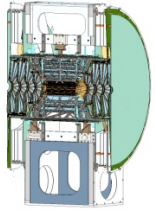
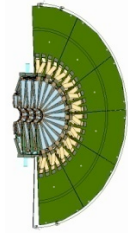


FVTX Mechanical Status: WBS 1.6

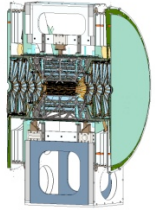
Walter Sondheim - *LANL*
Mechanical Project Engineer; VTX & FVTX



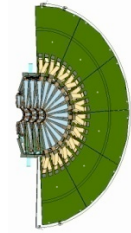
Outline:



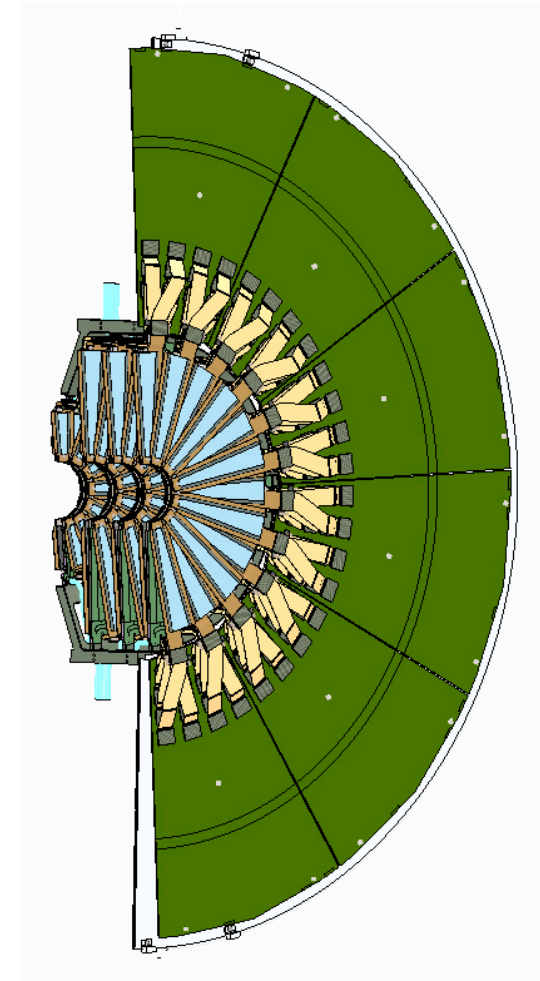
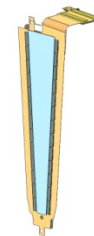
- *Terminology*
- *Wedge*
 - construction
 - Thermal study
- *Station Disk*
 - Construction
 - Thermal study
- *Cage*
 - Interface with VTX assembly
- *Big-wheel*



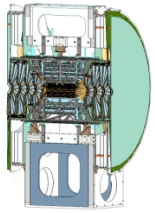
FVTX *Terminology*:



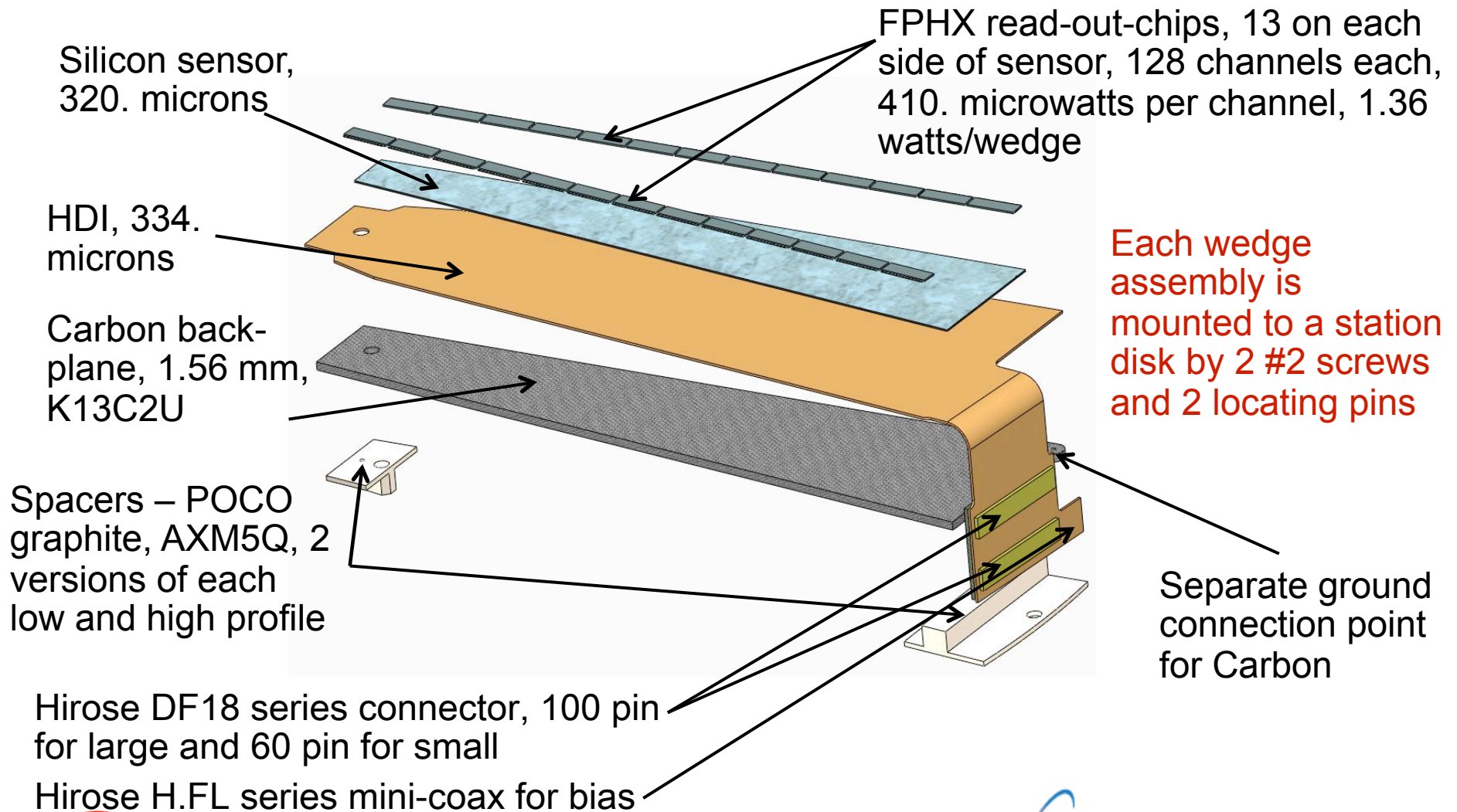
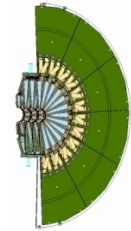
- *Big-wheel* ; location for the *Wedge* Read-Out-Card - ROC, 6 per detector assembly
- *Cage*; Carbon composite structure that holds the *Station Disk*
- *Station Disk*; Carbon composite skins making a panel that the Silicon *Detector Modules* attach to
- *Wedge* or *Detector Module*; consisting of mini-strip Silicon detector, HDI (with FPHX read-out chips) and a Carbon composite backing for mechanical support and thermal transfer

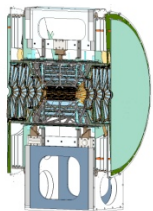


FVTX Assembly

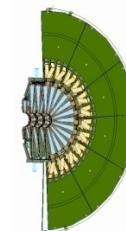


Large *Wedge* Construction:

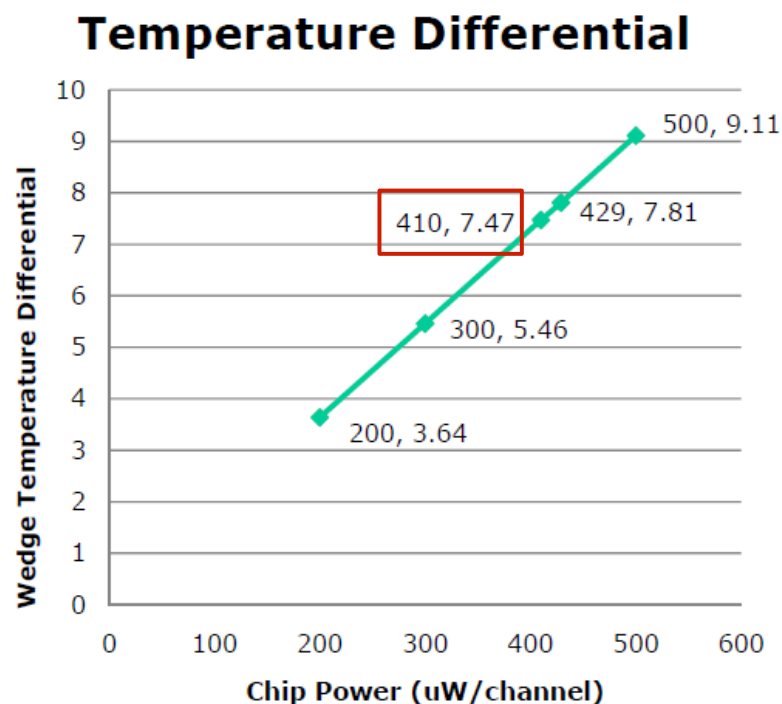
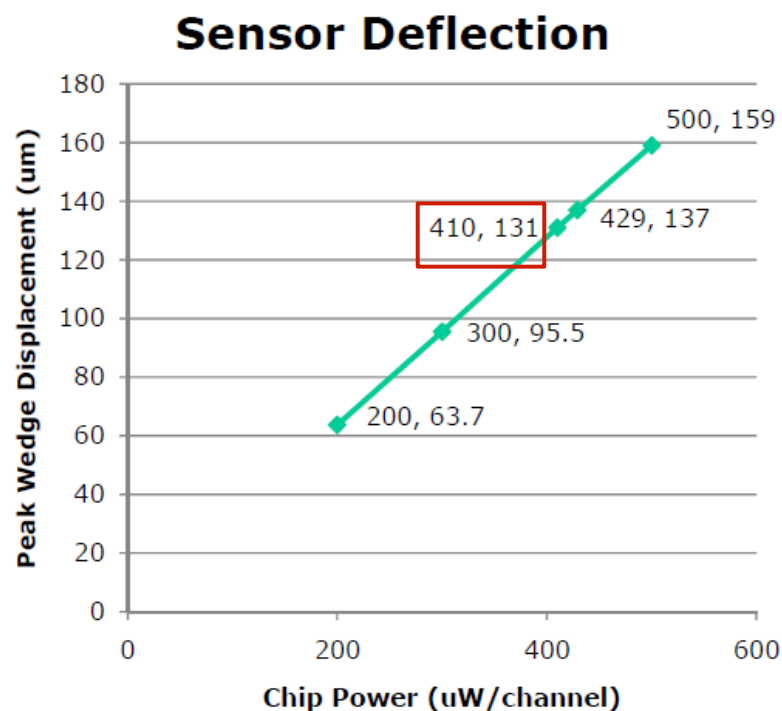




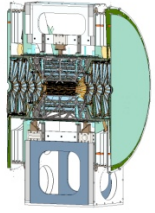
Wedge Construction:



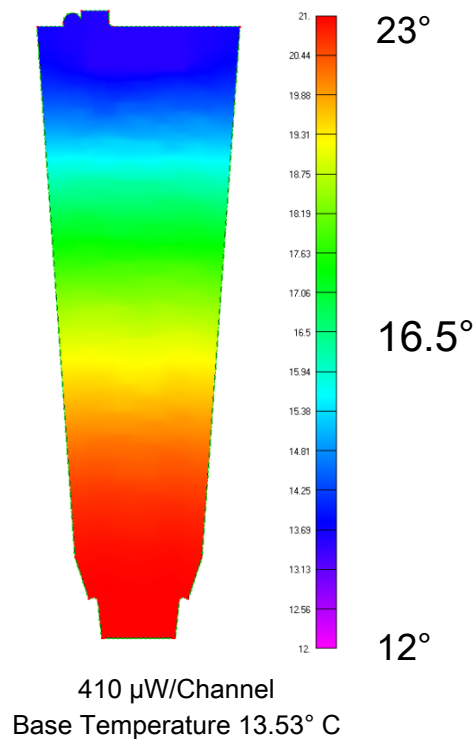
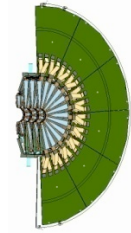
- Thermal study of large Detector *Wedge* assembly;



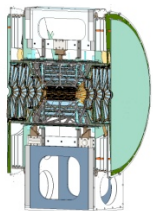
- FPHX operating power ~410 microwatts per channel, 1.33 watts total per large *Wedge*



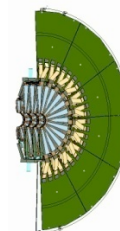
Large *Wedge* Construction:



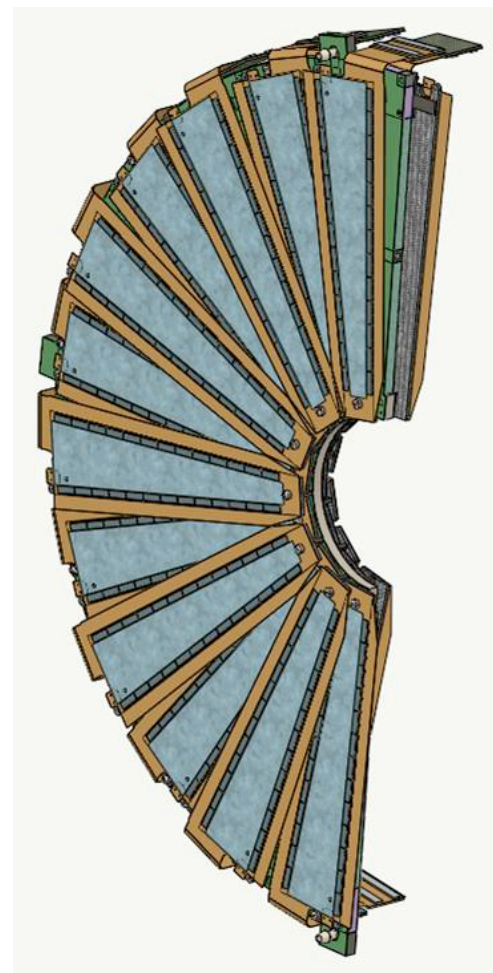
- Thermal path for heat generated on large *Wedge*
 - Delta T on large *Wedge* is ~7.47 degrees C
 - Heat from FPHX chips passes through HDI into Carbon backplane – through POCO graphite thermal block to *Station Disk* where coolant flows around perimeter – NOVEC 7200 coolant
 - Delta T from *Disk* to *Wedge* ~ 8. degrees C
 - In analysis a temp constraint was set to keep peak FPHX chip temp at 21 degrees C
 - Bonding of all elements of *Wedge* assembly, made using Arclad 7876 transfer adhesive, 50. micron thick

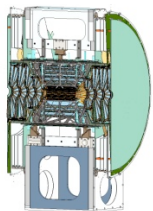


Station Disks:

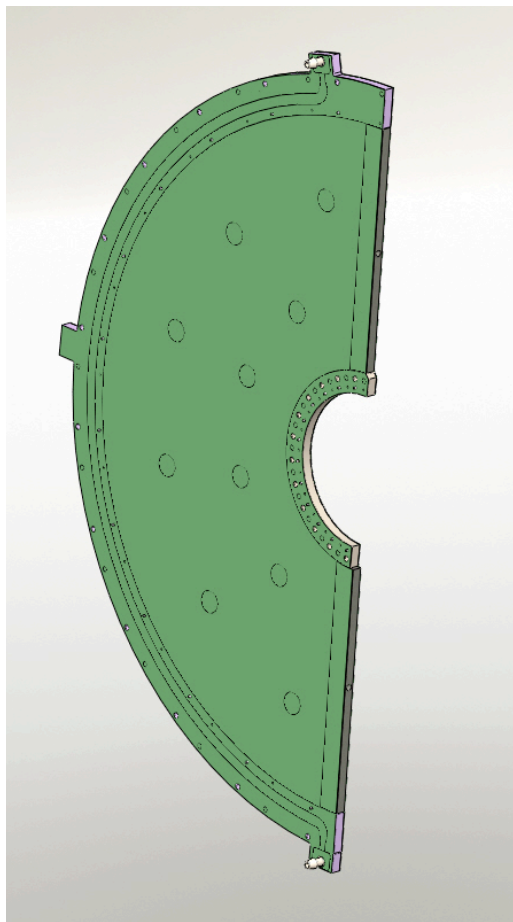
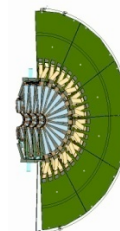


- View of a *Station Disk* Assembly with large *Wedges* attached to both sides
- Each *Wedge* covers 15 degrees, each sensor covers 7.5 degrees, *Wedges* on both sides of *Disk* staggered by 7.5 degrees front to back – hermetic coverage in phi
- Estimated thermal load from 24 large sensor *Wedges* ~32.6 watts per stations 2, 3 & 4
- Estimated thermal load from 24 small sensor *Wedges* ~12.6watts per station 1

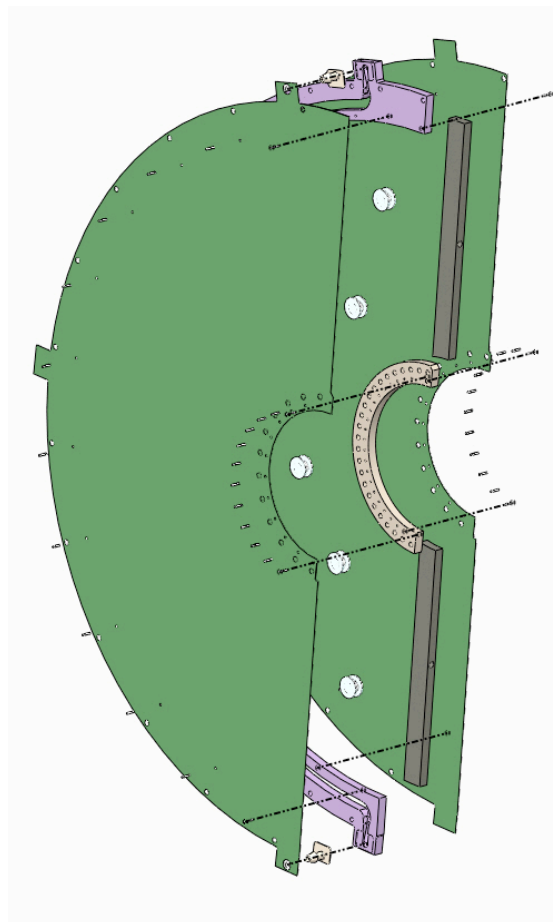




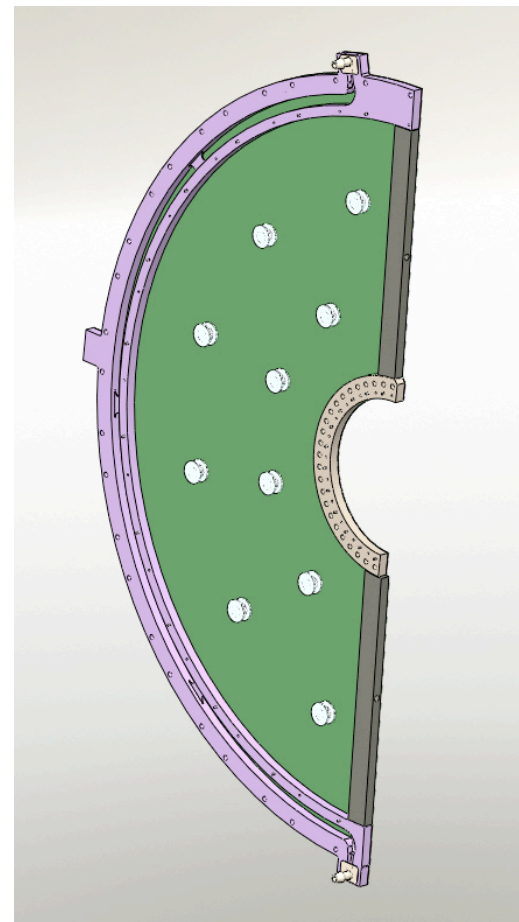
Station Disks:



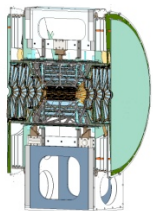
Assembled Disk,
5.3 mm thick



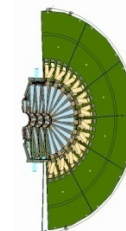
Disk exploded view



Disk, face sheet removed



Station Disk Construction:



K13 Uni-fiber face sheets, .
40mm thick

PEEK cooling
channel

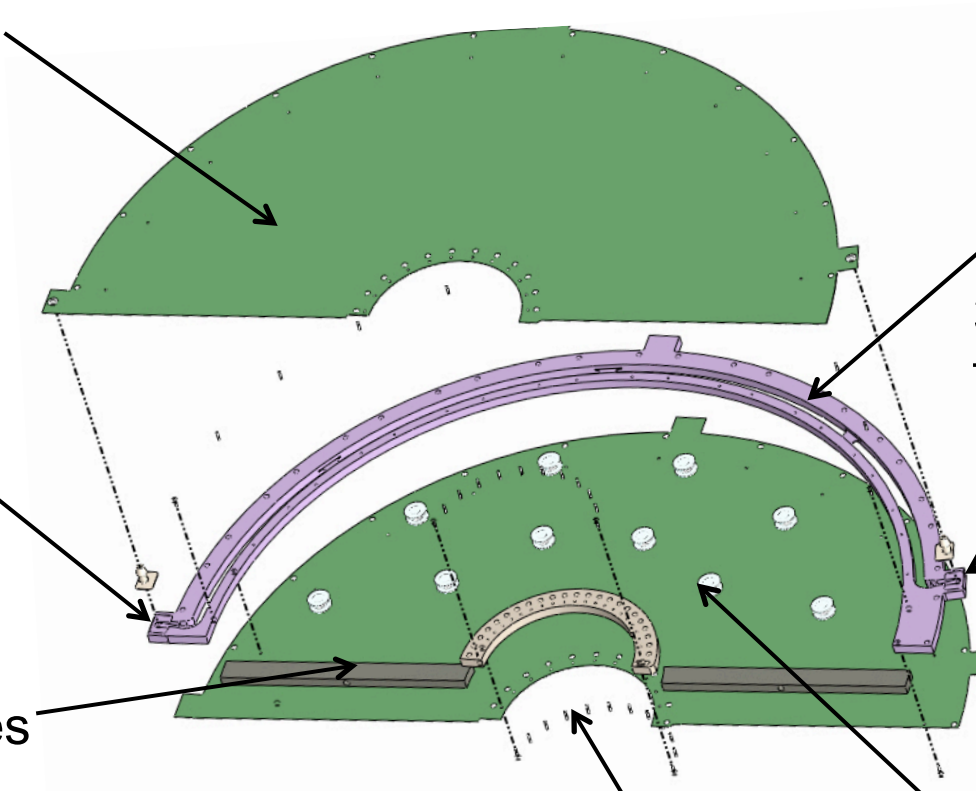
Mounting tab
to Cage, one
of three

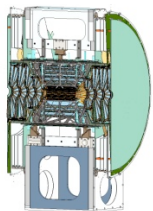
3 holes for alignment
flags around perimeter

PEEK pieces

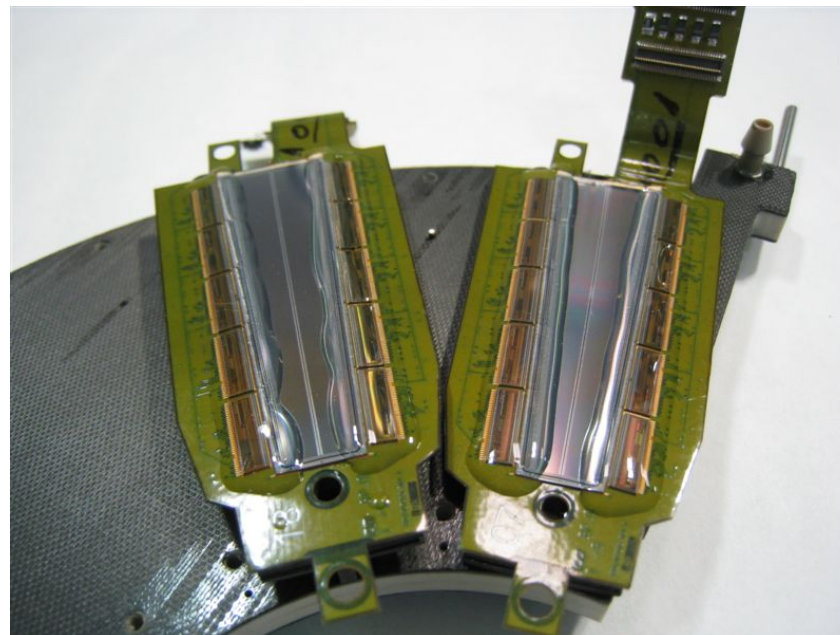
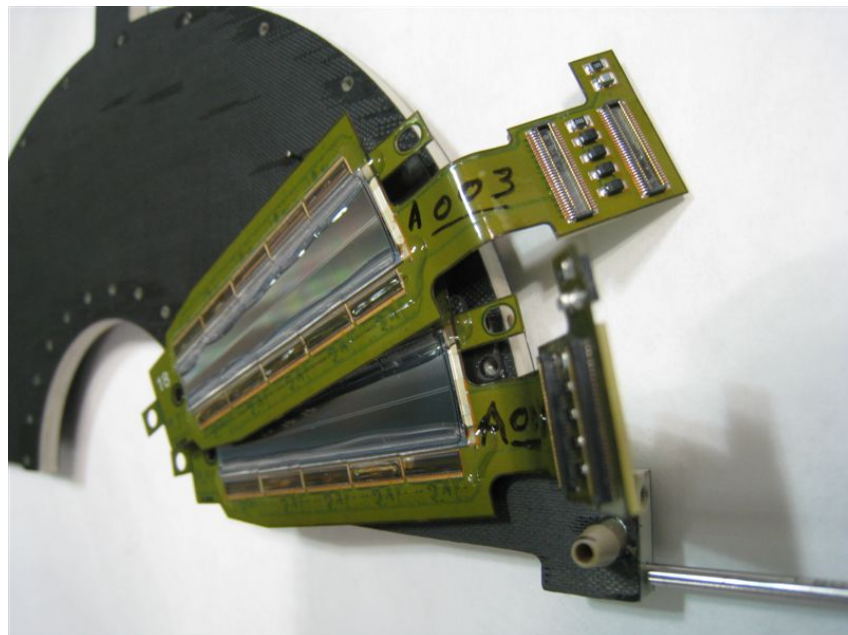
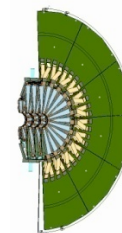
Hardware to mount and
align Wedges to Disk

Polyimide "bobbins"

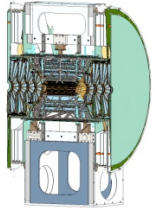




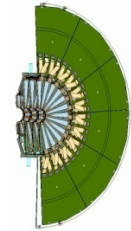
Station Disk - Station 1:



- Initial test fit of small *Wedge* to the *Station 1 Disk*, two wedges attached at LBNL composite shop
- Schedule to receive all small *Station Disks* in December, large *Station Disks* to follow

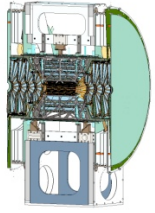


Station Disk Cooling:

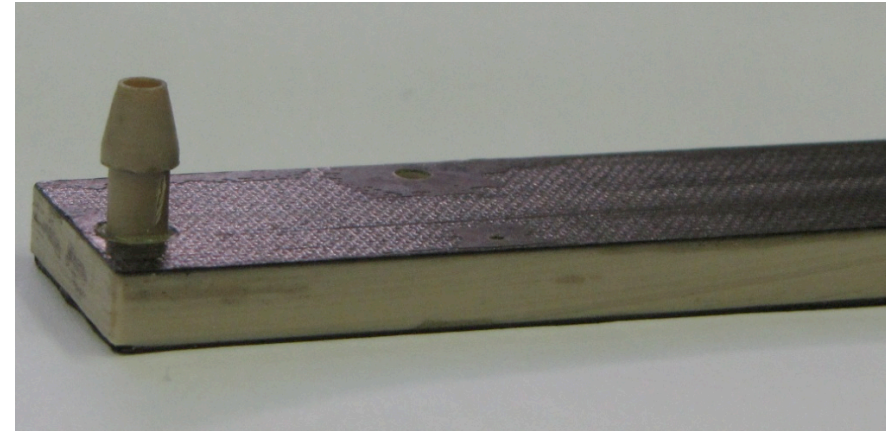
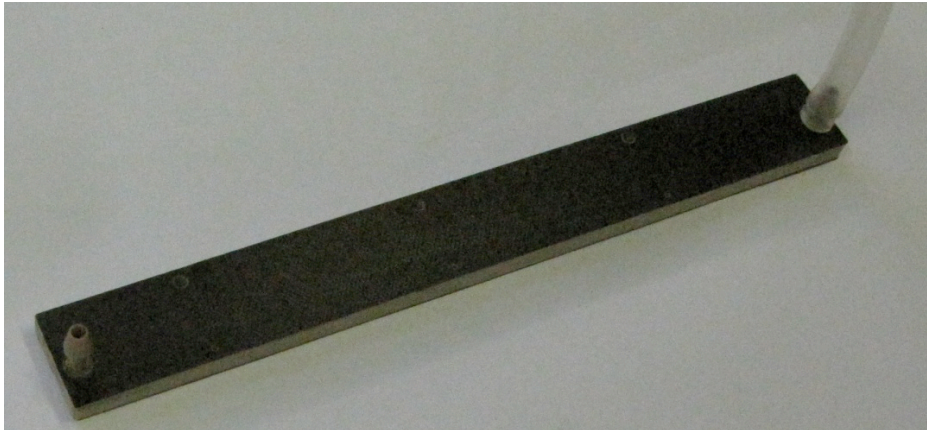
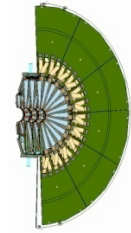


- Coolant used in Disks is 3M Novec 7200*
 - Novec 7200 is benign and environmentally friendly
 - Boiling Point 76 degrees C
 - Vapor Pressure 109 mmHg @ 25 degrees
 - Neutron irradiation study at LANL's WNR facility, total dose 6.7×10^{11} n/cm², nominal energy 800 Mev. Irradiated samples sent to 3M for analysis, no free Fluoride radicals detected.
 - Inlet pressure to disk 20. psi, each disk will be tested to 30. psi flow rate 19.0 ml/sec in PHENIX
 - Each Disk supplied in parallel, from external manifold

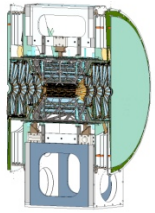
*specification - data sheet for Novec 7200 in back-up slides



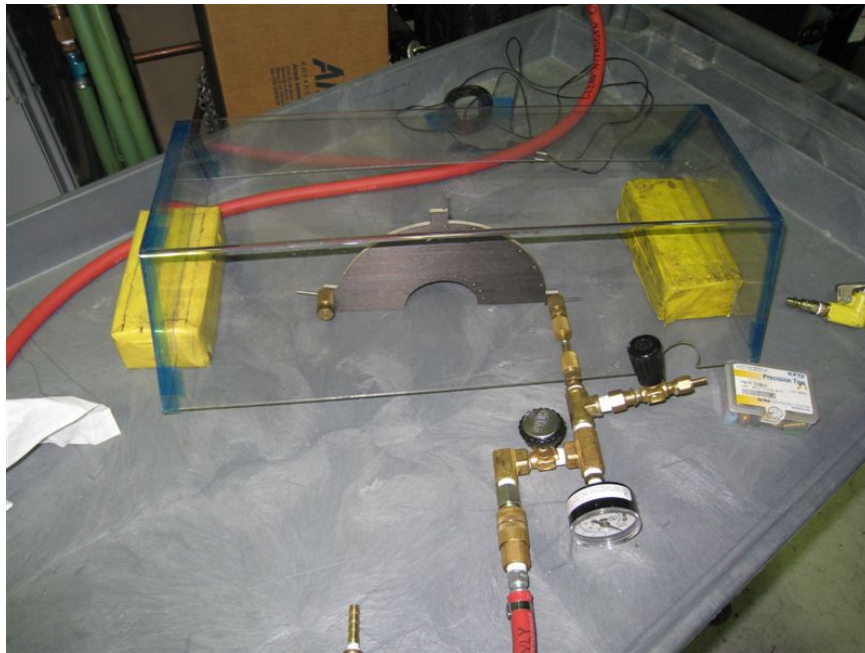
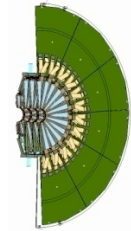
Station Disk Cooling test:



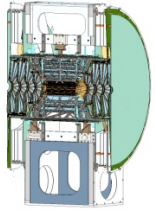
- A test channel was constructed at LBNL composite shop using the same material as the production Disks will have
- Flow and pressure tests were made up to 50. psi
- At a pressure of 20. psi a flow rate of 29.8 ml/sec was measured using water
- PHENIX will supply NOVEC 7200 at 20. psi and an estimated flow rate of 19. ml/sec



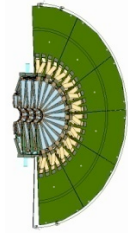
Station Disk Pressure Test:



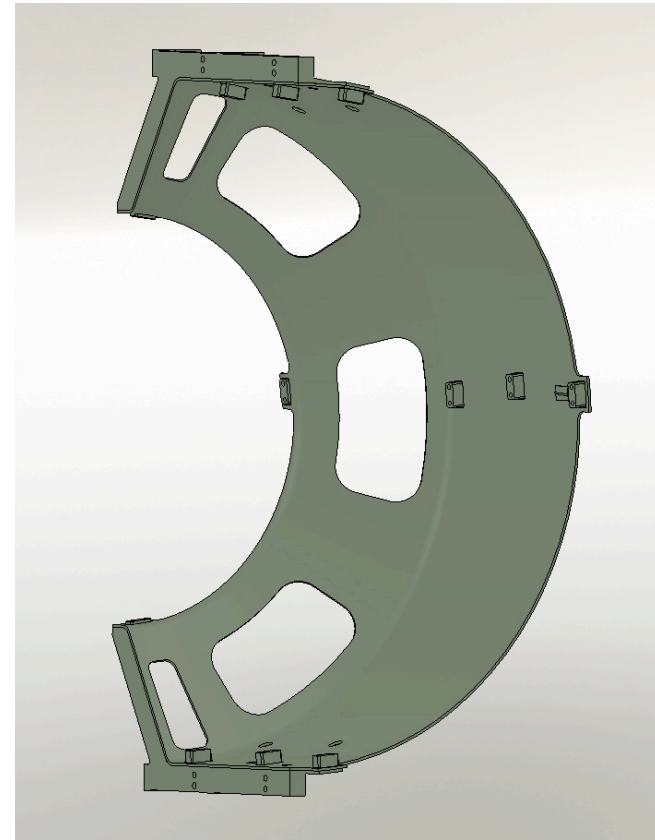
- Pressure test of station 1 disk at LBNL composite shop, cycled 5 times to 30. psi
- Test on *Station disk* passed

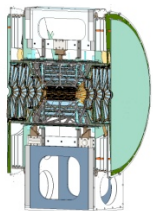


Cage:

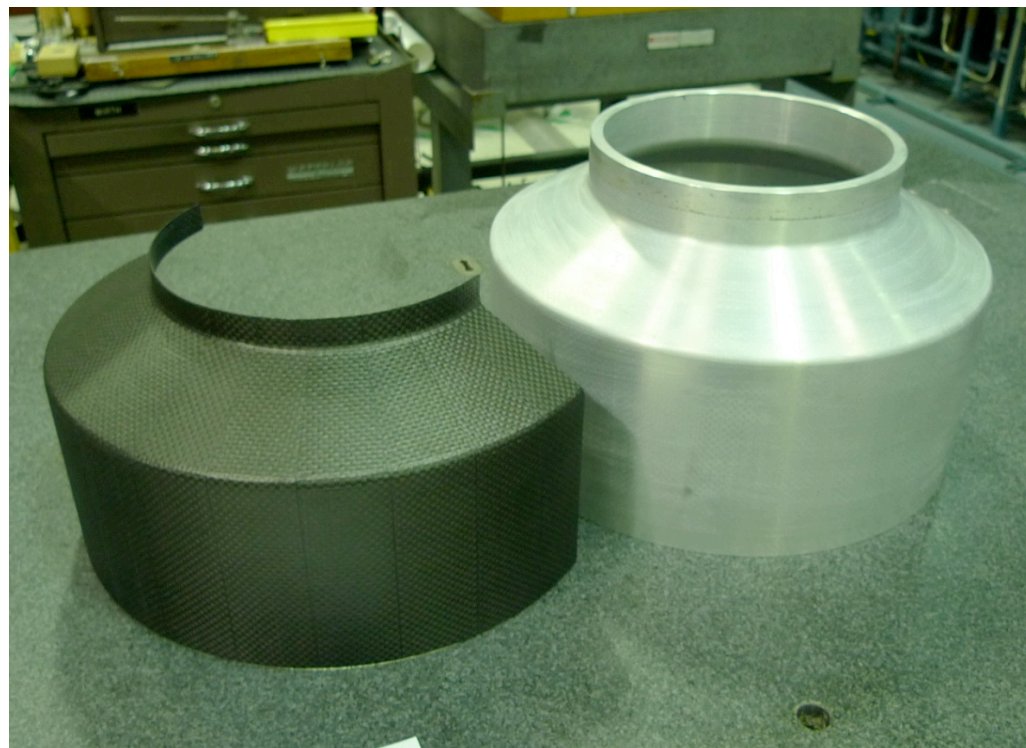
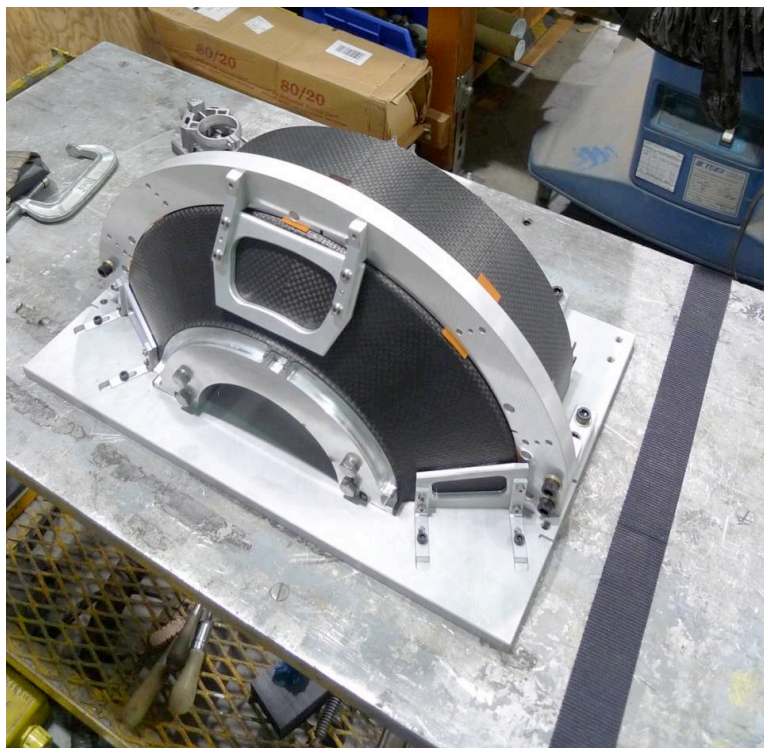
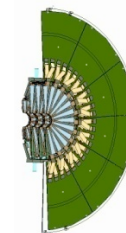


- *Cage* design uses CN60 Carbon fabric with EX1515 resin. FEA analysis indicates very rigid structure <25. microns.
- *Station Disks* are staggered in phi; 0, 2.8125, .9375, 1.875 degrees, improves stereo views
- Mating half *Cage* rotates 180 degrees about beam axis
- Each *Station Disk* mounted to *Cage* at three locations by a pin and screw

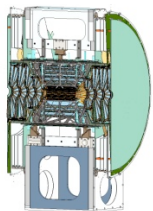




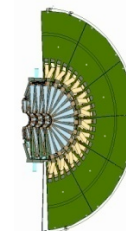
Cage Construction:



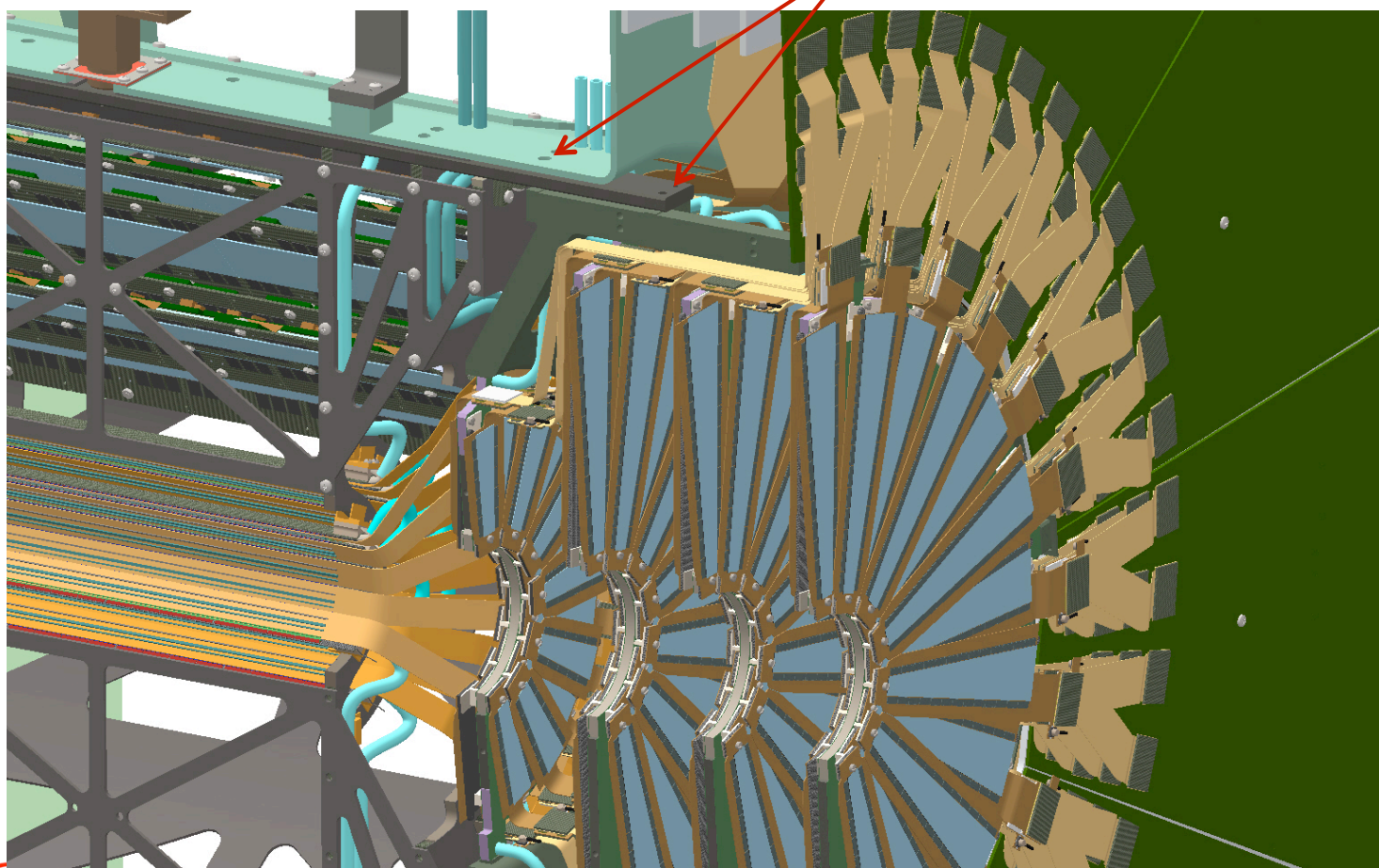
- *Cage* construction views from LBNL composite shop prior to final machining and bonding
- Complete cylinder laminated on tool , cured then split
- Schedule has first *Cage* delivered to BNL by end of 2010

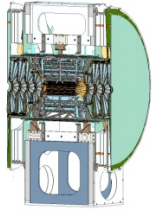


Cage Interface with VTX:

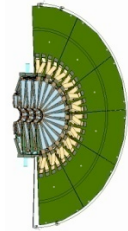


- Attachment points between FVTX *Cage* and VTX support structure using 2 pins and 2 screws, top and bottom

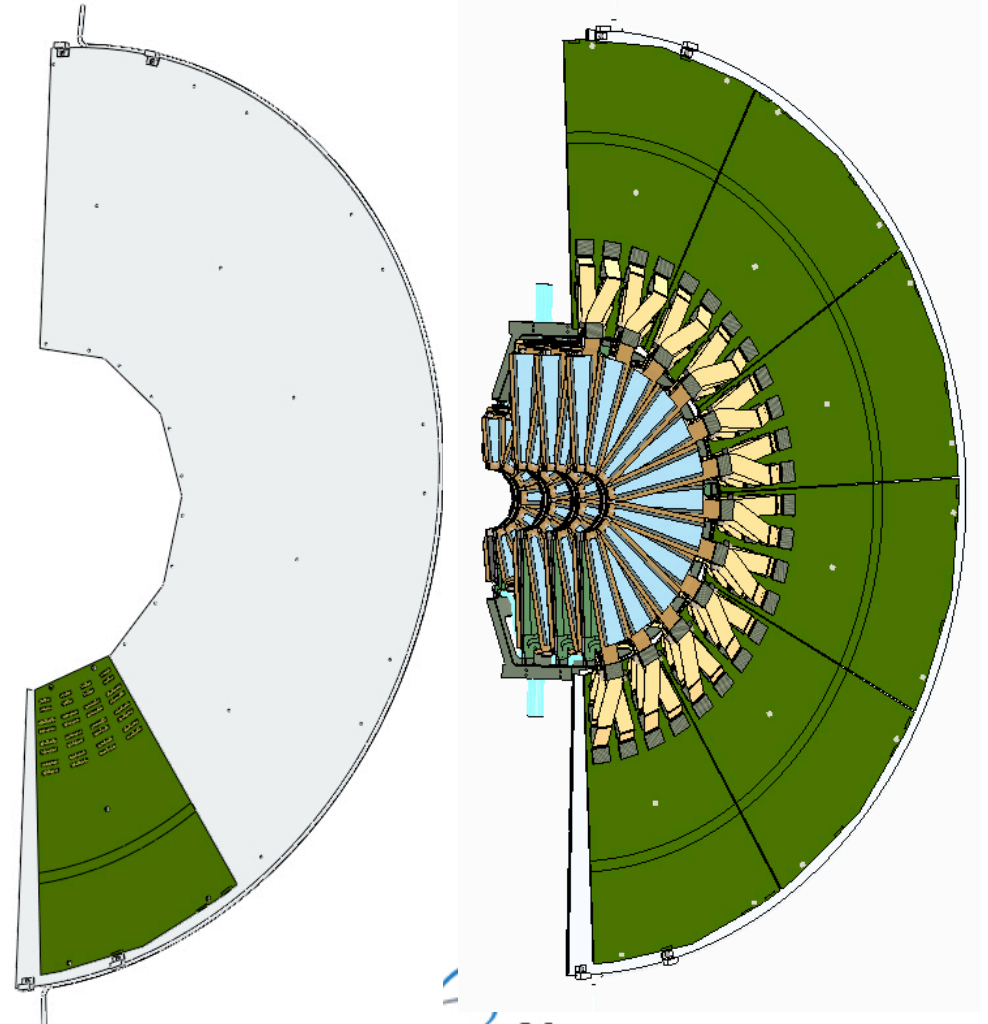


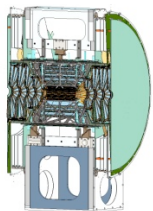


Big Wheel:

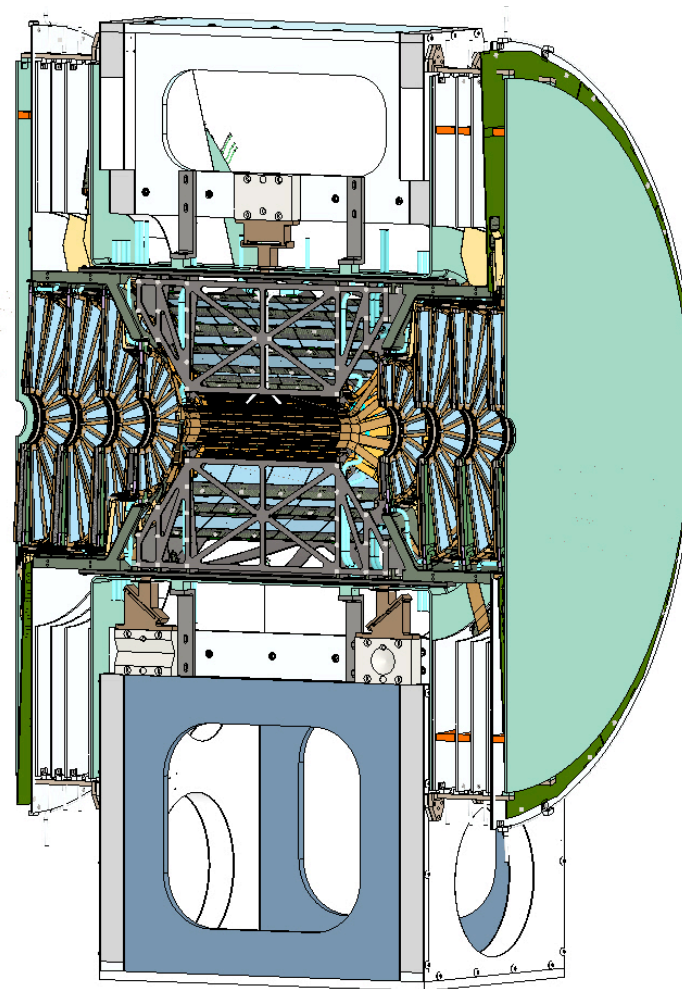
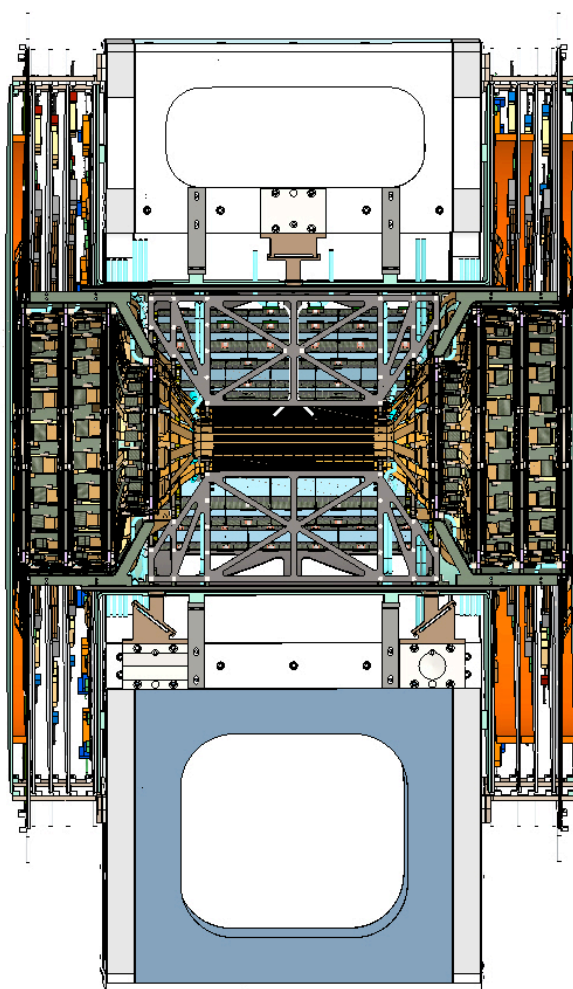
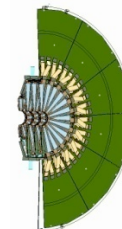


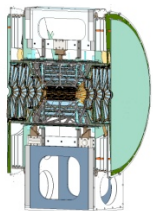
- *Big wheel* 1/8" thick Aluminum plate with Aluminum cooling tube dip-brazed along edge
- 6 read-out-cards (ROC) are mounted to this plate using a thermal pad interface called Gap-pad by Bergquest
- *Big wheel* plate is supported off the VTX assembly support structure, while the FVTX *Cage* is supported off the VTX support structure's main beam
- Total mass of a FVTX assembly 17.56 pounds



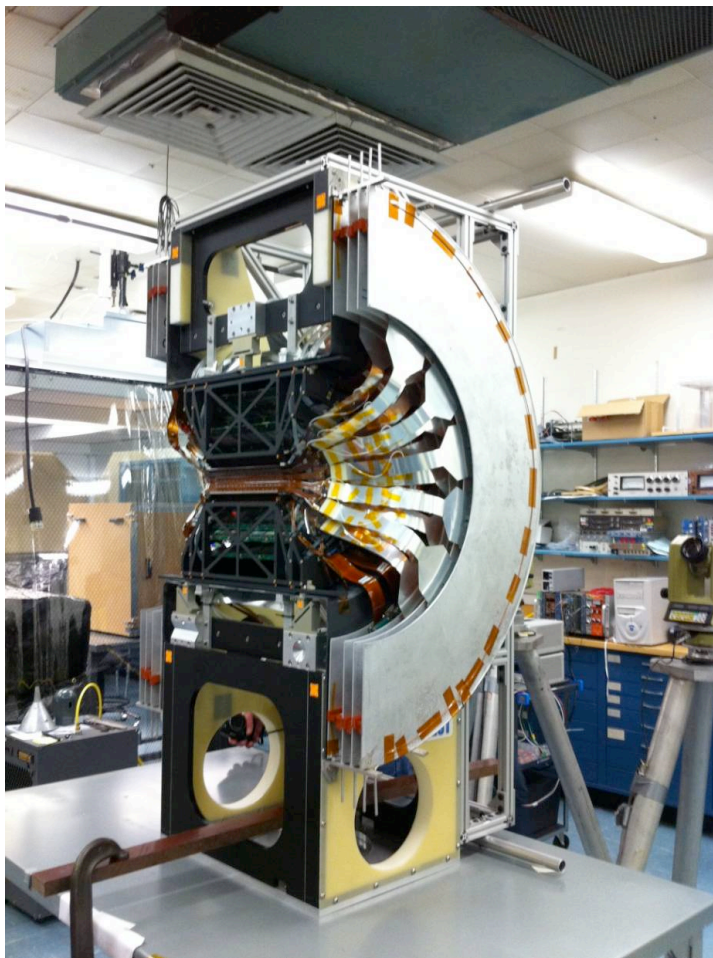
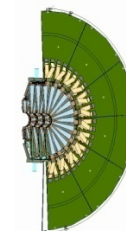


Assembly Views:

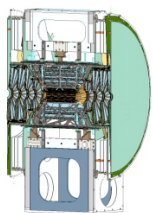




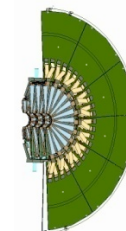
Assembly Views:



West half VTX assembled in lab
11/5/2010, total estimated
weight with FVTX added ~ 200.
pounds



Back-up slide:



3M™ Novec™ 7200 Engineered Fluid

Typical Physical Properties – Table 1

Data compiled
from published
information

Not for
specification
purposes

Properties

Properties	Novec 7200
Formula $C_4F_9OC_2H_5$	
Molecular Wt.	264
Boiling Pt. °C	76
Freeze Pt. °C	-138
Liquid Density ¹	1.43
Surface Tension ²	13.6
Solubility of Solvent in Water ³	<20
Solubility of Water in Solvent ³	92
Vapor Pressure ⁴	109
Viscosity ⁵ 0.61	
Heat of Vaporization ⁶	30
Specific Heat ⁷	0.29

¹ g/ml @ 25°C ² dynes/cm @ 25°C ³ ppm by weight ⁴ mm Hg @ 25°C ⁵ cps @ 25°C
⁶ cal/g @ boiling point ⁷ cal/g °C @ 25°C

Environmental and Exposure Guidelines – Table 2

Data compiled
from published
information

Not for
specification
purposes

Properties

Properties	Novec 7200
Ozone Depletion Potential ¹ —ODP	0.00
Global Warming Potential ² —GWP	55
Atmospheric Lifetime—ALT (yrs)	0.77
Flashpoint	None
Flammability Range in Air	2.4–12.4%
Exposure Guidelines (8 hr. time-weighted average)	200 ppm
Acute Toxicity (4 hr. LC ₅₀ [Rat])	>92,000 ppm

¹ CFC-11 = 1.0 ² GWP-100 year Integration Time Horizon (ITH) Note: HCFC-225 ca/cb ratio is 45/55