

# LHC Accelerator Research Program Beam Instrumentation Summary

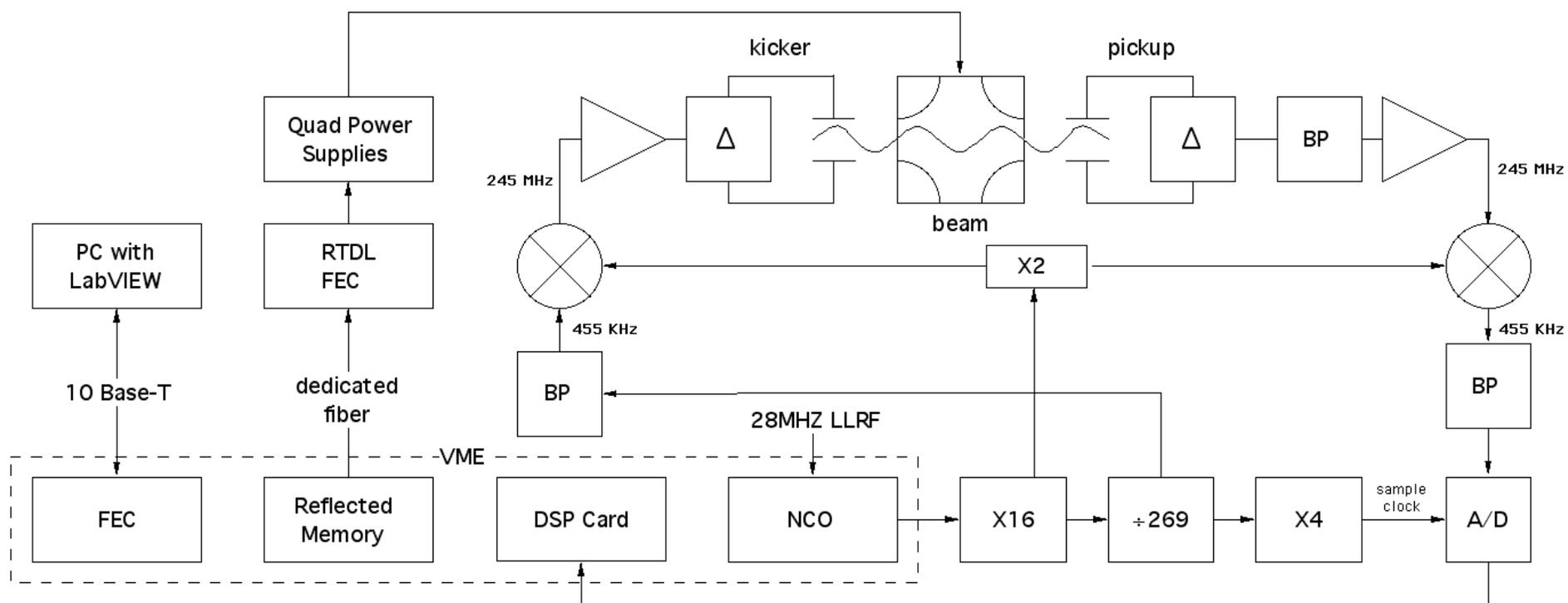
LARP Collaboration Meeting  
Fermilab

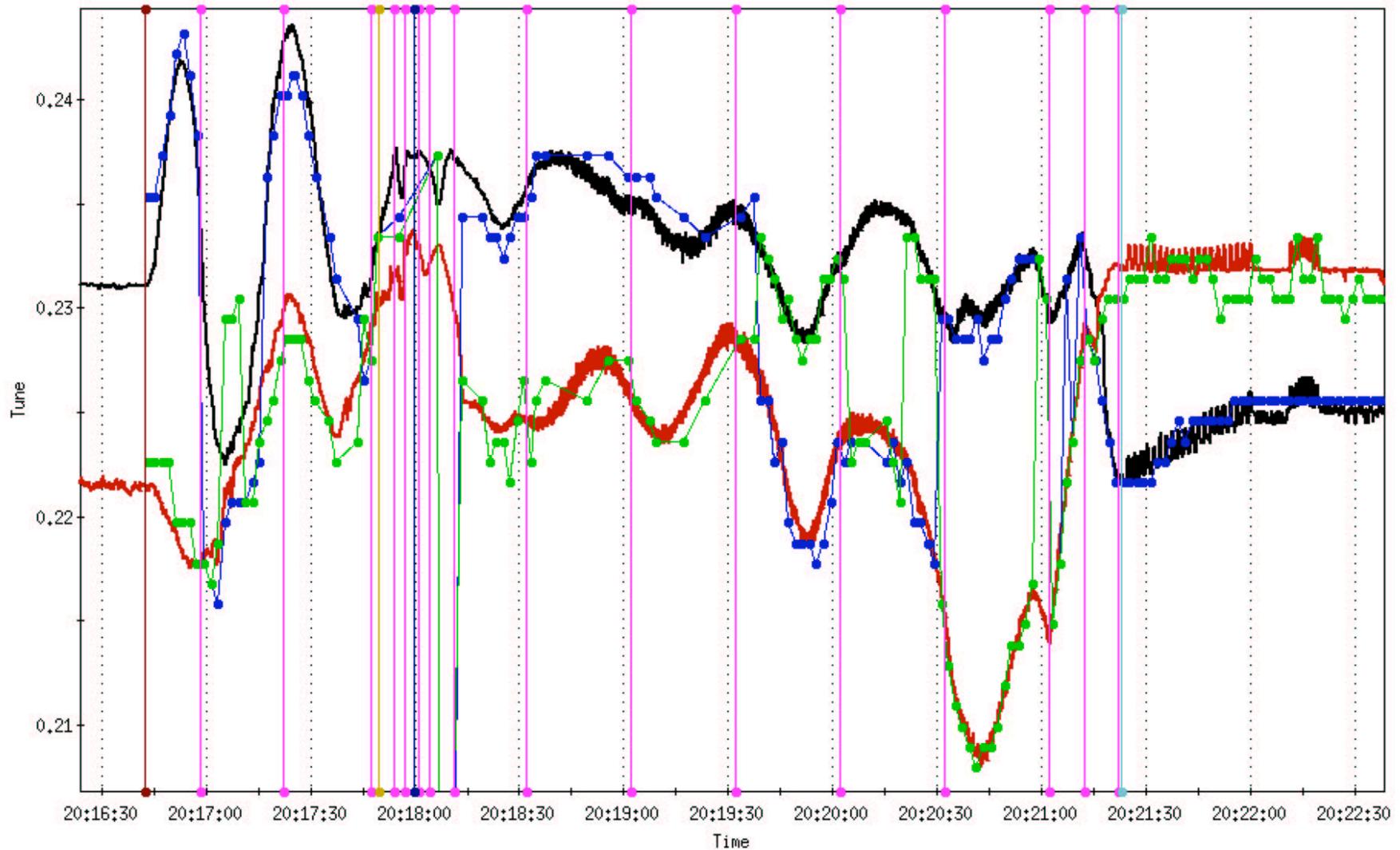
26-27 February, 2004

John Byrd, C.Y. Tan, Peter Cameron, Alex Ratti, Peter Denes, Bill  
Barletta, Hermann Schmickler, Andreas Jansson



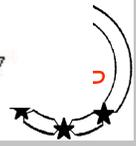
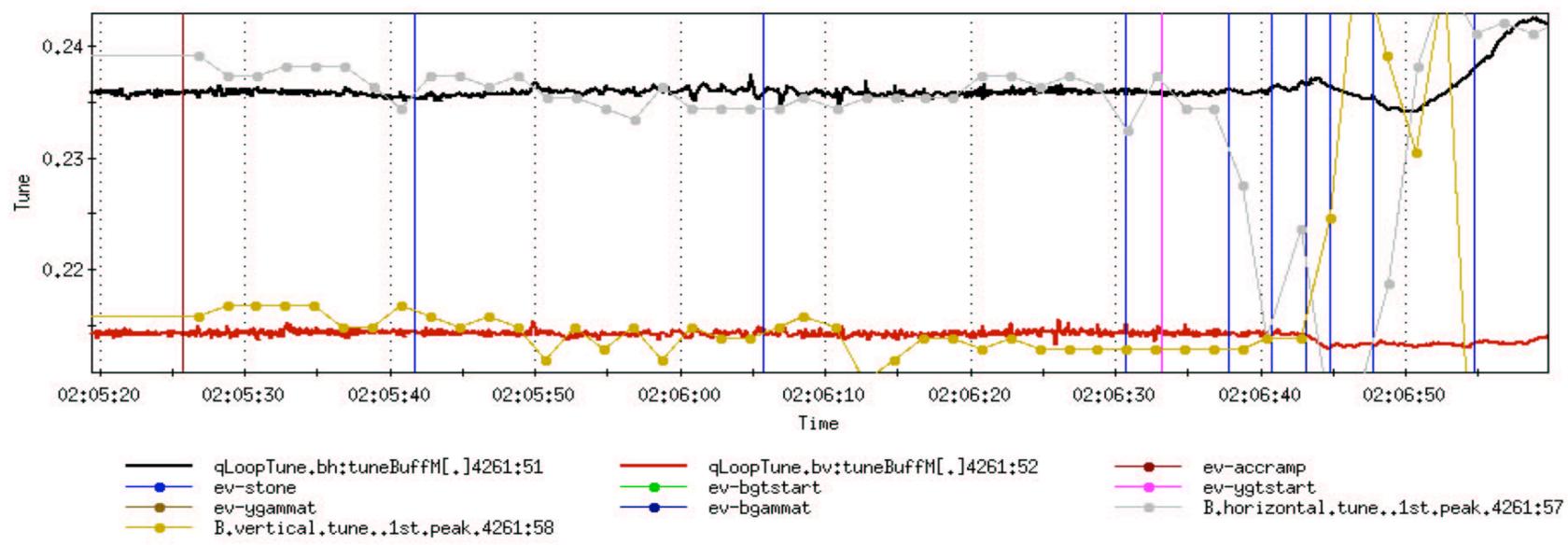
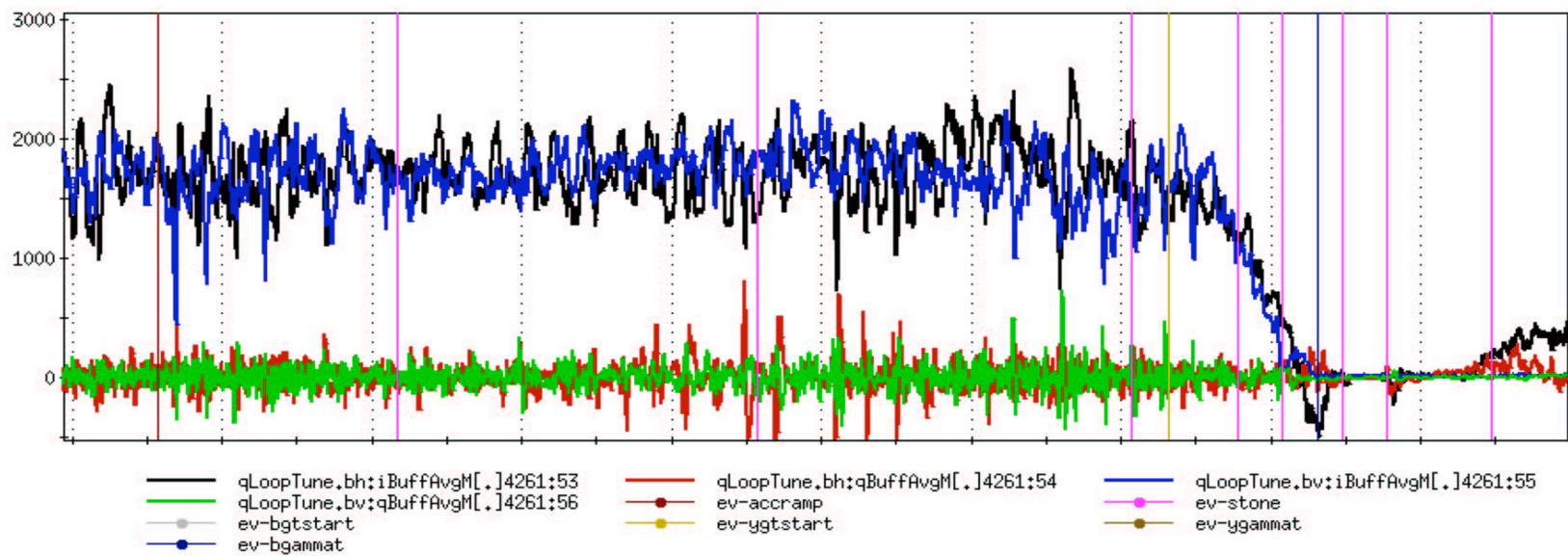
# PLL Block Diagram





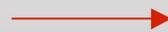
- |     |                                    |     |                                      |
|-----|------------------------------------|-----|--------------------------------------|
| —   | qLoopTune.yh;tuneBuffM[.].4172:264 | —●— | Y.horizontal.tune..1st.peak.4172:266 |
| —●— | Y.vertical.tune..1st.peak.4172:267 | —●— | ev-stone                             |
| —●— | ev-bgtstart                        | —●— | ev-ygammat                           |
| —●— | ev-bgammat                         | —●— | ev-endramp                           |
| —●— | ev-rebucket                        | —●— |                                      |
| —●— | ev-accramp                         |     |                                      |
| —●— | ev-ygtstart                        |     |                                      |
| —●— | ev-flattop                         |     |                                      |
| —●— | ev-lumi                            |     |                                      |

Window Event



# PLL Problems/Plans

No crossing with  
TF, always a problem  
otherwise?  
Coupling is a problem,  
Even without crossing



chirp, multi-carrier, synch satellites
multiple systems
damper noise floor
signal-to-noise
stability and loop tuning
dynamic range
phase stability
emittance growth
tune crossing
autoexcitation
modeling
beam simulator
chromaticity measurement
coupling measurement
beam experiments considerations



# PLL Budget

hardware and software					50	80
testing with beam					40	20
<b>BNL totals</b>	77	36	130	110	205	220
	<b>FY04 total</b>	<b>113</b>	<b>FY05 total</b>	<b>240</b>	<b>FY06 total</b>	<b>425</b>
<b>FNAL</b>						
theory of PLL (Burov - AP?)	10		26			
PLL implementation				26		
beam simulator		3		7		
Schottky feasibility study	5		13			
engineering student		20		26		
Engineer		5	39			
<b>FNAL totals</b>	15	28	78	59	0	0
	<b>FY04 total</b>	<b>43</b>	<b>FY05 total</b>	<b>137</b>	<b>FY06 total</b>	<b>0</b>
<b>total by FY, BNL + FNAL</b>		<b>156</b>		<b>377</b>		<b>425</b>
<b>'base' budget</b>		<b>138</b>		<b>160</b>		<b>370</b>



# Lumi: a year in review

- Lumi hardware design and construction
  - prototype chamber designed and built
  - improved electronics built
  - backup electronics built
  - CdTe detector received and installed for tests
- Beam and bench tests
  - electronics optimized for 25 nsec lumi pulses
  - extensive study of test at FNAL RTF (booster)
  - lumi beam tests at ALS booster (1 Hz pulses)
    - verify IC drift velocity modeling vs voltage, pressure, mix
    - demonstrated position detection < 100 micron sensitivity
  - lumi beam tests in ALS ring (~25 nsec pulses)
    - demonstrated feasibility of slow beam spill at 40 MHz

Almost 100% turnover in group (since Oct. 2002)

- still going strong
- institutional commitment has kept us alive

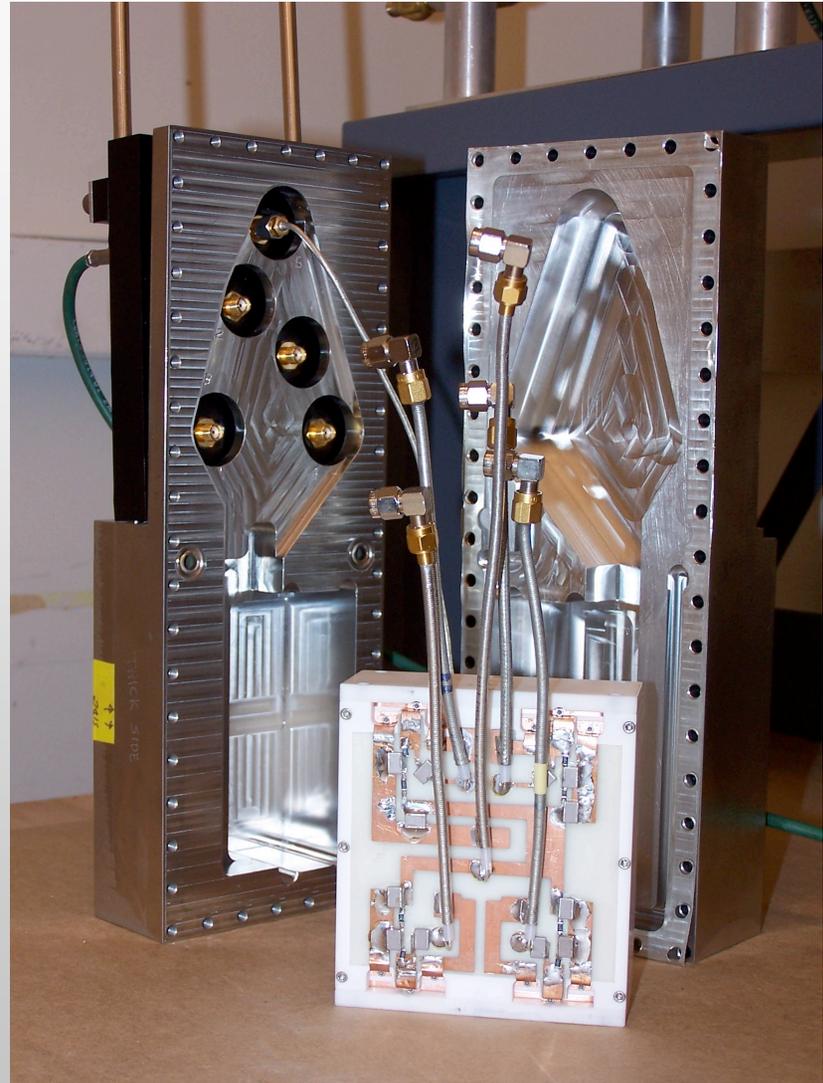


# Chamber built

- High pressure vessel

Six-layer chamber  
with ceramic  
insulation

Rad-hard signal and  
HV cables



# LUMI Plans

## FY04

- Continue performance tests
  - Complete 40 MHz test and optimization
- Start production engineering study

## FY 05

- Complete mechanical fabrication details
- Integrate test stand with standard CERN DAQ system
- Integration into TAN
- Continue performance tests and electronics integration - test at FNAL/RHIC?
- Radiation damage assessment

## FY06

- Fabrication of 4 units + spares
- Fabrication of auxiliary hardware (install and remove gear)
- Device tests, electronics integration and performance qualification

## FY07

- Transfer to CERN
- Installation support
- Pre-commissioning support

## FY08

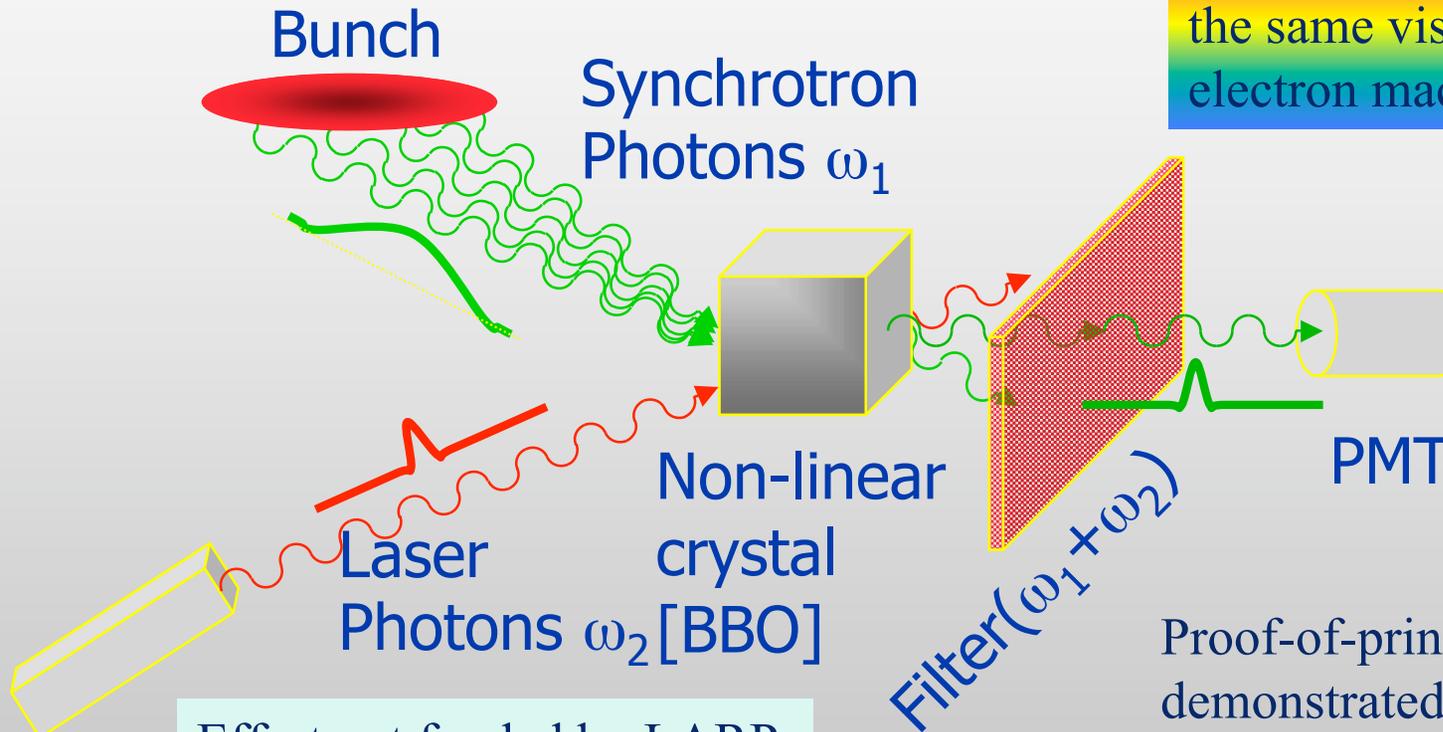
- Commissioning and pre-operations support



# Optical Sampling Technology

- Use mixing of synchrotron radiation with a short laser pulse to sample the longitudinal bunch profile

LHC beams ( $\gamma=7000$ ) emit the same visible light as electron machines



Effort not funded by LARP in FY04. Increase to 140k\$ in FY05

Proof-of-principle demonstrated on the ALS. Developed in collaboration with femtoslicing program.

# Abort Gap Monitor

Goal: detect presence of charge in gap for abort kicker rise time  
LHC Spec

Possible solution: detect synch light with gated MCP/PMT.

Effort not funded by LARP in FY04. Increase to 140k\$ in FY05.

**HAMAMATSU**

GATEABLE MICROCHANNEL PLATE  
PHOTOMULTIPLIER TUBE (MCP-PMTs)  
**R5916U-50 SERIES**

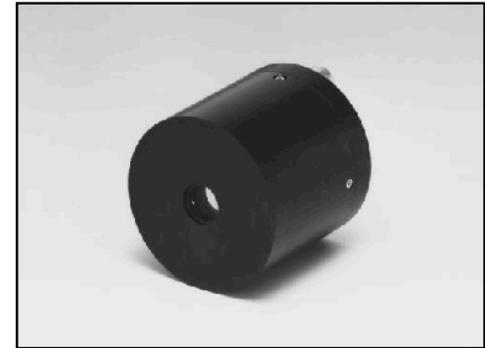
Featuring Fast Gating Function with Improved Time Response  
and Switching Ratio

#### FEATURES

- High Speed Gating by Low Supply Voltage (+10V)
  - Gate Rise Time : 1 ns<sup>1)</sup>
  - Gate Width : 5 ns
- Fast Rise Time : 180 ps
- Narrow TTS<sup>2)</sup> : 90 ps
- High Switching Ratio : 10<sup>9</sup> at 500 nm
- Low Switching Noise
- Low Dark Noise
- Variety of Photocathode Available

#### APPLICATIONS

- Environmental monitoring
- Satellite laser ranging
- Fluorescence decay analysis



Similar approach used in light sources to measure parasite bunches.

# LDM Plans

FY04

No funding!

FY05

Define application to CERN specification and requirements

Systems requirements and conceptual design

Engineering R&D - prototypes

FY 06

Production/procurement

Custom engineering

Integration with CERN DAQ systems

FY07

Transfer to CERN

Installation support

Pre-commissioning support

FY08

Commissioning and pre-operations support



# AGM Plans

FY04

Feasibility study  
Conceptual design

FY05-08

TBD

Nearly impossible to predict until a feasibility and conceptual design is complete



# Budget Summary

Cost guidelines from FY04 task sheets

Device/FY	04	05	06
In FY04 \$1,000s			
LUMI	203	450	950
LDM	0	198	697
AGM	80	TBD	

\* LDM+AGM request was 500 and 1000 combined



# Summary

## Tune Tracking/Feedback/PLL

- demonstrated at RHIC
- significant hardware progress
- effort beginning at FNAL

## Luminosity monitor

- prototype designed, built, and fully tested (almost!) to meet LHC specs
- 25 nsec test in progress; come on down!
- ready to begin of engineering prototype

## Longitudinal Density Monitor(ing)

- laser mixing technique demonstrated
  - effort required soon to determine feasibility in LHC
- Abort Gap Monitor
  - white paper study in progress
  - gated MCP/PMT appears promising



# Status

- Made lots of progress so far today
- Much work is still needed to define the multi-year scope of each activity
- Need to continue addressing all major points
- Today we are defining the process to get there
- We can also define the internal process of collaboration
- Planning detailed activities is the first step



# Process

We need to:

- Define SCOPE for each activity
- Integrate CERN and define the interface points
- Plan upcoming work
  - Meetings, deliverables, interaction points, check points
  - Prioritization of tasks (in conjunction with CERN)
- We will then have a budget

