

# Pixel Detector Mechanics Conceptual Design Review

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## Technical Specification

### Pixel Detector Disk Support Rings

*Abstract*

This document describes the technical specifications for the design and fabrication of the disk support rings for the ATLAS pixel detector.

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## 1 Introduction

The disk support rings for the ATLAS detector support the disk sector local supports and are held by the global support frame of the pixel detector as shown in Figure 1. There are six disk support rings in the



*Figure 1. ATLAS Pixel disk structures(support rings and disk sectors) inside the global support frame.*

complete Pixel Detector. All six disks are identical.

Two prototype rings have been fabricated and loaded with prototype disk sectors. These prototypes corresponded to a larger radius for the pixel detector but the analysis and test results(particularly of the 2<sup>nd</sup> prototype) are applicable to the current design. Analysis of the second prototype is described in ref. 1. Test results are described in ref. 2.

## 2 Dimensions and Envelopes

The current baseline dimensions of the disk support ring are shown in Figure 2. Detailed envelopes will be addressed later in the creation of fabrication drawings for the rings and subcomponents of the rings. The current envelopes for the radial dimensions of the ring exceed the nominal by 0.1 mm. The envelope for the thickness(including bow) is 0.2mm(each side) greater than the nominal dimensions.

There are 24 sector support buttons on each ring, arranged in groups of three for each sector. The surfaces of the buttons(averaged over the button) in a group of three are to be in a plane with a tolerance of  $\pm 0.1$ mm. Similarly the surface of any button with respect to the average of all buttons should not deviate from the average by more than  $\pm 0.1$ mm.

## 3 Interfaces

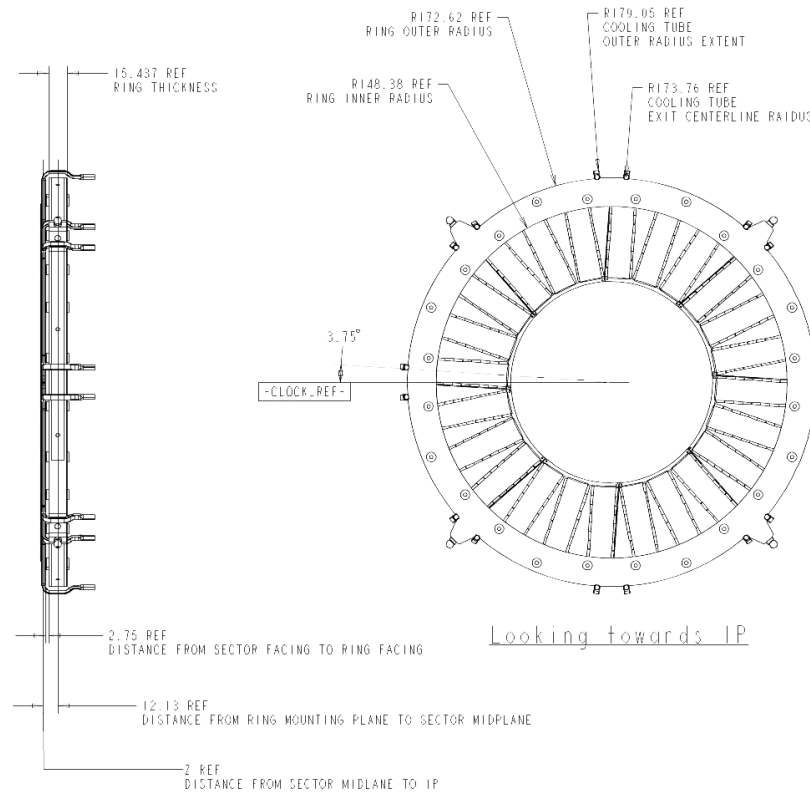
The principal interfaces to the disk support ring are (1) the disk sectors; (2) the global support frame; and (3) services(cables) from the modules mounted on the disk sectors.

### 3.1 Disk Sectors

The disk sectors are mounted on the disk support rings by fasteners that precisely align the sectors to the three mounting points on the ring. The locations of the three mounting points are to be set by tooling referenced to a master gauge used to fabricate the sectors. The aim is to allow any sector to be mounted

on any ring at any point on the ring. The nominal spacing between the ring facing and the sector facing is 2.75 mm and the minimum spacing is 2.5 mm.

There must be no uncontrolled electrical connection between the disk sector and the support ring. This is currently implemented by having non-conducting buttons on the disk sectors.



**Figure 2. Current baseline dimensions of the disk support ring.**

### 3.2 Global Support Frame

The disk support rings are held by four mounts in the global support frame. The mounting concept is illustrated in Figure 3.

These mounts have limited adjustment to allow the support ring to be centered on the axis of the frame, as well as provide means for disk removal. The small amount of travel that is provided by a built in differential lead screw, retracts the conical ball seat away from disk support ring spherical ball mount. An external access to this screw mechanism is provided. All four mounts use a precision spherical ball and conical seat combination to rigidly fix the contact points in XYZ. Rotation about the local contact point is permitted to limit moment transfer from the Global Support frame.



*Figure 3. PEEK based adjustable radial mount for the disk support ring. View rotated 45° for convenience of display.*

There must be no uncontrolled electrical connection between the disk ring and the global support. This is currently accomplished by having a non-conducting bushing in the global support frame.

### 3.3 Services

Electrical services(pigtails) pass over the support ring. Strain relief, if required, will be provided by gluing supports on to the support ring. The design of the strain relief has not been done but all strain relief elements will be added by LBNL after fabrication of a ring is complete. Fabrication and mounting of the strain relief pieces is not a responsibility of the ring fabrication vendor.

## 4 Final Assembly

Tooling is used to hold and locate the ring for assembly into the global support. The sector mounting holes are used to hold and align the ring to the tooling. No additional holes are required.

## 5 Survey Requirements

The location of modules on one side of the disk sectors are to be referenced by an optical coordinate measuring machine to the survey targets on the ring. These targets will be used to locate the ring inside the global support frame. These targets are not defined at this time but the location is to be on the four "ears" on the ring so that they are visible with sectors mounted on the ring. The ring survey targets are located on the side of the ring away from the IP. The targets for survey of the disks after mounting in the global support frame are not yet defined.

## 6 Load Conditions, Stability and Analysis

Finite element and other analyses are to be done on the ring. The critical requirements are that deflections under gravity, imposed loads, vibrations(stability) or as the result of cool down from room temperature. We calculate the allowable values assuming a 20% or less degradation in the pixel resolution and furthermore assume this is apportioned among the disk sector, disk support ring and global support in the ratio 1:2:4, respectively. Tolerance values are assumed to be (rms value) x  $\sqrt{12}$ . With these assumptions, the tolerance(rms) requirements in  $\phi$ , R and Z, are 12(3.4), 100(29), 212(62) microns, respectively. Analysis of the current design is described in ref. 3.

## 7 Other Requirements

The ring will be coated with Parylene(0.008-0.012 mm thick) after fabrication to contain conducting carbon dust or fragments.

## 8 Materials

The ring faceplates are to be carbon-carbon (C-C) material identical to the material used for sector fabrication. The nominal thickness of this material is 0.44mm. C-Channels, outer and inner, are used to bond the two C-C faces together. Woven cloth material (YSH50 graphite fiber), impregnated with cyanate ester resin is used for constructing the C-Channels. A 0/45/-45/0 fiber orientation is used for laying up the woven cloth, resulting in a nominal wall thickness of 0.5mm. The 24 inserts for mounting the sectors are machined and bonded to the front and back surfaces of the faceplates. Two insert materials have been identified for this application, PEEK and 3D C-C. The 3D C-C is preferred from a thermal dimensional stability standpoint. Material for supporting the 4 spherical mounting balls on the ring is 3D C-C. Hysol 9396 room temperature curing adhesive is used in all the bonding steps for joining this assembly. With the exception of the precision spherical ball on the disk ring, all mount materials are PEEK (thermoplastic). The spherical balls will most likely be from a ceramic material, although aluminum is an option.

## 9 Qualification Tests

Qualifications tests are to be performed by the fabrication vendor on materials to be used in the ring construction and on each ring after fabrication. LBNL will also perform qualification tests.

### 9.1 Materials

Tensile modulus and strength tests are to be done on the carbon-carbon material used for the faceplates and on the material used for the C-channels in the ring construction.

### 9.2 As-built Dimensions

The fabrication vendor will measure the average thickness, inner and outer radius of each ring. The critical dimensions of each ring(location of sector mounting holes and mounting points, planarity of the mounting buttons) are to be measured by LBNL for each ring.

### 9.3 Load Tests

The deflection of the ring midway between each of the support points is to be measured up to a 10N load by LBNL.

### 9.4 Sector Mounting Test

LBNL will provide a few test sectors and mounting pins/bolts to the fabrication vendor. The fabrication vendor will demonstrate that a test sector can be mounted at any location on all rings.

## 10 Quality Assurance

The fabrication vendor will provide a quality control plan to LBNL as part of the fabrication contract.

## 11 References

1. *Thermoelastic Static and Modal Analysis Of Composite Support Ring for a Pixel Detector Planar Array, HTN-106020-0001, June 1,2000*
2. *Static and Modal Testing of Composite Support Ring for a Pixel Detector Planar Array, HTN-106020-0002, June 1, 2000*
3. *Analysis of ATLAS Disk Support Ring, 432mm Global Support Structure, HTN-106210-0001, April 22, 2001*