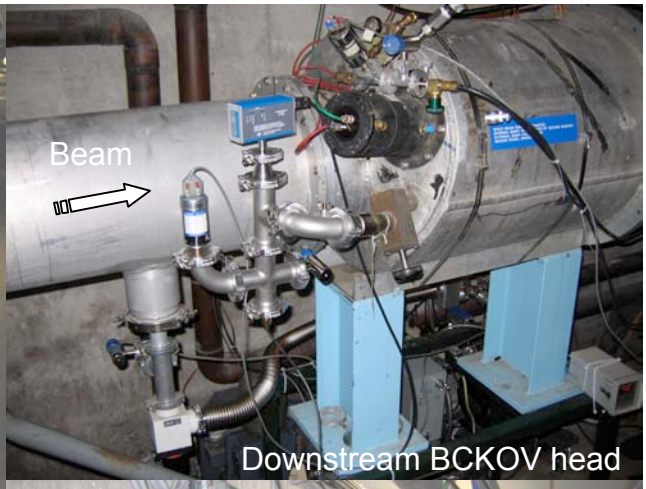
Terry Tope
3.5.07

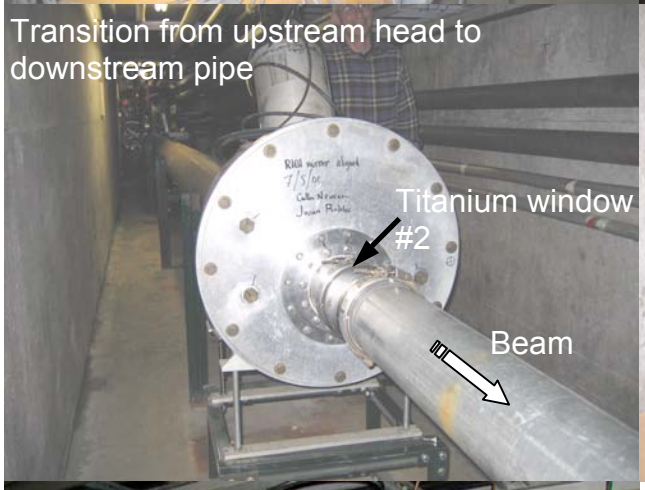
Meson Test Beam Cerenkov Counter Gas and Vacuum System Documentation

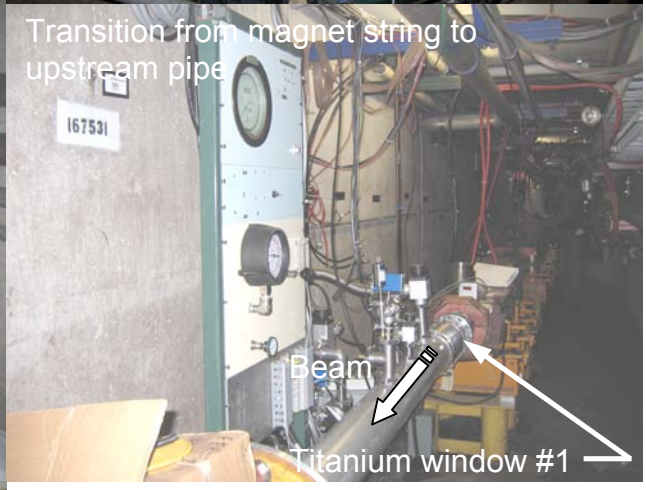
System Mechanical and Electrical Description

The Meson Test Beam Facility is outfitted with two beam CKOV counters (BCKOV). This document describes the gas and vacuum system that services these detectors.

Each ckov consists of a head that contains the mirror and phototube attached to a pipe that is 12 inches in diameter and 40 feet long.





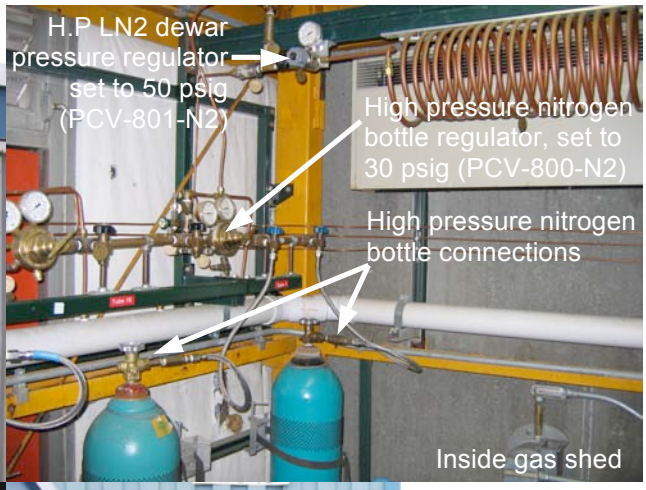


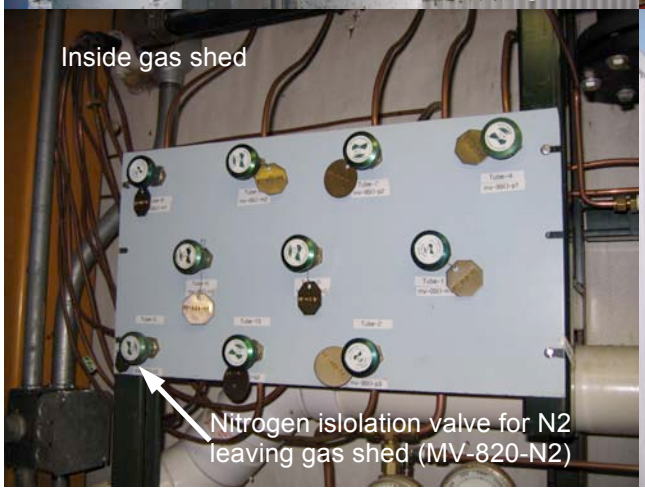
Downstream head will be replaced by a differential head in the near future.

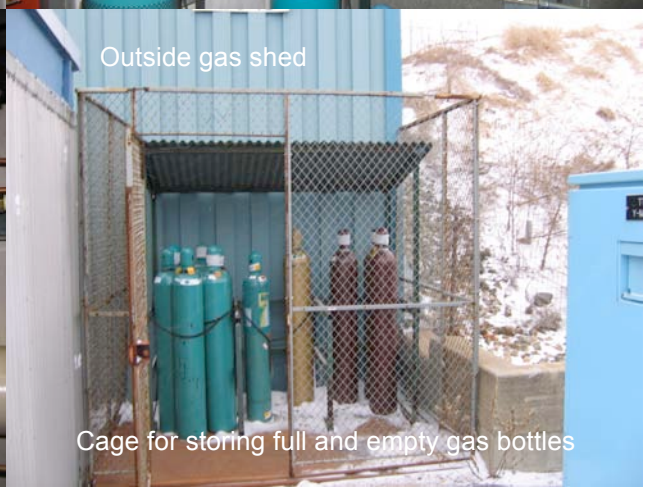
Beam

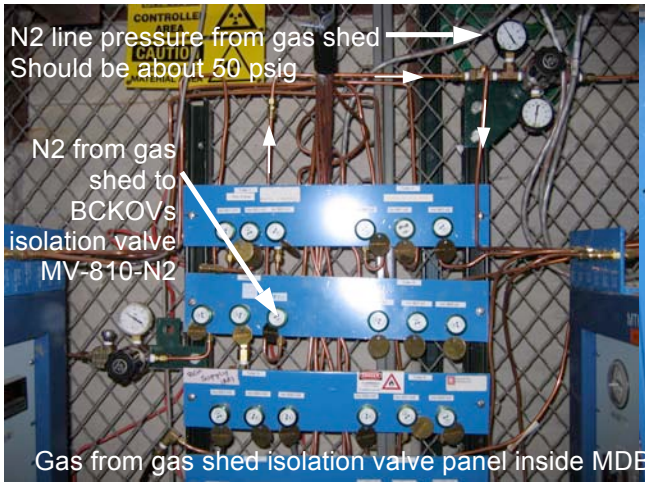
There are three 0.003 inch thick 4 inch diameter titanium windows. Window #1 separates the upstream BCKOV gas space from the magnet string vacuum. Window #2 separates the two BCKOV gas spaces. Window #3 is the downstream head beam exit window, is 0.007 inches thick, and will be replaced by a 0.003 inch thick window in the near future. Window's #2 and #3 are allowed to experience 50 pressure reversals. A pressure reversal is defined as follows. Let P1 be the pressure on one side of the titanium window and P2 the pressure on the other side. Initially P1 is greater than P2. If P2 increases in pressure to exceed P1 by 0.5 psi for at least 5 seconds, this is one reversal. Or if P1 decreases in pressure so that P2 exceeds P1 by 0.5 psi for 5 seconds this is also one reversal. After 50 such reversals, the control system will interlock the gas and vacuum sources and the window must be changed.

Fermilab print 9214.000-ME-397793 provides a schematic of the entire Meson Test Beam gas system including the BCKOVs. Nitrogen gas is provided by either a 160 liter high pressure liquid nitrogen dewar or two high pressure nitrogen gas bottles. Typically the high pressure bottles are utilized as the backup gas source. The liquid nitrogen dewar connection is outside the gas shed located on the west side of the Meson Detector Building. The stainless steel flex hose should be connected to the port on the liquid nitrogen dewar labeled gas use. The high pressure gas bottles are connected inside the gas shed. Both sources are available from the Fermilab stock room. When ordering a liquid nitrogen dewar, high pressure must be specifically requested. A full liquid nitrogen dewar contains nearly 5,000 ft^3 of gas while a high pressure nitrogen bottle contains about 200 ft^3. It takes about 46 ft^3 to fill each BCKOV from vacuum to atmospheric pressure. Before handling the liquid nitrogen dewar or high pressure gas bottles users should have the appropriate training. Empty gas bottles should have their full/empty tags orientated with the empty side facing up and stored in the gas bottle cage next to the gas shed. Empty dewars should have their full/empty tags orientated with the empty side up and left sitting next to the gas shed.





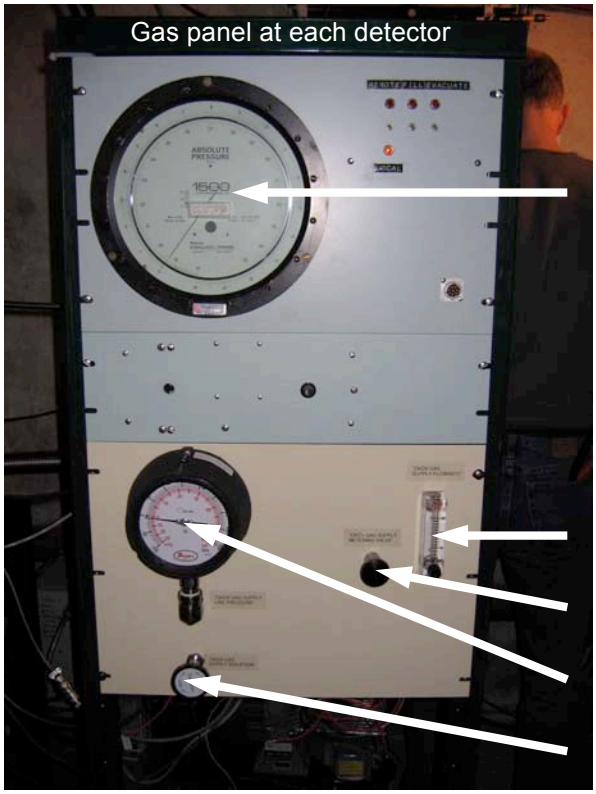




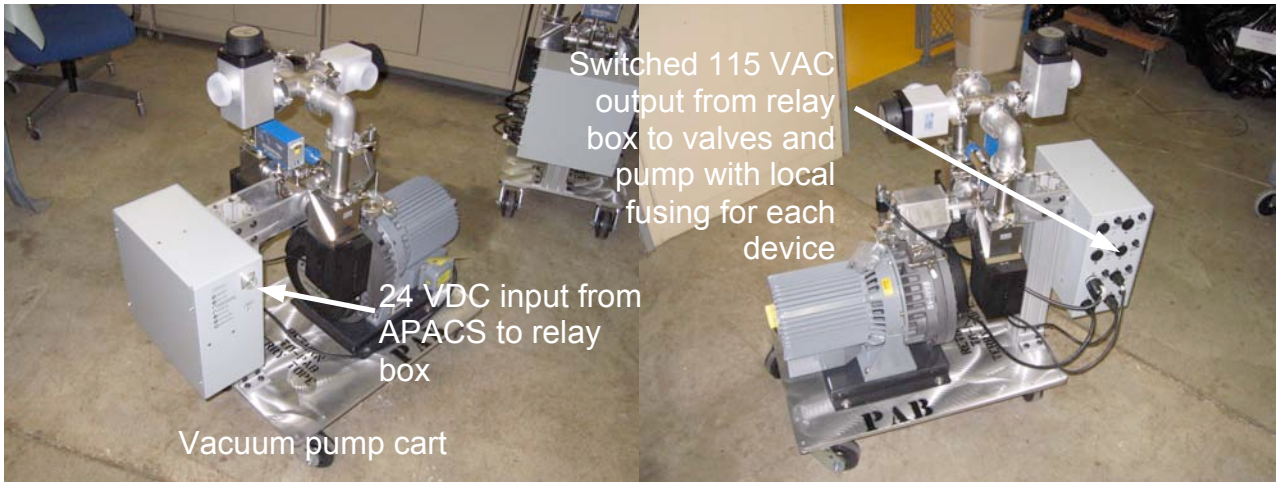
Nitrogen gas flows from the gas shed thru a multi-tube bundle and into the “gas tent” area inside MDB where 6 relay racks distribute the gas to the user areas and the BCKOVs. The dewar regulator PCV-801-N2 lowers the dewar pressure from a maximum of 350 psig to 50 psig. The bottle regulator set at 30 psig will flow nitrogen if the dewar pressure drops below 30 psig. Isolation valves exist on the nitrogen line in both the gas shed and in the gas tent area. The 50 psig N2 supply from the gas shed continues to the BCKOV gas selection valves at the bottom of the MT6-1A relay rack. The valves have 3 positions which are off, nitrogen, or an

open port to which another gas can be connected. The flow indicators will indicate if there is flow to either BCKOV.

The gas then flows thru 3/8 inch diameter black poly tubing to a gas panel located at each detector. The gas panels contain the AC solenoid valves that fill the detectors with gas, pressure gauges, a flow meter, a flow restriction, and an isolation valve.

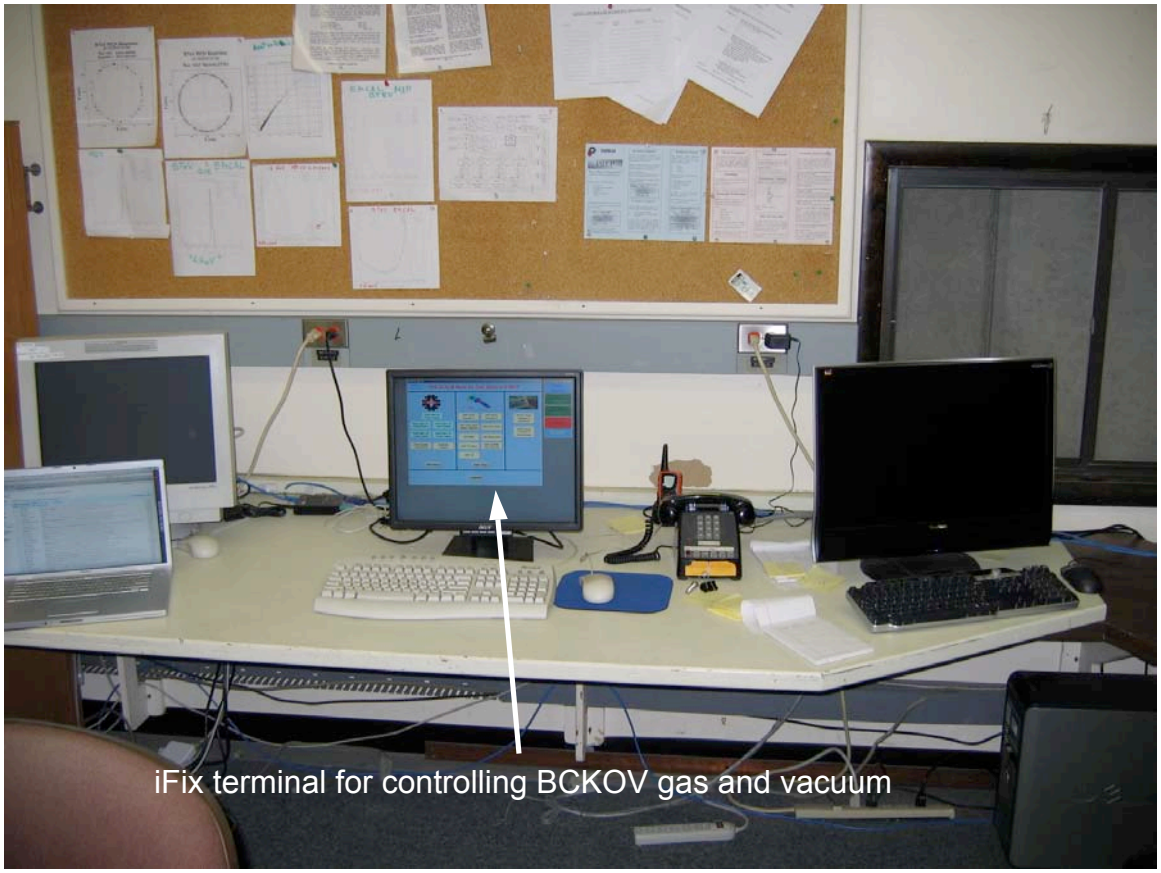


Each detector has its own vacuum pump cart which contains the vacuum pump, anti-suckback valve, the two vacuum solenoid valves, a vacuum transmitter, manual isolation valves, and an electrical box. The two vacuum valves provide a slow and fast pumping path. The fast path is used until the pressure is close to the desired setting and then the slow path eases to the set point. The anti-suckback valve closes anytime the pump loses AC power to preserve whatever pressure is in the detector. The relay box accepts 24 VDC discrete signals from APACS and contains relays to actuate the AC solenoid vacuum valves, the AC solenoid gas valves, and turns the pump itself on and off. The pump and the four solenoid valves have regular AC plugs on their ends so if needed they can be plugged directly into a 115 VAC local outlet. The box has capacity to switch two additional AC devices should the need arise.



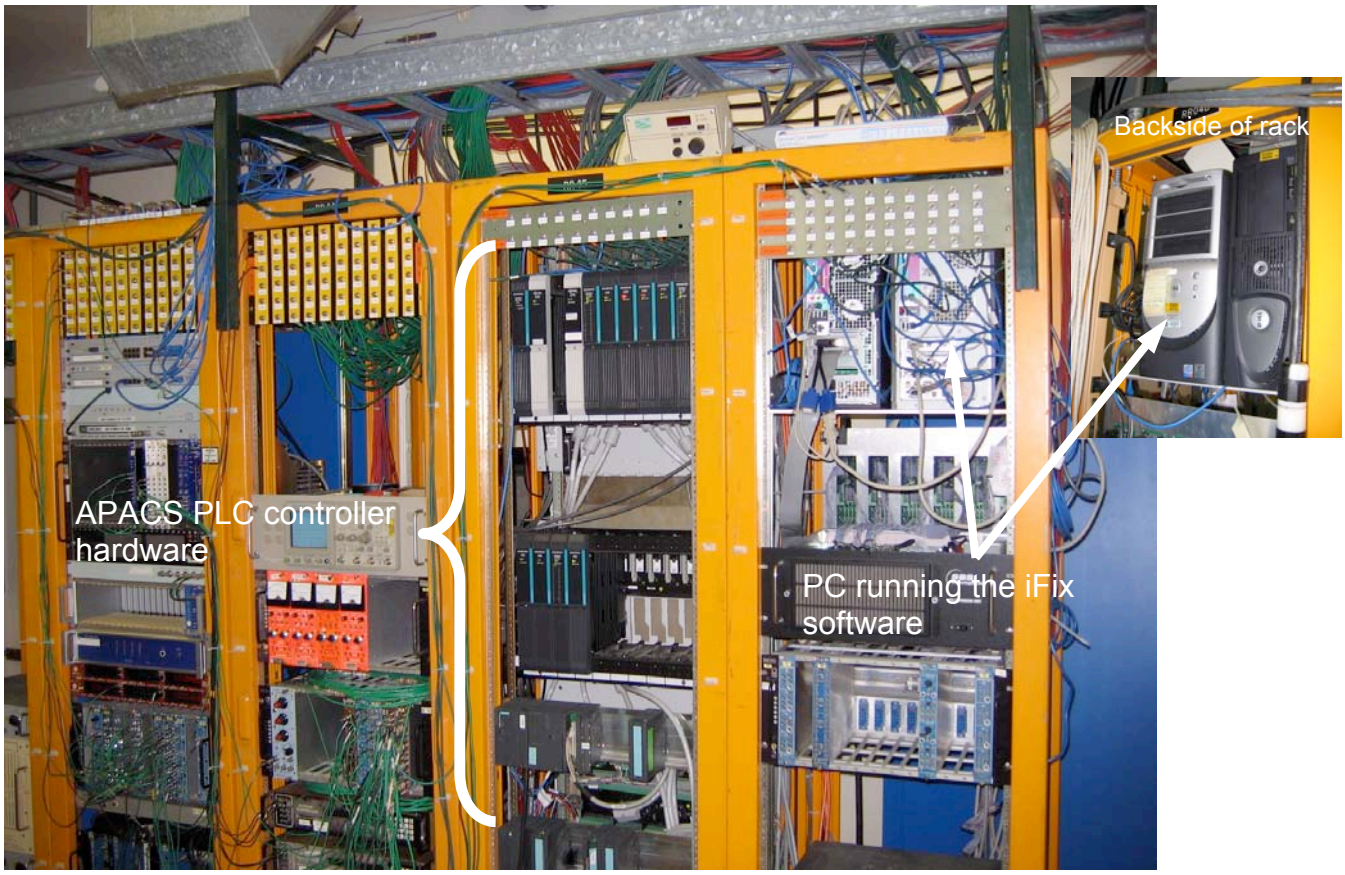
Control System

The gas and vacuum system is controlled using the iFix terminal located in the MTBF control room. The iFix software displays process values such as the pressure and temperature inside the detectors and allows the user to open and close solenoid valves to adjust the amount of gas contained in the detector. iFix also records pressures and temperatures so that they can be plotted as a function of time. The iFix node at the Test Beam also serves MIPP (E907). The iFix node MAY NOT BE USED TO CHECK EMAIL OR SURF THE WEB.



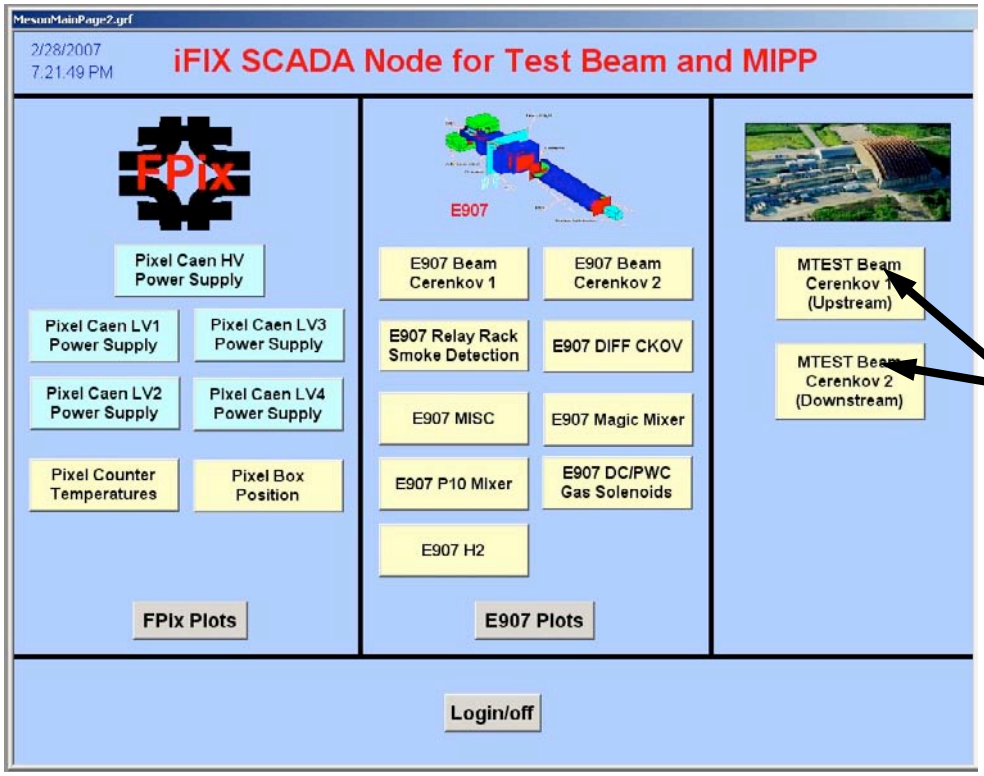
The PC running the iFIX software is remotely located in the top portion of the most upstream relay rack in the relay rack room adjacent to the control room. If the PC locks up it may have

to be rebooted. When it is rebooted, a login and password must be entered. The login is "btev-pixel06" and the password can be obtained from the test beam coordinator, Terry Tope (x2666, tope@fnal.gov), or Mark Knapp (x4382, knapp@fnal.gov). Once logged in, iFix will automatically start after a few minutes of processing startup scripts.

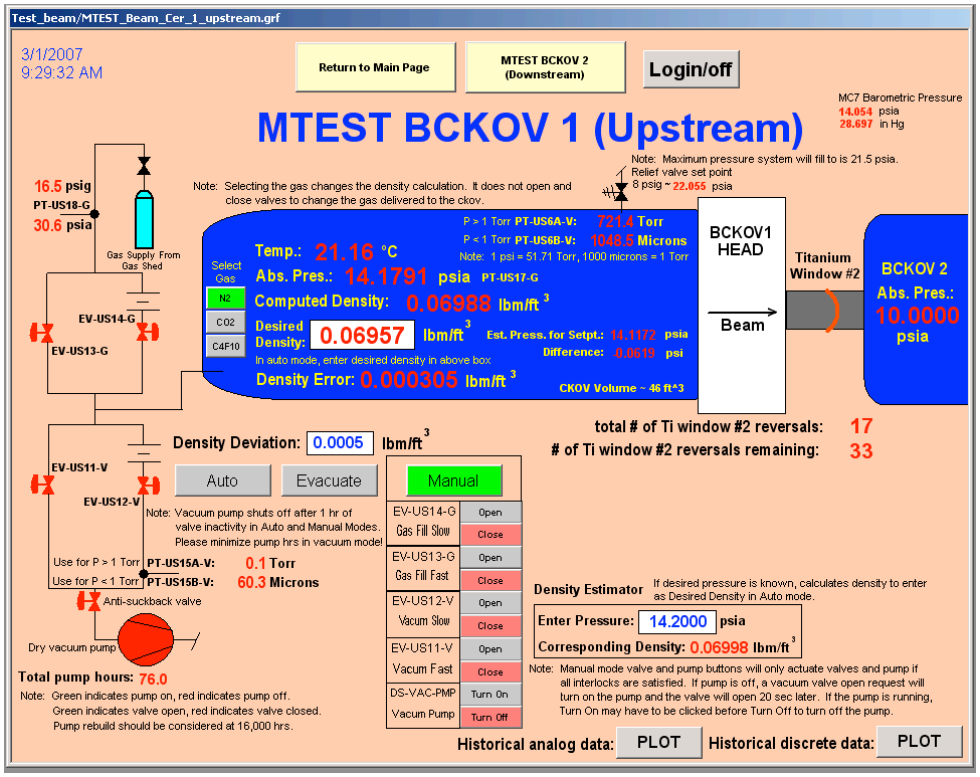


The iFix software communicates with the APACS programmable logic controller (PLC) located in the relay rack adjacent to the relay rack with the iFix computer. APACS makes the actual control decisions based on input from iFix. APACS is much more reliable than a Windows PC and will continue to run if iFix crashes. All interlocks are contained in APACS.

In iFix there is a picture for each BCKOV detector. Either picture is accessed from the main iFix page entitled "iFIX SCADA Node for Test Beam and MIPP."



Click to access test beam BCKOV pictures



BCKOV 1 Control Picture

Each ckov can be operated in one of three modes. The current mode's button is highlighted in bright green.

Auto Mode

In “Auto” mode, the user enters a density in the “Desired Density” input box. The density units are pounds per cubic foot and the computer calculates density based on the ideal gas law with temperature and pressure instrumentation inputs. The system will then open gas input or vacuum valves and turn on the vacuum pump if necessary to reach the set point. If the desired pressure is known, the “Density Estimator” can calculate a density based on the pressure typed into the “Enter Pressure” data entry box. The “Corresponding Density” can then be entered into the “Desired Density” data entry box. The system computes density based on the pressure reported by PT-US17-G for the upstream counter and PT-DS7-G for the downstream counter and the temperatures reported by upstream RTD TE-US-17-G and downstream RTD TE-DS-7-G. The pressure transmitter is a 0-25 psia unit with an accuracy of +/- 0.0275 psi. Thus at low pressures such as 0.25 psia, the density calculation will have significant error. For nitrogen, the acceptable range of density input is 0.0005 to 0.100 lb/ft^3. Other gases besides nitrogen may be introduced into the detectors. However the density formulas must be programmed into the controller and the gases must be physically plumbed into the system. The buttons that show CO2 and C4F10 are not active. Introduction of any gas besides nitrogen must 1st be approved by Terry Tope (x2666, tope@fnal.gov).

Evacuate Mode

In “Evacuate” mode, the system will turn on the vacuum pump (if necessary) and open the high conductance vacuum valve and pump on the ckov continuously. Ultimate vacuum achieved under this mode of operation should be less than 100 microns as measured by PT-US16B-V on the upstream counter or PT-DS6B-V on the downstream counter. Pumping down from atmospheric pressure to the 100 micron range could take as long as 8 hours.

Manual Mode

A switch to “Manual” mode causes any open solenoid valve to close. The user may then click open and close to actuate individual valves. If the vacuum pump is off (periods of inactivity will shut off the vacuum pump), a request to open a vacuum valve will turn on the vacuum pump. The vacuum valve will open 20 seconds after the pump has turned on to give the pump a chance to establish a vacuum. There are several interlocks that will prevent a valve open request from being accepted:

- Only 1 vacuum valve can be open at a time.
- Neither gas input valve can be opened if a vacuum valve is already open.
- A gas input valve cannot be opened if the detector pressure is equal to or has exceeded 21.5 psia.
- A vacuum valve cannot be opened if a gas input valve is already open.
- The “fast” vacuum valve cannot be opened if the detector pressure is above 15 psia.
- No valve can be opened if the number of window pressure reversal cycles has exceeded 50 reversals.

Due to the way the system is programmed, to manually turn off the vacuum pump there are certain instances where the “Turn on” button must 1st be clicked before clicking the “Turn off” button will actually turn off the pump.

Historical Data

Historical plots of the pressure, temperature, and valve position data is available for plotting by clicking the plot button at the bottom of either BCKOV picture.

Supporting Documentation