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Silicon Vertex Tracker – Space Requirements

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Table of Contents:

1. Introduction

The space requirements for integrating the SVT subsystem are detailed in this note. NOT discussed is the space required for the 24 READOUT ELECTRONICS locations and the space required for the SVT and its physical support structure. This document will be updated as more information becomes available or changes are made. All versions of this document will be dated to avoid confusion as to the latest version. The latest version will be kept on the World Wide Web. From the STAR Home Page follow the path STAR → STAR Subsystems → SVT Documents → SVT hardware documents.

Space is required for the following SVT subsystem interconnections:

- Electrical CABLES from the SVT RACKS to the SVT READOUT ELECTRONICS or passed through the READOUT ELECTRONICS to the SVT CARRIERS OR CARRIER INTERFACES
- Electrical CABLES from the SVT READOUT ELECTRONICS to the SVT CARRIER INTERFACES
- OPTICAL FIBERS from the SVT READOUT ELECTRONICS to the COUNTING HOUSE (DATA ACQUISITION)
- WATER LINES to the SVT WATER MANIFOLDS
- AIR DUCTS to the SVT LIGHT PLATES
- RACK space for power supplies, TRIGGER distribution electronics, CALIBRATION electronics, SLOW CONTROLS, WATER system, etc.
- OTHER space needs

For the discussion in this document: the RACKS location is on the NORTH PLATFORM, SECOND LEVEL; the READOUT ELECTRONICS locations are on the TPC endcaps near the ends of the SVT SUPPORT CONES; the CARRIERS and CARRIER INTERFACES are located near each end of the SVT; and CABLE refers to either a single conductor cable or a multiconductor cable.

2. Executive Summary

Tables 1-6 summarize electrical CABLE requirements, optical FIBER requirements, WATER line requirements, AIR DUCT requirements, RACK requirements, and OTHER space requirements for the SVT. These requirements are justified in **Sections 3-9**. In estimating the cross sectional area of cable paths required, cables were treated as having **square** cross sections of area $A = diameter^2$.

For **each** RACKS to **individual** READOUT ELECTRONICS location (i.e., 24 **separate** paths, 12 to **each** end of the TPC) the integrated cross sectional area of the required CABLES (11 CABLES) is 3 in^2.

All CABLES entering **each** end of the SVT SUPPORT STRUCTURE (360 CABLES) have an integrated cross sectional area of 35 in^2. WATER lines require an additional 6 in^2 of space in **each** end, so at least 41 in^2 is required through **each** end of the SVT SUPPORT STRUCTURE. The cross sectional area of a 1 in wide ring with an outer radius of 7.8 in (the radius at the small end of the "CONE") is 46 in^2.

Two OPTICAL FIBERS from **each** of the 24 READOUT ELECTRONICS locations go directly to DATA ACQUISITION in the COUNTING HOUSE. Sharp turns must be avoided and **each** of the 24 paths requires a cross sectional area of 0.1 in^2.

Two WATER lines (1.5 in, inside diameter, each) must connect the supply side of the SVT HEAT EXCHANGER (located outside the experimental hall) to two WATER MANIFOLDS near one end of the SVT SUPPORT STRUCTURE; from each MANIFOLD 5 – (0.75 in, outside diameter, **each**) WATER lines enter the SUPPORT STRUCTURE (10, total) and go to another WATER MANIFOLD near the SVT. An identical requirement exists at the other end of the SVT in order to return the water to the HEAT EXCHANGER (via a low pressure water system located on the NORTH PLATFORM, THIRD LEVEL). This water cooling system must be independent from any other cooling system. SPACE is required for the mechanical part of this system (**see Section 9**).

Large AIR DUCTS must be located at **each** end of the SVT SUPPORT STRUCTURE for SDD surface cooling. These DUCTS connect to the SVT LIGHT PLATES which make the SVT light tight. The SVT AIR CONDITIONING system must be independent from any other air conditioning system. SPACE is required for the MECHANICAL part of this system (**see Section 9**).

NOTE: A multi-conductor (number of conductors to be determined) must run from the RACKS to the Capacitive Displacement Measuring System (CDMS) located on the SVT ladders.

NOTE: In addition, WATER must be provided to **each** of the 24 READOUT ELECTRONICS locations for electronics cooling. The TPC WATER system which cools the TPC READOUT ELECTRONICS will provide the SVT READOUT ELECTRONICS cooling WATER. **Each** (24 total) READOUT ELECTRONICS area will generate about 100 Watts of power.

3. Electrical CABLES from the SVT RACKS to the SVT READOUT ELECTRONICS or passed through the READOUT ELECTRONICS to the SVT CARRIERS OR CARRIER INTERFACES

requirement: The required CABLES to **each** of the 24 READOUT ELECTRONICS locations are listed in Table 1. The total number of CABLES required is 24 times the numbers in Table 1. The cross sectional area of the bundle of CABLES that runs from the RACKS to **each** of the 24 READOUT ELECTRONICS LOCATIONS (11 CABLES) is 3.0 in^2.

Function	Conductors	Diameter (inches)	Number
HIGH VOLTAGE	1 Coaxial	0.25	3
CALIBRATION	6 shielded pair	0.5	3
LOW VOLTAGE	4 conductor	0.75	2
TRIGGER Distribution	8 shielded pair	0.5	1
SC (HDLC) LINK	4 shielded pair	0.5	1
SPARE	8 shielded pair	0.5	1

Table 1: CABLES required from SVT RACKS to **each** READOUT ELECTRONICS locations or passed through READOUT ELECTRONICS to CARRIERS OR CARRIER INTERFACES. There are 24 READOUT ELECTRONICS locations on the TPC end caps. 12 are on right side and 12 are on the left side. The HIGH VOLTAGE CABLES pass through the READOUT ELECTRONICS locations, through the SVT SUPPORT STRUCTURE, to HIGH VOLTAGE DIVIDER BOARDS near the ends of the SVT LADDERS. The CALIBRATION CABLES pass through the READOUT ELECTRONICS locations, through the SVT SUPPORT STRUCTURE, to the CARRIER INTERFACES. All CABLES are plenum rated.

justification: THE SVT LOW VOLTAGE power supplies, HIGH VOLTAGE power supplies, TRIGGER/CLOCK distribution point, SDD CALIBRATION-source electronics, and the SLOW CONTROLS system are located in the RACKS. Electrical CABLES must connect these systems to the SVT READOUT ELECTRONICS, the CARRIERS, and the CARRIER INTERFACES.

The SVT contains 36 ladders. Near the water manifolds close to both ends of each ladder are voltage DIVIDER BOARDS. A separate HIGH VOLTAGE line connects to each DIVIDER BOARD, so that a total of 72 HIGH VOLTAGE lines is needed. Since there are 24 READOUT ELECTRONICS locations at each TPC endcap, 3 HIGH VOLTAGE lines from the RACKS through **each** of the 24 READOUT ELECTRONICS locations are required. The HIGH VOLTAGE lines pass through the READOUT ELECTRONICS locations, through the SVT SUPPORT STRUCTURE, to DIVIDER BOARDS located near the ends of the SVT LADDERS.

[From each DIVIDER BOARD a flex cable with 50 voltage levels runs to the first detector on its side of the ladder. Each detector has about 500 cathodes, and each 10th cathode is supported externally. The voltage lines are then *daisy chained* to the other detectors on the ladder. The actual number of Silicon Drift Detectors associated with each of the 72 HIGH VOLTAGE lines is 2, 3, or 4. The number of 50-line HIGH VOLTAGE distribution cables from the water manifolds to the ladder is 72.]

Each SDD requires 6 CALIBRATION signals. A total of 72 – (6 shielded pair) CABLES are required. **Each** cable goes to one end of **each** ladder and the 6 CALIBRATION signals are *daisy chained* to either 2, 3, or 4 SDDs on that end of the ladder. Since there are 24 READOUT ELECTRONICS locations (12 on **each** TPC endcap), 3 CALIBRATION signal lines are routed from the RACKS through **each** of the 24 READOUT ELECTRONICS locations, through the SVT SUPPORT STRUCTURE, to the CARRIER INTERFACES.

Each READOUT ELECTRONICS location requires LOW VOLTAGE power for POWER CONDITIONERS that generate -1,+4, +5A, +5D, +12, -12 VDC for use by the READOUT ELECTRONICS and the HYBRIDS. These 6 voltages will be provided to **each** READOUT ELECTRONICS location using 2 – (4-conductor) cables from power supplies in the RACKS. [The additional 2 conductors are for 2 grounds (A&D).]

Each READOUT ELECTRONICS location requires 1-(4 shielded pair) from the CLOCK/TRIGGER distribution tree.

Each READOUT ELECTRONICS location requires 1-(4 shielded pair) to interface the READOUT ELECTRONICS to the SLOW CONTROLS (HDLC).

In addition 1–(8 shielded pair) should be provided to **each** READOUT ELECTRONICS location for SPARE, SAFETY, INTERLOCK, ETC., purposes.

NOTE: A multi-conductor (number of conductors to be determined) must connect **one** of the RACKS to the Capacitive Displacement Measuring System (CDMS) located on the SVT ladders.

4. Electrical CABLES from the SVT READOUT ELECTRONICS to the SVT CARRIER INTERFACES

requirement: The required CABLES from **each** READOUT ELECTRONICS location to to the SVT CARRIERS or CARRIER INTERFACES are listed in Table 2. The cross sectional area of the bundle of CABLES (360 CABLES) (from 12 READOUT ELECTRONICS locations) that enters **each** end of the SUPPORT STRUCTURE is 35 in^2 (including 36 HIGH VOLTAGE and 36 CALIBRATION CABLES, Table 1).

Function	Conductors	Diameter (inches)	Number
LOW VOLTAGE	8 conductors	0.4	6
TIMING/CONTROL	8 shielded pair	0.25	6
MULTIPLEXED ANALOG	4 shielded pair	0.25	6
CARRIER ID, MONITORS	10 conductor	0.2	6

Table 2: CABLES required from **each** SVT READOUT ELECTRONICS location to SVT CARRIERS or SVT CARRIER INTERFACES. There are 12 READOUT ELECTRONICS locations on **each** of the two TPC endcaps. The total number of CABLES entering the SVT SUPPORT STRUCTURE from **each** end is therefore **12 times** the numbers in this table **plus** 36 HIGH VOLTAGE and 36 CALIBRATION CABLES passed through the READOUT ELECTRONICS locations. All CABLES are plenum rated.

justification: The SVT has 142 CARRIER INTERFACES. **Each** READOUT ELECTRONICS must connect with 6 CARRIER INTERFACES. **Each** CARRIER INTERFACE requires LOW VOLTAGE (8 conductor, same as required for READOUT ELECTRONICS), TIMING/CONTROL (8 shielded pair), MULTIPLEXED ANALOG lines (4 shielded pair), and CARRIER ID, MONITORS lines (10 conductor).

The total number of CABLES required for **each** side of the SVT is 12 times the numbers in Table 2, **plus** 36 HIGH VOLTAGE and 36 CALIBRATION CABLES listed in Table 1.

5. OPTICAL FIBERS from the SVT READOUT ELECTRONICS to the COUNTING HOUSE (DATA ACQUISITION)

requirement: Table 3 shows the OPTICAL FIBERS, per **each** READOUT ELECTRONICS location, that connect the READOUT ELECTRONICS to DATA ACQUISITION RECEIVERS in the COUNTING HOUSE. A path with a square cross sectional area of 0.1 in^2 is required from **each** READOUT ELECTRONICS location to DAQ. Sharp bends must be avoided.

Function	Diameter (inches)	Number
FIBER LINK	0.2	2

Table 3: OPTICAL FIBERS required from **each** SVT READOUT ELECTRONICS location to DATA ACQUISITION (COUNTING HOUSE) RECEIVER ELECTRONICS. There are 12 READOUT ELECTRONICS locations on **each** of the two TPC endcaps. The total number of OPTICAL FIBER CABLES arriving at DAQ is 48.

justification: The READOUT ELECTRONICS interface to the DATA ACQUISITION RECEIVER ELECTRONICS via OPTICAL FIBER links. **Each** READOUT ELECTRONICS requires a dual fiber link to DAQ; a total of 48 OPTICAL FIBERS are required.

6. WATER LINES to the SVT WATER MANIFOLDS

requirement: Table 4 gives WATER line requirements at **each** end of the SVT for SDD/HYBRID cooling. The SVT must have its own water cooling system.

Function	Diameter (inches)	Number
HEAT EXCHANGER to STAR	1.5 (inside)	2
STAR to WATER MANIFOLD	0.75 (outside)	10

Table 4: WATER requirements at **each** end of SVT for cooling.

justification: The SVT Silicon Drift Detectors (SDDs) and CARRIER ELECTRONICS must be maintained at a constant temperature. Cooling WATER will be provided by a dedicated water system. Two 1.5 *in* (inside diameter) WATER lines must go from the HEAT EXCHANGER of a HIGH PRESSURE water system located OUTSIDE the experimental hall to 2 WATER MANIFOLDS (about $4\ in \times 4\ in \times 4\ in$, each) located near one TPC endcap region. Each MANIFOLD connects to 5 – 0.75 *in* (outside diameter) WATER lines for entry into the SUPPORT STRUCTURE. These 10 lines connect to a WATER MANIFOLD near the SVT CARRIER INTERFACES. On the other side of the SVT SUPPORT STRUCTURE an identical arrangement **returns** the water THROUGH a LOW PRESSURE water system (located in the experimental area on the NORTH PLATFORM, THIRD LEVEL) to the HEAT EXCHANGER located outside the experimental hall. The TPC water cooling system is inadequate for use by the SVT for SDD/HYBRID cooling.

NOTE: In addition, WATER must be provided to **each** of the 24 READOUT ELECTRONICS locations for electronics cooling. The TPC WATER system which cools the TPC READOUT ELECTRONICS will provide the SVT READOUT ELECTRONICS cooling WATER. **Each** READOUT ELECTRONICS area will generate about 100 Watts of power.

7. AIR DUCTS to the SVT LIGHT PLATES

requirement: AIR DUCT requirements at **each** end of the SVT SUPPORT STRUCTURE are given in Table 5. These DUCTS attach to the SVT LIGHT PLATES at **each** end of the SVT SUPPORT STRUCTURE. The SVT must have its own AIR CONDITIONING system.

Function	Diameter (inches)	Number
AIR FLOW to SVT	TBD	4

Table 5: AIR DUCTS required at **each** end of SVT SUPPORT STRUCTURE

justification: AIR flow through the SVT is required to provide surface cooling of the Silicon Drift Detectors. The STAR AIR CONDITIONING is inadequate for SVT use.

8. RACK space for power supplies, TRIGGER distribution, CALIBRATION distribution, SLOW CONTROLS, WATER system, etc.

requirement: RACK space requirements are given in Table 6. A total of 8 RACKS is required. The RACKS are located on the NORTH PLATFORM, SECOND LEVEL. The RACKS are assumed to be standard width (19 *inch*) and height (about 6 *feet*).

Function	Number
HIGH VOLTAGE Power Supplies	1
LOW VOLTAGE Power Supplies	3
Slow Controls	2
TRIGGER Distribution, CALIBRATION	1
WATER, Misc.	1

Table 6: RACK space required for SVT.

justification: The SVT uses HIGH VOLTAGE power supplies, LOW VOLTAGE power supplies, WATER cooling, AIR cooling, READOUT ELECTRONICS, CALIBRATION electronics, TRIGGER distribution electronics, SLOW CONTROLS electronics, and DATA ACQUISITION electronics.

9. OTHER space needs

requirement: The SVT HIGH PRESSURE water system requires a floor space of 5 $ft \times 5\ ft$ outside the experimental hall. The SVT LOW PRESSURE water system requires a floor space of 3 $ft \times 3\ ft$ on the NORTH PLATFORM, THIRD LEVEL. The SVT AIR CONDITIONING system requires a floor space of 2 $ft \times 5\ ft$ and its location remains to be determined.

justification: The WATER cooling system and the AIR conditioning systems require space.