Status of MI Resonant Extraction

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September 30, 2003

History of Resonant Extraction from FMI

- March 1999: Resonant removal with only harmonic quad circuits. No attempt to use electrostatic septa.
- February 2000: Two shifts to establish resonantly extracted beam to F17. Started commissioning of QXR.
- September 5, 2003: Attempted resonant extraction – several problems *(will come back to this)*

Commissioning Studies

- **How do commissioning studies fit within the Run II Operation?**
  - Dedicated studies period – a period with no Collier operation
  - Semi-parasitic studies – may have (*minimum*) impact on Collider program
  - Parasitic studies – little or no impact on Collider program
- *Study time is requested and the Run II Coordinator along with Run II Management make study request decisions.*
- Constraints (currently):
  - Until (*fully)* commissioned, slow spill studies are performed with Tevatron off or at injection -> **loss free transmission of resonant extracted beam to A0**
  - Use of dedicated Main Injector $21 cycle – single batch
- Manpower:
  - Two staff half time (Johnson,Yang)
  - Software support (Wu)
  - Support as required from Controls,EE, and MI Dept

Resonant Extraction and Operations

- SY120 cycles must be compatible with all other operations (septa at 16 mm)
  - Collider at 980 GeV – no beam loss to quench TeV
  - Stacking – orbits, flattop momentum, and bunch structure
  - Recycler Operation
- All Simulations (J. Johnstone) performed with dp/p = 0
  - The ½ integer resonant extraction process is linear and can be induced by a quadrupole field but additionally utilizes the (large) octupole content in the quads to introduce an amplitude dependent tune spread ($\Delta\nu \ \alpha \ x^2$) to separate the stable and unstable phase space.
  - Operation at dp/p not 0 requires additional simulation

Current Status of Resonant Extraction

- Prior to study period the motors for the electrostatic septa were changed and the last of the harmonic quads were re-installed.
- After verifying correct harmonic quad polarity, the half-integer stop band (**for dp/p = 0**) was compensated at 120 GeV.
- Generated MI time bumps to give cycle dependent orbit control at flattop (I.e. don't affect pbar cycles)
- Verified the correct sign of the QC206 family to produce proper phase space at MI52.
- **Re-established stacking with septa at the nominal extraction position (16 mm from MI centerline)**
- Could not "see" resonant extraction beam in beamline.
  - -> all data implied little or no separation between circulating and "extracted" beam at Lambertsons.
    - **We believe the root problem was with the septa alignment.**
      - The calibration of the LVDT and adjustment of limit switches
      - Alignment request for septa

Commissioning Plan:

- Retune beamline (MI-SY) with fast extraction for dp/p = 0 operation (**4 hours**)
- Establish resonant beam to F17 using MW (**Two 4 hour periods**)
  - Establish proper extraction orbit at both the electrostatic septa and the extraction Lambertsons
  - Establish the proper septa alignment
  - Commission scanning target to measure beam separation
  - Commissioning of beamline resonant BPM's
  - Commissioning QXR
- Establish loss free resonant beam to A0 using MW (**4 hours**)

Initial Commissioning

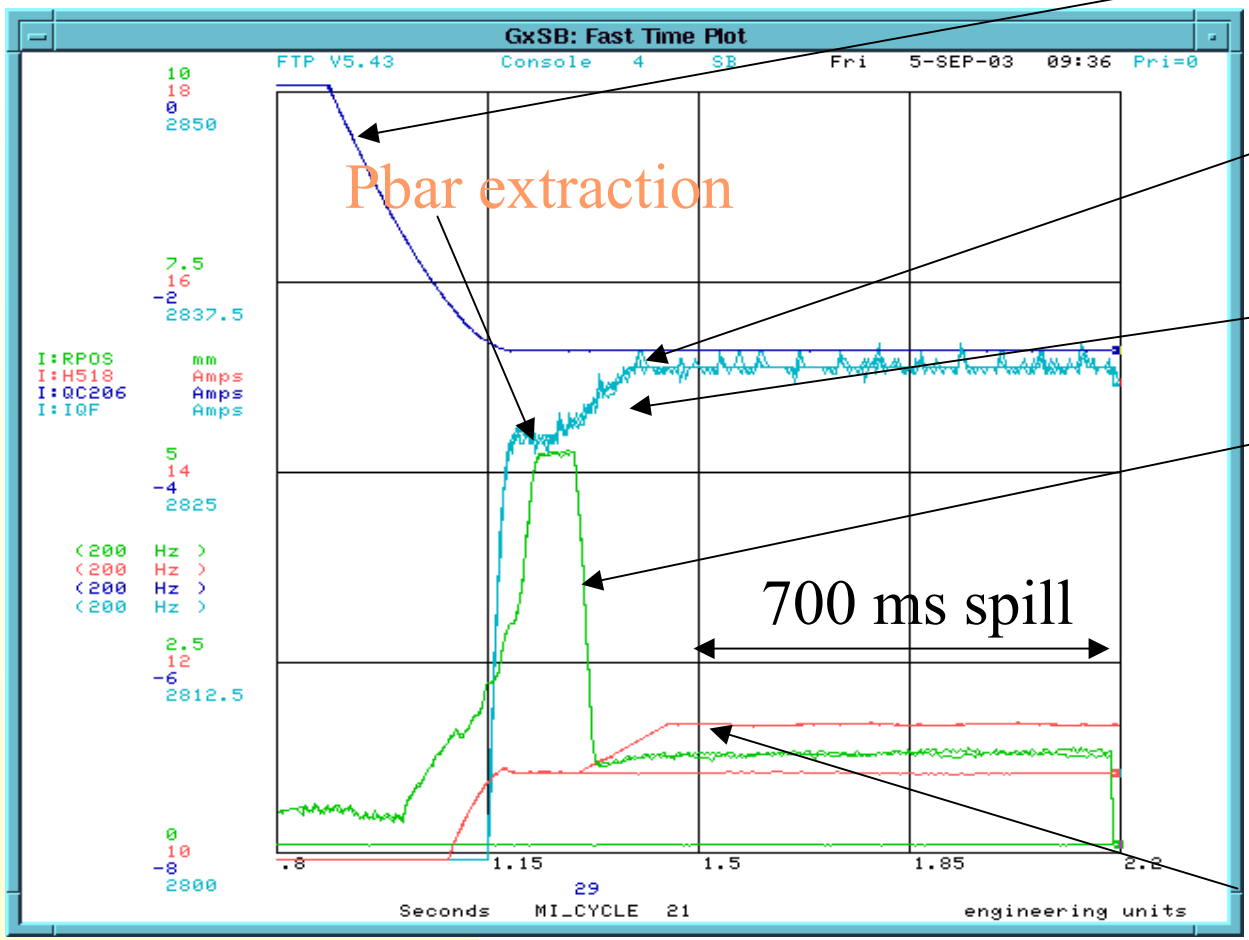
- Will utilize one batch operation
- Low duty cycle without QXR
- Will utilize central momentum (dp/p = 0)
  - For dp/p >0 , strong tune shift from sextupoles and harmonic content of quad is different than on central orbit. (no resonant extraction simulations were done for off momentum beam)

Integration of Slow Spill into Program

- How are slow spill cycles integrated into the program (such that they minimize Luminosity loss and maximize resonant extracted beam to experiments)?
  - **Establish reliable single batch resonant extraction until we get some experience under our belts.**
  - The feasibility of multi-batch operation will be pursued.

Flattop timing for slow spill

MI cycle time 2.78 sec / Total 3.25 sec



Half-integer comp.

Pbar extraction

Start ramp harmonic quads

Tune quads -.485

RPOS: Reset dp/p to zero

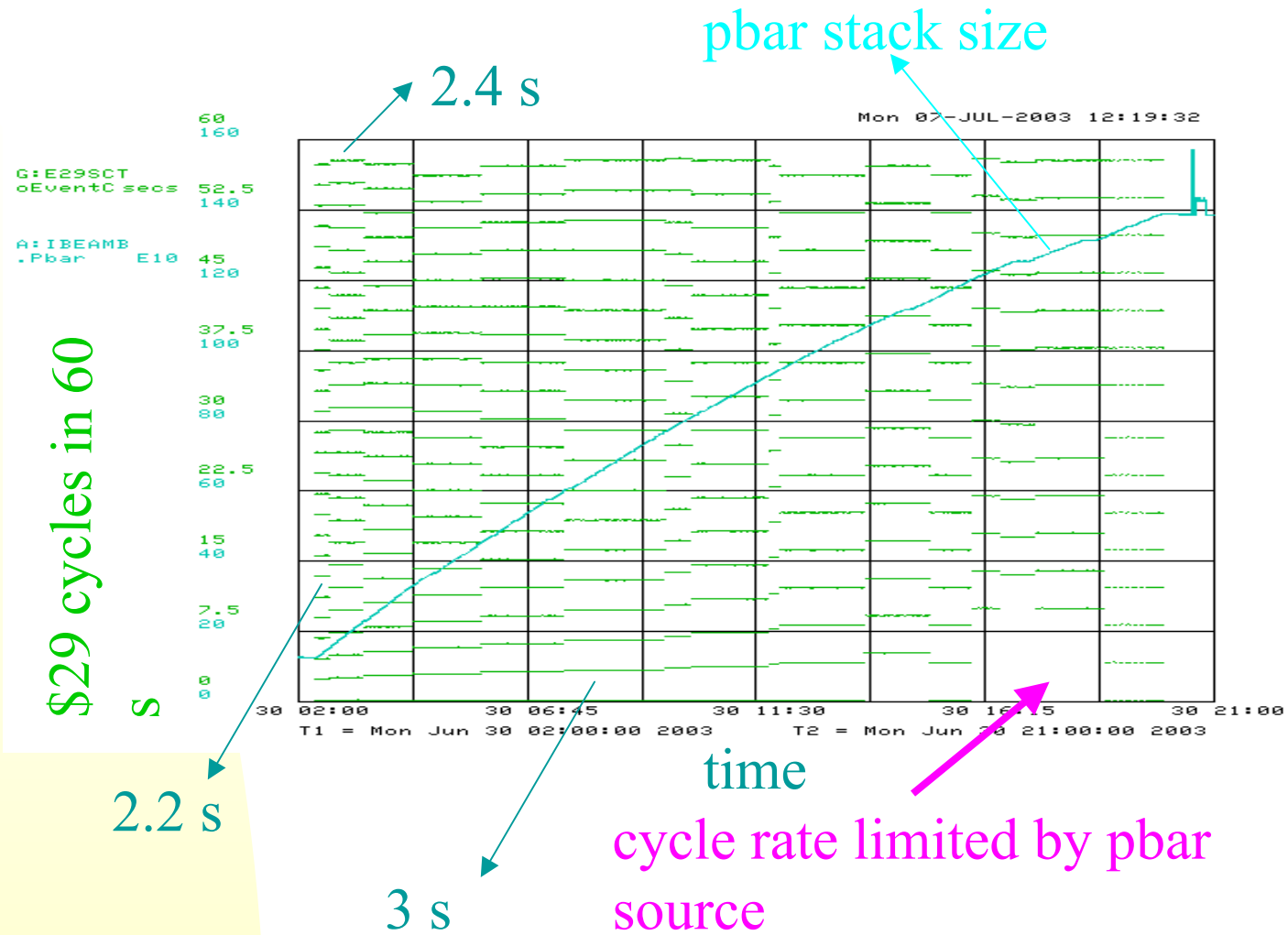
700 ms spill

Establish slow spill orbit

Two Batch Operation

- Booster needs solve cogging problem for multi-batch injection into the MI.
- Two scenario's
  - 1st batch to pbar – 2nd batch resonantly extracted
    - Problems:
      - Bunch rotation
      - Different dp/p for pbar production and resonant extraction
      - Multiple flattop values for beamline supplies
  - 1st batch to pbar – 2nd batch 10% resonantly extracted then 90% fast extracted to pbar
    - The required beam manipulations are far from trivial and need further investigation
    - Pbar stacking rate limitations

Pbar Cycle Time



Summary

- Continue to request study time
- Continue to set up procedures to integrate slow spill into operation
- Resurrect resonant extraction simulations