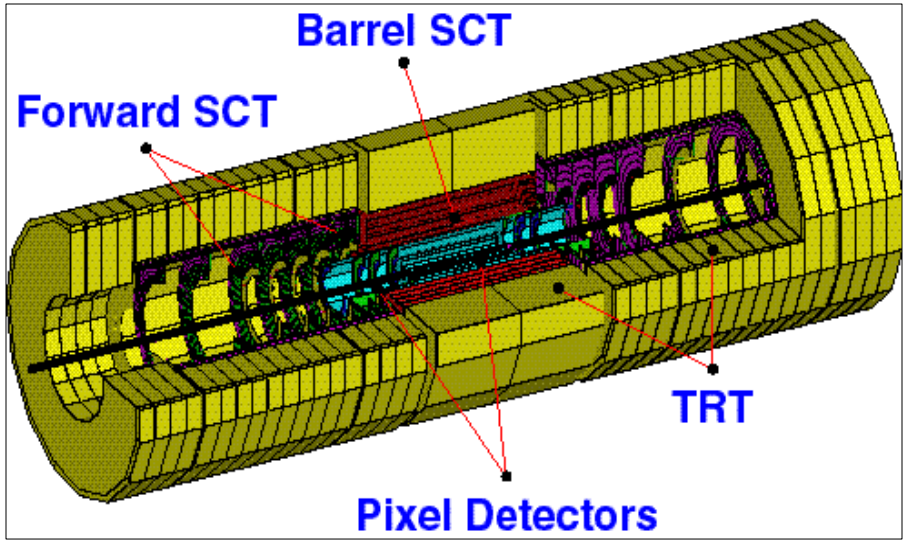
What's new with TRT?

- Physics with TRT
- Progress in 1999
  - Barrel and electronics
- Completion of
- Module 2.0, 3.0
- Component production
  - straws shells HV plates
- Module Production



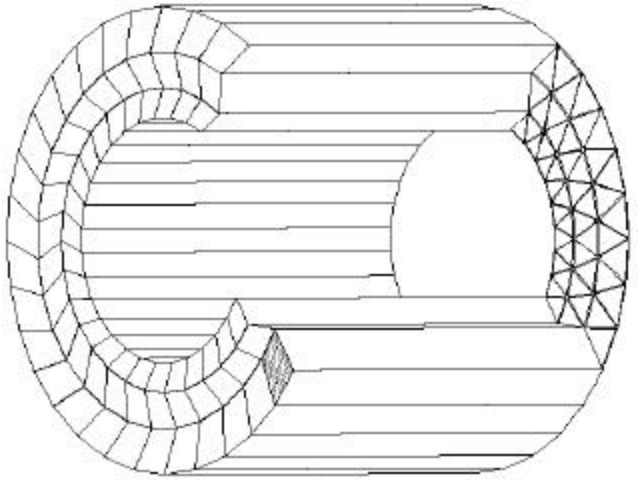
US INSTITUTIONS-TRT BARREL

Mechanics

Duke University

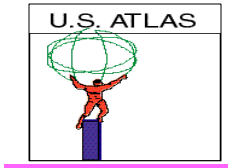
Indiana University

Hampton University



Electronics

University of Pennsylvania

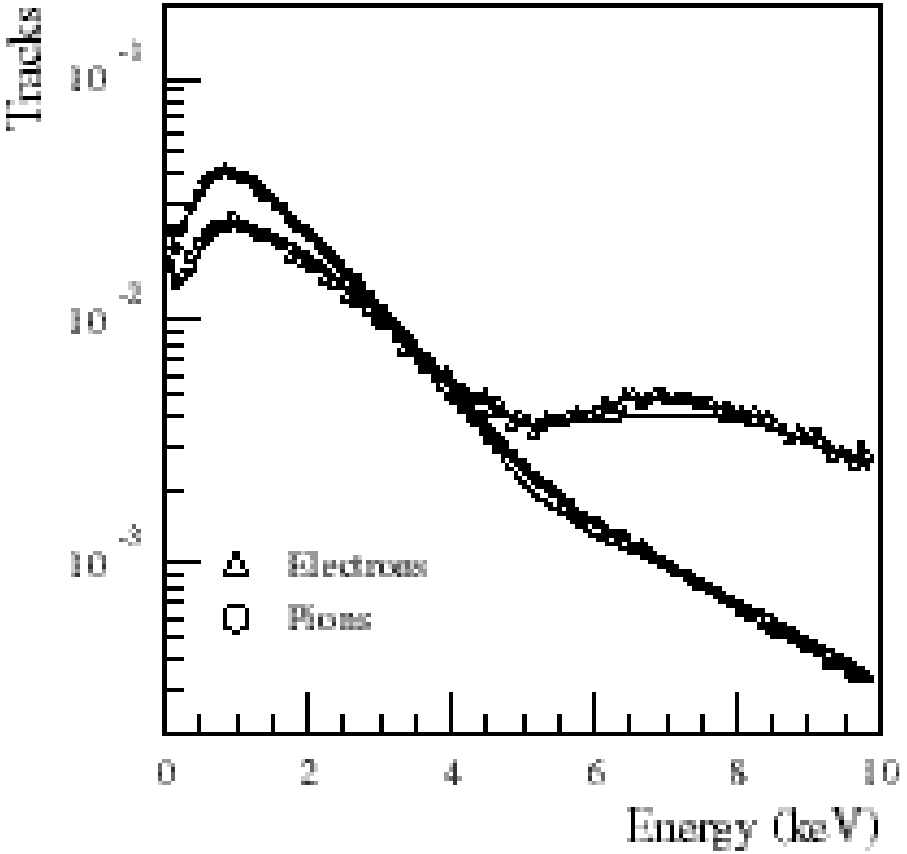


Purpose of Barrel TRT.

- **e/π separation**
  - **TRT system - rejection factor of 50-100 for pions with an electron efficiency above 90%.**
- **Momentum resolution**
  - **Important contribution to the momentum measurement precision for charged particles.**
- **Tracking finding**
  - **Barrel is an important starting point for track finding**

e/pi separation

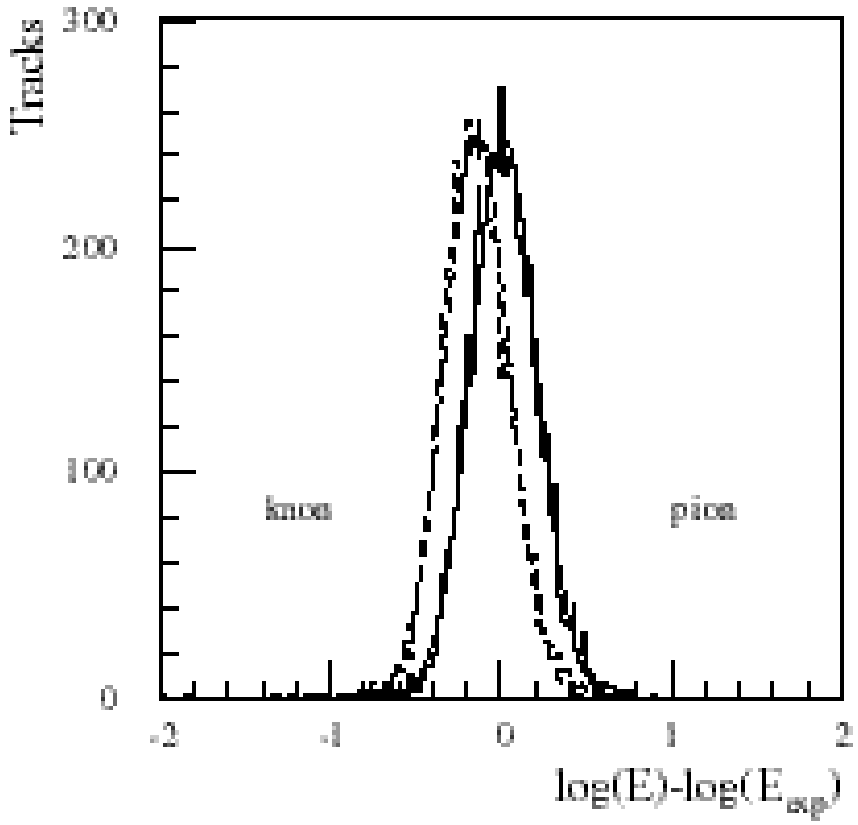
- Transition radiation produces a gamma dependent photon radiation with a substantial high energy component > 6 KeV. A high threshold discriminator on front-end electronics registers the straws that have pulse height > 6 KeV.
- Requiring greater than 5 high threshold hits on a track identifies the track as an electron with ~90% efficiency and about <2% pion fake rate.



Physics TDR update
dE/dx with TRT

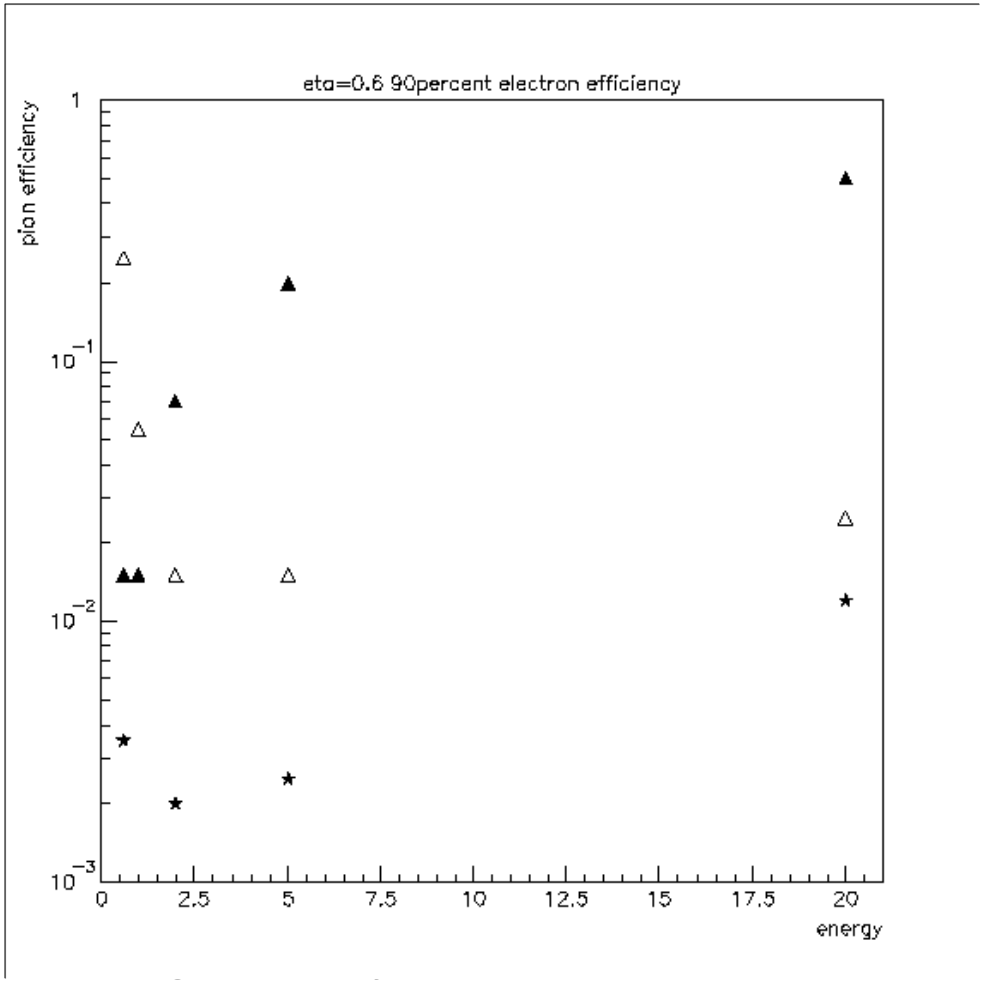
Something new in the Physics TDR.

In addition to the transition radiation measurements, the TRT can be used for particle identification with a measurement of the energy loss. Initial work by D. Rousseau at CERN.



More dE/dx with TRT

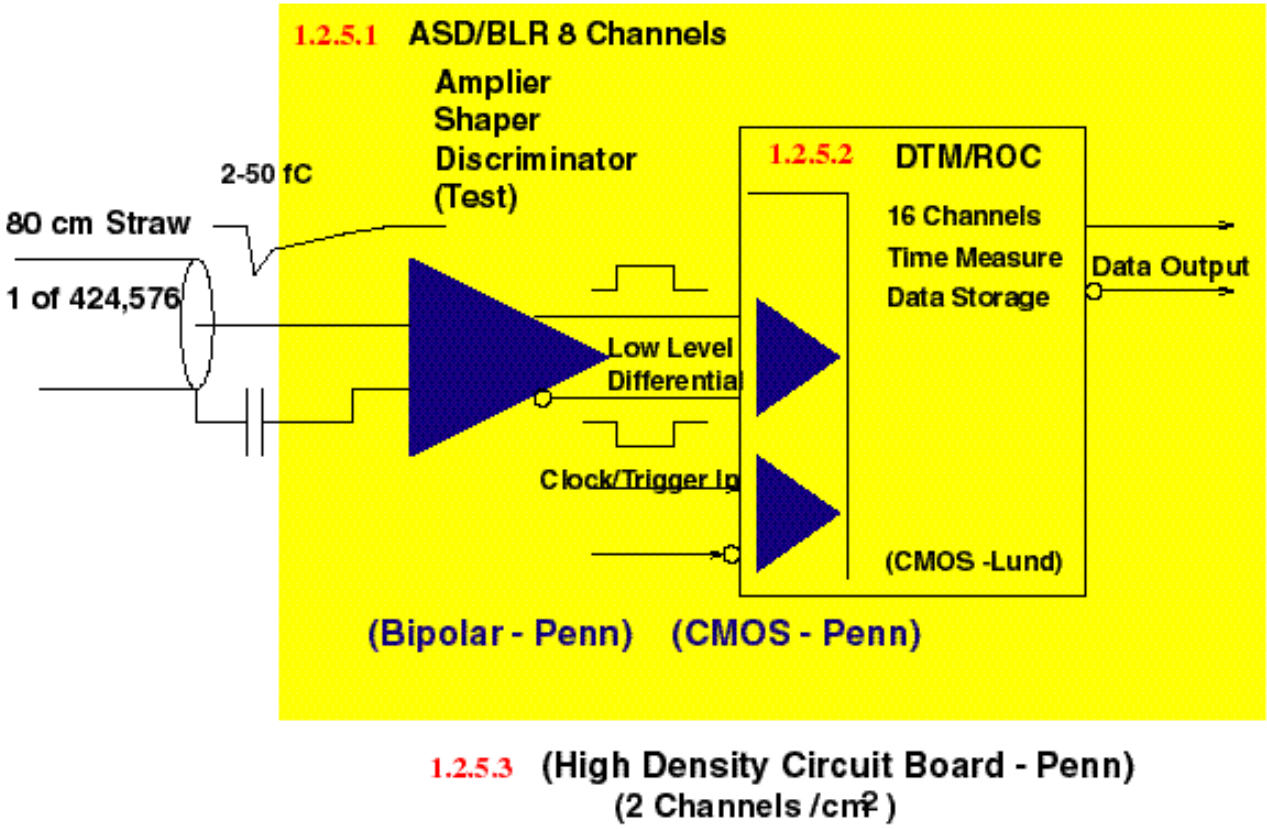
In another preliminary study by A. Manara at Indiana, the dE/dx is measured using the width of the low threshold signal. Using mean values for a track gives approximately the same e/π separation as TRT! Beam tests need to be done to comfirm this.

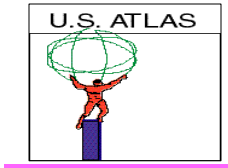


Barrel TRT Front End Electronics

Simulation of ASDBLR, DTMROC designs are now complete.

Preparation for submission by end of July or early August.





ASDBLRs

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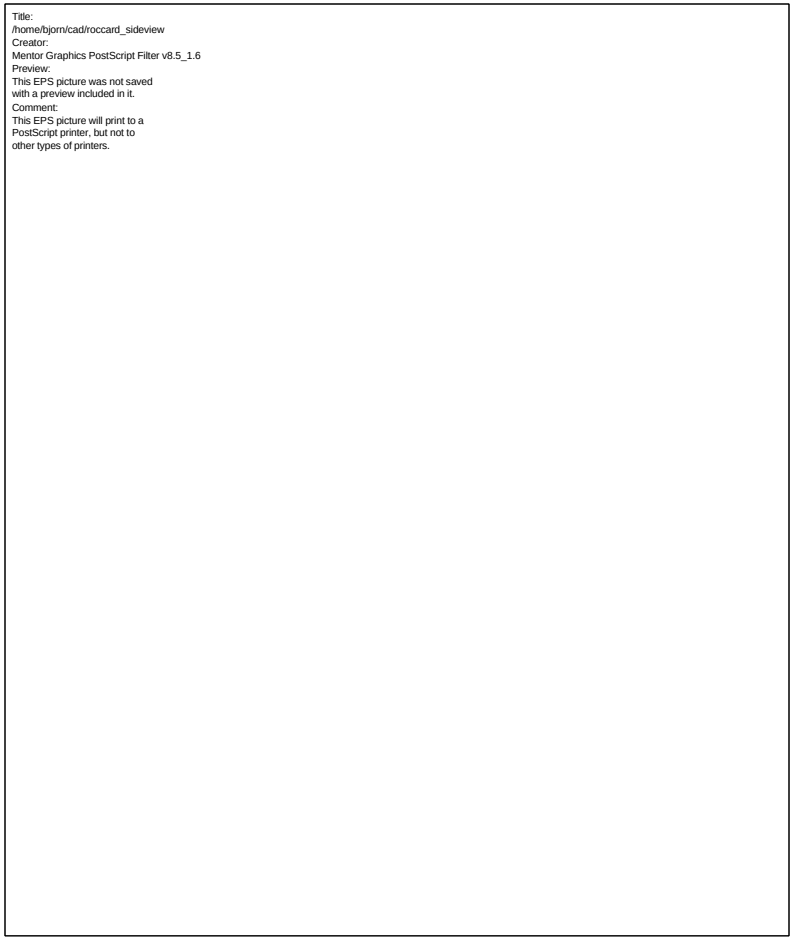
DTMROC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PostScript printer, but not to
other types of printers.

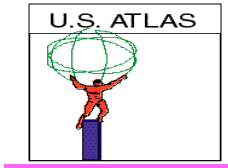
DTMROC responsibility at PENN

- **Ternary Receiver**
  - decodes tri-level differential signals
- **Differential Driver**
  - LVDS compatible
  - tri-state
  - programmable current drive
- **Test Pulse**
  - programmable delay
  - pulse shape similar to Xenon chamber signal

- **Command Decoder**
  - decodes all commands for Level 1
- **Top Level Verification- Spice**
  - Spice level simulation of all functionality
  - basic time measurements
  - writing into pipeline
  - Read/Write Registers
  - Receiver/Drivers, Test Pulse
- **Top Level Verification- Verilog**
  - taken over the top-level verilog code, testing

Subsystem tests

- **At our June TRT workshop in Krakow we worked out a system test plan for all module 0's**
  - **Penn will have a miniROD readout scheme in operation this summer. They will prepare for barrel module tests using existing DTMROC and ASDBLR chips.**
  - **In September Duke will have finished x-ray scans of Mod. 2.0. This module will go to Penn.**
  - **Module 3.0 tests at Indiana will focus on tension plate cross talk analysis, and mechanical stack up evaluations. August- September.**
  - **Module 1 will be built with production grade components. When Module 1 is completed in October it will go to Penn for final system test.**



System Test for TRT

- **Tests of Endcap Sector Prototype**
  - Underway at Penn & CERN
  - during last year
  - 64-300 channels
  - noise immunity looks promising
- **Tests of Barrel Module at Penn**
  - Sept- Nov 1999
  - 200-300 channels
  - existing ASDBLRs, DTMROCS
  - will use Mini-ROD in VME crate
  - verify operation at low threshold,

- **Test of full 8-layer endcap**
  - Jan-May 2000
  - 3000-4000 channels
  - new ASDBLR and DTMROC
  - major sign off on test of electronics,
  - cooling, electro-mechanical
- **Test of completed barrel module**
  - Feb-June
  - 1600 channels
  - new ASDBLR & DTMROCS chips
  - revised “postage stamp” PCB design
  - final “sign off” test of
  - electronics, cooling, electro-mecanical

Module 0 assembly - Production

Evaluate components Work out assembly techniques Test operation

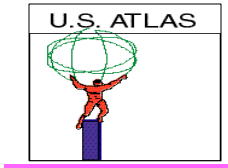
Finalize all QA documents and Assembly documents

- Module 2 .0 - Duke
  - Assembly complete
  - Wires are strung (520)
  - HV tests
  - Xray wire scan of wire and straw positions
  - gain vs Z.

- Module 3.0 Indiana
  - Assembly complete
  - Wires are strung (796)
  - Tension testing complete
  - HV testing underway
  - Gas sealing- tests underway
  - Cross talk testing

System test at Penn beginning in September, 1999.

Module 1 will be assembled from production components



Facility preparation

- **Hampton**
  - Straw pressure testing, twister gluing, cutting
  - Divider and radiator assembly
  - High Voltage plate assembly, capacitor assembly
  - Final module scanning
- **Duke**
  - Wire joint production
  - Module assembly
- **Indiana**
  - Shell preparation
  - Module assembly

Facilities at Hampton

- Jefferson Lab
  - **Use Clean Room for inspection and storage**
  - **Set up of assembly stations**
  - **Use ventilated oven for shrinking foam parts and curing epoxy**
- Hampton University
  - **New assembly area almost complete- move in August and begin component preparation.**

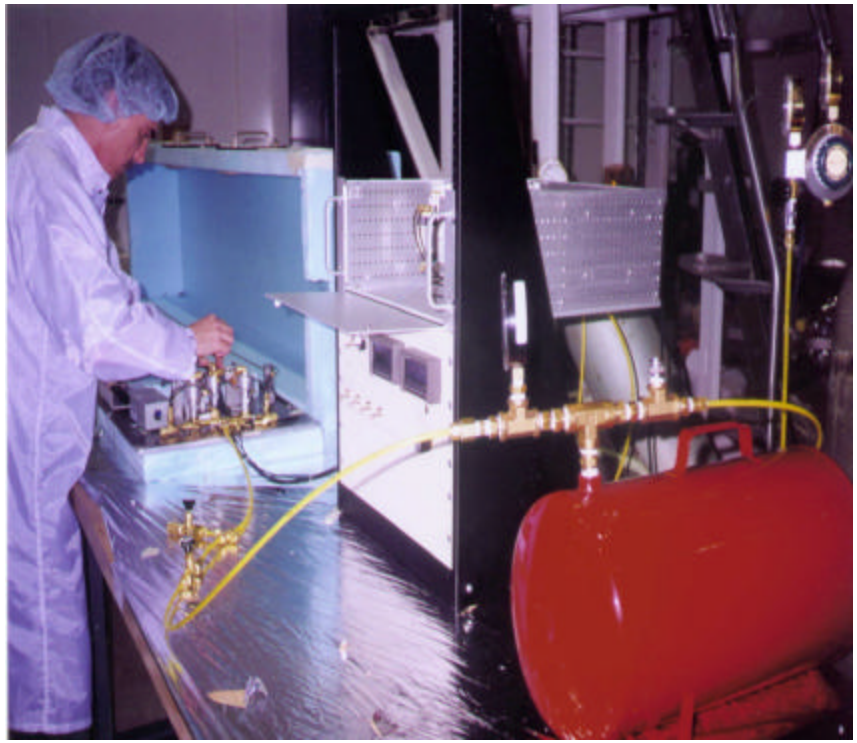
H. Ogren - BNL July 21, 1999

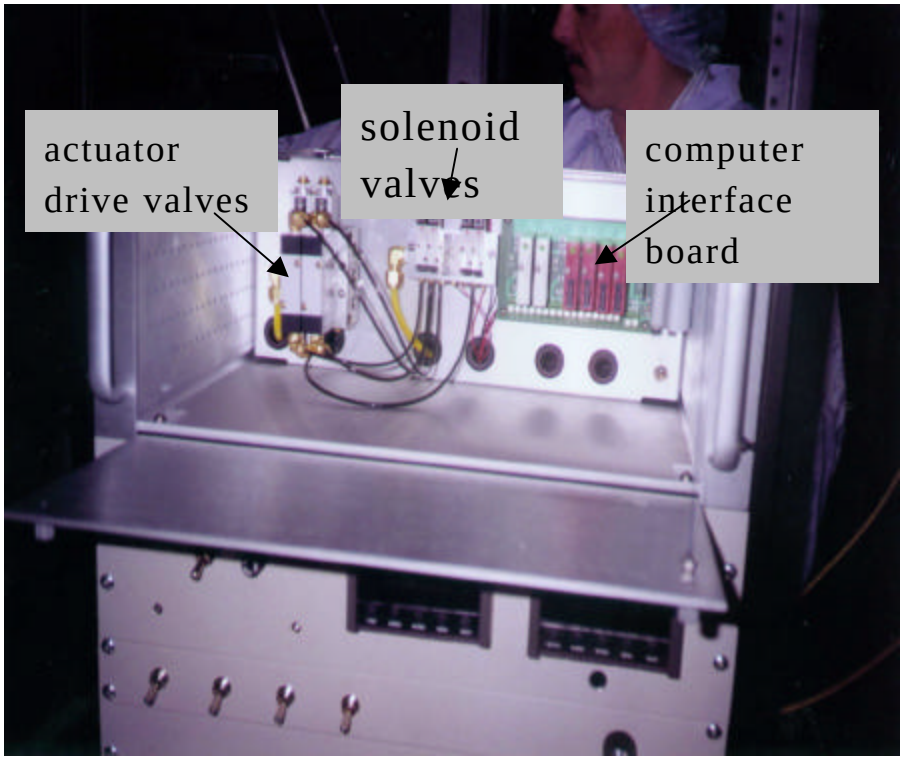
Straw Leak Testing

- **With one straw tester the rate was five minutes/straw. This could be a bottle-neck in production, PRR requested automation**
- **A study with a one-straw and a two-straw manual system gives the time taken for N straws tested manually as (4+N) minutes. If some aspects are automated, this may go to (3.5+0.5N) minutes.**
- **120 straws/shift required**

No. of straws tested/cycle	Manual	Automated
1	72	90
2	120	160
4	180	260
8	240	380

Two straw leak test & control box

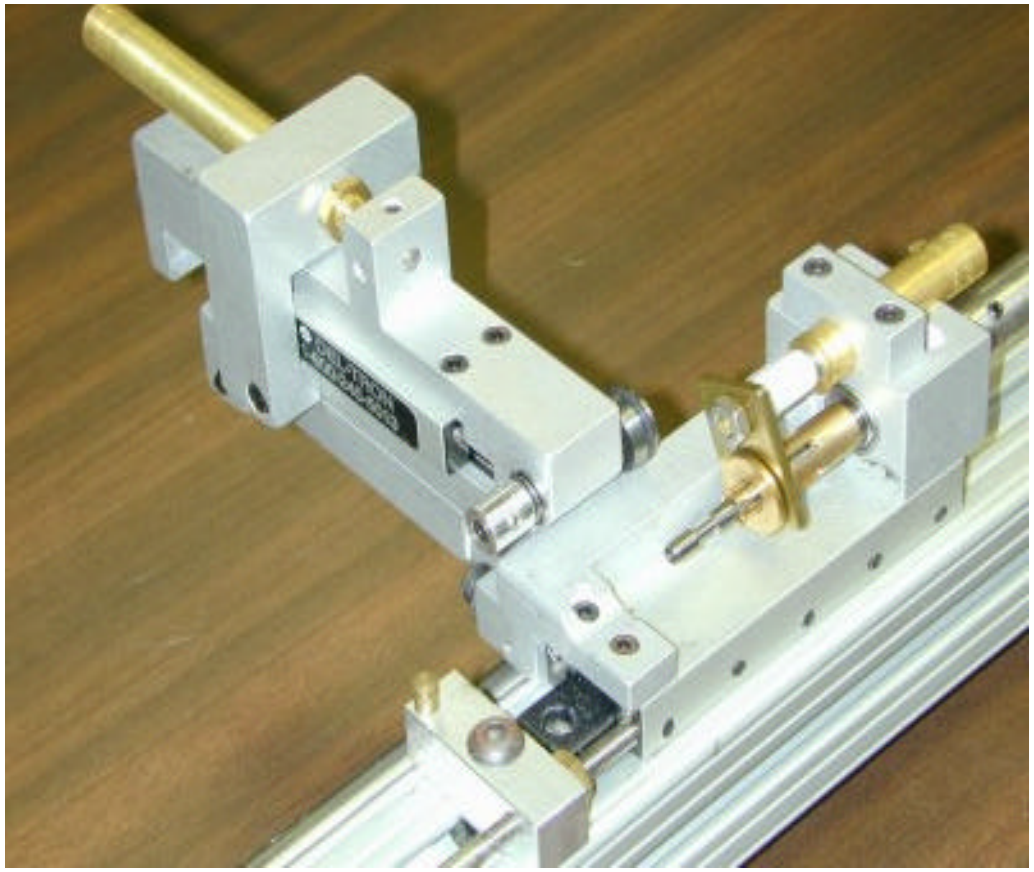




Note: designed to operate 8 straw system

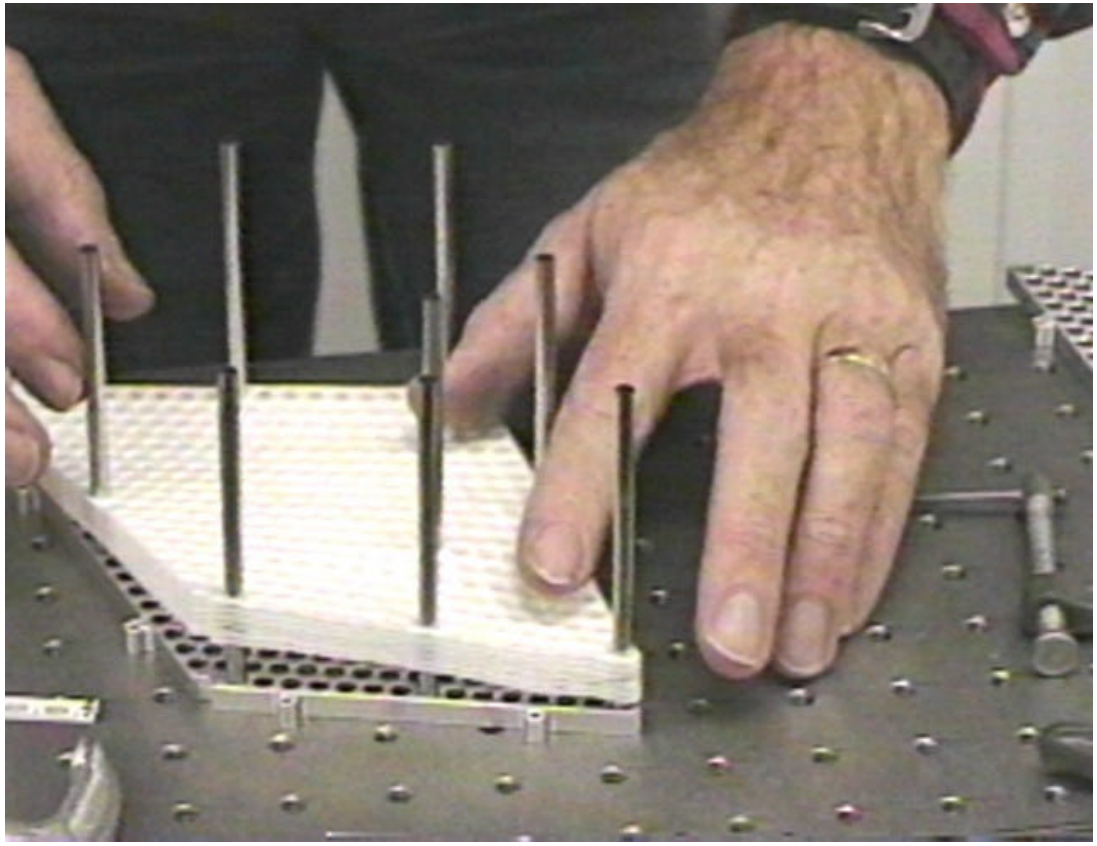
Straw cutting head features

- Carbide knife and anvil
- Pre-loaded knife and anvil bearings to control longitudinal position of cutting edges
- Positive straw drive by collet with five angled slots to ensure gripping 4-fiber straw
- Coarse and fine cutting edge position adjustments



Radiator assembly

Punched radiator material is received at Hampton.
Radiator packs are assembled and inspected.
Shipped to Indiana and Duke.



Divider storage

- **Divider preparation**
  - Facilities in place
  - Procedures in place
  - Tooling available for low rate
  - Full production rate expected to be 12-15 per day; ~700 to do (min. is 666 assembly operations)
  - Parts on order for full production
  - Parts in bar-coded storage
  - Dividers in bar-coded bags

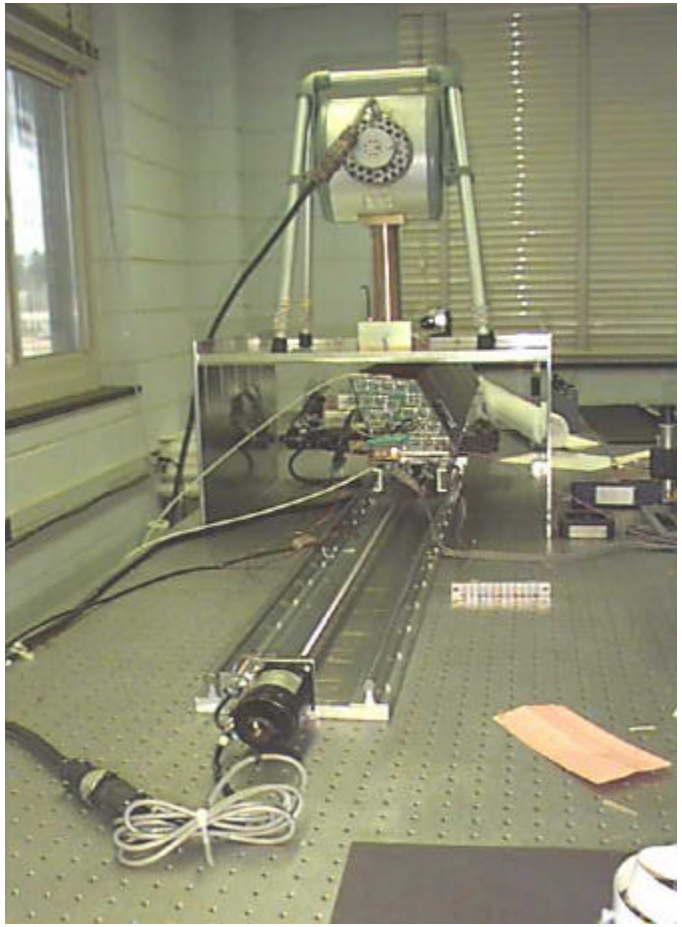
Duke Assembly

Wire Joint production

- Wire joint manufacture will be done at Duke University
- They are setting up a facility the manufacture of 70,000 wire joints on ~ 150 Km of wire.

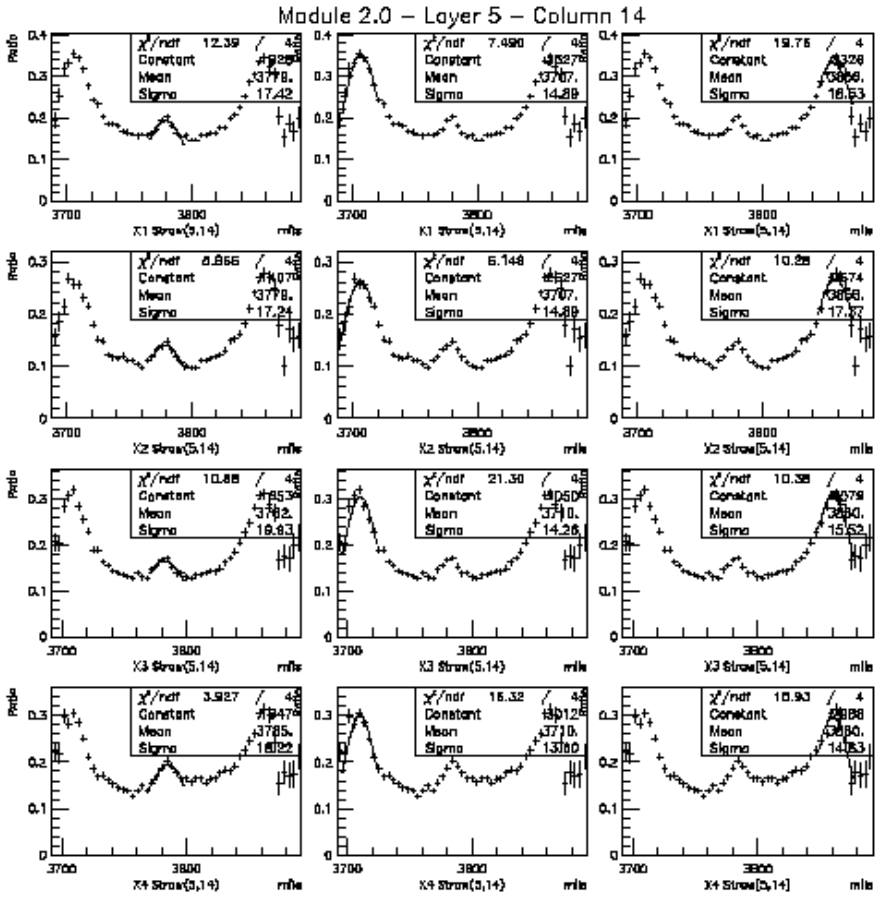
xray scan (Duke)

- Duke has developed an x-ray scanning technique that can image the wires and straws.
- A similar facility will be set up at Hampton for the final module mapping for all production modules.



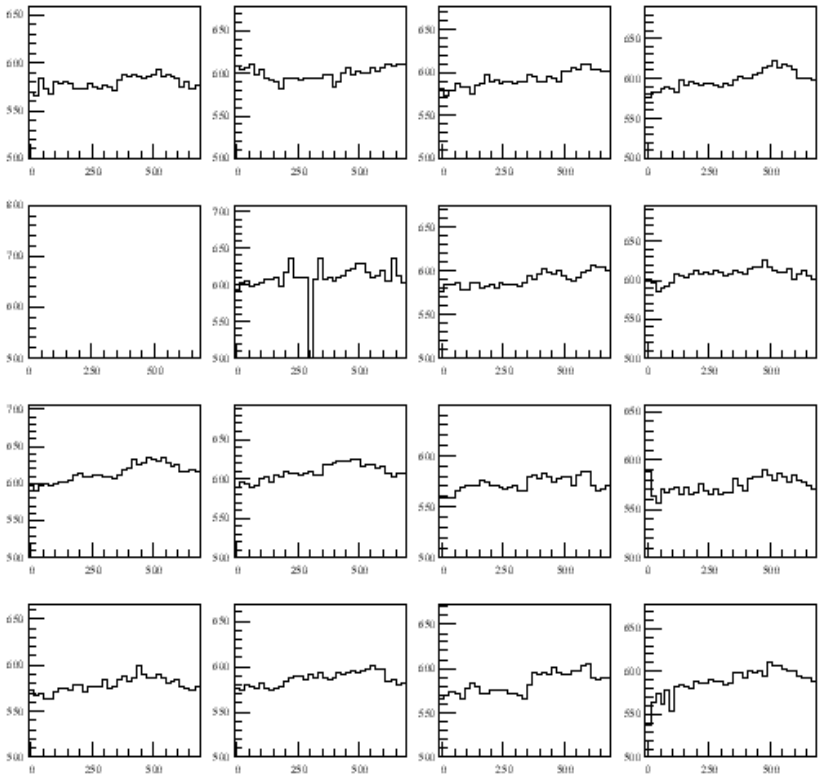
Wire placement measurements

- Multiple straw scans with Xray beam collimated to 100 microns.
- Determine the position of the wire and the straw with an accuracy of about σ =50μ
- Figure show 4 separate wires scanned at positions along their length - Mod 2.0
- Module can be rotate to scan the orthogonal coordinate.



HV and Gain tests (Duke)

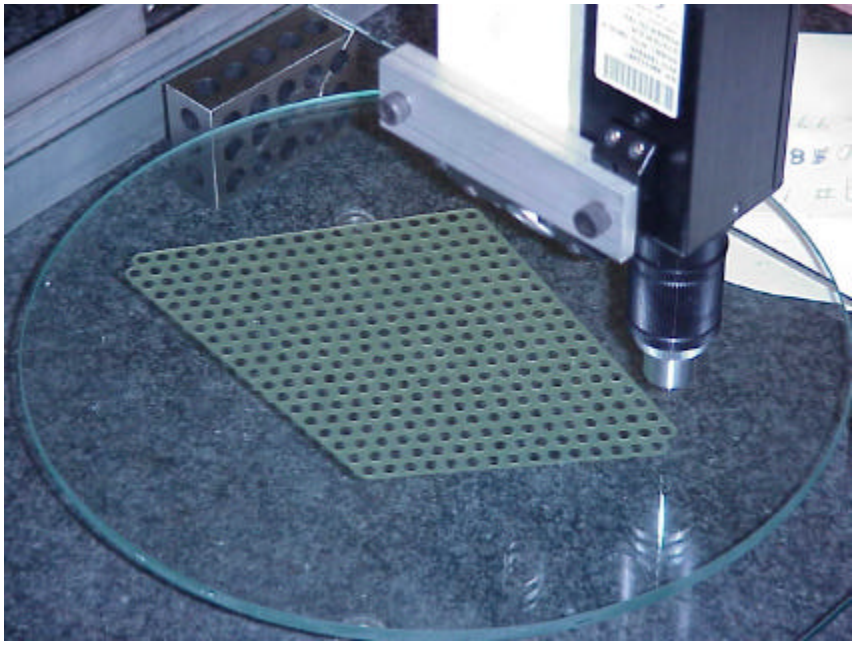
- Gain measurements on the Module2.0
- More than 200 straws have been measured. Gain vs. z position.
- Most straws are within +- 3%
- Correlation with wire position is under way.



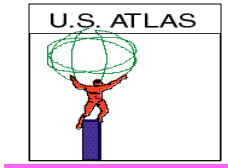
Indiana Assembly Area

- Preseries shells are being measured at Indiana University.
- Module 1 preparing for assembly.
- Production tooling for shells will be completed in a few weeks.

Divider Inspection



- **Divider production is underway.**
- **Initial sets of FR4 divider foils are measured at Indiana with a CMM optical scan before being sent to Hampton for assembly. Need to verify the hole placement and diameters.**

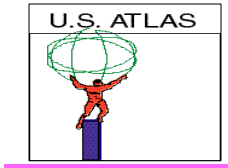


Module carbon composite shells

- This was the largest single purchase. Contract written, cost was on budget.
- Vision composites has completed the pre-series of Module 1, 2, 3 shells.
- QA at Vision has finished
- Shell are now at Indiana for verification of measurements and go ahead for full production.
- If Module 1 shell meets specs it will be used to start Mod 1 construction immediately.
- If Module 3 meets specs sent to Duke to start Module 3.1 immediately.

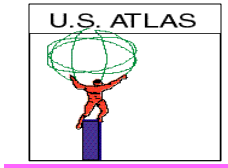
Vison composites

Vison Composites has produced three production modules. They have be been measured for straightness and twist. They are now at Indiana University.



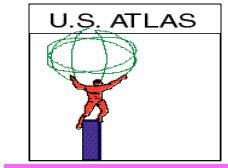
Straw production

- Lamina completed a 10000 straw run in June.
- Straws have been shipped to PNIPI (9000) and to Dubna (1000).
- PNPI will reinforce about 500 straws the last week of July
- PNPI will ship these to Hampton.
- Hampton will insert center wire guide, pressure test, cut
- Hampton will ship to Indiana for assembly of Module 1
- Regular shipments will follow.



Signal wire

- **Wire aging**
  - **Tests at three institutions have now verified that earlier indications of wire aging (loss of gain) were due to small amounts of water permeating through the straw walls. Aging disappears when the straws are used in a CO_2 environment.**
  - **Tests at Indiana are continuing on several wire types. We have accumulated more than 6 C/cm on several wires.**
  - **Wire specifications are being written up at CERN**
  - **Wire will be ordered in September. We expect to an initial delivery very soon after that for beginning wire joint production.**

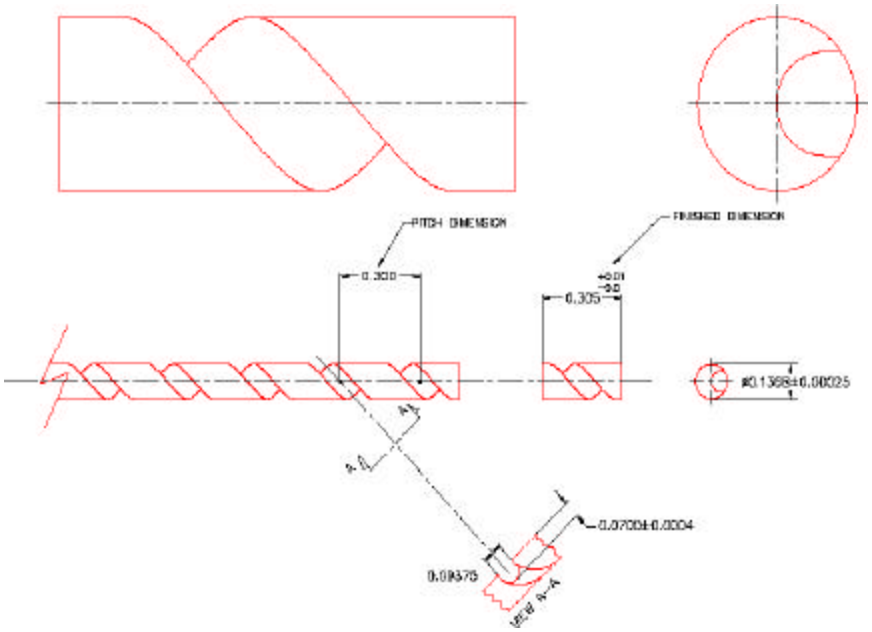


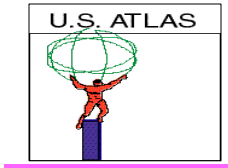
High Voltage plate

- The high voltage plate is probably the most complicated element in the module. It interfaces with shell, HV connectors, gas system, alignment, tension plate and frontend electronics, and cooling plate.
- Production review at Krakow focused on several details of the design that could increase our risk. We are working to redesign some details on the HV feed, methods of bonding the three elements of the plate, and compatibility with the electronics envelope.
- Preseries RFQ has been sent out. Contract work is almost complete. Tests on the preseries components will give us confidence about starting the production.

Wire Guides

- A preseries of Ultem twisters is scheduled for early August.
- The preseries of Ultem sleeves should be finished about the same time.
- The preseries of Ultem endplugs will follow shortly after the sleeves.
- Assuming that the components meet our requirements we will go into production and the preseries will be used in Module 1



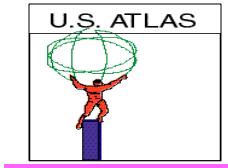


Cooling plate

- **Previous discussion about aluminum or pyrolytic graphite cooling plates was finalized at the TRT meeting in Krakow.**
- **The aluminum plate design is the base line. We could not justify the large additional cost of pyrolytic graphite with the small savings in radiation length.**
- **However, we also learned at Krakow that the power consumption of the DTMROC (and perhaps the ASDBLR) may go up. This forces us to redesign a cooling system that has a capacity of 100 mW/ch instead of 75 mW/ch.**
- **This is a very active area of R&D at the moment; Thermal model being created, prototypes being built and a new look at the over all design is under way. We are trying to do this in a way that will be decoupled from our module assembly schedule!**

Automation

- Picture- HV tester -Duke
  - Autoscan of up to 100 HV islands. Measure currents.
- xyz scanner (Indiana)
  - Video inspection of ends of straws and glue joints. and glue machine.
- Auto glue application
  - Apply precise amount of glue to endplugs during assembly.
- LabView-BridgeView interfaces for most production stations.
- Access data base for inventory and QA.



Conclusions

- Major components are beginning production (shells, dividers, radiators)
- Module component costs have been on budget.
- Our schedule is being delayed by HV plate redesign and manufacture, cooling plate redesign. We expect wire guide and straw delivery in August, several months behind schedule. Although we have made excellent progress in many areas, we are behind schedule for startup of production by about four or five months.
- We have a detailed plan for getting into production this year and completing module production on time - May, 2002.