



MIPP TPC Hardware Overview

TPC Web:

<http://ppd.fnal.gov/experiments/e907/TPC/>

MIPP TPC Reconstruction Workshop

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TPC Hardware Components



- **TPC Mechanical**
- **Front-End Sticks**
- **DC Power Supply System and Interlock**
- **Clock and Trigger Distribution**
- **Gating Grid**
- **Gates and Trigger**
- **Gas System**
- **Environmental Monitoring**
- **High Voltage**
- **Data Links**

Conventions:

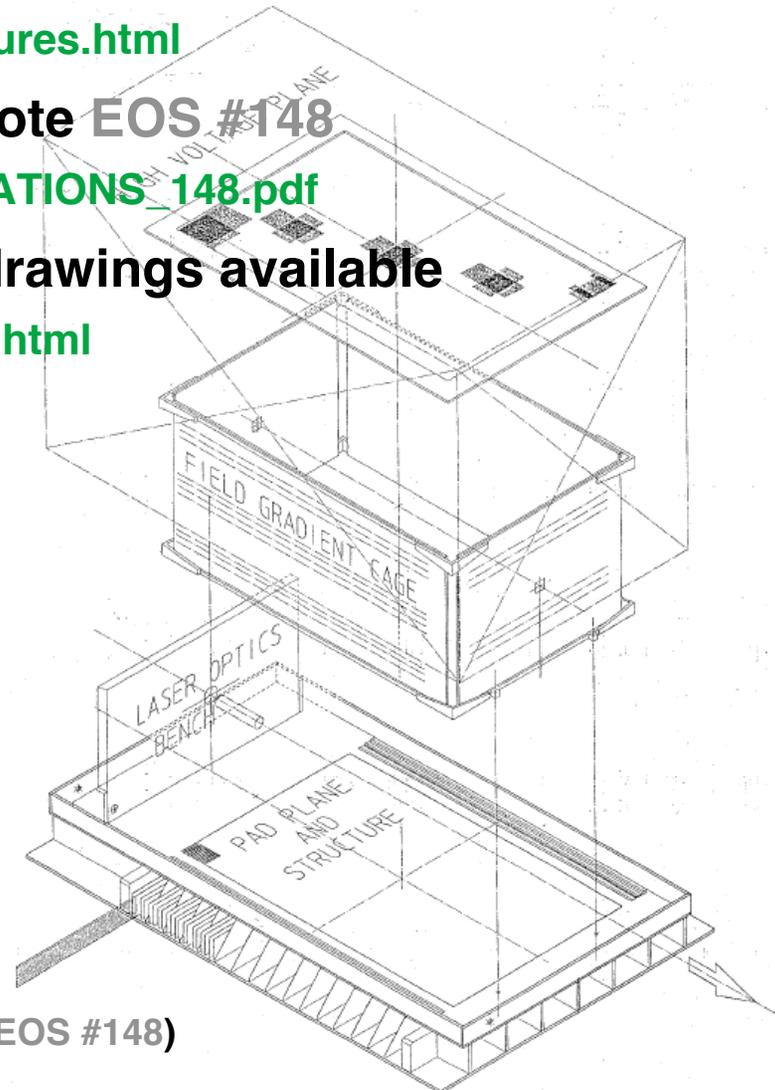
- **Dimensions in inches, C numbering (0 base counting)**

TPC Mechanical



- Fair number of pictures in various states of disassembly
 - [TPC_In_Pictures_Note/TPC_In_Pictures.html](#)
- Nice set of illustrations in EOS Note EOS #148
 - [LBL_Drawings/EOS_TPC_ILLUSTRATIONS_148.pdf](#)
- Fairly limited set of mechanical drawings available
 - [LBL_Drawings/TPC_LBL_Drawings.html](#)
- Focus here on geometry
 - Drift volume
 - Pad geometry
 - Beam location
 - Survey
- And wire planes
 - Gating grid
 - Anodes

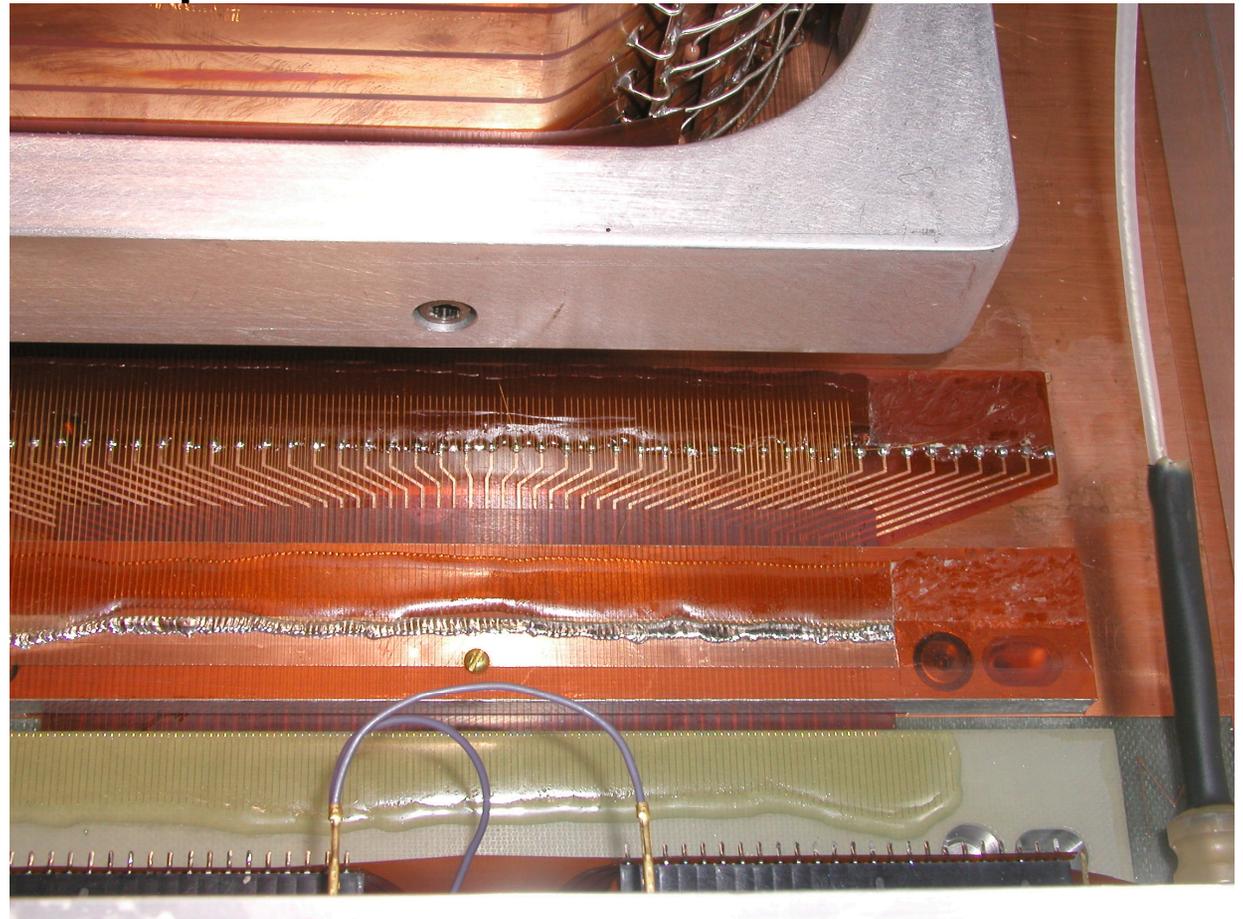
Drawing Reference → (EOS #148)



TPC Mechanical Drift Volume



- Foamcore panels with Copper on Kapton strips, both sides
- 78 strips, 0.401" pitch (22N7166)
- Inner and Outer FC have separate dividers
- 124 M Ω total

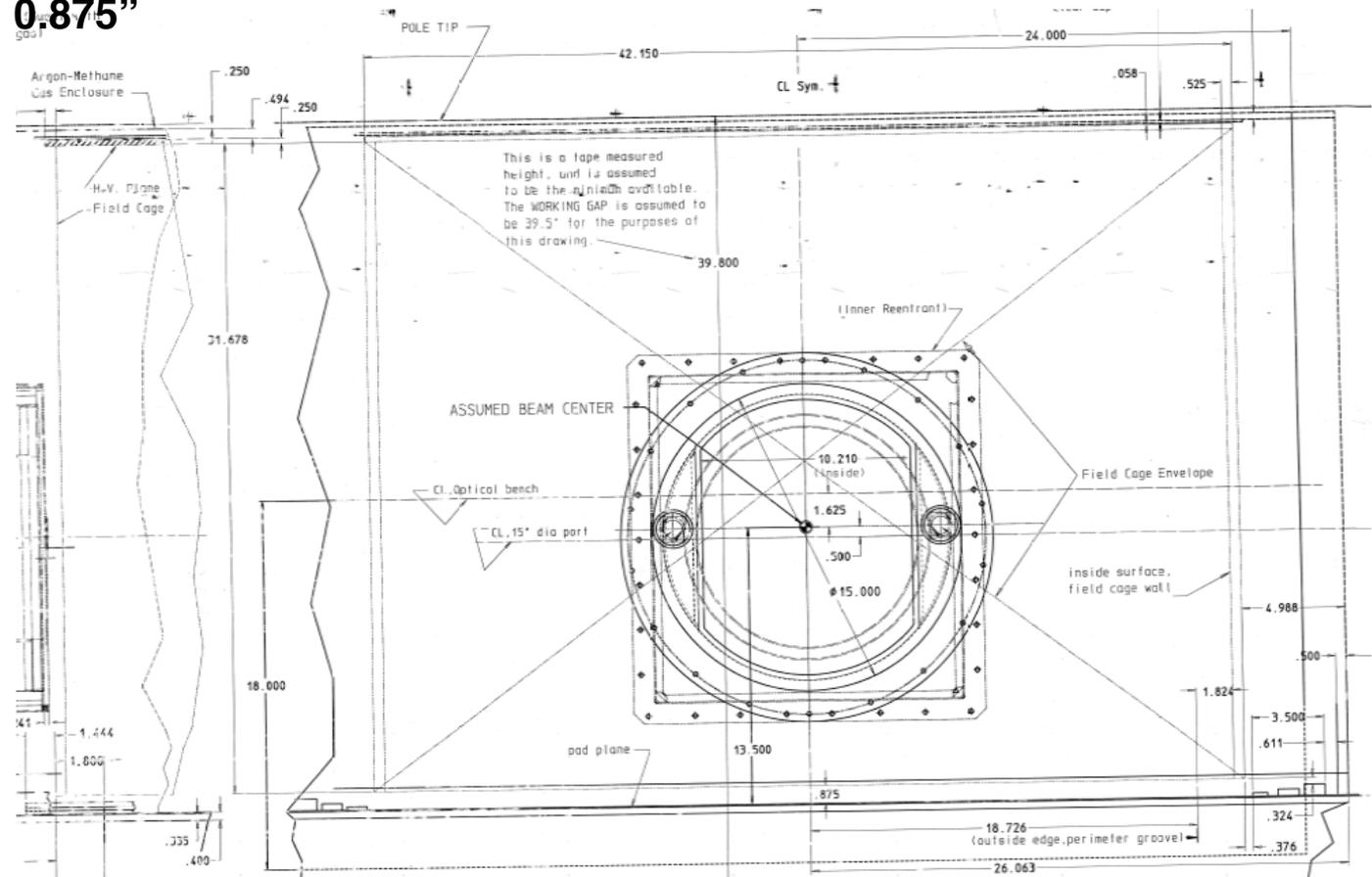


TPC Mechanical Drift Volume



- **Vertical Dimensions**

- **FC-Cath** **31.678"**
- **GG-FC** **0.324"**
- **PP-GG** **0.875"**



(22N6686)

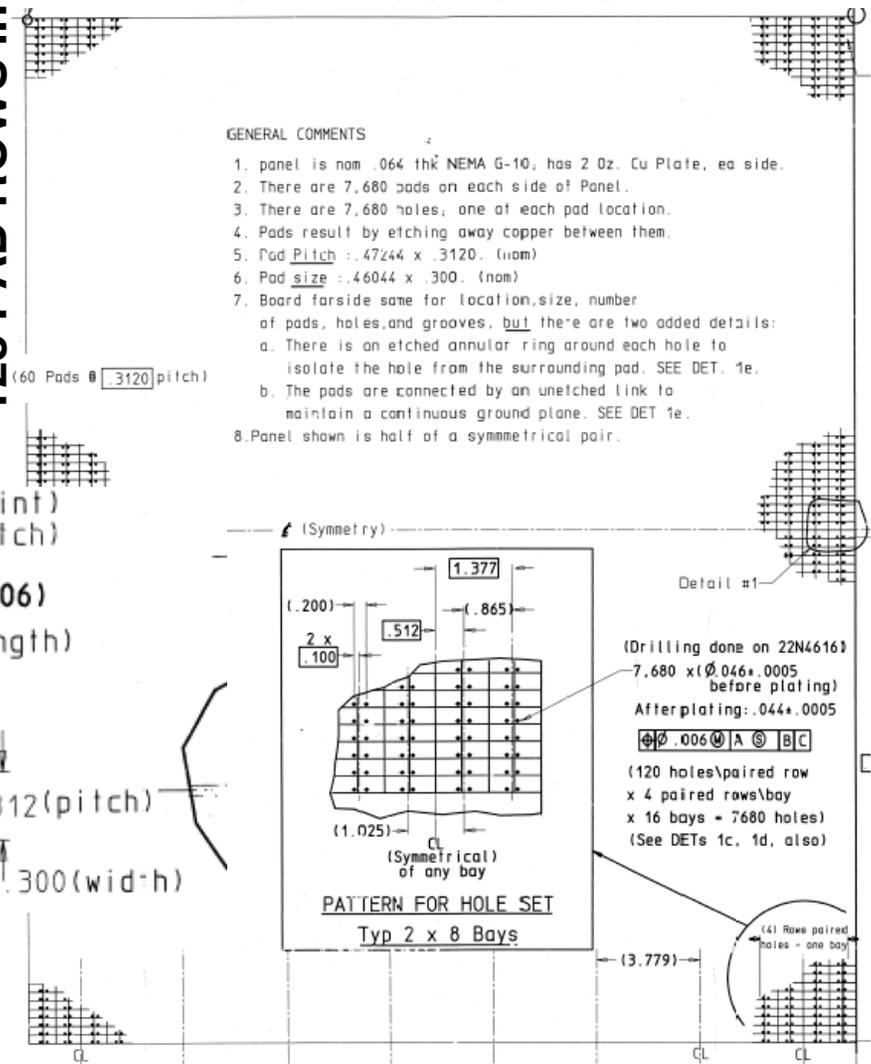
TPC Mechanical Pad Geometry



Pads are 0.300 in Z, 0.460 in X
Pitch is 0.312 in Z, 0.472 in X

128 PAD ROWS in Z

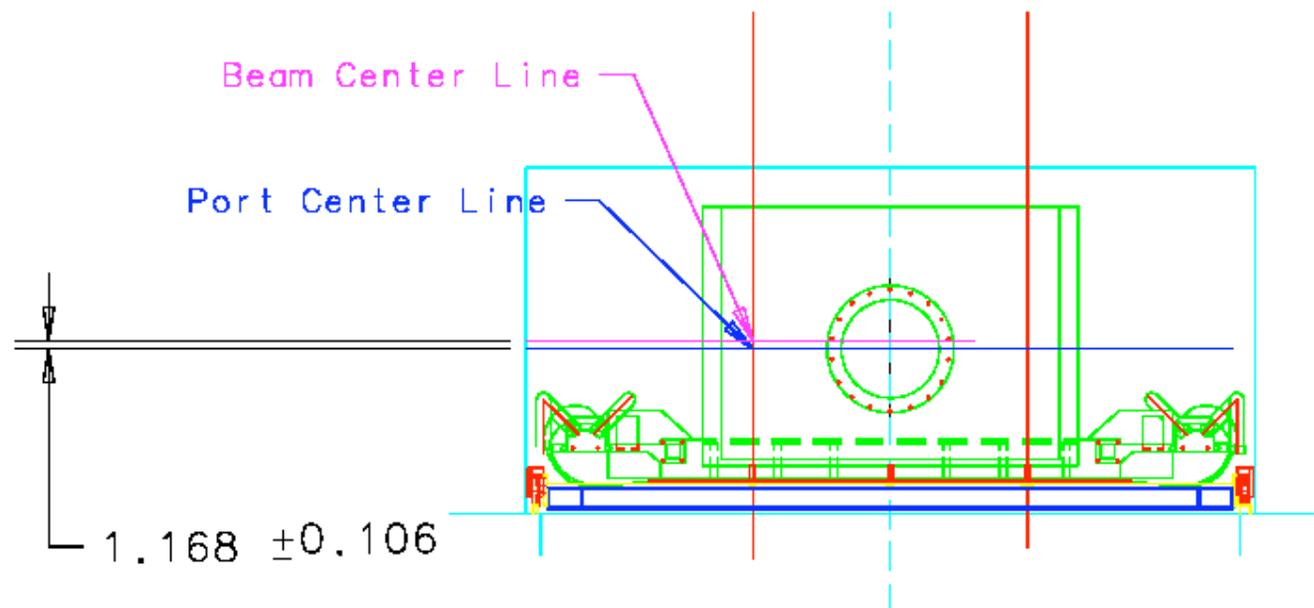
120 PAD COLUMNS in X



TPC Mechanical Beam Location



- Design beam elevation is 1.168" above port CL
- Port is 13.000" above PP
- ⇒ Design beam elevation is 14.168" above PP
- This is not the vertical center of the drift volume! (16.714")



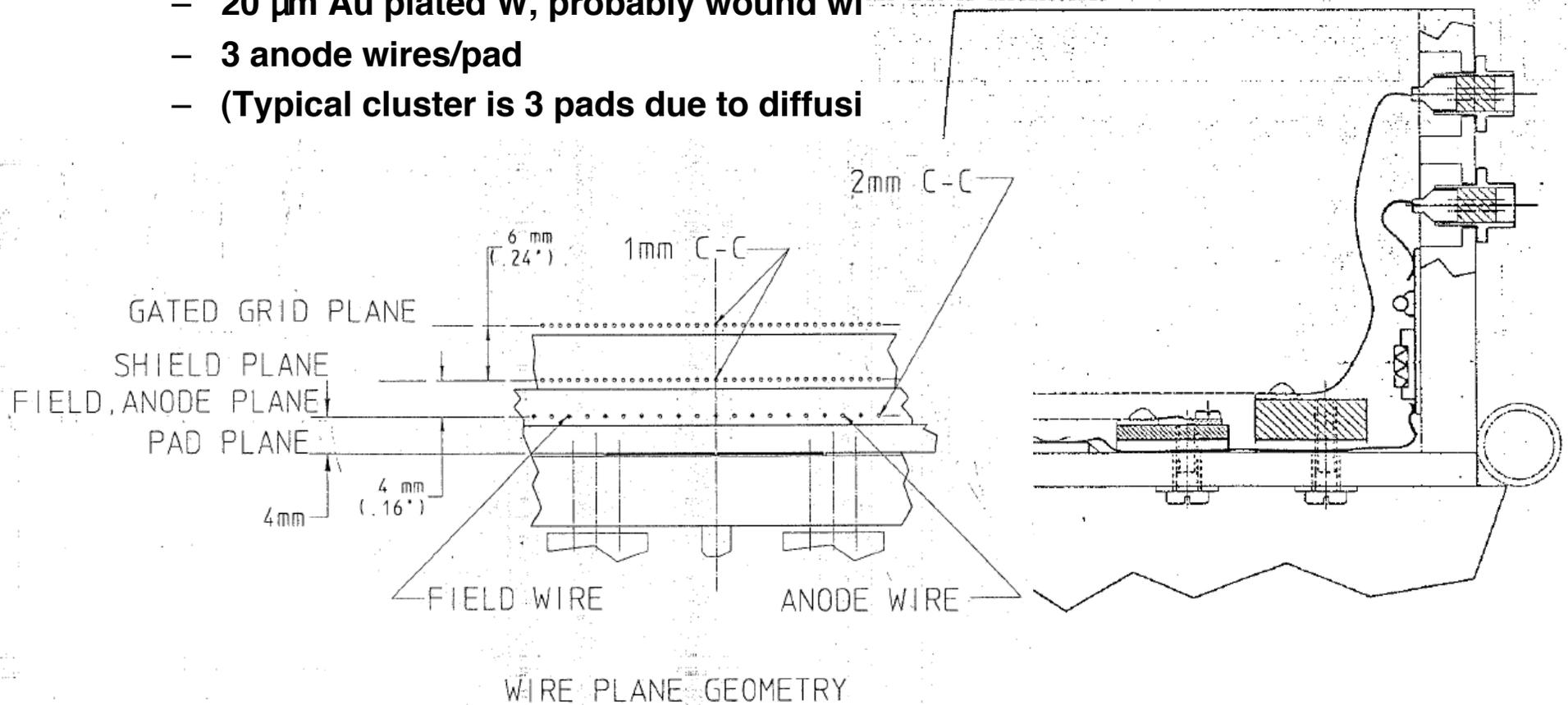


- **TPC survey coordinate system origin is**
 - **Z** center of pad plane, between PADROWS 63 and 64
 - **X** center of pad plane, between PADCOLs 59 and 60
 - **Y** center of port in optical table
- **Coordinate axes are**
 - **+Z** downstream
 - **+X** beam left
 - **+Y** up
- **Measured offsets of TPC origin from nominal upstream target face:**
 - **dZ** 33.626" (target face to center of TPC)
 - **dX** -0.013" (TPC left of beam)
 - **dY** -1.165" (TPC port CL below beam, as expected)
- **JGG offsets, for reference:**
 - **dZ** 33.624"
 - **dX** -0.047"
 - **dY** -0.281"

TPC Mechanical Wire Planes



- **Gating Grid, Ground, and Field Wires**
 - 75 μm Au plated BeCu, probably wound with 120 g tension
- **Anode sense wires**
 - 20 μm Au plated W, probably wound with 50 g tension
 - 3 anode wires/pad
 - (Typical cluster is 3 pads due to diffusion)

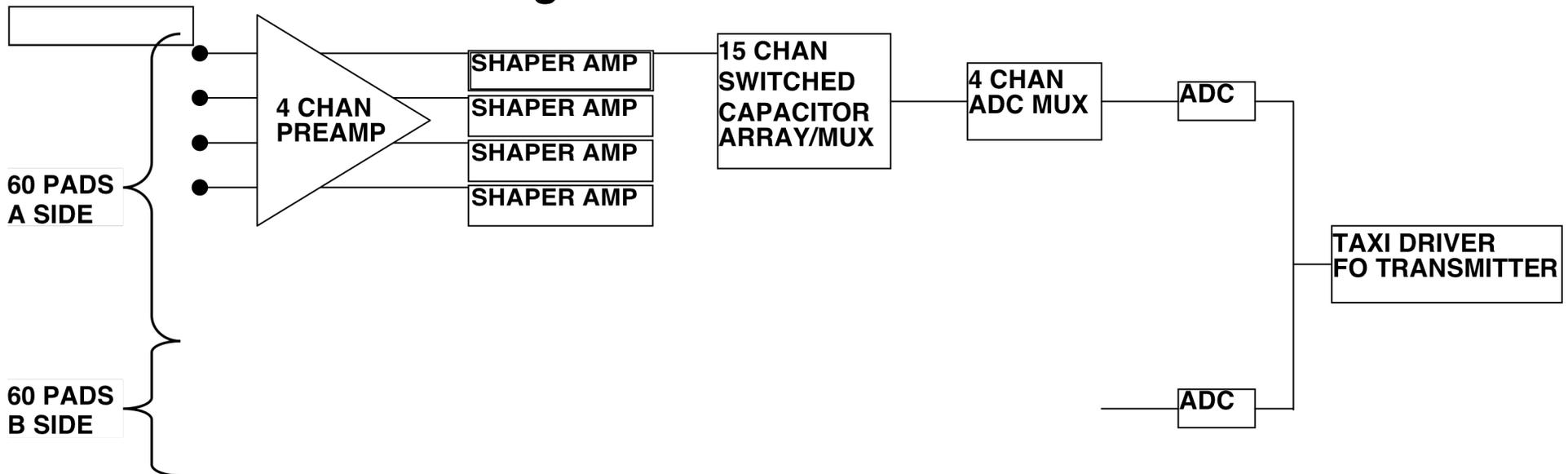


Front-End Sticks



- Nearly complete set of schematics
 - [LBL_Drawings/TPC_LBL_Drawings.html](#)
- Three IEEE TNS papers on preamp/shaper, SCA
 - [TPC.html#History](#)

- Data flow block diagram



- Lots of multiplexing
- Data on the fiber in time-major order (one time bucket from all pads)



- **BitBUS slow control — 1 bus per quadrant/VME**
 - Limited writable data memory
 - Calibration pulser
- **In addition to pad data, various housekeeping measurements:**
 - Stick serial number
 - set by cutting traces on the board
 - TPC quadrant and slot number
 - set by hard-wired connections on the pad plane
 - +15V , +6V, +5V with respect to -15V
 - -5V with respect to +15V (to keep measurement signal positive)
 - “VIN BIAS SB” ?
 - 2 temperatures, one at each end of stick
- **Additional details and photos**
 - [Electronics/Sticks/Sticks.html](#)

DC Power Supply and Interlocks



The following **conditions** are required to power the sticks:

- **Rack AC Power and Smoke Detector Interlock**

- AC CONTROL ON
- No rack smoke detectors alarming

I AC OVERRIDE

- **Master Interlock Chassis**

- Water chiller not alarming
- Water flow above limit
- CLK signal present

- **DC Power Supplies**

- No AIRFLOW fault in the rack
- Individual channel ENABLEd
- Stick INTERLOCK loop closed
 - Stick fully inserted (Bieser pin)
 - Stick thermal switches not over temperature
- One ENABLEd channel in the rack RESET

Remote reset
partially
implemented

Channel will not latch unless

- All voltages come up

DC Power Supply and Interlocks

Rack AC Power and Smoke Detector interlock



- **Blue panel controls all AC power in RR07–10**
 - **INTERLOCK/OVERRIDE switch (left)**
 - **AC CONTROL ON/OFF (right)**



DC Power Supply and Interlocks

Master Interlock Chassis



- **At power up**
 - CLK and WATER lights are on (tripped), the four rack lights are off
- **Picture shows the state when**
 - CLK and WATER have been reset
 - Individual supplies are enabled,
 - But racks have not been reset
 - Red lights indicate that a channel is enabled with good stick interlock but off
- **Full circuit at**
 - [LBL_Drawings/Electrical/MASTER_INTERLOCK.pdf](#)



DC Power Supply and Interlocks Water Chiller



- Closed loop water chiller
- Heat exchanger (aluminum tank)
- Closed loop circulation to TPC
- Chiller status included in WATER interlock loop



DC Power Supply and Interlocks

Water Pump



- **Flow rate to TPC controlled by variable speed pump**
 - Speed set to 40
- **Flow sensor part of WATER interlock loop**
 - 15 gpm normal flow
- **Drip pans under TPC**
 - Monitored by APACS/iFix
 - Trip shuts off pump AC power
 - Local **OVERRIDE** switch



DC Power Supply and Interlocks

CLK/TRG Module



- **EOS nomenclature is TPC-centric**
 - Module supplies Free-running 10 MHz CLK
 - Module receives a ~16 ms conversion GATE
 - Module generates TPC TRG: the first CLK edge in the GATE, marking the first time bucket
 - TRG is recorded by a TDC to capture the TPC CLK phase w.r.t. the experiment trigger
 - Schematic at
 - [Electronics/CLKTRG/CLK_TRG_Module.pdf](#)
- **Fanout Module**
 - Distributes CLK/TRG to 16 ribbon cables, each bussed to 8 sticks

DC Power Supply and Interlocks

DC Power Supplies



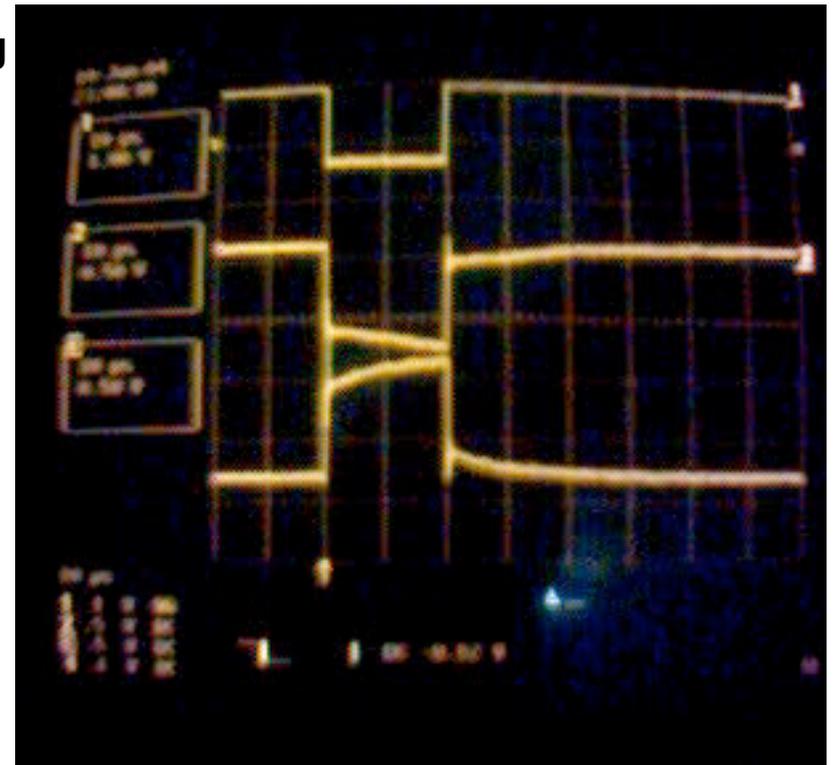
- **Each chassis powers four sticks independently**
 - Numbered label (“32”) identifies the lowest numbered stick slot powered by this chassis, *i.e.*, the most upstream stick in the quadrant
- **Operation**
 - Switch in the **ENABLE** position allows power to **STICK** on **RESET**
 - **RESET** button will turn on *all* **ENABLED** sticks in this rack
 - Green lamp lit when stick powered
- **Schematic at**
 - [LBL_Drawings/Electrical/EOS_TPC_LV_PS.pdf](#)



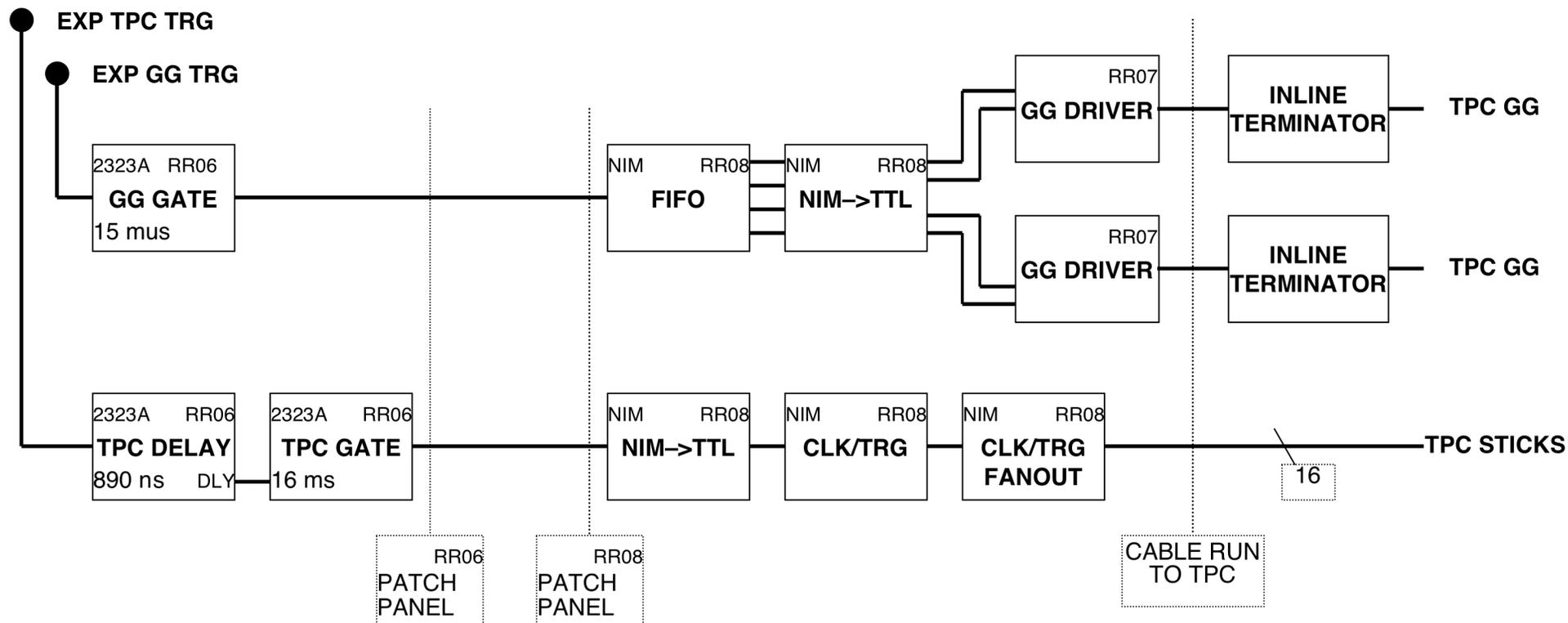
Gating Grid Driver



- **Essentially complete schematics available**
 - [Electronics/GatingGrid/GatingGrid.html](#)
- **DC voltages set to E895 values:**
 - Off (untriggered, opaque): +20 V -180 V
 - On (triggered, transparent): -80 V -80 V
 - DC dials and monitors not direct reading
- **Pulse monitor ports are distorted**
 - Slower rise/fall time
 - More ringing
 - Real pulses have 100 ns rise time
 - Real ringing can be reduced by tuning the output LR filter on the driver board
- **Cable termination boxes at TPC**
 - Also have probe points for scope



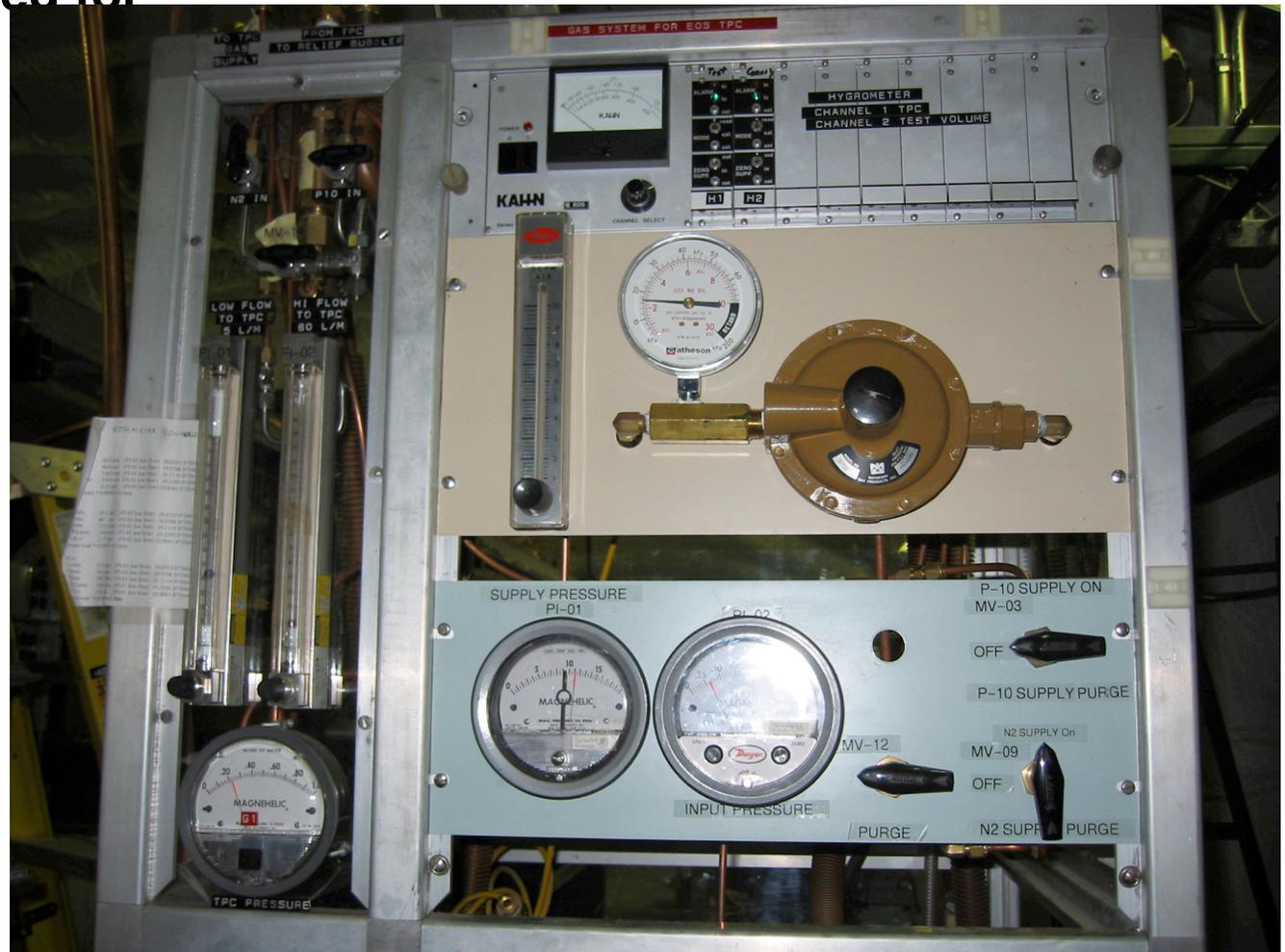
Gates and Trigger



Gas System



- [Gas/TPCGas.html](#)
- [../SlowControl/Monitor/Web/TPC_Gas.html](#)
- Exhaust Monitored for
 - Pressure
 - O₂ Content
 - H₂O Content
- Mixing System
 - Integral flows
- Hall Pressure



Gas System Bubblers



- Inlet relief (top)

- Main Exhaust (bottom)



Environmental Monitoring



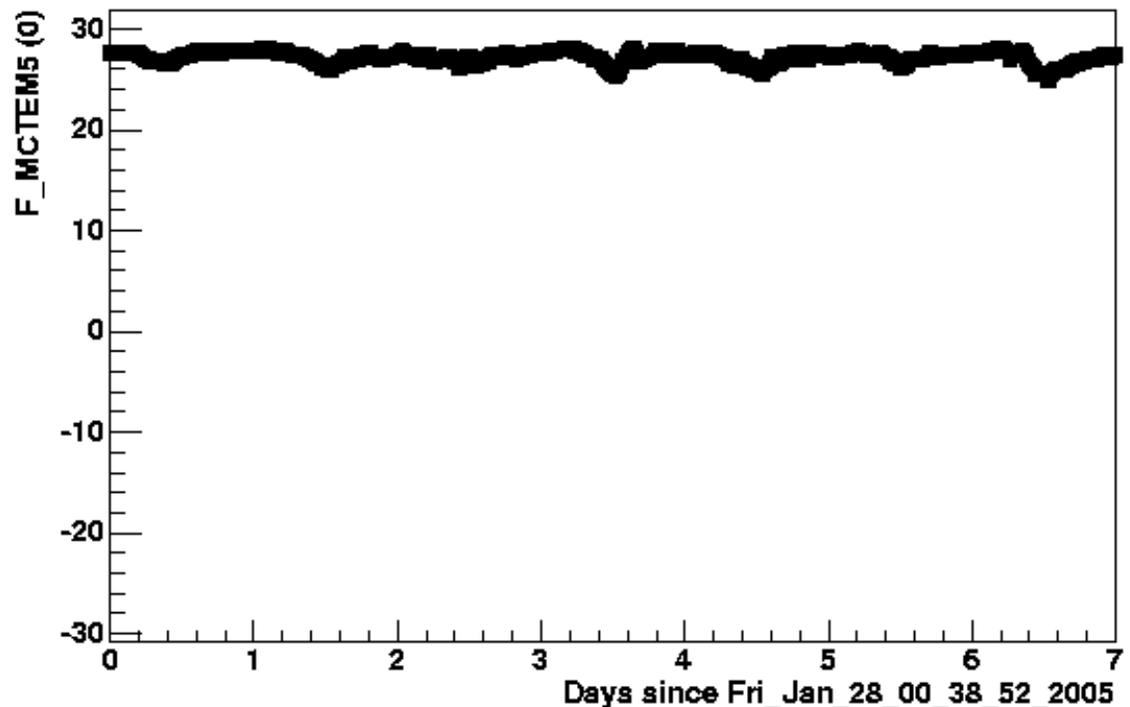
– ../SlowControl/Monitor/Web/TPC_Temperatures.html

- **MC7 Hall**

- Pressure
- Temperature (3 locations)
- Humidity (?)

- **TPC Temperature**

- 4 sensors
- Currently located at upstream corners of gas volume

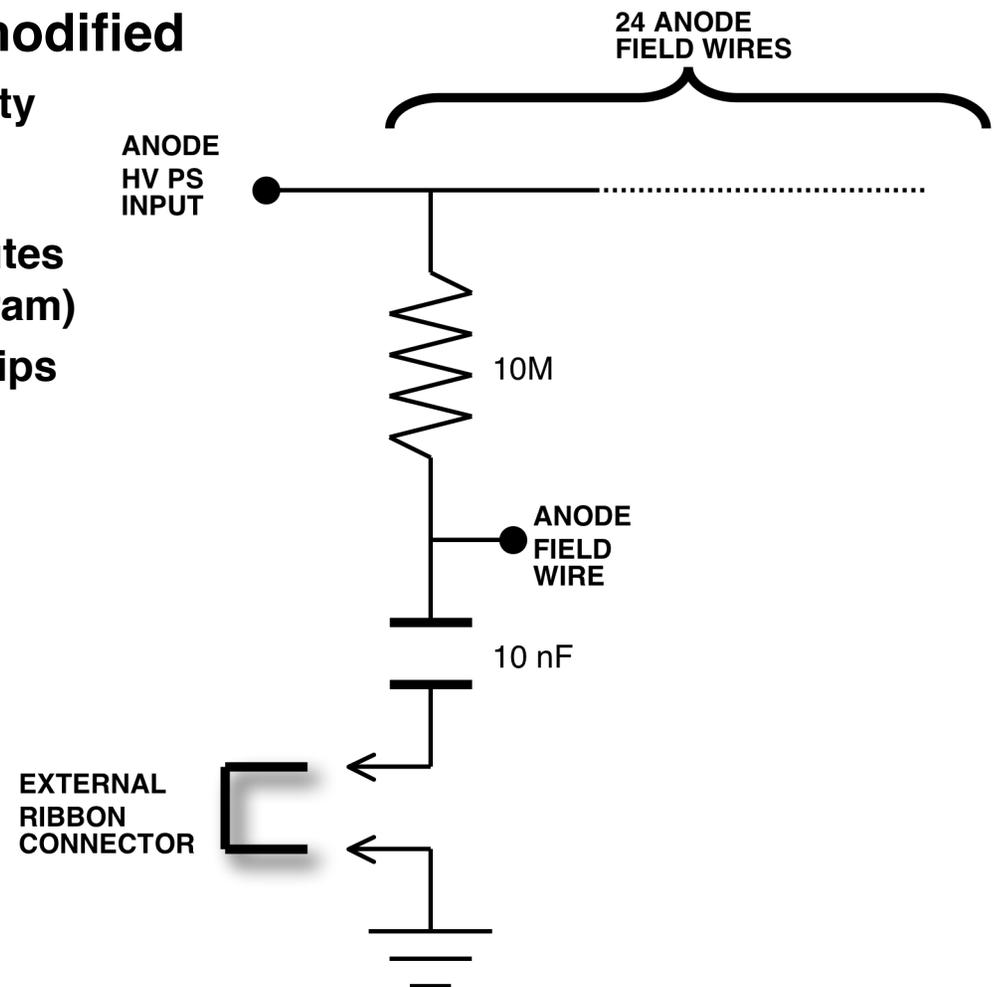


High Voltage Anodes



– [Electronics/TPC_Anode/TPC_Anode.html](#)

- 16 channels
- LeCroy 1440-based system, modified
 - 5 nA trip and readback sensitivity
- All channels monitored
 - Time resolution only a few minutes (sampling time of monitor program)
 - Partially useful for identifying trips
- Internal distribution board
 - RC = 0.1 s filter
 - External ground connection
 - Allows detection of fast wire signal for 2nd level trigger



High Voltage Cathode



- **Nominally 10 kV \Rightarrow 125 V/cm**
 - Field cage resistor ladders add up to 124 M Ω \Rightarrow 80.6 μ A
- **Monitoring program mode exists**
 - Does it log to the database?
- **Never trips**
 - Unless we have bent the lid guard ring resistor ladder



Data Links



- **Fiber optic bundles**
 - **Bundles of 100/140 micron or 62.5/125 micron fibers**
 - **Original LBL EOS set, augmented by extensions for BNL layout**
 - **287 fibers originally, ~220 still good**