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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

Diagnostics
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Workshop on Accelerator Operations
SLAC National Accelerator Laboratory
CERN’s Proton 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**
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)
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
2\textsuperscript{nd} scenario: adapt application to your needs

- In general CERN-(too)-generic applications
  - LHC is so different from our \textbf{small pulsed} accelerators!
  - Development for LHC is the priority
  - So many different beams = so many different settings
  - \textbf{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?