Assembly and Maintenance of the ATLAS Pixel Detector

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TDR Review, LHCC Meeting

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Outline of Presentation

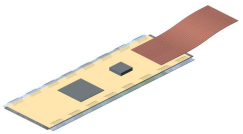
- **Manufacture and Assembly**
- **Installation into Inner Detector Barrel**
- **B-Layer installation**
- **Maintenance**

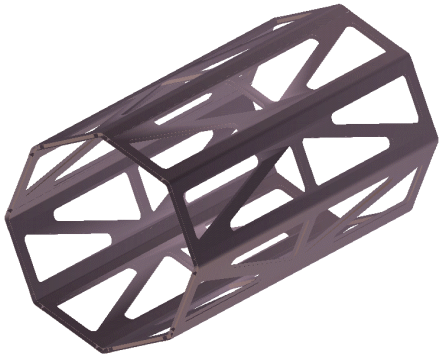
Manufacture and Assembly

- **Module Assembly**
- **Stave/Sector manufacture**
  - Module Placement and Tests
  - Metrology
- **Local Supports Assembly**
  - Barrel/Disk Assembly
  - metrology
- **Global Support Structure Assembly**
- **Final Integration and Assembly (at CERN)**

Manufacture and Assembly

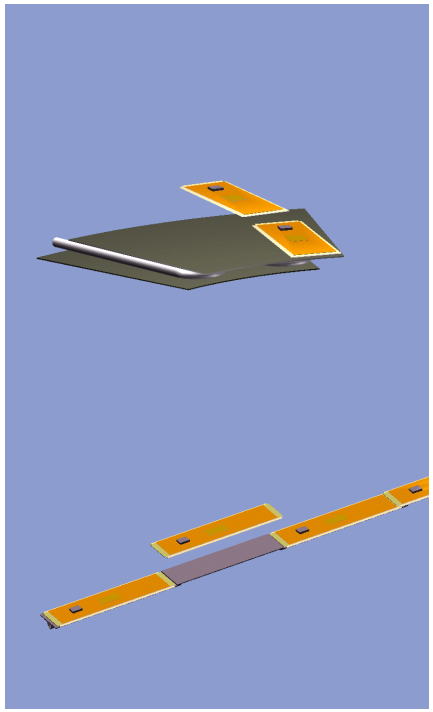
- **Parallel Manufacture of**
  - Modules
  - Local Support Elements
  - Global Support Structure
- **Module Placement**
  - Couples Modules to Thermal Management Structures
  - Occurs in Parallel with Manufacture



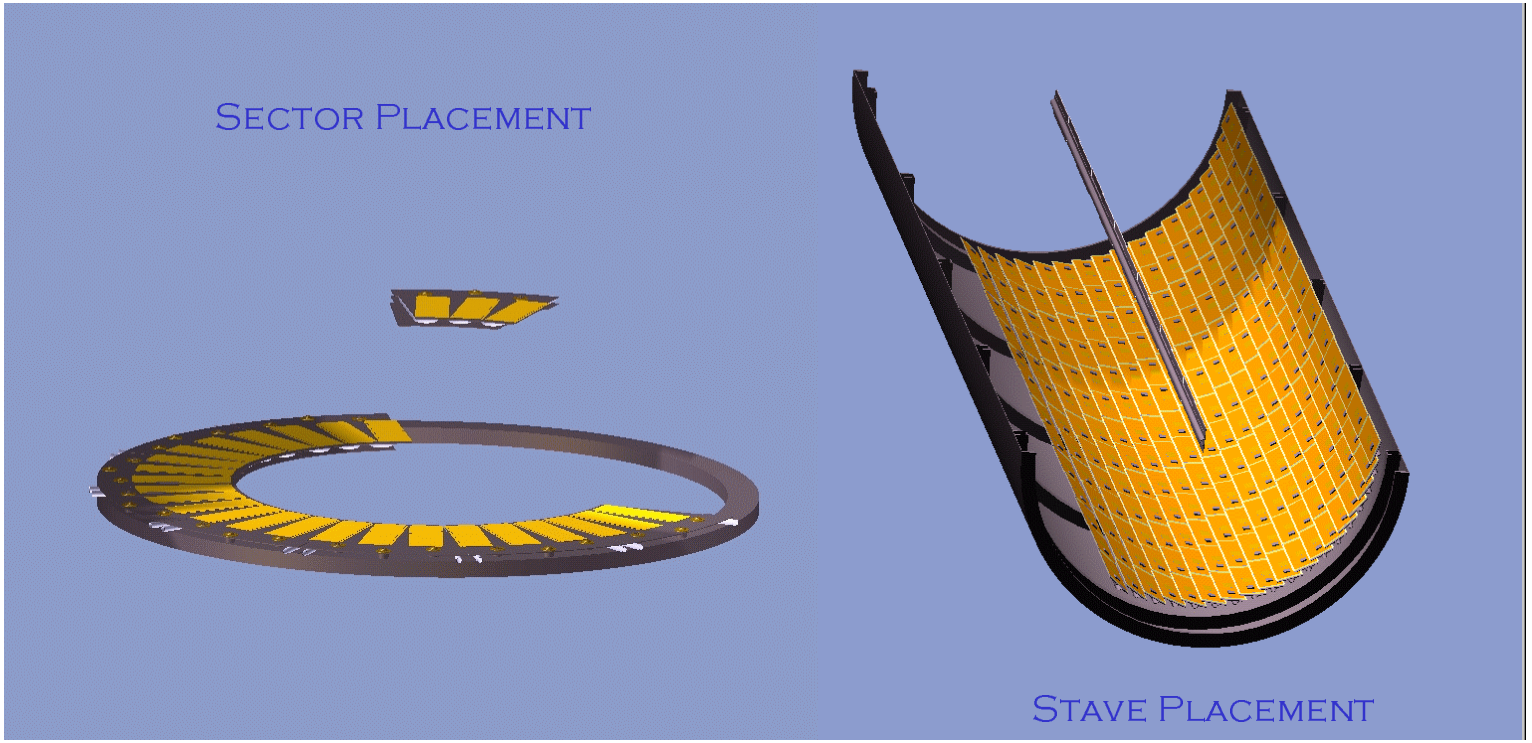


Module Placement and Test

- **Placement**
  - Placement tolerances determined primarily by required overlap
  - Positions Measured after placement
- **Module Testing On Supports**
  - Thermal Tests
    - Determine thermal coupling of modules
  - Repeat Electrical Tests
  - Complete System Test of Local Supports
    - Determine overall thermal performance and deflections



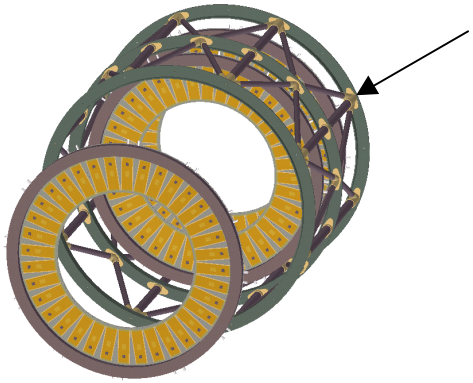
Disk and Barrel Assembly



- **Global Placement of Modules Measured**
- **Thermal Stability will also be determined**
- **Disks and Half Barrels Delivered (pretested) to CERN**

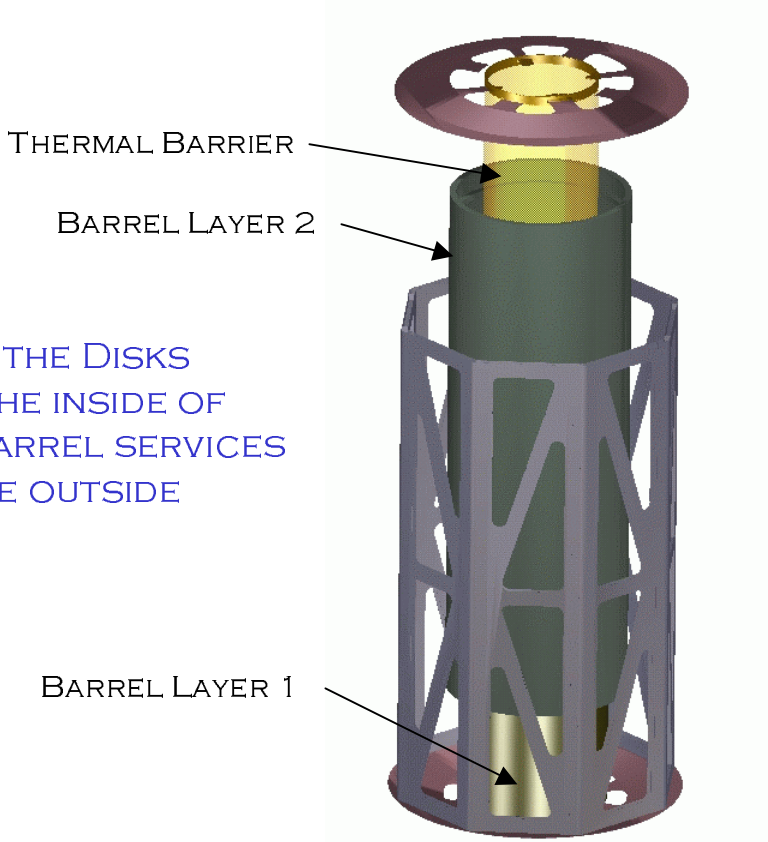
INTEGRATION WITH SUPPORT FRAME

DISKS AND BARRELS ARE MATED WITH RESPECTIVE SUPPORT FRAMES PRIOR TO OVERALL ASSEMBLY OF DETECTOR



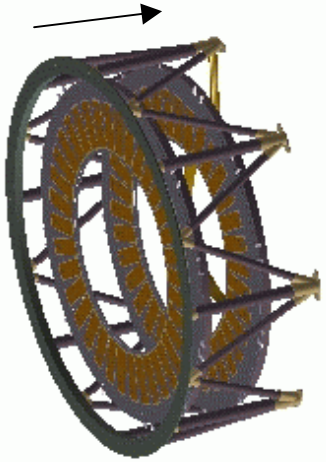
SERVICES FOR THE DISKS WILL RUN ON THE INSIDE OF THIS FRAME, BARREL SERVICES RUN ALONG THE OUTSIDE

DISK ELEMENTS ARE INSERTED INTO END-FRAMES WITH SERVICES RUNNING ALONG INSIDE OF FRAME

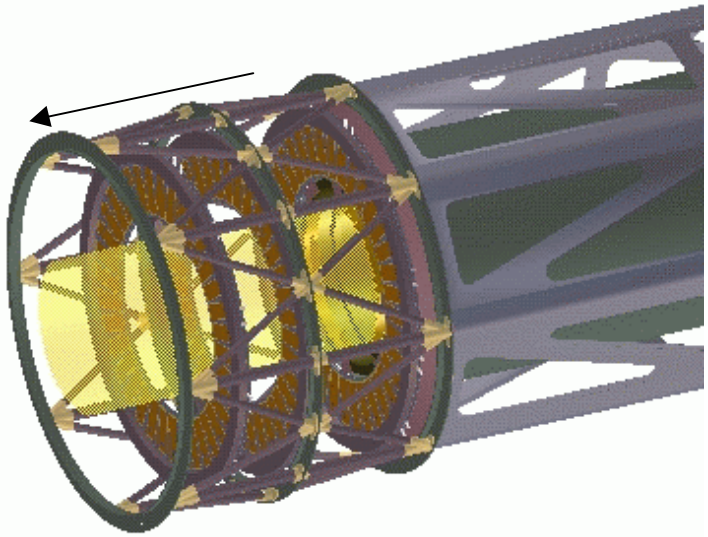


BARREL REGION IS ASSEMBLED VERTICALLY

Pixel Detector Sub-Assembly



This is the Gap where Services Turn up to PPB1

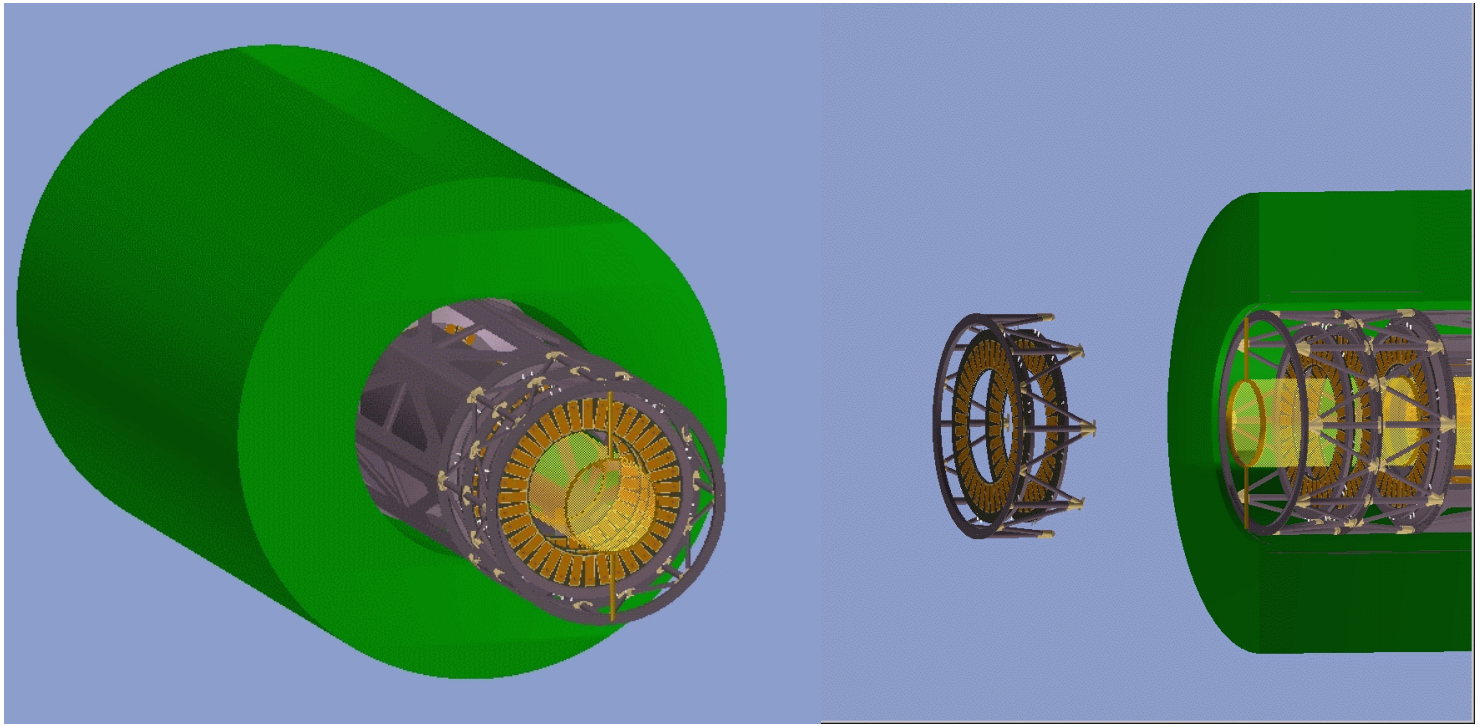


Disks 1-3 are within the SCT Barrel

Disks 4-5 Extend Beyond the Barrel Region

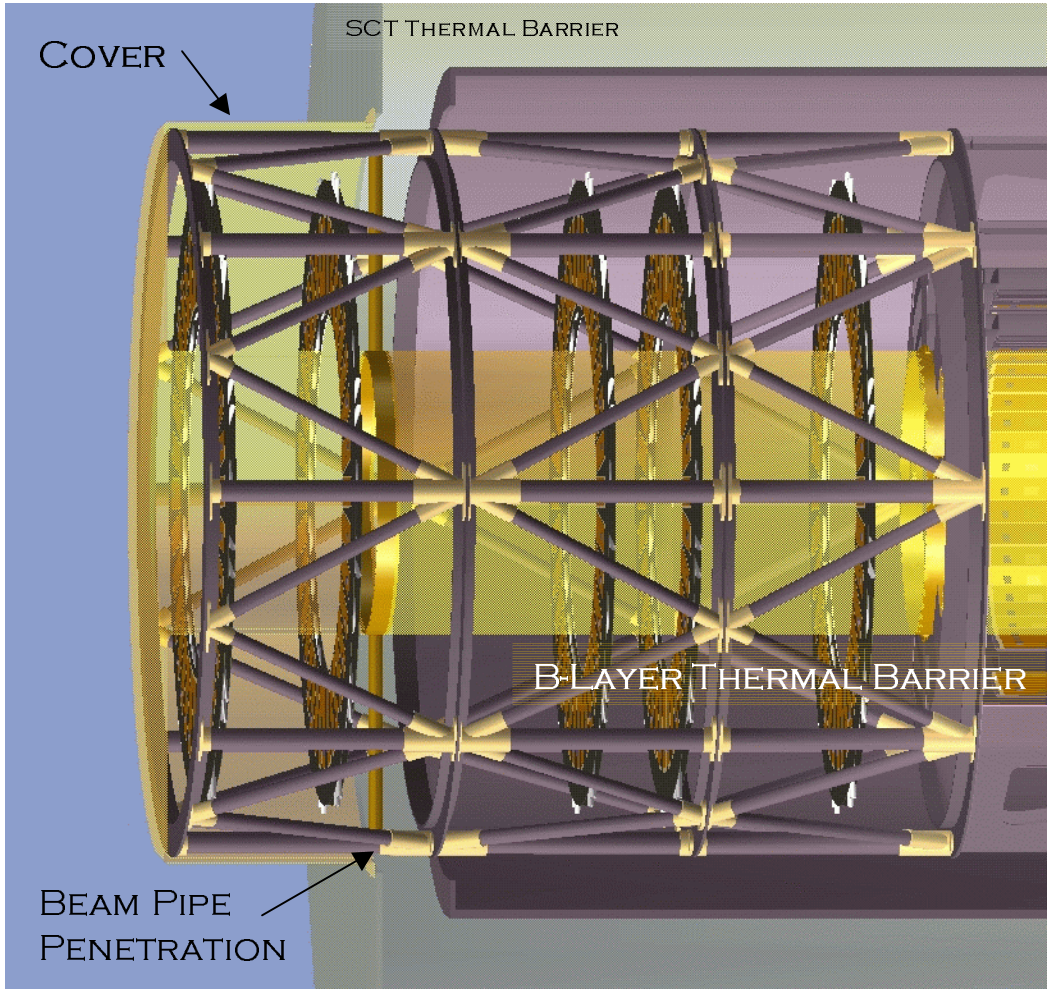
It is logical to break up the Disks in this way to facilitate routing of services during assembly

Overall Assembly



The Pixel Detector is inserted into the SCT volume without Disks 4-5 which are mounted after the services for the rest of the Pixel Detector are in place

Integration into ID Barrel



After mounting Disks 4-5, the thermal barrier is terminated to the SCT Barrel Thermal Barrier, as well as the B-Layer Thermal Barrier via the cover over the end of the Disk Region

The Beam Pipe penetrates the pixel detector at the location of the thermal barrier support

Beam pipe is not installed until after Barrel is lowered and installed.

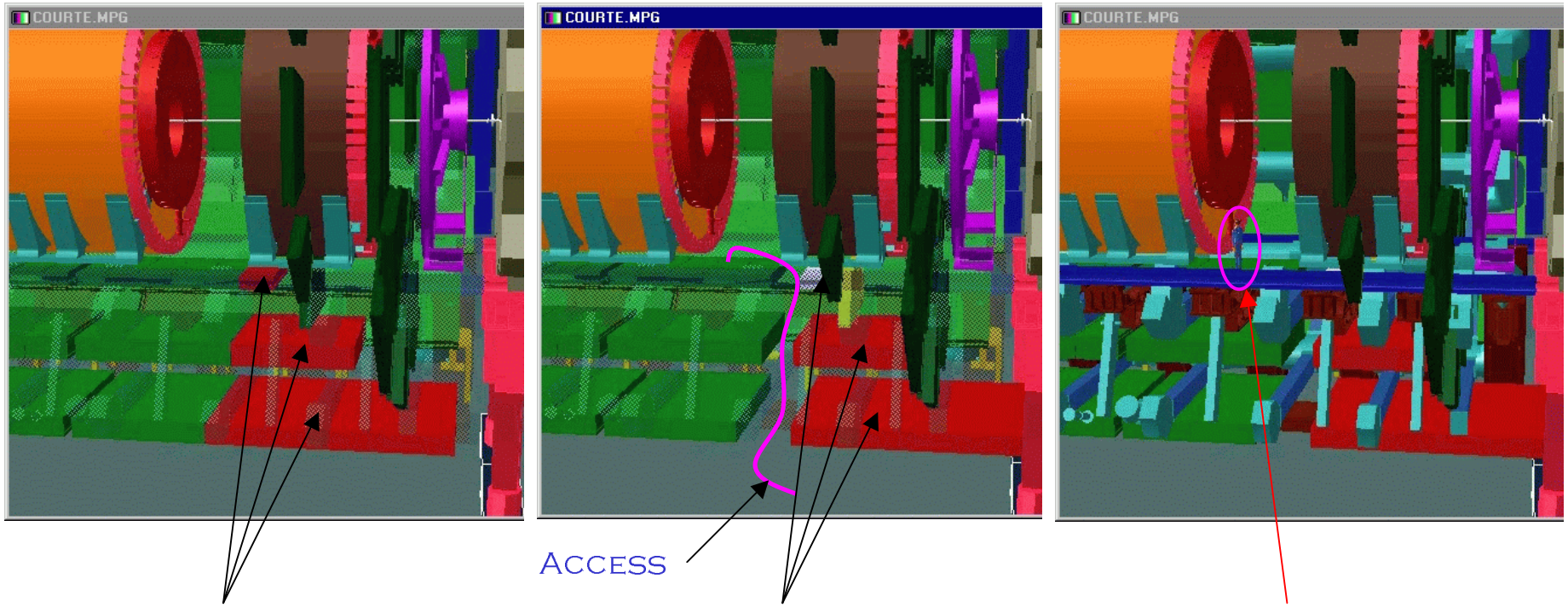
B-Layer Installation

- **Requirements/Necessity**
  - Beam Pipe bake-out
  - Finite Detector Life
- **Access**
  - Short Opening Scenario
- **Constraints**
  - Space limits
  - Special requirements
- **Procedure**
  - Description of Tooling
  - Detail of Procedure

Removal of B-Layer is Necessary

- **Bake-out of Beam pipe**
  - Small Beampipe diameter leads to Vacuum instability
  - Bake out jacket will not fit with B-Layer in place
  - Bake out temperatures would destroy B-Layer
  - Bake out is necessary whenever vacuum is broken
- **Finite life of B-Layer**
  - The B-Layer is expected to survive the first 3-4 years as LHC ramps up luminosity
  - At full LHC Luminosity, expected life of the B-Layer could be as short as one year

Access to B-Layer



Chambers indicated in RED, Closed Position

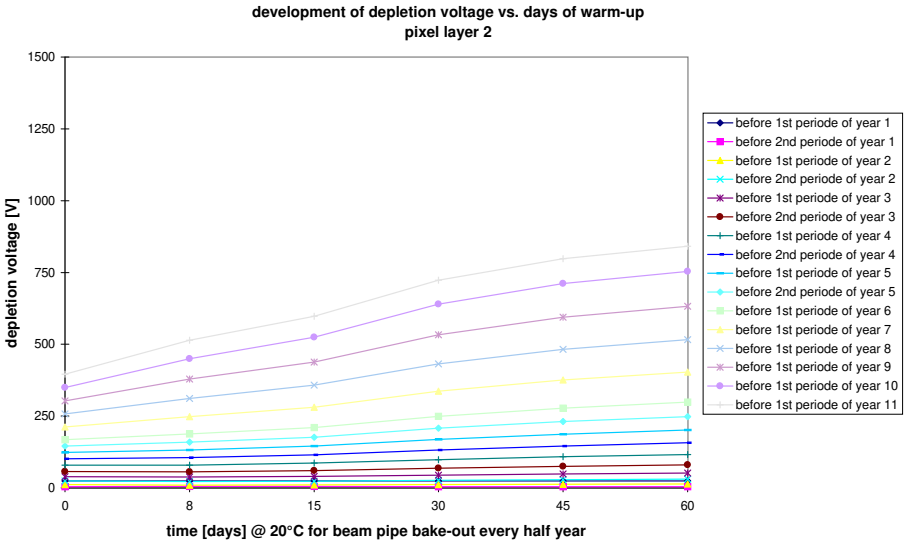
Chambers in Open Positions

Reference Man

Constraints and Requirements

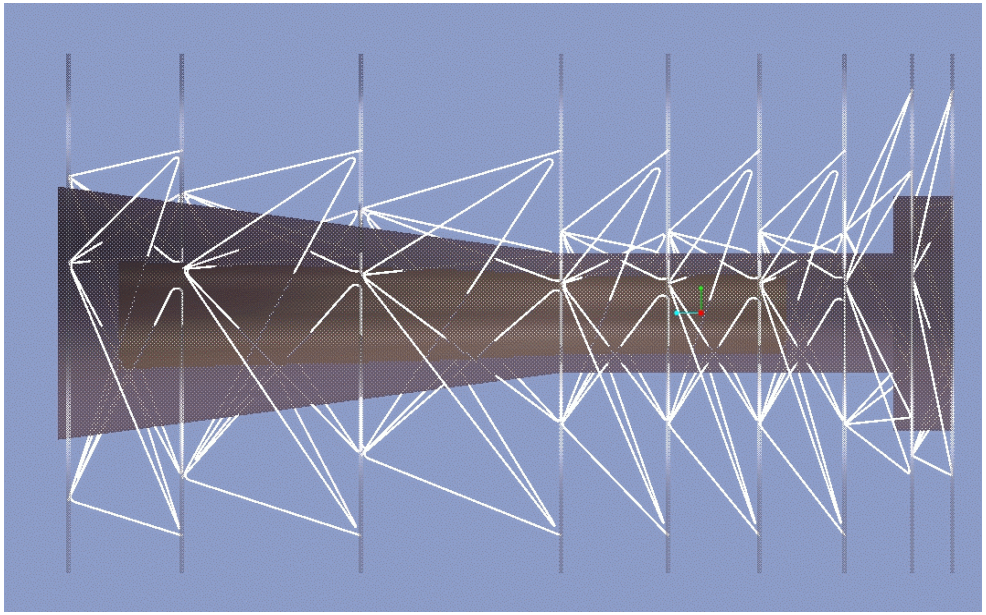
- **Work-Space Limitations**
  - Access Port is .7 X 1.5 Meters
  - Available Length is 3 Meters
  - Tool must weigh less than 200kg
- **Internal Constraints**
  - Beam pipe support at +/- 800mm
  - Alignment Paths in SCT Forward
- **Thermal Barriers**
  - 13 Deg C Dewpoint Cavern Air
  - Warm-up scenarios
- **Time**
  - Short Opening Schedule
- **Common Tooling With Bake-Out Jacket**

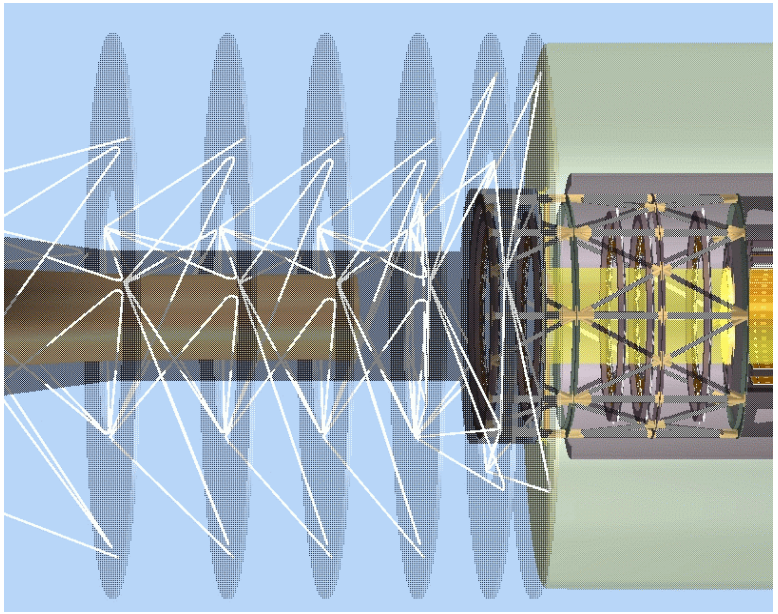
Thermal Barrier Requirements



- No Condensation is allowed on any surface
- Sensitivity of Silicon in Layers 1 and 2 of Pixel Barrel to warmup
- Possibility of letting detector warm up during B-Layer installation/removal
- Requires Knowledge of Installation/Removal Times and failure scenarios

Thermal Barriers and Forward Region Space



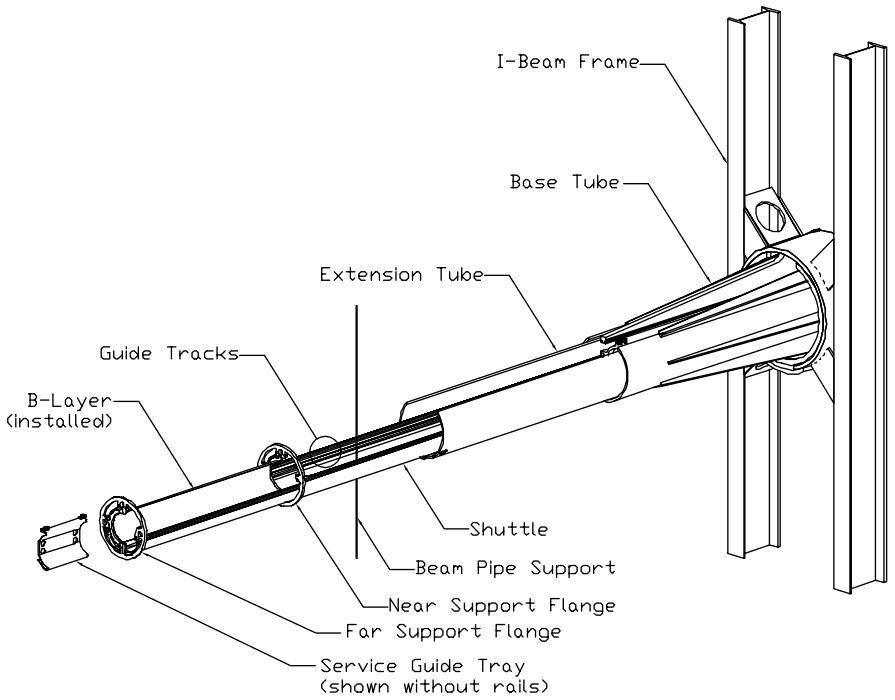


Outer gray cone is Forward Region Thermal Barrier. Gold cone is space allowed by Current Alignment Grid.

B-Layer tooling must fit inside of Thermal Barrier, which must fit inside of alignment Grid.

Thermal Barrier is designed to have a warm exterior surface above the dewpoint.
To achieve this with a minimum of thickness and material the exterior is heated actively.

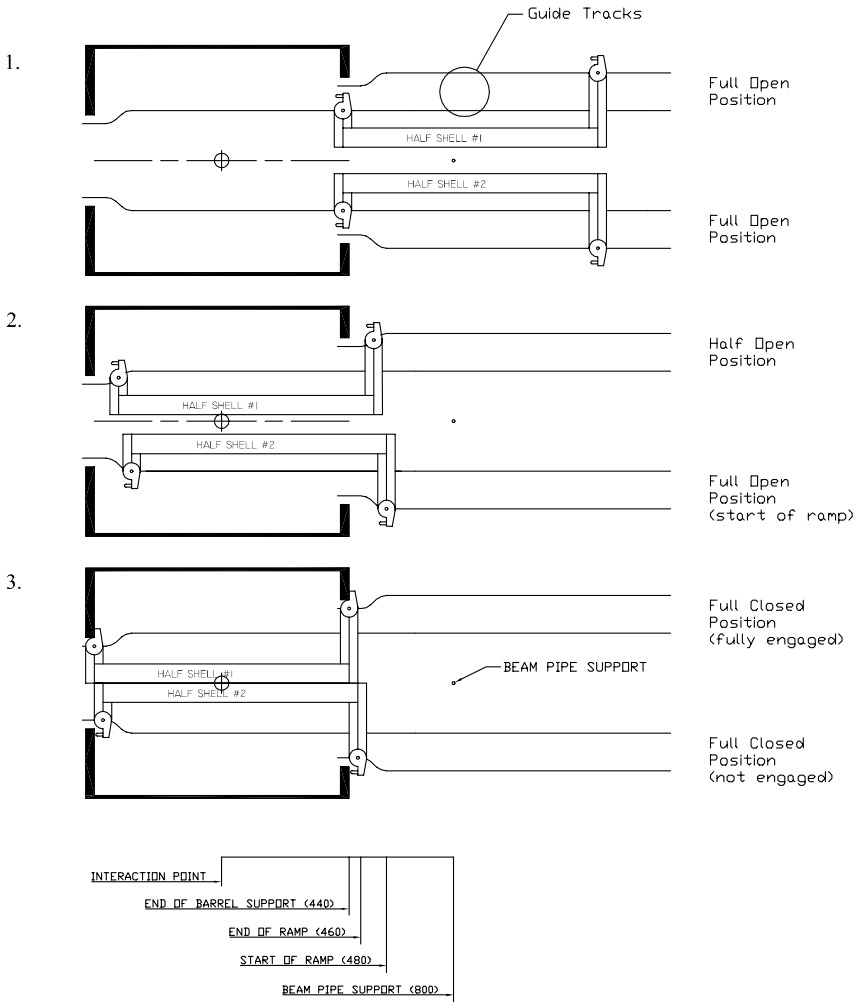
B-LAYER TOOLING



- **PASSIVE DESIGN**
  - MOTION GUIDED BY PASSIVE MACHINED FEATURES
- **MEETS EXTERNAL SPACE CONSTRAINT**
  - TELESCOPIC DESIGN ALLOWS FOR ASSEMBLY IN AVAILABLE SPACE
- **ADDRESSES INTERNAL CONSTRAINTS***
  - DESIGN CLEARS BEAMPIPE SUPPORT
  - ALLOWS FOR SUPPORT AND DEPLOYMENT OF SERVICES

*DESIGN LAYOUT COMPLETED PRIOR TO INCLUSION OF THERMAL BARRIERS WITHIN PIXEL VOLUME.

PRINCIPLE OF OPERATION



- B-LAYER IS INSTALLED ON SHUTTLE IN GUIDE TRACKS IN RETARDED POSITION (POSITION 1)
- B-LAYER IS ARTICULATED AROUND BEAM PIPE SUPPORT BY SLIDING IN TRACKS (POSITION 2)
- FLANGES ON B-LAYER INCLUDES REGISTRATION FOR GUIDE TRACKS AS WELL AS LOCATING PINS TO REGISTER WITH PIXEL DETECTOR (POSITION 3)

Installation Procedure

- Access is gained from the ground
- Tooling is brought in pieces through access port
- I-Beam Frame is mounted
- tooling is assembled and aligned
- Using Shuttle, Service Guide Rails are fed through Detector
- Services to far side are installed on Guide Rails
- B-Layer is inserted into Shuttle and attached to far side services
- Near side services are attached to B-layer and laid into Shuttle
- Shuttle is pushed into Pixel Detector
- B-Layer is pushed/pulled along rails until it engages
- B-Layer is fastened to Pixel Detector
- Services are unfurled and terminated at PPF1
- Tooling is removed

Future work on B-Layer Tooling

- **Dimensions in Forward Region need to feed into design**
- **More adequate access is needed**
- **More work will be done for Technical Coord. TDR**
  - Iterate current design to fit inside of thermal shields
  - Investigate lighter options
  - Produce prototype based on iterations
  - Scheduled completion 12/98

Maintenance

- **Access to Pixel Detector is very limited**
  - Removal of both Forward regions is required
  - Lowest risk access involves also removing Barrel
- **Reliability is crucial design goal**
- **B-Layer is removable**
- **In the event of disassembly, designs aim to reduce the amount of disassembly**
  - This is also important during assembly