

Hybrid Mechanical/Thermal Design ideas

Issues

- Heat removal to externally cooled interface - assume 0.4 w/ chip
- Reduce scattering in chip area
- Demountability of individual layers
- Flexibility of thermal connection
- Routeing of flex connections to controller chips
- Internal alignment of the 10 ?? planes
- External station alignment to beam pipe, wire alignment system

Materials choices

		CTE ppm/K	Thermal Conductivity W/m.K	Density Kg.m3	Rad Lengt h mm	
Silicon		4.7	148	2.33	94	
Al Nitride		4.4	180-200	3.26	84	Laser cuting
Machinable AlN (Shapal)		5.2	90	2.95	93	Machinable
Carbon - Carbon		1.5 6	250-300 parallel 50-100 perp	1.3/1.8	188	Easily machinable
Carbon - Carbon 'Atlas sct'			700 parallel 20 perp	1.3/1.8	220	
BeO		8	300	2.85	144	Toxic
Copper		16.7	385	8.96	14.4	5.5

Active Solder

Active Solder Technology - Solder joining of ceramics

- Titanium/rare earth additives to conventional Sn/Ag 92/4 solder

- additives react at oxide surfaces

- Direct wetting of ceramics, metals

- AiN , graphites , steel, aluminium

- S-Bond 220 Sn/Ag 92/4

- Solidus 221 C Liquidus 232 C Joining temp 250 - 280

- Thermal Conductivity 48 W/m.k

- See www.s-bond.com

X hybrid

Copper foil

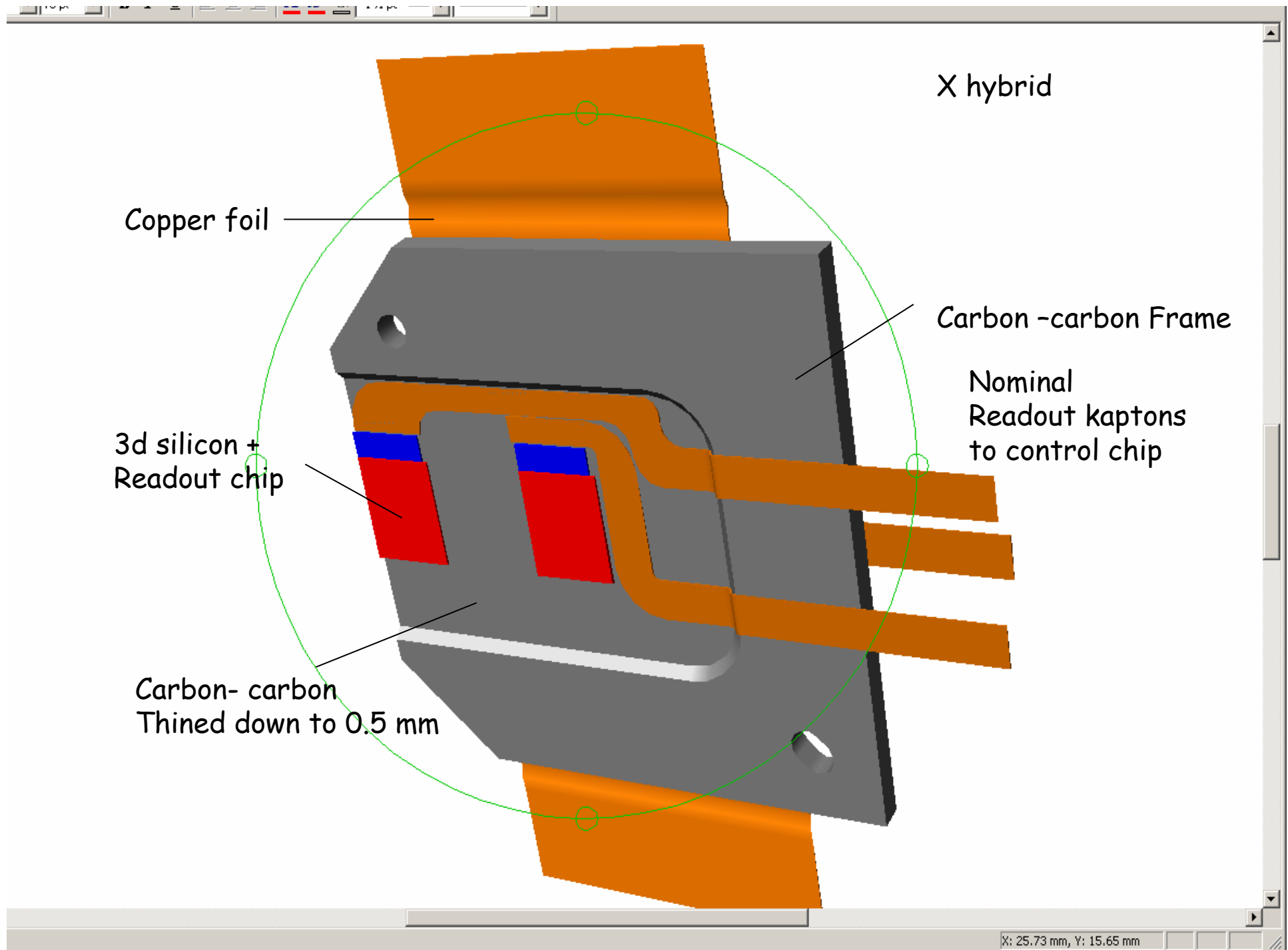
Carbon -carbon Frame

3d silicon +
Readout chip

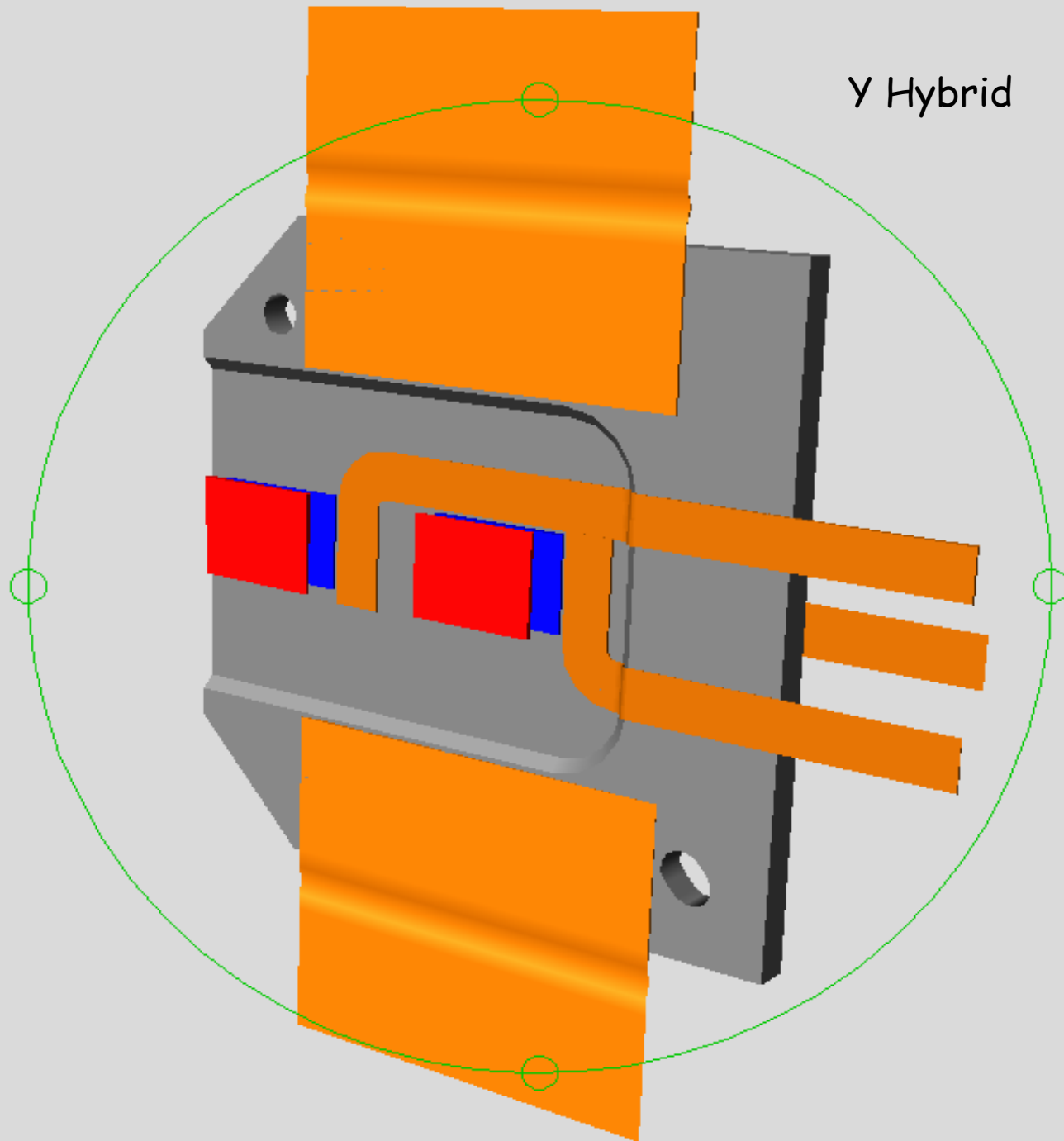
Nominal
Readout kaptons
to control chip

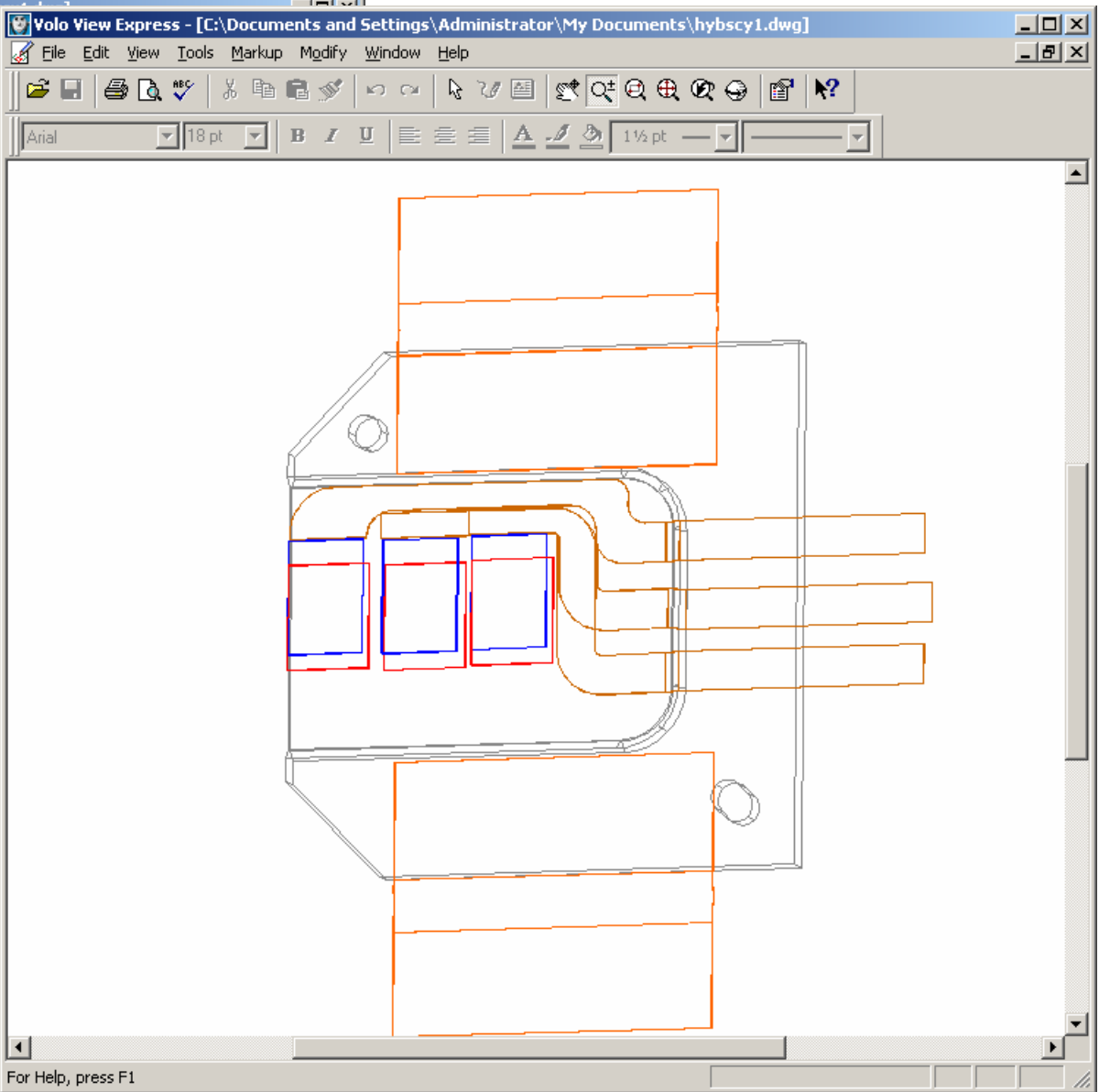
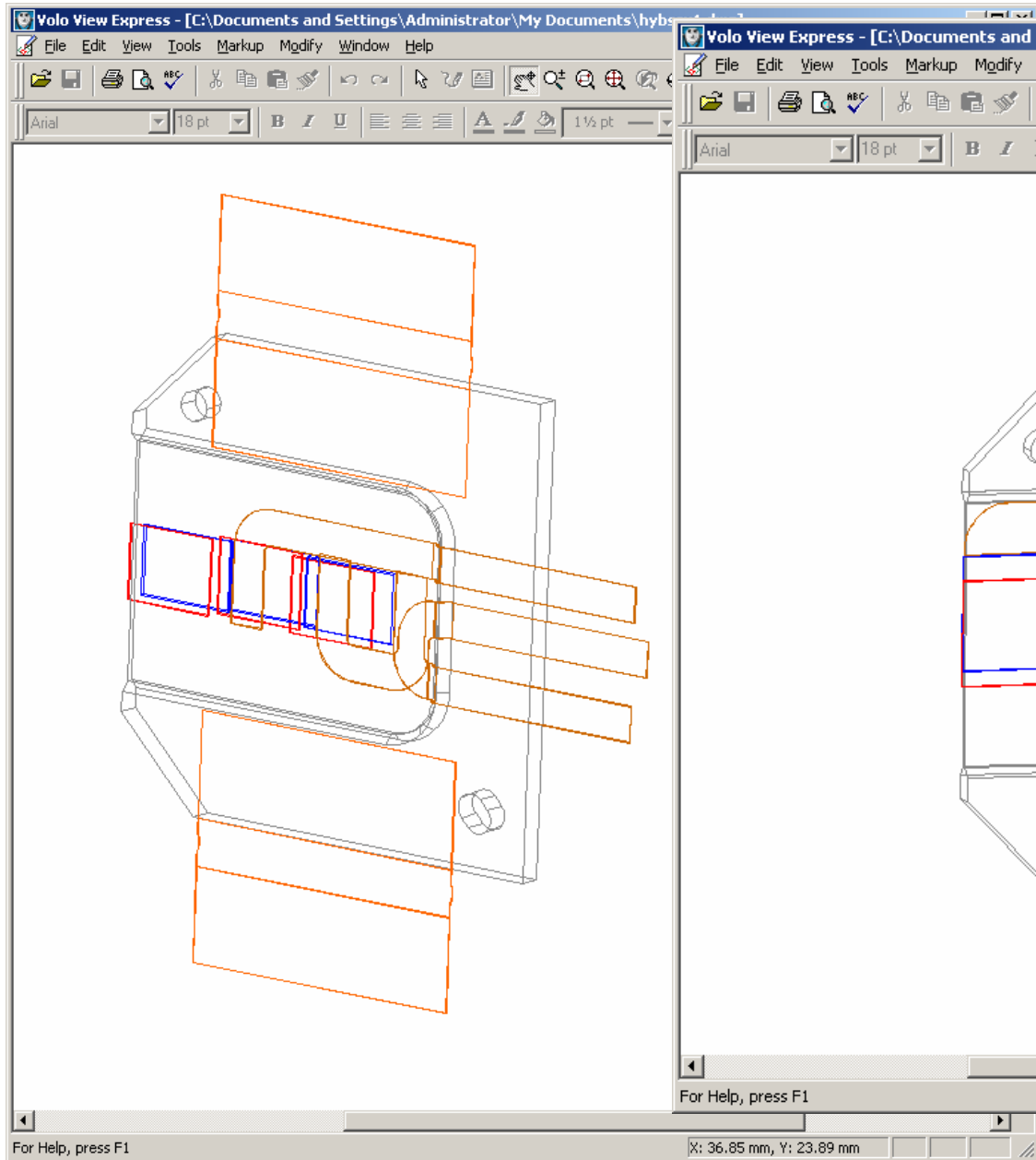
Carbon- carbon
Thined down to 0.5 mm

X: 25.73 mm, Y: 15.65 mm



Y Hybrid





Thermal connections

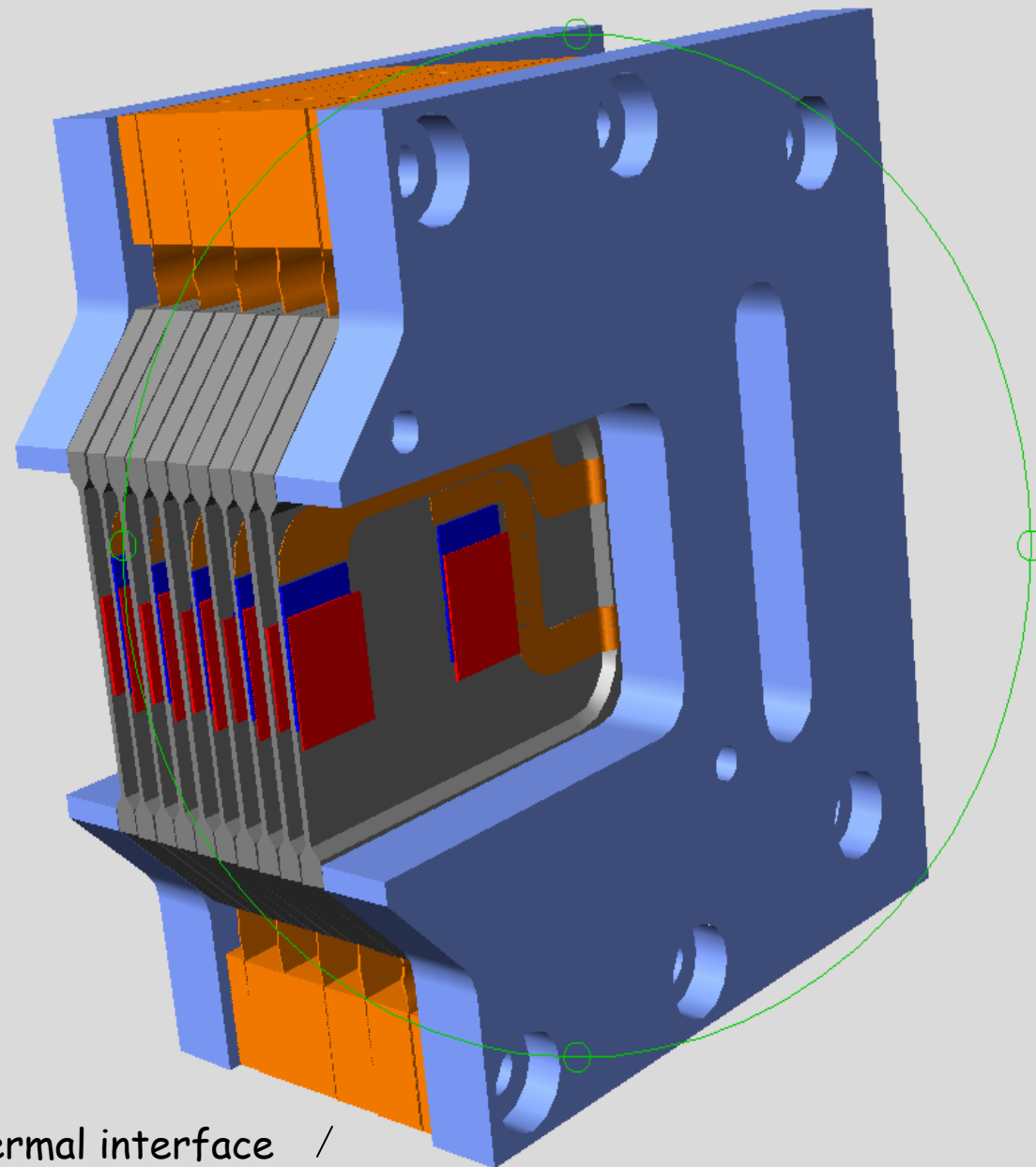
Has to be demountable at the hybrid level

Has to be flexible/ moveable to take up CTE Mismatch

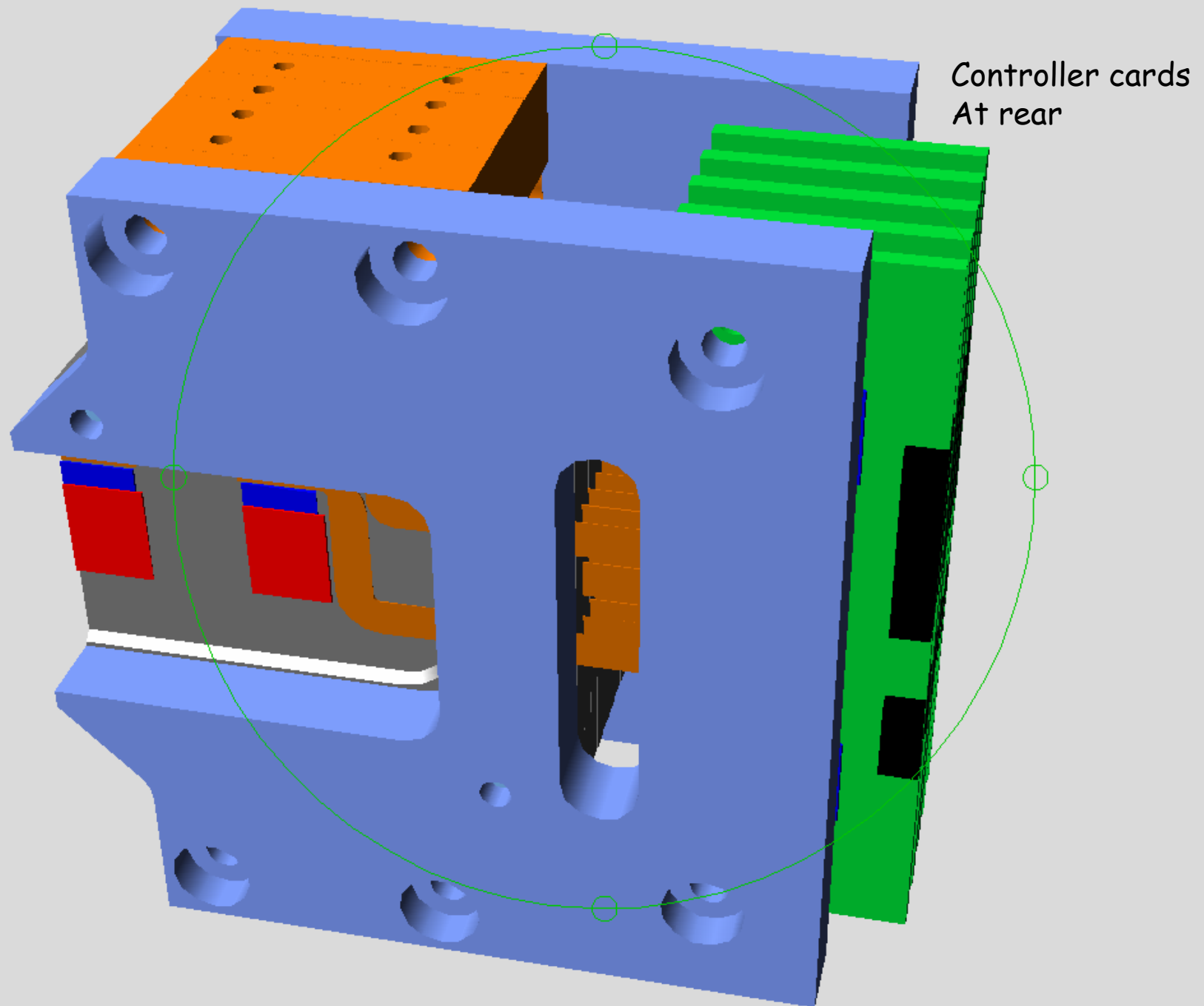
2 options - stress v mess

Mismatch in CTE

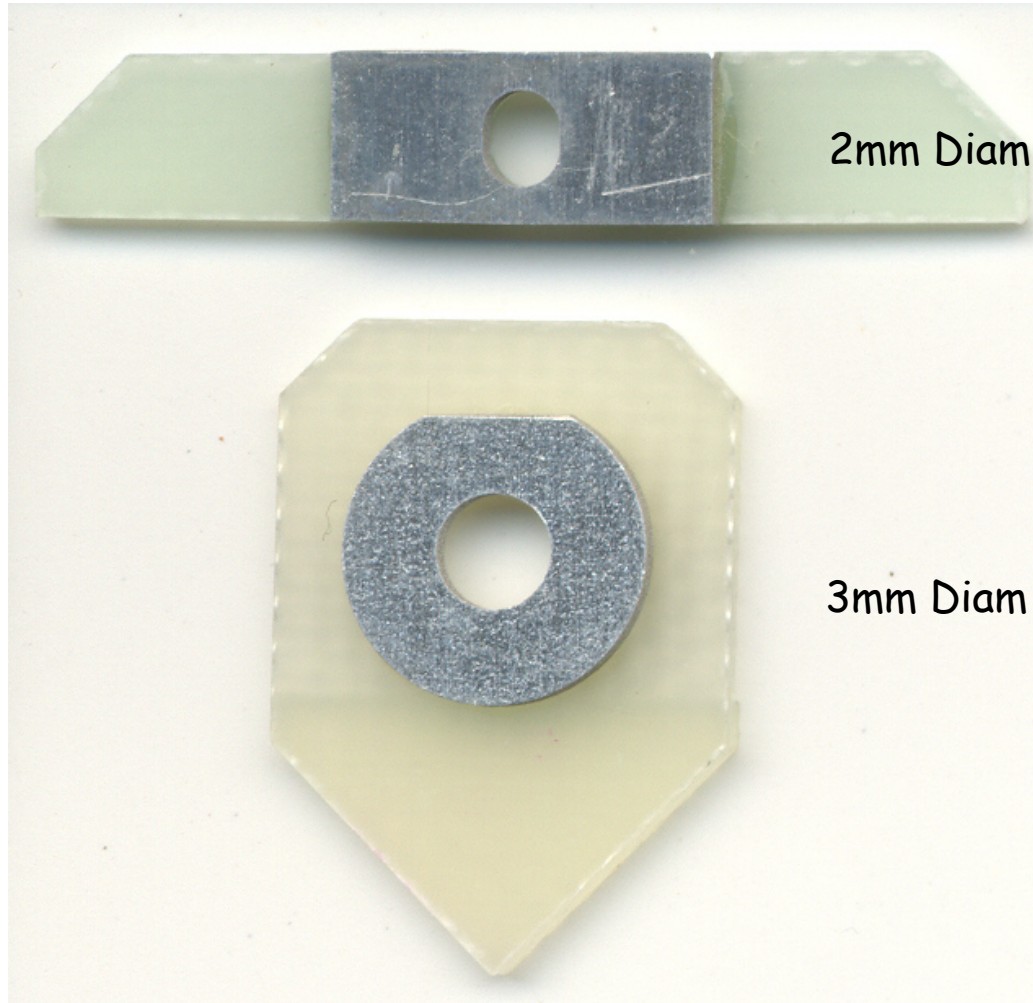
1. Copper foil - accept CTE mismatch , foil , Ω shape stress reduction
2. Direct sliding Thermal grease connections to Carbon Carbon
 - Long term stability ?
 - sharing between planes ?



Copper Thermal interface /



Precision alignment washers



2mm Diam +1mm

Used on Atlas Sct
Modules

3mm Diam

Wirecut Al
+/- 5 micron

Tolerance
3.000
3.010

Scattering material

	micron	X0 mm	% X0
Silicon	200	93.6	0.214
chip	250	93.6	0.267
bumps 25 u solder 50/r	0.2	10	0.002
cond glue Eotite p102	50	43	0.116
carbon carbon	500	190	0.263
Total			0.862
comparisons			
Al2O3	1000	75.5	1.325
AlN (200)	500	84	0.595

Previously 1mm ceramic 1.325% RL
gave rise to 0.47% loss

0.5 mm Carbon- Carbon 0.263 % RL

Overall now 0.862 % RL per plane

Crude scaling with RL would give

0.32 % loss /plane Not that Simple

X20 planes (4,6,10) gives 6.4% loss

Note conducting glue is 13 % of hybrid

Crude temperature drops

Material	K w/mK	X mm	y mm	thickness L	area A mm ²	Power	dt Deg C
Glue layer	2	24	7	0.05	168	1.2	0.18
Thin c-c 0.	300	24	0.5	15	12	0.6	2.5
Thick c-c 5	300	24	2	5	120	0.6	0.21
solder join	50	24	5	0.1	120	0.6	0.01
copper foil	385	24	0.1	10	2.4	0.6	6.49
Cu- Cu join efficiency							
Interface to Cooling							
Sum							9.27
Thick cc lc	300	10	5	50	50	0.6	2

Cooling interface 15-20 Deg below chip operating temp.

Next steps

Agree acceptability of

Sort out routeing of kaptons to control cards

- May affect final positioning of cooling interface/ control cards

Machine carbon- carbon samples

Agree Chip glue - acceptable chip stresses

- (electrical) conducting or not

check - joining techniques

- measure real thermal gradients (c-c anisotropy)
- mechanical stability - Thermal cycling
- alignment accuracy

Detailed thermal /stress Simulation

