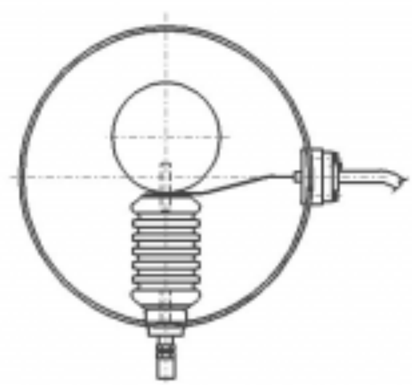
THE DEFLECTOR TEST STAND

D. Poe, F. Marti P. Miller, G. Stork

It is important to have reliable deflectors for the upgraded coupled cyclotron mode of operation. They must provide adequate electric field for all desired beams as well as operation with beams of significant power. To that end, a deflector test stand has been set up and is now operating in the N1 vault. This allows for offline testing of critical high voltage components, as well as the deflectors themselves. It is necessary to provide both vacuum and magnetic field for realistic tests.

The test stand uses a large magnet (the “Hunter’s Point” magnet) with a vacuum chamber and a K1200 style high voltage feed through. Voltage is supplied by a Glassman series WR 100 Kilovolt power supply, running in negative mode. The power supply connects to an external resistor tank with a resistance of five megohms, which then connects to the feed through.

The resistor tank is a stainless steel cylinder, which is pressurized with air at 30 PSI. Inside it has four conducting spheres mounted on insulators with high voltage 1.67 megohm resistors between the spheres. HV cable connections are made at each end of the resistor string, with the cable into the feed through being hollow. This provides a stream of high voltage air to cool the feed through and ultimately the high voltage electrode. (The high voltage cable has its center conductor removed to provide the air passage. The voltage is carried by the carbon sheath, which surrounds the conductor.) This is the same system as used on the K1200 cyclotron.



Above is a cross section through the resistor tank, showing one of the insulating posts and spheres. The resistors are connected between the four spheres.

The test stand was initially run in the transfer hall while beams were being run through the hall. This made for difficult access. After the main shut down began the system was disassembled and moved into the N1 vault, where it presently resides.

Two pickup loops have been installed to allow for the viewing of sparks by oscilloscope. One surrounds the high voltage cable leading into the feed through, while the other surrounds a wire leading from the ground plane of the deflector to real ground, with the deflector ground being insulated for this purpose. The former responds to changes in current in the high voltage cable while the latter to sparks going to the ground plane. The loops themselves are Pearson Electronics Model 4100 standard current monitors, and are mounted in stainless steel cylinders to provide proper ground return. They show that sparks typically last for approximately 20 to 50 microseconds before they extinguish.

Vacuum is provided by a mechanical roughing pump and a cryopump. Pressure is read out by an ion gauge, which is used to interlock the high voltage. A residual gas analyzer was installed to provide data on the vacuum conditions, especially to observe gasses emitted from sparking material.

Testing is typically done using a control program that automatically ramps the voltage up while monitoring the current. If the current exceeds a limiting value, the voltage is turned down a set amount. The ramp rate, current limit, the fractional voltage turn down and the ultimate desired voltage are all variable. It also allows one to use the resistance as a limit rather than the current. Since oxygen gas is often bled into the deflector to enhance conditioning and voltage holding, this program also controls the oxygen supply valve. A similar program has been used to condition the deflectors in the K1200 cyclotron for the last few years.

It was necessary first to verify that the feed through itself was reliable at 100 KV for long periods of time, which was not found to initially be the case. The feed through is a tube of MACOR into which the high voltage cable slides. Its base and nose are made of titanium that is bonded to the MACOR by means of a powdered glass, which is used as a solder. (The same technique is used in making the deflector insulators.) We found that these would not reliably run at 100 KV, but would degrade over time. A long blackened region would appear on the side of the feed through in the median plane. We believe this to be due to damage to the glass joint at the nose from the intense electric field. We provided a corona ring to electrostatically guard this space, and the problem seems to have been cured.

We have used the stand to test deflectors from both machines, as well as a small device we call a pseudo deflector. This is essentially a short deflector that allows us to test materials and principles in the test stand. For example, we used this to test a bonded material of copper and stainless steel for sparking plates, which seems to work quite well.

We recently tested a K500 deflector in the stand with a slot in the septum. The reason for the slot is to spread the power of the incident beam out over a larger area, thereby improving the voltage holding with high power. The test showed that the deflector still held voltage properly with the slot in place.

A test was done recently of a high voltage cathode coated with titanium nitride in the pseudo deflector. This ran a normal voltage and is of possible use in future deflectors.