU want
  - Ask a piquet service for applications YOU consider critical
  - Make sure you have efficient issues reporting tools
- If some operators are able to code (and no one gets offended)
  - Either adapt existing applications to your needs
  - Or do 100% of the work…but OP can't provide the same infrastructure as a dedicated group
- Thank you for your attention, and…how do you get what you want?