Diagnostics Summary

Retreat Diagnostics Agenda

- HF Instrumentation Plans - P. Cameron
- LHC Chromaticity Control - H. Schmickler
- Tune and Chromaticity - P. Cameron
- Electron Detectors - H. Hseuh
- IPM Performance and Plans - R. Connolly
- BPM System Upgrade - T. Satogata
- Longitudinal Damping / Transverse Coherence Monitor - M. Brennan
- Transverse Dampers - A. Drees

The Goal and the Obstacles

- How we (Diagnostics) understand our job
- Goal - to assist in providing L and P^2
- Obstacles - limits are defined by
  - Control of Tune, Chromaticity, and Coupling
  - Injection Efficiency - matching, damping, IBS, e-cloud/vacuum, beam-beam, dynamic aperture,...
  - Ramp Reliability - IBS, e-cloud/vacuum, beam-beam (anti-cog?), instabilities, transition (chromaticity jump), ...
  - L/P^2 Lifetime at Store - IBS (cavity voltage improvement, beam-beam, e-cloud/vacuum, dynamic aperture, resonance compensation, nonlinearities,…
  - Short lifetime (IBS for gold, polarization measurement for protons, beam - beam) requires good injection efficiency and ramp reliability

HF Instrumentation - P. Cameron

- ARTUS - version 2 AFE will simplify timing, improve reliability, permit all large β BPMs and another coherence monitor
- HF and LF Schottky's
  - Aperture problem around IP2 must be solved - activation survey complete, position survey requested, BLM analysis underway
  - improved DAQ (VME-based DSP) and software, Controls interface
- AC Dipole - coherent excitation w/o emittance growth
  - Spin flipper
  - Studies of optics, coupling, non-linearities,...
- Head-Tail, Buttons, resonant QMM, WCM FFT - new systems
  - Share fast (1 GS/s) scope-based DAQ, LAN interface to Controls
  - Transients, beam loss events, longitudinal and transverse FFT, matching,...

LHC Tune and Chromaticity Control
H. Schmickler

- Tune feedback is essential for successful LHC operation
- Tune feedback requires good chromaticity control/feedback
- This requires reliable q and q' measurement methods
- Method of choice for q is PLL, possible improvement is multiple carrier (complicated by synchrotron satellites)
- Method of choice for q' is not yet clear
  - Head-tail is a powerful tool, probably not adequate for q' control
  - RF phase modulation ~3 degrees (complicated by synchrotron satellites?)

LHC Tune and Chromaticity Control
H. Schmickler

- Summary – the LHC plan
  - R&D on multiple carrier and fuzzy logic analysis for q
  - Continuous radial/phase excitations for q'
  - Full simulation of PLL including beam transfer function
  - Collaboration with RHIC
- Recommendations for RHIC
  - Full integration into Control System
  - AGC for beam excitation
  - Measure horizontal and vertical tune on different bunches - coupling
  - 'Clean up' BTF to remove synchrotron satellites – BPM at 180 degrees to remove synchrotron satellites

Tune and Chromaticity - P. Cameron

- ALL tune measurement systems are being improved
- Focus is PLL, tune feedback, chromaticity & coupling control
- Lessons Learned – one NCO per phase loop, 1/4 heliax and RF leakage, details of P-I algorithm, DSP code speed, phase compensation from VME, autolock at constant phase, filter filter filter, chromaticity and coupling control is essential
- Where we stand
  - Defined state of the art in tune accuracy and resolution – fancy diagnostics tool
  - By end of run system was stable, repeatable, reliable (specialist tool)
  - Reliable autolock
  - 4/5 successful upramps (chromaticity!), none down (chromaticity!)
  - Successful radial modulation for chromaticity measurement

Tune and Chromaticity - P. Cameron

- Plan for the next run is:
- Tune feedback from day one, chromaticity/coupling feedforward
- Tool training – develop understanding of how to use PLL/TF
- System plans
  - Position control of moveable BPM via Q3 and Q4 BPMs
  - Improved shielding, analog filtering, mixer boxes, AGC
  - Improved digitizer, DSP/FPGA, digital filtering – move out of BPM IFE, into VME based DSP system (will also be used for LF and HF Schottky)
  - Tools for chromaticity/coupling feedforward will be in place
- Interface and Integration
  - Operation from MCR is essential, integration with Applications desirable

Electron Detectors and Solenoid - H. Hseuh

- CERN style electron detectors at 12 locations
  - Well shielded
  - Grids for energy selection
- Select a few locations near ED to wind coils on the 12cm beampipe
  - Keep electrons away from the walls
  - Gives measurement of solenoid effectiveness
- Electron multipliers at 2 locations – sensitivity
- Detector calibration – electron gun
- RGAs for gas composition

IPM Performance and Plans - R. Connolly

- Aperture problem around IP2 must be solved
- Electrons from ionization give accurate profiles
- Backgrounds from RF coupling and electrons should be greatly reduced by new 'nested' design
- Rebuild of horizontal IPMs will have reduced channel widths to measure narrow beam better
- 'Optical IPM' – phosphorescent screen in vacuum
  - Components in hand, planned test at Linac derailed by Luminescence
- Luminescence monitor
  - Simple, nothing in vacuum, signal ~.001 x IPM
  - AGS test (E-15? C-15?) moving ahead for this run

BPM System Upgrade - T. Satogata

- IFE move to alcoves - $250K, attempting to pare
  - CERN corrector controller DSPs in tunnel – error correction
- Repair broken IFEs – DSP replacement
- Improve/automate diagnosis and recovery – IFE move, software,…
- Million turn BPM (2 per ring) – in existing VME crates
  - Postmortem – 13 seconds - coherence, FFT,…
- Commission automatic timing (DX's, overall)
  - Exercised early in RHIC 2001, bunch shape problem, only one shot
  - DEDICATED single bunch setup time
- Select BPM bunch globally in Manager, complete transition to new Manager,…

Longitudinal Damping - M. Brennan

- Improve injection by
  - Injection damping - strength
  - Improved AGS cycle to AGS cycle software feedback
- Instability damping
  - Passive damping [Landau cavities] – they damp single bunch instabilities, which are only instabilities seen in the longitudinal plane
  - Bunch-shape damping
  - Coupled-bunch mode damping
- Additional recommendation – include a low intensity (1/10) ‘witness’ bunch #57 on each fill

Transverse Damper - A. Drees

- No linear amplifiers (no bunch-by-bunch damping) next run. In the plan for RHIC 2004
- Bang – Bang injection damping using existing ARTUS kicker
- No plan to power both striplines simultaneously
- Will add special damper PUE at the location of the kicker
- Electronics will be extension of present AGS damper

Summary

- A lot of activity, both in existing systems and new diagnostics
- Most systems are fairly mature, and focus is moving somewhat towards Interface and Integration
- Improved control of tune, chromaticity, and coupling is highest priority for next run to
  - minimize commissioning time
  - maximize integrated luminosity
  - provide flexibility in meeting the needs of the experimenters.
- Collaboration with CERN/LHC Diagnostics will be beneficial to tune feedback, could extend into other areas.

Unified Data Display

- Three monitors (ie CRTs) - two frequency domain, one time domain
- Zoomable windows
- Frequency domain - broadband and narrowband
  - Broadband - WCM, Buttons, Head-tail…
  - Narrowband - Artus, Schottky (10 ch?),…
  - Format - spectrogram plus most recent in conventional line presentation
- Time Domain - Tune/Chrom/Coupling and Others
  - Tune/Chrom/Coupling - BPMs, ARTUS, PLL, Schottkys,...
  - Others - emittance, coherence, WCM/DCCT, RF BPMs, QMM, BLM?,...
- Three Conditions (with auto-switching) - Injection, Ramp, Store
- Data management issues - update rates, replication, display speed,...
- Recoverable from archive in this format - unzoom time scale?

Interface and Integration

- Diagnostics are maturing
  - Major systems are in place and shaken out
  - Effort shifting to Interface and Integration
- Interface to Operations
  - Unified Data Displays - Injection, Ramp, Store
  - Minimize need for Documentation and Specialists
- Integration During L/P^2 and Machine Development
  - Instruments run from the Sequencer, or
  - Instruments integrated with Applications where possible, or
  - Instruments operable from MCR w/o specialists