FVTX INTEGRATION INTO PHENIX

BNL 12/6/2005

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Layout for end-cap silicon detectors is driven by required physics performance.

Mechanical Structure: Lightweight - low mass, low Z materials

Stiff – minimal sag, micron deflection

Stable – low CTE and CME

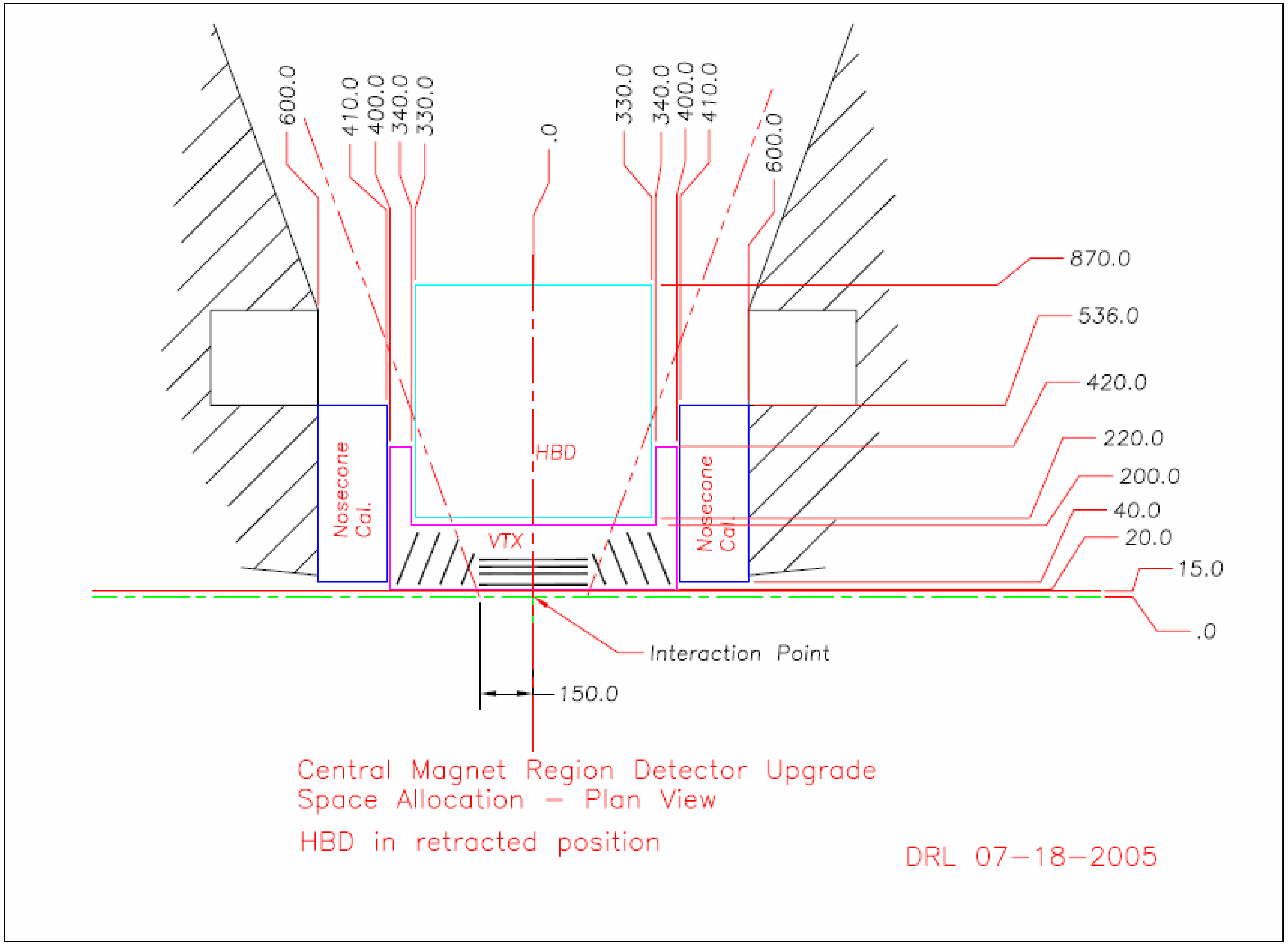
Rad. hard – 10 yrs. ~ 300krad (R. Nouicer, BNL 11/05)

Compatibility – must work with VTX barrel structure

Thermal – Cooling issues:

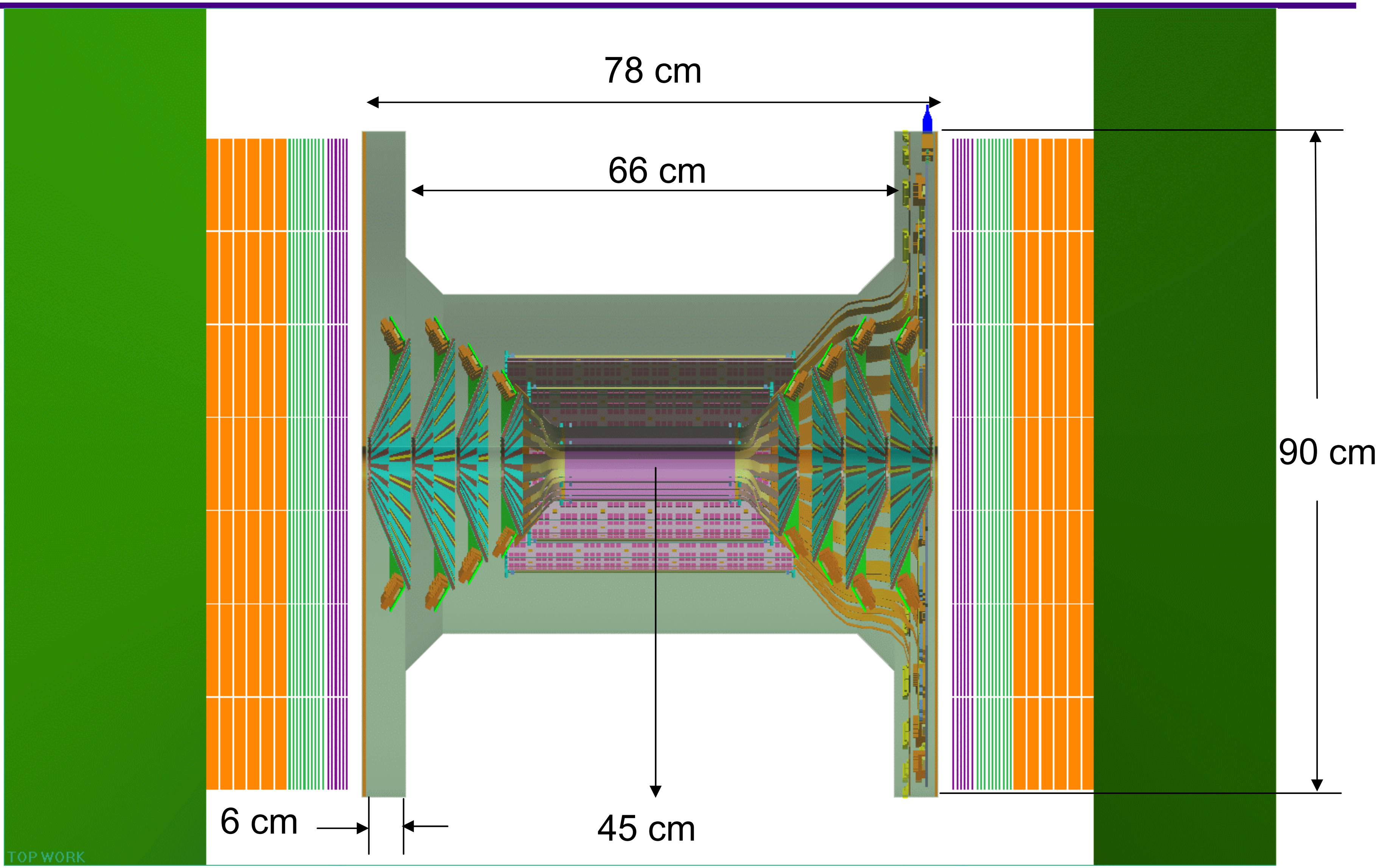
Coolant; low density, low Z, low viscosity, stable,

non-flammable, non-toxic, electrically insulator

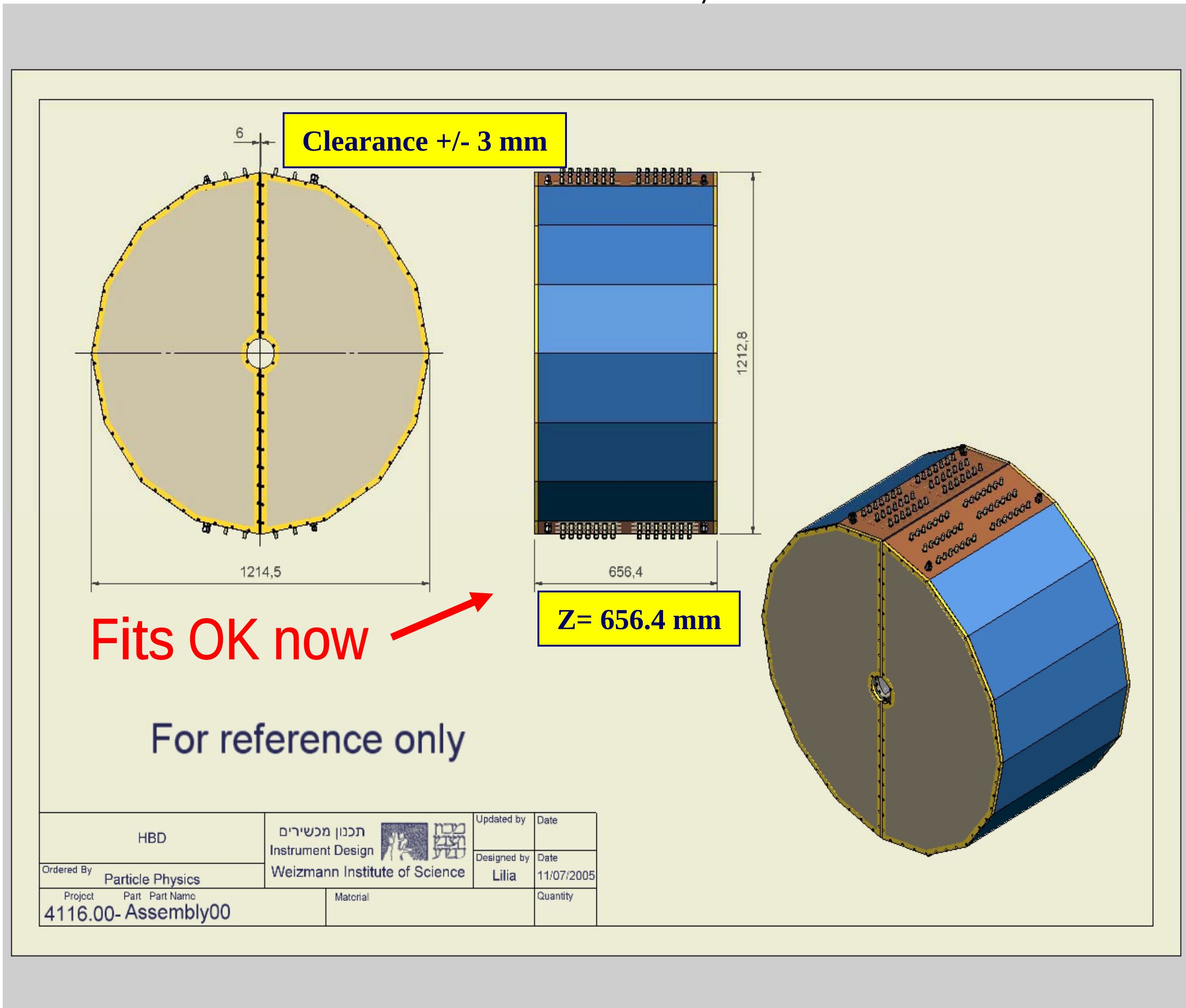


600.0
410.0
400.0
340.0
330.0
.0
330.0
340.0
400.0
410.0
600.0
870.0
536.0
420.0
220.0
200.0
40.0
20.0
15.0
.0
HBD
VTX
Nosecone Cal.
Nosecone Cal.
Interaction Point
150.0
Central Magnet Region Detector Upgrade
Space Allocation — Plan View
HBD in retracted position
DRL 07-18-2005

LANL 3D CAD MODEL OF VTX ENVELOPE



WEIZMANN'S FINAL DESIGN FOR HBD, PRESENTED 7/12/2005



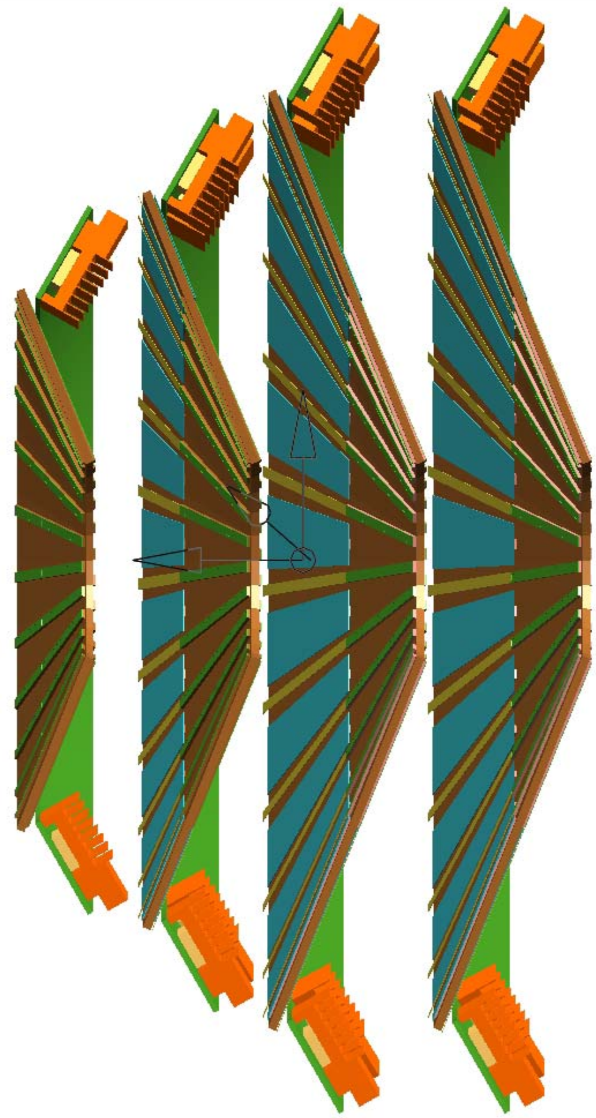
ANYTHING IS POSSIBLE!

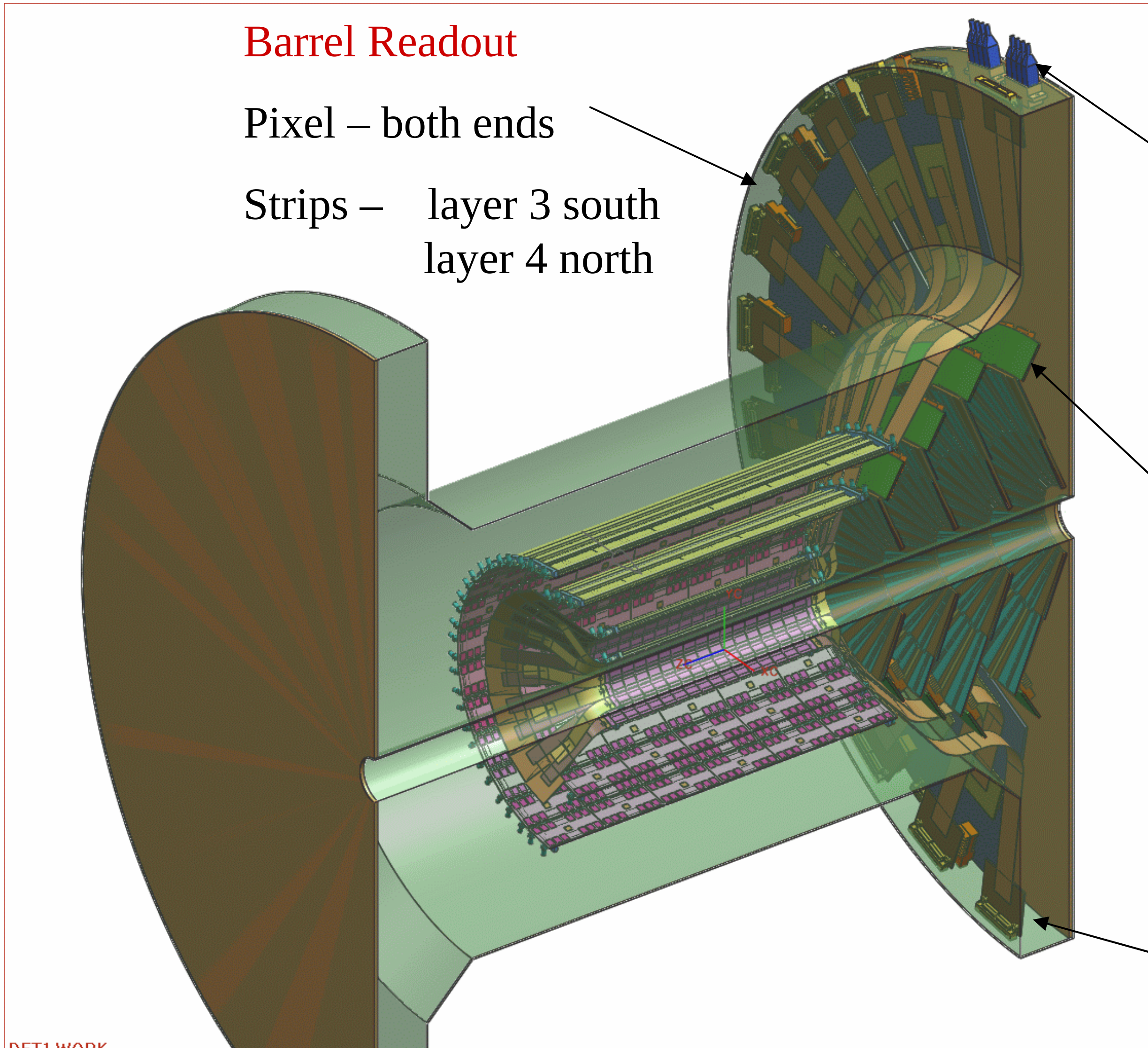
FVTX:

*Four planes per endcap

*884,000 channels per endcap

*90 microwatts per ~ 80 watts per endcap




Barrel Readout
Pixel – both ends
Strips – layer 3 south
layer 4 north
DET1 WORK
Endcap Fiber Optic
Readout Molex
Quad 24 fibers
FVTX bus and
output interface
Strip layer 4
readout conn.

CONTRACTED IN 2005 TO ENGINEER FOUR TASKS:

1, STUDY ALLOCATED SPACE FOR VTX DETECTOR

2, ENGINEER COOLING FOR VTX BARREL

3, VERIFY CURRENT VTX DESIGN WITH REST OF PHENIX

4, LOOK AT R&D ISSUES FOR FUTURE

CURRENT STUDY WITH ENDCAP DETECTORS:

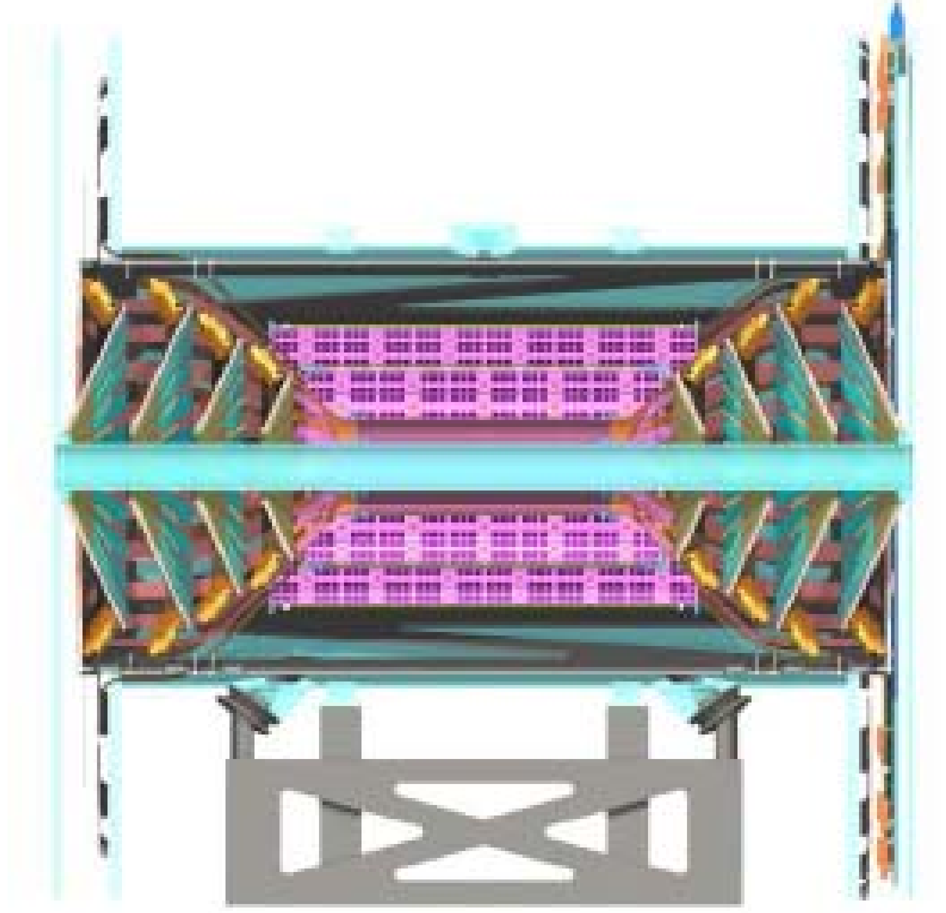


Fig. 1 Section view of PHENIX silicon vertex detector (VTX)

HYTEC report cont.

Global support structure, carbon

Gas enclosure

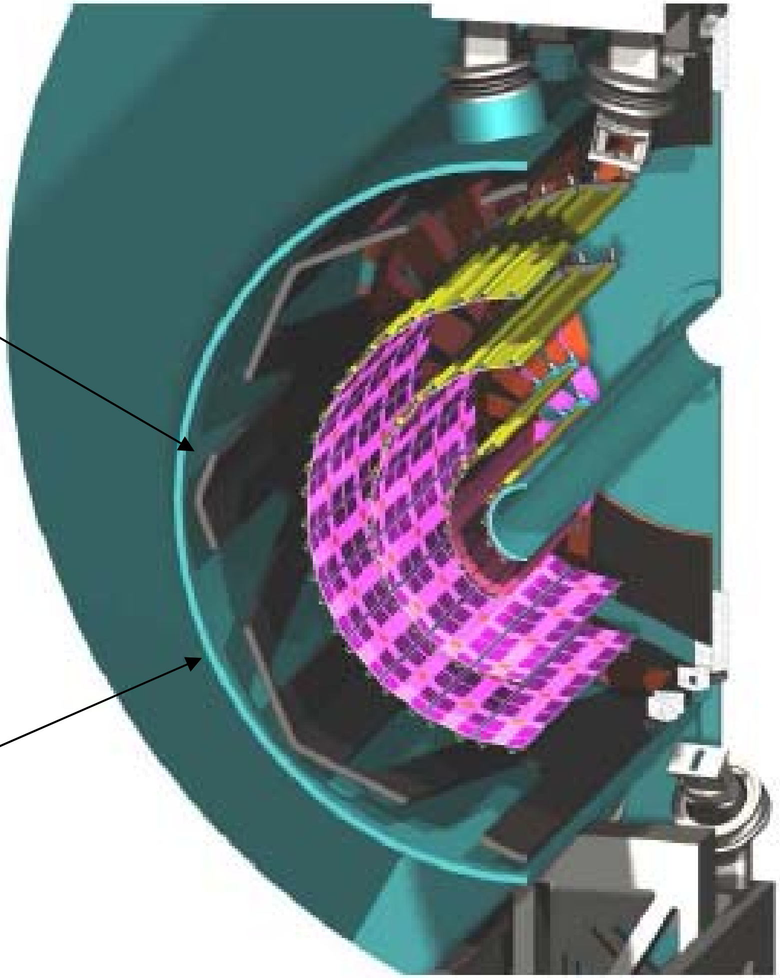


Fig. 2 Isometric view of the VTX showing the internal design structure

GAS ENCLSURE SUPPORTED SEPERATELY FOR GLOBAL SUPPORT STRUCTURE.

HYTEC report cont.

Global “tree point support system”

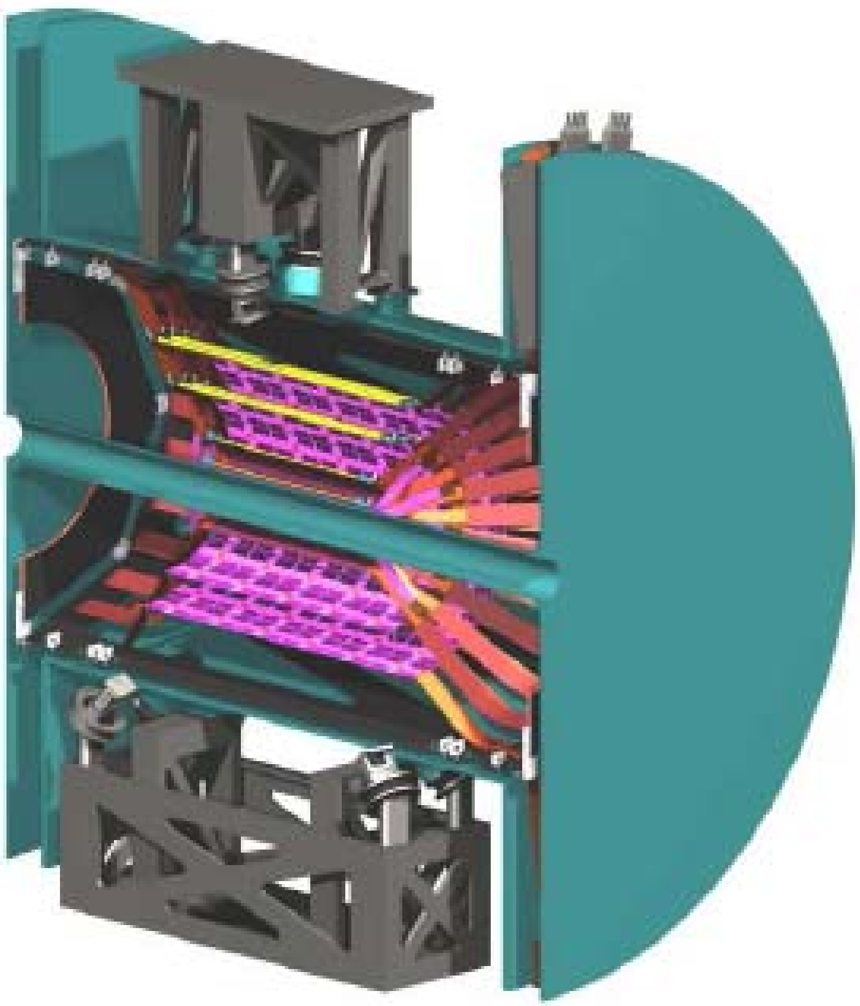
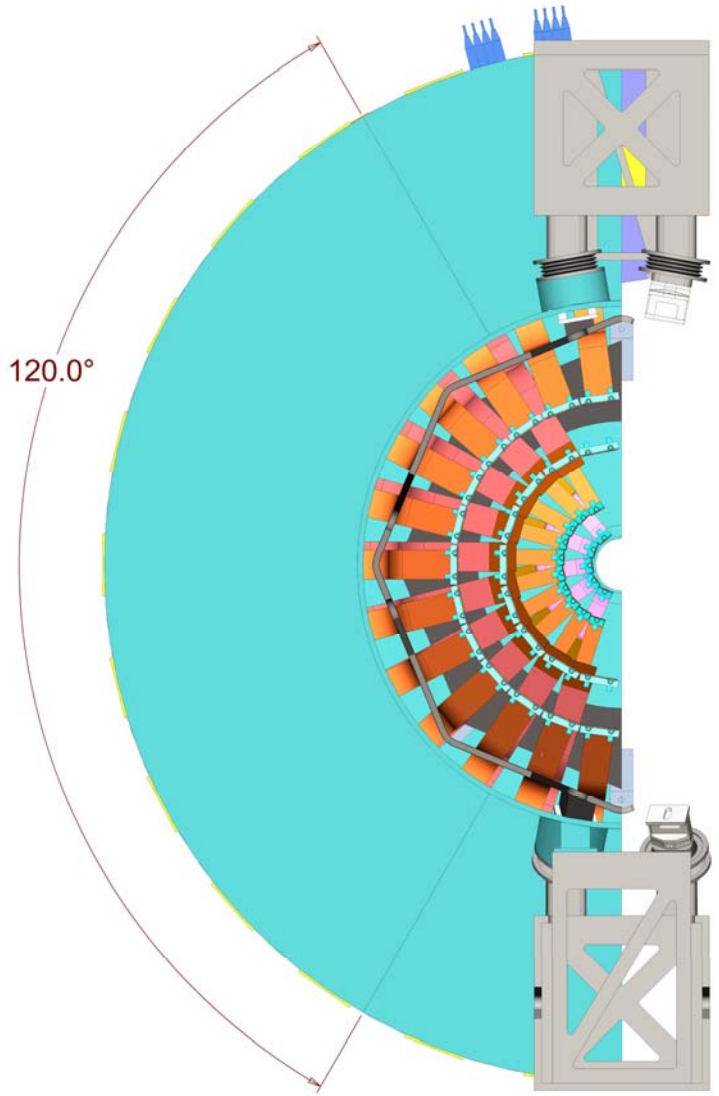
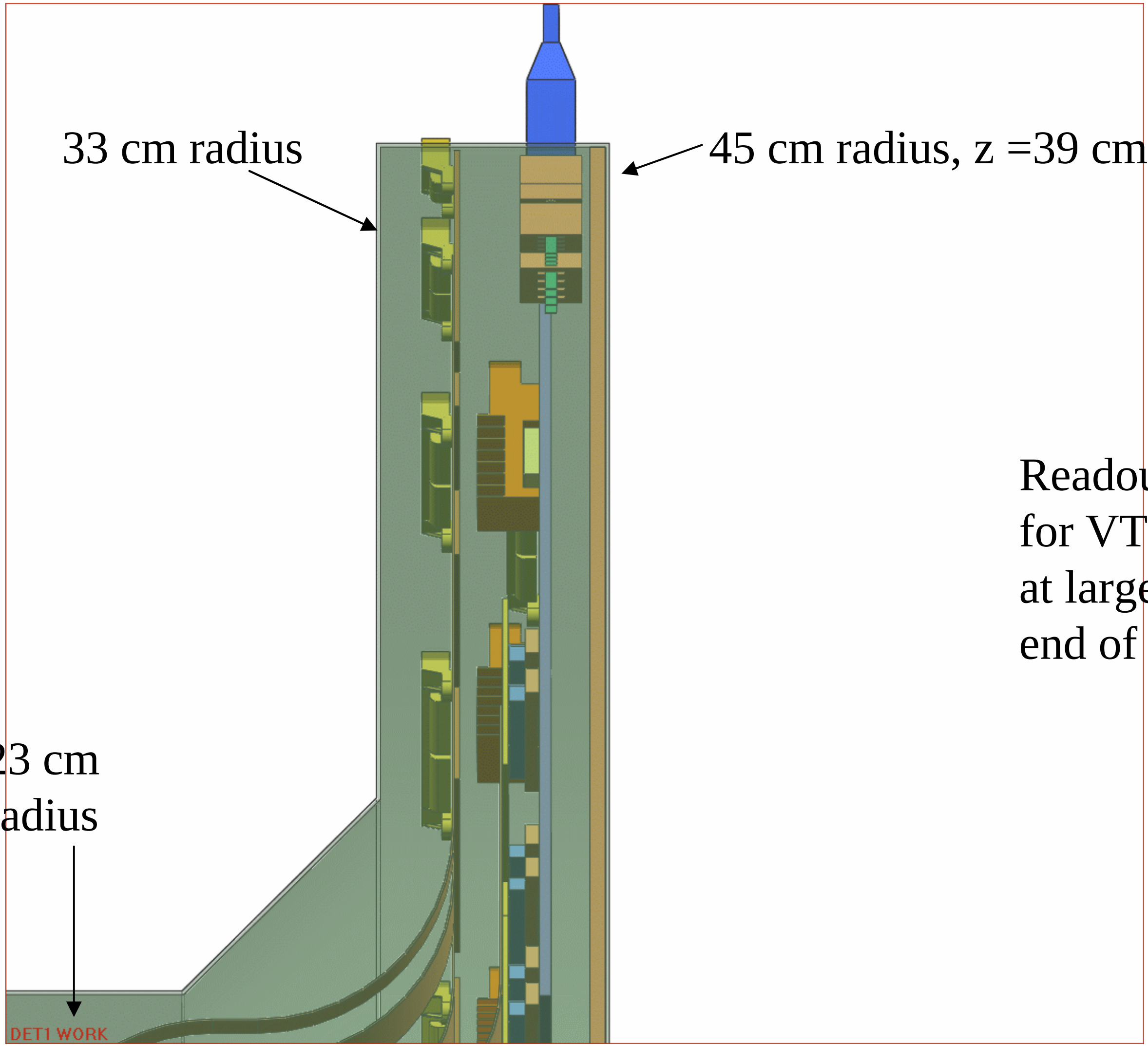


Fig. 3 VTX dry-gas enclosure and suspension system

HYTEC report cont.

INTERNAL DETECTORS MOUNTED TO 25 micron POSITION ACCURACY, GLOBAL DETECTOR LOCATION KNOWN TO SURVEY ACCURACY IN DETECTOR HALL.





Readout and services for VTX barrel detector at larger radius – either end of enclosure

GLOBAL SUPPORT STRUCTURE GFRP COMPOSITE.

COOLANT – SINGLE PHASE PER-FLOUROCARBON FLUID, C5F12 or C6F14.

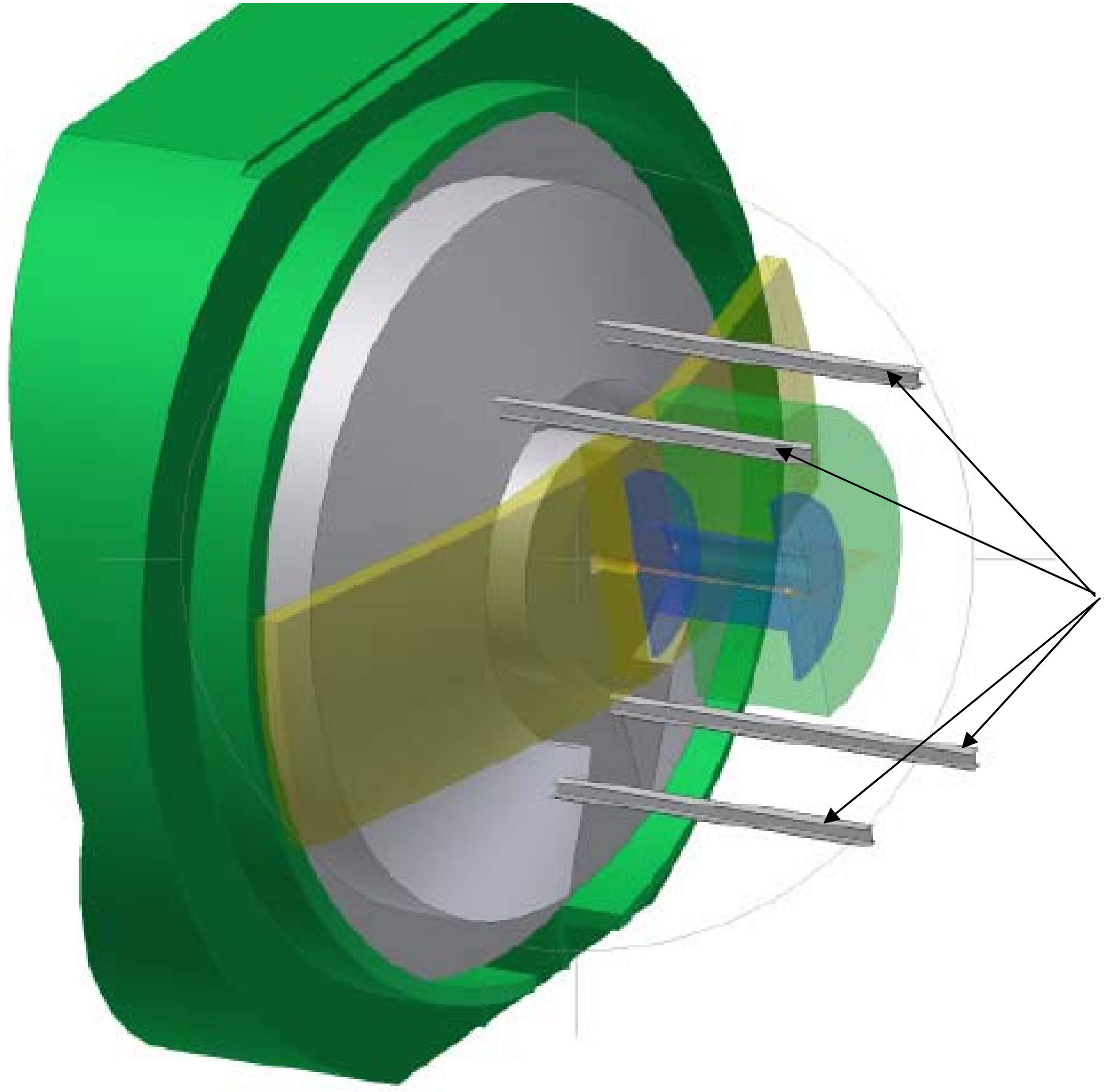
COOLANT WILL BE SUPPLIED AT 0 DEGRRES C AT COOLING TUBES.

GAS ENCLOSURE WILL OPERATE AT O DEGREES C.

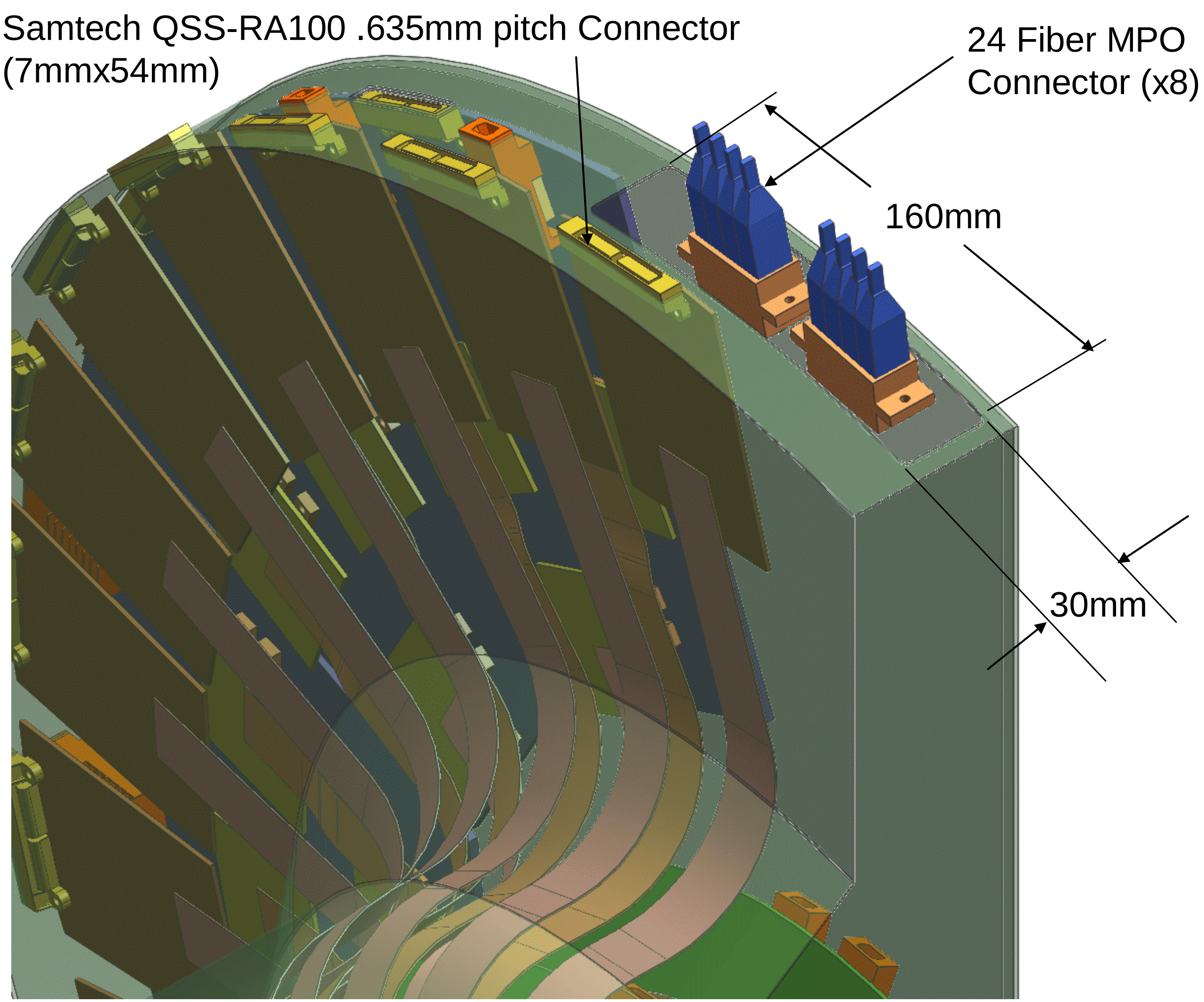
What's needed for VTX now:

- Designing an integrated support structure that will allow for the installation of endcap silicon detectors and have minimum impact on an existing VTX detector system.
- Designing a plan for the integration of services from the FVTX detectors, routing of cables, cooling circuits, etc.
- It is vital that any additional detectors – materials – have minimal impact on the existing stability of the VTX assembly.
- All "new" components should introduce minimal strain to the existing global structure.
- Make certain that all new detector components have a demonstrated reliability prior to their addition to the VTX detector system.

FOLLOWING ARE BACK-UP SLIDES:



FOUR BEAMS TO SUPPORT: HBD AND VTX DETECTORS


Samtech QSS-RA100 .635mm pitch Connector
(7mmx54mm)
24 Fiber MPO
Connector (x8)
160mm
30mm

General Cooling System comments:

- fluorocarbon coolants are the best choice for pixel detectors:
  - excellent stability
  - good thermal properties
  - relatively low viscosity at low temperature
  - electrically insulator
- Alice and CMS adopted so far C_6F_{14} monophase liquid cooling as baseline
- current ATLAS baseline is an evaporative system with C_3F_8 (due to high power dissipation: 19 kW inside a detector volume of about 0.3 m^3)
- however careful attention has to be paid to:
  - material compatibility (diluting action on resins and corrosion under irradiation)
  - coolant purification (moisture contamination has to be absolutely prevented)

From: M. Olcese, PIXEL-2000 talk

Thermal management: disk specific solutions

ATLAS

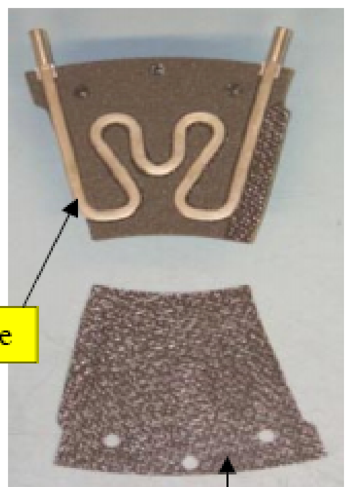
- flattened Al pipe embedded in between two carbon-carbon sheets
- thermal coupling by conductive grease

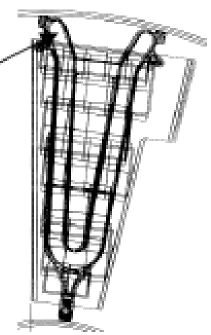
CMS

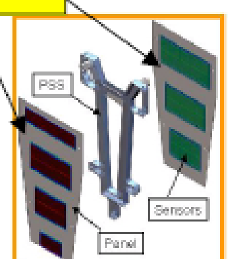
- Beryllium (Be) cooling tube in-between two Be plates (glue or thermal grease)
- chip integrated support blade (Si-kapton) connected to Be plates by soft adhesive

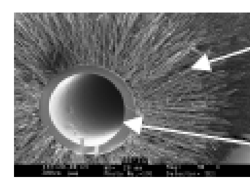
BTeV

- Glassy carbon pipe thermally coupled to chips with floacked carbon fibers
- CVD densification process to allow surface machining
- chips glued directly onto fuzzy surface shingle machined





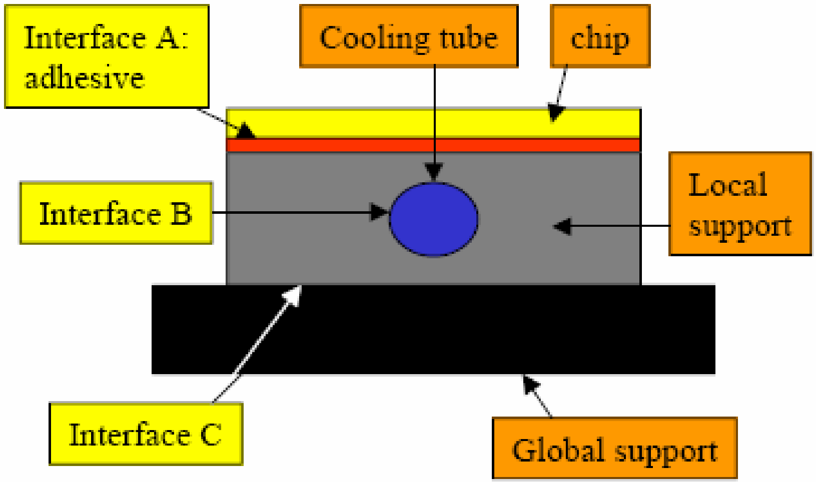




Thermal stability: fundamentals

background:

- detector fabricated at room temperature and operated below 0 °C (not true for Alice)
- local operating temperature gradients chips-to-cooling pipe on local supports



Goal: minimize by-metallic distortions due to

- CTE mismatches
- temperature gradients

Interface A

- chip CTE: fixed
- difficult to mate with support CTE
- either soft adhesive
- or very high rigidity of local support

Interface B

- same materials (small CTE)
- or flexible joint:
  - thermal grease
  - flocked fibers

Interface C

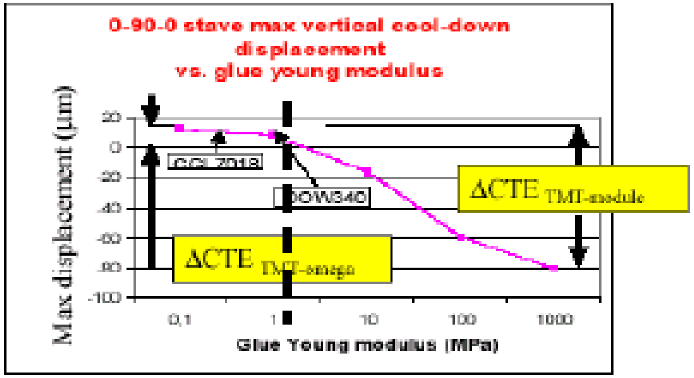
- same materials
- or kinematics joints

The thermal stability requirements impose very strong constraint on material selection

Thermal stability: chip-to-support interface

- Common problem for all detector
- adhesive has to be: soft, thermally conductive, rad-hard, room temperature curing
- difficult to find candidates meeting all specs
- modulus threshold depends on support stiffness and allowable stresses on chips

Typical effect on local support stability

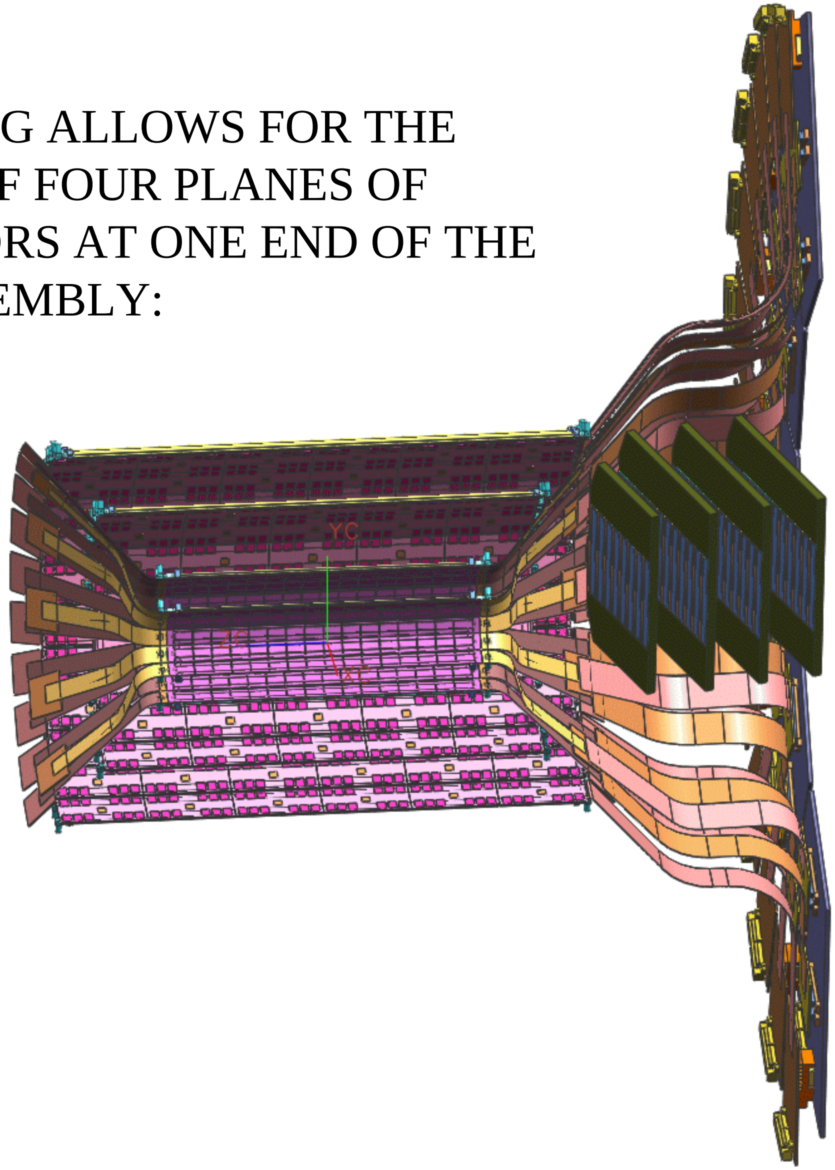


Thermal pastes:
- need UV tags
- reliability?

Silicon adhesives:
get much harder after irradiation

Long term test program always needed to qualify the specific adhesive joint

CURRENT FUNDING ALLOWS FOR THE IMPLEMENTION OF FOUR PLANES OF SILICON DETECTORS AT ONE END OF THE VTX BARREL ASSEMBLY:



A CONTRACT WITH HYTEC WAS FINALLY PUT IN PLACE, THROUGH LOS ALAMOS AT THE END OF AUGUST 2005 WITH BNL.

THIS COTRACT HAS THREE TASKS STATED:

1 - PROVIDE PRELIMENARY STUDY, IN APPROXIMTELY THREE WEEKS TIME, REVIEWING THE LATEST DETECTOR SPACE ENVELOPE, THIS WILL PLAY STRONGLY TOWARDS A DESIGN FOR THE ENCLOSURE.

2 - VERIFY THAT COOLING CAN BE ENGINEERED INTO THE PROPOSED DETECTOR MODEL AS WELL AS THE SUPPORT STRUCTURE.

3 - A FIRST PASS IS NEEDED TO VERIFY THAT THE ENTIRE VERTEX DETECTOR WILL BE ABLE TO INTEGRATE INTO THE REST OF THE PHENIX EXPERIMENT, IN THE ALLOTED SPACE THAT HAS BEEN ALLOWED. THIS IS BASED ON THE CURRENT "BOUNDARY CONTROL" FROM DON LYNCH AND ED O'BRIEN.

ISSUES; DEVELOP A LISTS OF R&D CONCERNS THAT WILL NEED TO BE ADDRESSED IN A FOLLOW UP CONTRACT FOR FY-2006, SOME OF THESE MAY INCLUDE DEVELOPMENT OF COLLING FOR THE STRIP DETECTORS. ALL OF THESE R&D ISSUES WILL NEED TO BE ADDRESSED DURING FY-2006 IN ORDER FOR CONSTRUCTION TO BEGIN IN FY-2008.