BESII Vertex Chamber and MDCII Feedthroughs

Russell Malchow

BES II Upgrade

ELSEVIER

Nuclear Instruments and Methods in Physics Research A 458 (2001) 627–637

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

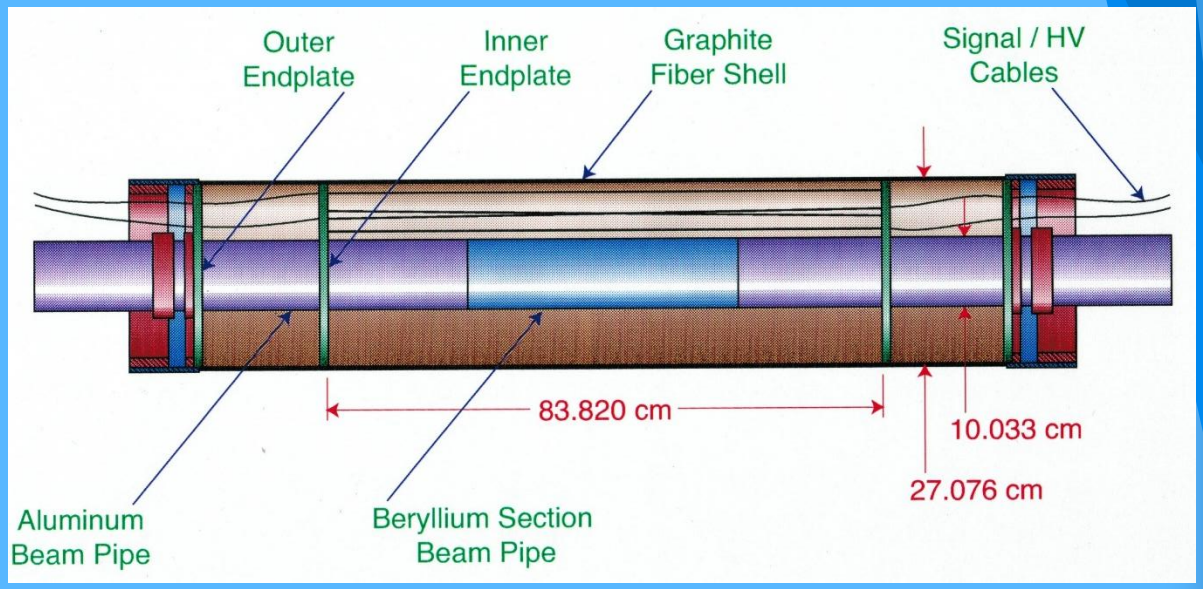
www.elsevier.nl/locate/nima

The BES upgrade

J.Z. Bai[a], H.C. Bao[a], I. Blum[b], Z.W. Chai[a], G.P. Chen[a], H.F. Chen[c], J. Chen[d],

Mark III Vertex Chamber Rebuild

As delivered to CSU



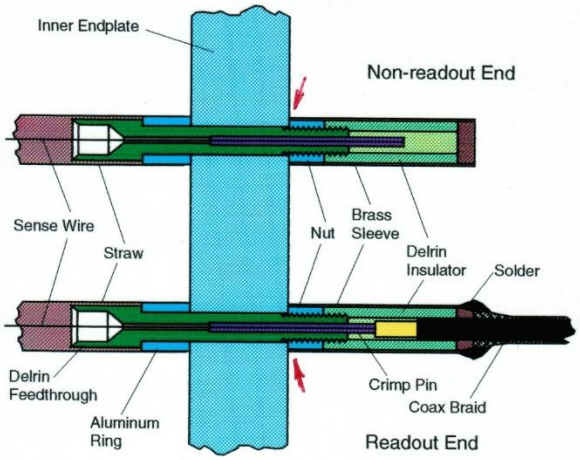
Initially it was thought that the straws and sense wires were intact, and only the high pressure endplate needed to be repaired. (Front-end electronics also had to be replaced.)

Vertex Chamber required a more extensive rebuild: feedthroughs (and straws and wires) had to be replaced.

- 16% of the feedthroughs on the north inner plate were broken (46% on south, but disassembly was much quicker).

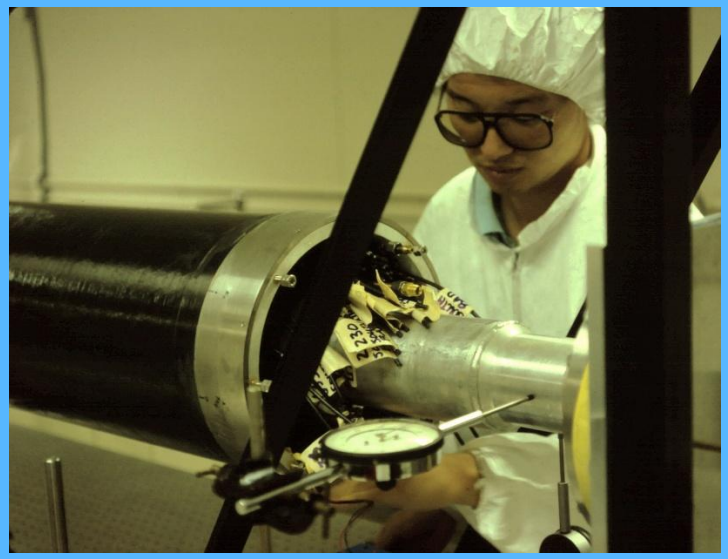
  ⇒ About 1/3 of all channels affected.

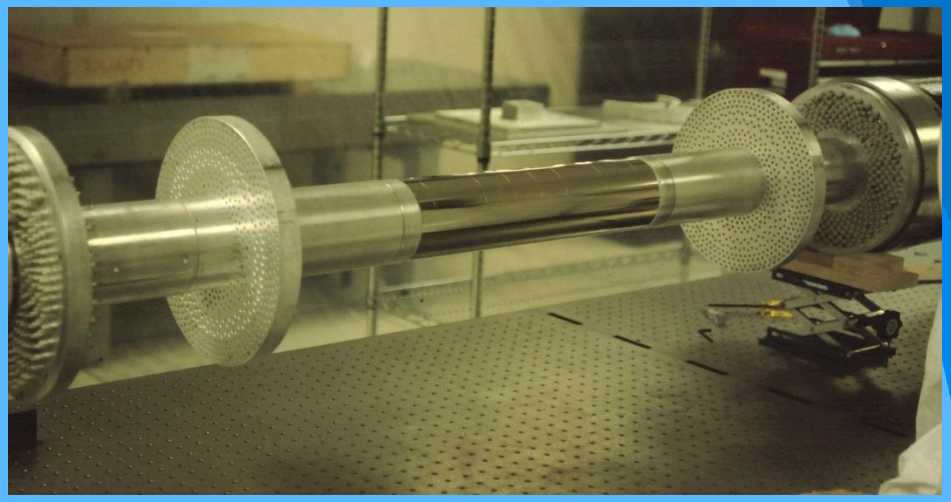
  ⇒ Breaks are between endplate and aluminum nut.

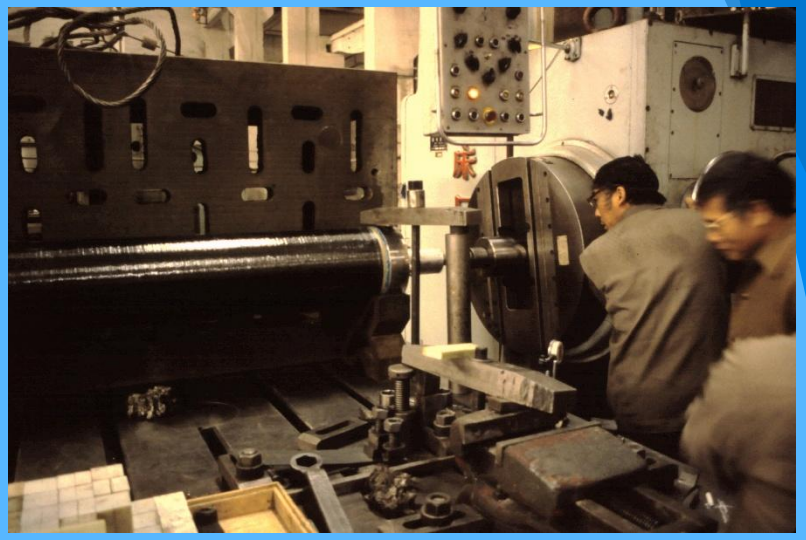


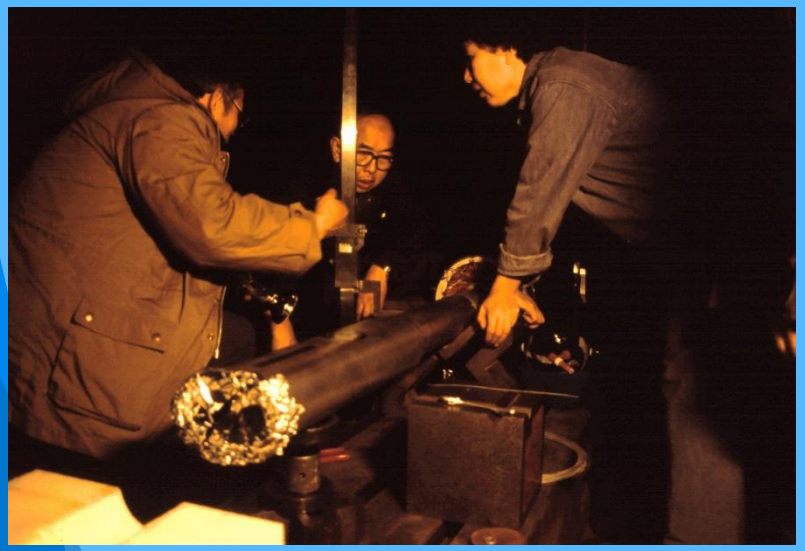
- More complex chemistry could be happening. DuPont says the following combination causes damage to Delrin:
  1) Zinc/zinc alloy (e.g. brass) in contact with acetal resin (Delrin).
  2) Halogen (F, Cl, etc.; common component of solder rosin).
  3) Intermittent moisture (Ar/ethane was bubbled through water).

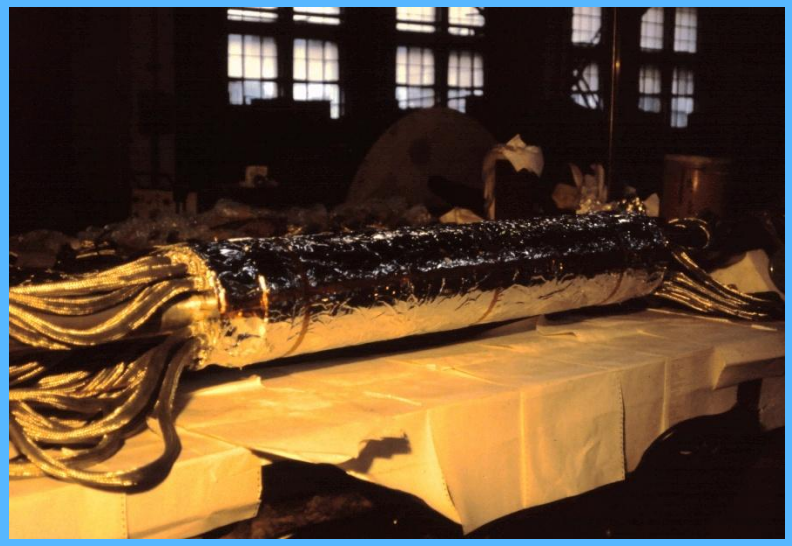
1/26/95 CSU DOE Review

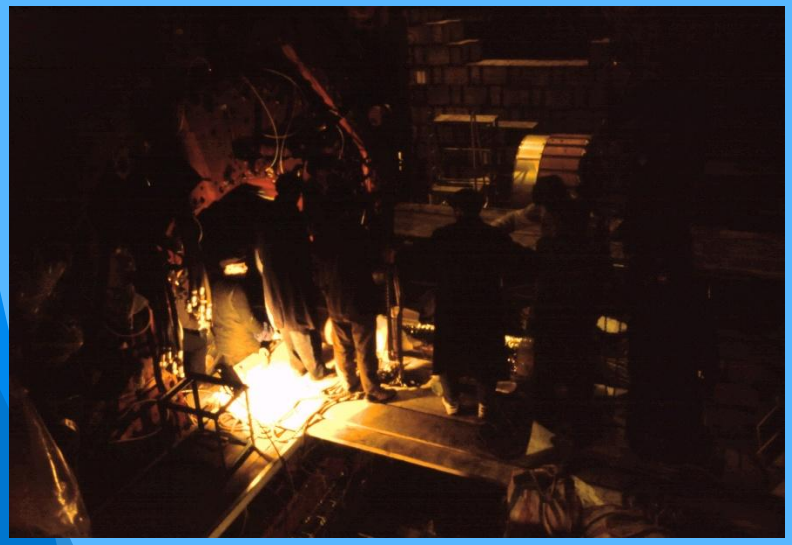


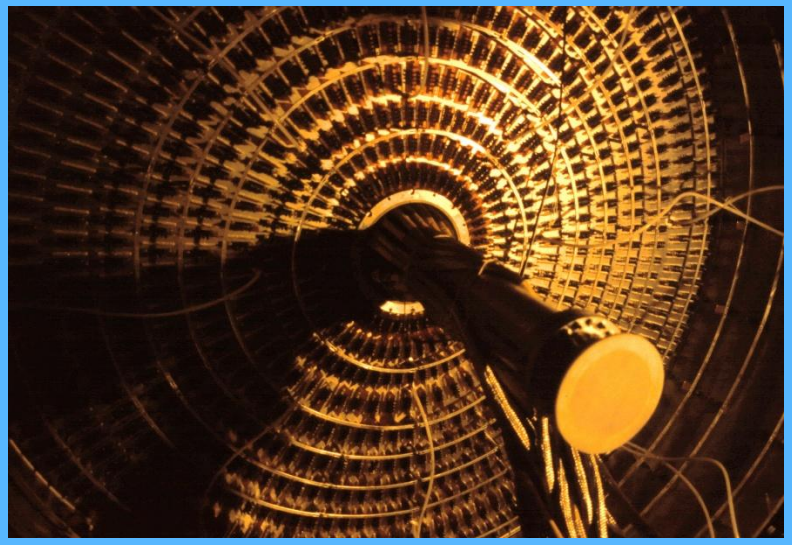




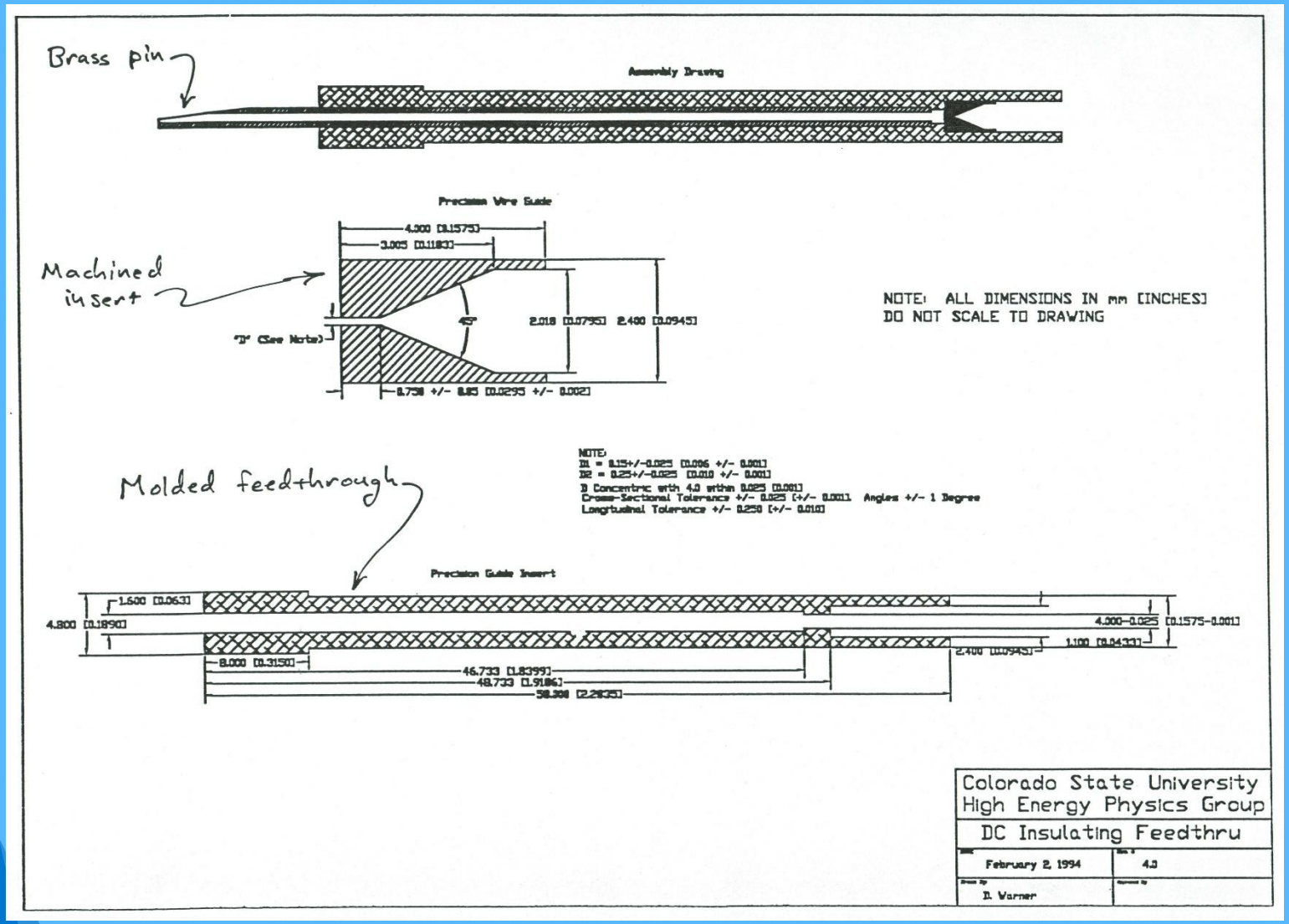






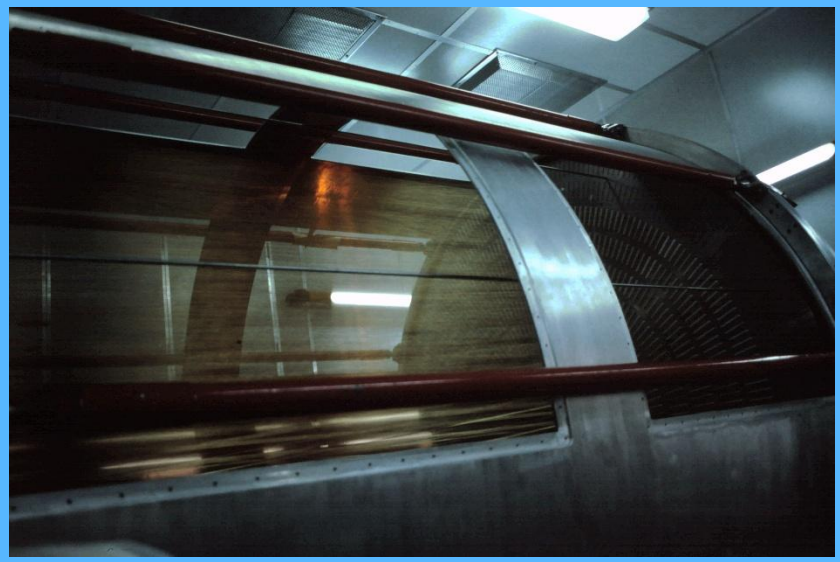


MDC II Feedthrough Design



MDCII Feedthrough Timeline

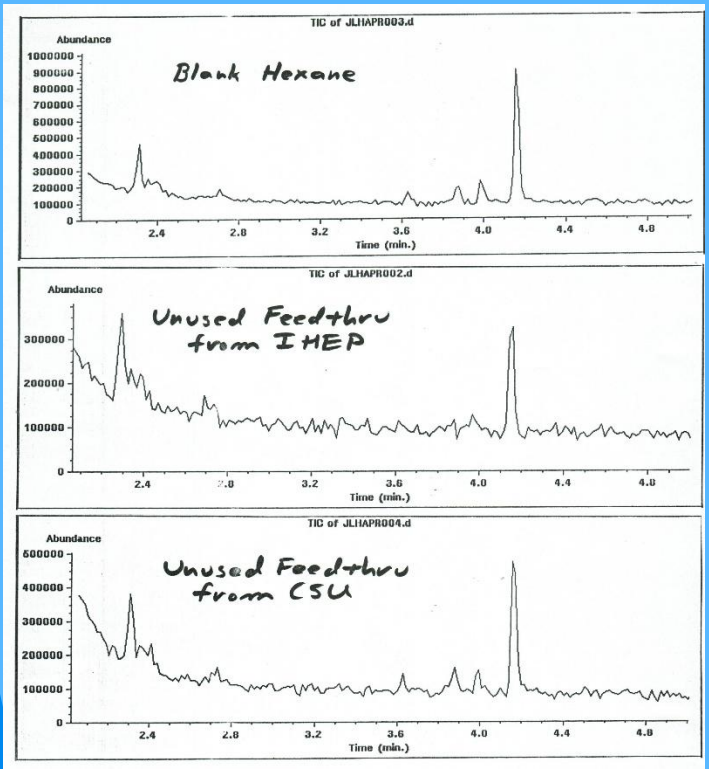
- Fall/Winter 1993: Design finalized and molder selected.
- Spring 1994: Feedthroughs prototyped.
- Summer/Fall 1994: Feedthroughs produced in Colorado. (~52,000).
- 1995: Feedthroughs and MDC II installed at IHEP.
- May 1996: Voltage applied to MDCII, then turned off for summer.
- October 1996: MDCII turned back on and run more or less continuously.



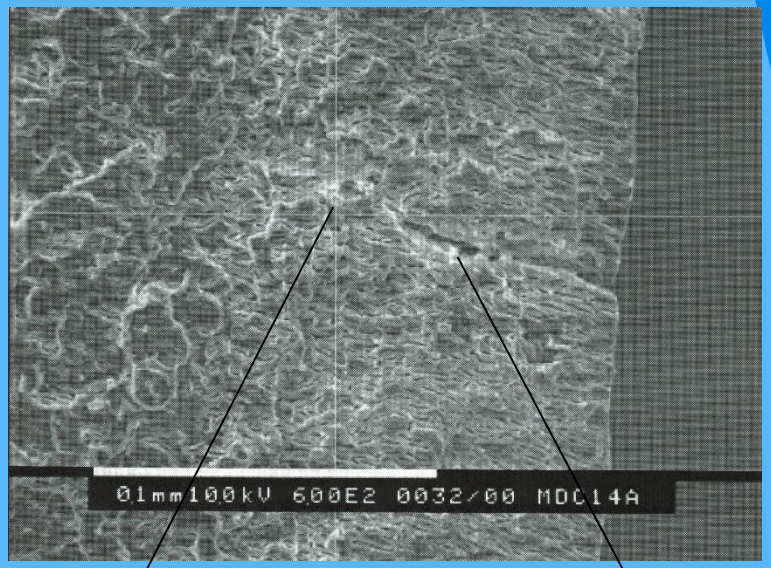
After running for a few weeks:

- High current draw noticed on MDCII.
- Prototype chamber at IHEP also developed high current.
- Feedthroughs on HV at CSU showed similar behavior.
- Feedthroughs were checked for surface contamination (hexane wash and gas chromatograph). They were clean.
- Used and unused feedthroughs were returned to CSU for evaluation.
- Feedthroughs were examined in SEM.
- Samples were sent to DuPont for evaluation.

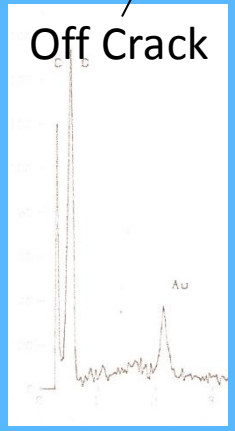
Hexane Wash and Gas Chromatograph



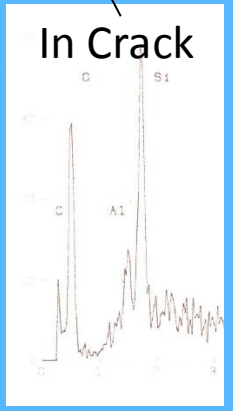
Energy Dispersive Spectroscopy



Off Crack



In Crack



SEM images of outer surfaces of MDCII feedthroughs

Unused Feedthrough: ~1 micron cracks

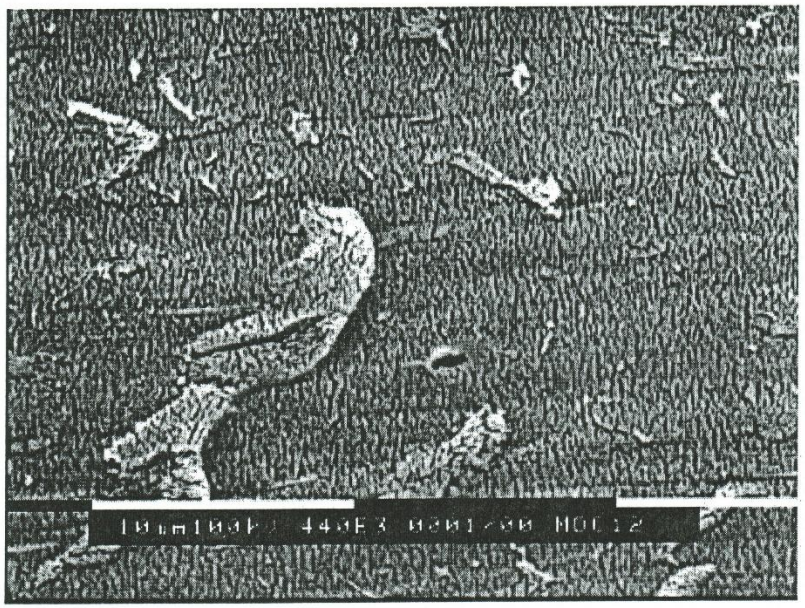


Figure 2. Micrograph of the outer surface of an unused MDC-II feedthrough. The first white bar in the information strip is 10 microns long. The feedthrough axis is horizontal in this picture. The widths of the cracks in the picture are less than 1 micron.

Used Feedthrough: ~10 micron cracks

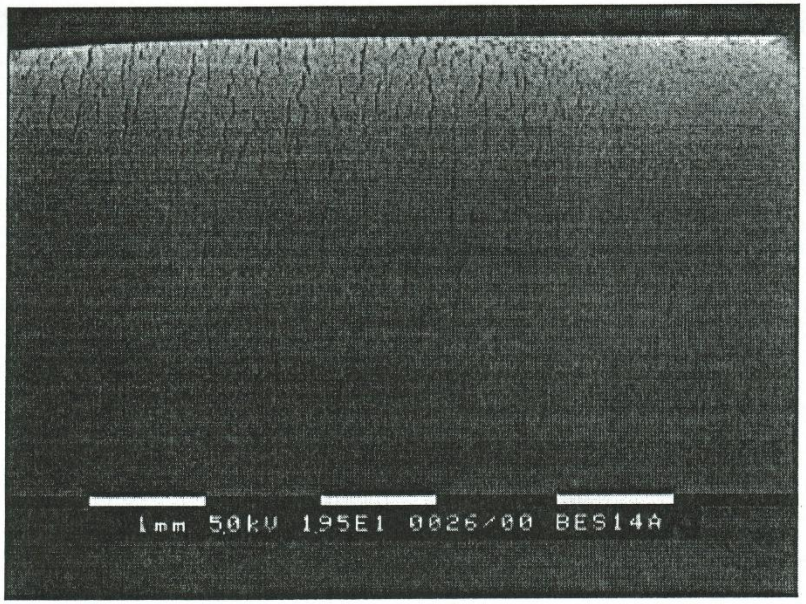
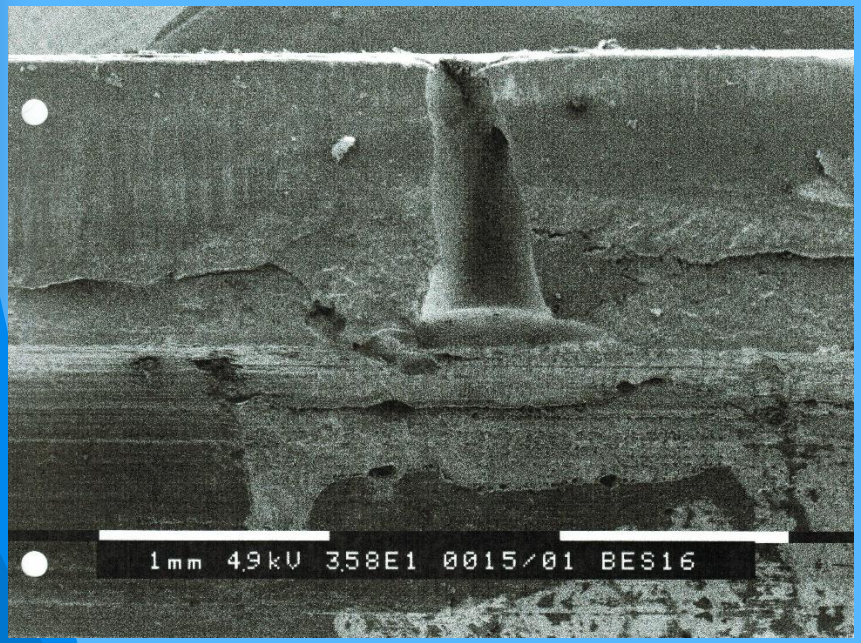


Figure 3. Micrograph of the outer surface of an MDC-II feedthrough that was used in the prototype at IHEP. The first white bar in the information strip is 1 mm long. Nearly the full diameter of the feedthrough is seen. The width of the largest cracks is on the order of 10 microns.

Used MDC II Feedthrough Damage



DuPont Engineering Polymers
Chestnut Run Plaza
P.O. Box 80713
Wilmington, DE 19880-0713

DuPont Engineering Polymers

May 1, 1997

Mr. Russell Malchow
Colorado State University
Department of Physics
Fort Collins, Colorado 80523

Dear Russell:

The parts that you sent to us were analyzed by use of MSA. In the enclosed picture you can see that the crystalline structure of the material is not good at the surface. This is usually due to cold mold temperatures or cold melt. Also, if the part is molded around a core pin that is not heated, this will also cause cold melt.

After showing your part to the Delrin® product specialist and another chemical engineer, they said that long term application of voltage could cause this kind of stress cracking, but since we have not done any testing of this kind, we could not say for sure. Exposure to glues, expoxies, or other solvents could accelerate this kind of stress cracking.

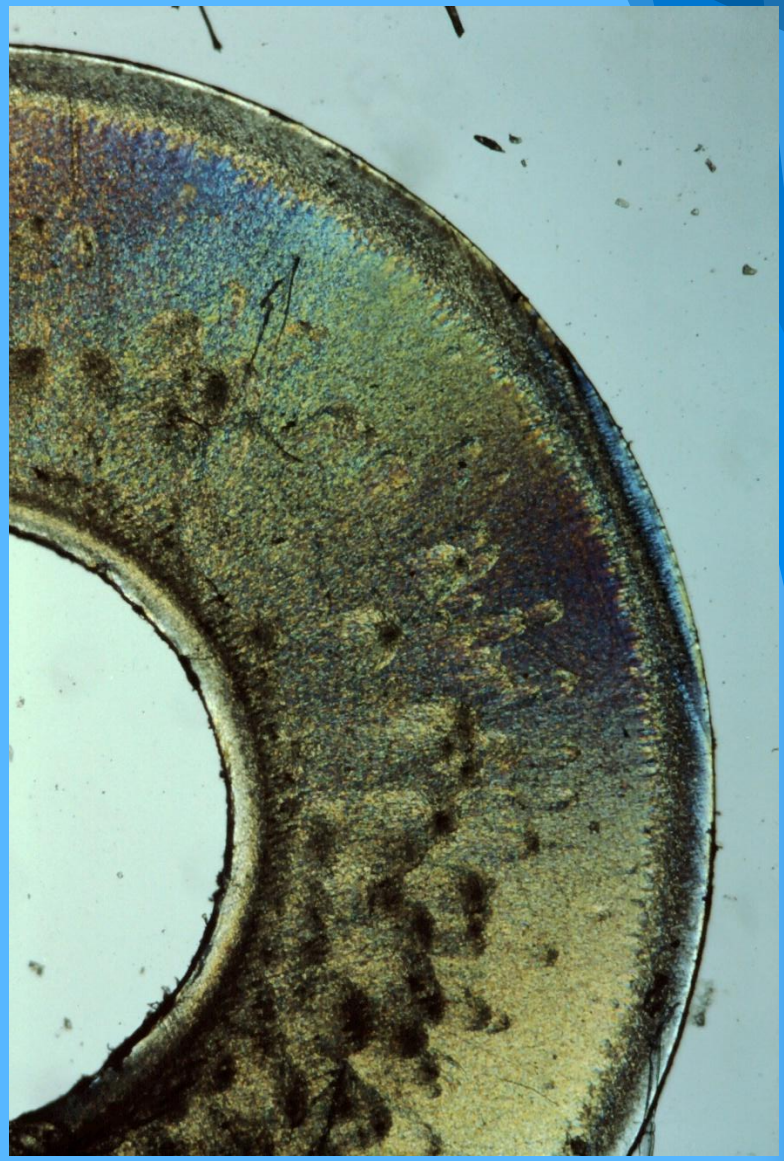
Hope this helps answer your questions. If you need further help, please call.

Sincerely,

Nancy Eckrich
Sales Representative

NE:lad
Enclosure

Delrin® is DuPont's registered trademark for acetal resin.



Conclusion:

The molder adjusted temperatures in order to release parts from the mold and maintain mechanical tolerances.

The temperature settings he used were outside Dupont's recommendation, and resulted in poorly crystallized Delrin.

Conclusion continued:

The feedthroughs shrank with time, opening stress cracks, which enlarged in the high electric field of the endplates, degrading dielectric properties of the feedthroughs to the point of failure.

A split HV scheme was adopted at BES, dividing the voltage between the sense and field wires.

In the end:

China and US split funding for a replacement MDC.

Time, money, and data were lost, but hard work and excellent US/China cooperation solved the problems, and BES moved forward.