

SSD cable packing

The following exercise estimates the area required for packing the SSD cables. The example illustrated uses cat 5 cables for slow control cables. Cable dimensions have been measured from samples of insulated wire for the items listed in the Christophe summary. Only 10 cooling tubes have been included since this is believed to be the only ones required to pass by the FGT.

A bundle area is calculated which conforms to NASA bundle standards. The total area required, 6 sq. in, is significantly less than, 11 sq. in, the area available in a single FGT quadrant gap according to the Jim Kelsey model:

Star Upgrade Layout Rev. 5 wout SSD.STEP

This suggests that the current radius of the FGT is not an issue, particularly since one would expect that the cables would be divided between two gaps. Additional work is required to determine optimum cable routing, but radius reduction is not an obvious requirement at this point.

A visual aid is provided to illustrate how the bundle of cables fit in the FGT gap.

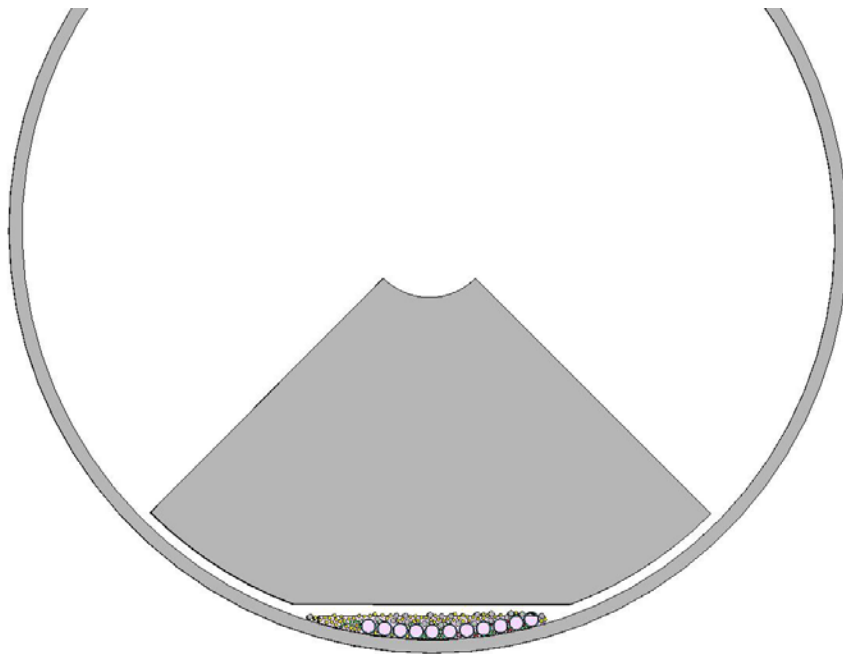


Figure showing all the SSD cables positioned in a single FGT quadrant gap.

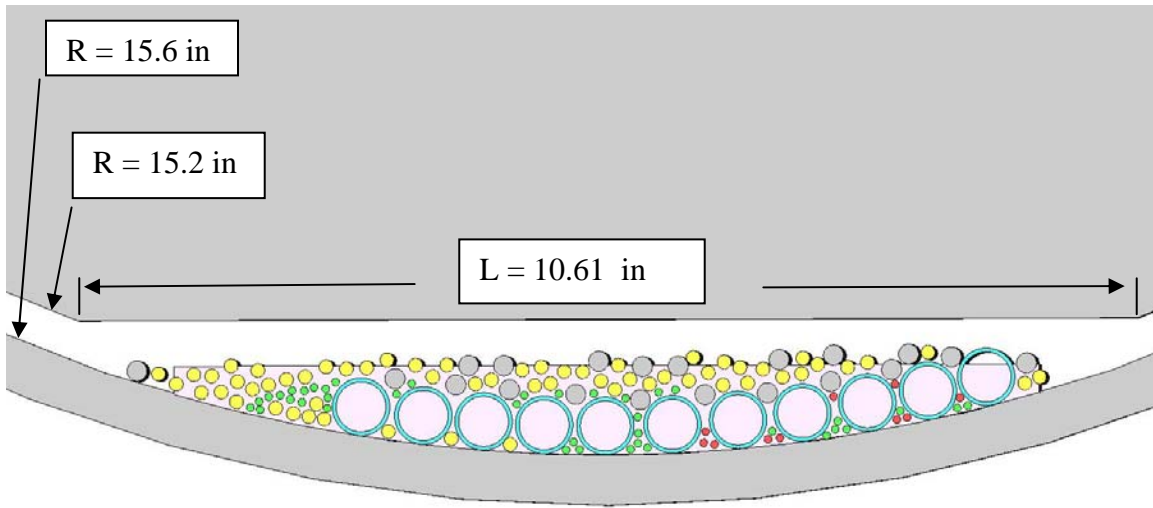


Figure showing expanded view of all the SSD cables positioned in a single FGT quadrant gap. Cables have been casually distributed by hand. The distribution of cables conforms roughly with the calculated NASA bundle area illustrated in pale violet.

- cooling tubes: blue
- voltage sensor pairs: green
- JTAG cables: grey
- Low Voltage power pairs: yellow
- High Voltage pairs: red
- NASA packing area: violet

SSD cable packing

$$\eta_h = \frac{1}{6} \cdot \pi \cdot \sqrt{3} \quad \text{circle packing density number}$$

<http://mathworld.wolfram.com/CirclePacking.html>

$$\eta_h = 0.907$$

$$A_{cp}(n, d) = \pi \cdot \left(\frac{d}{2}\right)^2 \cdot \frac{n}{\eta_h} \quad \text{Area of } n \text{ close packed circles with diameter } d$$

LV Power bundle - twisted pairs #18

$$d_{18} = 1.75 \text{ mm} \cdot 2 \quad \text{diameter of twisted pair \#18}$$

$$N_{p18} = 3 \cdot 20 \quad \text{Number of pairs}$$

$$A_{cp18} = A_{cp}(N_{p18}, d_{18})$$

$$A_{cp18} = 0.99 \text{ in}^2 \quad A_{cp18} = 6.4 \text{ cm}^2 \quad \text{close packed area}$$

Voltage sensor bundle - #24

$$d_{24s} = .99 \text{ mm} \cdot 2 \quad \text{diameter of twisted pair \#24}$$

$$N_{p24s} = 2 \cdot 20 \quad \text{Number of pairs}$$

$$A_{cp24s} = A_{cp}(N_{p24s}, d_{24s})$$

$$A_{cp24s} = 0.21 \text{ in}^2 \quad A_{cp24s} = 136 \text{ mm}^2$$

HV bundle - twisted pairs #24

$d_{24hv} = .99\text{mm}$ twisted pair diameter

$N_{24hv} = 10$ Number of HV pairs

$$A_{cp24hv} = A_{cp}(N_{24hv}, d_{24hv})$$

$$A_{cp24hv} = 0.1\text{ in}^2 \quad A_{cp24hv} = 34\text{ mm}^2$$

Slow controls JTAG

one per CAT 5 cable, individual shielded twisted pairs, 8

$d_{jtag} = .2\text{in}$ cable diameter

$N_{jtag} = 20$ number of JTAG cables

$$A_{jtag} = A_{cp}(N_{jtag}, d_{jtag})$$

$$A_{jtag} = 0.7\text{ in}^2 \quad A_{jtag} = 4.5\text{ cm}^2$$

Cooling tubes

$d_{cool} = .575\text{in}$ cooling OD

$N_{cool} = 10$ Number of cooling tubes passing by FGT

$$A_{cpcool} = A_{cp}(N_{cool}, d_{cool})$$

$$A_{cpcool} = 2.86\text{ in}^2 \quad A_{cpcool} = 18.5\text{ cm}^2$$

Total

$$A_{total} = A_{cp18} + A_{cp24s} + A_{cp24hv} + A_{cpcool} + A_{jtag}$$

$$A_{total} = 4.81\text{ in}^2 \quad A_{total} = 31\text{ cm}^2$$

NASA bundle diameter see: cross_section_99.pdf

ATLAS/Eric Anderssen

$$D_{NASA} = \sqrt{\frac{4}{\pi} \cdot n \cdot d^2 \cdot WF}$$

where $WF = 1.08$

NASA weight factor

n = number of wires

d = wire diameter

so NASA bundle area is

$$A_{NASA} = n \cdot d^2 \cdot WF$$

$$E_{nasa} = \frac{A_{NASA}}{A_{cp}}$$

NASA to close packed ratio

$$E_{nasa} = n \cdot d^2 \cdot WF \cdot \frac{\frac{1}{6} \cdot \pi \cdot \sqrt{3}}{\pi \cdot \left(\frac{d}{2}\right)^2 \cdot n} = \frac{2}{3} \cdot WF \cdot 3^{\frac{1}{2}} = 1.25$$

Summary of results

	"Service type"	"close pack"	"NASA bundle"
Area =	"LV power"	6.4	8
	"V sensor"	1.4	1.7
	"HV"	0.3	0.4
	"Slow Controls"	4.5	5.6
	"cooling"	18.5	23.1
	"Total"	31	38.8

cm²

Area =

"Service type"	"close pack"	"NASA bundle"
"LV power"	0.99	1.23
"V sensor"	0.21	0.26
"HV"	0.05	0.07
"Slow Controls"	0.69	0.87
"cooling"	2.86	3.58
"Total"	4.81	6.01

in²