MIPP Upgrade hardware needs and status

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MIPP upgrade goals and tasks

- Increase detector readout rate to 3kHz and keep electronics maintainable
  - TPC readout electronics
  - Almost all the other detector readouts
- Get better JGG field uniformity
  - New JGG coils
- Get backward hemisphere instrumented
  - Add half of the Plastic Ball detector from KVI/GSI
- Improve interaction triggering
  - Add BTeV/PHENIX style FPIX planes
- Miscellaneous repairs and improvements
  - Gas systems, TPC rewind, Beam Veto-wall, CKOV radiator (gas volume) length, ...

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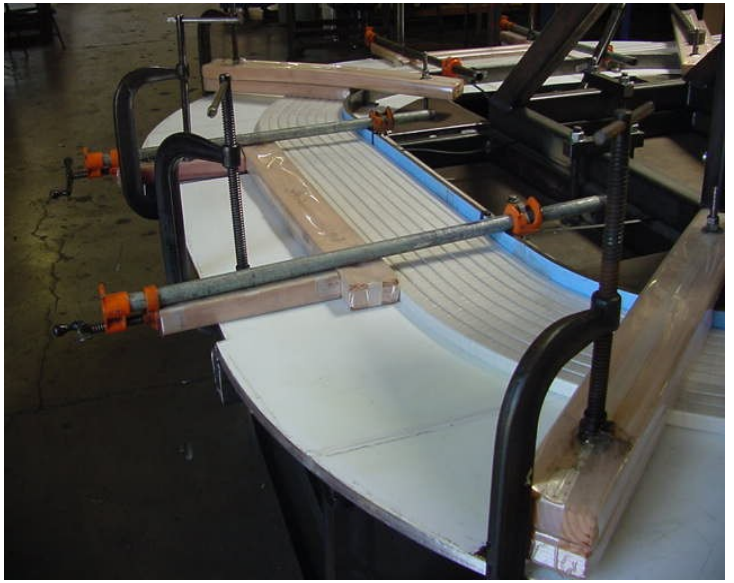
Full list of tasks with cost/labor estimates in MIPP Upgrade WBS, MIPP-Doc-164 (MS-project) and MIPP-Doc-139 (pdf)
(Does not show what has been done already.)

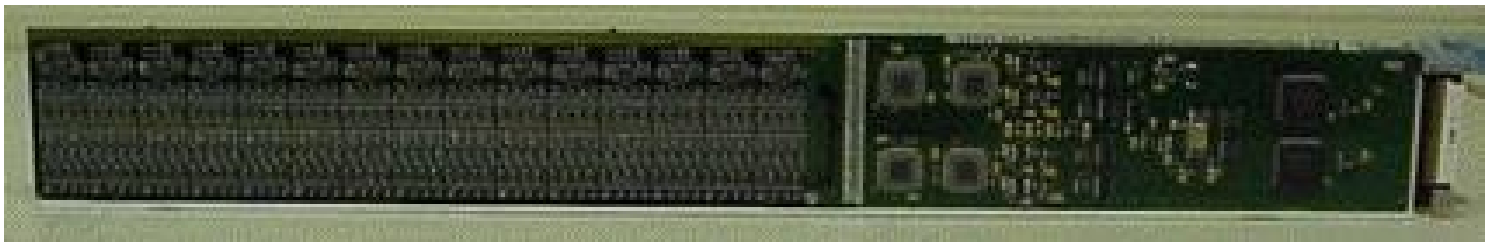
JGG coils



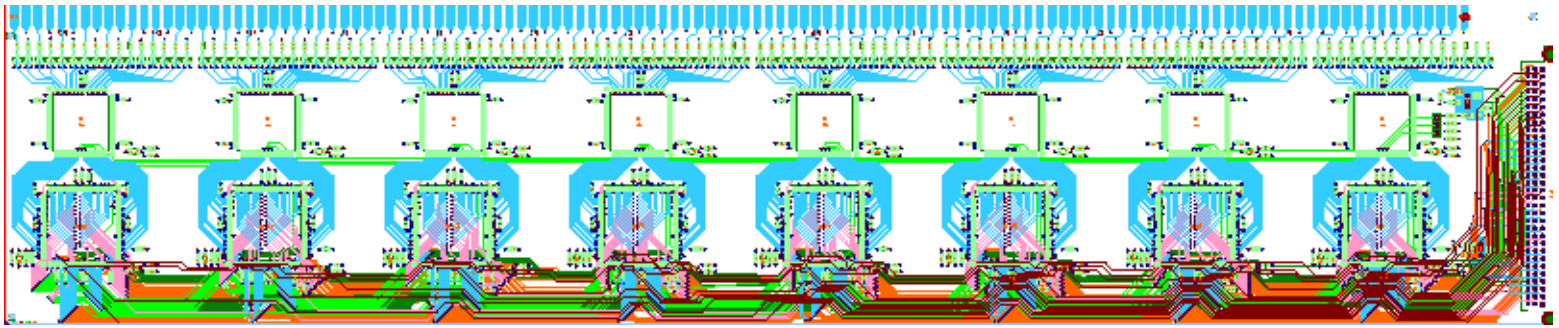
- New coils have been delivered to Fermilab
  - Better B-field uniformity over the range of the TPC
- ~13 man-weeks left to install and connect power and LCW (~1 calendar month)
- Ziptrack the new magnetic field
  - Ziptrack refurbishing/upgrade is essentially complete This upgrade was driven by MIPP. Ziptrack is now more precise and easier to use.
    - Position along beam is read from tape encoder rather than string
    - New Hall probes
    - OS changed from DOS to Labview
    - Also to be used by MICE
- Important to complete:
  - Coils have been tested upon arrival to Fermilab, are ok.
  - We will not really know if they work until we get JGG up to high current/magnetic field.
  - Also: Ziptrack needs empty space around the JGG, so detectors around JGG can't be installed until Ziptrack is done

TPC readout electronics

- Old MIPP TPC “stick” – 120 of these



- New MIPP TPC “sticks” with daughter cards



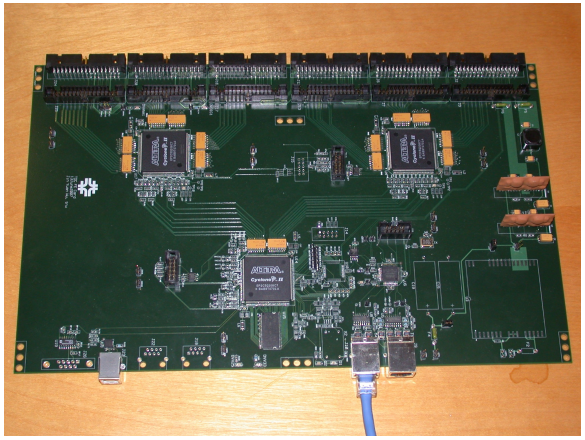
  - Prototypes fabricated
  - Altro/PASA chips at Fermilab, only $100k because order was combined with STAR at BNL.
  - Effort to completion: ~$100k + 1 EE & 1 Tech for 6 months (MIPP-Doc-834, M. Larwill, Nov.2008)

Common readout backend

- Common to all MIPP detector readouts
- Fully designed, successful communication tests between prototype boards
  - Specification Document: MIPP-Doc-764
  - Very similar to COUPP muon veto readout – the project Sten spent much of this year on. “We can synchronize the front end time stamps, phase lock the clocks, and control and read out buffered data from the front ends.”
- Few CAT5 cables, simple installation in MC7

Wire chamber readouts

- Use 96 channel TDC cards
  (Jin-Yuan Wu, implemented in FPGA)
- Preamp daughter cards for MIPP Drift Chambers and MWPCs
  (Sten Hansen, prototype stage)
- Total of ~10^4 channels

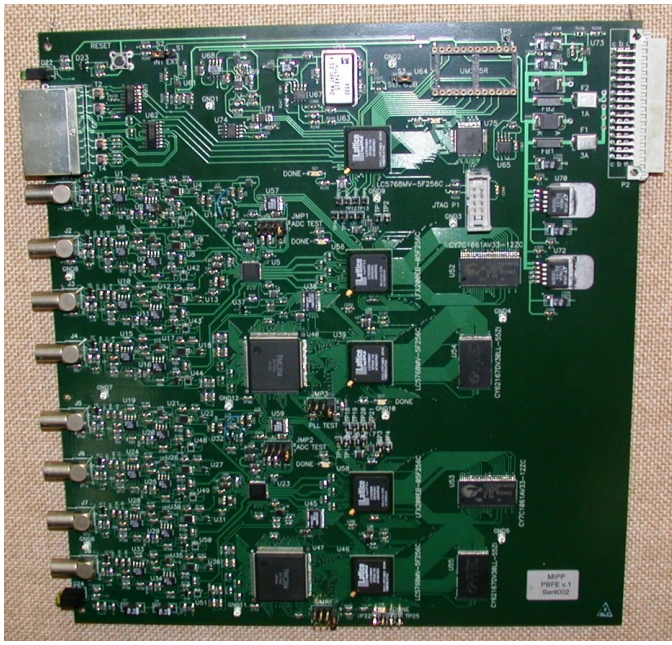


Ckov and TOF readouts

- Similar to wire chambers
  - No preamps, add ADCs, higher resolution TDCs for TOF
  - Designs, no prototypes
  - only ~100 channels for each

Plastic Ball readout

- Plastic Ball electronics: (B. Baldin)
  - Two 8-channel PBFE prototype boards are assembled and tested
  - The software for data readout and unpacking is developed
  - Test pulse data has been collected and histogrammed
  - Awaiting for a test with Plastic Ball detectors with cosmics



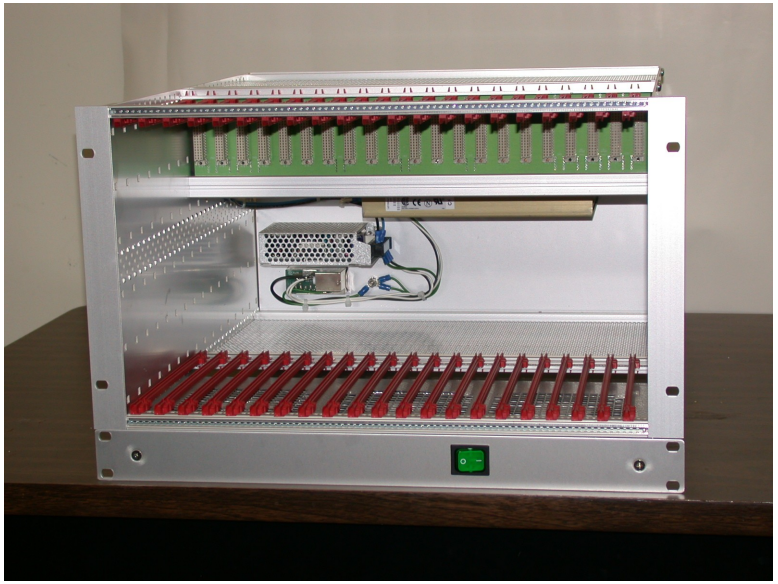
  - Plastic Ball detector elements were shipped to FNAL to test electronics on real detector.
  - “MIPP Plastic Ball Electronics Upgrade”, 5th International Conference on New Developments in Photodetection 2008 in Aix-les-Bains, France, June 15-20, 2008, 10.1016/j.nima.2009.05.096.

Calorimeter readout

- EMCal electronics:
  - Five 8-channel Wire Amplifier boards are assembled and tested
  - The board fits existing space on the EMCal PWC
  - Awaiting results from the test with the PWC (Durga)

  - The 32-channel ECFE board design is fully developed including the firmware
  - The reqs for three PCB and corresponding parts submitted to the PPD office, but are held until October 1st

- PBFE and ECFE Europack crate:
  - A common VME-like crate design developed
  - One crate is assembled and tested



Benefits of electronics upgrades

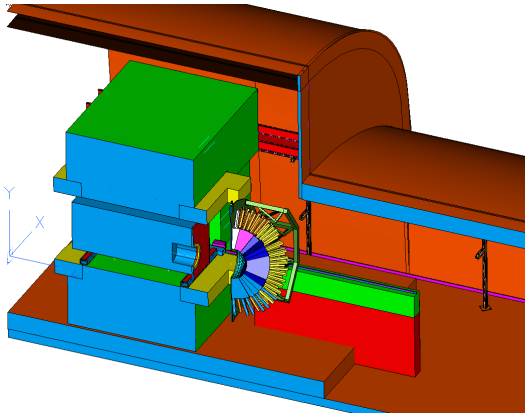
- Few CAT5 cables, simple installation in MC7
  - Much simpler than the old systems with long delay cables
- Less power dissipation by new electronics
  - Better temperature stability in the hall will likely result in better alignment for the chambers
  - A/C units were run at limit of their capacity
- No cross talk or temperature drifts in TOF readout
- Overall system reliability
  - No more old RMH electronics without spares, …
- Buffered readout allows for more flexible trigger

Miscellaneous upgrades

- **Beam Veto wall**:
  - Designed, assembled, in storage at FNAL, ready for installation (ACU)
- **Cryo-target** upgrades: (WBS Task 3.2 M&S $68K Labor$ 76K)
  - Increase diameter of transfer pipe to cut interactions due to beam tails.
  - Spare cryo-cooler
  - Operate with Liquid N2 flask.
- **Gas system and slow control upgrades** to improve reliability and simplify operations: (WBS task 3.1 M&S $40.5K, Labor $29.9K)
  - Methylal refrigerator filling to be automated
  - Automate RICH vessel topping up with CO2
  - Upgrade P10 gas system-to be supplied semi trailer rather than bottles.
  - Upgrade Beam CKOV vacuum instrumentation (failure detection)
  - More temperature probes in hall.
  - CKOV pressure sensors to be replaced
  - Additional slow control infra-structure – APACS system
- **RICH and CKOV phototubes:**
  - 7 CKOV PMT's need replacement (total 96) (WBS task 3.5 M&S $10K)
  - 912 PMT's in RICH were lost due to fire. RICH works without them. But upgrading it by more PMT's will help with efficiency near threshold. (WBS task 3.6 FNAL M&S $0K In kind $150K)
- **Beamline:** (WBS task 8 M&S $100K)
  - Power supplies and Hall probes to run at low momentum

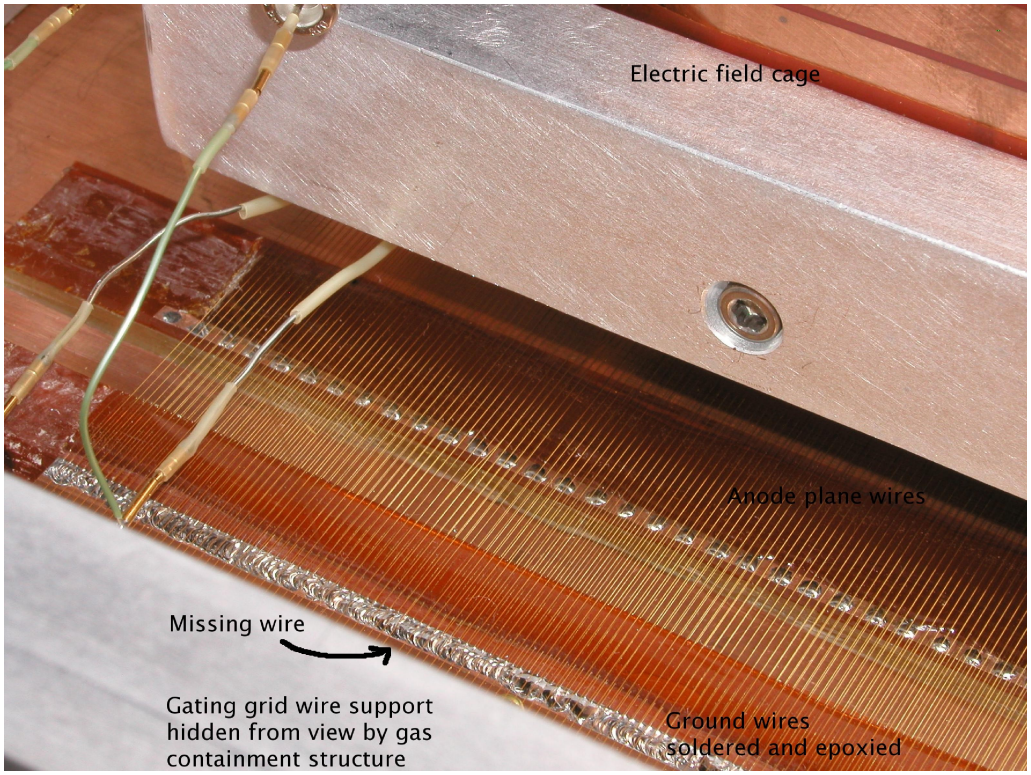
Open issues and needs for the MIPP upgrade

- No open issues from a technical point of view
  - At least conceptual designs exist for all tasks and many tasks are ~50% done
- Least developed (in my mind):
  - Mechanical support upstream of JGG
    - Plastic Ball, Si-trigger, cryo-/wheel-/NuMI target, access
  - Details of how to rewind the TPC
    - Frame holding wires, use of winding machine in lab6,...
  - Interaction trigger Si-plane readout
    - Used in other places, just needs manpower to integrate with MIPP.



TPC rewind

- ...because
  - Some missing wires
  - two anode sections do not hold full HV.



- This should be started soon so that it does not become a critical path item.
- Need to test in beam in MC7 to confirm operation with correct gas
  - Can be done with old TPC readout electronics
  - Want to see tracks to verify success

Summary and Conclusion

- A detailed WBS for the MIPP upgrade project exists.
- The various electronics and other upgrades need engineering and technician support and M&S
  - Precise estimates are difficult when the project timeline is uncertain
    E.g.: Are FPIX planes available from previous production runs? They get used by other projects over time.
    On the other hand: Maybe we can benefit from efforts on other projects.
  - Total cost for MIPP upgrade is $2 million. Approximately $0.5 million has been spent, $1.5 million remains.
- The highest priority items are:
  - Finish JGG coil installation: $60k
  - Rewind the TPC: $40k
  - Beam line upgrades: $100k