BNL - FNAL - LBNL - SLAC

LARP

LARP BEAM INSTRUMENTATION

A. Ratti

LBNL

Presented at the DoE review of LARP

Fermilab

June 12 -14, 2006

Outline

Overview of existing instruments

- Schottky Monitor (lead by FNAL)
- Tune Feedback (lead by BNL)
- Luminosity Monitor (lead by LBNL)

Common instrumentation issues

- Data Acquisition

Documentation and integration at CERN

Budget and Schedule Status

Highligths

From Steve's highlights:

Simultaneous tune and coupling feedback was demonstrated in RHIC - a world first

US colliders are an essential part of the LARP contribution to the LHC

- Developing all instruments with experimental support of colliding beam operations

Documentation, integration issues are becoming more urgent and being addressed with a systematic approach both within the LARP and the CERN (EDMS) frameworks

Year by year funding needs to be managed closely

Introduction

LARP

- Three instruments at different levels of maturity
  - Schottky monitors will be mostly completed by the end of FY06
  - Luminosity monitors will be under production through 06 and into 07
  - Tune and coupling feedback are still under development and will reach a final design in early FY07
- All three devices are on schedule to support LHC commissioning
- The data acquisition platform is defined by CERN and therefore common to all LARP instruments
  - Successful workshop on April 25, 2006

Schottky Monitors

Advanced enabling technology for:

- Non invasive tune measurement for each ring
- Non invasive chromaticity measurements
- Measure momentum spread
- Continuous online emittance monitor
- Measure beam-beam tune shift

Build in capability to monitor gain variation with time

Measure individual or multiple bunches

Technical Approach

Center frequency of 4.8 GHz

3dB BW - 300 MHz

Sufficient for 25ns bunch spacing

Small longitudinal Z/n

No absorbers allowed

Below frequency of Schottky band overlap

Allows for adequate physical aperture

Matched pairs of SiO_2 Coax cables

Slotted Waveguide Pickup

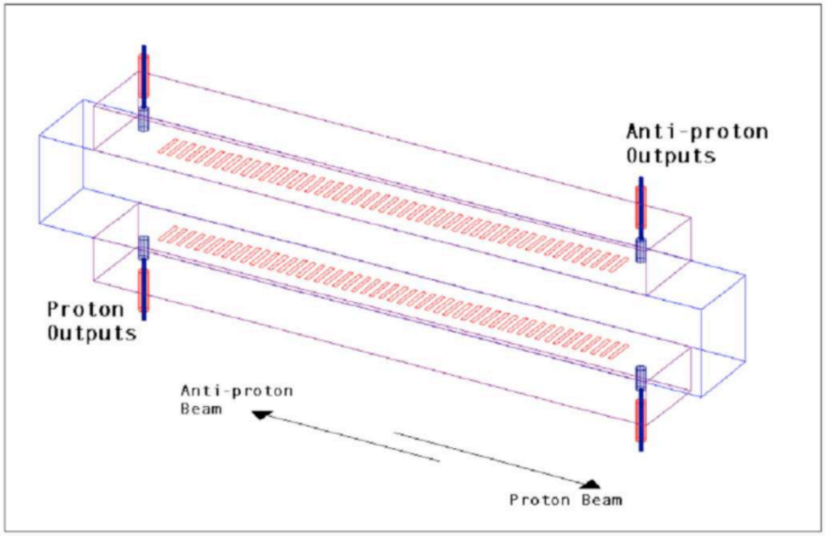
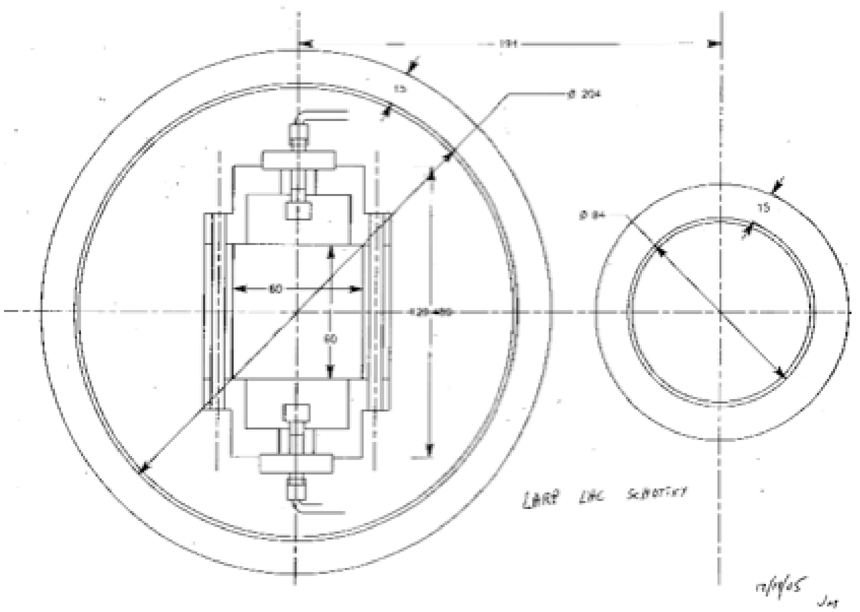


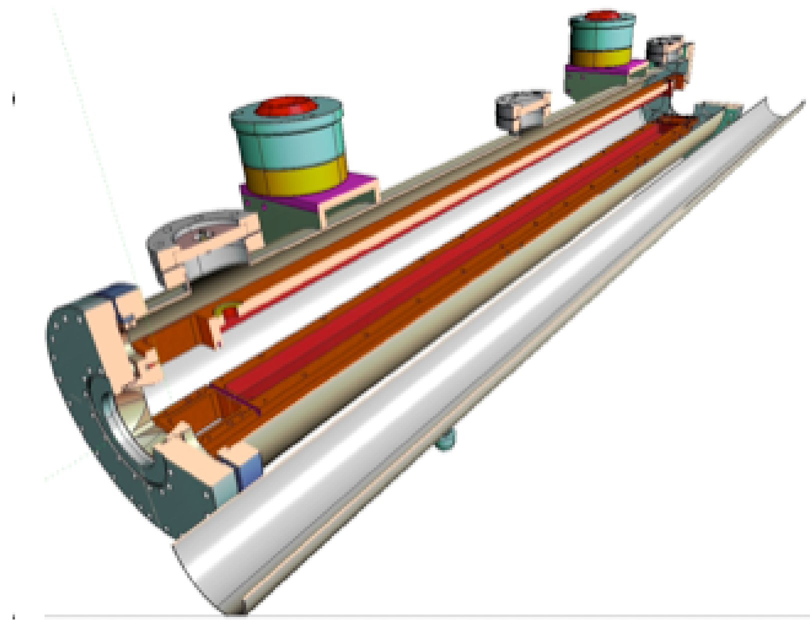
Table 1. Parameters of LHC Schottky Pickup (unit: mm)

Slot length	Slot width	Slot Spacing	Number of Slots	Waveguide width	Waveguide height	Beam pipe width	Beam pipe height
20.52	2.032	2.032	246	47.549	22.149	60.00	60.00

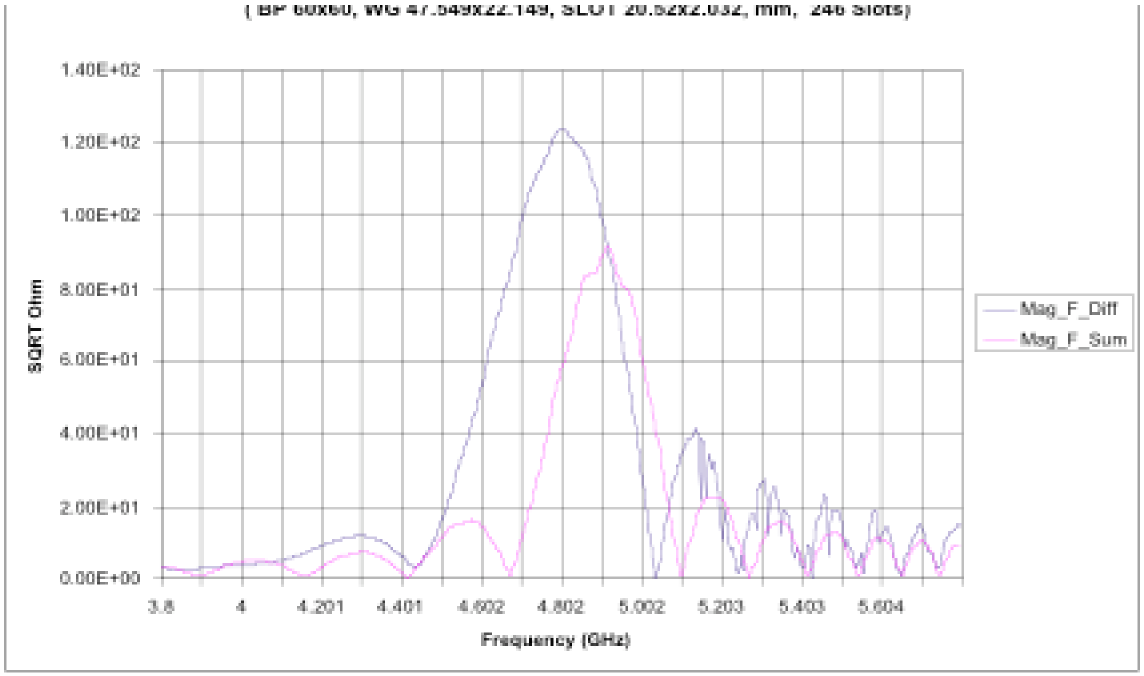
LARP

Pickup and Adjacent Beampipe

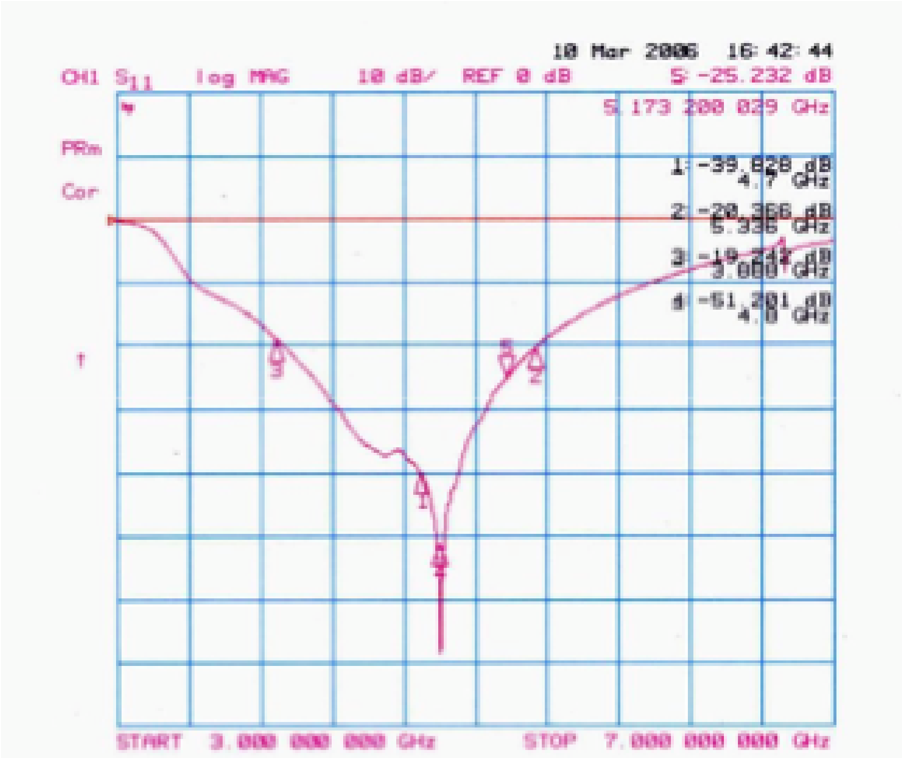




Mode Launcher Impedance



Mode Launcher Response



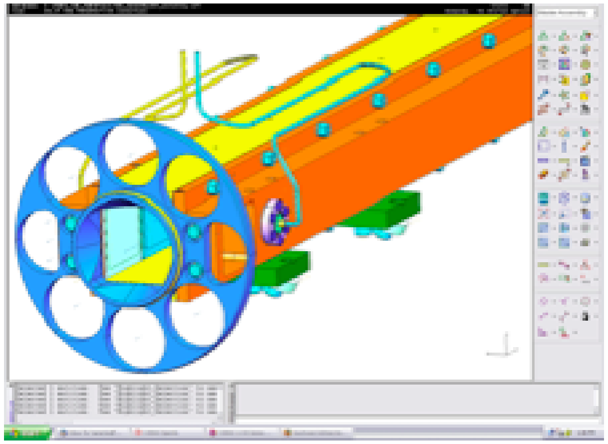
Connections and Processing

Feedthroughs and tunnel connections are critical

CERN ordering the coaxial cables

FNAL provided detailed layouts for phase matched cables

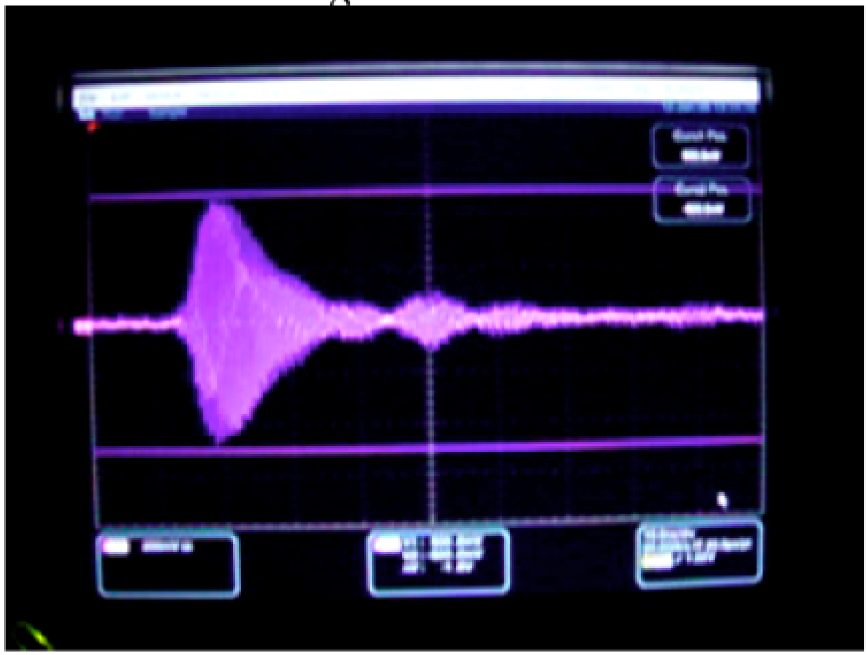
Installation planned in point 4 of LHC



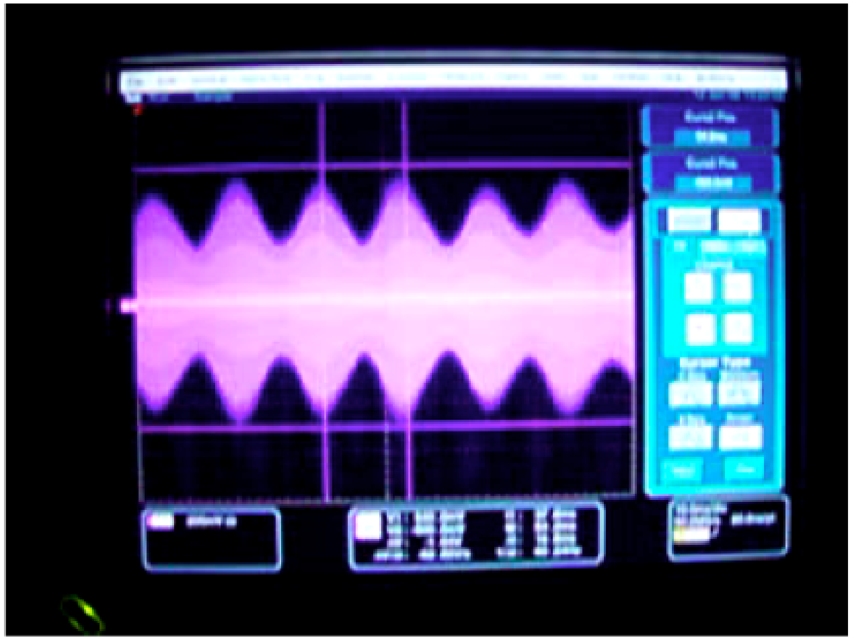
Tevatron Experience

LARP

Tevatron Single Bunch Horizontal Protons



60 Hz Modulation on Tevatron Schottky Signals

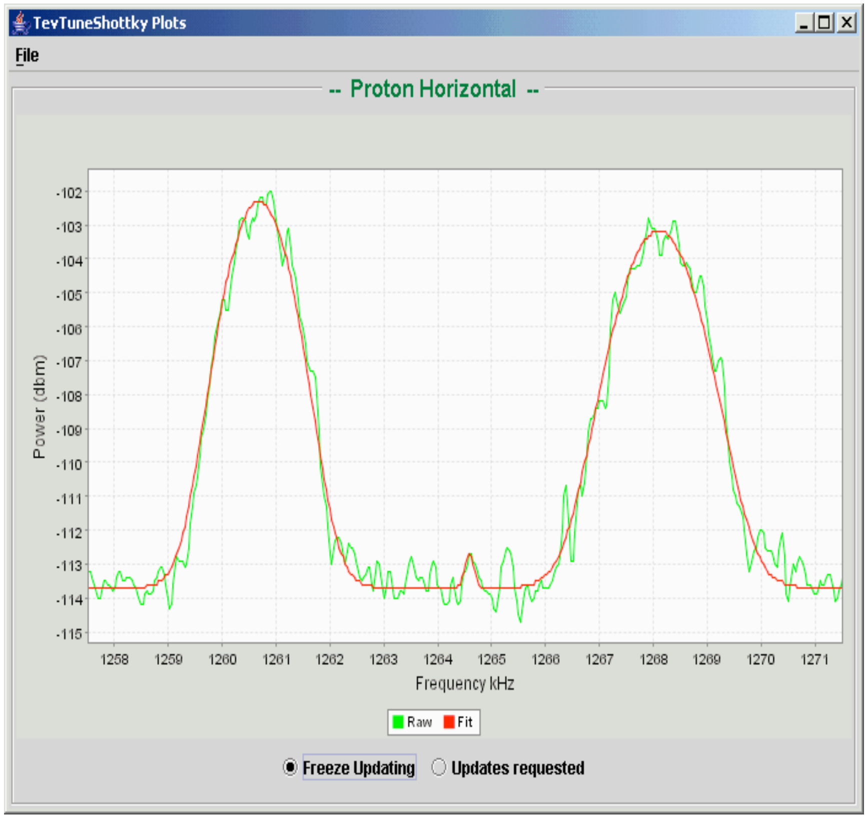


LARP

Schottky Measurements at Tevatron

Allows measurements of:

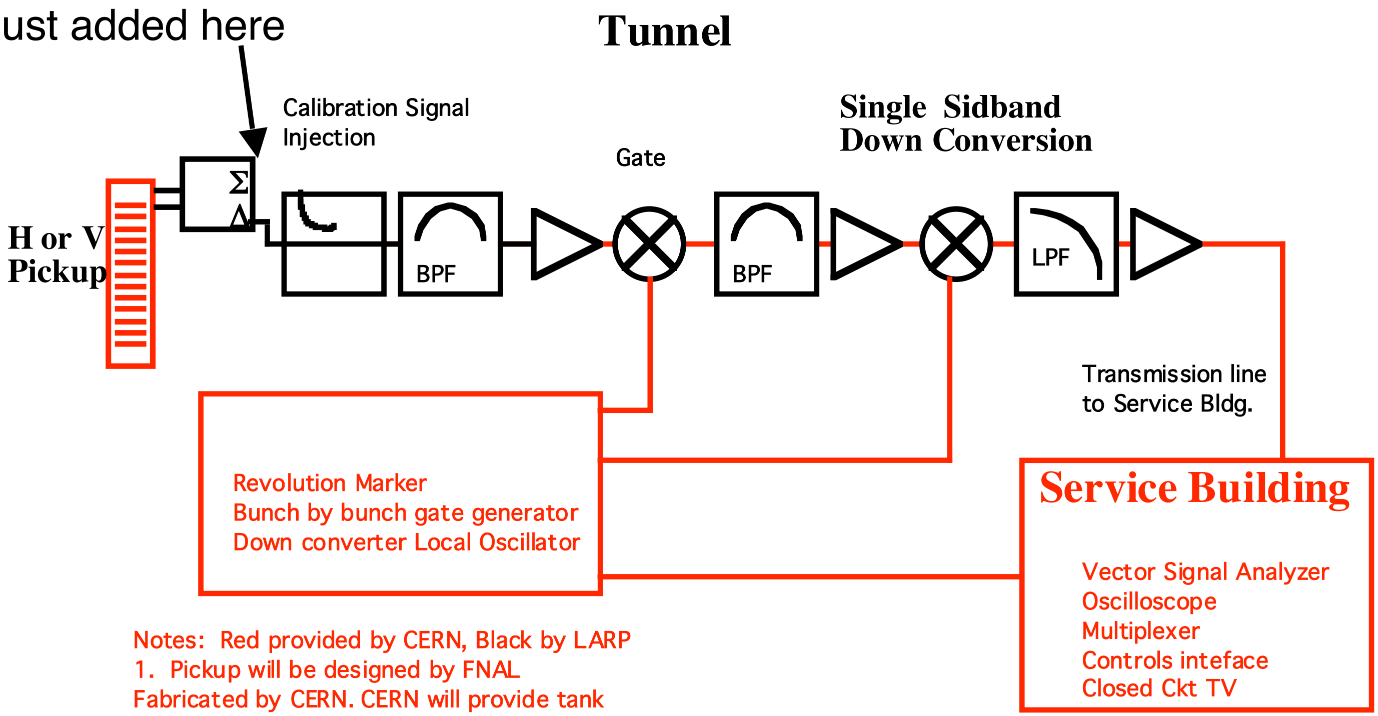
- Tunes from peak positions
- Momentum spread from average width
- Chromaticity from differential width
- Emittance from average band power



Schottky Electronics Block Diagram

LARP

Additonal downconversion stage just added here



Notes: Red provided by CERN, Black by LARP

1. Pickup will be designed by FNAL
Fabricated by CERN. CERN will provide tank stand, motion controls, bake out hardware.
2. Fermilab has developed software for measureing beam parameters. This software can be made available to CERN. Fermilab does not intend to port software to CERN control system.

Also shows roles and responsibilities
Red = CERN, Black = FNAL

Schottky Processing Electronics

LARP

Triple down-conversion preserves single sideband signal with Chromaticity information

- First IF uses the 11th harmonic of the 400MHz clock to convert the 4.8 GHz signal to 400 MHz
- Second at 45 MHz, using a LO locked to the 40MHz LHC clock reference

  A crystal filter selects a 15 kHz band of schottky signal

- Third IF takes the signal down to DC-80KHz baseband

Data is then collected with 20-24 bits CERN DAQ cards in DAB-IV environment

Schottky Monitor - Roles and Responsibilities

LARP

FNAL

- Deliver a complete, ready to print drawing package to CERN
- Deliver a full set of front end electronics to connect to the detectors
- Provide installation and hardware commissioning support

CERN

- Build beamline devices to FNAL's prints
- Provide local cabling, installation,
- Local Oscillators, Reference signals, Data Acquisition hardware
- Final integration with control system

LARP - Commissioning

- The beam commissioning of these devices will be supported by the Beam Commissioning group

LARP

Schottky Monitor Planning

FY06

Final Design Review at CERN on June 22

- Lots of integration activities as well

CERN fabricates and installs the devices in the LHC

- Summer 2006, depending upon LHC's installation schedule
- All cables have been specified and requested
  - Including request for timing and synchronization signals

FNAL will build the analog processing electronics during the summer

FY07

Activities include hardware commissioning and installation support

In particular two trips to CERN, one to test the hardware without beam, and the next to test with beam (when beam occurs)

LUMI - Requirements

LARP

Requirements (Lumi mini Workshop, 16-17 Apr. 99)

- Absolute L measurement with $\delta L/L \sim 5\%$ for $L > 10^{30}\ cm^{-2}sec^{-1}$
- Cross calibration with LHC experiment measurements of L (every few months)
- Sensitivity of L measurement to variations of IP position ($x^*, y^* < 1mm$) and crossing angle ($x^{*\prime}, y^{*\prime} < 10\mu rad$) less than 1%
- Dynamic range with "reasonable" acquisition times for 1% precision to cover $10^{28} cm^{-2}\ sec^{-1}$ to $10^{34} cm^{-2}\ sec^{-1}$
- Capable of use to keep machine tuned within ~ 2% of optimum L
- Bandwidth 40 MHz to resolve the luminosity of individual bunches
- Backgrounds less than 10% of the L signal and correctable

LBNL
25 Jan. 2002

40 MHz Ionization Chamber
W.C. Turner

11

Help bring beams into collisions too

LUMI - Specification

LARP

CERN
CH-1211 Geneva 23
Switzerland

the **Large Hadron Collider** project

LHC Project Document No.
LHC-B-ES-0007 rev 0.4

CERN Div./Group or Supplier/Contractor Document No.
AB-BDI

EDMS Document No.
347396

Date: 2003-06-11

Functional Specification

MEASUREMENT OF THE RELATIVE LUMINOSITY AT THE LHC

Abstract

This functional specification defines the requirements for the measurement and optimization of the interaction rates or relative luminosity at the four LHC interaction points. The beam and machine scenarios and the anticipated uses in operation are analysed to define the required dynamic ranges, precision, time response,...of the machine luminometers. The potential for absolute calibration, the complementarities with the experimental absolute luminometers and the data exchange between machine and experiments are discussed and specified. The requirement for the measurement of the background to the experiments by standardized detectors was identified and will be dealt with in a separate document.

Prepared by	***Checked by :***	***Approval Leader :***
R. Assmann/AB-ABP	*Oliver Brüning [AB/ABP]*	
J.P. Koutchouk/AB-BDI	*J-Jacques Gras [AB/BDI]*	
M. Placidi/AB-BDI	*Rüdiger Schmidt [AB/CO]*	
E. Tsesmelis/EST-LEA	*Jörg Wenninger [AB/OP]*	

Approval Group Members

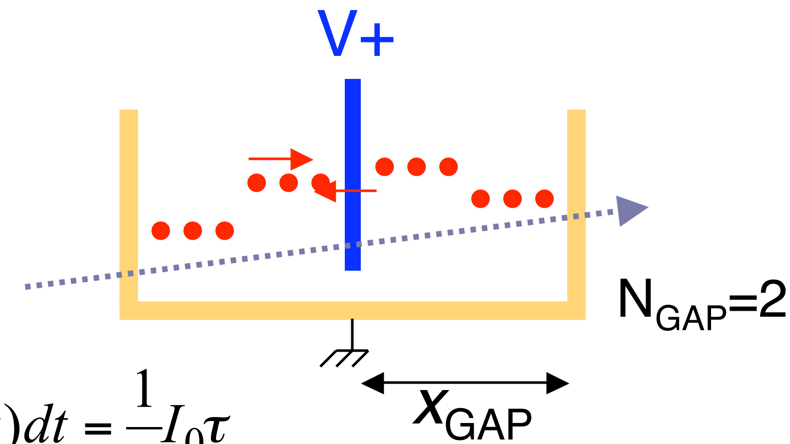
LTC: S. Myers, P. Collier; AB/ABP: J.-P. Riunaud, S. Fartoukh, W. Herr, F. Ruggiero;
AB/BDI: H. Schmickler, R. Jung, E. Bravin, W.C. Turner; AB/OP: S. Baird, K. Cornelis;
EST/LEA: K. Potter;
ALICE: D. Evans, C. Fabjan, L. Leistam, A. Morsch; ATLAS: N. Ellis, P. Grafstrom, M. Nessi;
CMS: A. Ball, A. Herve, M. Huhtinen, W. Smith; LHCb: R. Jacobsson, A. Smith, W. Witzeling;
TOTEM: M. Bozzo, K. Eggert, D. Macina, M. Oriunno;

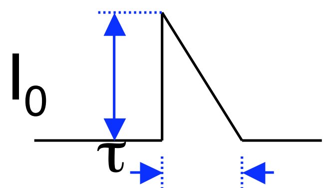
Prepared by	***Checked by :***	***Approval Leader :***
R. Assmann/AB-ABP	*Oliver Brüning [AB/ABP]*	
J.P. Koutchouk/AB-BDI	*J-Jacques Gras [AB/BDI]*	
M. Placidi/AB-BDI	*Rüdiger Schmidt [AB/CO]*	
E. Tsesmelis/EST-LEA	*Jörg Wenninger [AB/OP]*	

Approval Group Members

LTC: S. Myers, P. Collier; AB/ABP: J.-P. Riunaud, S. Fartoukh, W. Herr, F. Ruggiero;
AB/BDI: H. Schmickler, R. Jung, E. Bravin, W.C. Turner; AB/OP: S. Baird, K. Cornelis;
EST/LEA: K. Potter;
ALICE: D. Evans, C. Fabjan, L. Leistam, A. Morsch; ATLAS: N. Ellis, P. Grafstrom, M. Nessi;
CMS: A. Ball, A. Herve, M. Huhtinen, W. Smith; LHCb: R. Jacobsson, A. Smith, W. Witzeling;
TOTEM: M. Bozzo, K. Eggert, D. Macina, M. Oriunno;

LUMI - Conceptual Design
Argon Ionization Chamber





$\tau = x_{GAP}/v_D \quad Q = \int_0^{\tau} I(t)dt = \frac{1}{2} I_0 \tau$

Signal is proportional to the number of parallel gaps
Capacitance add up with n. of gaps + slows down the signal

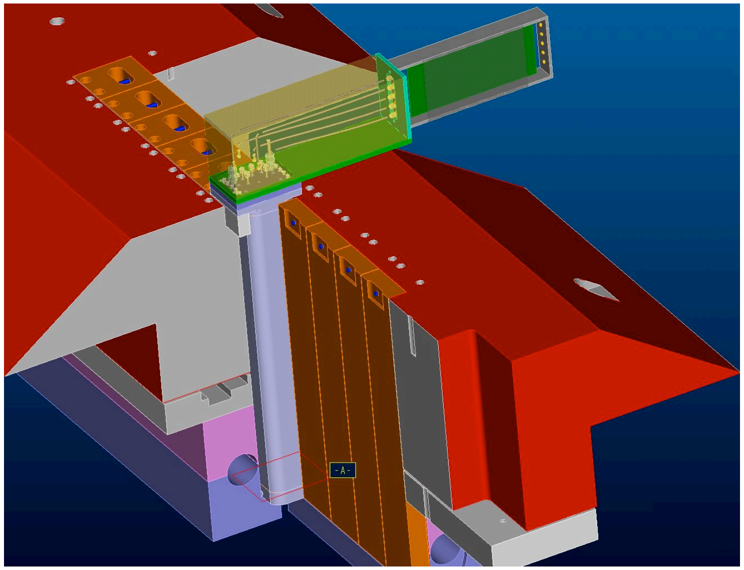
→Optimized for 6 gaps
→Must live in a radiation environment 100x worse than accelerator instruments have ever seen
→~10GGy/yr, ~10^{18} N/cm^2 over lifetime (20 yrs), ~10^{16} p/cm^2 over lifetime

LUMI Status

- Final design complete
  - Successful design review on April 24, 2006
- Most critical R&D parameters demonstrated
  - Successful high speed (40 MHz test) using X-ray beamline at ALS
- Final design presented here
- Some R&D still ongoing
  - Testing prototype in RHIC
  - Rad damage tests underway

Final Design Review Results

- Excellent review
  - Highlighted several areas of possible improvement
  - Endorsed basic design
  - Recognized progress
  - Recommended fast path to production



- Final report just released

Mechanical Design

LARP

Ready for final prints and production

Performed thermal and stress analysis

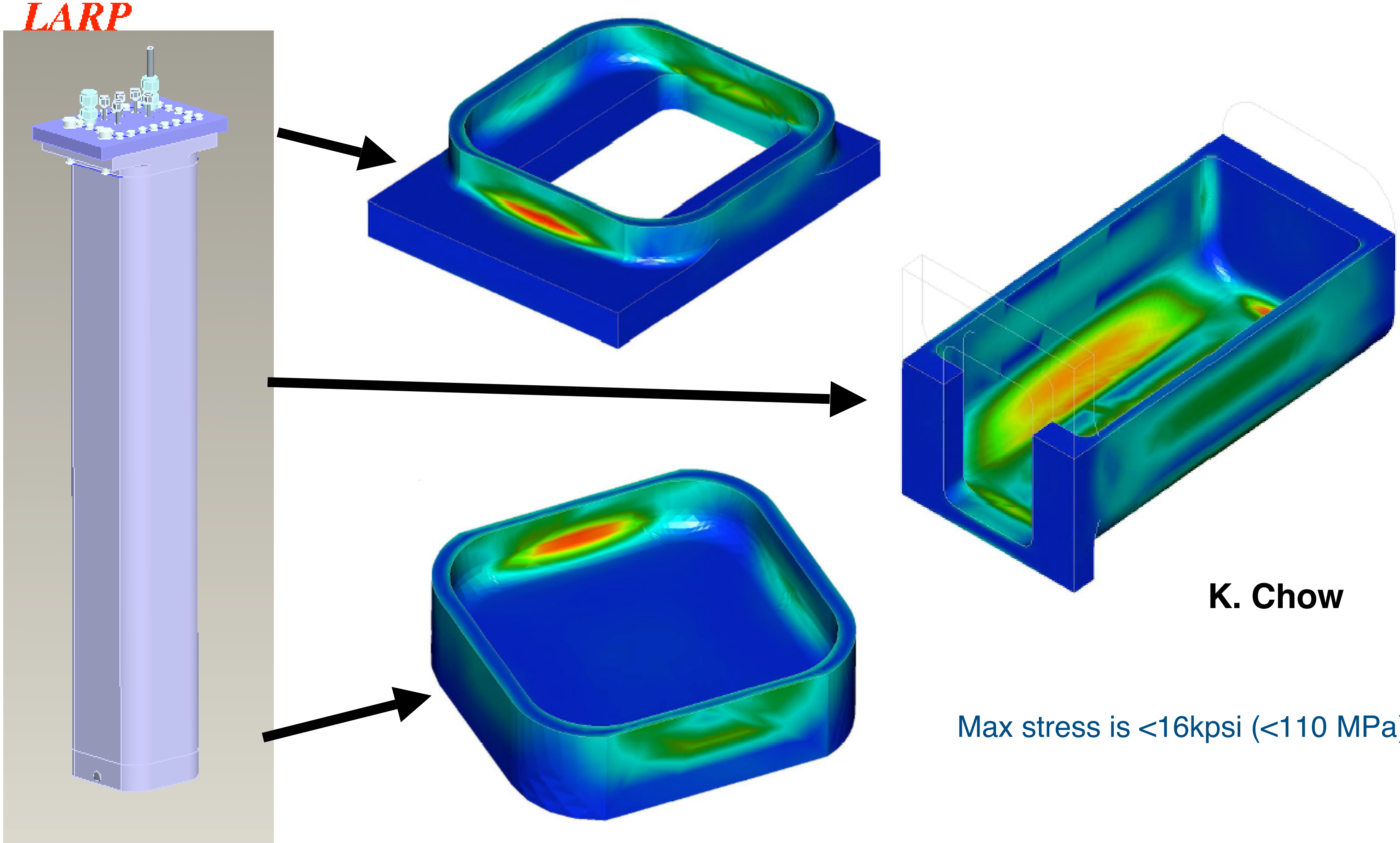
Performed gas flow modeling through the chamber

Completely revised the housing and fabrication

- Detector nearly identical to the prototype

Fabrication process defined

Case is designed to manage stress levels

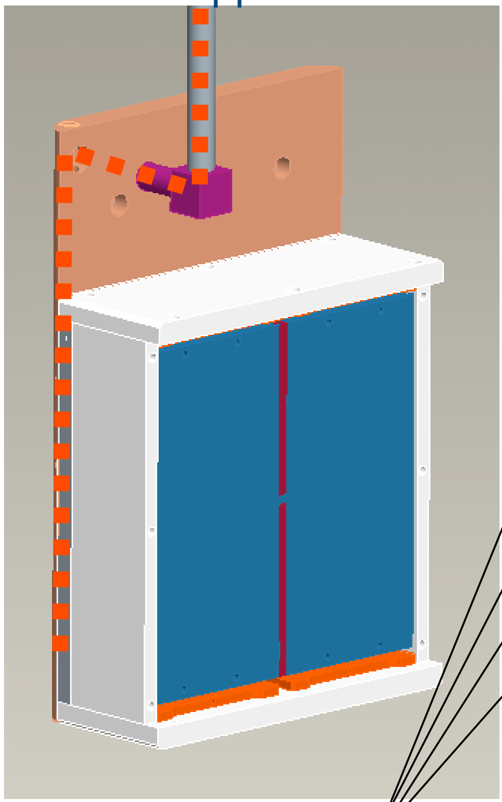


K. Chow

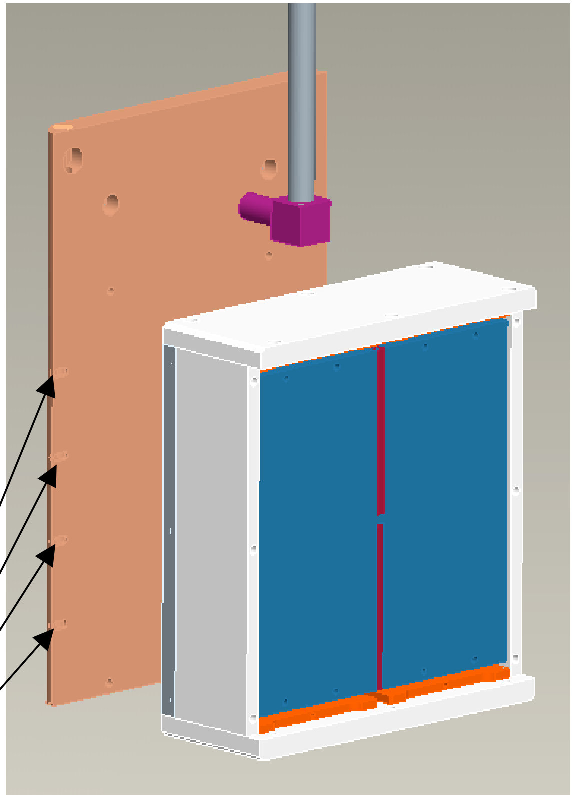
Max stress is <16kpsi (<110 MPa)

Gas flow through ionization chamber

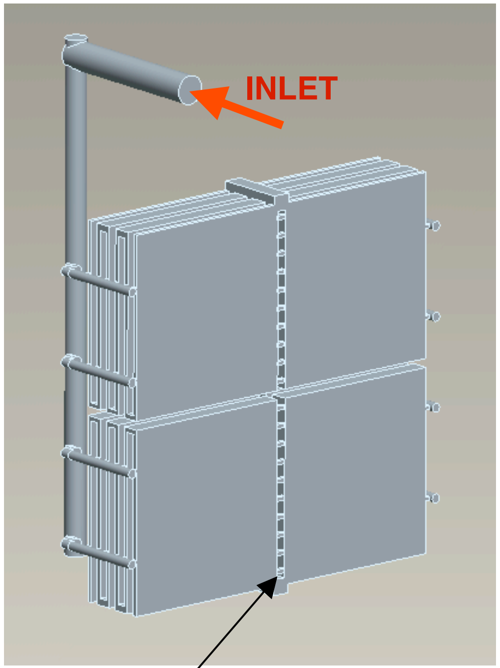
Detail of ionization chamber without copper bar



With support plate displaced in beam direction



Chamber gas flow volume model

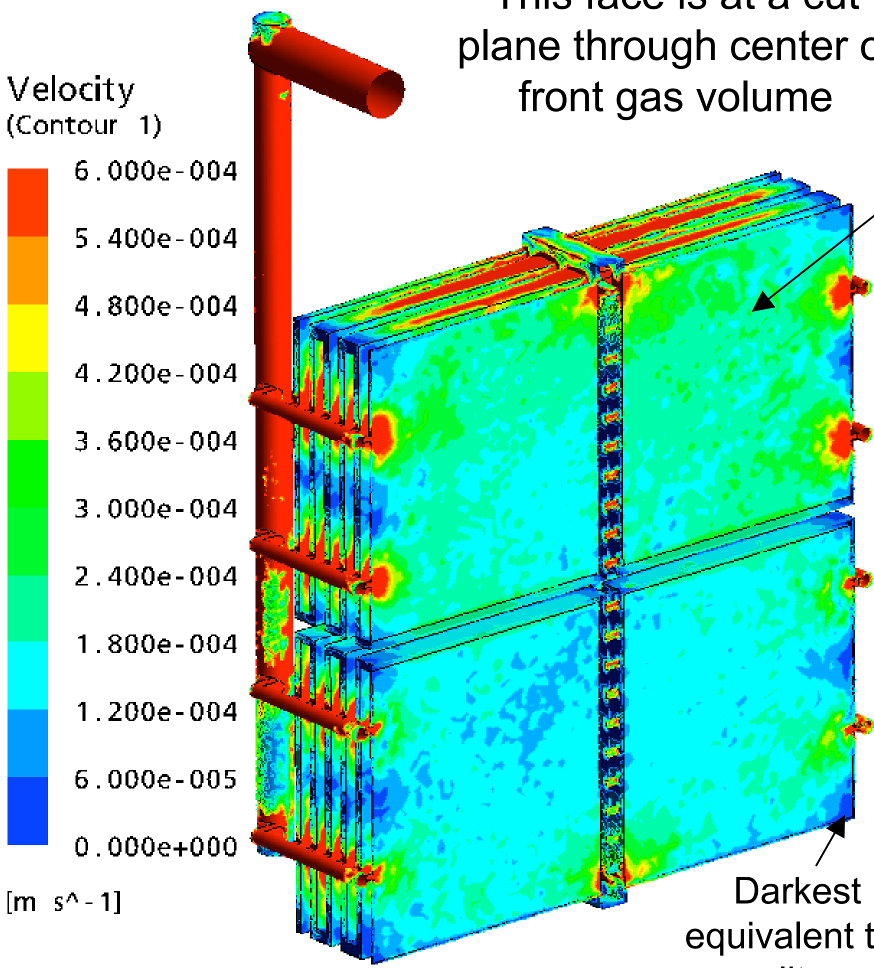


K. Chow

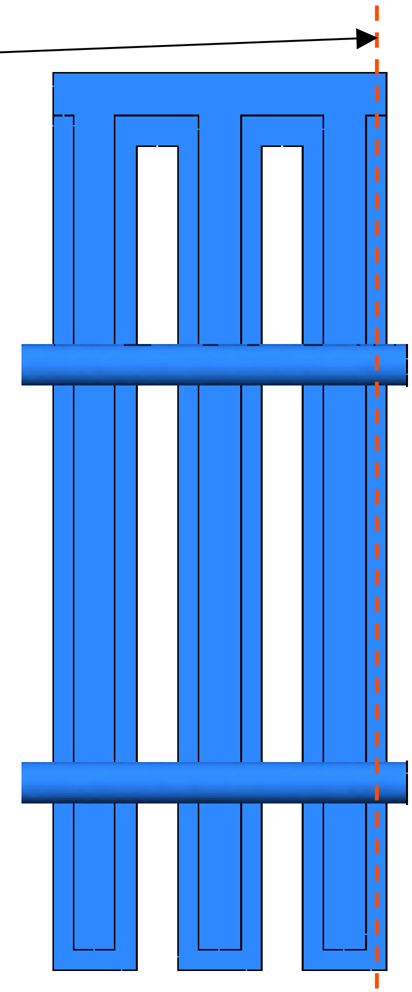
120 holes in ground plane, 1 mm diameter each

4 gas inlet holes on support plate

Gas velocity in production chamber



This face is at a cut plane through center of front gas volume



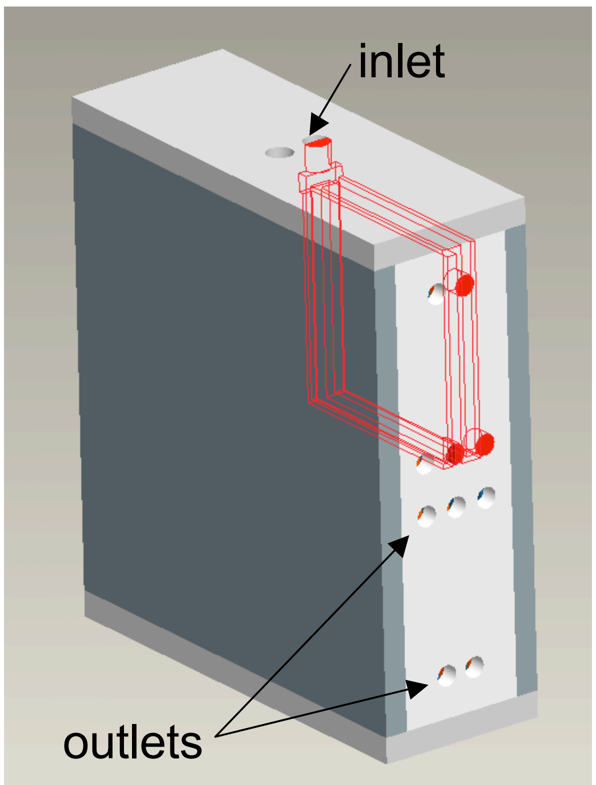
K. Chow

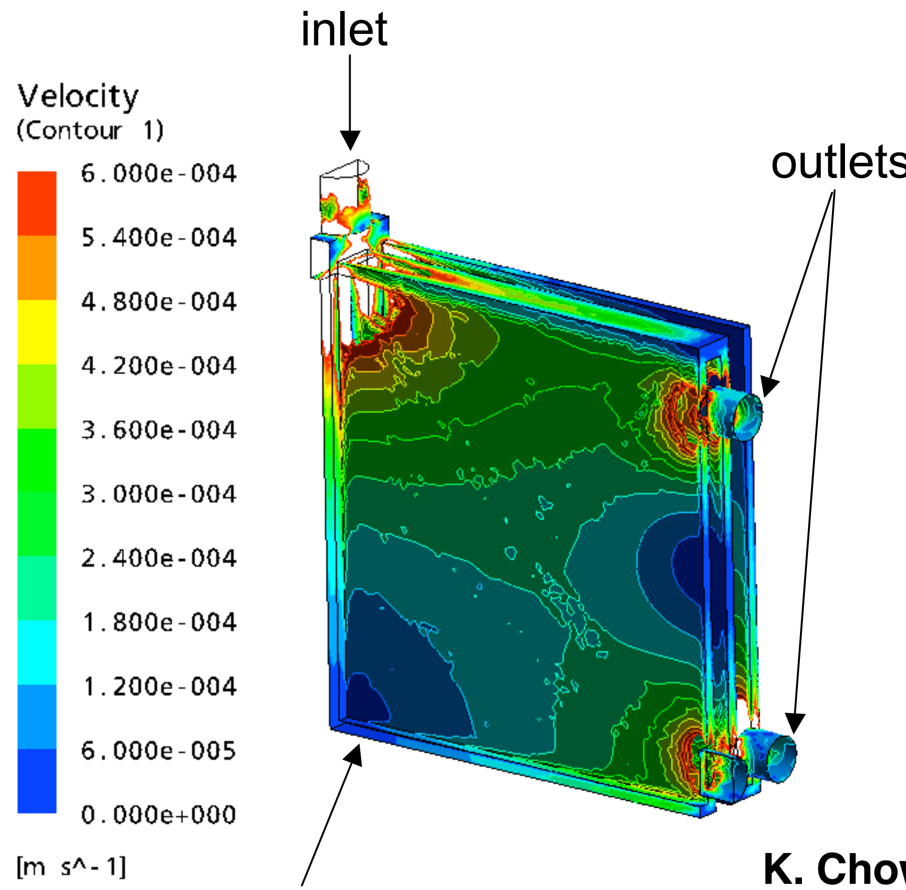
Darkest blue areas are equivalent to less than 0.017 liter per hour flow

Compare: gas velocities in prototype chamber

LARP

Prototype ionization chamber showing outline of 1/8 symmetric gas flow model





K. Chow

Darkest blue areas are equivalent to less than 0.017 liter per hour flow

Thermal conditions during TAN bakeout

LARP

Bakeout operation

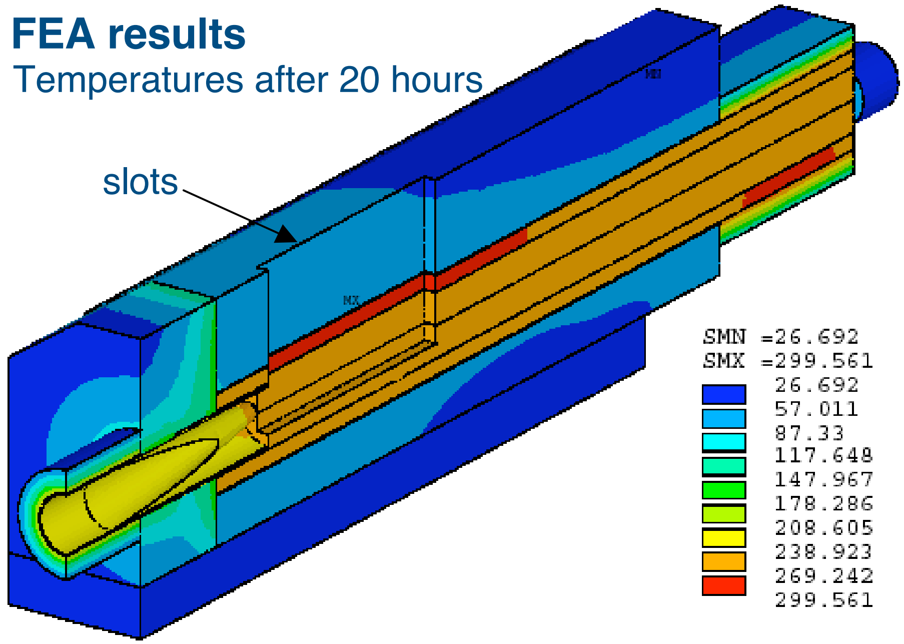
- Heat up the beam tube to 200 deg C in 24 hours.
- Stay at 200 deg C for a minimum of 24 hours
- Ambient cooldown

Bakeout performed in situ whenever beam tube exposed to atmospheric pressure

Maximum temperature in absorber box is up to 300 deg C

FEA results

Temperatures after 20 hours



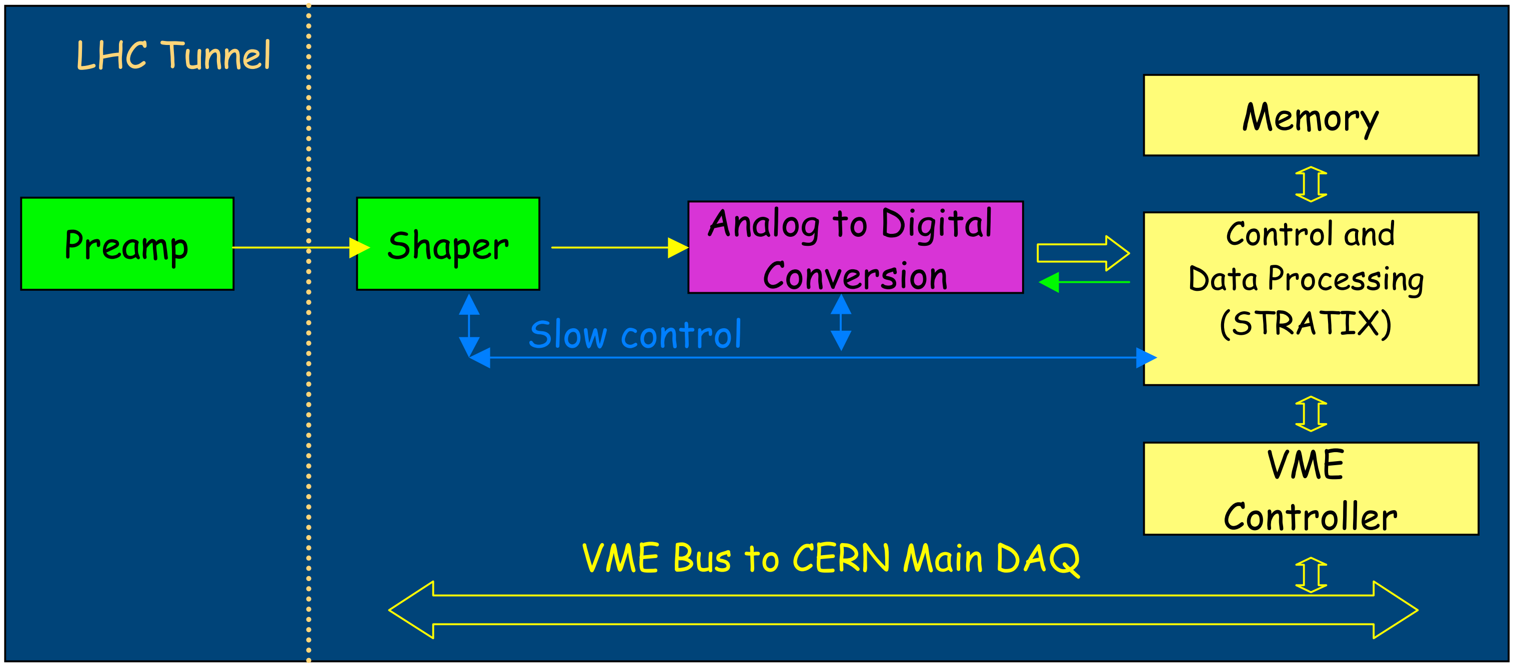
Details of the handling plan for LUMI are being formulated

K. Chow

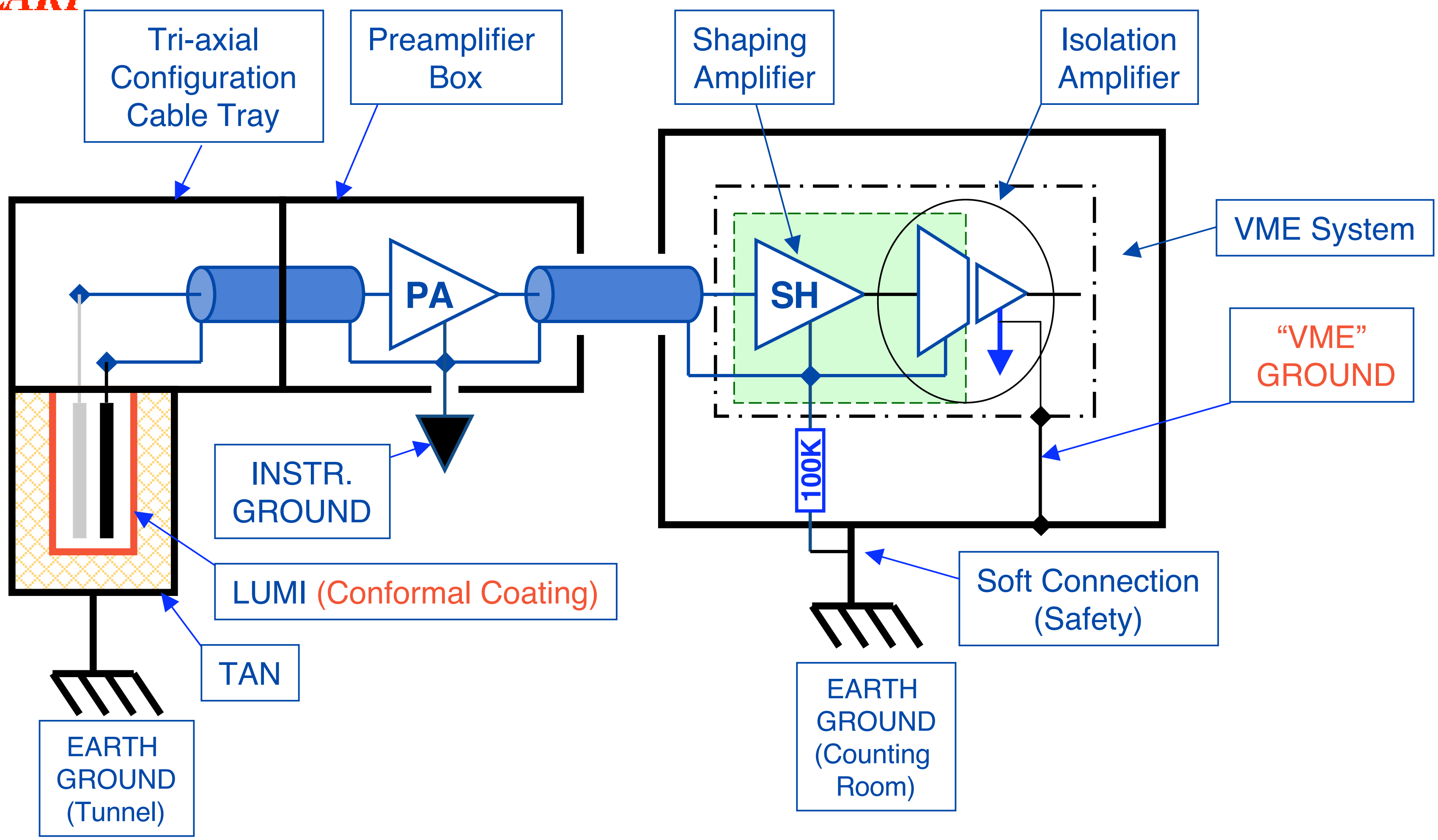
- Analysis will be used to estimate temperature rise in LUMI
- Temperatures in LUMI should be monitored during bakeout (with thermocouples) to determine if it exceeds its allowable temperature
- LUMI should be (partially) pulled out of slot if it may overheat (pullout has radiation exposure implications)

Signal Processing

- Very low noise pre-amp in the tunnel
- Shaper section completes the analog signal processing
- ADCs integrated in a VME64 mezzanine card
  - Interface defined by CERN BDI group



Electrical Connections



IBMS Mezzanine Board

LARP

Data from IBMS technical specifications document in EDMS (Jean-Jacques SAVIOZ)

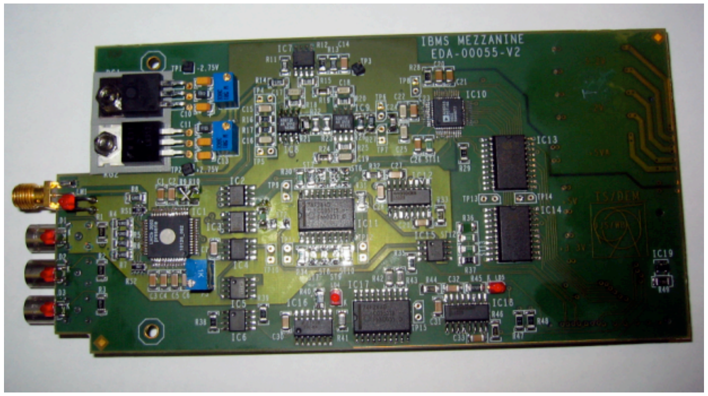
IBMS Mezzanine Board contains:

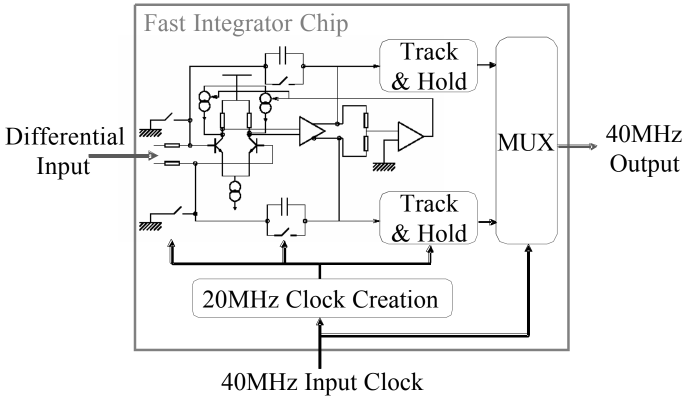
- Custom ASIC originally developed for the LHCb Preshower detector
- 14-bit digitizer (only 12 used).

ASIC:

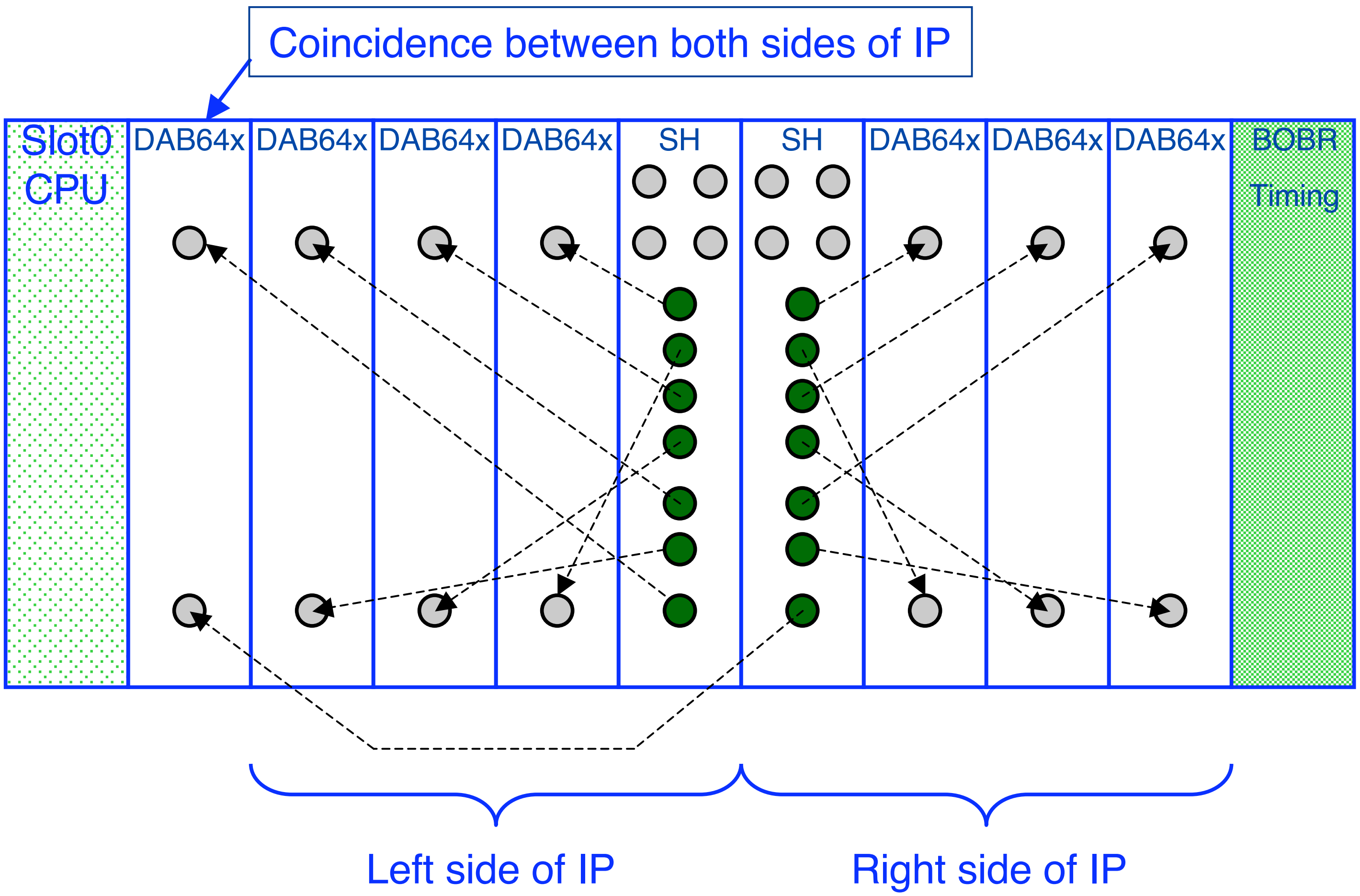
- Dual integrator + T/H circuit
- One integrator operates while other is in reset mode.

Differential input.





Shaper Board and DAB64x boards



Testing at RHIC

- RHIC run was suddenly restored
- Presented plan at RHIC APAX meeting in November
  - Asked for 2 shifts of 3-4 hours each
    - Need dedicated collisions
- Now setup in IR10, former PHOBOS area
- While ideal running condition is Au-Au, this run is p-p
  - We'll focus on backgrounds and on establishing operation of the device - 250 GeV will help
- Infinuim scope allows us to watch from LBL
  - Plan to use in parasitic mode while RHIC is running
  - Plan to replace with lumi DAQ system in the next run

Radiation Damage to passive components

LARP

Damage to passive components is mostly dominated by neutron scattering

DPAs are a best way to measure the effects of radiation exposure

While a DPA to first order is a DPA, neutron energy, flux, temperature changes can have a great impact on test results

- If an atom is displaced and quickly recombines, it could be no problem
- If this happens while an enormous amount of heat is dissipated, the material properties could easily change, the atom may not recombine…

Using the DPA approach, we can use neutrons at several test facilities

- Still important to have relatively high energies

LARP

Rad Damage Testing

At CERN

- At the ISOLDE ion source with a 1.4 GeV p beam from CERN PS Booster
  - ~10^13 protons per second
- Testing two identical kits, one exposed ~3 months, the second ~ 9 months

At BNL

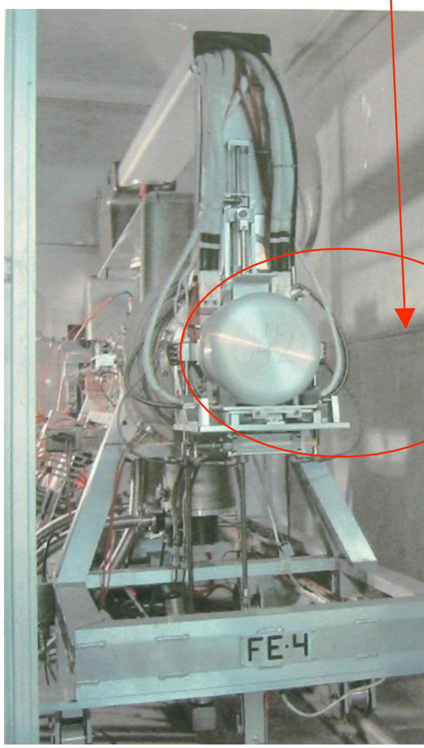
- Thanks to our colleagues in the collimation group (T. Markievich, N. Simos), we were able to add our samples to tests they were planning at the RHIC linac (200 MeV)
- Exposed all passive components to a dose >= 30 Grad
- Going to > 100 Grad
- Completed in June, in time for material's choice

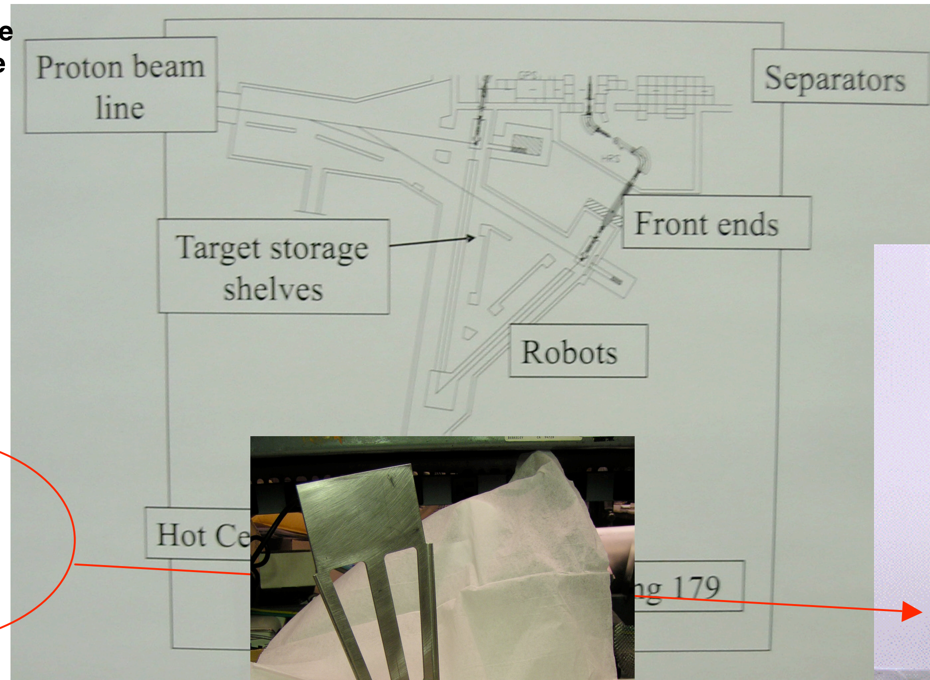
After irradiation we will perform mechanical testing and metallurgical investigations of the samples.

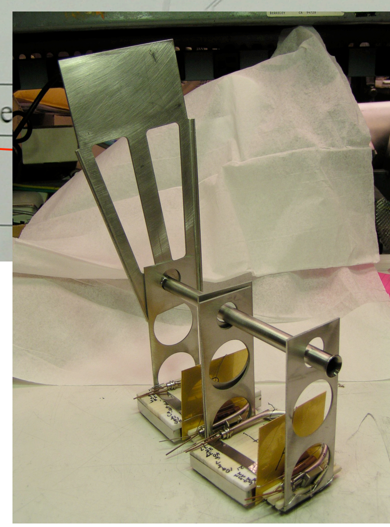
Setting up a MARS model to calculate DPAs in this configuration and compare with LHC projections

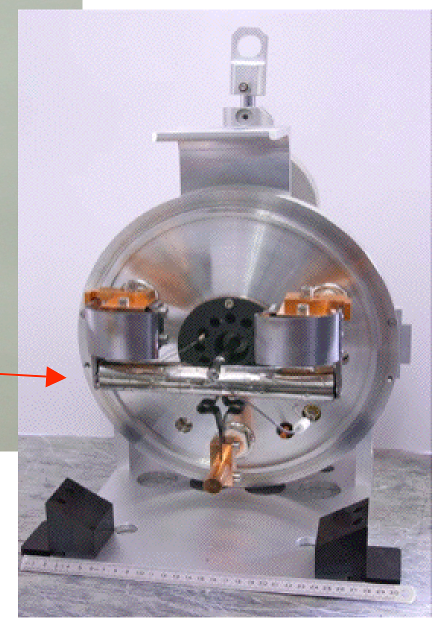
Setup at ISOLDE’s source

Our samples are mounted on the wall behind the source









Rad Damage of Active Components

LARP

In general a level of ~100 krad/yr is generally tolerated by bipolar transistors

Packaging front end electronics for fast replacement

- Dual channel to overcome random failures

Recommend replacement after a given integrated dose

- 1-2 years at highest luminosity
- Earlier operation at lower luminosity will allow for a longer time before replacement

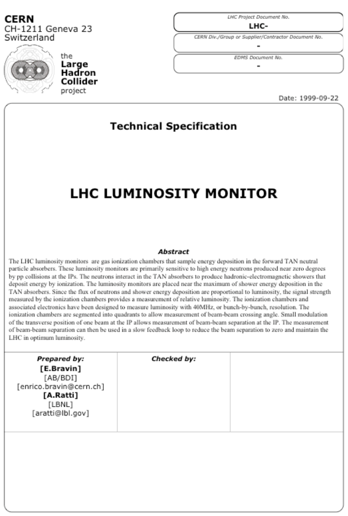
Have a kit a BNL ready for testing with high energy p beams

Do we have a choice??

Integration planning at CERN

LARP

- Complete system description
  - Technical, installation, safety, electronics, responsibilities, deliverables…
- Met with all relevant parties at CERN
- Final draft at CERN
- EDMS process underway



CERN
CH-1211 Geneva 23
Switzerland

the **Large Hadron Collider** project

LHC Project Document No. **LHC-**

CERN Div./Group or Supplier/Contractor Document No. -

EDMS Document No. -

Date: 1999-09-22

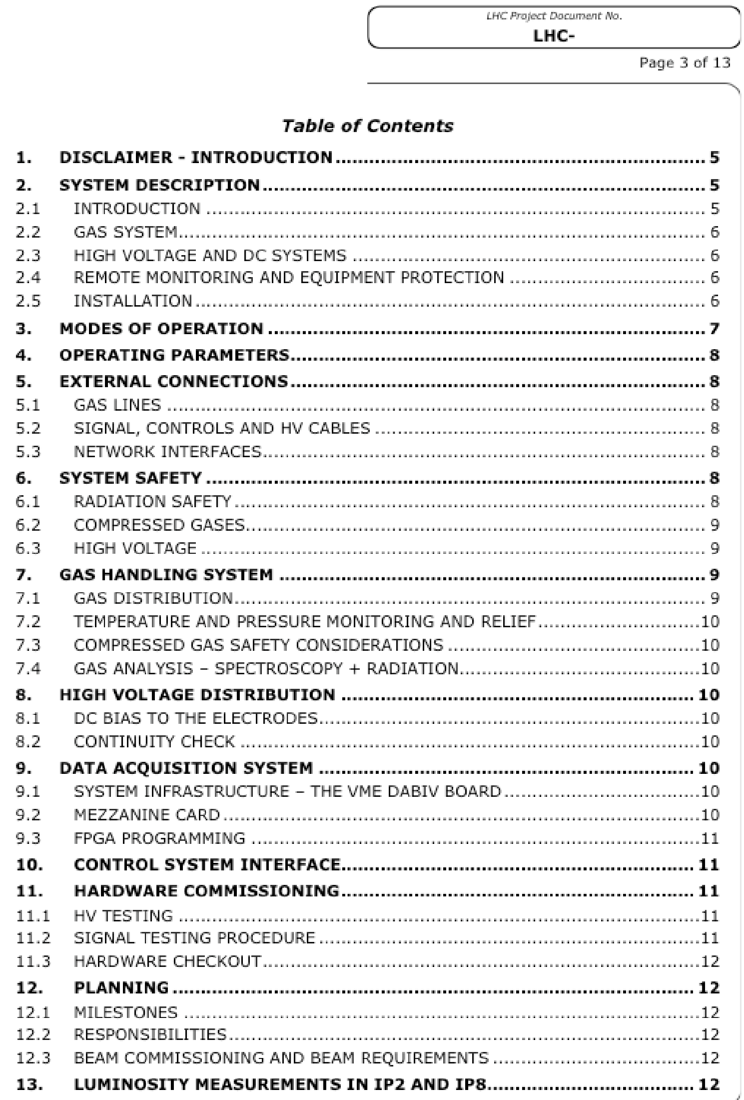
Technical Specification

LHC LUMINOSITY MONITOR

Abstract

The LHC luminosity monitors are gas ionization chambers that sample energy deposition in the forward TAN neutral particle absorbers. These luminosity monitors are primarily sensitive to high energy neutrons produced near zero degrees by pp collisions at the IPs. The neutrons interact in the TAN absorbers to produce hadronic-electromagnetic showers that deposit energy by ionization. The luminosity monitors are placed near the maximum of shower energy deposition in the TAN absorbers. Since the flux of neutrons and shower energy deposition are proportional to luminosity, the signal strength measured by the ionization chambers provides a measurement of relative luminosity. The ionization chambers and associated electronics have been designed to measure luminosity with 40MHz, or bunch-by-bunch, resolution. The ionization chambers are segmented into quadrants to allow measurement of beam-beam crossing angle. Small modulation of the transverse position of one beam at the IP allows measurement of beam-beam separation at the IP. The measurement of beam-beam separation can then be used in a slow feedback loop to reduce the beam separation to zero and maintain the LHC in optimum luminosity.

Prepared by:	*Checked by:*	
[E.Bravin] [AB/BDI] [enrico.bravin@cern.ch] **[A.Ratti]** [LBNL] [aratti@lbl.gov]		



LHC Project Document No. **LHC-**

Page 3 of 13

Table of Contents

Integration effort at CERN

LARP

~8 FTE-months spent at CERN in integration activities

Two integration meetings in January and March

- Including an integration workshop with all groups instrumenting TAN

Opening a team account to support local expenses

Planning more visits to further plans and follow through

TS/LEA group now responsible to coordinate installation and documentation of TAN instrumentation area

- Generates 3D layout of the area
- Coordinates gas installation activities

LUMI Long Term Plans
(from 2005)

FY06
Fabrication of first article
Design of auxiliary hardware
Device tests, electronics integration and performance qualification
Deliver first unit to CERN - delayed ~3 months

FY07
Fabricate balance of units and auxiliary hardware
Transfer to CERN
Installation support
Commissioning support

FY08
Post-commissioning and pre-operations support

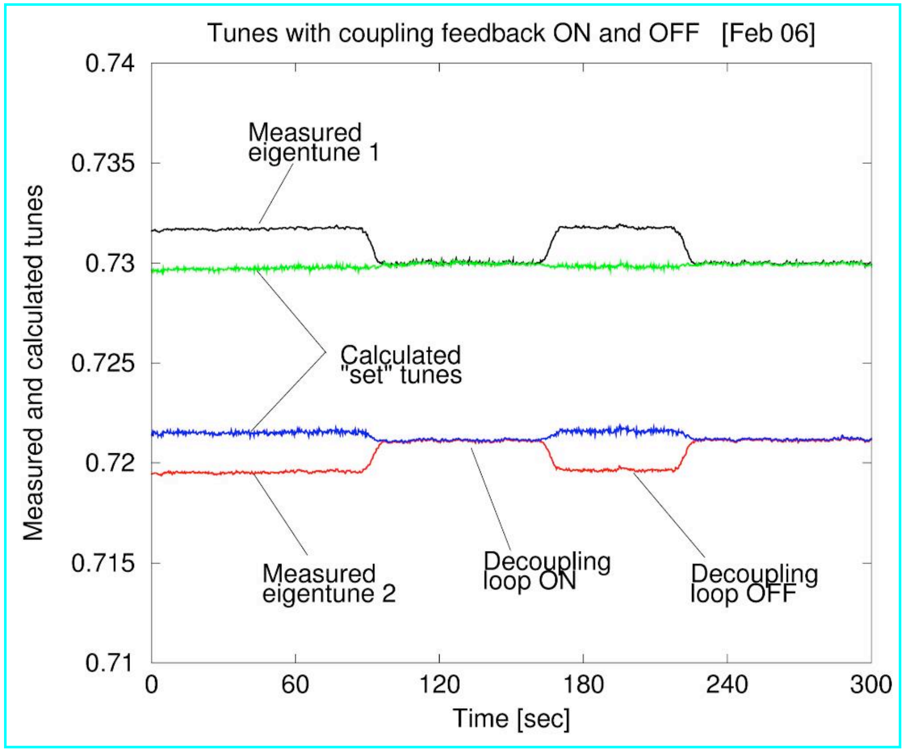
Tune Feedback

- Objective: Control Tune, Coupling and eventually chromaticity during ramp and store
- Recent Progress
  - Tune and Coupling feedback used in RHIC run 6, a world first
  - Major Improvements for RHIC Run 6
    - coupling feedback
    - Direct Diode Detection (3D) analog front end
  - Delayed Milestones
    - Final Design Review – Oct. 26, 2006
    - SPS testing – planned for this summer, after RHIC run

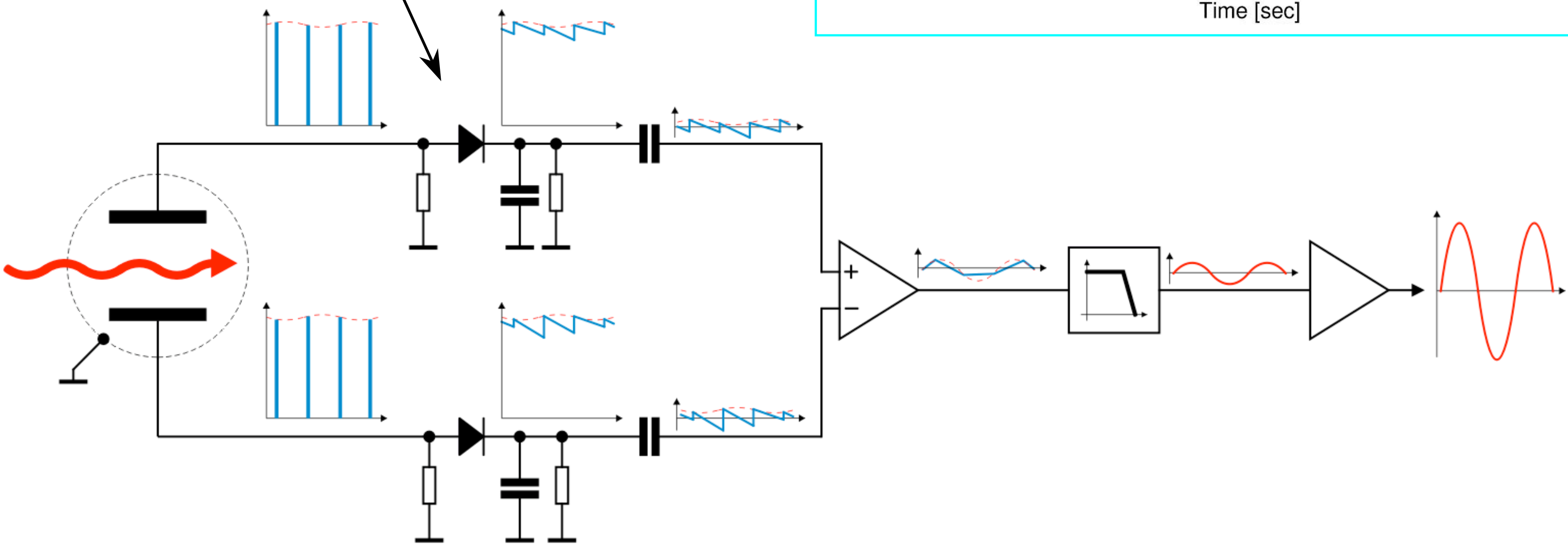
3D system is an excellent tool for Beam Transfer Function Measurements

VME BBQ in RHIC - 2 improvements

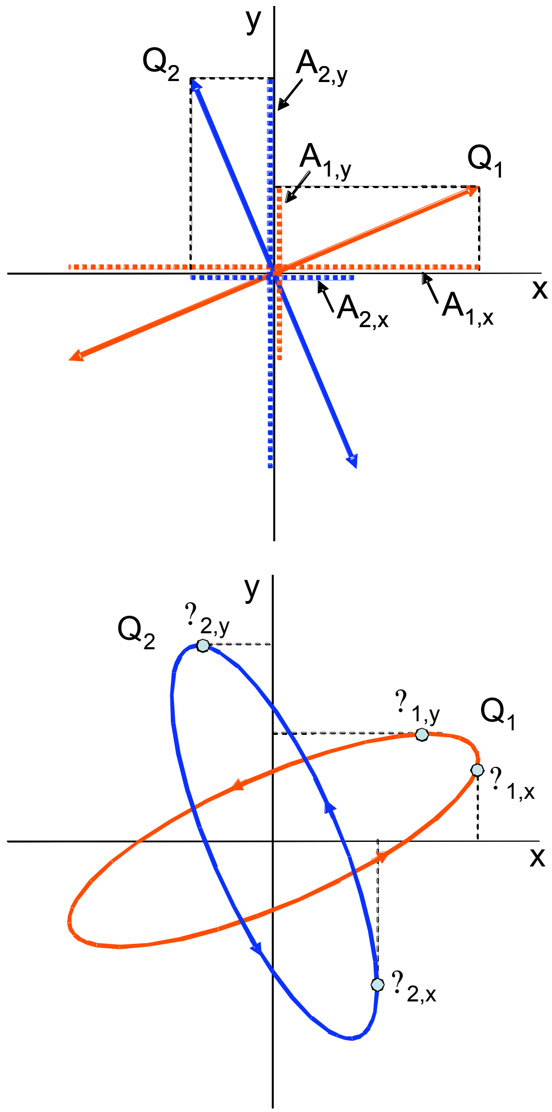
Continuous coupling measurement – made coupling feedback possible, which made tune feedback possible

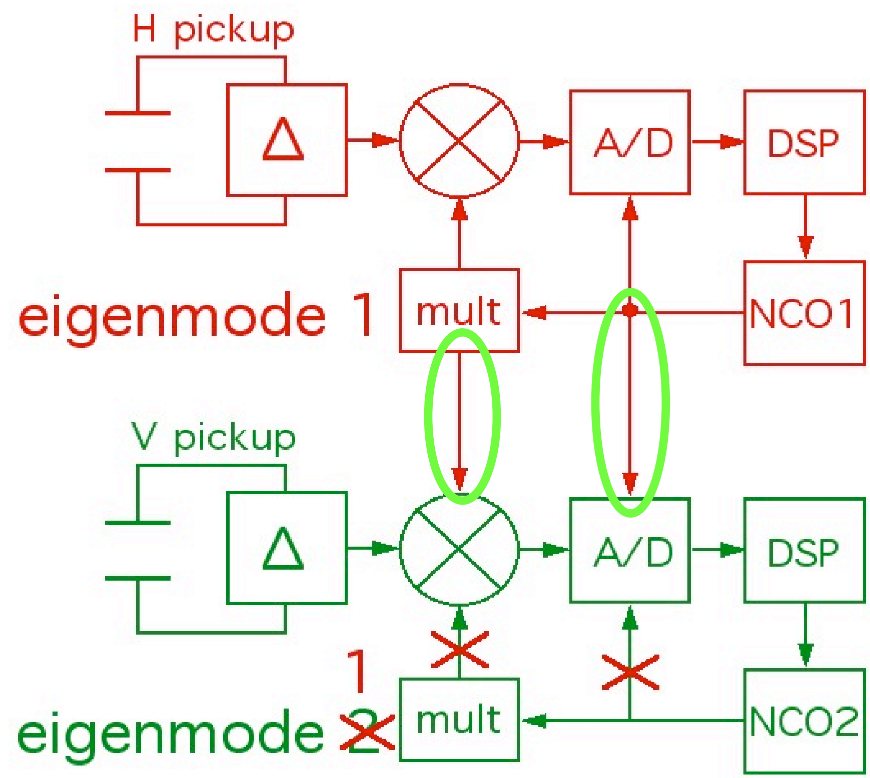


Direct Diode Detection Analog Front End (3D AFE) – improved sensitivity (~10nm!) and dynamic range



Coupling Measurement with PLL Tune Tracker

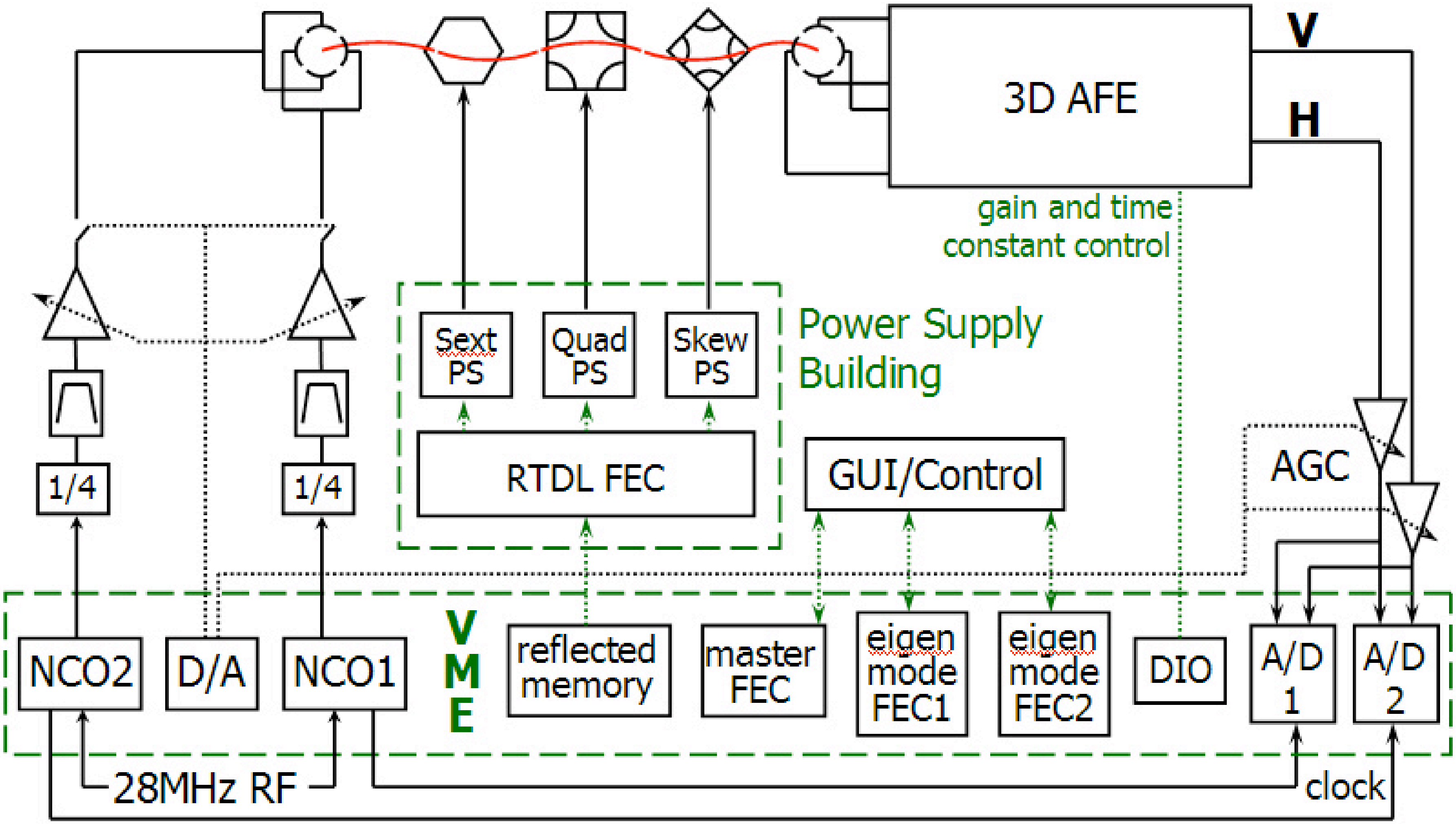




Tracking the vertical mode in the horizontal plane & vice-versa allows the coupling parameters to be calculated

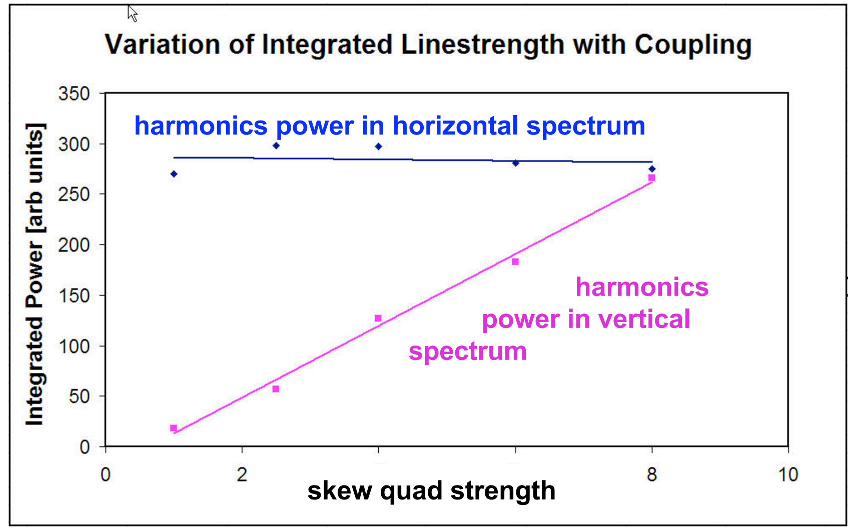
C-A/AP/204 - Towards a Robust Phase Locked Loop Tune Feedback System, R. Jones et al
http://www.rhichome.bnl.gov/AP/ap_notes/cad_ap_index.html

RHIC VME-based System Diagram

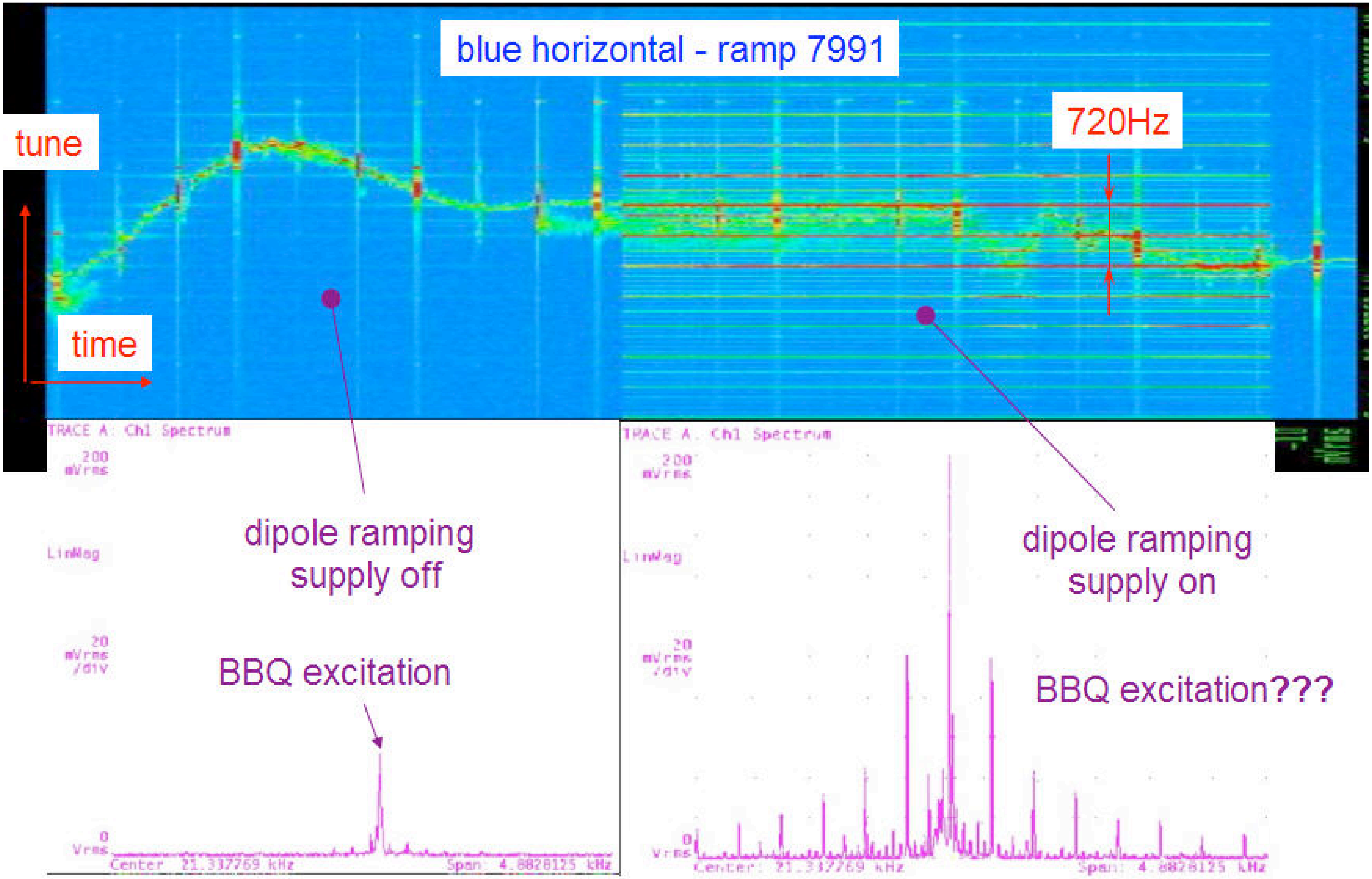


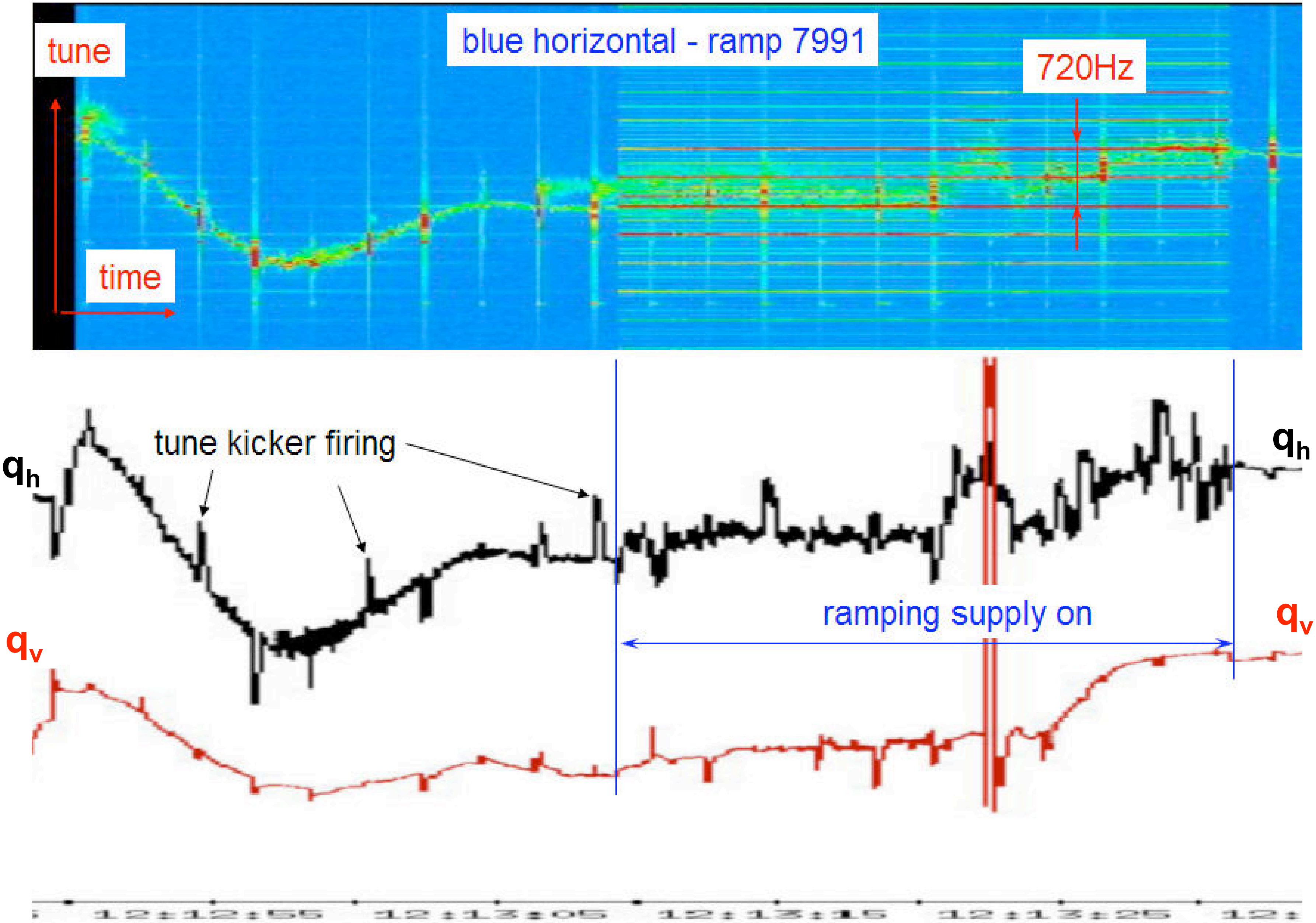
Mains Harmonics

- Direct excitation of betatron line by high harmonics of power line frequency
- Recent measurements show it ~80dB above 3D noise floor
- Studies identified it as main dipoles
  - correlation with coupling
  - correlation with ramping (next slide)
- Seen at all accelerators where 3D AFE has been installed
- ~50dB stronger at RHIC than elsewhere

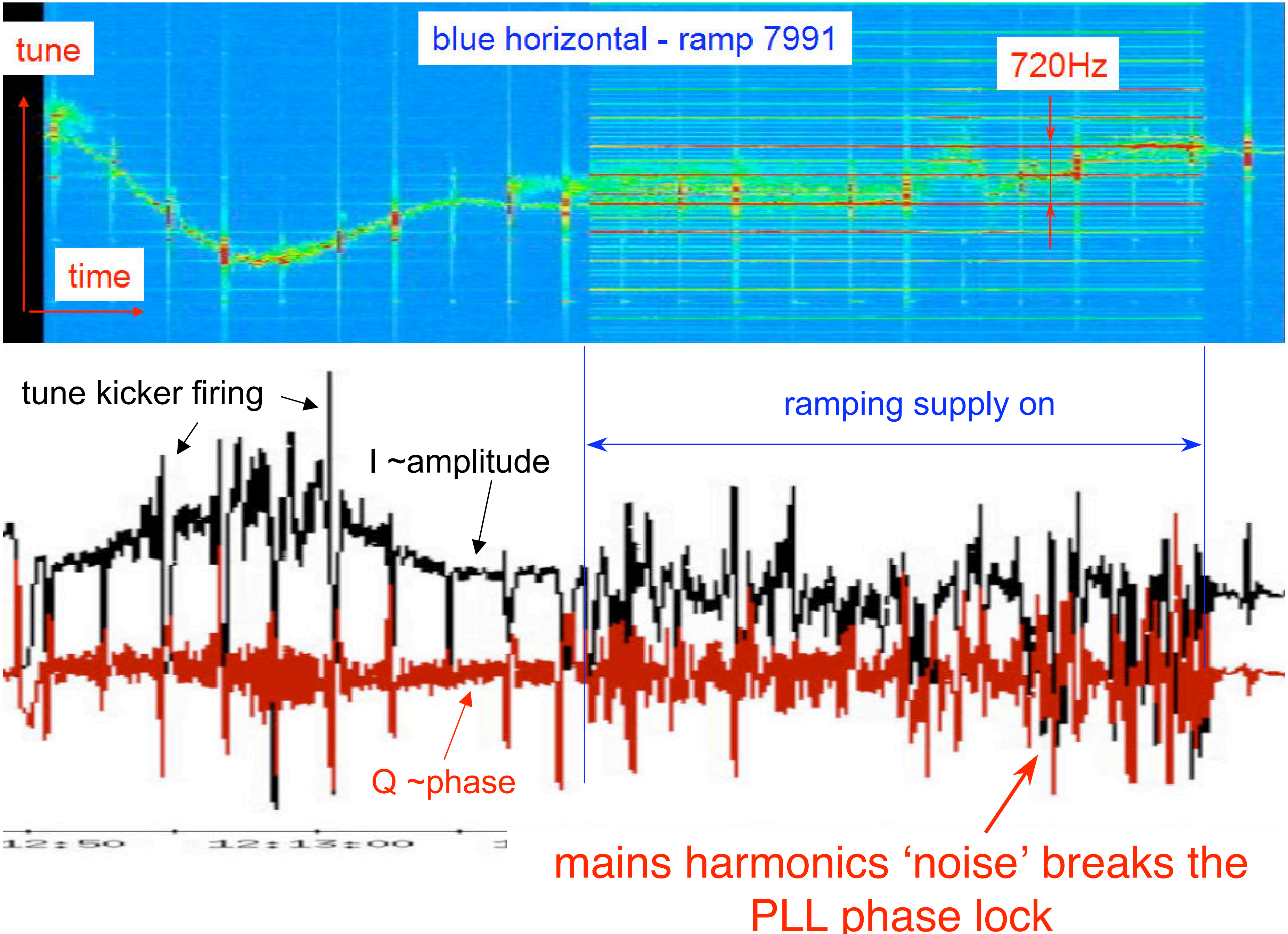


- Complicates transition to operational status in RHIC
- Scheduled for 3 hours dedicated beam time during June 15th beam studies


blue horizontal - ramp 7991
tune
time
720Hz
TRACE A: Ch1 Spectrum
dipole ramping supply off
BBQ excitation
Center 21.337769 kHz
Span: 4.8828125 kHz
dipole ramping supply on
BBQ excitation???



tune
time
blue horizontal - ramp 7991
720Hz
tune kicker firing
q_h
q_h
q_v
q_v
ramping supply on


tune
blue horizontal - ramp 7991
720Hz
time
tune kicker firing
I ~amplitude
ramping supply on
Q ~phase
mains harmonics ‘noise’ breaks the PLL phase lock

Chromaticity Feedback

LARP

Challenge:

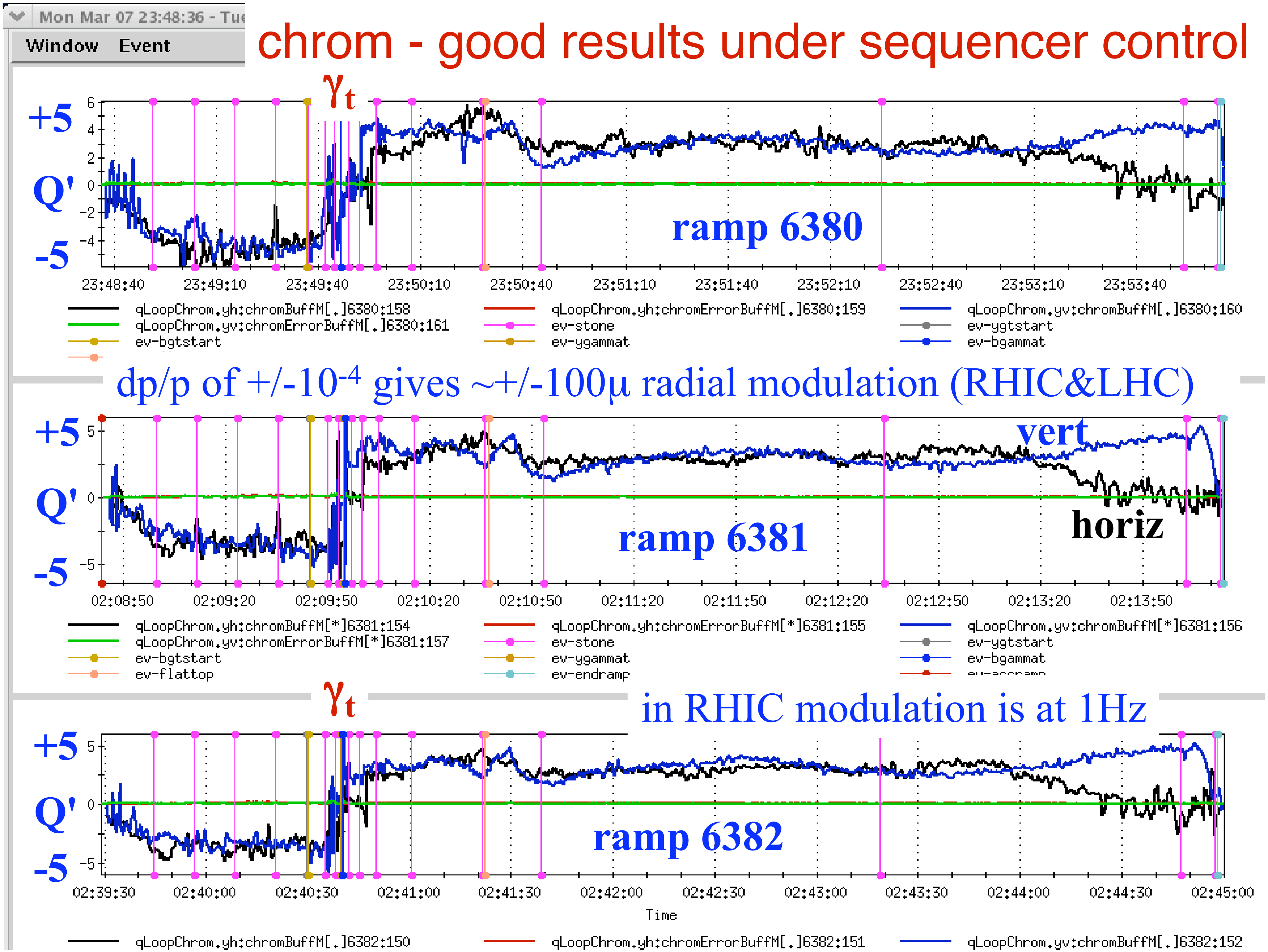
- persistent current effects in SC magnets can strongly perturb machine lattice, especially during energy ramp (aka “snapback”)
  - Betatron tunes ($Q_{x,y}$) and chromaticities ($Q'_{x,y}=EdQ_{x,y}/dE$) can vary significantly due to “snapback” resulting in beam loss, emittance growth.
- Effects for LHC predicted to be large.

Solution: make fast, precision Q, Q’ measurements and use these signals to feedback to tuning quadrupoles and sextupoles.

This effort is ideally suited for a collaboration with RHIC, which can be the benchmark and testing ground for this effort.

- slow (1Hz) radial (1mm) modulation – next slide
- faster phase modulation – under investigation

chrom - good results under sequencer control



LARP

Scope, Boundaries, Responsibilities...

CERN provides all hardware for LHC

- •kicker amplifiers, kickers, and pickups
- •Direct Diode Detection AFEs
- •Digitizer boards
- •DAB64 Boards
- •VME crates and crate computers
- •non-PLL gate array code

LARP provides software

- •PLL-specific gate array code
- •LabVIEW control program
- •testing at RHIC, with and without beam
- •commissioning support at LHC

CERN
CH-1211 Geneva 23
Switzerland

the Large Hadron Collider project

LHC Project Document No.
LHC-BQ-ES-0001 draft

CERN Div./Group or Supplier/Contractor Document No.
AB/BDI

EDMS Document No.

Date: 2005-06-14

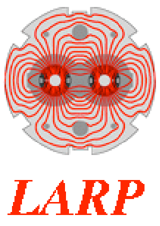
Functional Specification

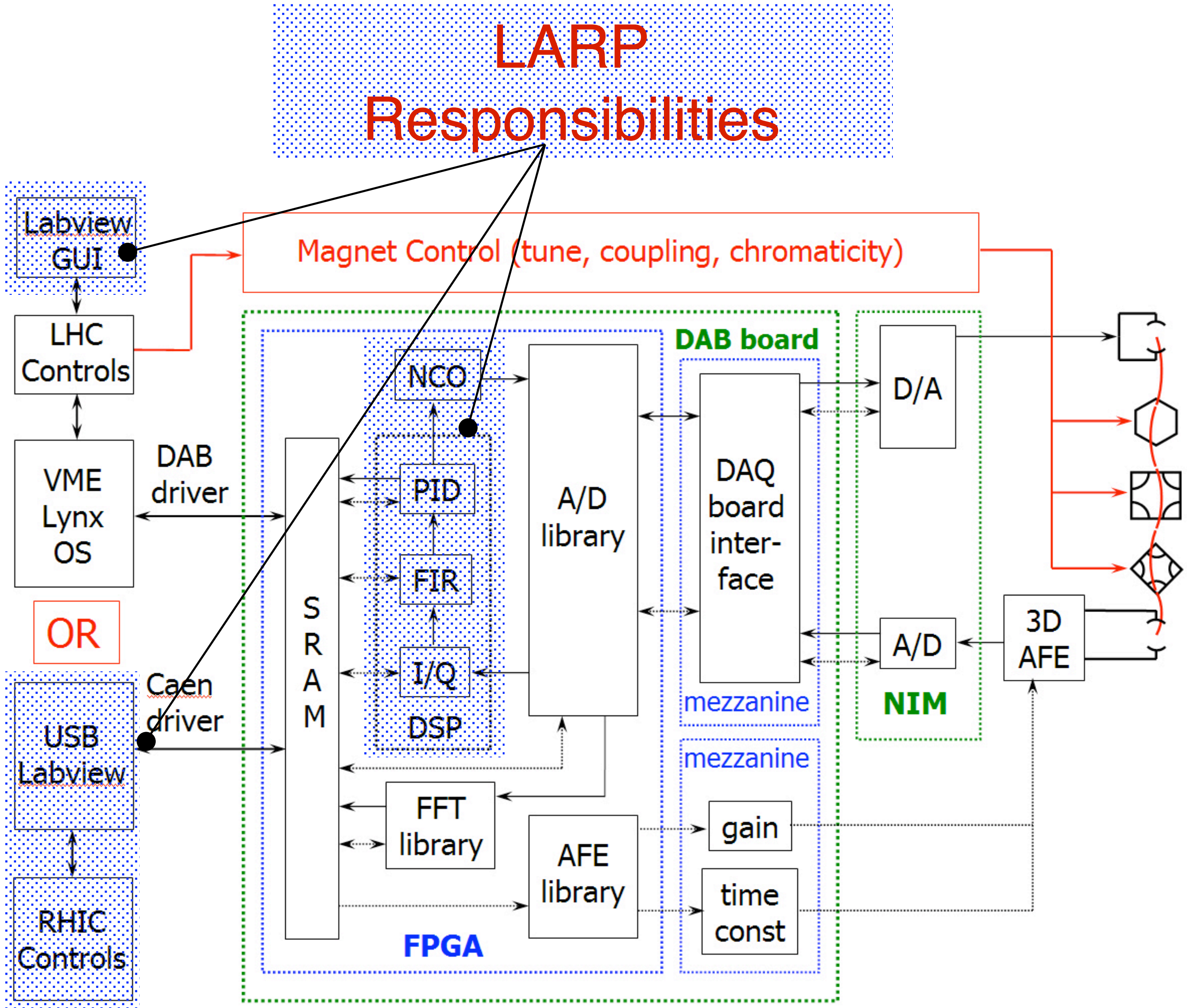
DEFINITION OF THE SCOPE, BOUNDARIES AND SHARE OF RESPONSIBILITIES FOR THE LHC TUNE FEEDBACK TASK WITHIN THE US-LARP FRAMEWORK

Abstract

This specification will define the scope of the LHC tune feedback task within the US LHC Accelerator Research Programme (LARP). The boundaries and share of responsibilities between CERN and its US partners will be clearly defined.

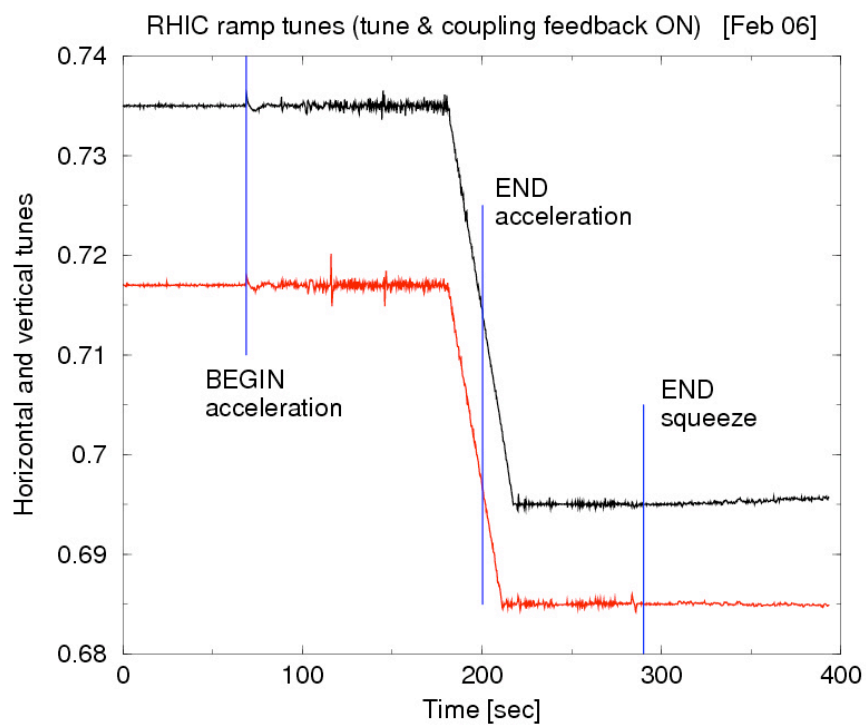
Prepared by :	*Checked by :*	*Approval Leader:*
Rhodri Jones [AB-BDI/CERN] rhodri.jones@CERN.CH **Peter Cameron** [BNL] cameron@BNL.GOV		


LARP


LARP
Responsibilities
Labview
GUI
LHC
Controls
VME
Lynx
OS
DAB
driver
OR
USB
Labview
Caen
driver
RHIC
Controls
Magnet Control (tune, coupling, chromaticity)
DAB board
S
R
A
M
NCO
PID
FIR
I/Q
DSP
A/D
library
FFT
library
AFE
library
FPGA
DAQ
board
inter-
face
mezzanine
mezzanine
gain
time
const
D/A
A/D
NIM
3D
AFE

FY06 Milestones and Deliverables

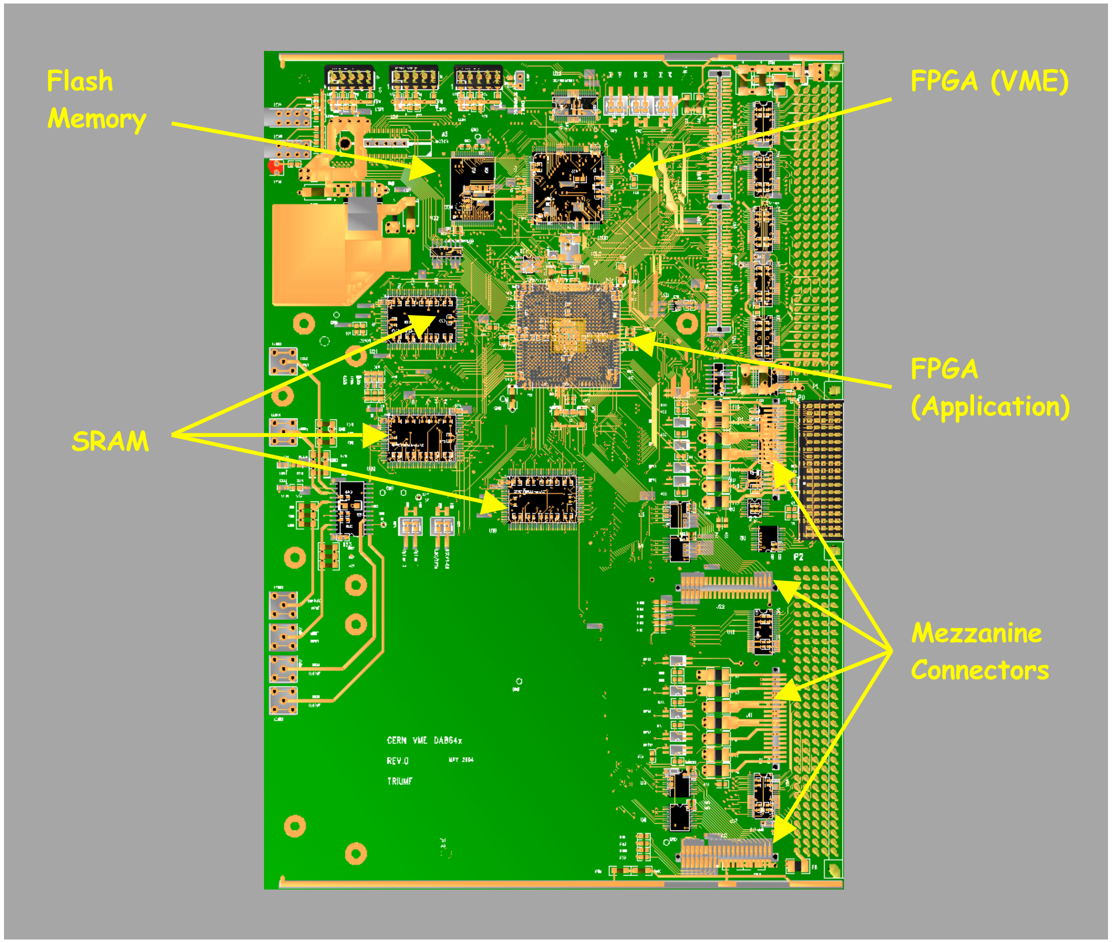
- January: VME-based Baseband Tune (BBQ) in RHIC
  - deal with coupling problem – coupling breaks tune feedback
  - world first simultaneous tune and coupling feedback – delivered decoupled beam to full energy on the first attempt
  - Improvement of mains harmonics is needed to continue developing chrom. feedback,…
  - dedicated study – 3 hours dedicated beam time on June 15th
- May: Final Design Review – moved to October
  - Still allows for on time delivery for LHC commissioning
- June : DAB-based BBQ for SPS testing
  - Triumf DAB board delays
  - Moved to September



FY07 Milestones and Deliverables

- September + October – Operation of DAB-based BBQ at SPS
- October 26 – Final Design Review
- November onwards – further evaluation of VME-based Baseband Tune (BBQ) in RHIC
  - Mains harmonics
  - Loop parameters
  - Chromaticity feedback,…
- January – commissioning of DAB-based BBQ
- February to end of RHIC Run 7 – evaluation of DAB-based BBQ in RHIC
- July – finalization of LHC system
- August onwards – support of installation and commissioning at LHC

LHC DAQ Interface - DABIV Board



D Bishop, TRIUMF

LARP DAQ Workshop

- Attended by representatives of all labs
  - April 25, 2006
- Daryl Bishop (TRUIMF), designer of the DAB board, gave a comprehensive description of the board design and its firmware programming
- Rhodri Jones did a live demonstration of the hardware functionality at LBL
  - Used signal from pulse generator, processed by LUMI analog shaper
- Round table discussion on how to implement system at LARP labs

DAQ software/firmware for LARP instruments

LARP

- Real Time OS problem to compile LynxOS at US labs
  - This stalled our efforts for months
  - Licensing problem
- LabView proposed by CERN
  - Use VME-USB bridge card
- LARP labs can develop expert Vis in LabView and deliver to CERN
  - Uses the bridge card in the US
- CERN implements the FESA interface, provides LabView connection
- Expert panels available through CERN's FESA
- LARP labs provide functional specification of memory interface
- CERN develops GUIs for device controls
  - Both expert and operator

LARP

Open Issue/Opportunity

LHC@FNAL opens the door to experiments or observations at LHC directly from LARP sites

- FNAL is leading the way

Ideal for 'passive' devices

- I.e. Schottky monitor, luminosity monitor
- Could make present effort on Shottky more effective

Not clear how much will be available by commissioning

- CERN controls must be deeply involved for this to happen

CERN is now looking at ways to facilitate

LARP Instrumentation Integration Plan

LARP

Planned documentation for each instrument

1. FS - Roles and Responsibilities
   Defines who does what, when
2. ES- Technical Specification
   Complete description of the device, its interfaces, its requirements….
3. ES - Functional Spec (of DAB 64x interface)
   Definition of what functions and features are included in the data acquisition system
4. ES - Memory Map of Firmware
   How the data is transferred to the control system
5. Any other document
   (ES) Safety, installation, HW checkout and commissioning,
6. FS - Acceptance Plan and signoff list
   Contains a list of deliverables from LARP to CERN
   Signoff list
   Once accepted, defines the end point of LARP's contribution to the instrument

FS= Functional Specification ES=Engineering Specification

Implementation

LARP

The above docs have approvals on both sides

- CERN and LARP

PIs are the single points of contact at each side of the ocean

Documents reside in EDMS and in LARP's databases

We are working towards the completion of the first two and the last one in June

Response to Previous Reviews

LARP

- Task sheets are revised as plans change:

1. When the RHIC run was revived, the plan for tune feedback changed completely, an updated task sheet reflects the changes
2. Annual system specific LARP reviews validate the work, its technical merit, funding requests and proposed schedules. Both are management tools to ensure tracking of progress and convergence towards the program's goals

- CERN decided to adopt a different technology for monitoring luminosity in IP2 and 8, and is no longer seeking ionization chambers for these IPs

- Only minimal funding goes to ZDC electronics, to ensure that we will have analog signals available to cross calibrate the devices and monitor performance in particular at low luminosity

Covered and integrated in Steve's scorecard

New Tasks

- Several new tasks are emerging
  - AC Dipole
  - Synchrotron light based diagnostics
- Being considered with other AS new proposals
- As the existing tasks come to an end, funds will become available for new proposals
- Instruments are chosen in close collaboration with CERN
  - Current devices were not part of baseline design of LHC

Spending to date

	Budget	Spent	Balance (as of 5.31.2006)
Luminosity Monitor	960	485	475
Schottky Monitor	245	151	94
Tune Feedback	430	349	81

in $1,000s

Conclusions - Challenges

Funding

- We are working with LARP management to continue securing adequate funding
- With LHC commissioning approaching, we cannot tolerate schedule slips

LARP task sheets continue to define scope and budget year by year

Funding requests are also managed through task sheets

- Detail 'project' reviews validate overall cost and schedule

Integration with beam commissioning activities is essential to the survival of the instruments provided by the LARP collaboration and LARP is planning accordingly

Summary

LARP

LARP Instrumentation will build, commission, and integrate into LHC operations advanced instrumentation and diagnostics for helping LHC

- reach design energy
- reach design luminosity

Strong collaborative efforts are in place and evolving

- Tune feedback is fully leveraging RHIC experience and includes CERN staff
- Lumi testing in RHIC is extremely valuable
- Schottky's experience at FNAL is a great asset
- US colliders are an essential test bed for system development

This program will advance the US HEP program by

- Enhancing US accelerator skills
- Developing advanced diagnostic techniques that will apply to present and future US programs
- Help maximize LHC performance