Review of the mechanical design of the final focusing region of the HIF Point Design

T. Brown

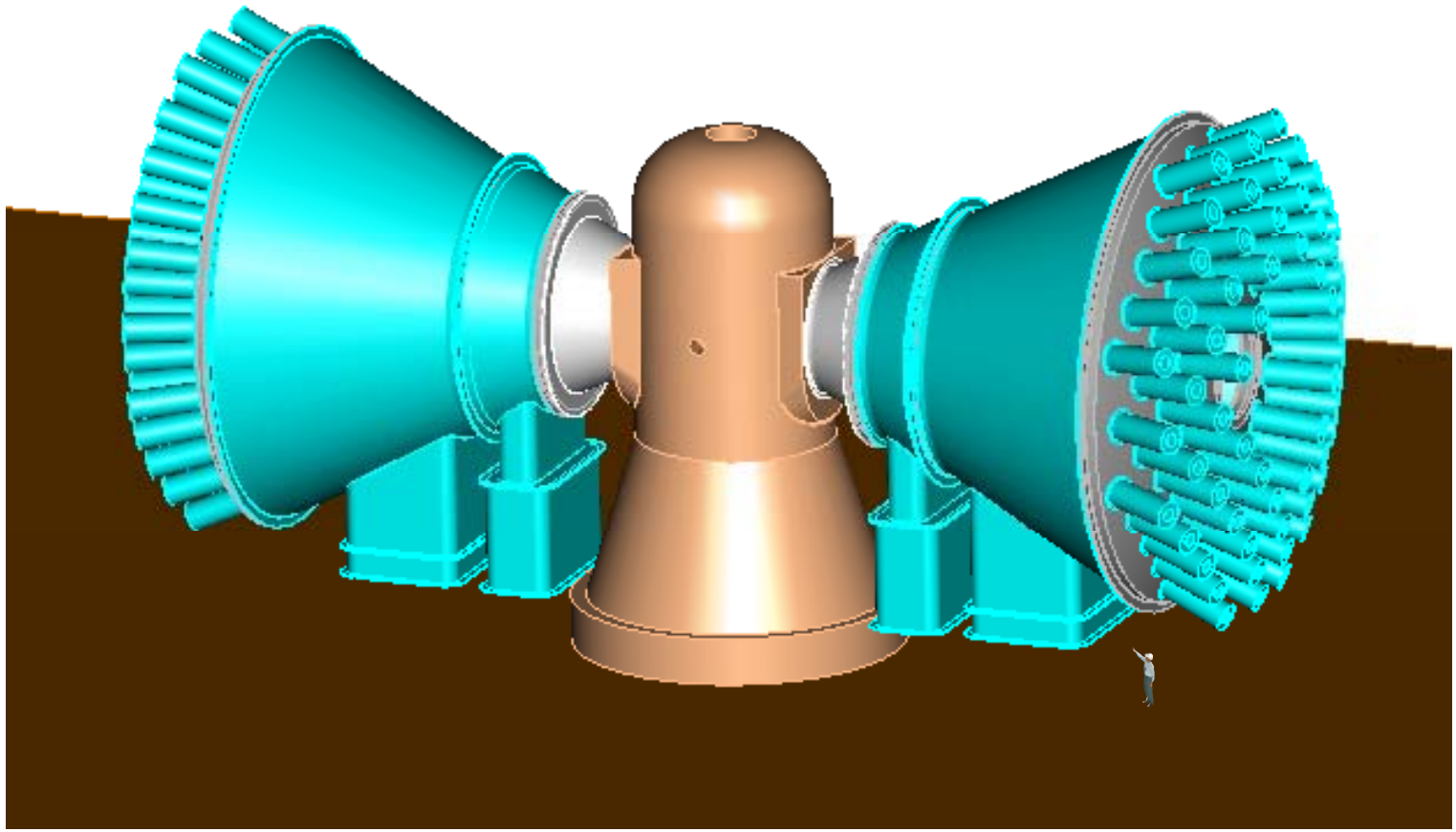
ARIES Project Meeting

January 8, 2003

Overall Design Philosophy

- Quadrupole magnets are located in common cryostats. One cryostat structure houses magnet 1 quadrupoles and a second cryostat contains magnets 2 and 3 quadrupole assemblies.
- Intermagnet supporting structure is used to align and support magnets 1,2 and 3 plus add to the overall shielding requirements.
- The current design assumes that a complete focus magnet section is replaced if maintenance is required.

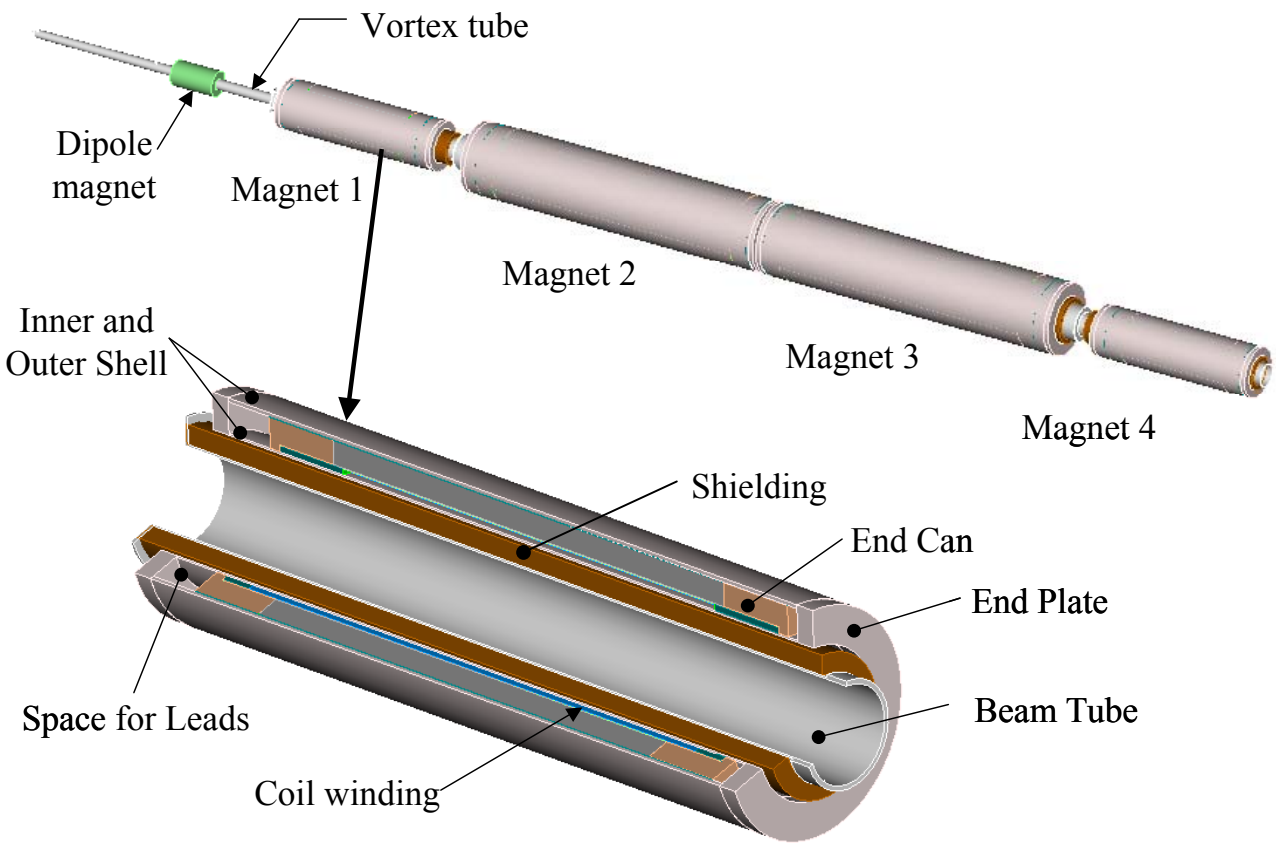
An isometric view illustrating the configuration arrangement of the Robust Point Design (RPD-2002) for a Heavy Ion Power Plant



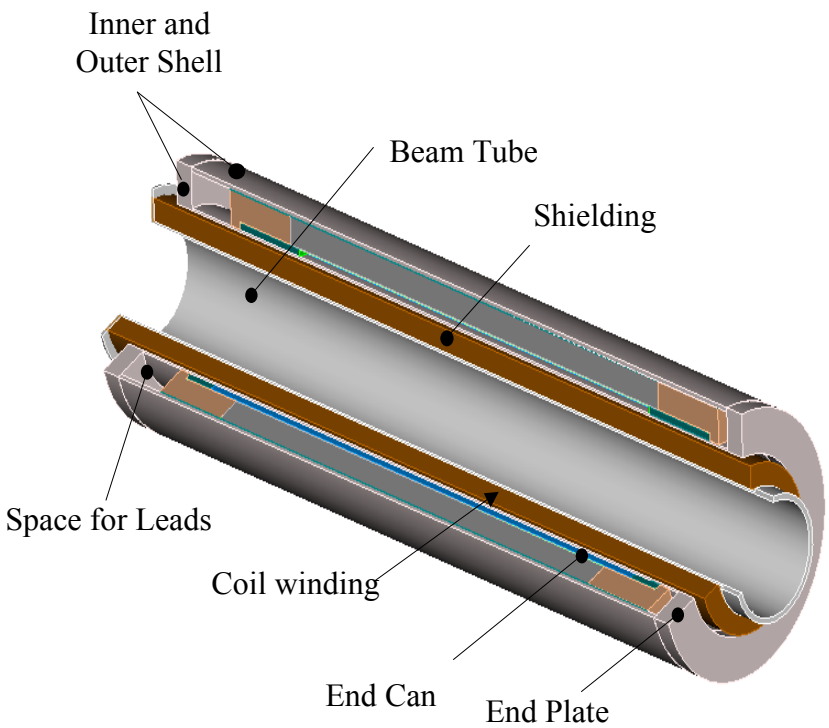
Accelerator and Final Focus Array Parameters

Parameter	Value
Accelerator	
Number of beams	120
Ion species-A	Bi-209
Ion energy - foot pulse	3.3 GeV
No. of foot pulse beams	48
Ion energy - main pulse	4.0 GeV
No. of main pulse beams	72
Final Focus Array	
Maximum array angle	24°
Beam half angle	10 mrad
Chamber array size	9x9
Angle between array rows	5.4°
Illumination	2-sided
Dist. to end of first magnet	6 m

Final focus Magnet System Array



Magnet 1 Build Dimensions



Component Details	R (cm)	dR (cm)
Bore inner radius	12	
Pipe and water		0.5
Shielding inner radius	12.5	
Shield thickness		5
Gap		0.5
Cold mass	18	
Microcrystalline		0.5
LHe inner vessel		0.5
Winding inner radius	19	
Winding build		1.5
Winding outer radius	20.5	
Ground wrap		0.2
Coil support shell		6
Slip plane		0.1
Outer shell thickness		1
Coil support structure	27.8	

The following tables list the magnet and conductor parameters for the final four quad magnets.

Final Focus Quadrupole Parameters

quad[1]	B'(T/m)	$B(r_p)$(T)	r_p(cm)	l(m)	ldrift[2](m)
1st	21.8	2.61	12	1.33	6.33
2nd	-19.1	-3.6	18.9	3	1.1
3rd	19.1	3.74	19.6	3	0.5
4th	-21.8	-2.99	13.7	1.33	1.1

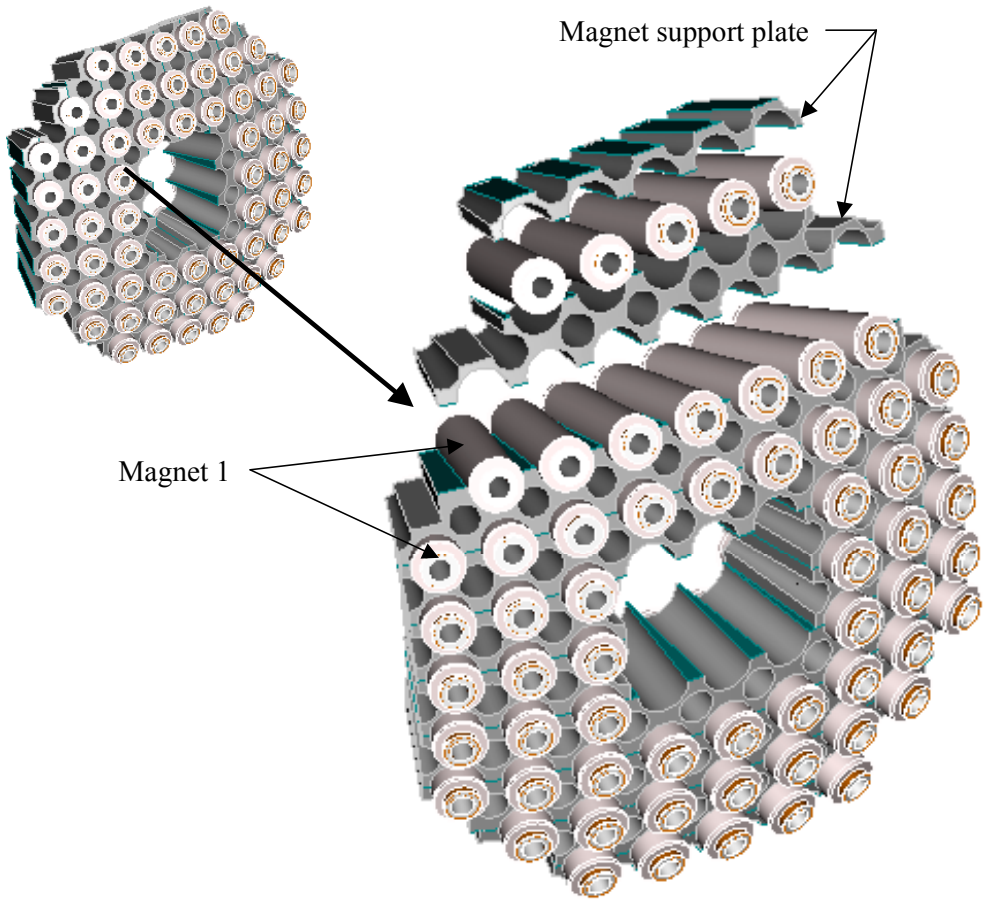
Magnet Parameters

Parameter	Symbol	Units	Magnet 1	Magnet 2
Operating	G_{op}	T/m	21.8	19.1
Coil aperture	R_{ic}	cm	19	25.9
Current/octan	I_{oct}	MA	0.61	1.02
Operating	T_{op}	K	4.35	4.5
Energy/chann	U_{op}	MJ/m	0.8	2.3
Operating	I_{op}	kA	15.6	20
Cu current	$(J_{cu})_{op}$	kA/mm^2	1	0.45
Lorentz stress	σ^{max}_{ss}	MPa	73	70
Coil peak	B^{pk}_{ss}	T	6.8	7.8
Short sample	G_{ss}	T/m	24.1	28.6

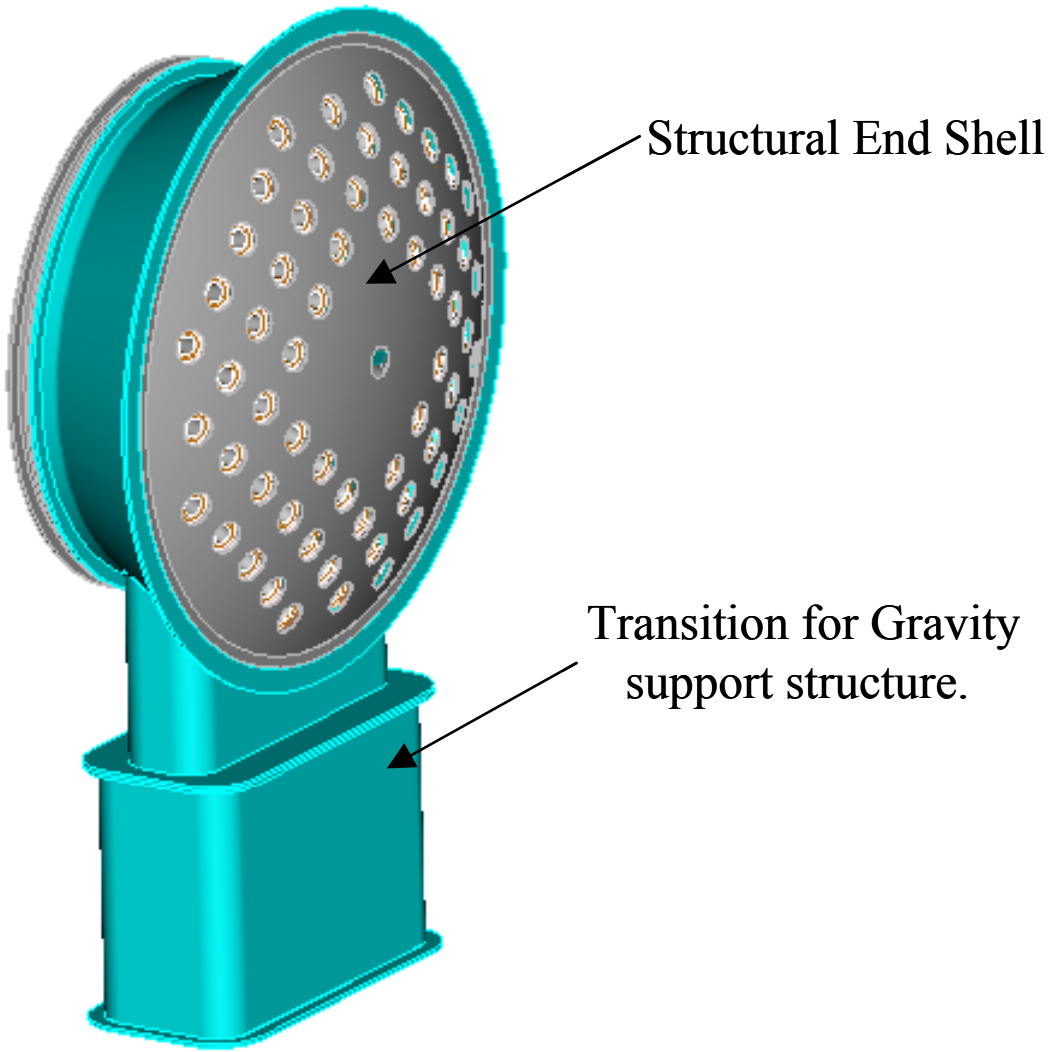
Conductor, Cable and Coil Parameters

Parameter	Units	Magnet	Magnet 2
Conductor		NbTi	Nb_3Sn
Strand diameter	mm	1.3	1.3
Number of strands		24	47
Cu/Sc ratio		1	3
Cable width (bare)	mm	15	29.6
Cable mid-thickness	mm	2.34	2.34
Keystone angle	deg	0.83	0.59
Insulation thickness	mm	0.1	0.2
Number of turns/oct		39	51
Number of layers		1	1

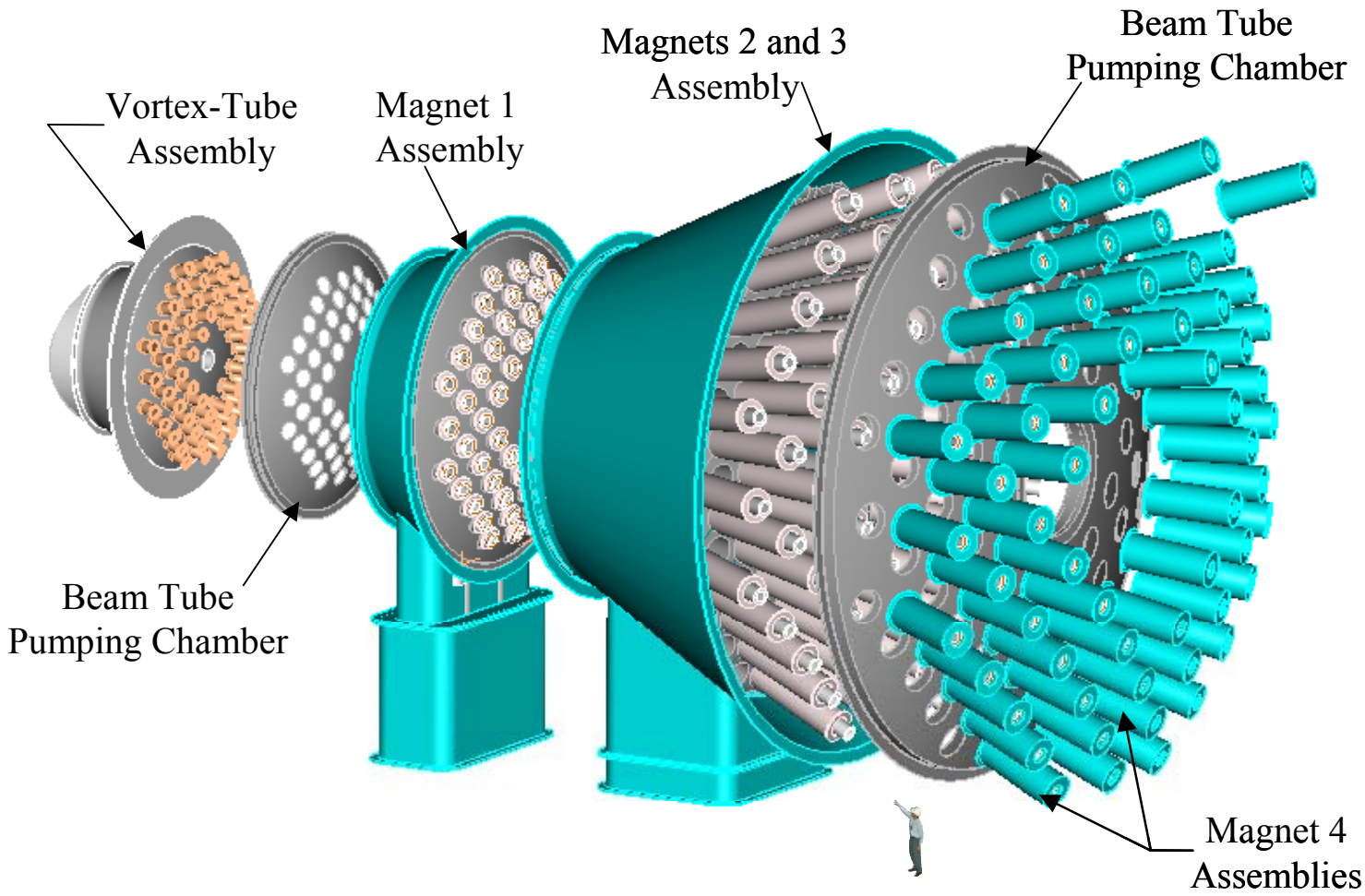
Magnet System Support and Assembly Concept



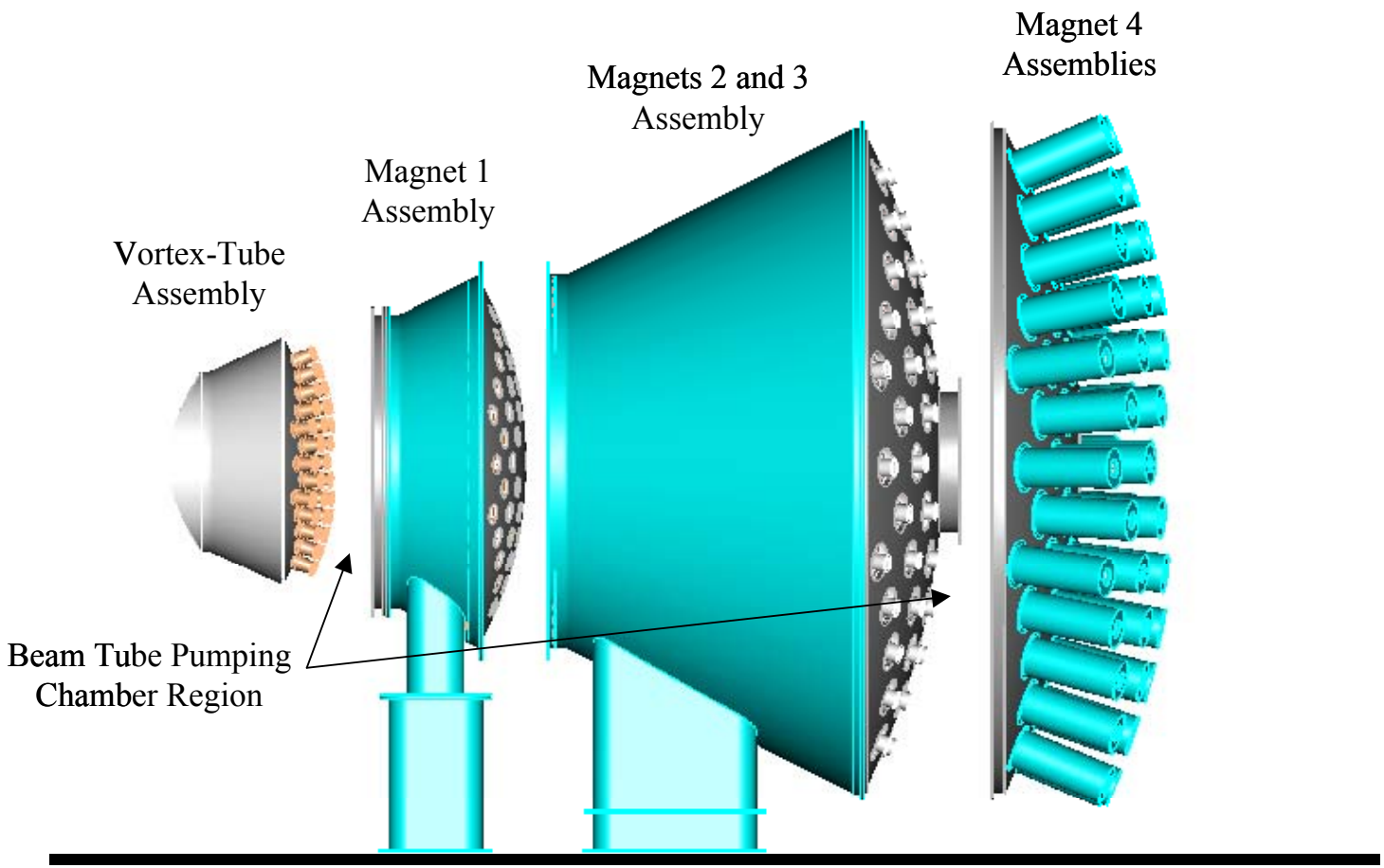
Magnet 1 Cryostat Assembly



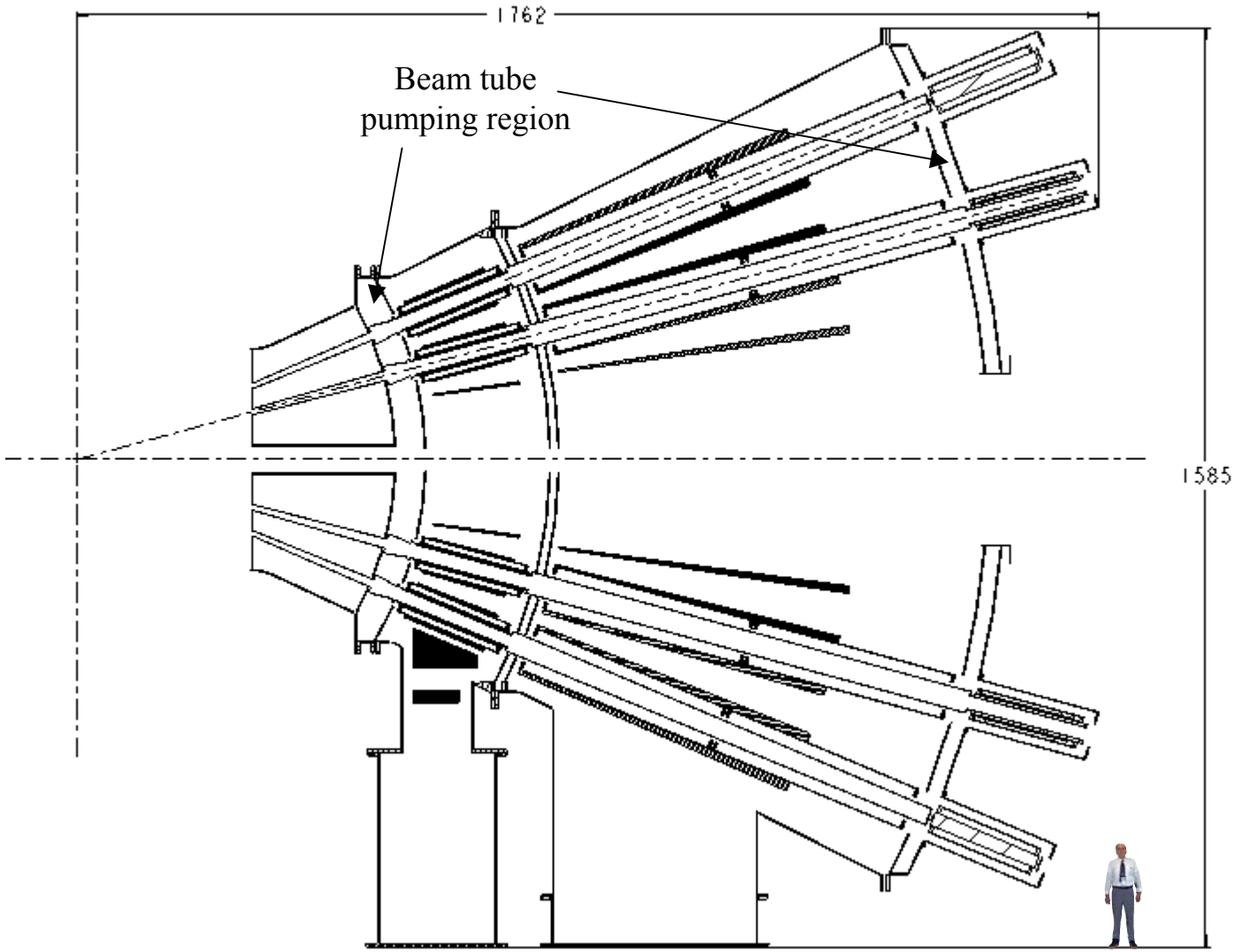
Exploded View of the Final Focusing Magnet



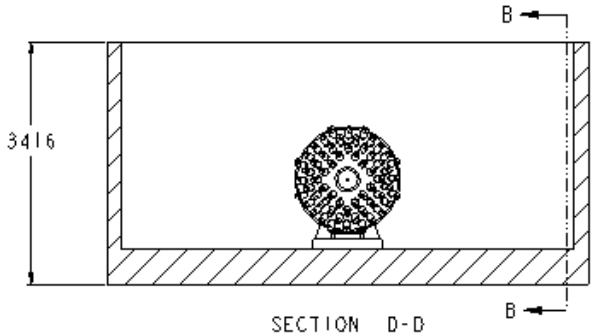
Modular Breakdown of Final Focus Magnets

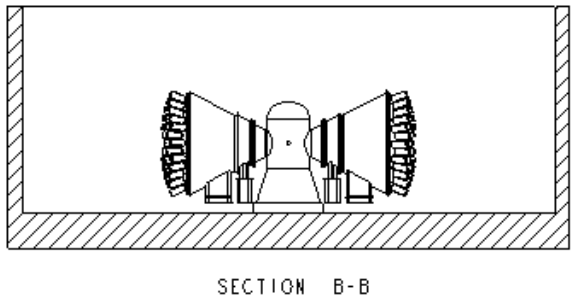


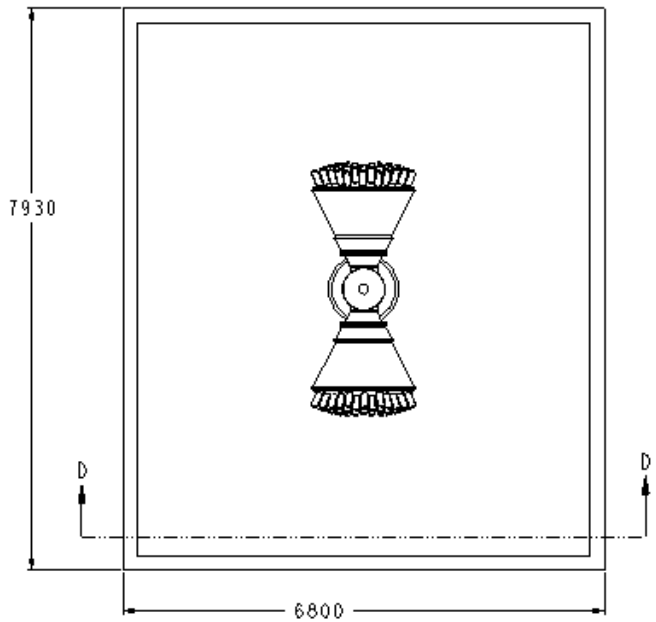
Final Focus Magnets Section Cut



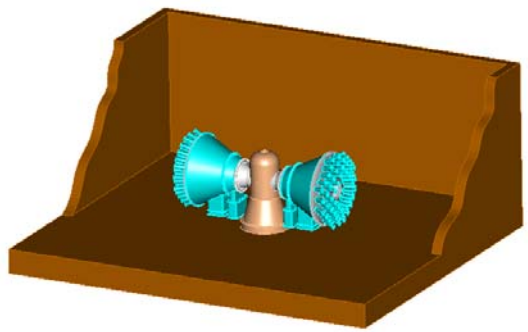
RPD-2002 Power Plant Located in the ITER Building







NOTE: ALL DIMENSIONS IN CM



Conclusion

- **The RPD-2002 configuration is in its early stage of development with further design details, machine options and system trade-offs to be investigated.**
- **Maintainability issues need to be more fully understood from the point of view of component activation and personnel access.**
- **Design details of the beam tube pumping chambers need to be developed to assure pumping requirements are met and beam tube connections can be made.**
- **The details of the matching magnets will affect a the assembly process; consequently their integration into the design is needed.**