

## SP Detector Support Structure (DSS) Design Specification

### Introduction

The DSS is a structure that provides the required supports for the Endwalls, APAs and CPAs in the DUNE SP Detector. The DSS is supported by the cryostat. The connection to the cryostat is at a flange on the outside of the cryostat and extends through the structure and insulation. The DSS must meet the design specifications listed below.

### Design specifications

The design specifications are:

- Support the weight, both dry and wet, of the detector (Endwall, top/bottom FC, APA, CPA)
- Be able to accommodate the **roof deflection during cooldown and filling.** – THE ROOF DEFORMATIONS NEED TO BE DEFINED
- Accommodate the variation in the feed thru locations and variation in the flange angle due to installation tolerances and the loading on the warm structure. **WHAT IS THE TOLERANCE OF THE FEED THRU POSITION, LOOK BACK AT PROTODUNE DATA**
- Accommodate the shrinkage of the detector and DSS from ambient temperatures to 87°K (LAr temperatures).
- Minimize the gaps that develop between APAs during cool down less than 12mm (11.424 per side) A proposed design uses beams that are 6.4m long, which support 2 or 3 APAs on each segment. This design results in a zero gap developing between the APA's on the same beam but a 17mm gap opening up between adjacent APA's that are on separate beams.
- Define the position of the detector components relative to each other **NEED TO DEFINE THIS TOLERANCE (the DSS can only control the position of the yokes WRT the DSS beam, it cannot maintain the relationship between the yoke and the active region, this is inherent in the design and manufacturing of the APA)**
  - **KZ: One CPA/FC Super assembly (there are 50 of these units per SP detector) is supported by the DSS at two locations. To maintain detector row squareness and alignment, one CPA/FC Super assembly must not straddle two DSS beams. It is reasonably to suspect that DSS beams supporting CPAs will differ in length from beams supporting APAs.**
  - **KZ: Gaps between detector rows will change. Preliminary linear studies suggest gaps open up by as much as 17mm.**
- The CPA to APA centerline distance and tolerance envelope must be maintained  $3.574\text{mm} \pm y$  mm **NEED TO DEFINE TOLERANCE**
- The DSS is electrically connected to the cryostat ground
- The APA/CPA/FC/Endwall are electrically isolated from the DSS
- The DSS penetrations must be purged with GAr to maintain a positive pressure in order to prevent contaminants from diffusing to the liquid
- The instrumentation cabling must not interfere with the DSS. **What is the expected envelop of the cabling?**
- The DSS components must be able to be installed through the TCO
- A QA program is required
- The DSS is to designed to meet **the appropriate code designated and agreed upon in the analysis plan.**
- The DSS will be designed to meet seismic requirements suitable for 1 mile underground at SURF
- All materials must be compatible for operation in ultrapure LAr

- ~~The DSS beams will be completely submerged in LAr (this is not a requirement)~~
- The DSS supports shall not interfere with the cryostat I-Beam structures
- ~~The DSS shall be designed such that it supports the detector so that the lower ground plane is above the cryogenic piping and the top of the DSS beams are submerged in LAr while leaving a 4.5% ullage at the top of the cryostat.~~
- The DSS shall be designed to accommodate the movement of the detector elements during installation.

## Interfaces

The DSS has several interfaces that have to be considered.

### 1. APA

The DSS provides support to the APA's. Currently the APA's are supported at two points during installation. Once the APA is in its final position it is permanently attached to the DSS at a single center point and the trolleys used for installation are removed. **Our discussion on 11-Dec-19**

### 2. CPA

A pair of CPA's will be attached to the DSS as a single unit. A 1-13 threaded rod will extend from each CPA to the trolley on the DSS. After the CPA has been moved into its final position the trolleys will be removed and the CPA will be permanently mounted to the DSS. The pair of trolley's moving the CPA's must be tied together to prevent them from potentially applying any load other than the vertical load to the CPA **CONFIRM**

### 3. Endwall

The endwall must be supported by the DSS from the beams that support the APA and CPA. The DSS must also provide whatever support is needed to assemble the Endwall in place

### 4. Cryostat

The cryostat will have a flange on the outside of the warm structure that the DSS will mount to. A 200 mm diameter OD crossing tube (**ID TBD**) will be provided concentric to this flange that will provide access to the inside of the cryostat. The mounting flange will be able to resist XXX kg of vertical load, YYY kg of lateral load, and a moment that is equal to the ZZZ kg lateral load multiplied by the length of the feedthrough. **Loads will be calculated from detector mass.**

### 5. Cryogenic system

~~The DSS sets the location of the detector. The detector must be positioned so that the lower ground plane does not conflict with the cryogenic piping along the floor. It must also be situated so that the cryogenic pipes at both ends of the detector see a safe field.~~

### 6. Calibration and cryogenic monitoring

Like the cryogenic monitoring the detector location must be such that the other detector services can operate in region with low risk of electric discharge.

### 7. TPC Cold Electronics

**After an APA pair is mounted to the DSS the CE cable tray is transferred to a DSS beam.**