Radial Build Updates for Flibe/FS System

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http://fti.neep.wisc.edu/FTI/ARIES/FEB2003/lae.pdf

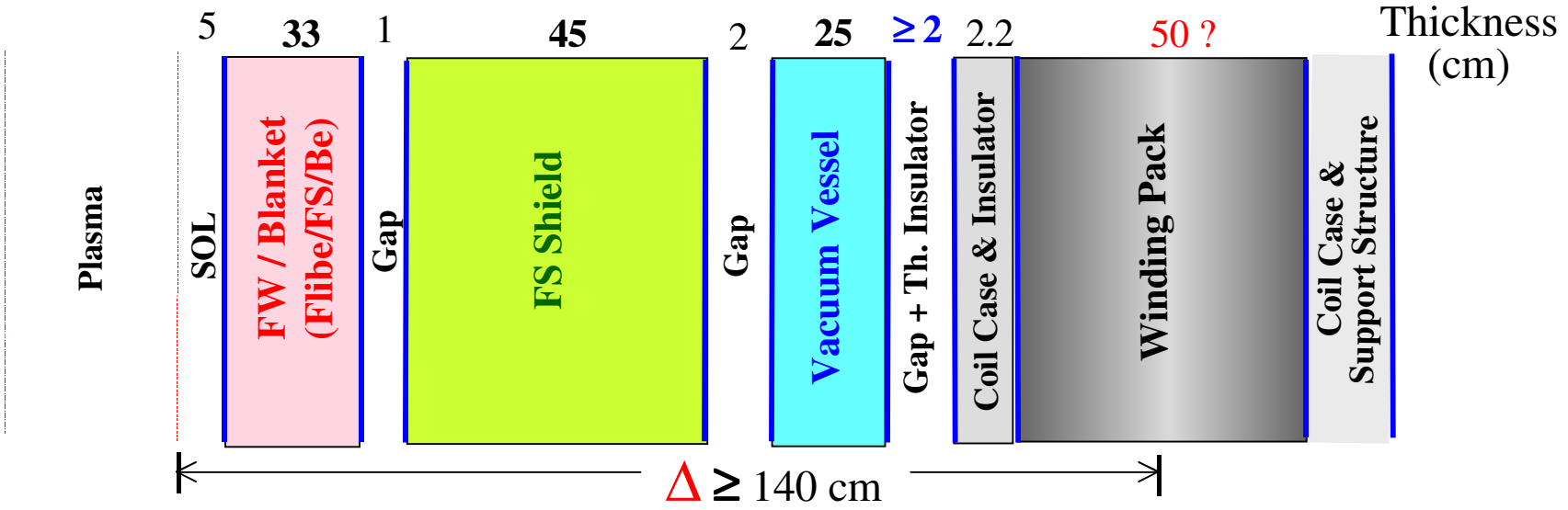
Design Changes and Implications

	Old	New	Design Implications
Av. Γ (MW/m^2)	1.4	2	
Peak Γ (MW/m^2)	~2	~3	– Need thicker blanket (> 30 cm) to protect shield.
Δ_{min}	Expected at Middle of Field Period (2% of FW area)	Twice per Field Period	– Higher coverage for shield-only zones – Lower breeding – More expensive WC shield.
Magnet	HT or LT?	LT @ 4k Nb_3Sn or NbTi?	– Assume Nb_3Sn with 10^{19} n/cm^2 fluence limit and 2 mW/cm^3 heating limit.
Cryostat	?	2 cm inner coil case	– Assume 0.2 cm GFF polyimide electric insulator.
Winding Pack (WP)	?	– 25 cm, or – 50 cm	– 100% coverage (impractical). – 50% coverage: – Toroidal spacing between coils ? – Acceptable for FW/B/D maintenance ?!

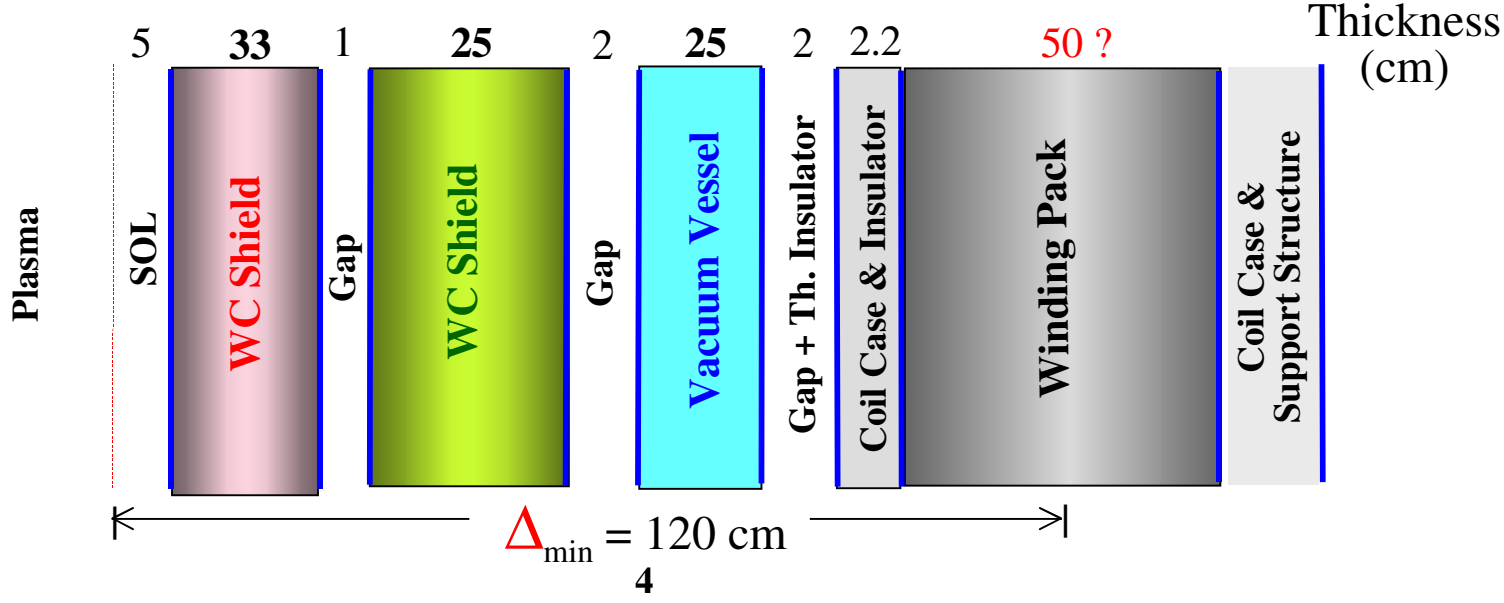
Along with 33 cm Blanket and 45 cm FS Shield, 25 cm VV Protects Magnet

Components	Composition
33 cm Blanket	84% Flibe with enritched Li 10% FS Structure 6% Be
45 cm FS Shield	15% FS Structure 10% Flibe 75% Borated Steel Filler
25 cm VV	**28% FS Structure** **72% Borated Water**
50 cm Winding Pack (Assuming same composition as for SPPS magnet)	25% Incoloy Structure 20% Cu Stabilizer 15% Nb_3Sn + Conduit 25% GFF Polyimide 15% LHe

Recommended Radial Build. Is 50 cm Winding Pack Acceptable?



Shield Only Zones

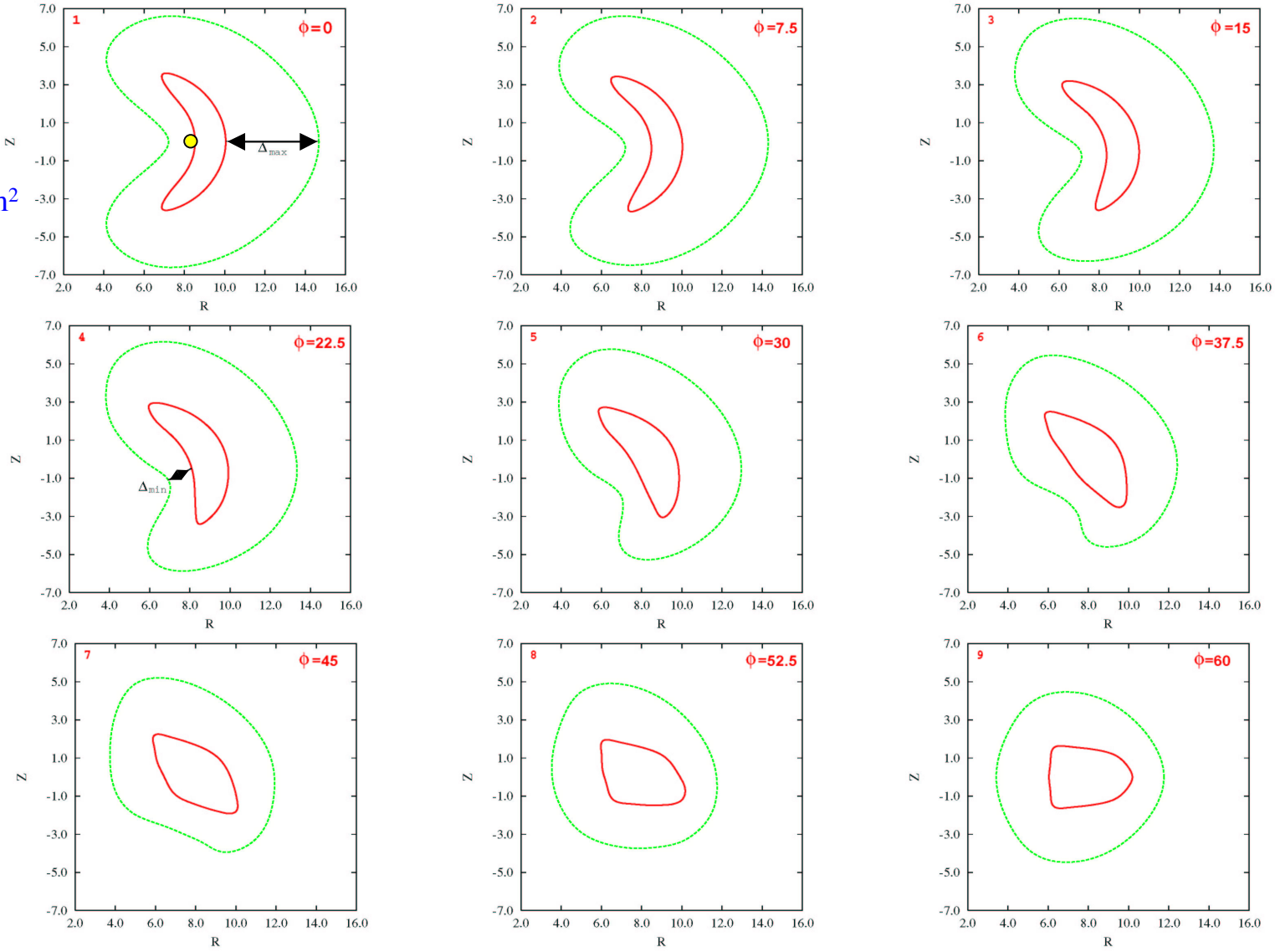


9 Xns of Plasma Boundary (red) and WP Center (green) Covering Half Field Period*

Δ_{max}~ 4.6 m

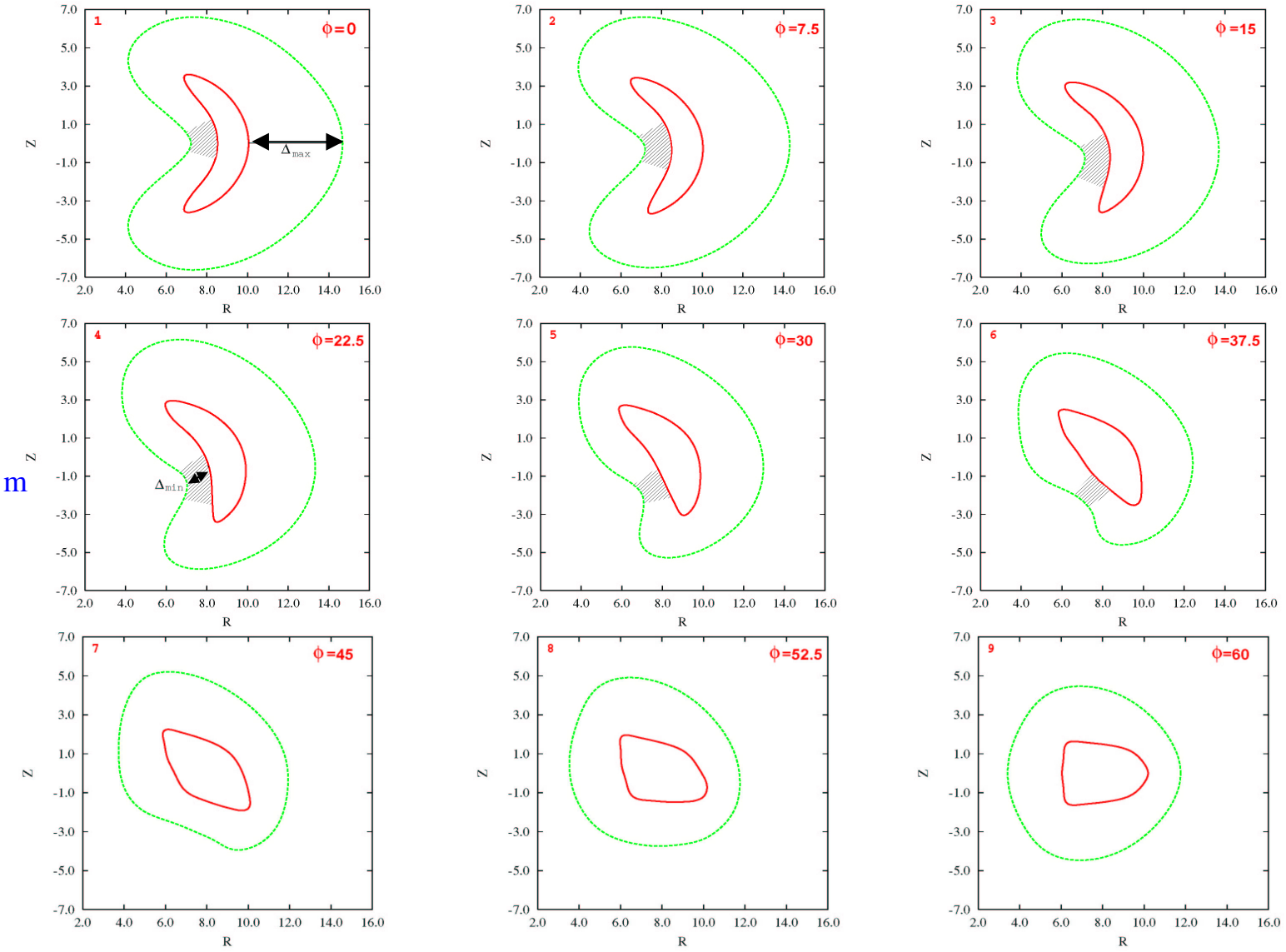
Γ peaks @ ~ 3 MW/m^2 at yellow dot.

Δ_{min}= 1.2 m



* ~9 m toroidally

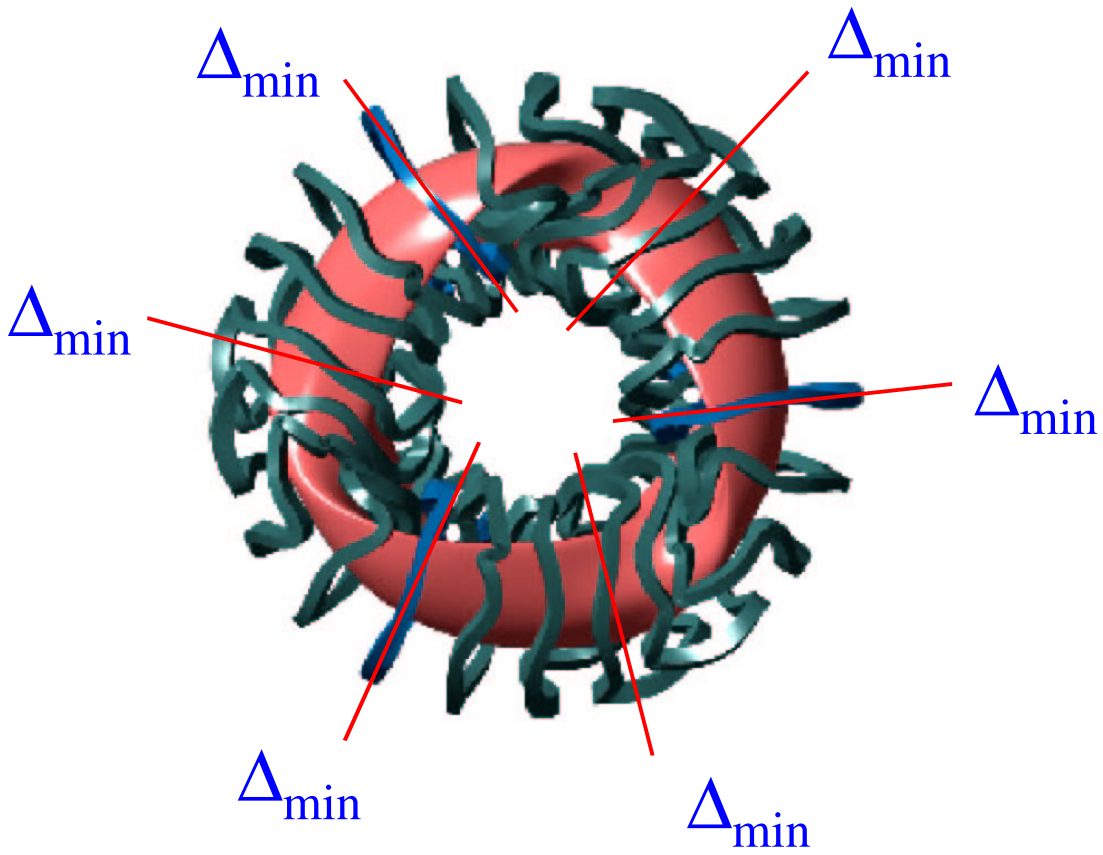
Gray Areas Designate 1.2 m ≤ Δ ≤ 1.4 m Covering ~10% of Total FW Area



Δ_{min} = 1.2 m

Δ_{min} Occurs Twice per Field Period

(NCSX Configuration Used for Illustration)



Is there a configuration with single Δ_{min} per field period?

Comparison Between Radial Builds

	SPPS	HSR#,*,@	QA#2*	ARIES-CS	
				Blanket and Shield	Shield only
Thickness (cm):					
SOL	15	30	5	5	5
FW/Blanket	36 (Li/V)	43 (LiPb/H_2O/FS)	30 (LiPb/SiC)	33 (Flibe/Fs)	33 (WC Shield)
Gap	2	5	1	1	1
HT Shield	45	30 ?	49	45	25
Gap	2	–	2	2	2
VV or LT Shield	35	20 ?	20	25	25
Gap +Th. Insulator	≥ 8	≥ 10	≥ 2	≥ 2	≥ 2
Cryostat +1/2 WP	15+38	15+30	51	2+25	2+25
Δ	**196**	**183 ?**	**160**	**140**	**120**

CD Beidler et.al., "Recent Developments in Helias Reactor Studies", March 2002, http://www.ipp.mpg.de/eng/for/bereiche/e3/for_ber_e3_proj_sss.html

* J. Lyon's presentation, ARIES project meeting at PPPL, Oct 2-4, 2002.

@ HSR numbers need to be confirmed. LiPb blanket/shield may not protect VV for life.

Remarks and Recommendations

- Δ_{min}=120 cm and $\Delta \geq$ 140 cm are adequate for Flibe/FS system providing that 50 cm-thick winding pack with 50% magnet coverage is acceptable.
- WC shield zones cover large fraction of FW area (~10%) and may cause breeding and economic problems:
  - For Flibe/FS system, more Be (> 6 %) and higher enrichment (> 30 %) could solve breeding problem
  - Breeding of LiPb system could be marginal
  - Be and WC are expensive
- Find alternate configuration with single Δ_{min} per field period to alleviate engineering problems.