ATF2 Q-BPM System

19 Dec. 2007

Fifth ATF2 Project Meeting

J. May, D. McCormick, T. Smith (SLAC)

S. Boogert (RH) B. Meller (Cornell)

Y. Honda (KEK)

Goals

- Same as before
  - Provide all hardware required to process the signal from the output of the QBPM hybrid up to and including the VME digitizers.
  - Produce software to process the QBPM signals, extract position information and pass it to the ATF control system for display.
  - Produce software for QBPM calibration and system monitoring.

Outline

- Hardware Installation
  - Rack hardware
  - Cable plant
  - Tunnel Installation
- Initial System Checkout
  - DC power and LO power setup
  - 1st pulse calibration hardware setup
  - 1st pulse calibration software checkout
  - Full BPM calibration software checkout

Outline (cont)

- System Commissioning with Beam
  - 1st Pulse calibration.
  - Full magnet mover QBPM calibration.
  - QBPM operations
- Software Development

Rack Installation

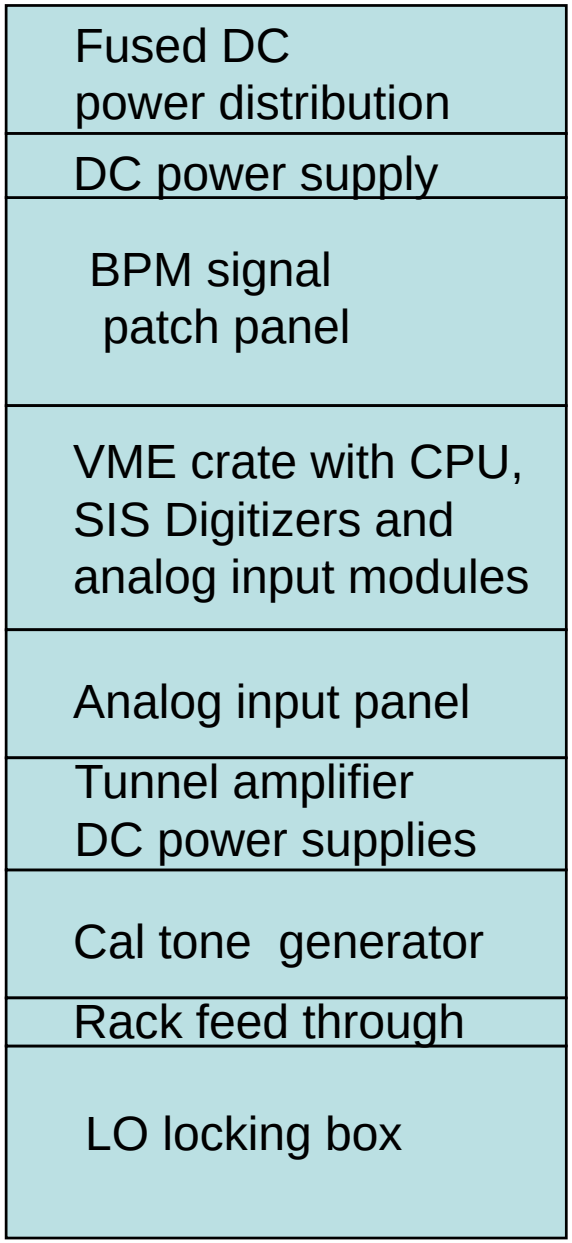
Already on hand:

- Locking box
- Analog input panel
- BPM signal patch panel
- Down mix DC power supply
- DC distribution panel
- SIS digitizers
- Analog input modules

Still needed :

- VME crate
- CPU
- Cal tone generator
- Amplifier DC power supplies

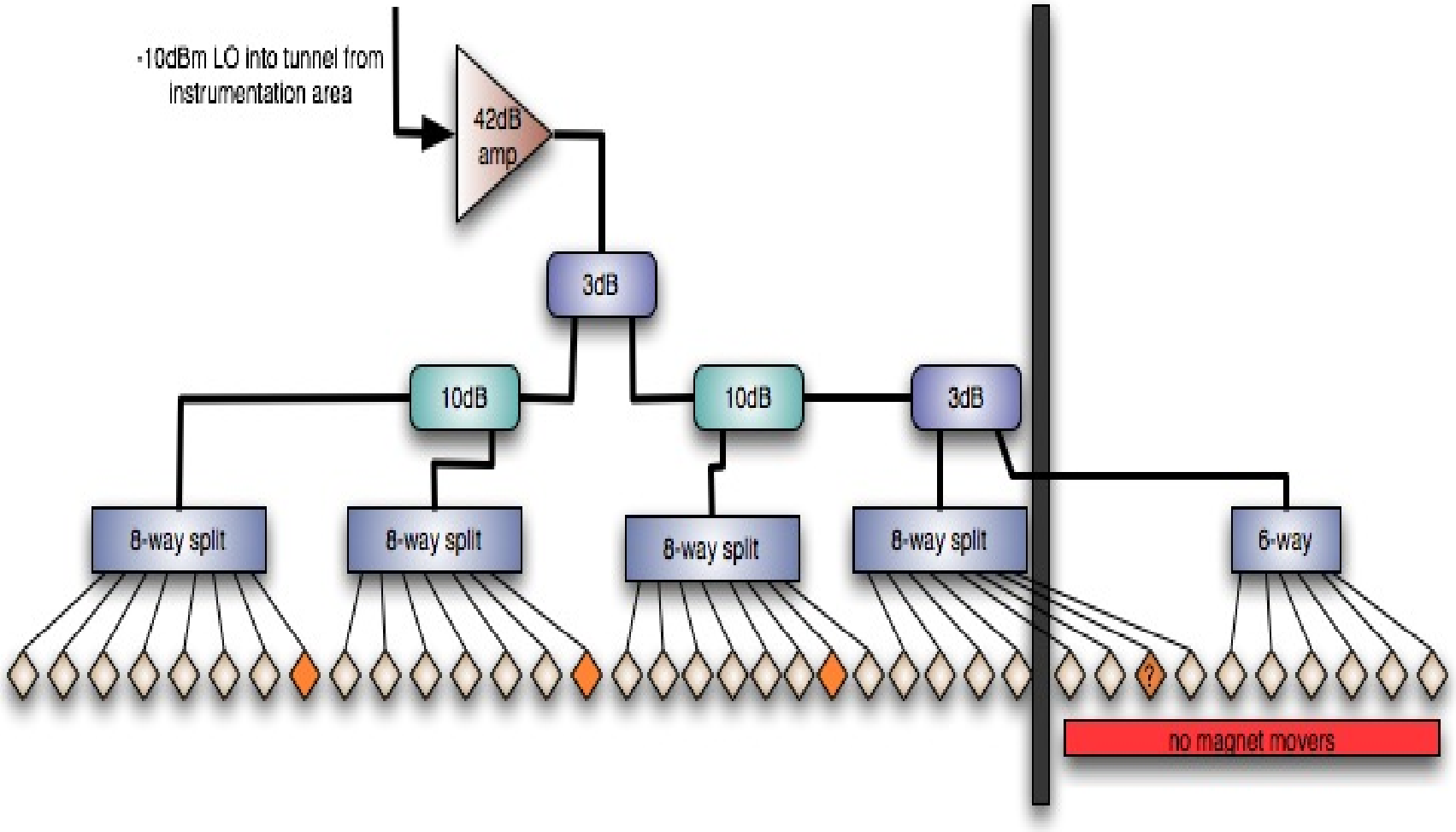
QBPM Rack Layout



Cable Plant

- The following hardware is to be installed in the tunnel
- Already have:
  - DC Power cable for down mix boxes
  - Most amplifiers, couplers and splitters for LO and CAL system
  - Base band BPM signal cables
- Still to get:
  - Heliax cable for LO and CAL systems
  - Four pair cable for analog read back
  - Six additional splitters

RF Distribution System



Tunnel Installation

- The following hardware is to be installed in the tunnel
  - 34 down mix boxes for QBPMs
  - 3 down mix boxes for reference cavities.
    - Have 38 full working units. Need to purchase parts to load 9 unused boards for spares.
  - Down mix boxes to be mounted on the side of the quad support pillars.
  - Pull in heliax for LO and CAL distribution system
  - Pull in DC power and analog read back cables.

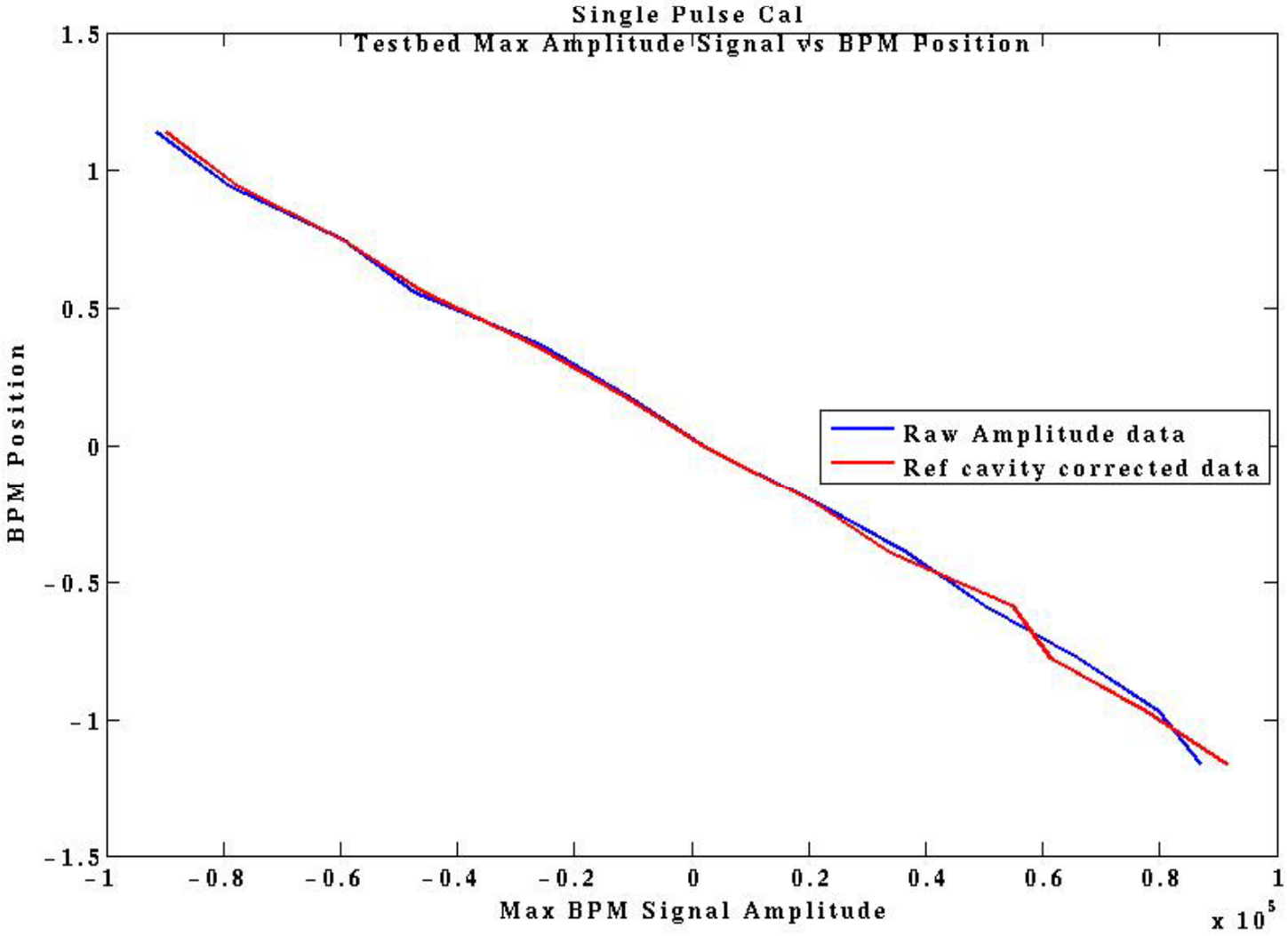
Initial Systems Checkout May 2007

- For each down mix box:
  - Set up and check DC LO and CAL levels at each downmix box.
  - Check electronics calibration tone read backs
  - Check all analog read backs
    - On board dc power
    - Board temperature
    - LO power

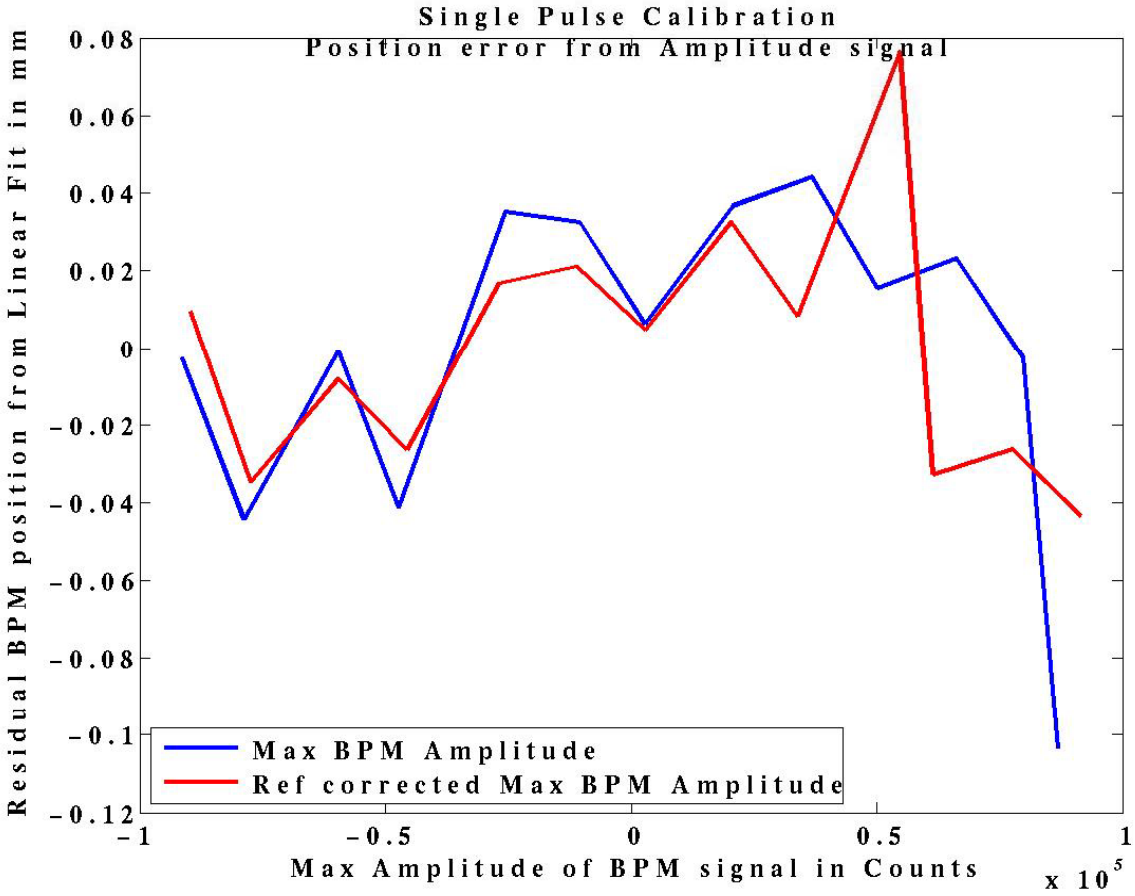
Initial Systems Checkout May 2007 (cont)

- 1st pulse calibration
  - System works
    - Tested using ATF QBPM testbed in extraction line.
  - Setup:
    - Phase match QBPM cables.
    - Apply the same 6426MHz tone to the x and y cables pairs for each bpm. The resultant 15 MHz signal is compared to the 15MHz from a reference cavity. The phases of the 15MHz tones are matched for each subsequent QBPM by adjusting the LO phase at each downmix box.
    - Measure the distance between each QBPM.
    - Translate this into the 6426MHz phase advance between QBPMs. This is determines whether QBPM waveform will have a positive or negative phase for a positive X or Y displacement.

Results of 1st pulse calibration tests from ATF testbed. Position from waveform amplitude



1st pulse calibration position error



Initial Systems Checkout May 2007 (cont)

- Magnet mover QBPM calibration
  - Test mover based QBPM calibration routines on the testbed and on ATF2 QBPMs
  - Check software connection to ATF control system
  - Test tone calibration. Do electronics stability checks

System Commissioning with Beam

- 1st pulse calibration
  - Bump the beam down and right in the first QBPM.
  - Run the 1st pulse calibration software that determines the phase (sign) of the waveform that corresponds to these bumps.
  - Using the relative phase information between the QBPMs produced during the initial checkout, and the now known phase for a positive bump in the first QBPM, the software corrects all downstream QBPM positions to give the proper position.

System Commissioning with Beam (cont)

- Magnitude of the positions are determined by applying slope information (counts/micron) obtained from the testbed QBPM setup to the digitized waveforms and scaling this result by the electronics gain ratios and reference cavity signals.
- Given all the uncertainties of this method the absolute position accuracy should be no worse than 100um. This should allow the beam to be quickly steered down to the dump.

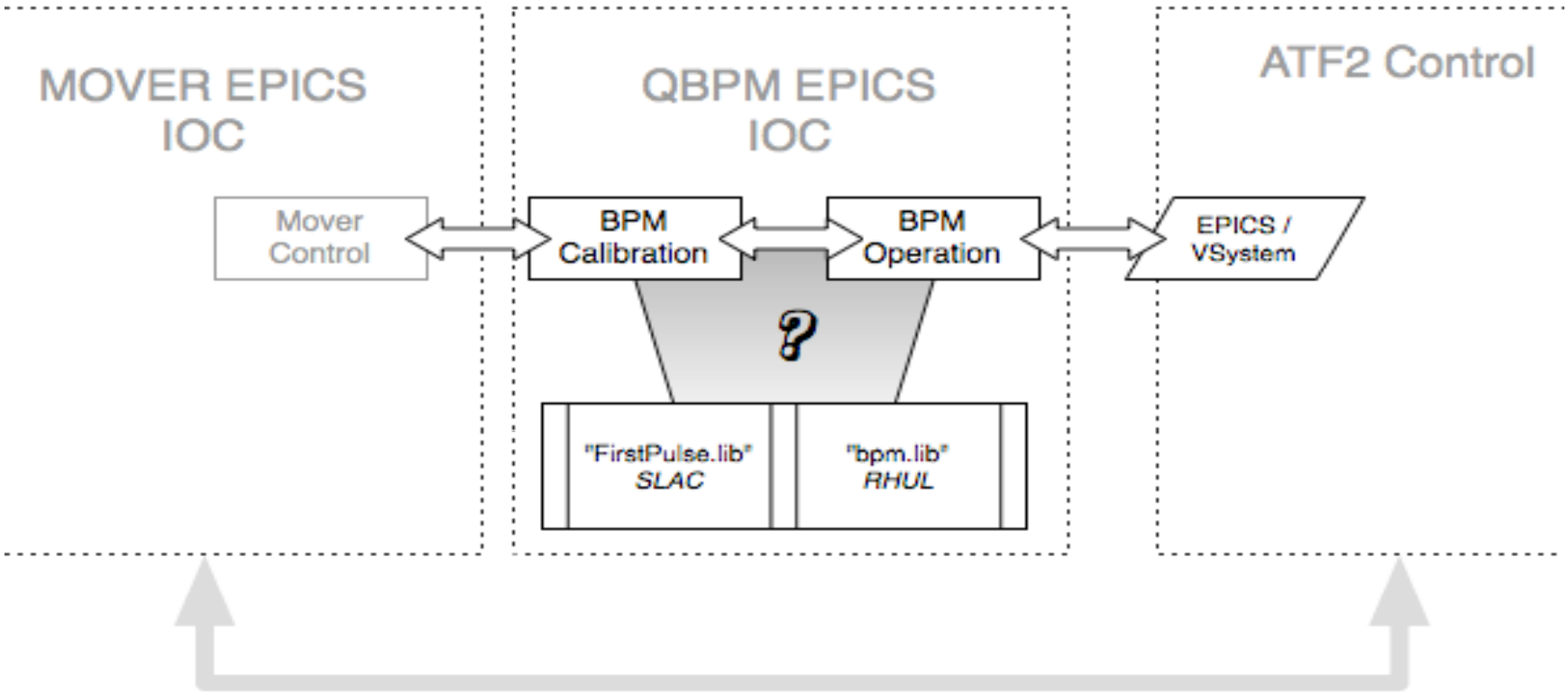
System Commissioning With Beam (cont)

- Full QBPM calibration
  - Run magnet movers through calibration cycle. Calculate and install constants in database.
  - Check QBPMs resolution
  - Check stability of calibration constants over hours or days.
  - Confirm operation of calibration tone system
  - Check on interface to control system.

Software Development

- BPM processing libraries written (RHUL)
  - Tested at SLAC (End Station A)
- First-Pulse Operation algorithms essentially finished (SLAC), Matlab code tested with ATF testbed
  - Needs conversion to final form

QBPM Software Architecture



However…..

- We need a plan for integrating these components, and connecting to the control system
- Key elements
  - EPICS IOC
  - High Level Algorithms
  - When and how do we tell the movers to move or calibrate?
  - How do we handle the electronics tone calibration system?

Conclusions

- Acquisition of hardware is almost complete
  - Need to:
  - Fabricate calibration tone chassis
    - Produce 6426 tone by multiplying ring 714 MHz by 9
    - Add gating circuitry to output for pulsed operation
  - Purchase or obtain :
    - RF cables and parts
    - VME crate and CPU
    - Amplifier power supplies
    - Analog read back cables

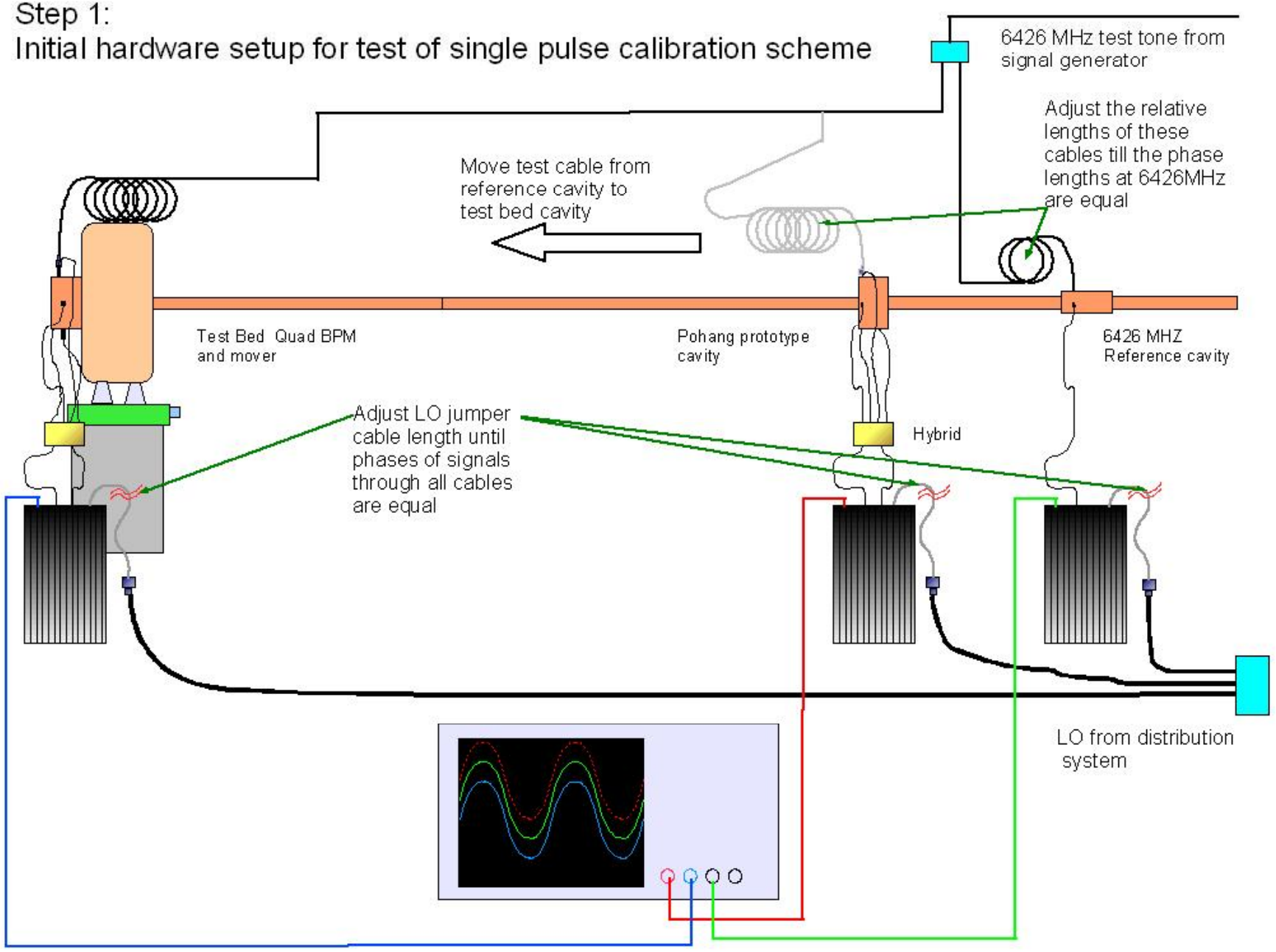
Conclusions

- 1st Pulse calibration scheme worked on testbed setup.
- Plan to test existing magnet mover calibration routines with testbed setup this trip.

Conclusions

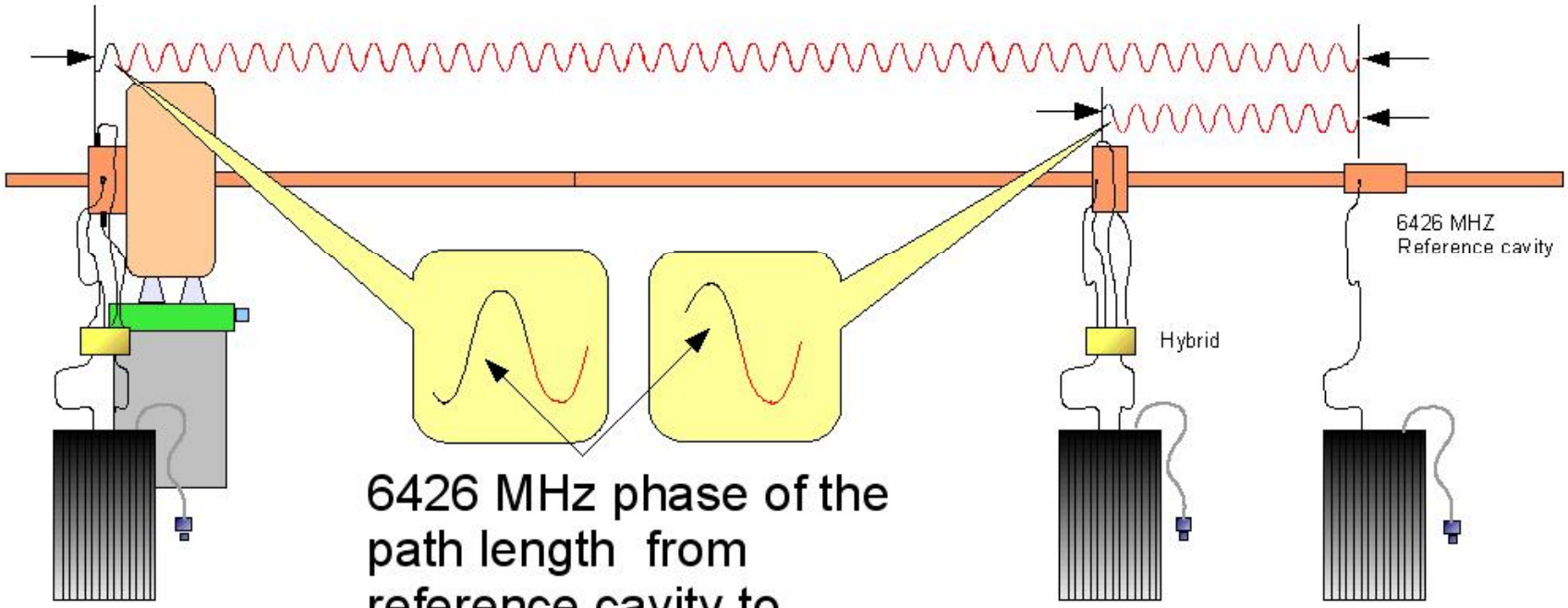
- Installation of hardware, electronics, cables etc. will require ATF support.
- Initial system checkout may also need ATF support.
- Software is the critical remaining issue.
  - Existing Matlab and C routines must be integrated into the control system!

Step 1:
Initial hardware setup for test of single pulse calibration scheme



STEP 2:
Determine the 6426 Mhz phase between reference cavity and BPMs

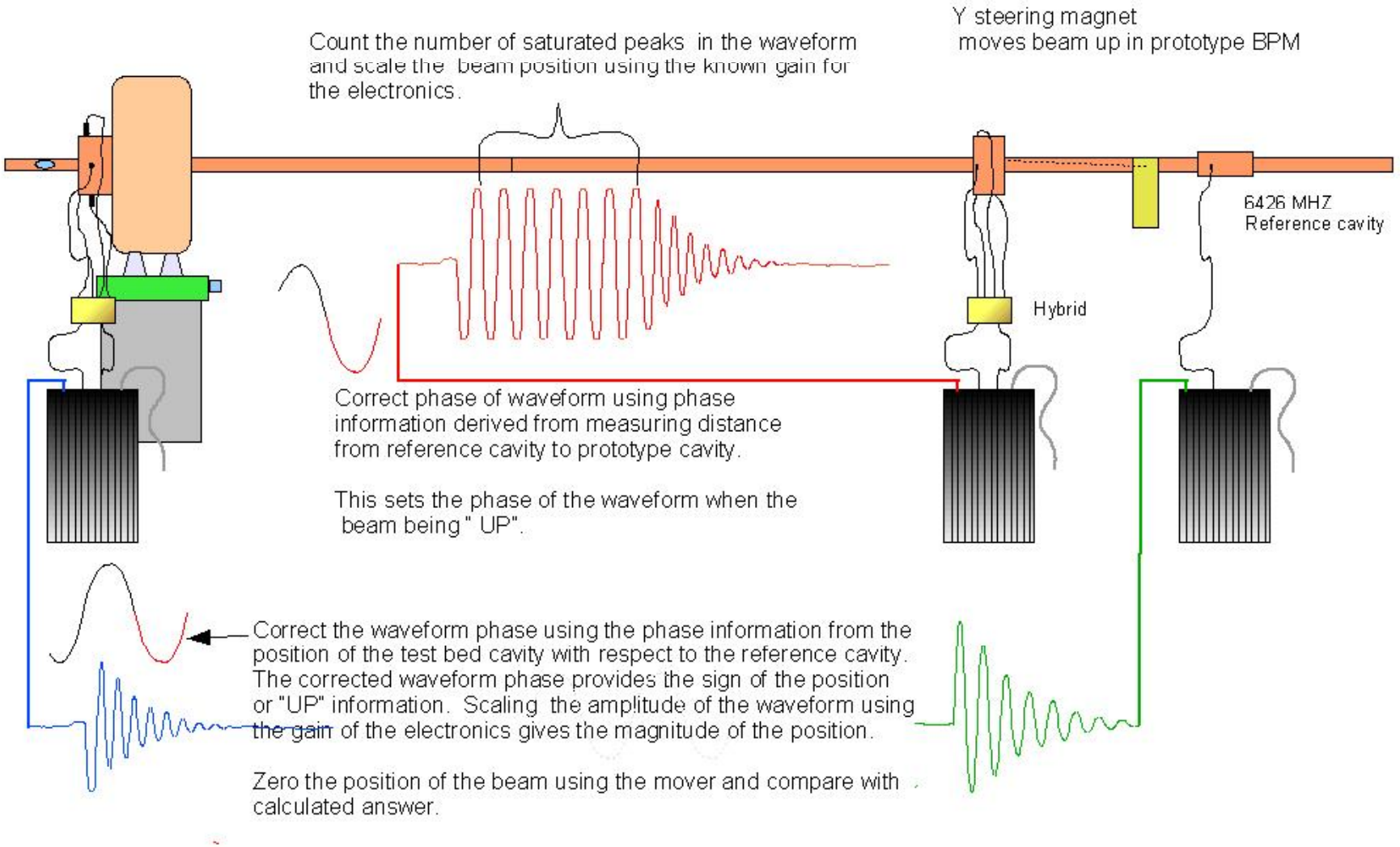
Measure the distance between the reference cavity and the BPMs in degrees of 6426MHz
Record phase information in BPM database



6426 MHz phase of the path length from reference cavity to prototype and test bed bpms

Step 3:
Single pulse calibration scheme

Use a Y steering magnet to move the beam high in the prototype BPM



Electronics over view

- Downmix ~6426 MHz to 26 MHz
- 2ch/box
- Single LO input. Level 3dbm
- Forward and reverse calibration inputs. Level from 0 to 20dbm
- DC input 5.8 W at 8V
- Analog outputs monitor LO power Calibration power and board temperature.
- Output to 14-bit 100 MHz SIS digitizers