New Radial Build Data

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Recent Changes to Radial Build
(3 FP Configuration; LiPb/FS System)

6 Shield-only zones:

- 20 cm thick He manifolds* added; two modules per zone; one He access tube per module (32 cm ID).
- Issues and concerns:
  - Impact of manifolds on overall machine size and cost
  - Impact of tubes on reweldability of manifolds
  - Tubes remove ~40 cm of shielding materials hot spots at magnet
  - Thick local shield needed behind VV to protect magnet.
- Rewelding of VV in this area can be avoided, per Siegfried.

Nominal Blanket/shield zone:

- HT shield increased from 18 cm to 28 cm to protect manifolds.
- Tubes remove ~30 cm of shielding materials hot spots at magnet
- 206 local shields needed to protect VV and magnet.
- **Observations**:
  - No major impact on machine size
  - More expensive shield.

* Siegfried suggests 15 cm thick manifolds.

Recent Changes to Radial Build (Cont.)
(LiPb/FS System)

New magnet design:

- 4K magnet composition, per Leslie:
  - 18.5% Incoloy-908
  - 48.2% Cu
  - 12.8% Nb_3Sn
  - 10.0% Insulation*
  - 10.5% Liquid He
- Winding pack dimension not available. 30 x 30 cm assumed.
- Thickness of external and side structures not available. 10-20 cm assumed.

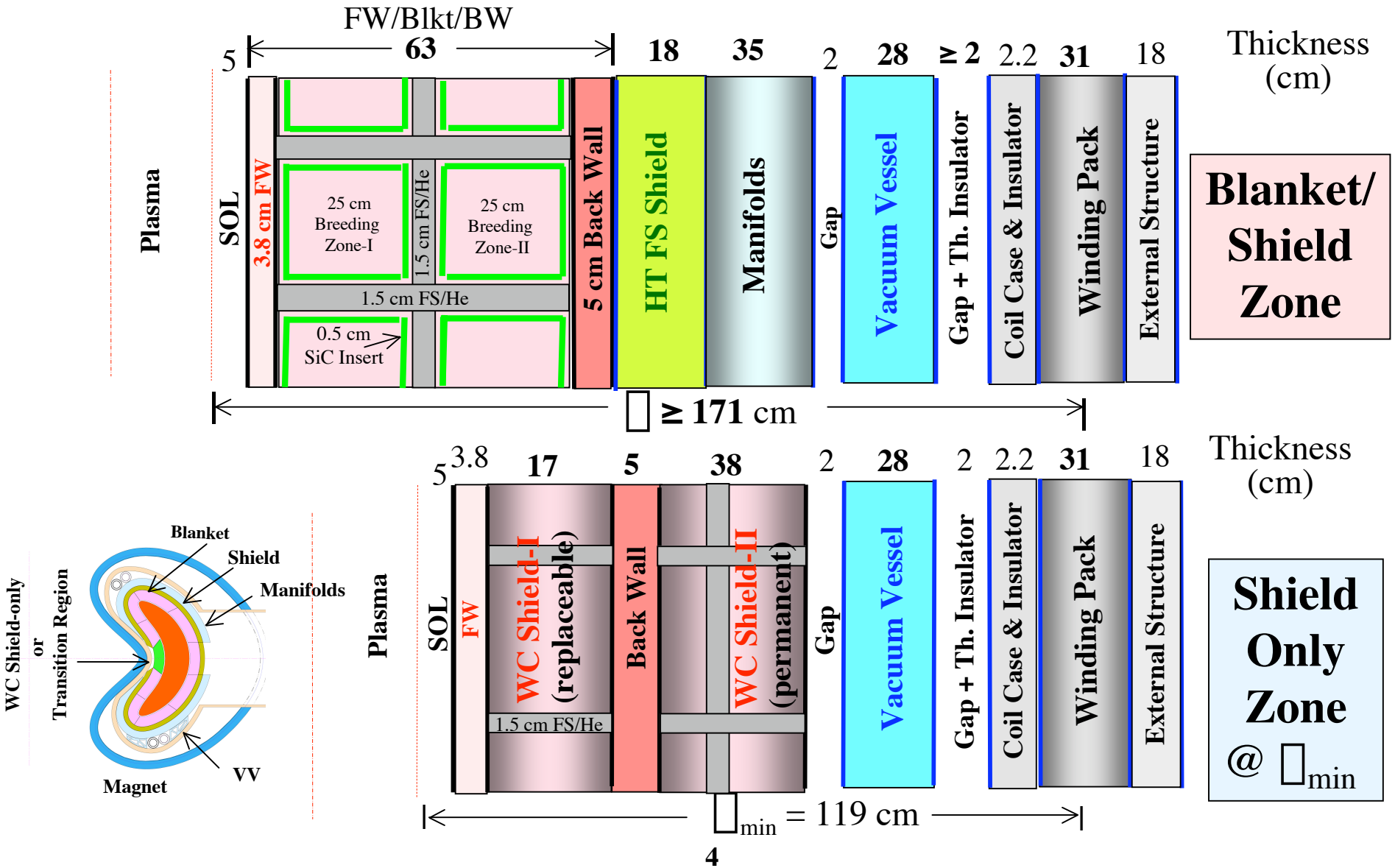
- **Monitor**:
  - Peak (< 2 mW/cm^3) and
  - Total nuclear heating at magnet and cryogenic heat load
  - dpa to Cu stabilizer (< $6x10^{-3}$)

New magnet has no major impact on radial build definition

* Type not available. Used GFF polyimide as placeholder.

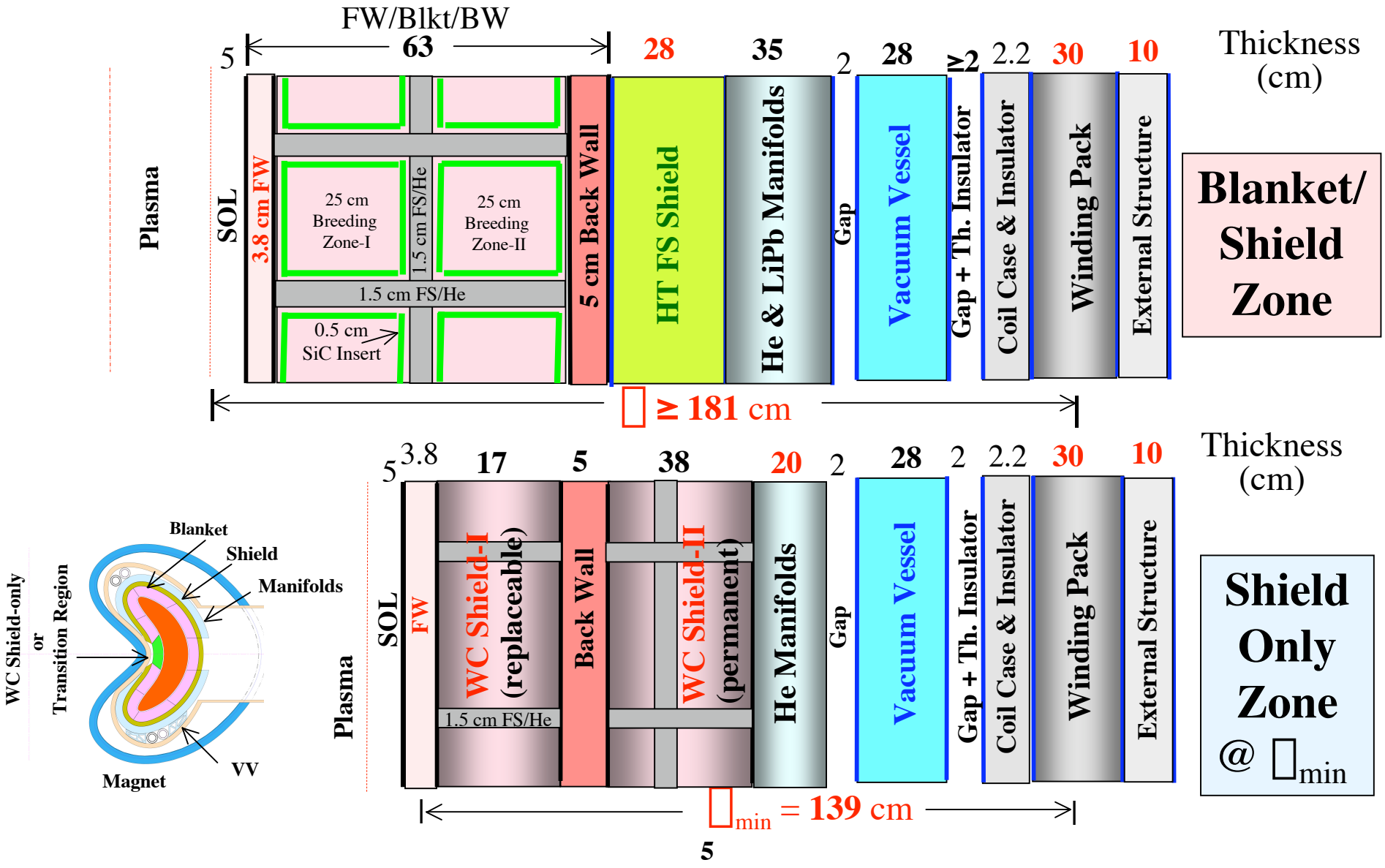
9/05 Radial Build

(3 MW/m^2 peak □)



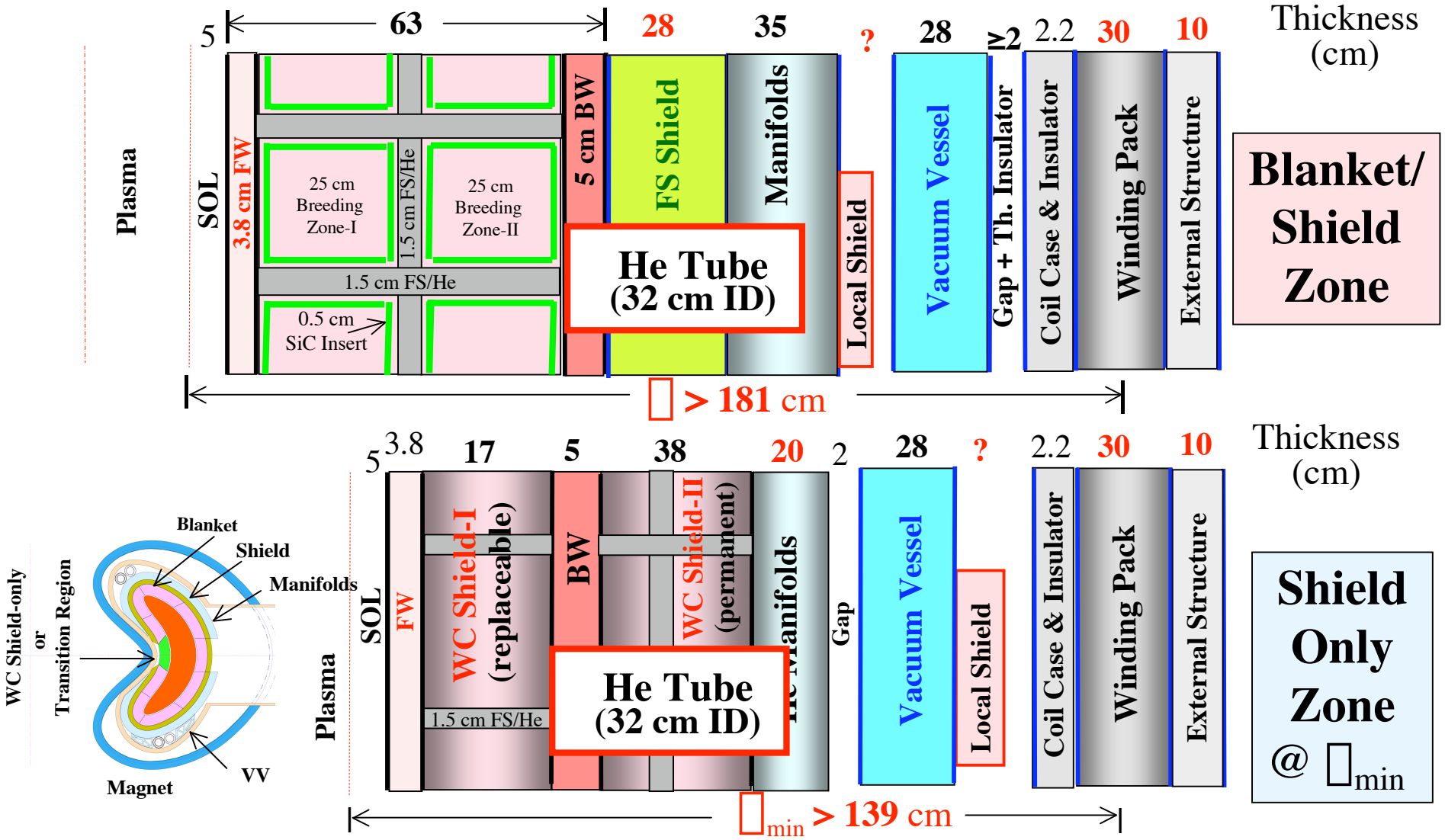
New Radial Build

(3 MW/m^2 peak □, changes marked in red)



Xn through He Access Tubes

(3 MW/m^2 peak □)



Suggestion

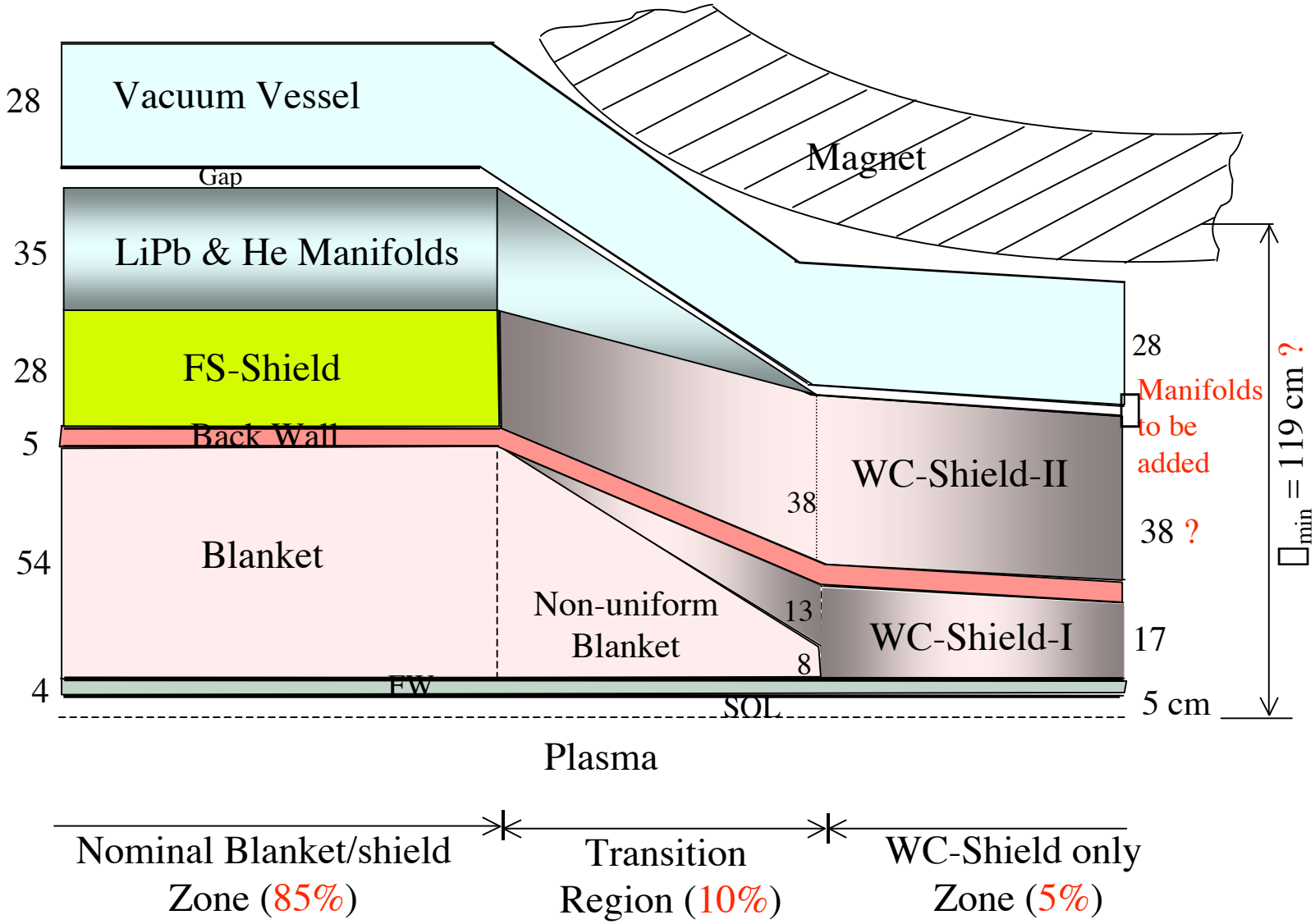
- To alleviate impact of access tubes on radial build, use LiPb, instead of He, to cool **shield-only zones** that cover 5% of FW area.

- **Disadvantages**:
  - WC shield operates at lower temperature
    $\Rightarrow$ slightly lower η_{th}

- **Advantages**:
  - Lower impact on radial build and overall machine
  - Less severe streaming problem
  - Thinner local shield
  - Lower temperature during LOCA/LOFA

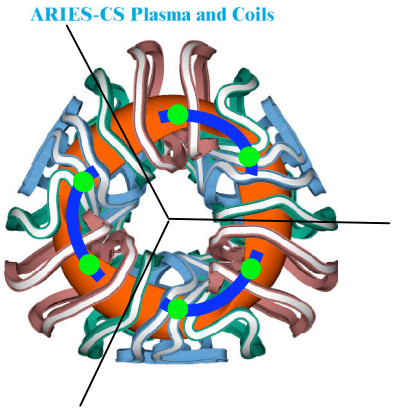
- **Question**: Could **all** HT shields be cooled with LiPb?
  Benefits: more compact nominal radial build, smaller He access tube, less streaming, and thinner local shields.

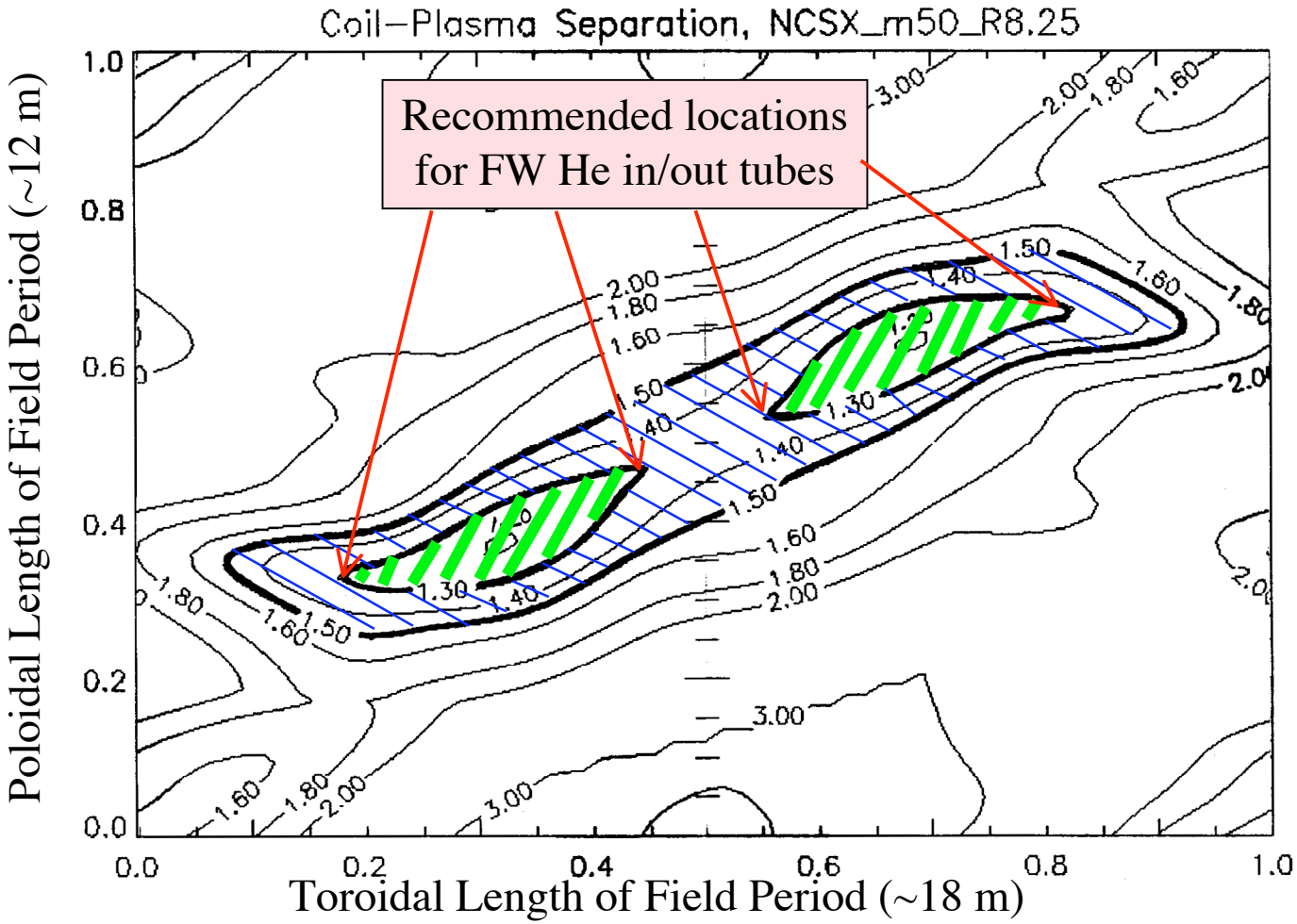
Nominal, Transition, and Shield-only Zones



2 Shield-Only Zones Per Field period

(3 FP Configuration, R= 8.25 m)





Shield-only zone (**green**), transition region (**blue**), and nominal blanket zone cover **5%, 10% and 85%** of FW area, respectively

Magnet Cryogenic Heat Load

- **Assumptions**:
  - 2 MW/m^2 average □
  - Continuous 4K structure surrounding winding packs
  - 300 W_e needed to remove 1 W of nuclear heating

- **Roughly estimated 0.014 MW of nuclear heating.**

Cryogenic load to remove nuclear heating ~ 4 MW_e

Other non-nuclear heat load to magnet?

Future Plan

- Check effect of shield LiPb coolant on radial build.
- Post new radial build on UW website:
  http://fti.neep.wisc.edu/aries-cs/builds/build.html
- Optimize dimensions of local shield behind access tubes and confirm VV/magnet protection with 3-D analysis.

ARIES-CS Publications

Submitted final manuscript to ICFRM-12 conference (Dec 4-9, 205, Santa Barbara):

The Feasibility of Recycling and Clearance of Active Materials from Fusion Power Plants

M. Zucchetti, L. El-Guebaly, R. Forrest, T. Marshall, N. Taylor, K. Tobita

Published full report as UW FDM:

Current Challenges Facing Recycling and Clearance of Fusion Radioactive Materials

L. El-Guebaly, R. Forrest, T. Marshall, N. Taylor, K. Tobita, M. Zucchetti,
Available at: http://fti.neep.wisc.edu/pdf/fdm1285.pdf