Science & Technology Facilities Council

Cold Magnetic Shield Update

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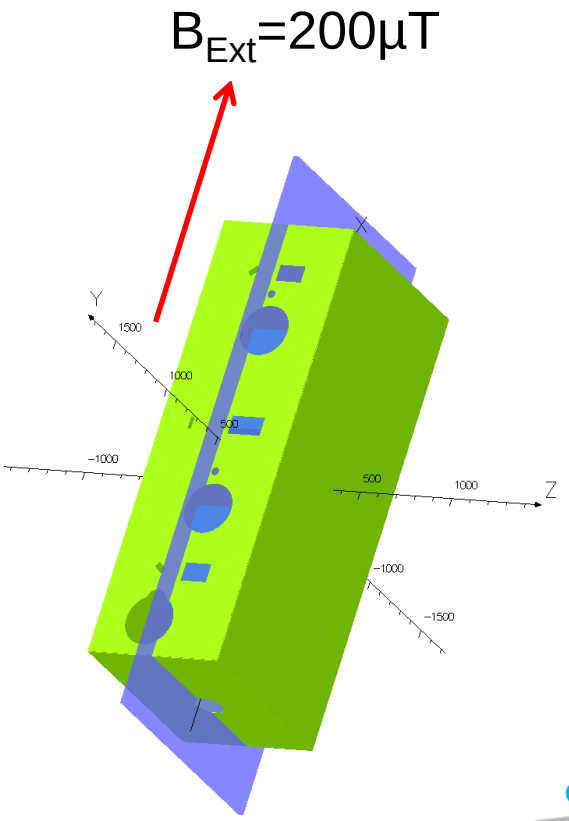
29/06/15

Updated OPERA Analysis by Kiril Marinov

- Specification: <1μT on cavity surface
- Loads: External Magnetic Field 200μT
  - Earth + Local Sources
  - Worst case longitudinal orientation
  - Assuming moderate bus bar shielding
- Model: Simplified DQW shields
  - Room Temp. 3mm MuMetal outer shield
  - 2K 1mm Cryophy inner shield



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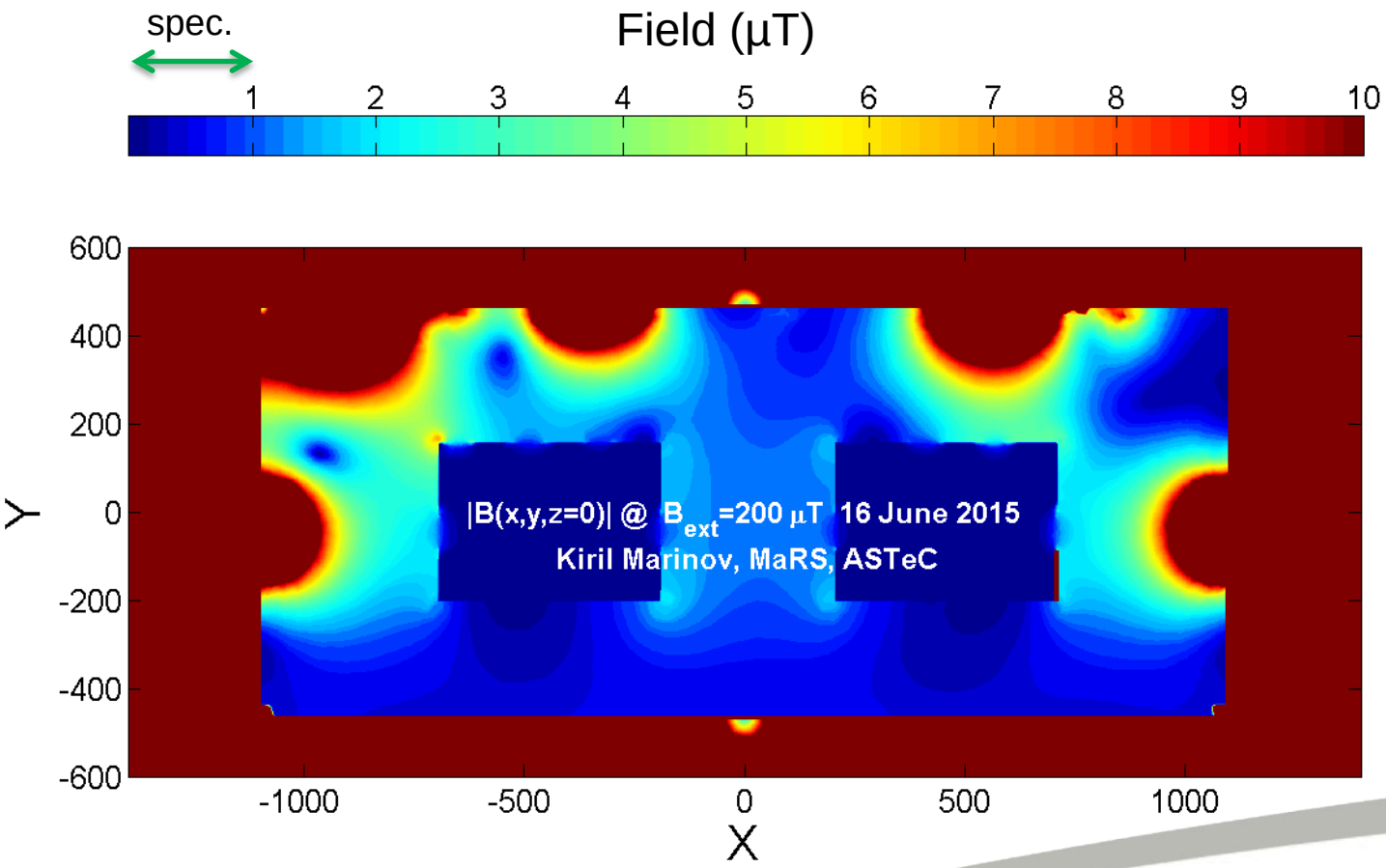
Updated OPERA Results by Kiril Marinov



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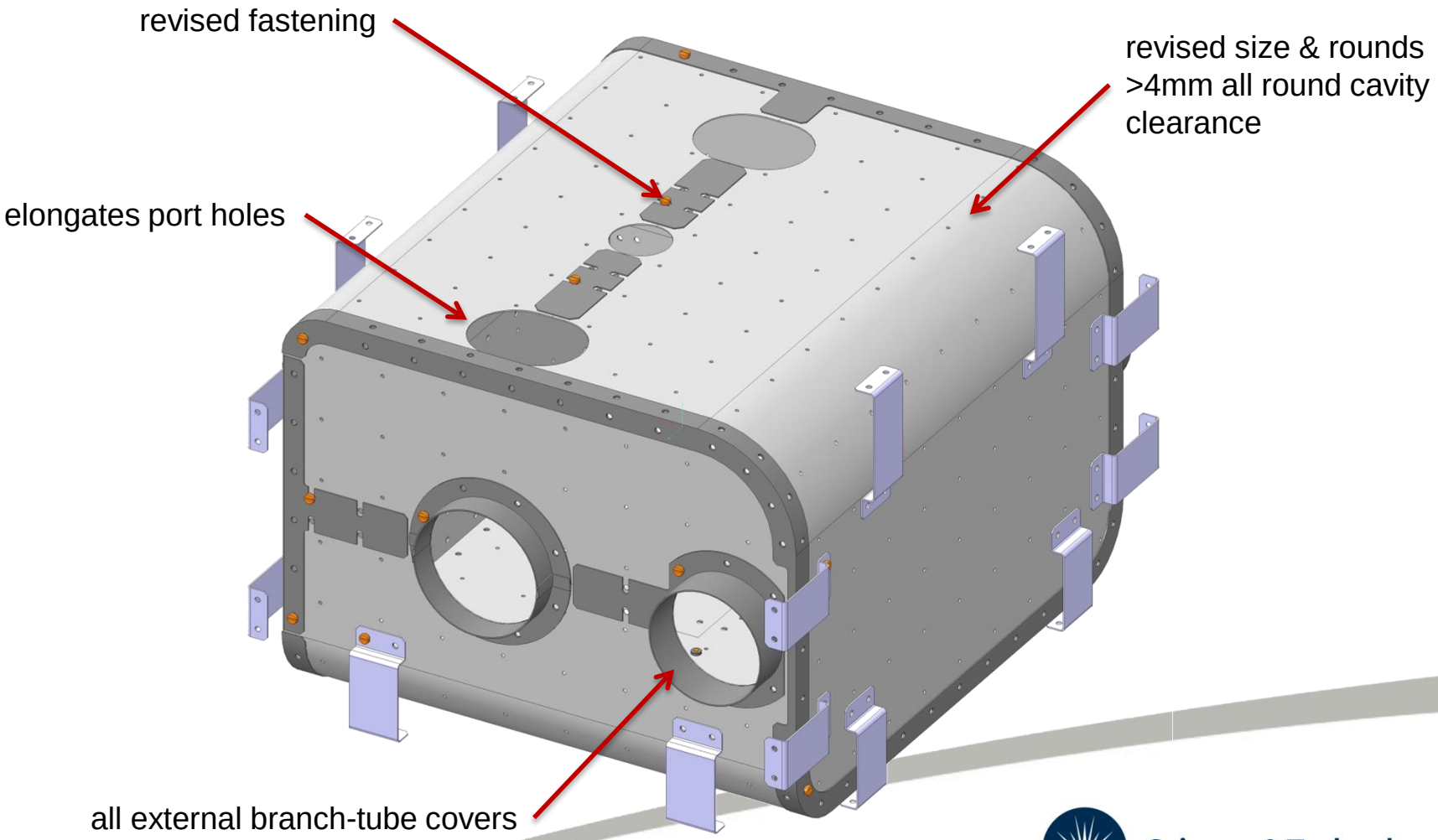
Revised DQW Cold Shield



iso front-top view

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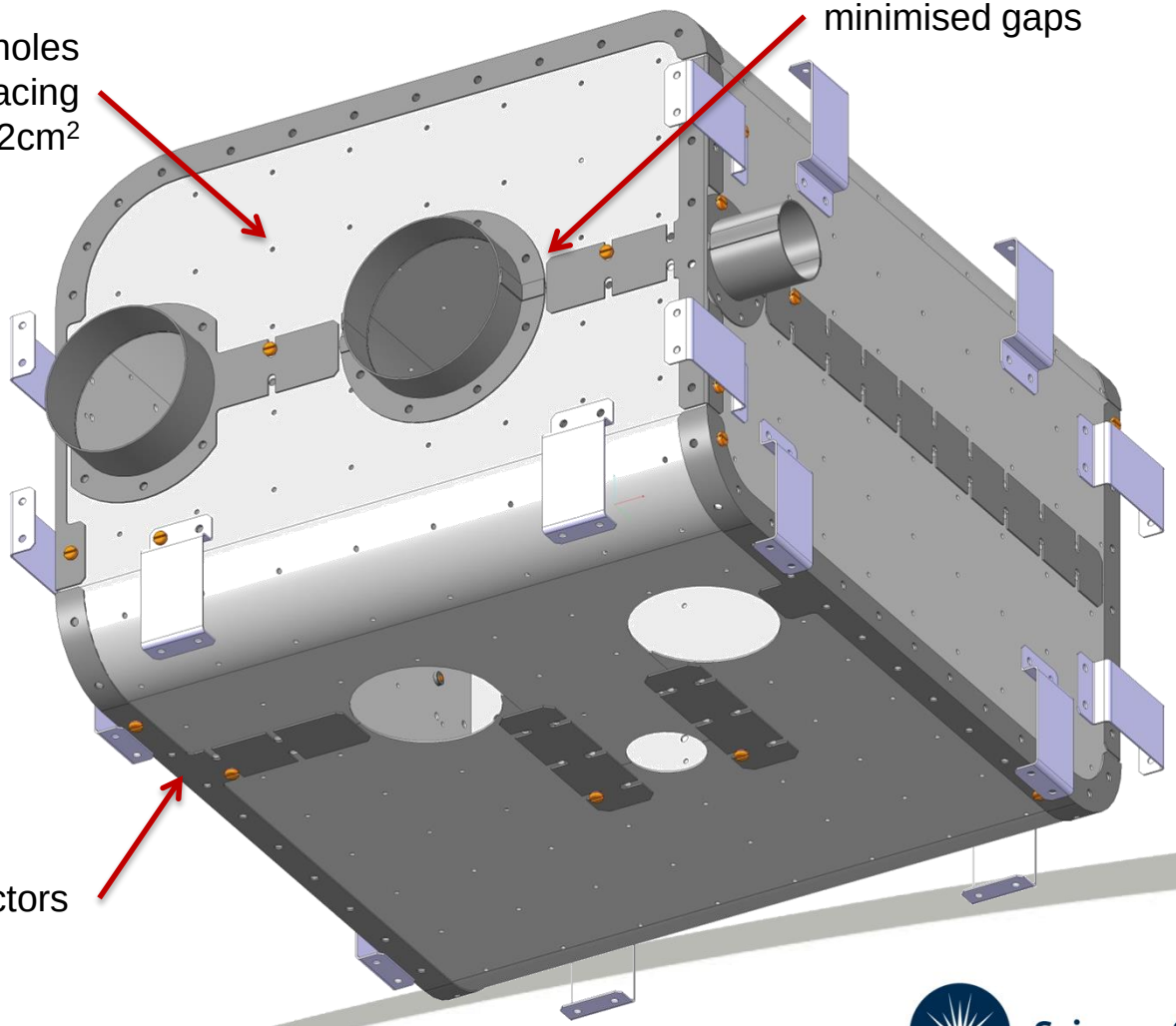
Revised DQW Cold Shield



iso back-bottom view

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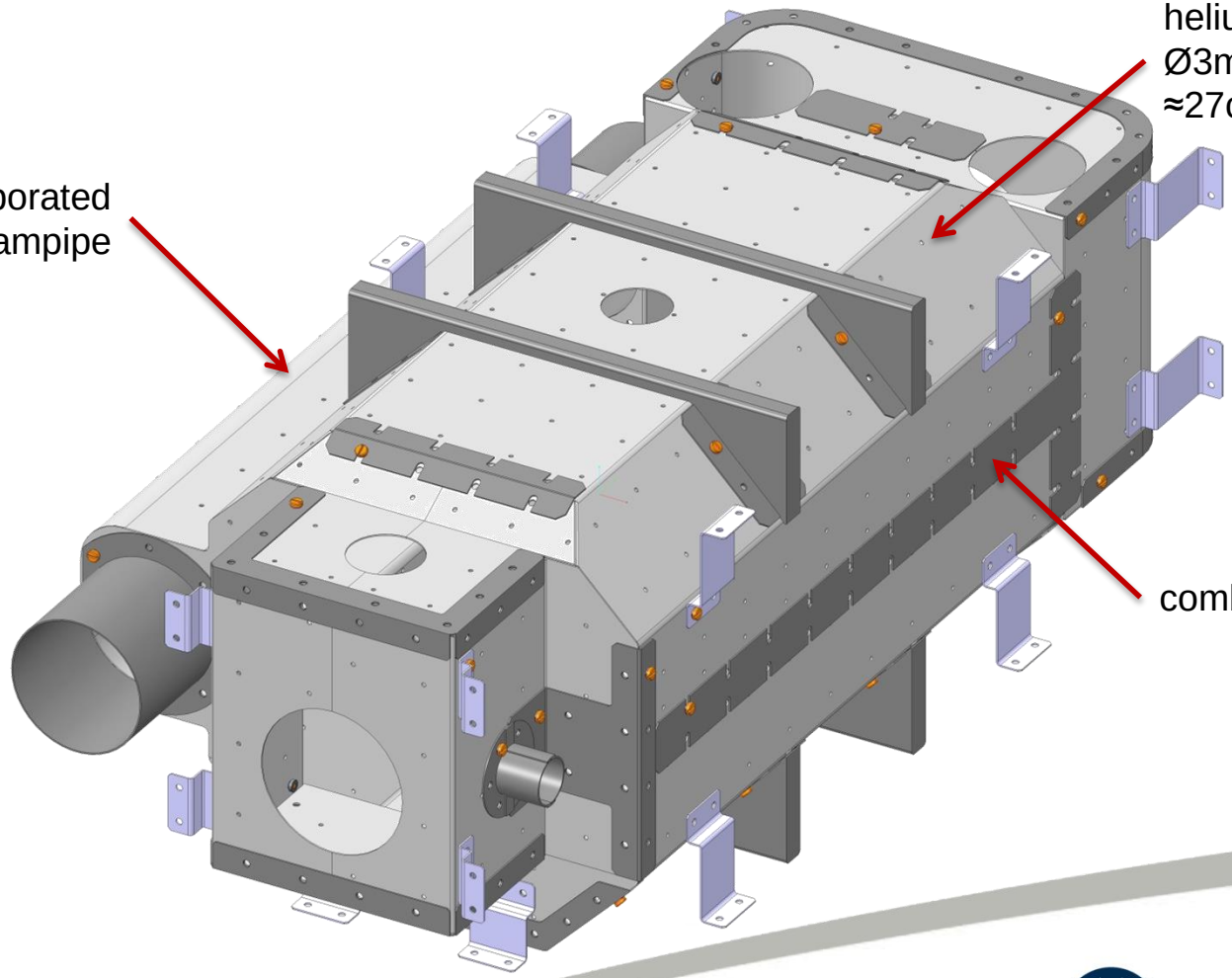
Revised RFD Cold Shield



iso front-top view

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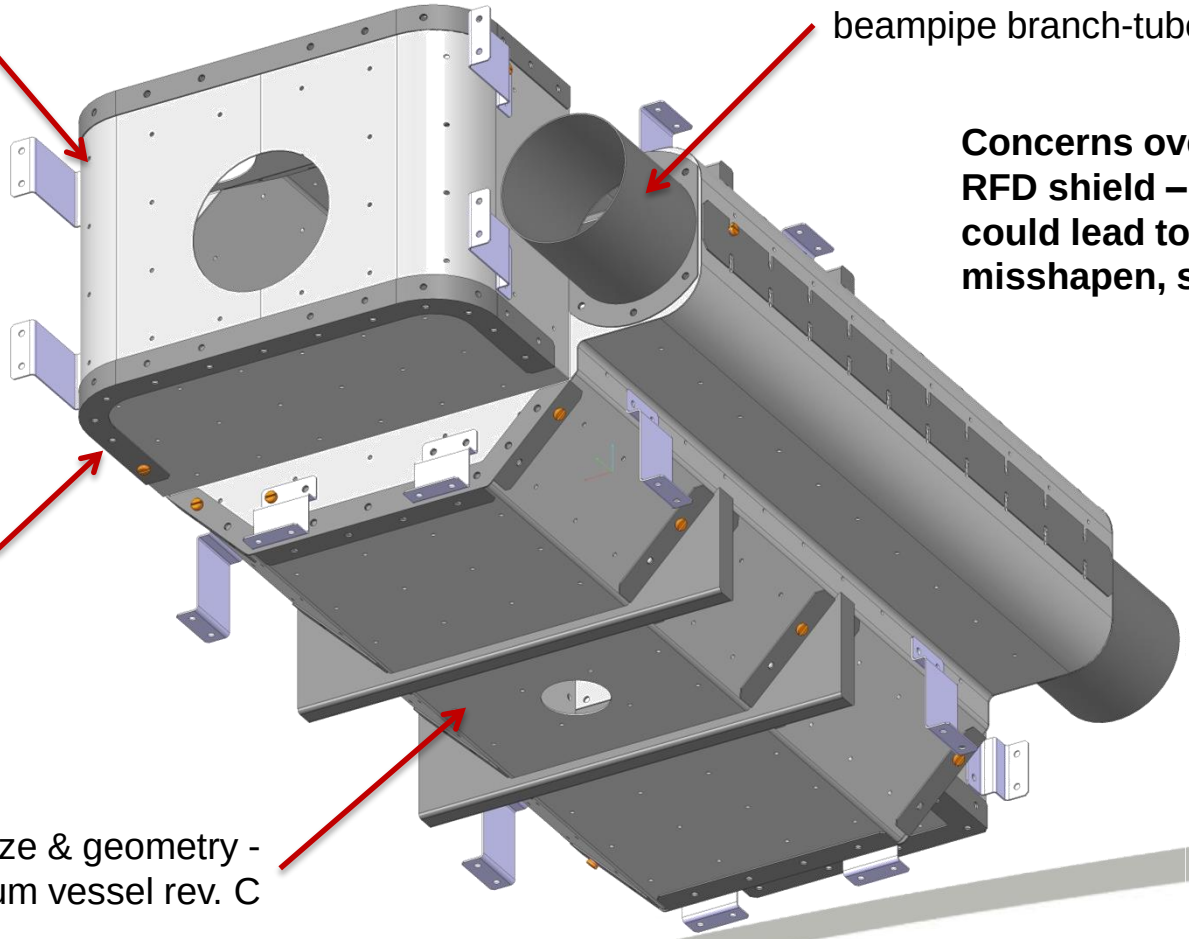
Revised RFD Cold Shield

>4mm all round cavity clearance

beampipe branch-tube cover



minimised gaps

revised size & geometry - helium vessel rev. C

Concerns over the complexity of RFD shield – difficult assembly could lead to shield becoming misshapen, stressed/damaged.

iso back-bottom view

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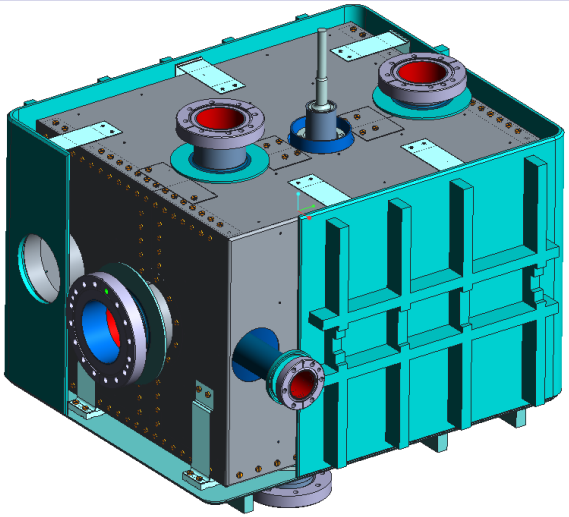
Internal Shield Evaluation

- Suggested by Akira Yamamoto (KEK) due to the complexity of the welded helium vessel
- Original reasons for internal shield:
  - Minimise number of penetrations
  - Tighter shield gives greater performance
  - Avoid complexity of external helium vessel geometry *(no longer valid)*
  - Protected from random damage
  - Minimal impact other dressed cavity systems
  - Ensure low operating temperature for best shield performance

initial internal shield for thin walled vessel



- However, the helium vessel external geometry is now more simple, should we reconsider a more traditional approach, at least for the RFD option?

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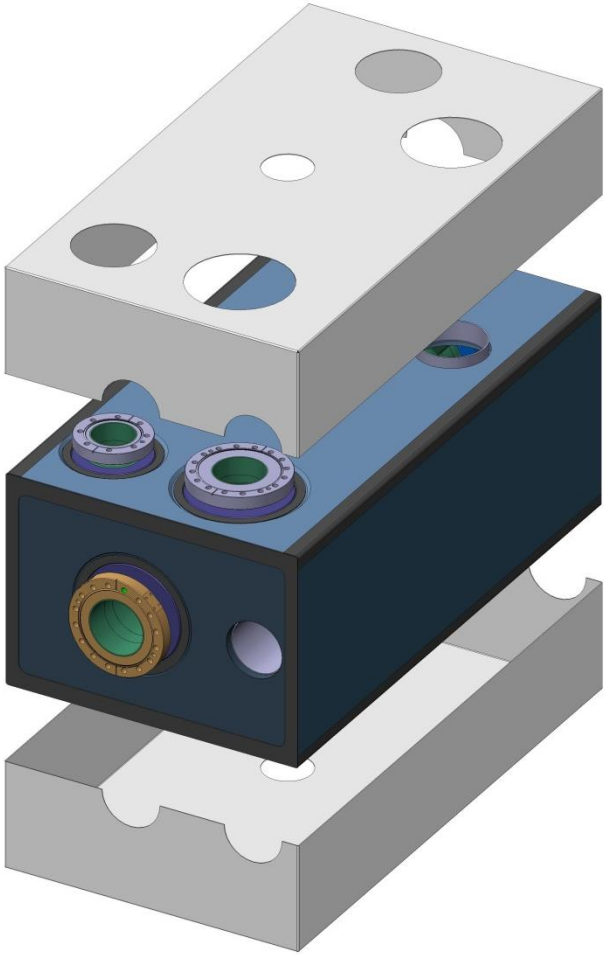
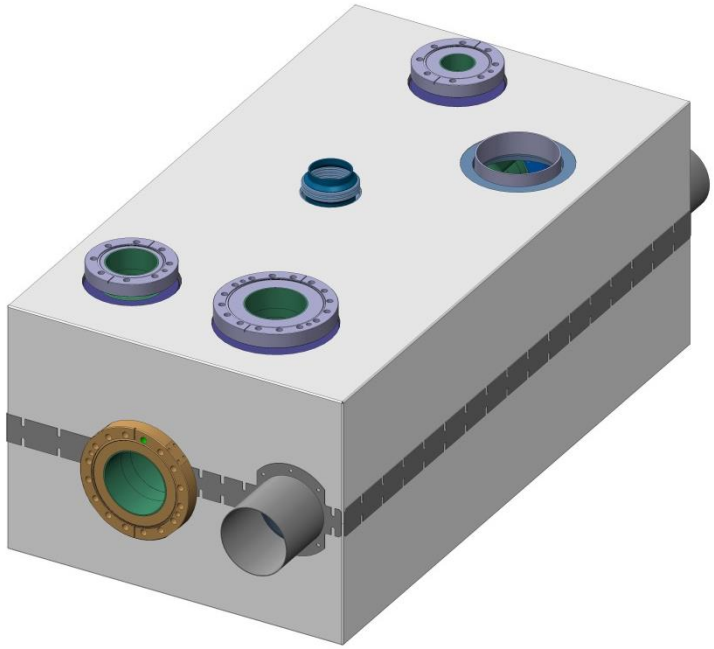
RFD external shield concept



2 folded shell panels top and bottom



additional strips connect panels and cover any gaps

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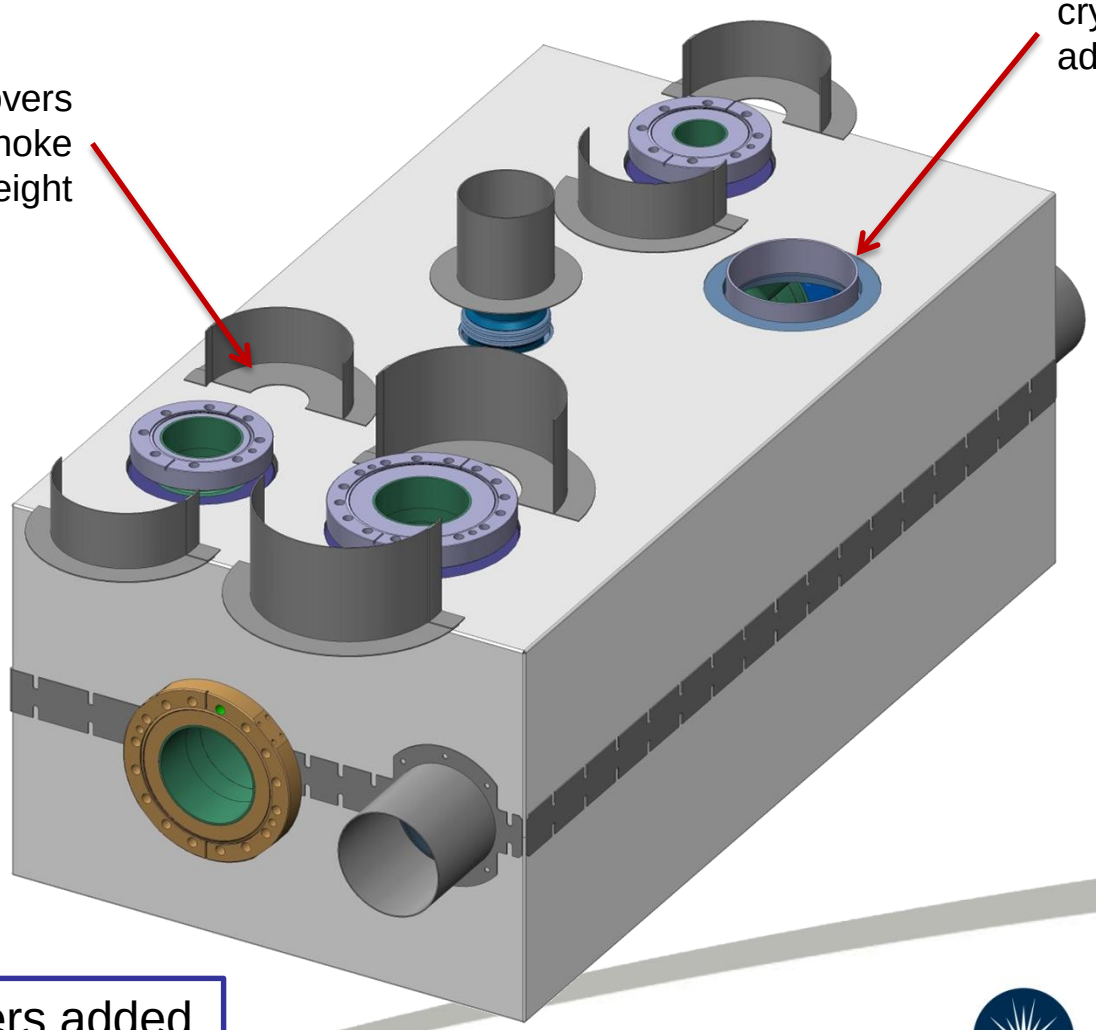
RFD external shield concept

cryoline cover
added after welding

branch-tube covers
clear flange and choke
ports to minimise height



branch-tube covers added

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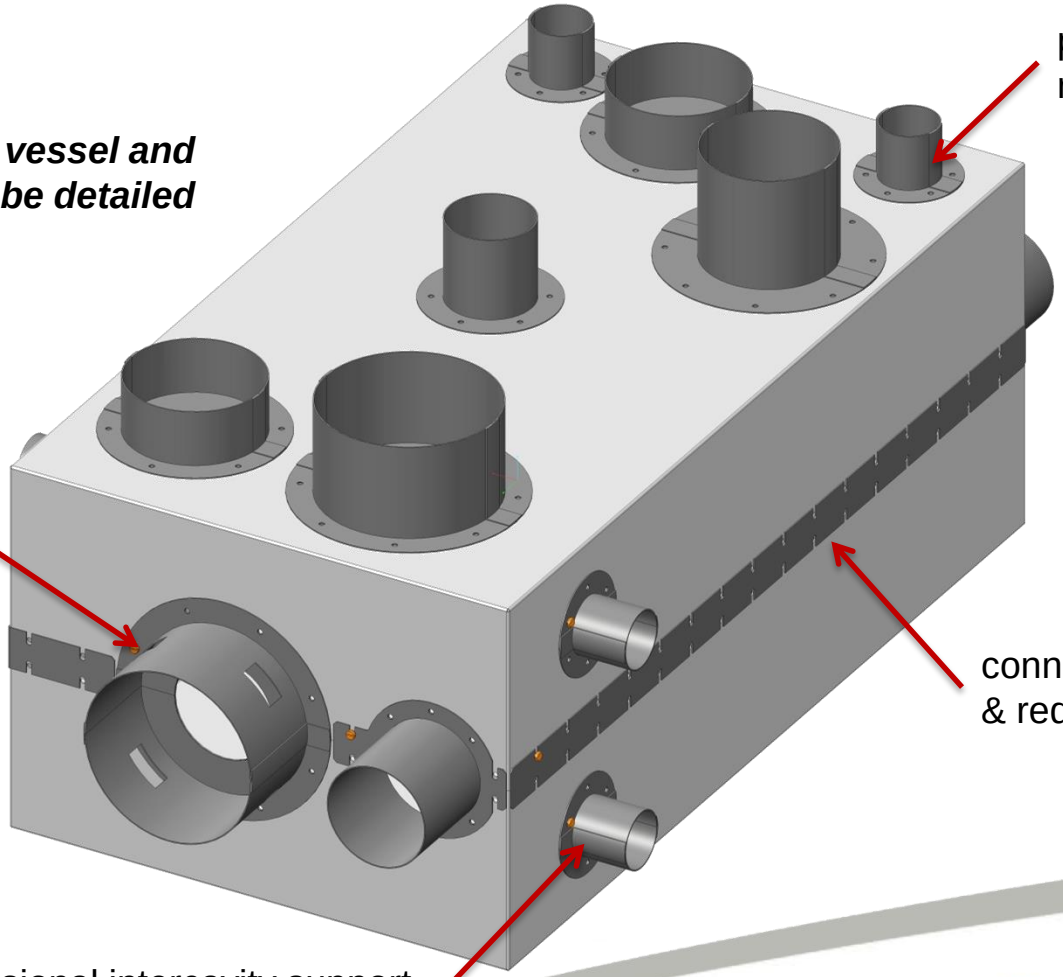
RFD external shield concept



provisional suspension rod covers

connection to helium vessel and thermalisation to be detailed

cuts for flange survey features

connection slots aide alignment & reduce thermal stresses

provisional intercavity support covers (for quotation purposes)

iso front-top view

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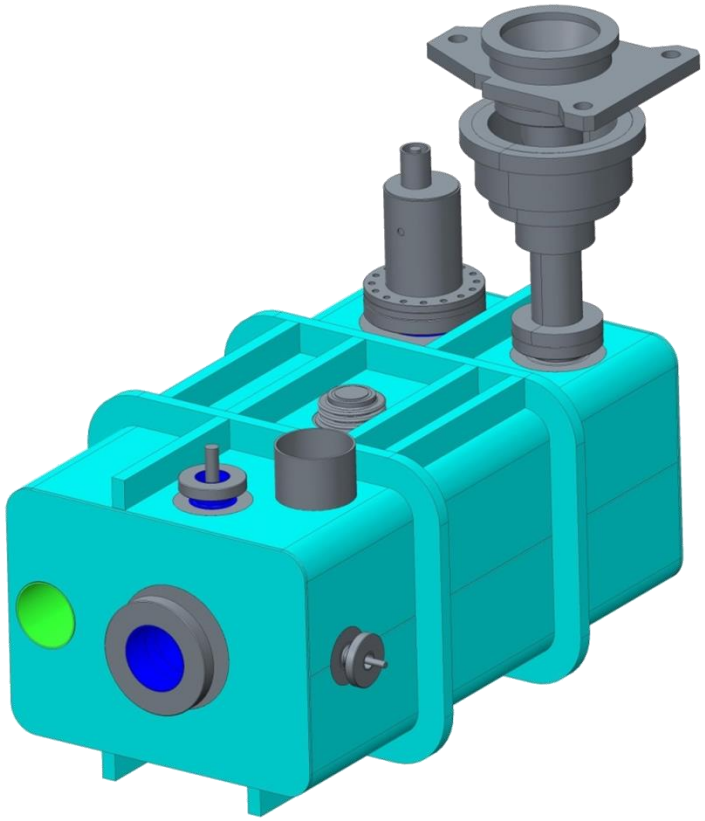
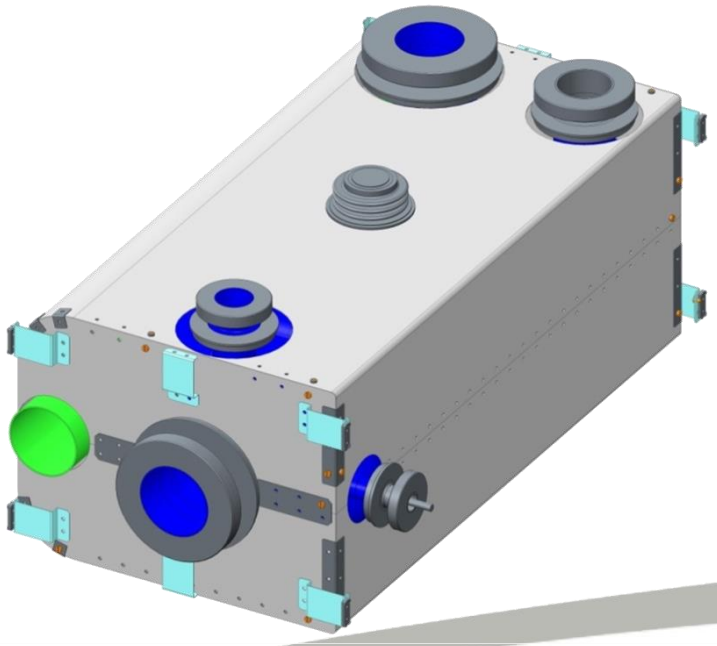
Previous RFD Concept

- Alternatively, we could reconsider and develop the thin walled options, should an appropriate vessel fabrication solution be found.





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Concept Comparison

RFD Internal

- Close fitting for greater performance
- Minimise size & number of penetrations
- Independent from other dressed cavity systems
- Protected from random damage during installation

- Difficult to access after helium vessel assembly
  - Maintenance, inspection, testing
- Complexity
  - Increased assembly time
  - Risk of assembly error & damage

RFD External

- Greater branch tube attenuation
- HOM Shielding
- Simplicity
- No risk of impacting cavity cooling
- Ease of inspection, maintenance, testing

- Additional penetrations for cryoline and support systems
- Risk of random damage during installation & commissioning
- Dependence on readiness of other dressed cavity systems

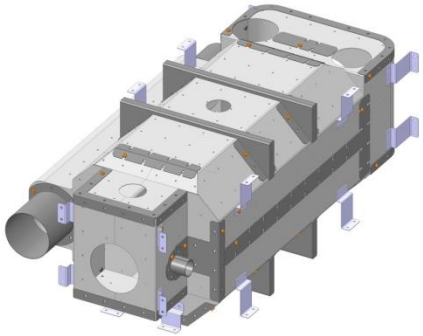
Other considerations

- No. panels & components
- Stiffness
- Curvature
- Overall size
- Design continuity
- Support flexibility
- Thermalisation
- Cleanliness

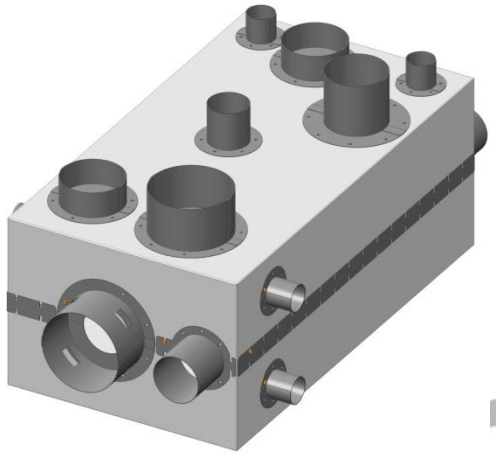
- Manufacture operations
  - Cuts, holes, folds, bends, welds
- Survey & alignment mounts
- Design modifications
- LHC compatibility
- Handling & tooling

Weighted Decision Matrix

Criteria	Description	Weighting (/100)	Score (0 - 4)		Weighted Score	
			Internal	External	Internal	External
Performance	According to specification	30	*4*	*4*	120	120
Independence	Minimal impact and reliance on other systems	20	3	1	60	20
Ease of Assembly	Minimal assembly time, tooling, risk of assembly damage	10	1	3	10	30
Access	For inspection, maintenance & adaptation	10	0	3	0	30
Protection	Minimal risk of random damage	10	3	1	30	10
Cost	Comparison quote from Magnetic Shields LTD	20	-	-	-	-
Readiness	**For tender & procurement**	-	**3**	**1**	-	-
		100			**220**	**210**
					TOTAL SCORE (/400):	



Internal Shield Concept



External Shield Concept

Scoring	Criteria Performance
0	Poor
1	Below Average
2	Average
3	Good
4	Excellent

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Conclusion

- DQW design has been improved and refined
- The result is a simple and effective internal shield which is ready for procurement

- RFD shield has also been developed and improved while alternative options have been explored due to unavoidable complexity and associated risk of internal shield design
- Many advantages & disadvantages when comparing internal and external RFD shield. Weighted Decision Matrix shows no clear preference
- Decision may come down to readiness & dependence on other dressed cavity systems

- Currently waiting on budget costing quotes from Magnetic Shields LTD