# Tevatron Ionization Profile Monitors

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Also thanks to:

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# Challenges in the Tevatron

**Solutions:**

- Two small beams separated by helix.

- Separate protons from pbars, injected from circulating beam

- Beam induced parasitic signals.

- Low vacuum pressure

- Fine pitch and many channels

- Single bunch resolution and gating

- Improved shielding and matched cables

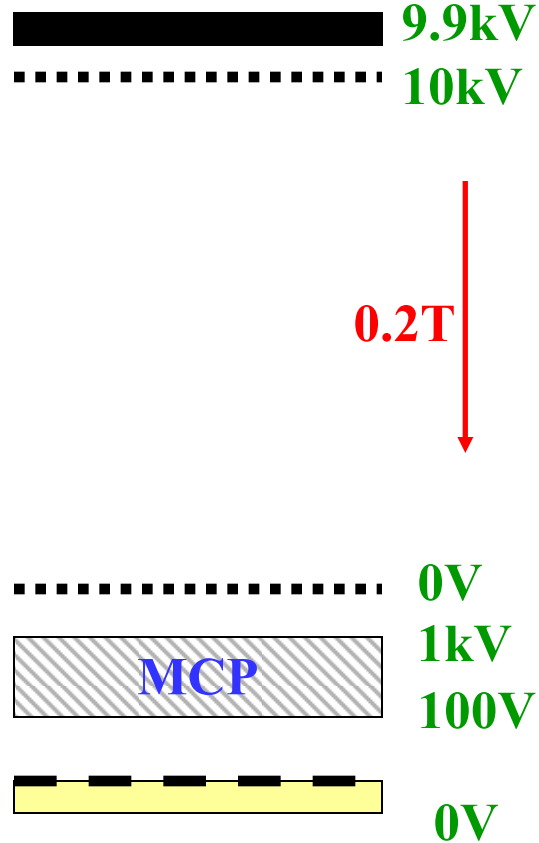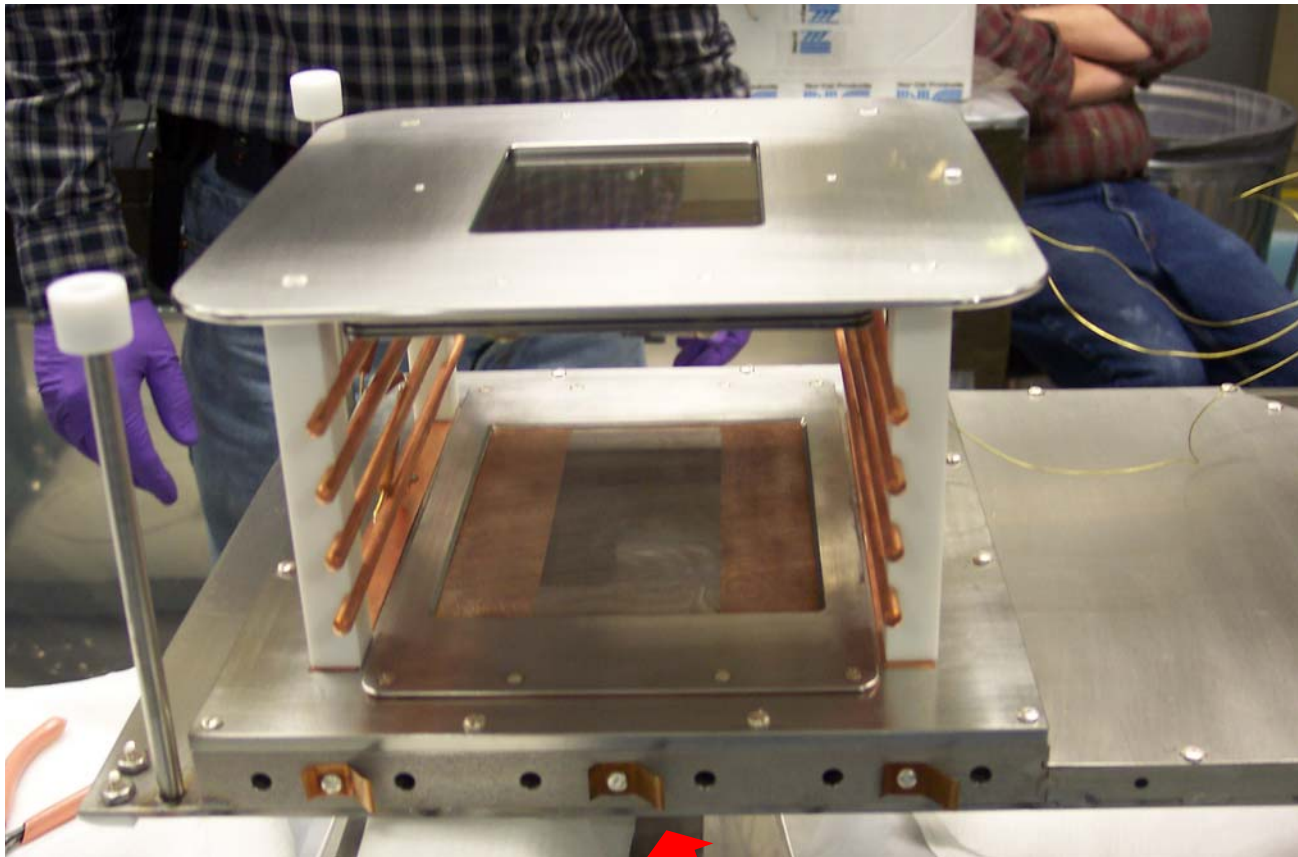- Local pressure bump with controlled leak

**Magnets, stands, vacuum chambers, pumps, cables, plumbing put in place during shutdown autumn 2004**
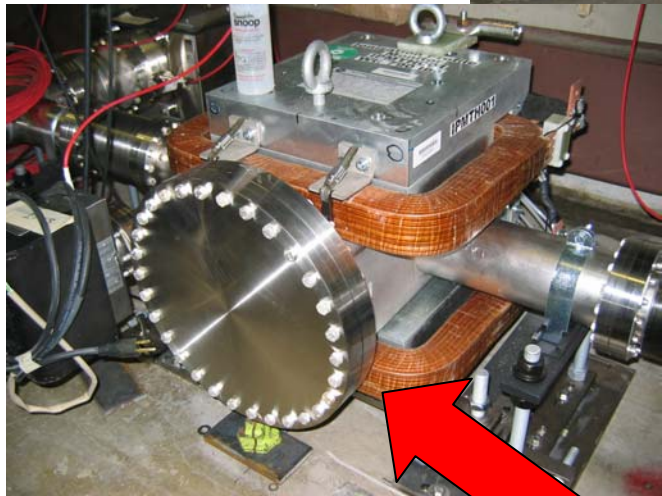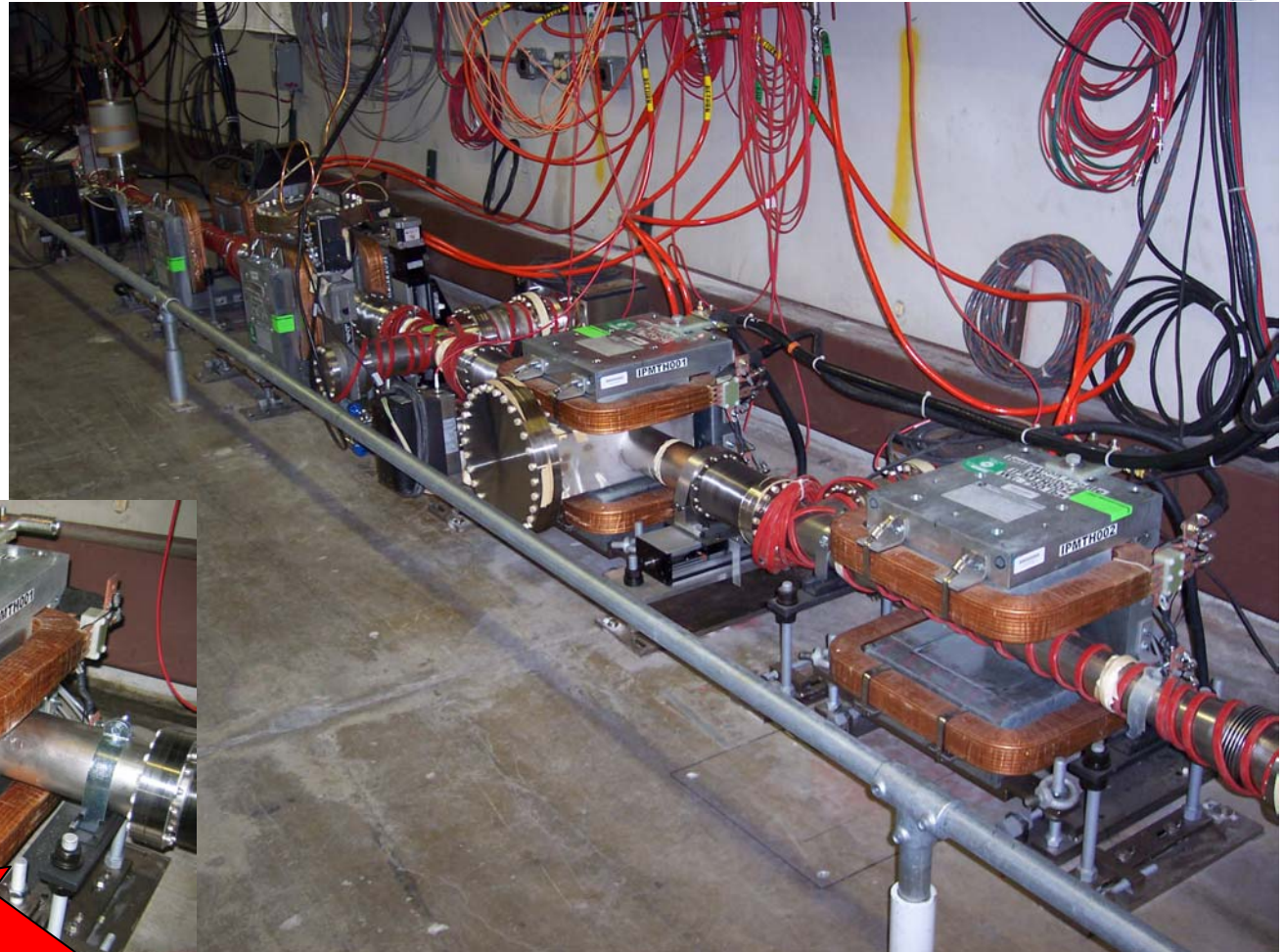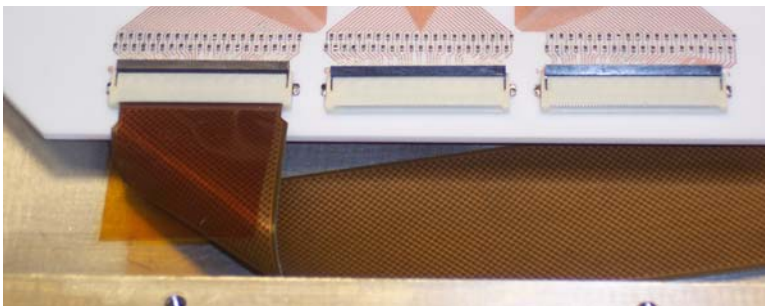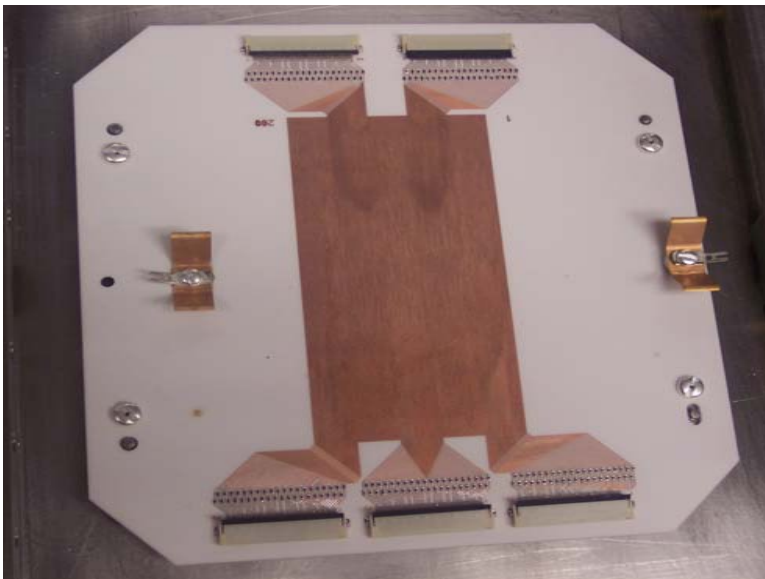


**Detector goes here!**

9.9kV
10kV

0.2T

0V
1kV
**MCP**
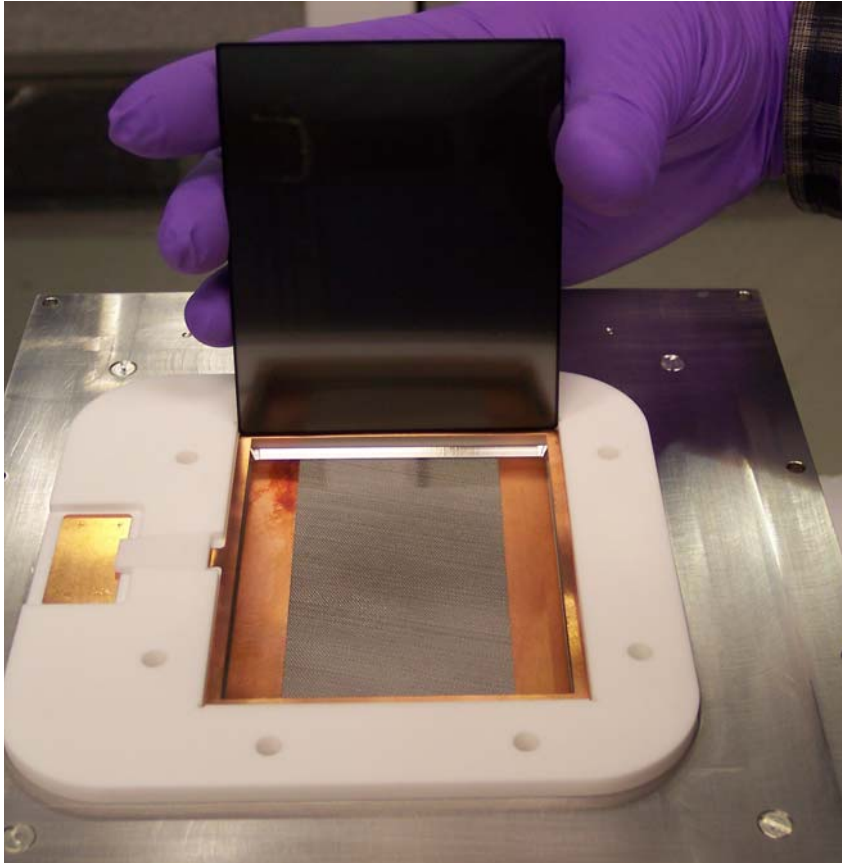100V

0V

**All signal cables are enclosed in a Faraday cage!**

# Anode board





- ¼ mm strip pitch
- 200 channels (128 instrumented)
- On-board LP filter/ back-termination (series resistor)
- In-vacuum signal using cabling UHV-compatible flex-circuits
- High resolution area can be moved by swapping connectors

# Microchannel plate

- With 36 proton bunches, useful gain is limited by saturation to ~1e4, which can be achieved with single plate
- With dual plates, each plate would run at a very low gain (and low bias/recharge current).
- Use single, extra-high bias current MCP.
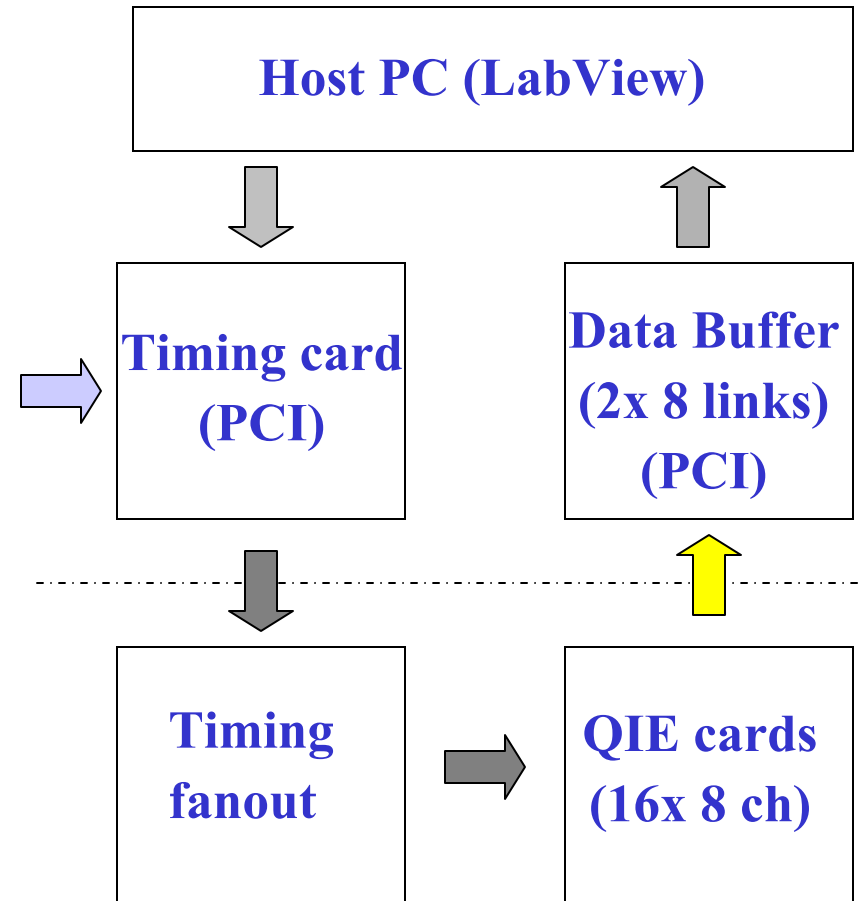
# Detector installation

**Mounted on vacuum flange for easy installation.**
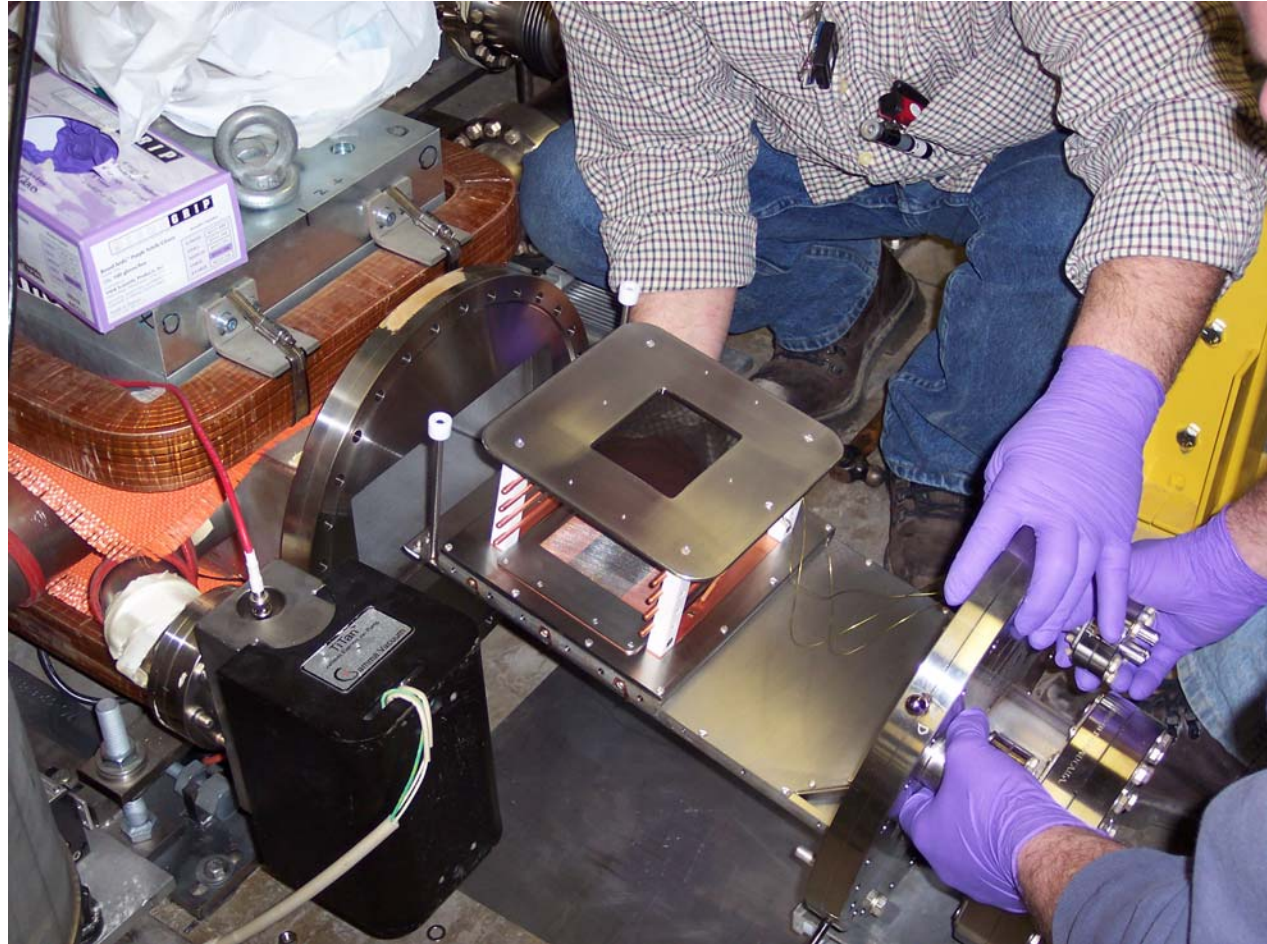
# DAQ system

- CMS-QIE front-end in tunnel.
- Serial data uplink on optical fiber
- Receiver and data buffer in upstairs PC
- Timing + clock + QIE settings supplied from PC thru cat-5E cable

**Host PC (LabView)**

**Timing card (PCI)**

**Data Buffer (2x 8 links) (PCI)**

**Timing fanout**

**QIE cards (16x 8 ch)**

# Timing card

- Produces the 15MHz (2/7 RF) FE clock
- Decodes and transmits beamsync (p & pbar) injection events
- Transmits QIE settings
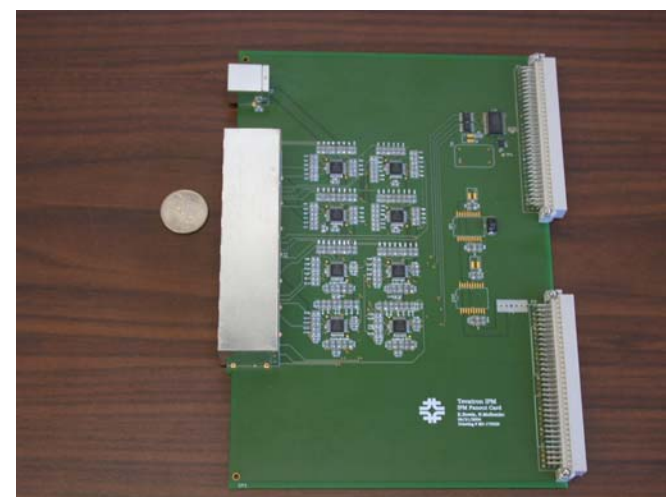- Separate version of card decode TCLK/MDAT



396 ns (21 buckets)

p-pbar separation
~120ns

RF

2/7
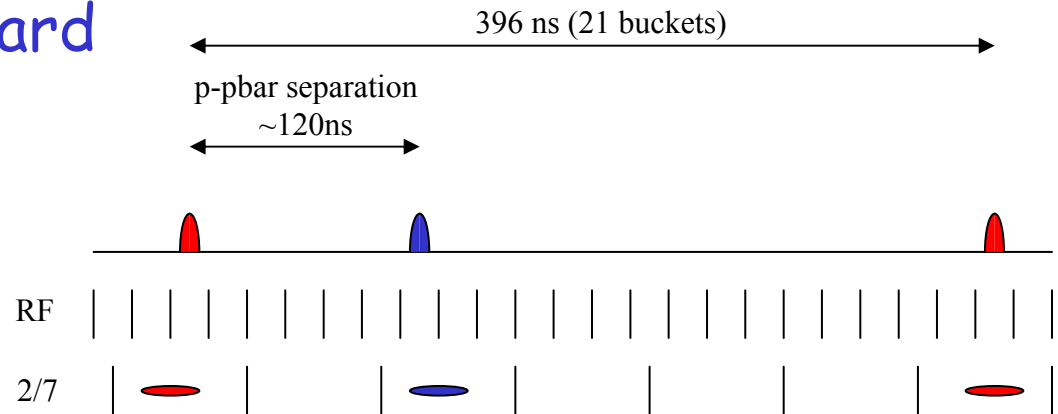
# Front end card

- 8 channels (CMS QIE) per board.
- Noise ~1.8fC w 4' cable.
- Data is combined with timing information, serialized by CERN GOL ASIC (rad hard) and sent thru optical fiber at 1.1Gbps data rate

- Timing fanout board cleans up and distributes clock and timing signals



**QIE card**



**timing fanout**

# Data buffer card

- Handles 8 incoming optical links (64 channels, 1.1 GB/s of data)
- Data can be sparsified on–the-fly based on timing masks
- 512MB RAM allows for
  - 20.000 turns of continuous data
  - 90.000 turns for 72 bunches
  - <u>6 million turns</u> for a single bunch
- Read out thru 64 bit PCI bus
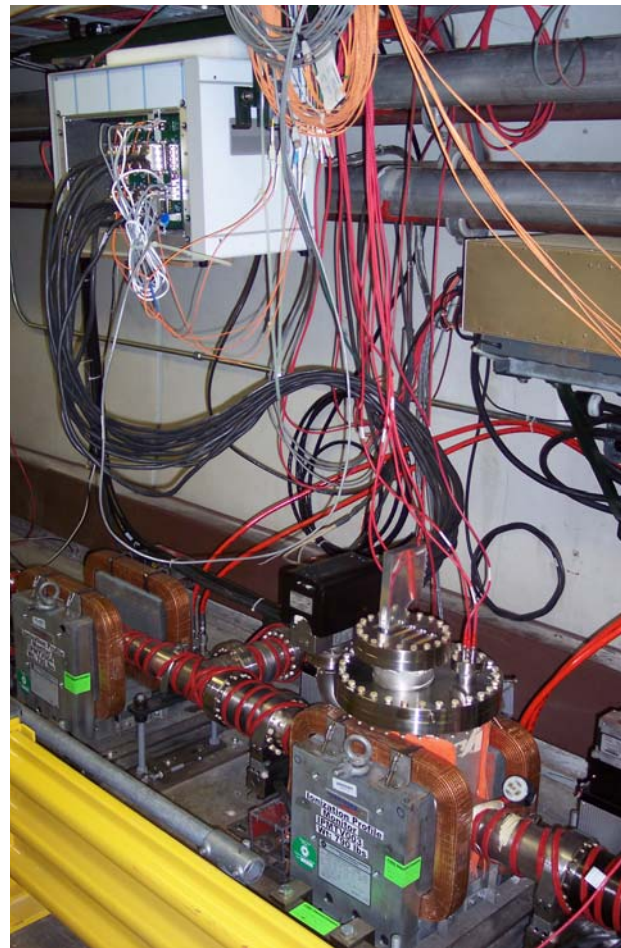- Two boards are used in a master-slave configuration, synchronized via a jumper cable



- IPM buffer board doubled as prototype for BTeV L1 data buffer.

# Setup for initial tests

- 2005 shutdown moved to 2006

- Took advantage of magnet failure to install the vertical detector.

- Test DAQ system with 40 channels, 1cm active width, single buffer board
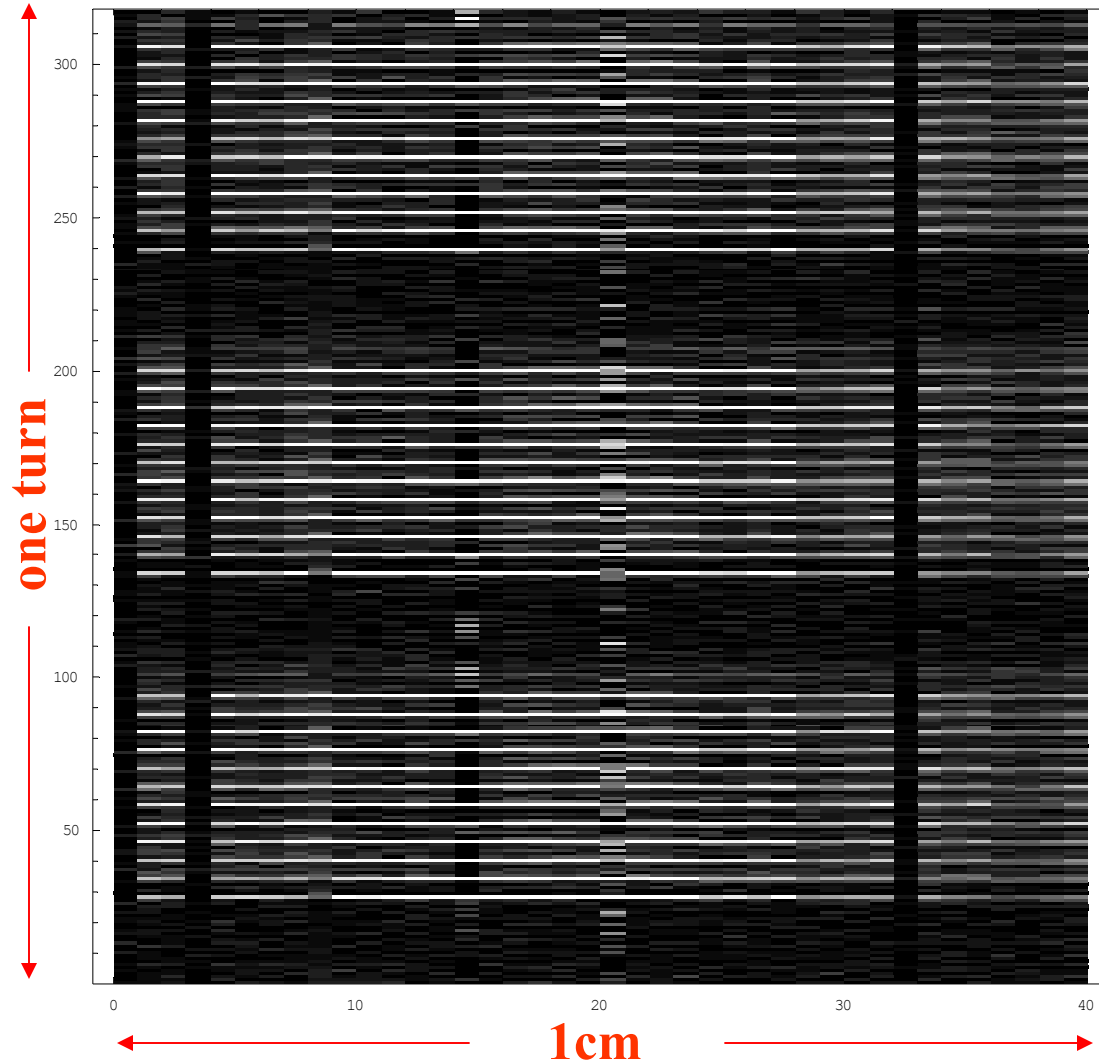


**E0 straight section**

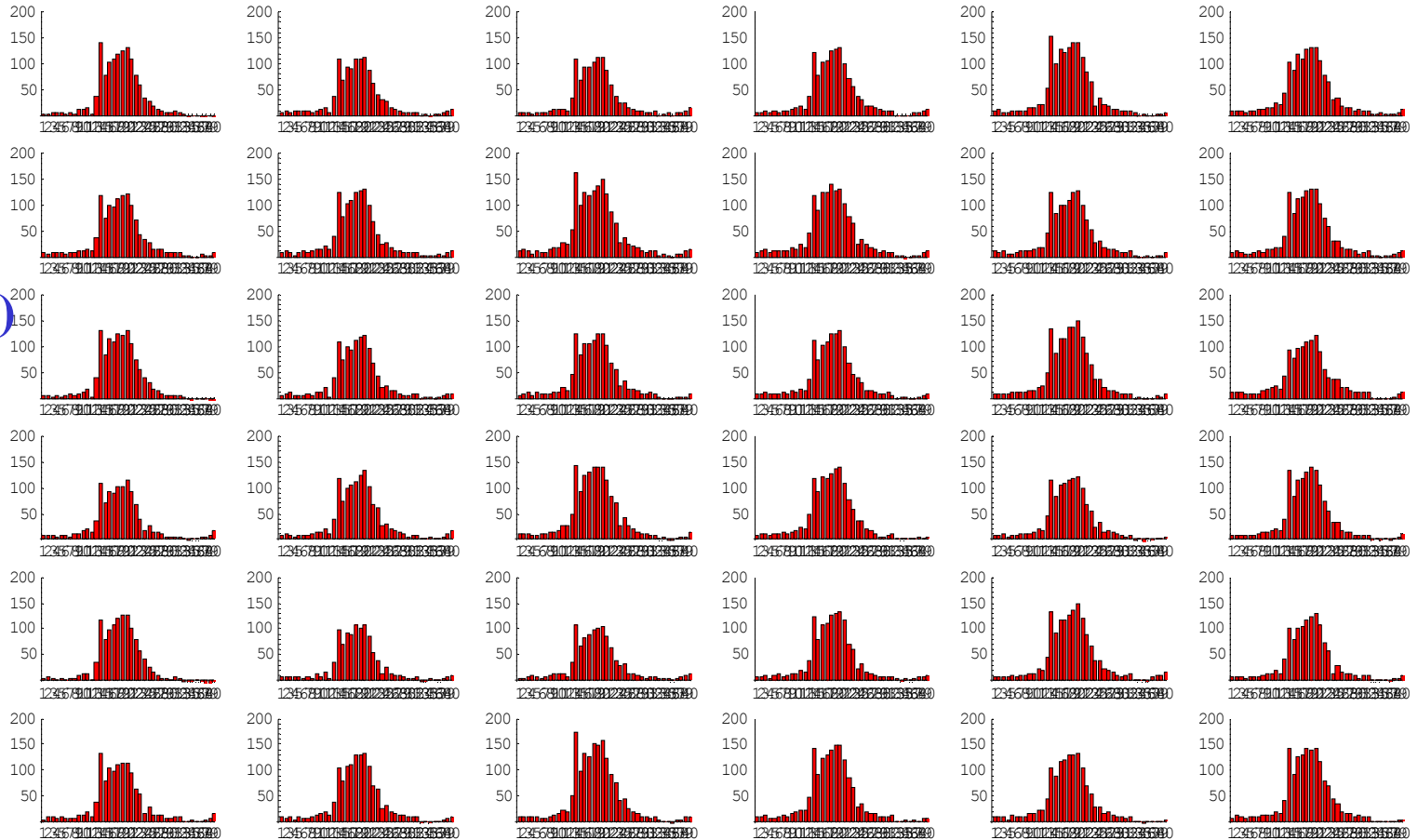**E0 service building**

# Very first beam results

- Once the beam was located, signals appeared...

- Data taken at 980GeV during store 4634 without magnetic field.

# Protons during store

**Store #4641**

**Magnet at 50A (nominal 200A)**

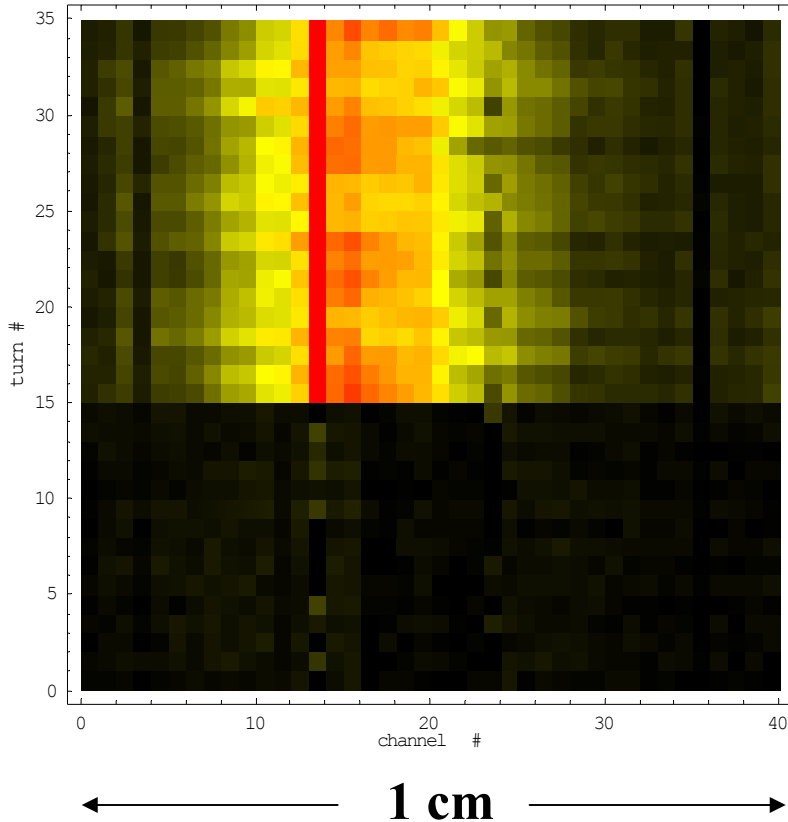**Single turn profiles for 36 proton bunches!**

**Measured profile widths at 980: 0.7-0.9 mm**

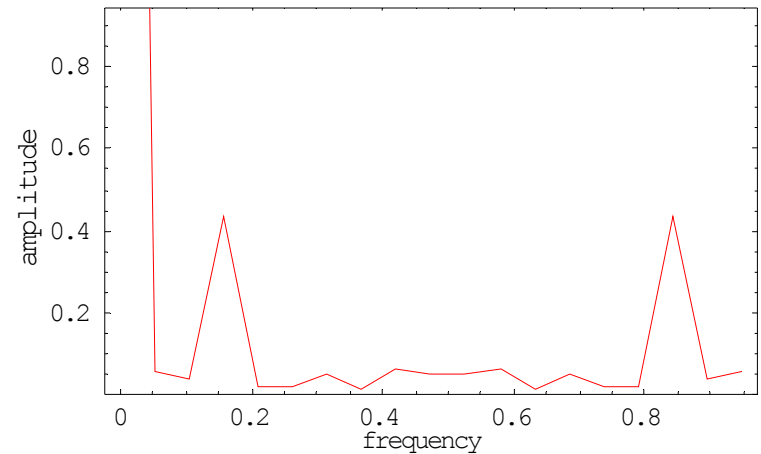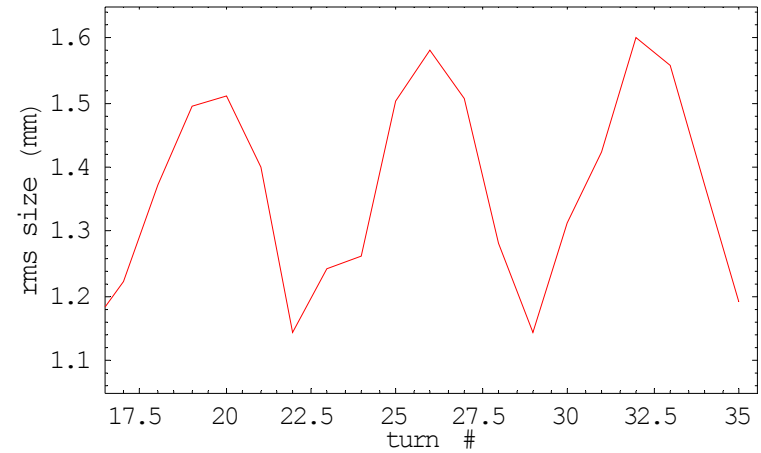**consistent with flying wires taking into account the lower B-field**

# Protons at injection

## Bunch 36 turn-by-turn

## RMS profile width



**1 cm**

**Store #4642    Magnet at 50A**

# Summary and conclusions

- The Tevatron IPMs can measure single bunches turn-by-turn both at injection and top energy.

- Electronics is largely borrowed or adapted from Particle Physics experiments

- Both systems will be (re)installed during the 2006 shutdown, with full readout electronics. More detailed studies to follow

- Some remaining parasitic signals to eliminate.

- Still need to try to measure pbars