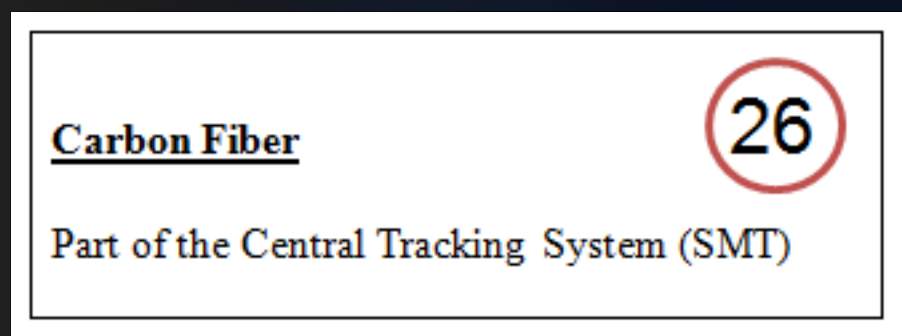
The DZero Calorimeter

You can use the exhibit number (circled on the card next to the piece) and locate the same number on these web pages.

Exhibit numbers for the Calorimeter System are the following: 11, 12, 14, 15, 18.

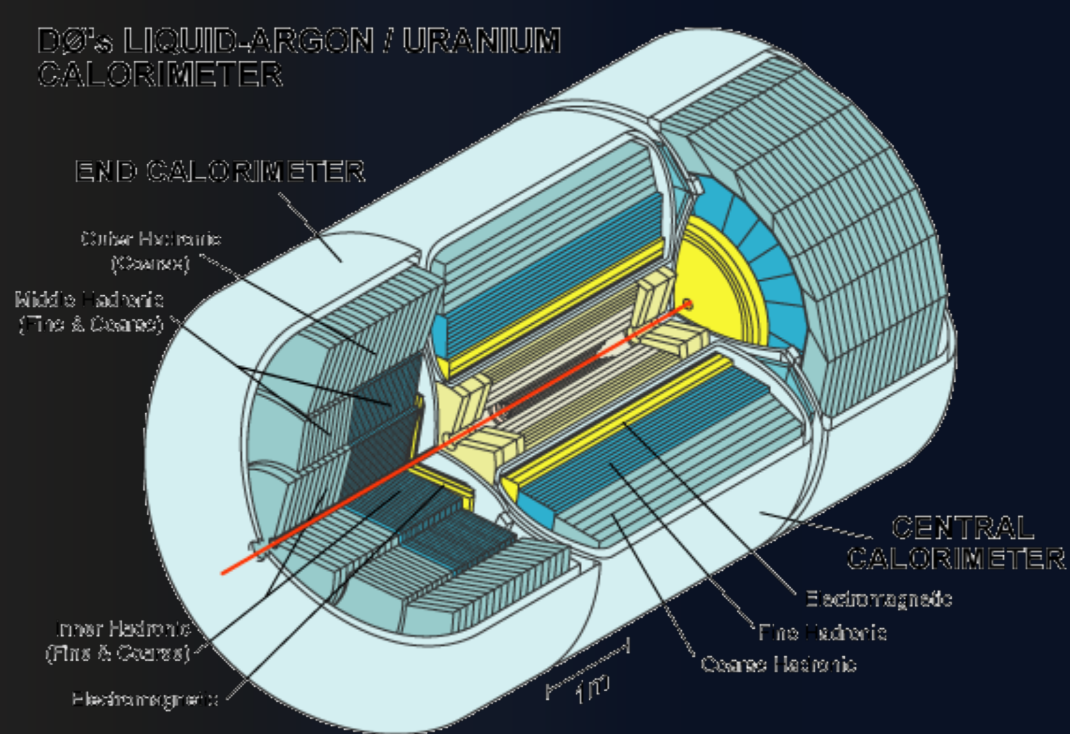

Carbon Fiber 26

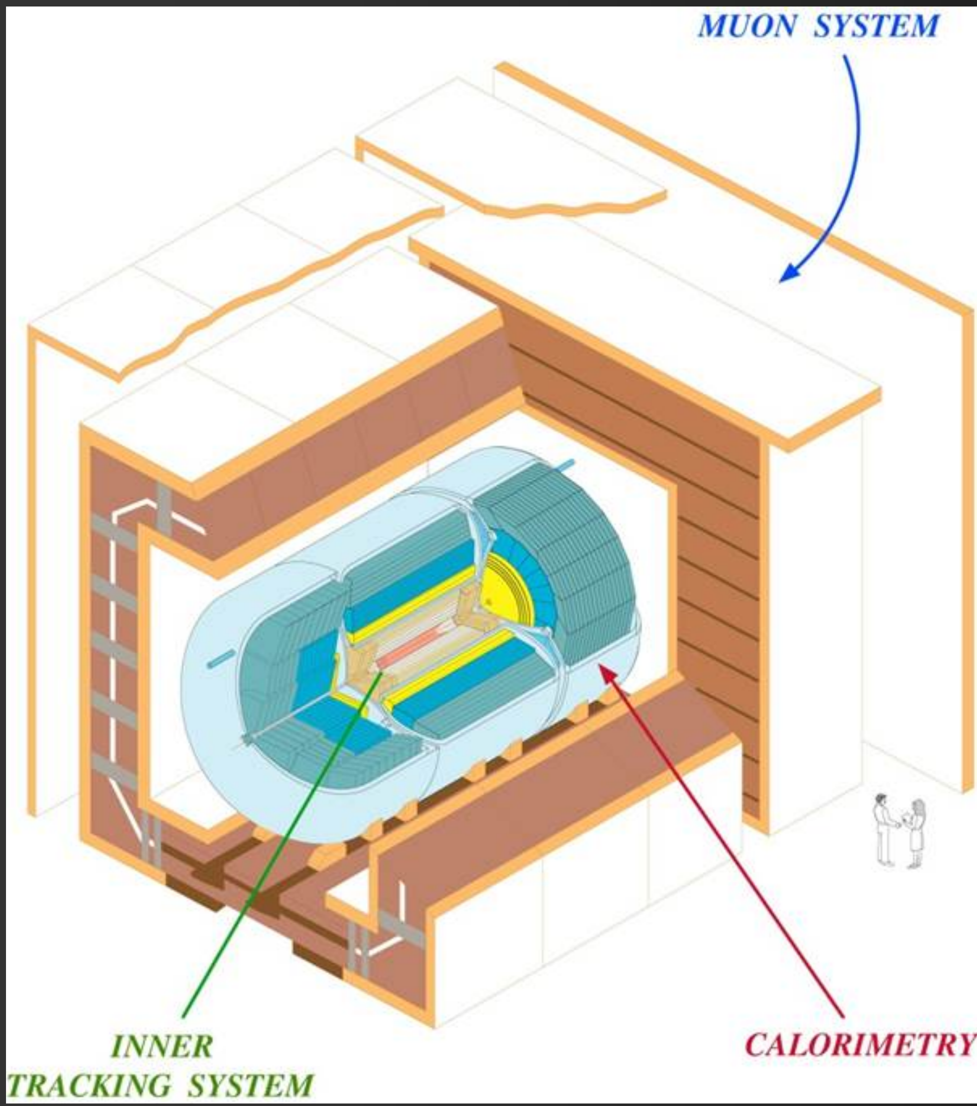
Part of the Central Tracking System (SMT)

The D0 calorimeter system measures the energy of showers of particles by absorbing them. The D0 calorimeter system consists of three sampling calorimeters (primarily made of uranium and liquid-argon), an intercryostat detector, and a preshower detector. You can find the information belonging to the calorimeter exhibit pieces further down on this page. First a few overview drawings and some pictures of the installation.

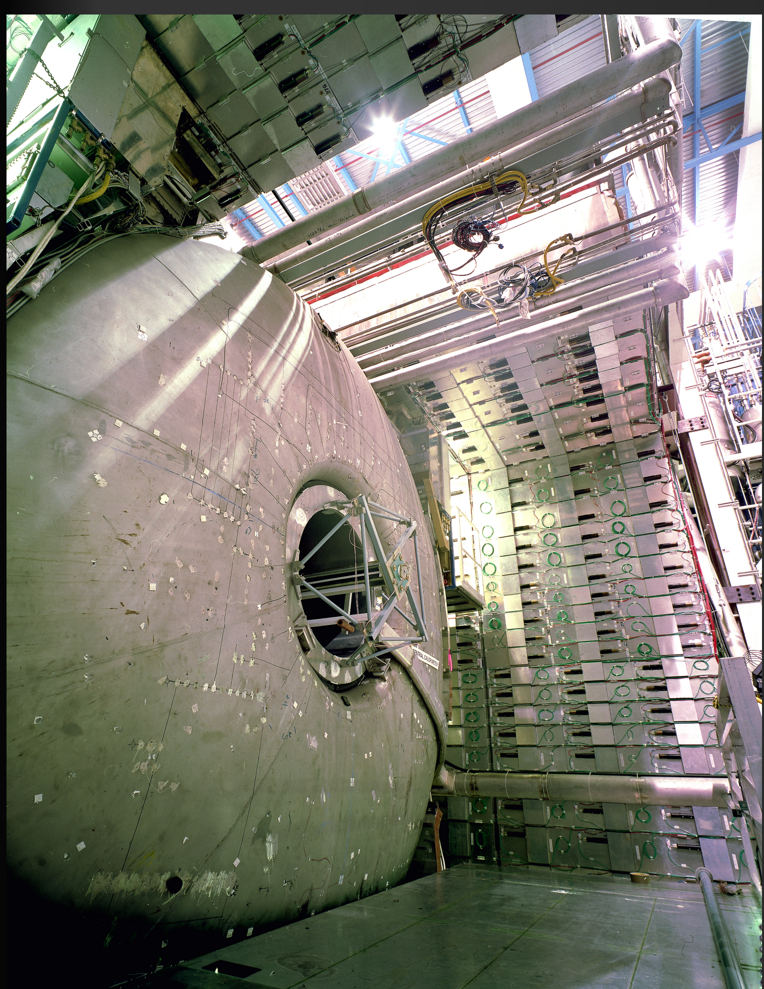
The D0 calorimeter is located between the inner tracker and the muon system

Isometric view of the central and two end calorimeters



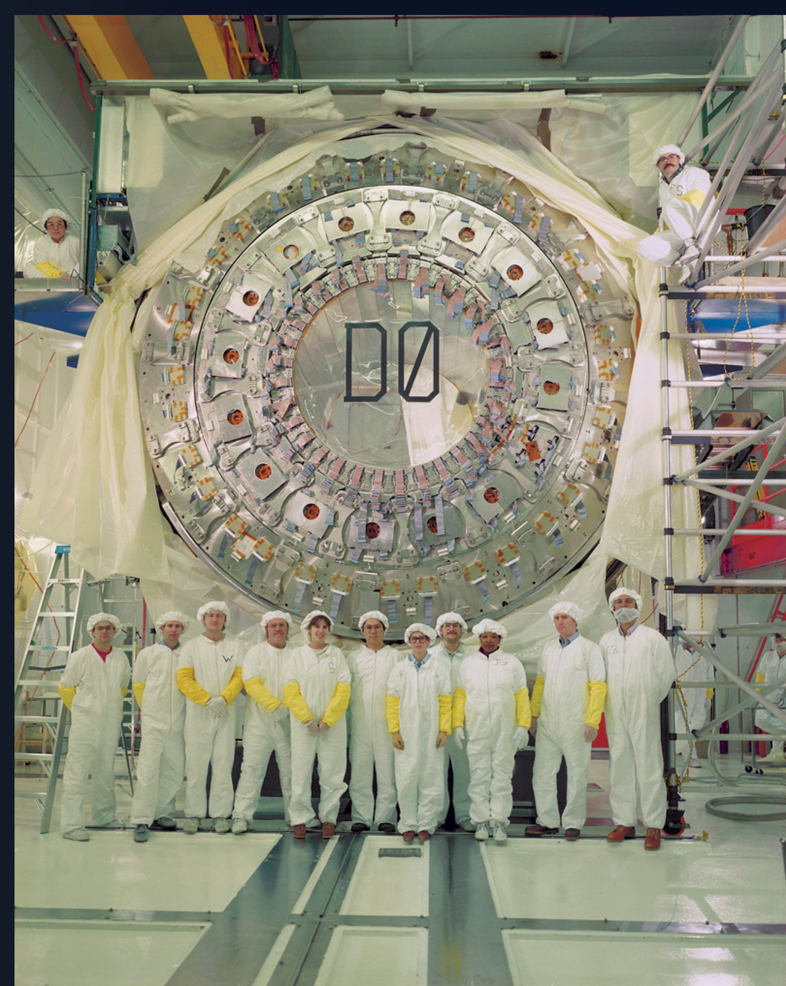


D0 Detector Central Calorimeter



D0 Detector South End Calorimeter

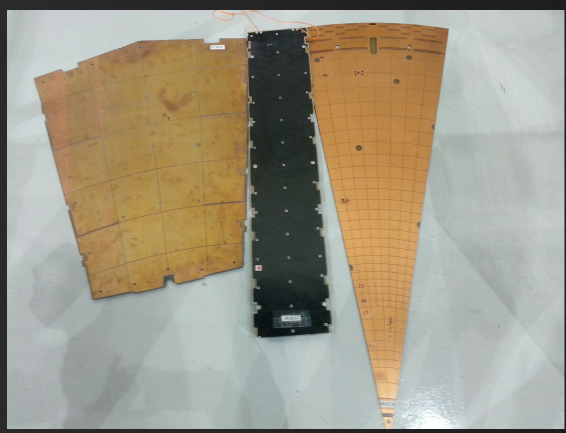
Assembled Central Calorimeter with Assembly Crew (*)



Uranium - Liquid Argon

The D0 uranium-liquid argon calorimeter consists of a cylindrical Central Calorimeter (CC) and two End Calorimeters, ECN (north) and ECS (south).

Each calorimeter contains an electromagnetic section closest to the interaction region followed by fine and coarse hadronic sections. The active medium for the calorimeters is liquid argon and each of the three calorimeters (CC, ECN, and ECS) is located within its own cryostat that maintains the detector temperature at approximately 90 K. Different absorber plates are used in different locations. The electromagnetic sections (EM) use thin plates (3 or 4 mm in the CC and EC, respectively), made from nearly pure depleted uranium. The fine hadronic sections are made from 6-mm-thick uranium-niobium (2%) alloy. The coarse hadronic modules contain relatively thick (46.5 mm) plates of copper (in the CC) or stainless steel (EC).



Read out boards: The shape of read out boards is different between the CC and EC detectors, long and thin in the CC while squarer in the EC. *(14, 15, 18)*

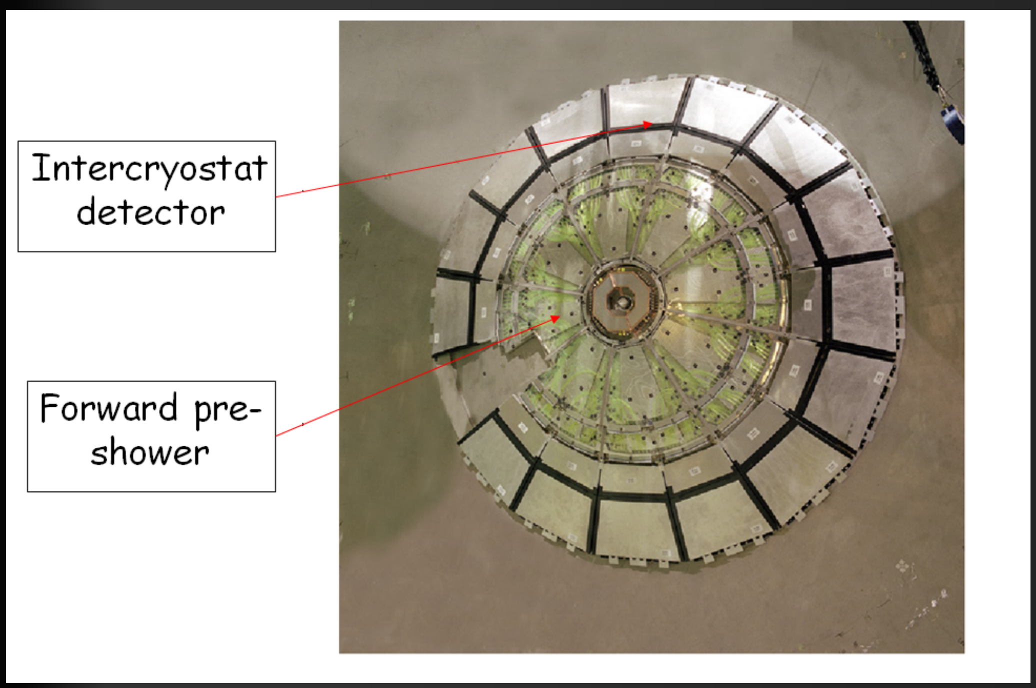
The interaction of the high-energy particles created in the collision with the uranium plates in the calorimeter creates a shower of particles with smaller energy that ionizes the liquid argon. The total amount of ionization charge is proportional to the energy of the particle that initiated the shower. The ionization is collected by copper plates (see picture above) where a high voltage is applied to attract the electrons freed in the liquid argon.

After the termination of D0 detector's operation, the liquid argon was transferred back to the Argon Storage Dewar, and all three calorimeters were warmed up. At this point, there is no intention to disassemble the calorimeters. The depleted uranium modules will stay inside the cryostats. Depleted uranium is a by-product of the uranium enrichment process. It is slightly radioactive and emits alpha, beta and gamma radiation. With the uranium safely enclosed in the cryostats, E\external radiation hazards are minimal. Alpha radiation has no external exposure hazards, as dead layers of skin stop it; beta radiation might have effects only when there is a direct contact with skin; and gamma rays are negligible - levels are extremely low. Depleted uranium is a pyrophoric material. Small shavings or even powder may ignite with presence of oxygen (air). Also, in presence of air and moisture it can oxidize. Depleted uranium can absorb moisture and keep oxidizing later, even after air and moisture are excluded. Uranium oxide can powder and flake off. This powder is also pyrophoric. Uranium oxide may create health problems if inhaled. Since uranium oxide is water soluble, it may enter the bloodstream and cause toxic effects. That's why it was decided to keep it safe in the cryostats.

Electronics that read the signal from the readout boards

Intercryostat detector

The Intercryostat Detector is located in the intermediate rapidity regions between the central and end calorimeters of the D0 detector and is designed to improve energy measurements in those regions. The ICD uses a layer of scintillator to sample particle showers as they pass through the detector. The amount of scintillation light is proportional to the energy of the particles in the shower. The frequency of the light is changed by wavelength shifting fibers embedded in the scintillator (see picture below). The light is then conducted by clear fibers to photomultiplier tubes that convert the light to an electric signal.



The Intercryostat Detector and Preshower Detector on the face of the south end calorimeter.

The missing tiles were removed to make room to cryogenic services.

ICD installation on the end calorimeter cryostat. The scintillation tiles are kept inside aluminum light-tight boxes. The scintillation light is conducted to the photomultiplier tubes using clear optical fibers.

Each ICD tile (11) is subdivided into twelve straight-edged trapezoidal subtiles. WLS fibers for readout are embedded into each subtile along the curved trapezoids.

Preshower Detectors

Preshower detectors are placed just after the solenoid and just before the calorimeter; they are positioned such that the showers of electrons and photons beginning in the solenoid coil are located and measured. The preshower detectors have much finer resolution that the calorimeter and thus assist in the tracking by indicating precisely where particles passed through the preshower detectors. They have three parts: central preshower detector (CPS) and two forward preshower detectors (FPS). Central and forward preshower detectors located just outside of the superconducting coil are constructed of several layers of extruded triangular scintillator strips that are read out using wavelength-shifting fibers and VLPCs (see Central Tracking System.aspx). The preshower detectors share common elements with the central fiber tracker, beginning with the waveguides and continuing through the entire readout electronics system. The last elements which are unique to the preshower detectors are the connections between the wavelength shifting fibers and the waveguides.

the Bulletin

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Detector Module Built at Brookhaven Featured in MoMA Art/Science Exhibit

BNL-linked science has once again entered the art world. Part of a detector — a "forward preshower (FPS) module," built at BNL for the DZero experiment at Fermi National Accelerator Laboratory (Fermilab) — is on display in "Signatures of the Invisible," an art exhibit at Museum of Modern Art's (MoMA) P.S.1 Contemporary Art Center Gallery (PS1), now in Long Island City, NY.

The exhibition, which is on tour in the United States, was born of a collaboration between artists of the London Institute, the world's largest college of art and design, and physicists from CERN in Geneva, Switzerland, the world's largest particle physics center.

The exhibition features contemporary art inspired by particle physics.

The initiative began in 1999 and resulted in a group of artworks' being exhibited in London, Beijing, Rome, Geneva, Lisbon, and now at PS1 until the end of August.

Elizabeth Clements of Fermilab's Public Affairs, who had been asked to find items for the show, had suggested entering the FPS module in the exhibit. She contacted the FPS production manager, Abid Patwa of BNL's Physics Department, who helped her put the display together. Said Clements, "As you can see from the picture, it is stunning to look at, and it also played a significant scientific role in the detector."

Patwa explained that the FPS detector is comprised of 64 modules. "The FPS module that was put on display was built as a spare," he said. "It is an exact representation of the FPS modules in the detector and is fully functional."

Now, the FPS module is among the works of 14 or so other artists all displaying the relationship between art and science.

Funded by the Office of High Energy Physics in DOE's Office of Science, the main part of the FPS detector was designed and built at BNL by a BNL and Stony Brook University collaboration, with some preparatory work done at Fermilab and the University of Illinois, Chicago, as was reported in the Bulletin of March 17, 2000, and CERN Courier of [illegible] (continued on page 2)

Roger Stoutenburgh

The BNL/Stony Brook University (SBU) Forward Preshower Detector team: (back, from left) Jonathan Kotcher, Anatoli Gordeev, Robert Soja, and Neil Donahue, all BNL; middle row: Bob Wheeler, BNL; Andrei Talalaevskii, SBU; Peter Yamin and Russell Burns, both BNL; (front) Satish Desai, SBU; and Abid Patwa , then SBU, now BNL. Other team members (not pictured) include Julian Brody, James Joffman, Laura Mgrdichian, Michael Rijssenbeek, Dennis Shpakov, and Jack Steffens, all of SBU; Ming Xiong Liu, BNL; and Manho Chung, University of Illinois, Chicago.

Photo courtesy of Fermi National Accelerator Laboratory

A module from the Forward Preshower Detector, built at BNL for the DZero experiment at Fermi National Accelerator Laboratory, is on exhibit through August at the Museum of Modern Art's P.S.1 exhibit, "Signatures of the Invisible."

Sambamurti Memorial Lecture, 4 p.m., 7/25

BNL, Battelle Biological Research Collaboration

The Forward Preshower module (12) contains arrays of plastic triangular scintillating strips in which green wavelength-shifting fibers are embedded. The connectors have been diamond-polished to optimize the light yield from the device. The strips are assembled into trapezoidal sections that are bent three-dimensionally to fit the surface of a large sphere. Clear fibers disperse from the center of a module, delivering blue LED light into the green fibers to monitor the system's performance.

(*) Among others, on the picture are: top left: Jaehoon Yu, bottom row: Gerald Blazey (left), John Najdzion (4th from left), Sarah Durston Johnson (5th from left), Bob McCarthy (2nd from right), top right: Sandor Feher