# PPPL NONCONFORMANCE REPORT NO: 3735 Open Date 11/15/07 Rev #: 1 , 12/20/2007

**Status** 1 - Eng Dept Head Concur Required **Trend** 05-Design Interferance

**Department** NCSX **Division** WBS 142

**Source/Org** Fabrication, Operations & Maintenance

**Item Dwg/Part#** b1_mtm_data_check.asm **Procurement #** WPF-1224

**Cost Center** **WBS/Other** 00/00/00

**RAP#** 3304 **Job Doc #** WPF-1224 **Vendor**

**RAP Title** Coil to Coil Assembly Trials

☐ HoldTag Applied

**Nonconforming Condition (include requirement(s) violated):**

MCWF B1 & C1; During the trial fit-up of the B1 and C1 NCSX modular coils an interference was discovered in the vicinity of winding clamp #67. The interference is between the copper chill plates of each coil just above the VPI groove where the vertical chill plates are attached to the horizontal or base cladding, see attachment 1 for details.

**Lot Size Recd** 0 **Sample Size Insp** 0 ☐ Lot Rejected **# Rejected** 0

**Reported By** Chrzanowski J **Validated By** Phelps C Colin Phelps Digitally signed by Colin Phelps DN: cn=Colin Phelps, c=US, o=PPPL, ou=QA, email=cphelps@pppl.gov Reason: I attest to the accuracy and integrity of this document Date: 2007.12.20 12:19:05 -05'00' **Validated Date** 12/20/07

**Distribution** **Cog** L. Dudek **Insp** C. Phelps

Proj. Doc Control (when closed) QC Files Malsbury J Boscoe J

J. Chrzanowski M. Viola Heitzenroeder P Brown T Williams M Simmons B

Tyrrell M Langish S Edwards J

**Disposition:** **Rework** X **Repair** ___ **Use As Is**___ **Return to Vendor**___ **Scrap**___

Rework coils by grinding away the casting where the castings interfere. Where the chill plates interfere, reform the chill plate by bending the joint up and out of the way.

Revised Disposition by Phil Heitzenroeder on 12/19/08 to include additional requirements and instructions: See attachment 2 pages 2 and 3. Attachment 2 is the entire analysis/justification regarding this situation by Phil H.

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**For rework or repair of vendor supplied equipment, fill in information below:**

**# Hours** 32 **$ Est Labor** 2720 **$ G&A**_____

**$ Material** _____ **$ Burden** _____ **$ Total** _____

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**Disposition by** _____

**Supervisor's Concurrence** _____

**Eng. Dept. Head Concurrence** _____

**Other (i.e., WCO/FPE) Concurrence** N/A

Digitally signed by N/A
DN: cn=N/A, c=US, o=PPPL, ou=QA
Date: 2007.12.20 12:17:53 -05'00'

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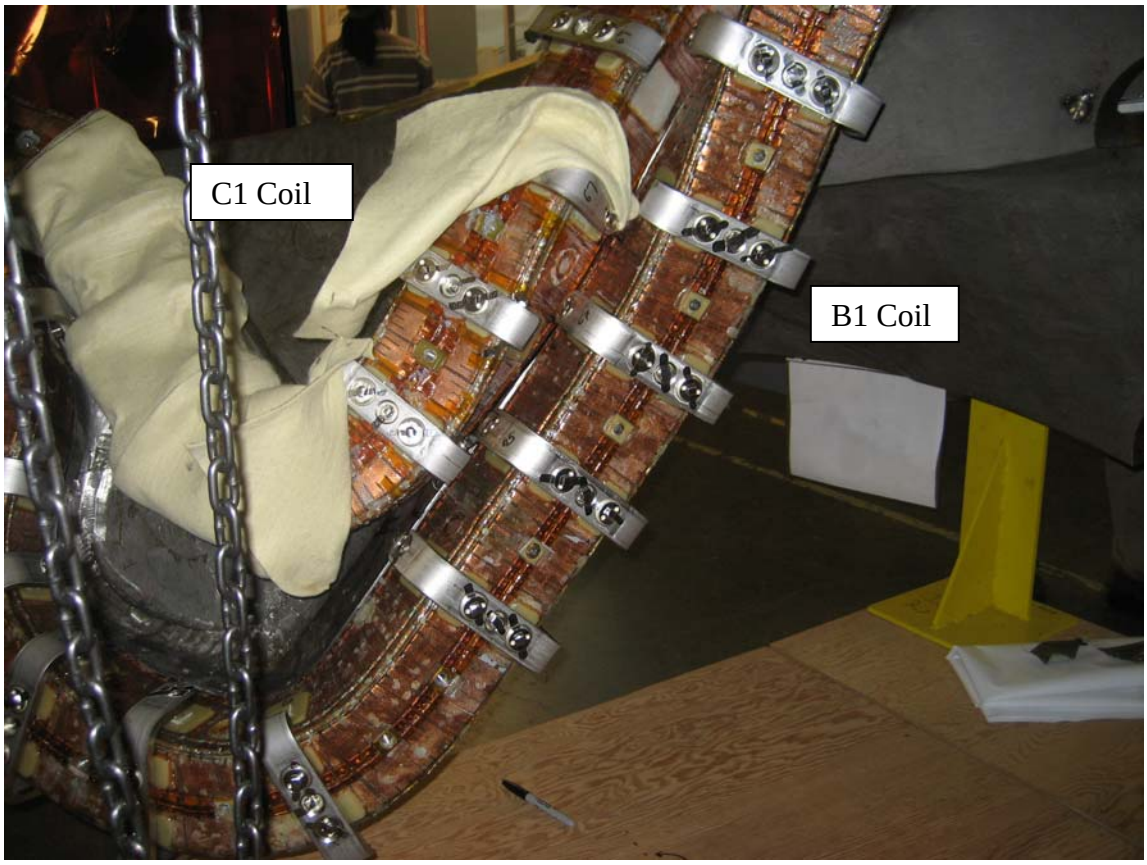
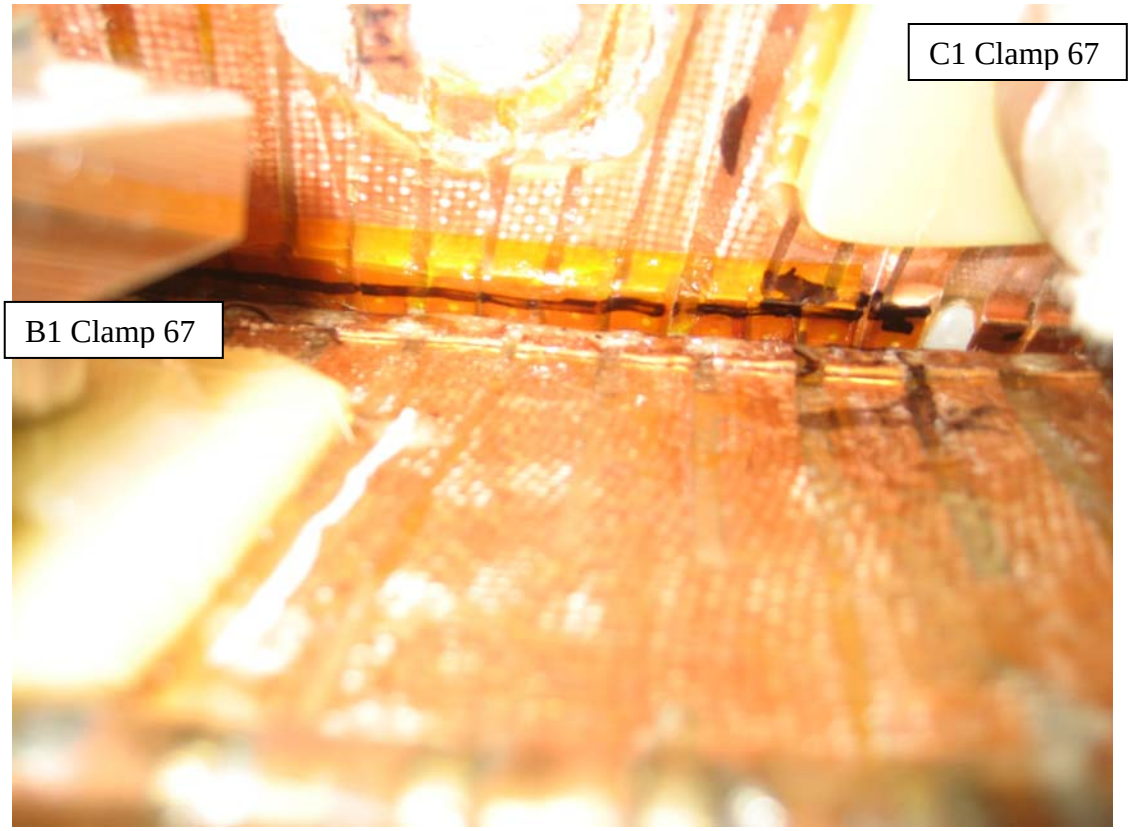
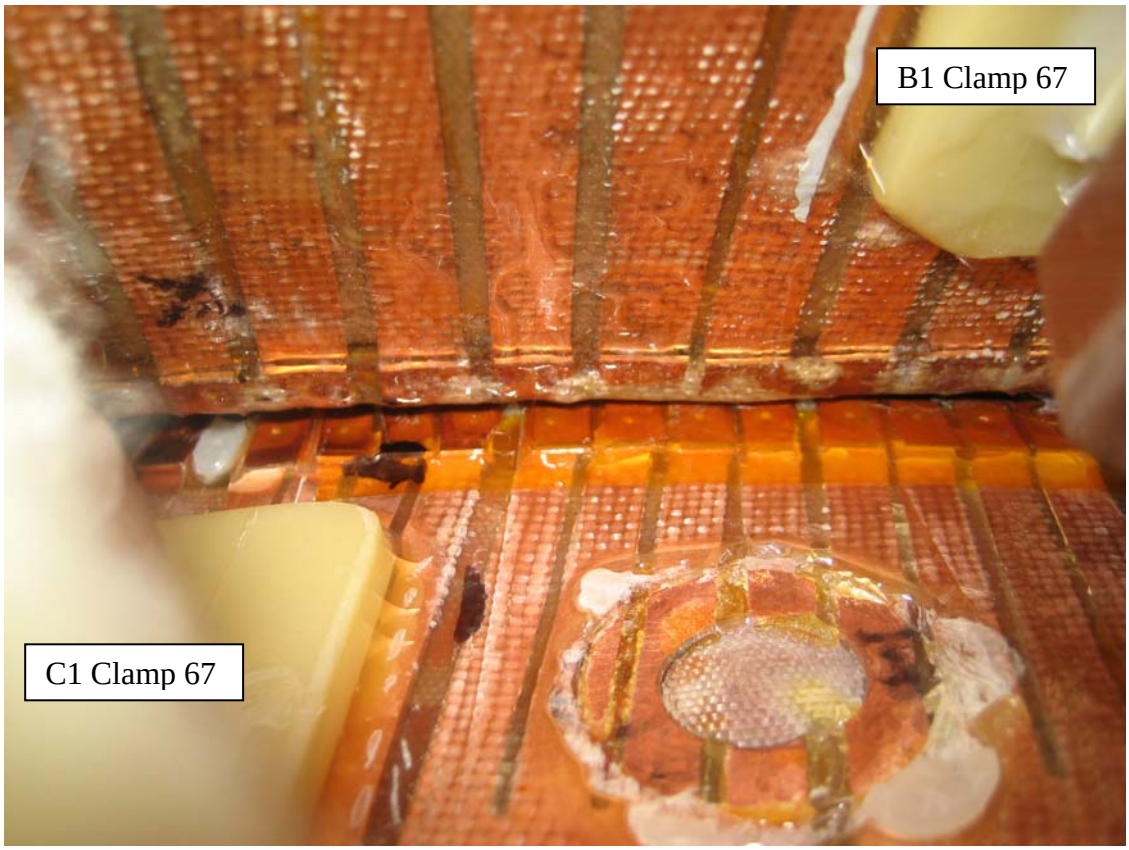
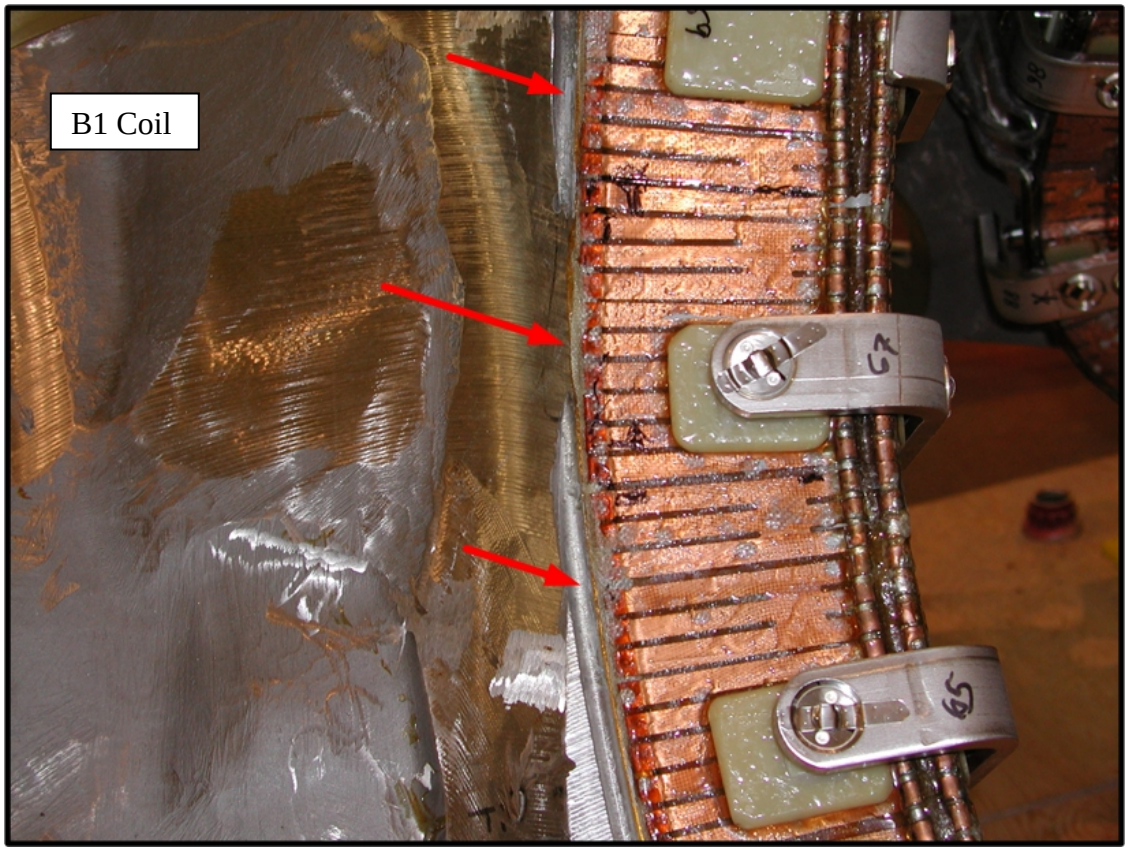
**PQA/QC Mgr Disposition Concurrence** _____

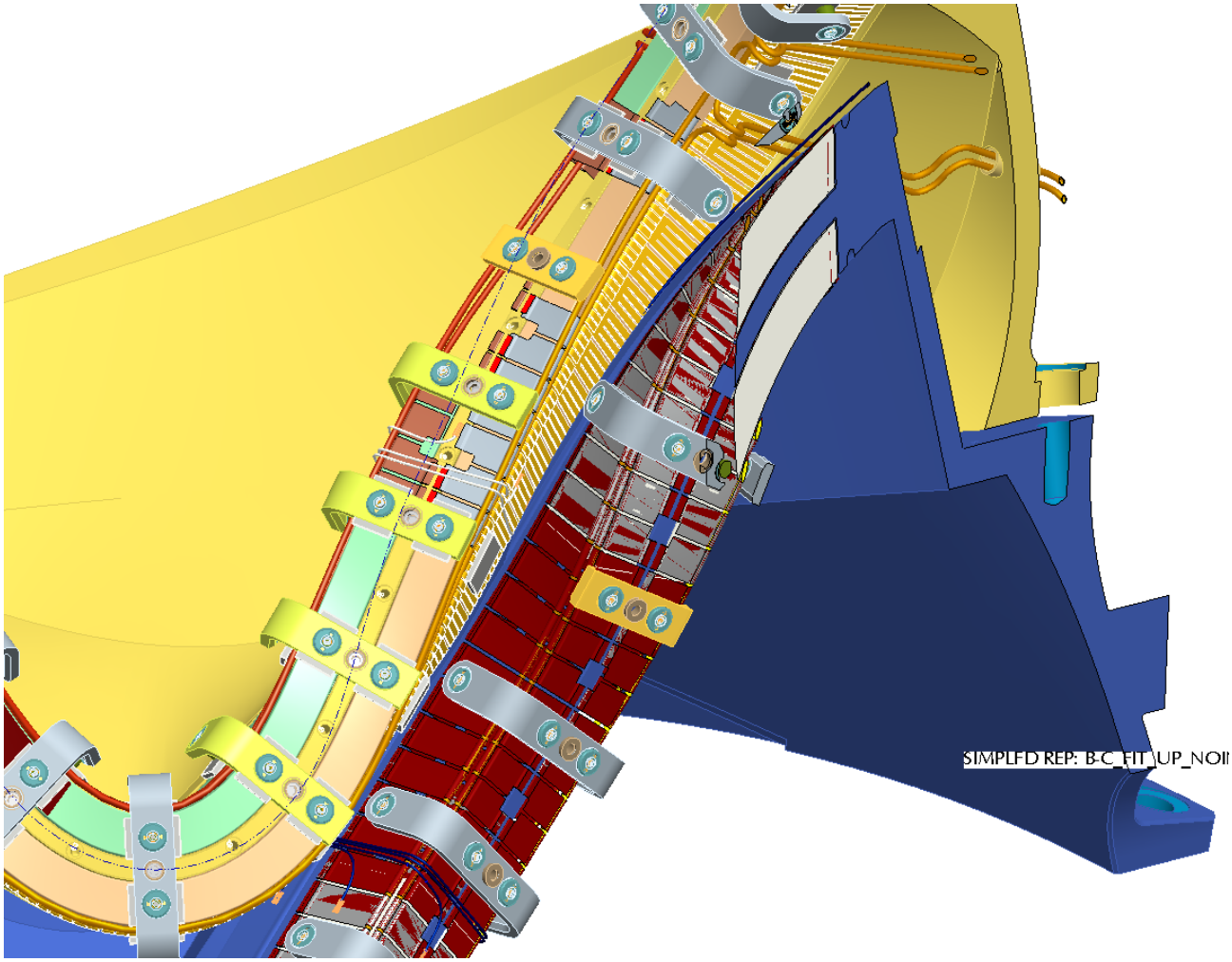
**QA Field Verification by** _____


C1 Coil
B1 Coil


C1 Clamp 67
B1 Clamp 67


B1 Clamp 67
C1 Clamp 67


B1 Coil




Portion of master machine model identified as “b1_mtm_data_check.asm” which brings together the top level MC assemblies, se141-102 and -103 which include the MC Type-B and Type-C details.

**NCR 3735 Attachment 2 – 12/19/08**

# Review of “B1” to “C1” interface Response to NCR 3735 and Deviation Request to Address Remaining B-C Coil Interfaces

**12/18/07**

Disposition to NCR 3735

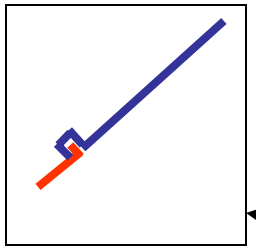
- Modify the copper cladding on B1 and C1 as shown on page 3.
  - The slides which follow this are given for reference.
- Resolve interference between MCWFs as shown in the following slide set, and as detailed in the grinding table shown on slide 17.
- Verify clearance as given below (Requirement on clearance).

RFD for Remaining B/C Coils:

- Coils B5,B6, and C6 are not yet VPI'd. These should be "preemptively" modified in a similar manner, with the exception being that instead of a crimp connection flat overlapped solder connections will be used (since heating due to soldering can be tolerated in a non-impregnated coil).
- Grinding of all C and B winding forms will be necessary, similar to the B1 and C1 that is described in the PowerPoint slides attached. Use these winding forms as models. Refer to Slide 17.
- The other C and B winding forms shall be ground to roughly the same profile as B1 and C1. This is not a highly stressed area (see slides), so grinding is not critical. IT IS IMPORTANT TO PROTECT THE COILS AGAINST POSSIBLE DAMAGE DURING THE GRINDING OPERATIONS.
- **Requirement on clearance:** There shall be a minimum of 1/16" clearance between the winding forms and cladding in the as-assembled position. This clearance must be verified by actual fit-up of the mating winding forms, by either clay method or feeler gauges.

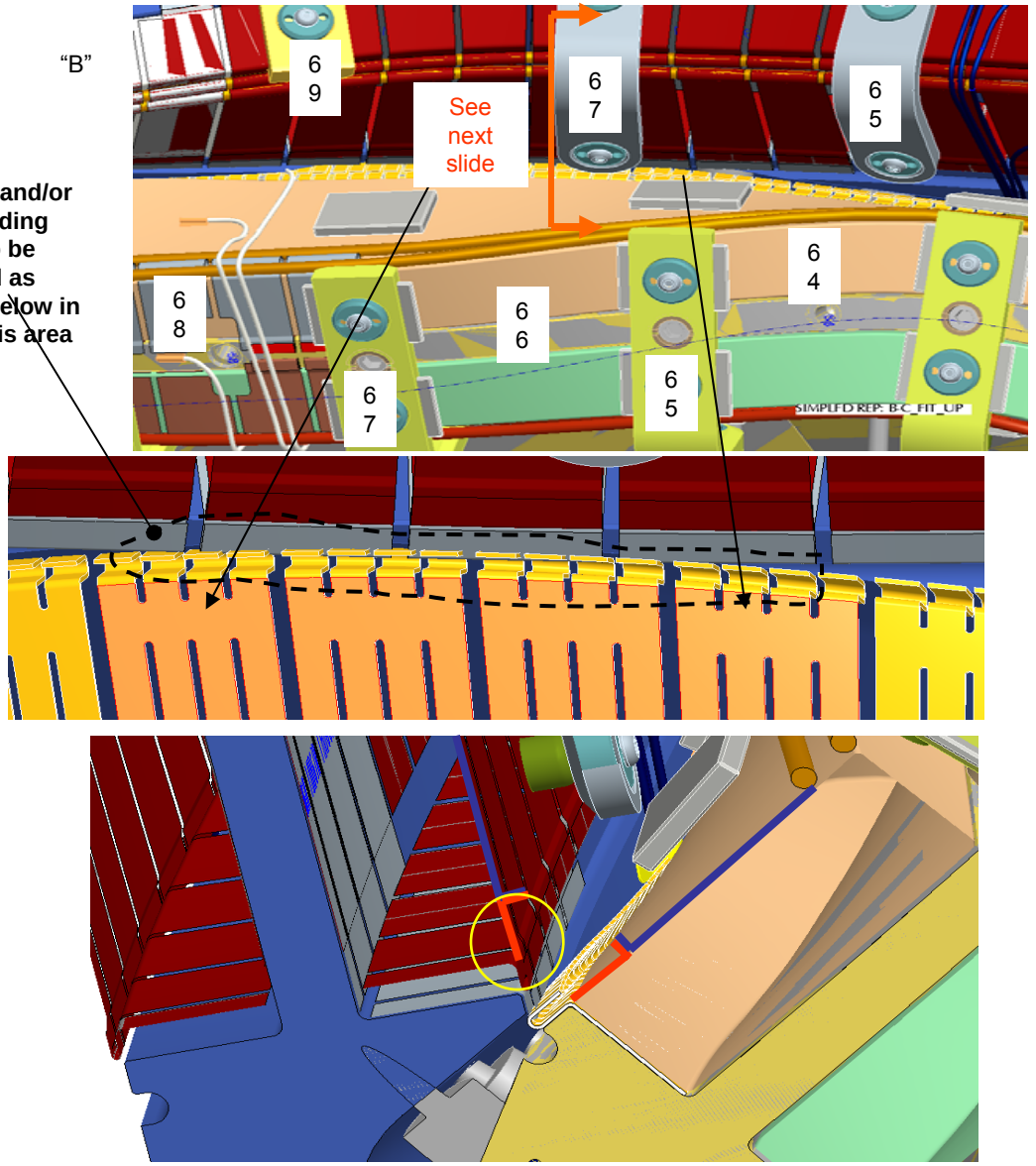
- It is likely that this same copper cladding modification will be needed on coils B2, B3,B4, C2,C3,C4, and C5.

# Elimination of cladding interference:

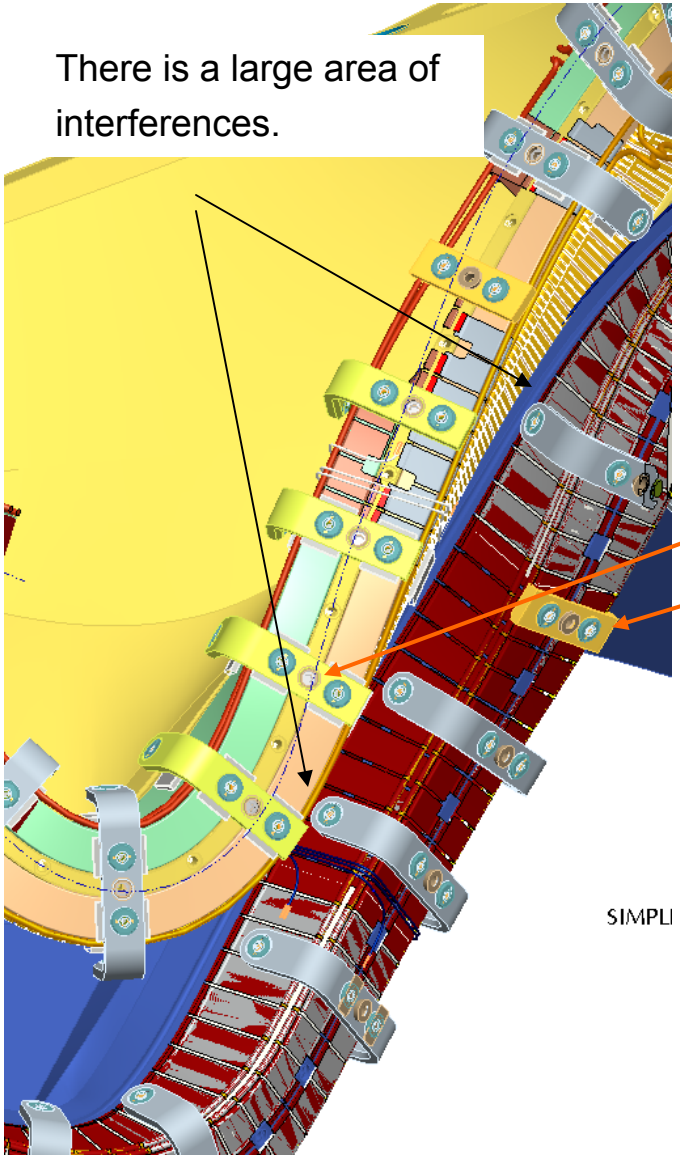


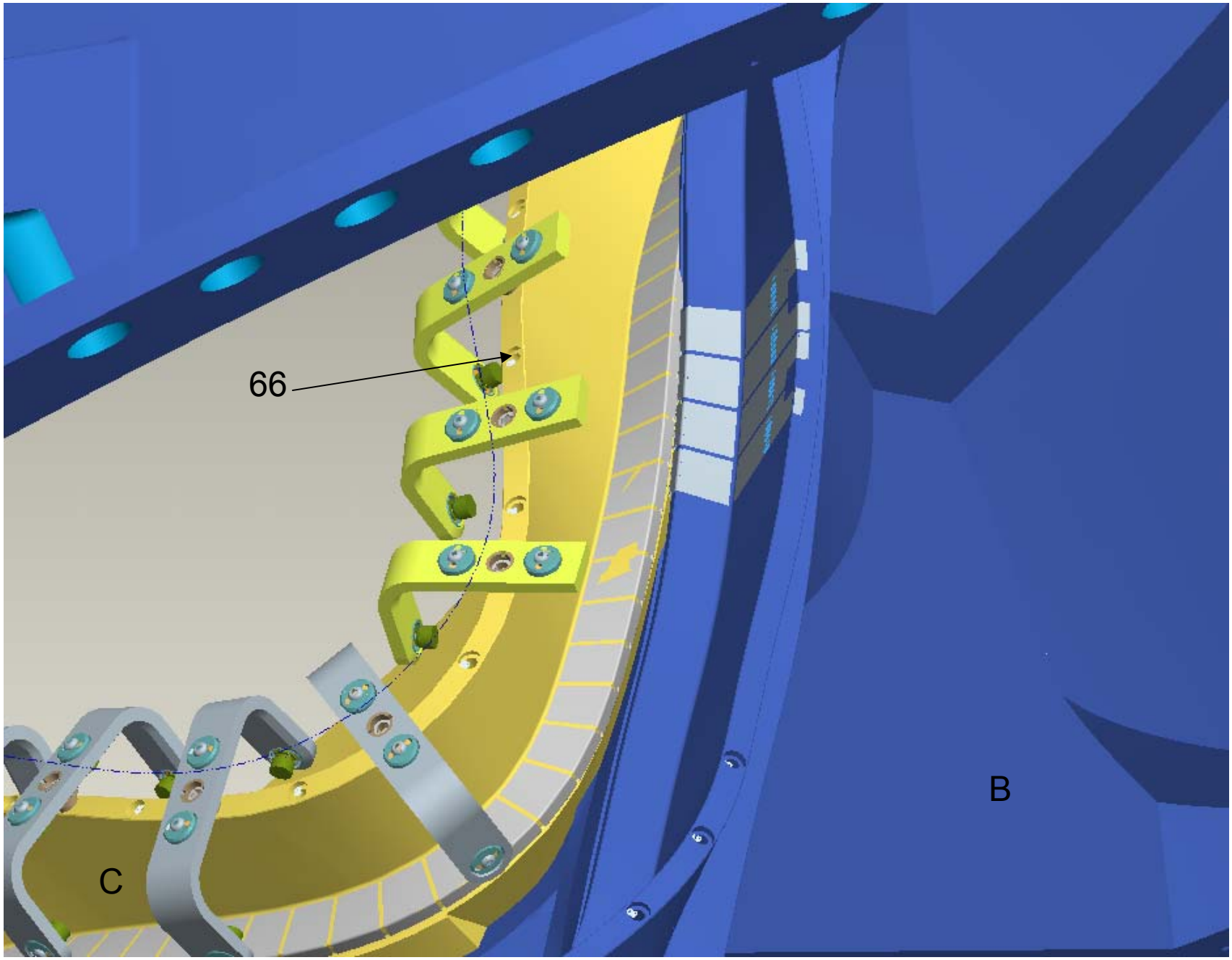
- On B coil, between clamp holes 65 & 69: and on C coil , between clamp holes 64 & 68:
  - Unbend copper crimps & straighten copper.
  - Form the copper as shown in the yellow circle. Bent out leg should be ~1/8".
  - Form the upper copper to meet the bent out leg and form a crimp U section over the lower piece.
  - Crimp the copper U.
  - Epoxy the copper to the coil and overlay the repaired region with glass – epoxy.
- *Every attempt should be made to avoid copper breakage*. However IF the copper breaks during the unbending operation, abandon that piece. Analyses (see slide 14) indicates that breakage of every other finger has a negligible effect on dT; ***if more than two adjacent fingers break, work shall be stopped and a NCR shall be written and dispositioned before proceeding.***

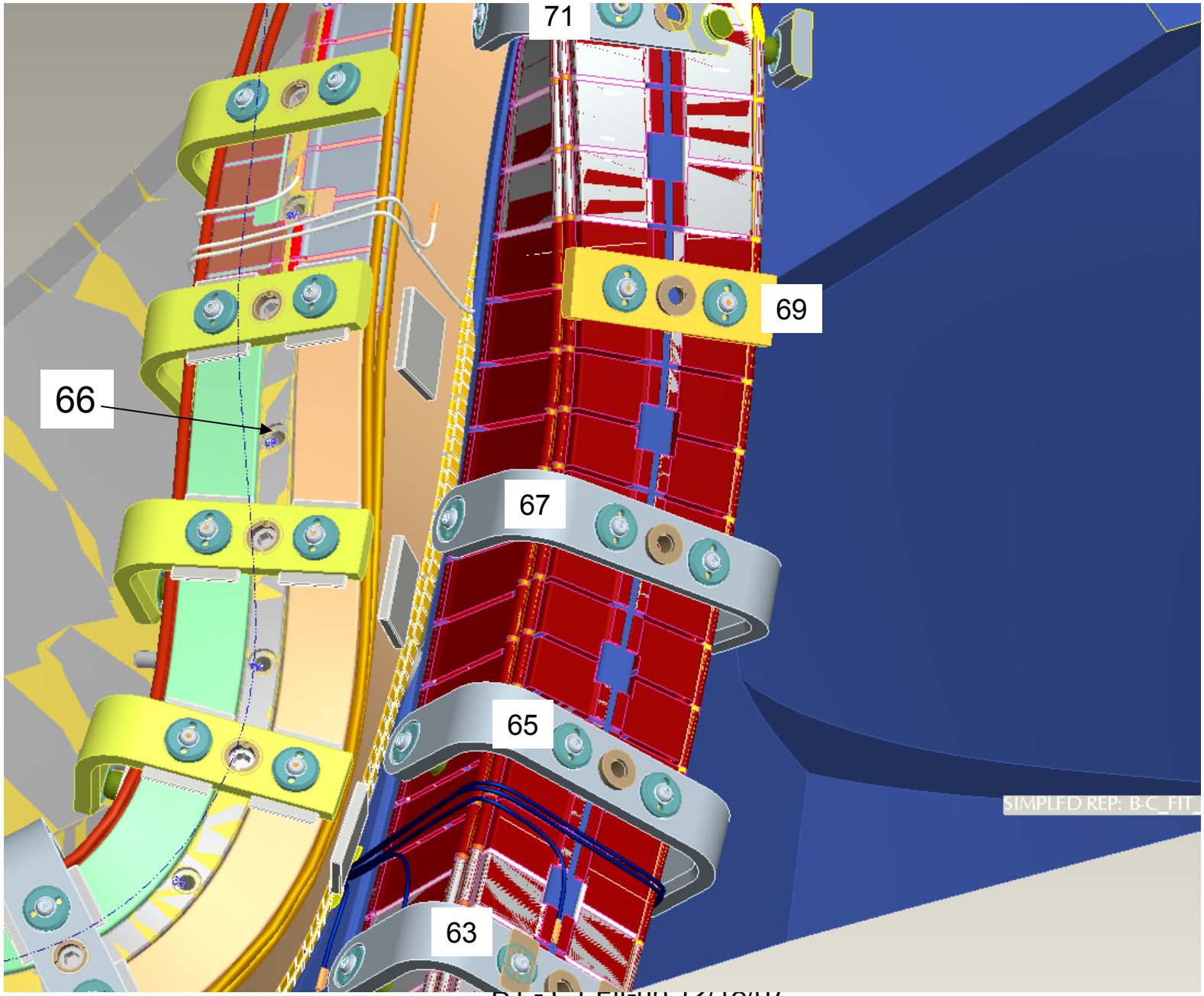
**The "B" and/or "C" cladding needs to be modified as shown below in red in this area**



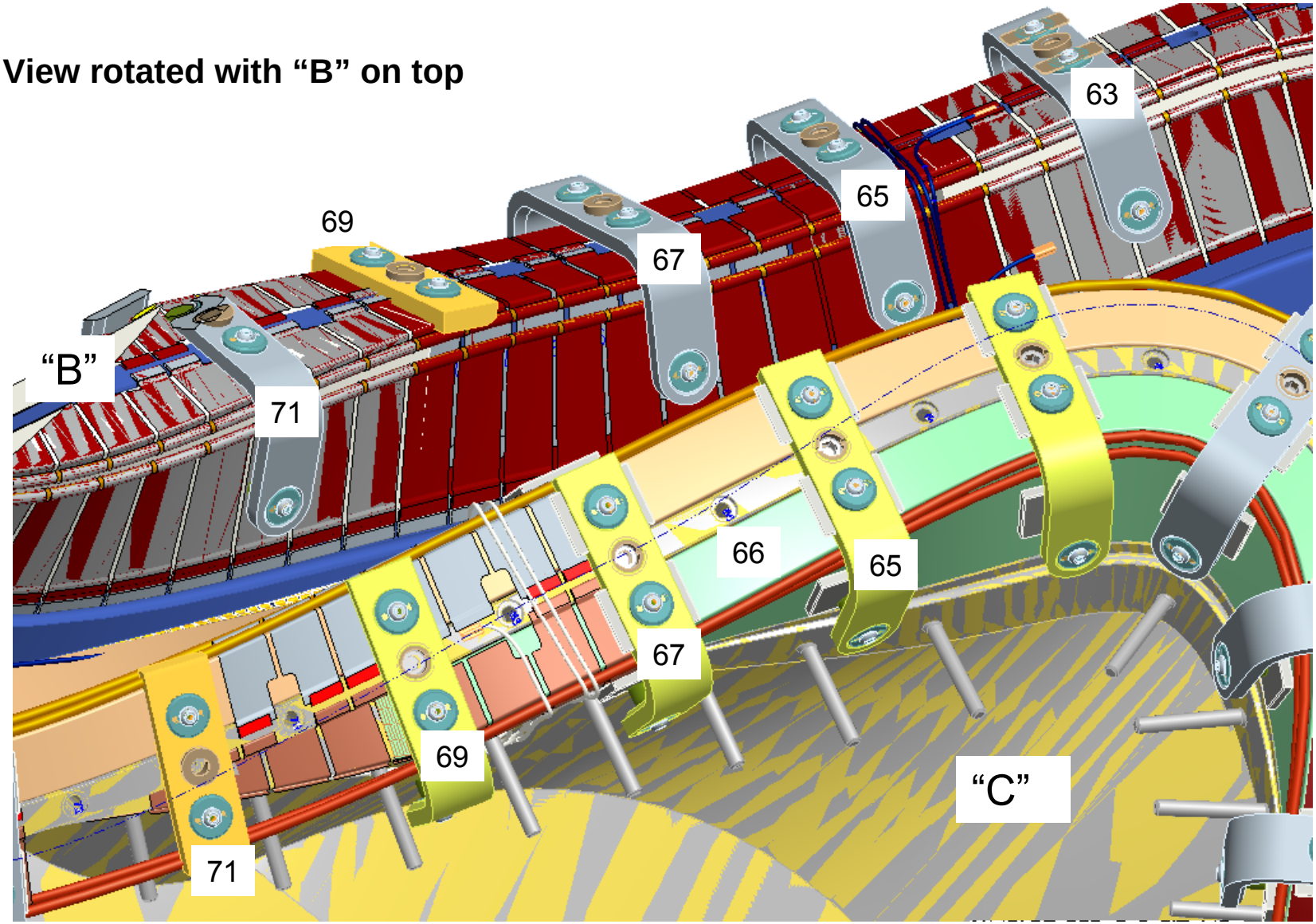
There is a large area of interferences.



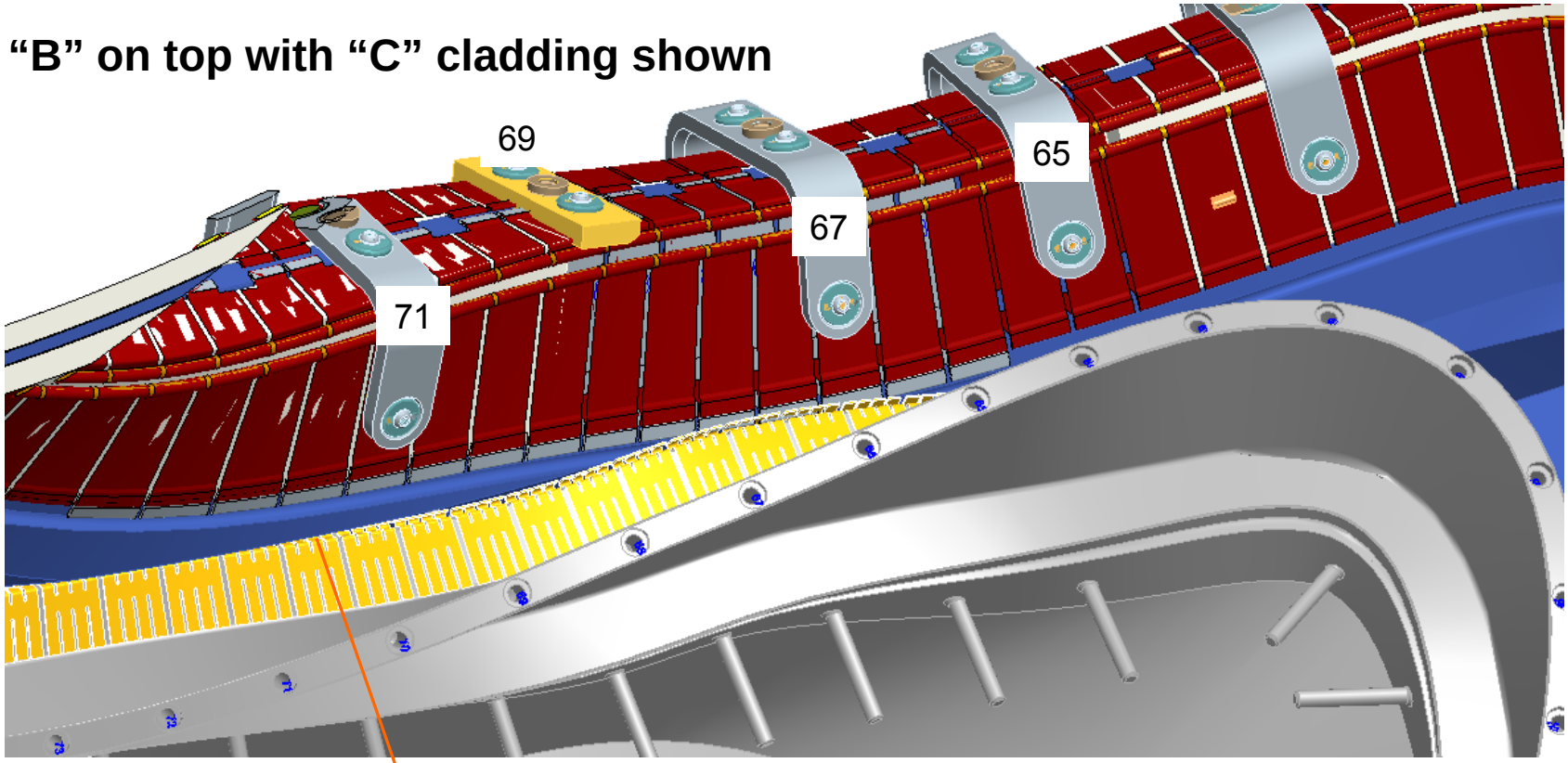


66
B
C

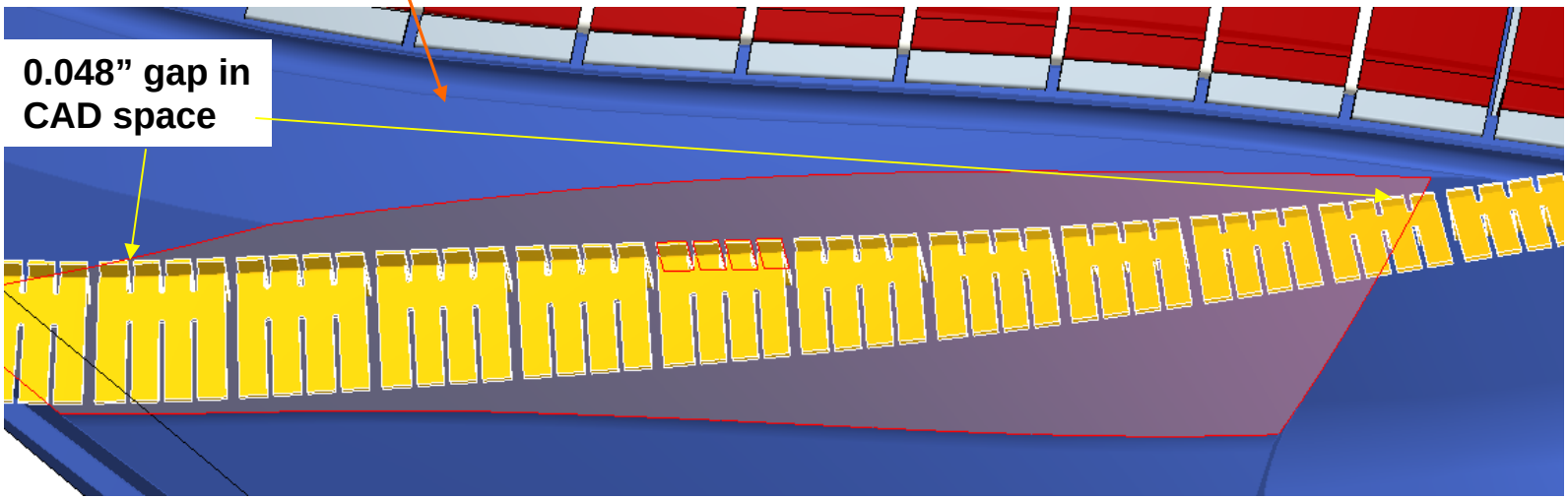

71
69
66
67
65
63
SIMPLFD REP: B-C_FIT_

**View rotated with “B” on top**

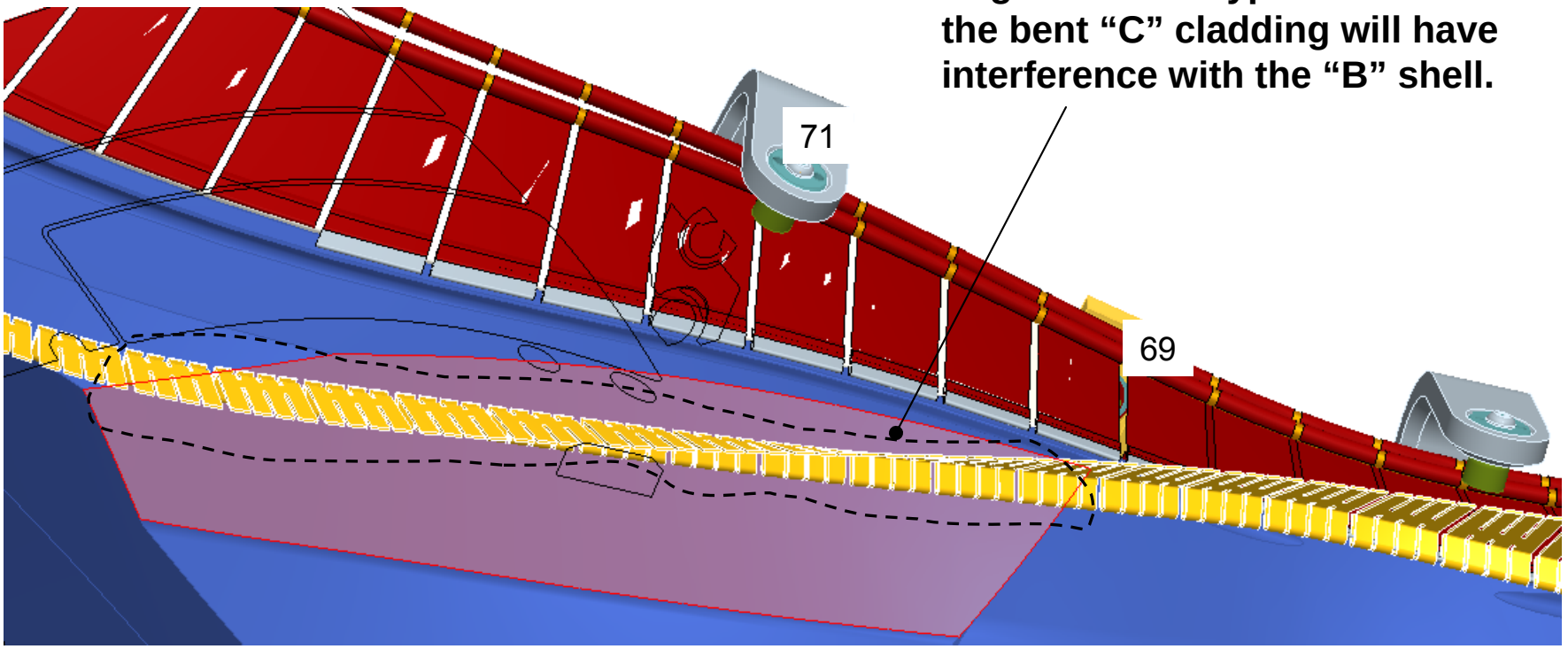


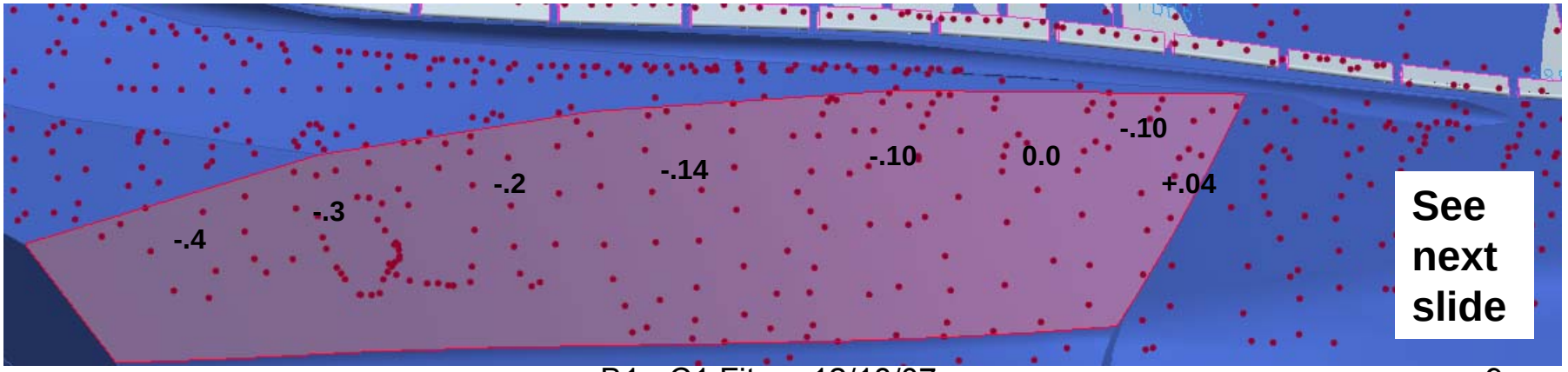
## “B” on top with “C” cladding shown

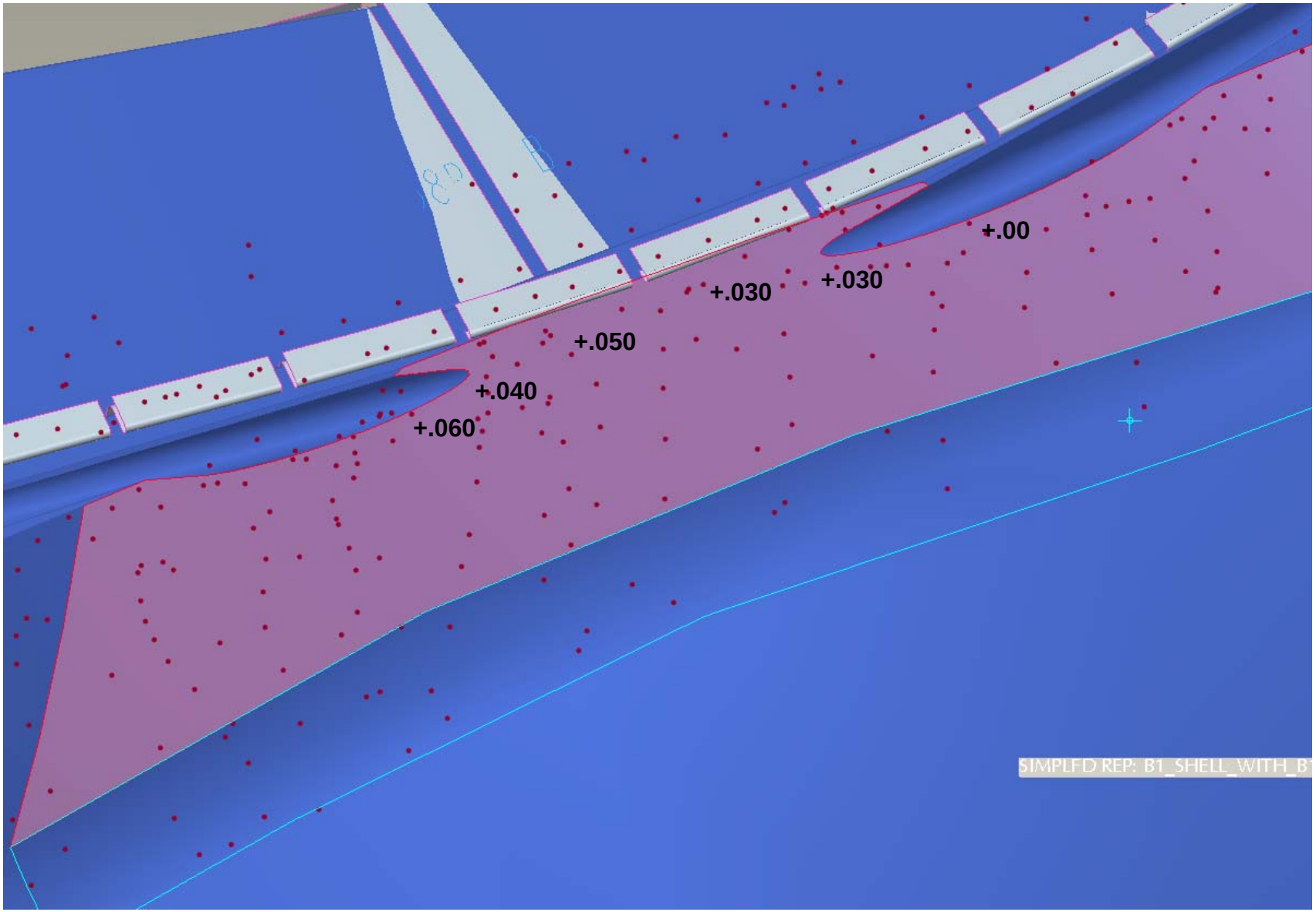


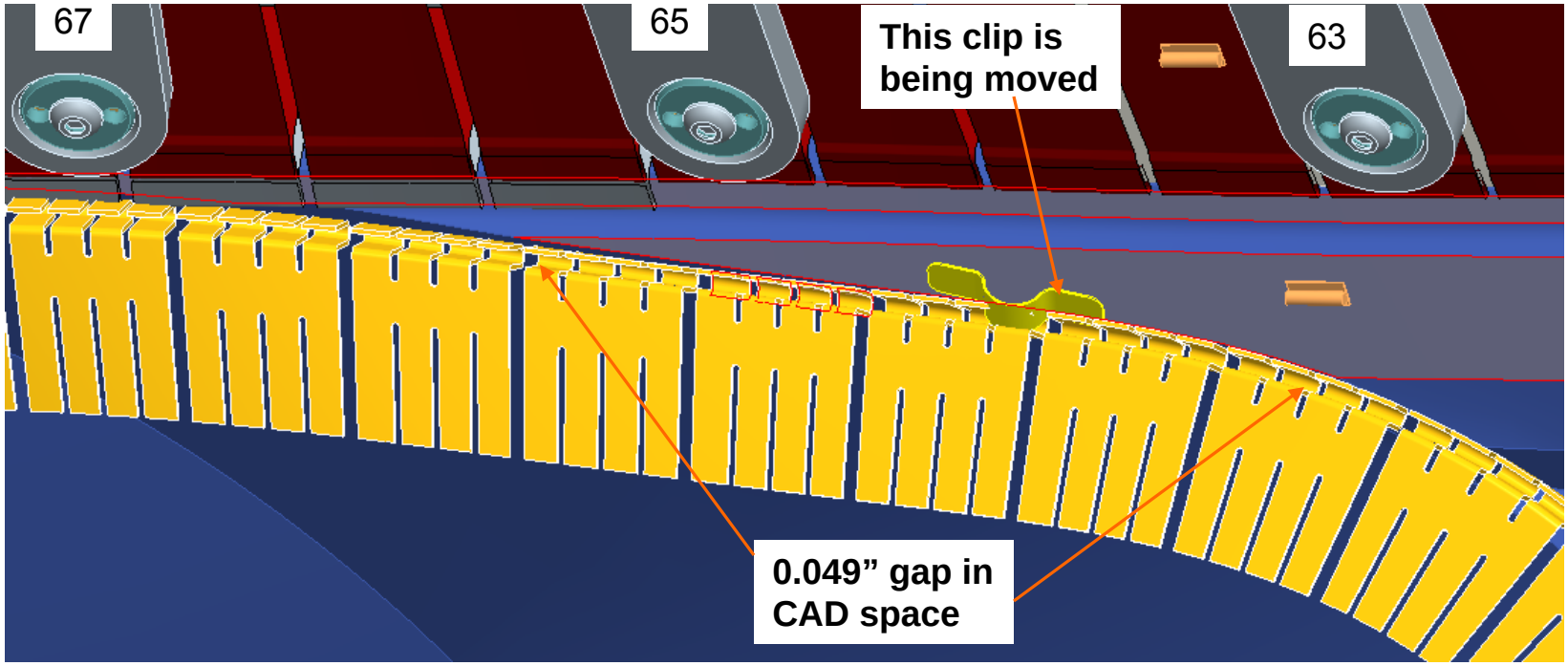



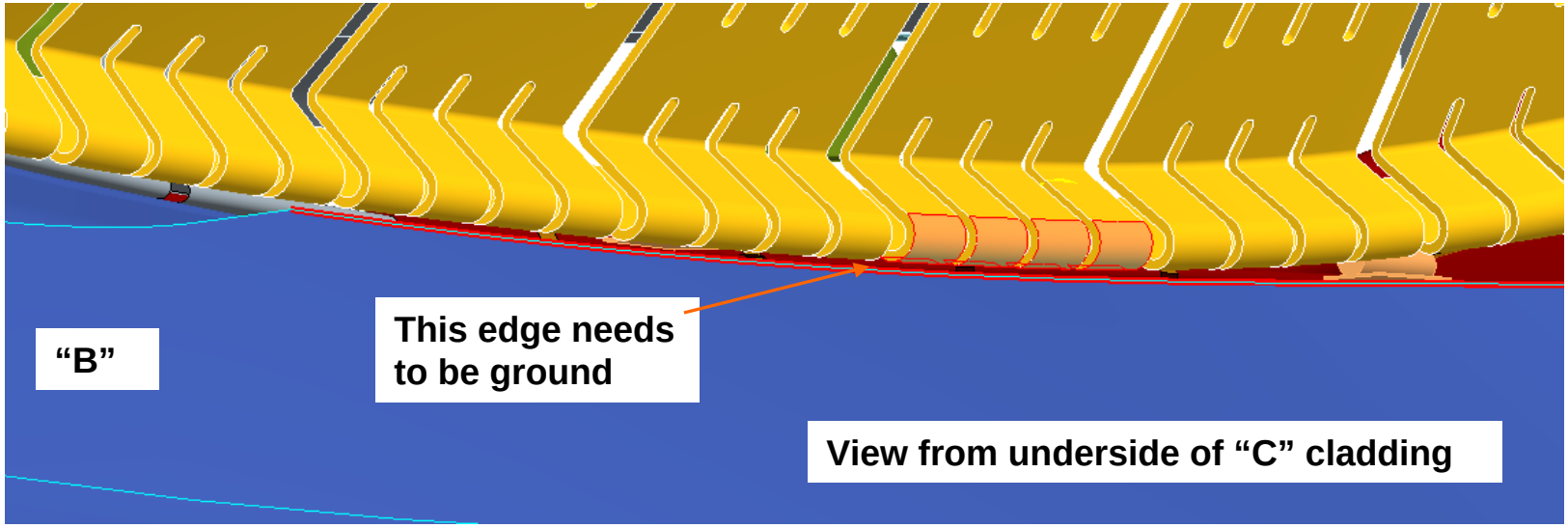
**Region on the Type-B where the bent "C" cladding will have interference with the "B" shell.**

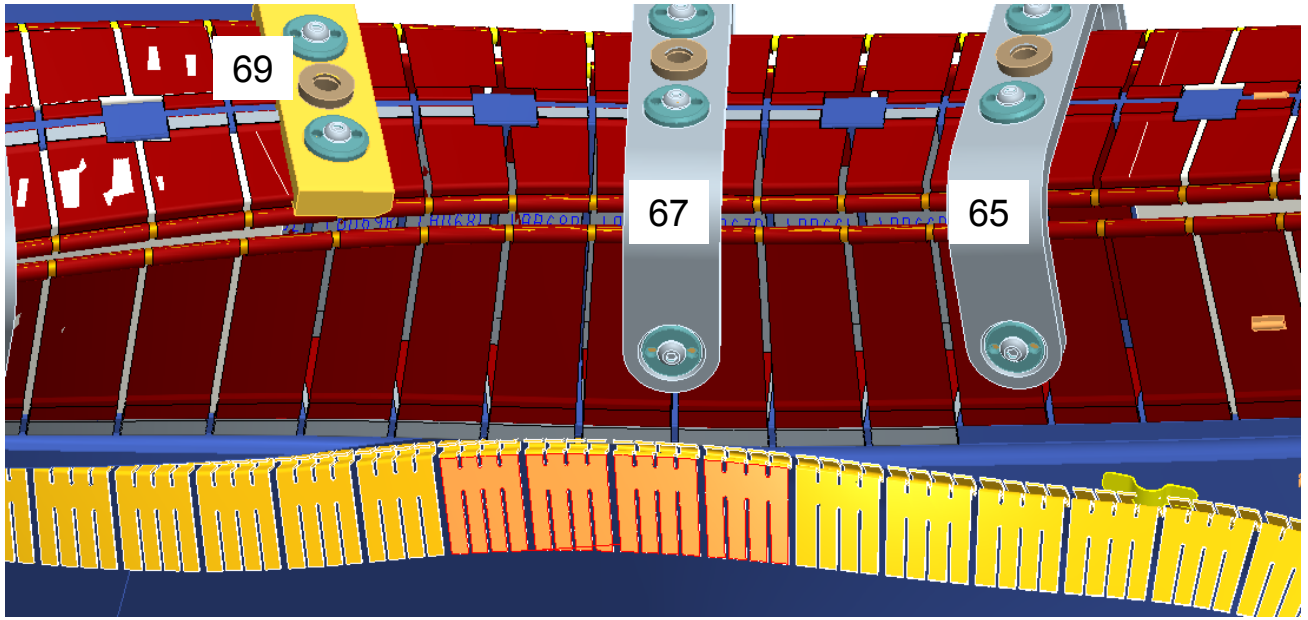



+.00
+.030
+.030
+.050
+.040
+.060
SIMPLIFD REP: B1_SHELL_WITH_B


67
65
This clip is being moved
63
0.049” gap in CAD space

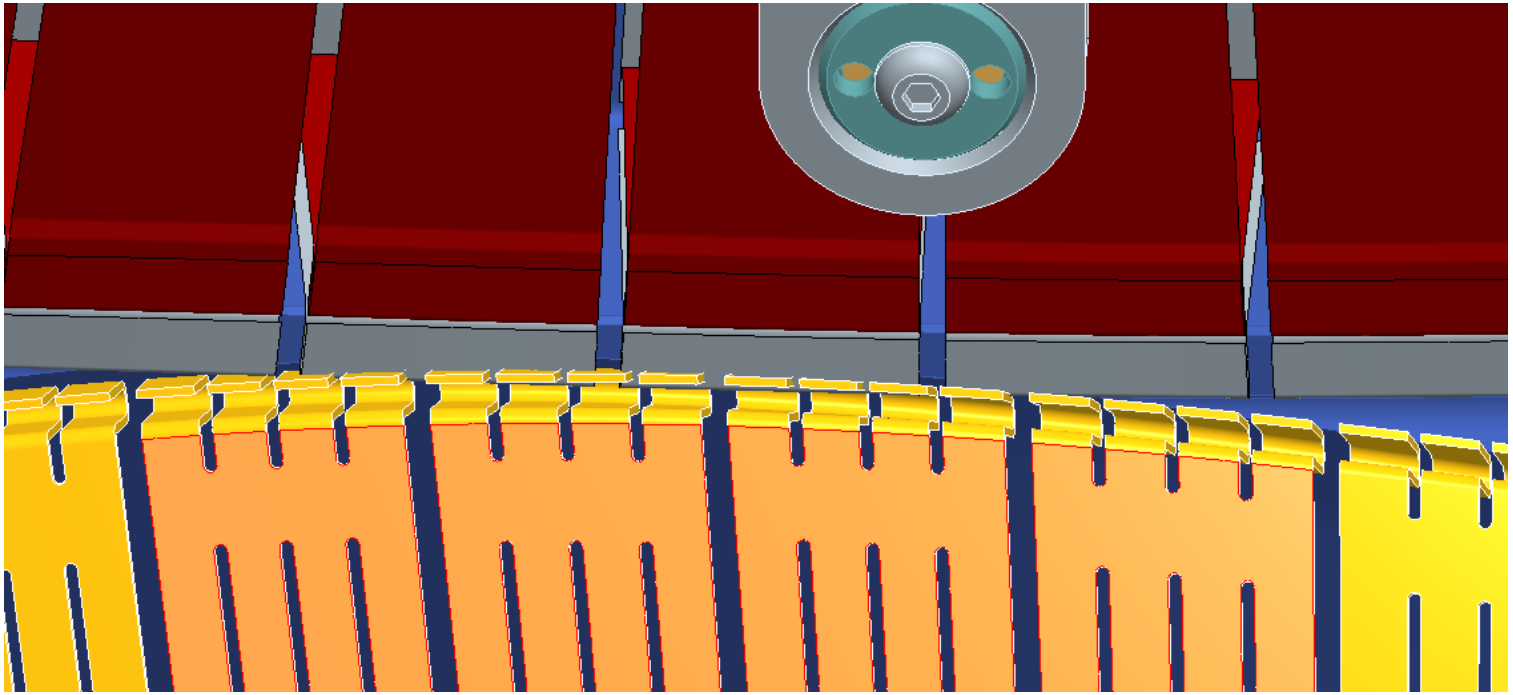

“B”
This edge needs to be ground
View from underside of “C” cladding




"B"

"C" cladding

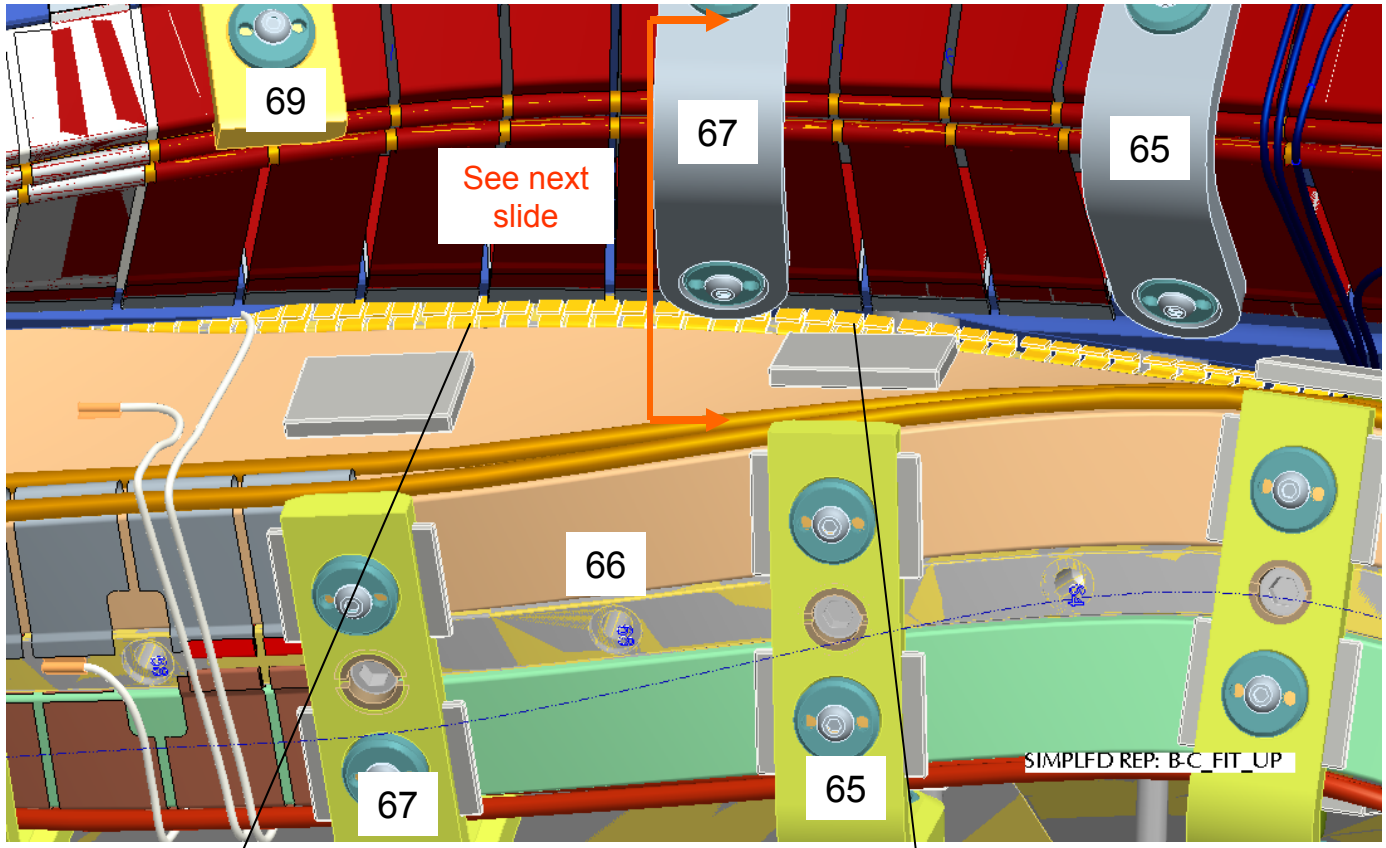
"B"

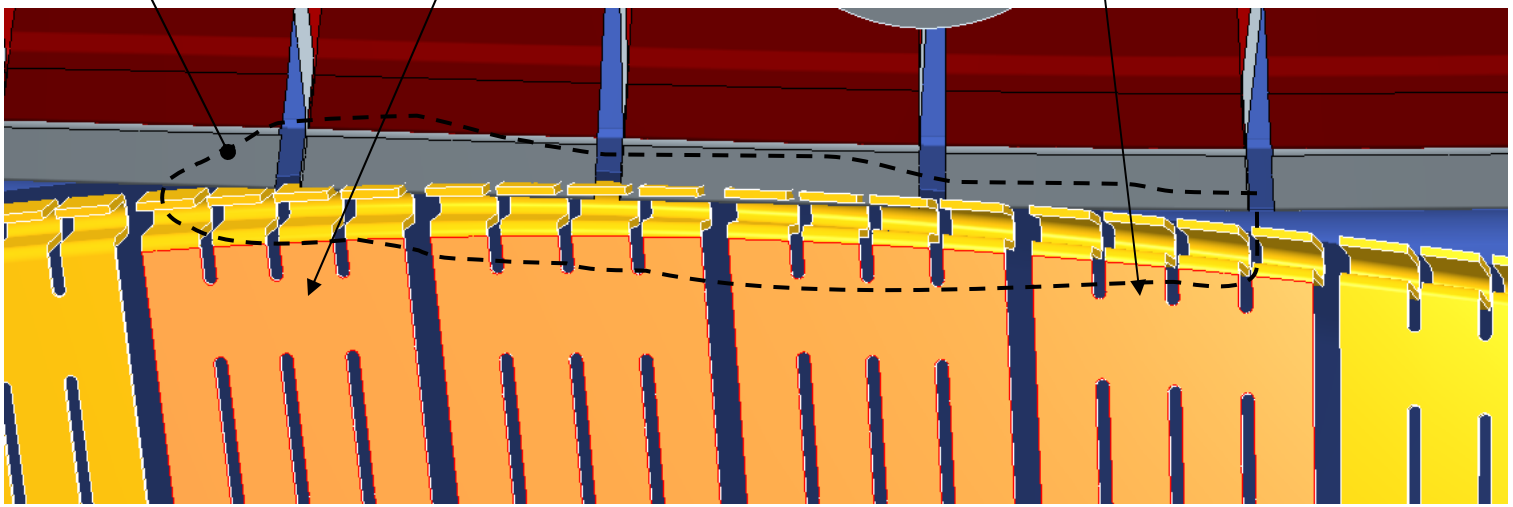


"C" cladding

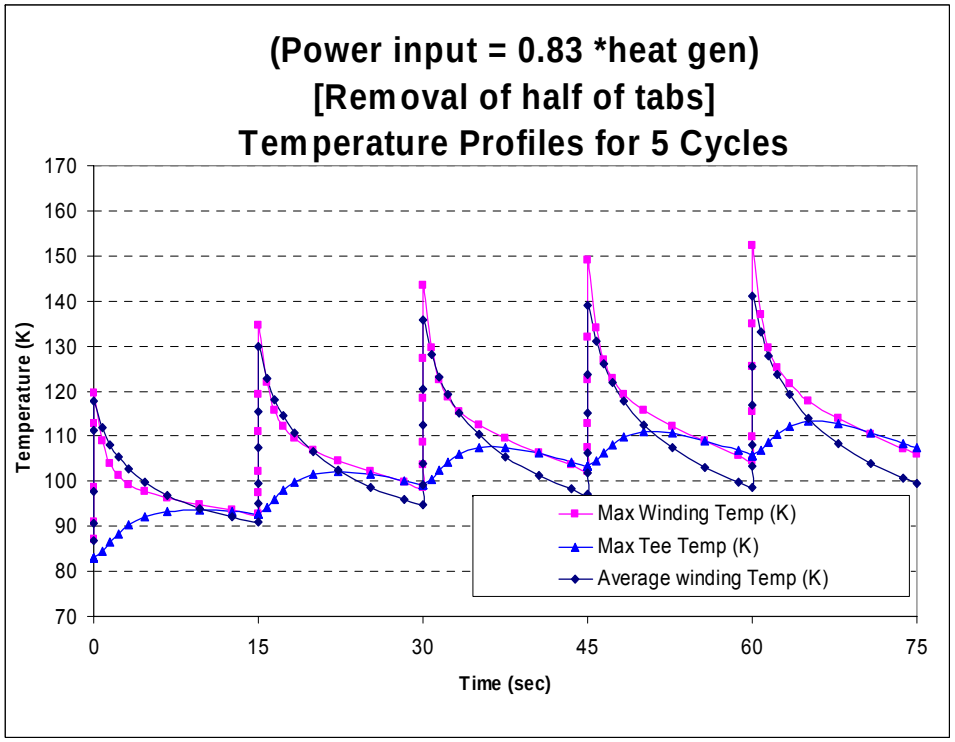
“B”

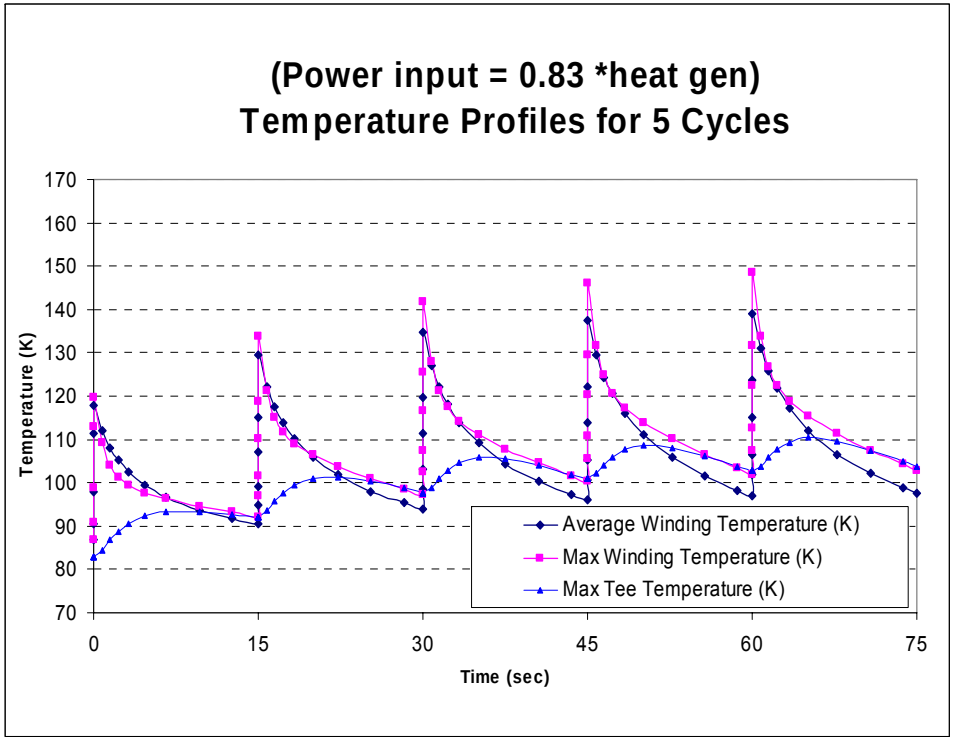
**The “B” and/or “C” cladding in this area needs to be cut back.**



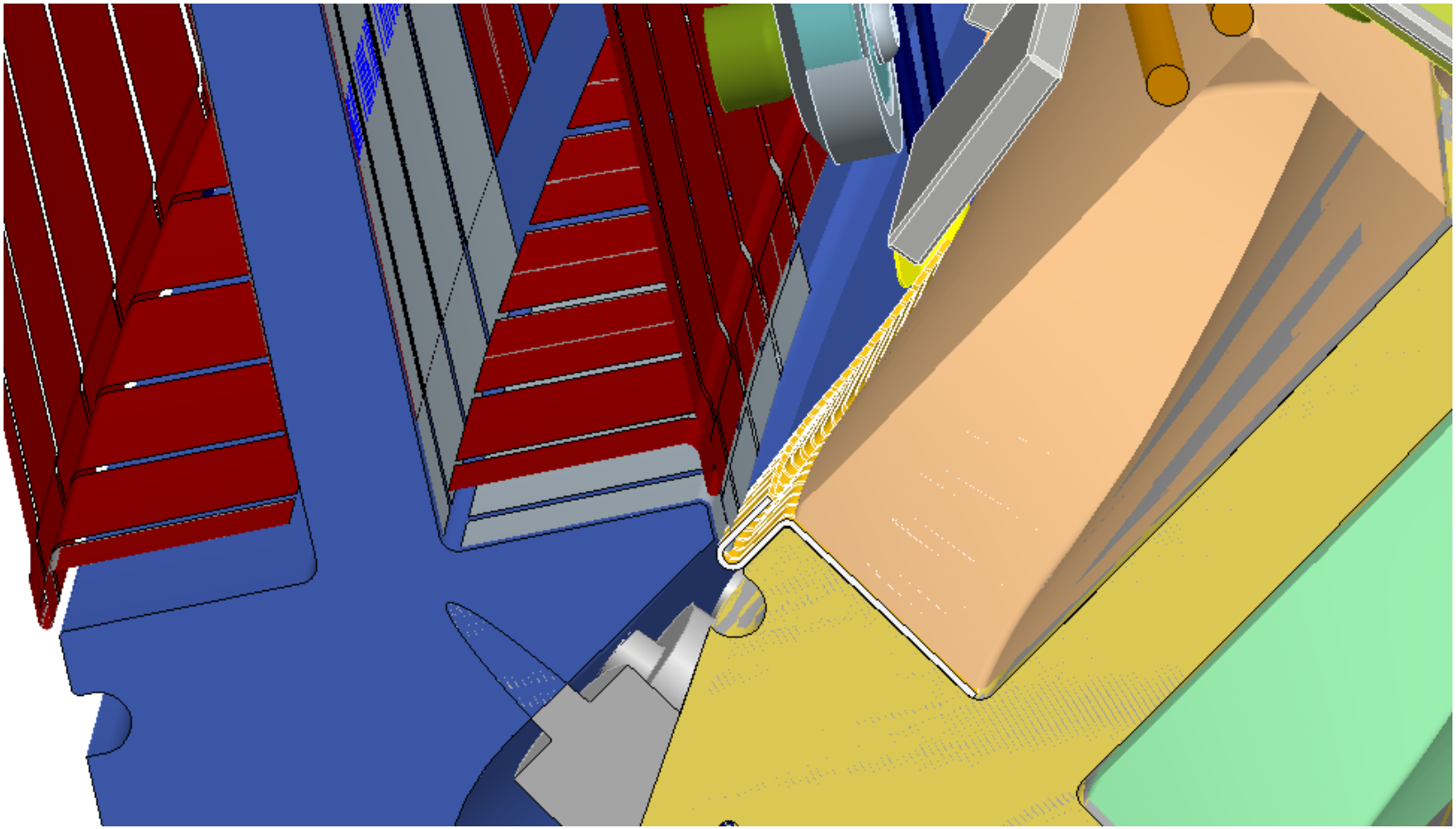



# Plot comparisons (1/2 tabs connected) (K. Freudenberg analysis)

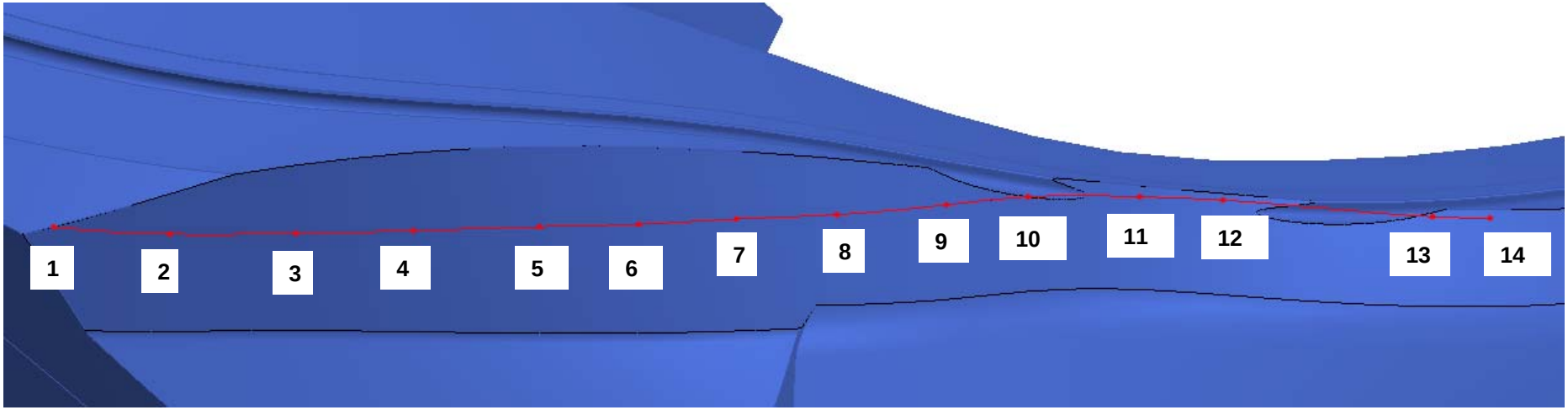


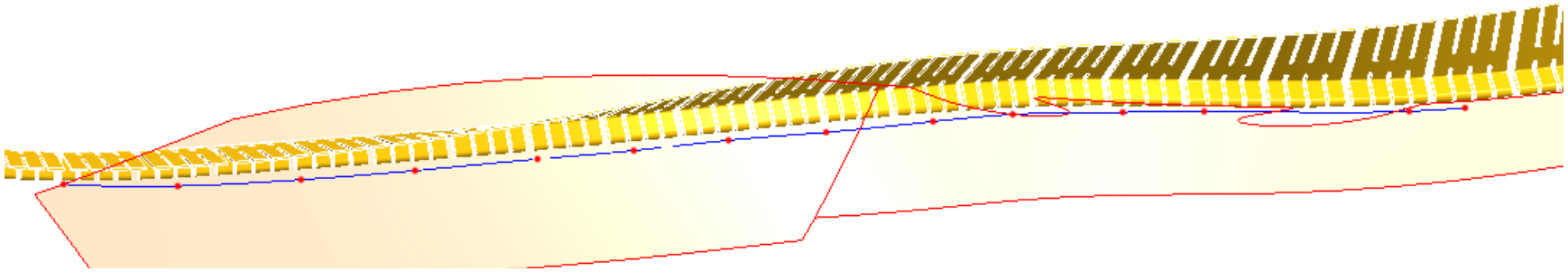




# Very little change (2 degrees max)



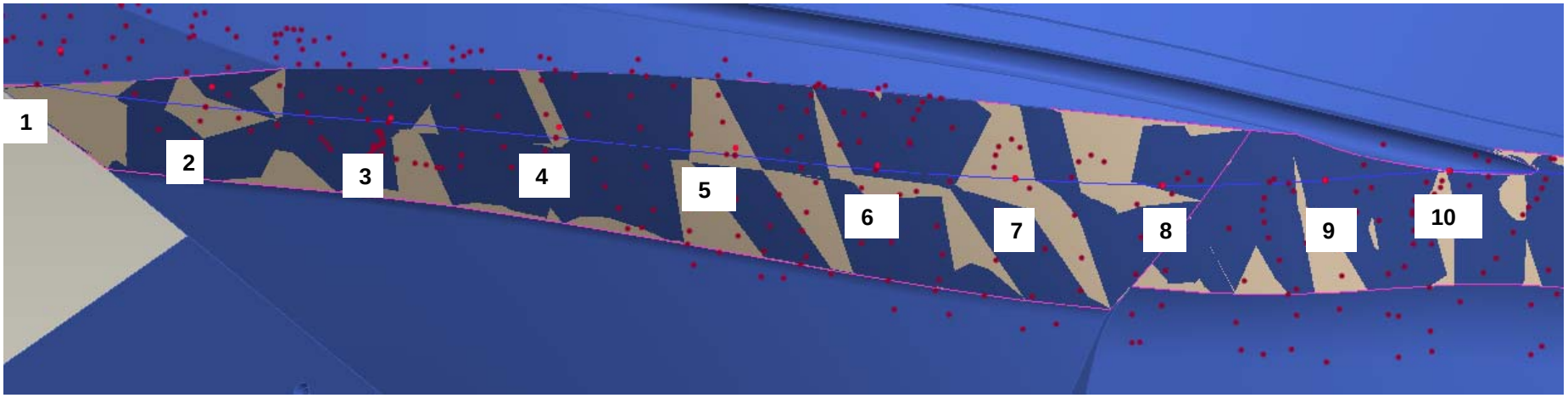
**Local section view**



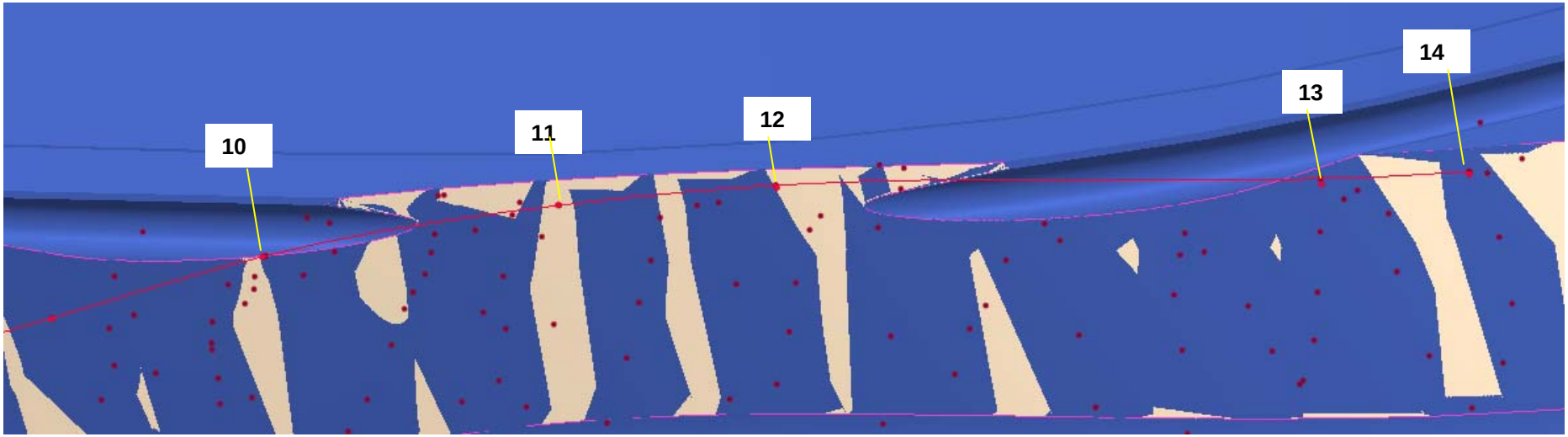
Point data relative to the "B' default coordinate system

| | X | Y | Z |
|---|---|---|---|
| 1 | 34.087 | -27.853 | -41.520 |
| 2 | 34.532 | -26.814 | -39.870 |
| 3 | 34.997 | -25.567 | -38.164 |
| 4 | 35.353 | -24.380 | -36.598 |
| 5 | 35.686 | -23.086 | -34.925 |
| 6 | 35.952 | -22.079 | -33.603 |
| 7 | 36.251 | -21.049 | -32.331 |
| 8 | 36.651 | -20.010 | -31.011 |
| 9 | 37.241 | -18.809 | -29.617 |
| 10 | 37.769 | -17.908 | -28.587 |
| 11 | 38.350 | -16.817 | -27.066 |
| 12 | 38.650 | -16.047 | -25.906 |
| 13 | 39.070 | -14.208 | -22.898 |
| 14 | 39.163 | -13.659 | -22.105 |




| Point data relative to the "B' default coordinate system | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | FOR B1 AND C1 | | | | Currnt. Ground | Currnt | Additional grinding | Added fractional |
| | | | | "B" surf to | Dist. from | "B" surf to | depth for | grinding |
| | X | Y | Z | "C" cladding | Met. Pts | "C" cladding | 1/4" gap | depth |
| 1 | 34.087 | -27.853 | -41.520 | 0.046 | 0.649 | 0.695 | | none |
| 2 | 34.532 | -26.814 | -39.870 | 0.046 | 0.361 | 0.407 | | none |
| 3 | 34.997 | -25.567 | -38.164 | 0.046 | 0.092 | 0.138 | 0.112 | 1/8 |
| 4 | 35.353 | -24.380 | -36.598 | 0.046 | 0.162 | 0.208 | 0.042 | 1/8 |
| 5 | 35.686 | -23.086 | -34.925 | 0.046 | 0.128 | 0.174 | 0.076 | 1/8 |
| 6 | 35.952 | -22.079 | -33.603 | 0.046 | 0.094 | 0.140 | 0.110 | 1/8 |
| 7 | 36.251 | -21.049 | -32.331 | 0.046 | 0.020 | 0.066 | 0.184 | 3/16 |
| 8 | 36.651 | -20.010 | -31.011 | 0.046 | -0.014 | 0.032 | 0.218 | 1/4 |
| 9 | 37.241 | -18.809 | -29.617 | 0.046 | 0.009 | 0.055 | 0.195 | 1/4 |
| 10 | 37.769 | -17.908 | -28.587 | 0.046 | 0.048 | 0.094 | 0.156 | 3/16 |
| 11 | 38.350 | -16.817 | -27.066 | 0.046 | 0.022 | 0.068 | 0.182 | 3/16 |
| 12 | 38.650 | -16.047 | -25.906 | 0.046 | 0.058 | 0.104 | 0.146 | 3/16 |
| 13 | 39.070 | -14.208 | -22.898 | 0.046 | 0.093 | 0.139 | 0.111 | 3/16 |
| 14 | 39.163 | -13.659 | -22.105 | 0.046 | 0.063 | 0.109 | 0.141 | 3/16 |

**Pts 3 thru 10**

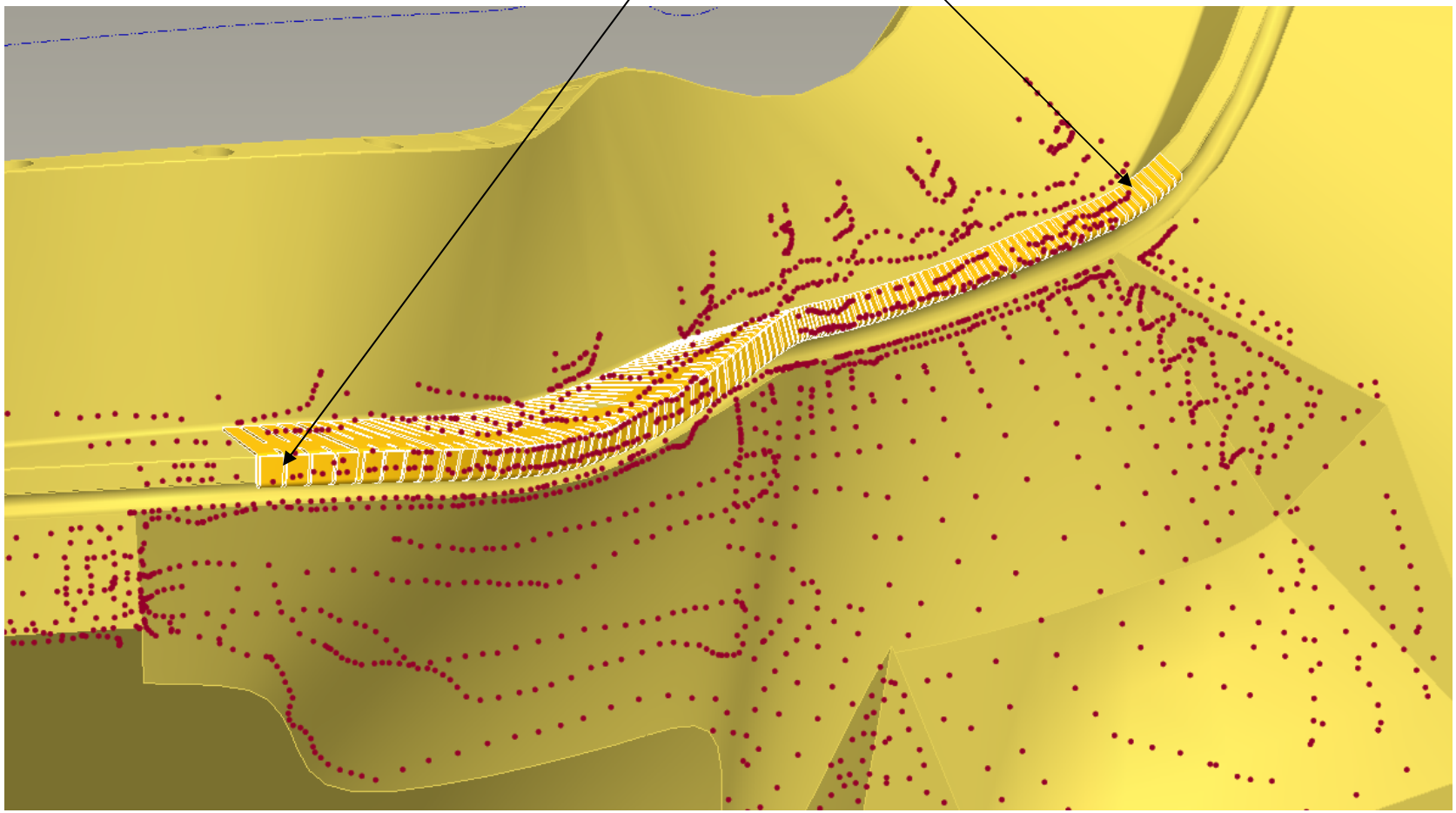


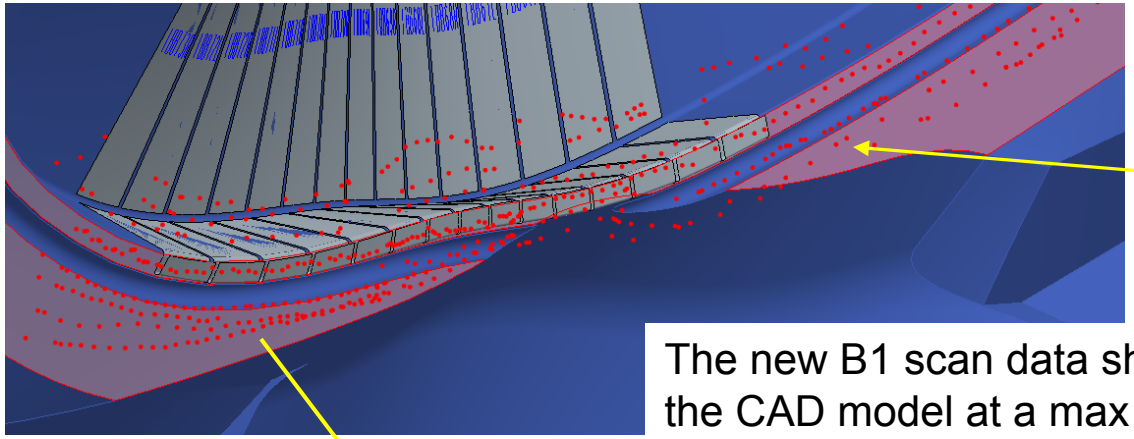

| Point data relative to the "B' default coordinate system | | | | | | | Additional | Added |
|---|---|---|---|---|---|---|---|---|
| | FOR B1 AND C1 | | | "B" surf to | Currnt. Ground Dist. from | Currnt "B" surf to | grinding depth for | fractional grinding |
| | X | Y | Z | "C" cladding | Met. Pts | "C" cladding | 1/4" gap | depth |
| 1 | 34.087 | -27.853 | -41.520 | 0.046 | 0.649 | 0.695 | | none |
| 2 | 34.532 | -26.814 | -39.870 | 0.046 | 0.361 | 0.407 | | none |
| 3 | 34.997 | -25.567 | -38.164 | 0.046 | 0.092 | 0.138 | 0.112 | 1/8 |
| 4 | 35.353 | -24.380 | -36.598 | 0.046 | 0.162 | 0.208 | 0.042 | 1/8 |
| 5 | 35.686 | -23.086 | -34.925 | 0.046 | 0.128 | 0.174 | 0.076 | 1/8 |
| 6 | 35.952 | -22.079 | -33.603 | 0.046 | 0.094 | 0.140 | 0.110 | 1/8 |
| 7 | 36.251 | -21.049 | -32.331 | 0.046 | 0.020 | 0.066 | 0.184 | 3/16 |
| 8 | 36.651 | -20.010 | -31.011 | 0.046 | -0.014 | 0.032 | 0.218 | 1/4 |
| 9 | 37.241 | -18.809 | -29.617 | 0.046 | 0.009 | 0.055 | 0.195 | 1/4 |
| 10 | 37.769 | -17.908 | -28.587 | 0.046 | 0.048 | 0.094 | 0.156 | 3/16 |
| 11 | 38.350 | -16.817 | -27.066 | 0.046 | 0.022 | 0.068 | 0.182 | 3/16 |
| 12 | 38.650 | -16.047 | -25.906 | 0.046 | 0.058 | 0.104 | 0.146 | 3/16 |
| 13 | 39.070 | -14.208 | -22.898 | 0.046 | 0.093 | 0.139 | 0.111 | 3/16 |
| 14 | 39.163 | -13.659 | -22.105 | 0.046 | 0.063 | 0.109 | 0.141 | 3/16 |

**Pts 10 thru 14**

"C" MC is shown along with C1 scan points

All scanned points along the cladding surface are in the range of -0.006" to -0.042" below the CAD model surface of the cladding… good news.

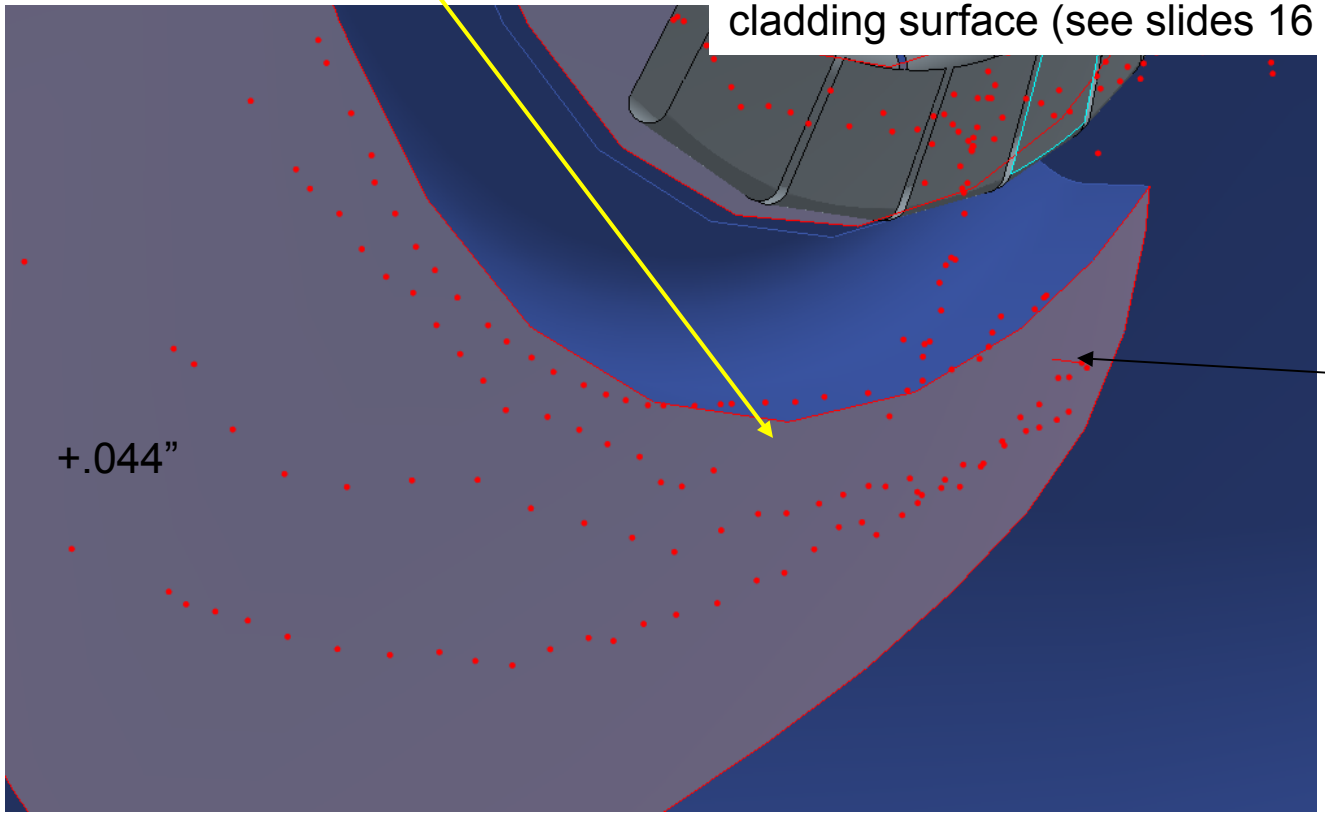




"B" MC is shown along with B1 scan points

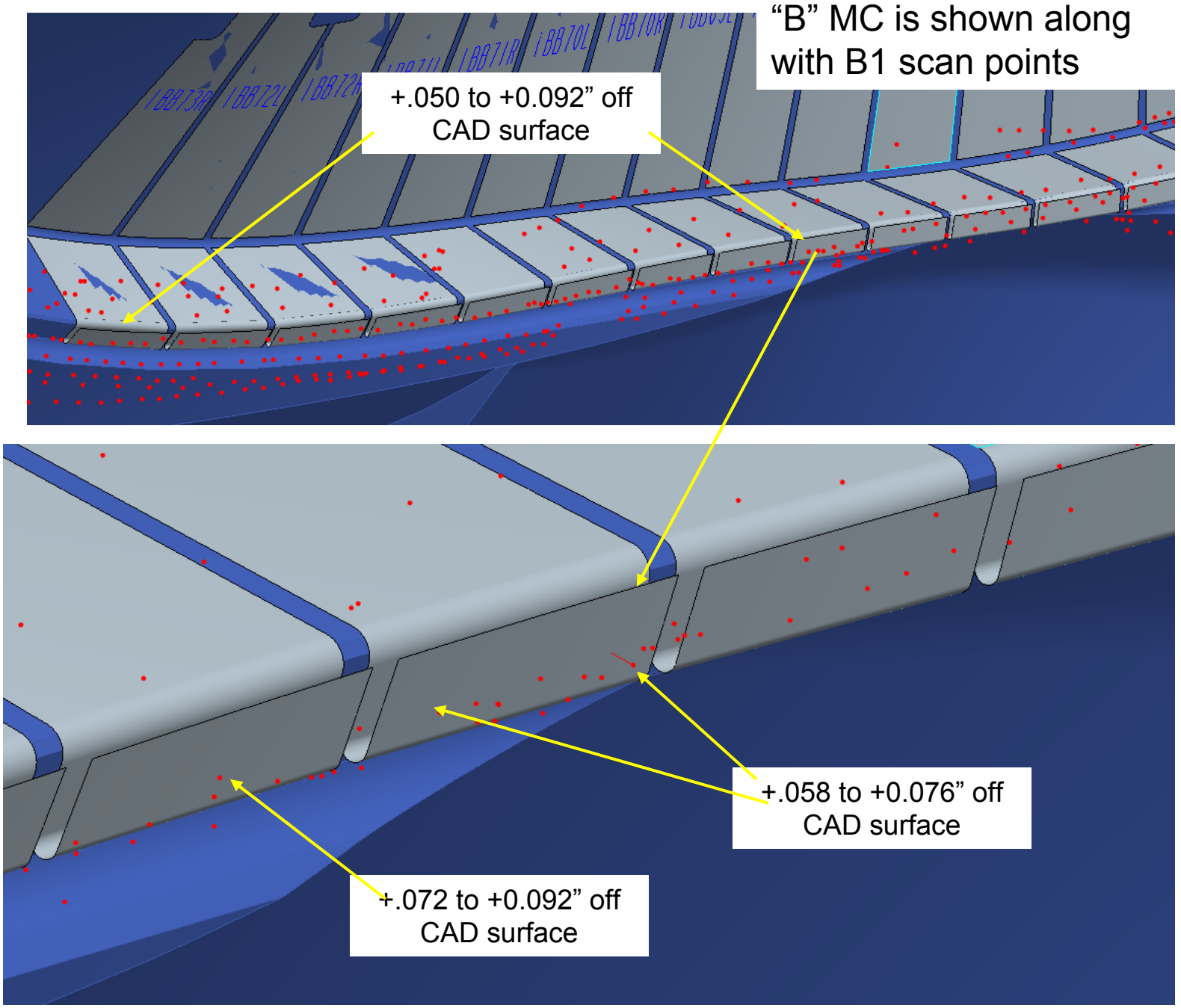
-.050" to +.016

The new B1 scan data shows the surfaces are off the CAD model at a max condition on the order of +.058" and has a max value of +.092" off the cladding surface (see slides 16 and 17).

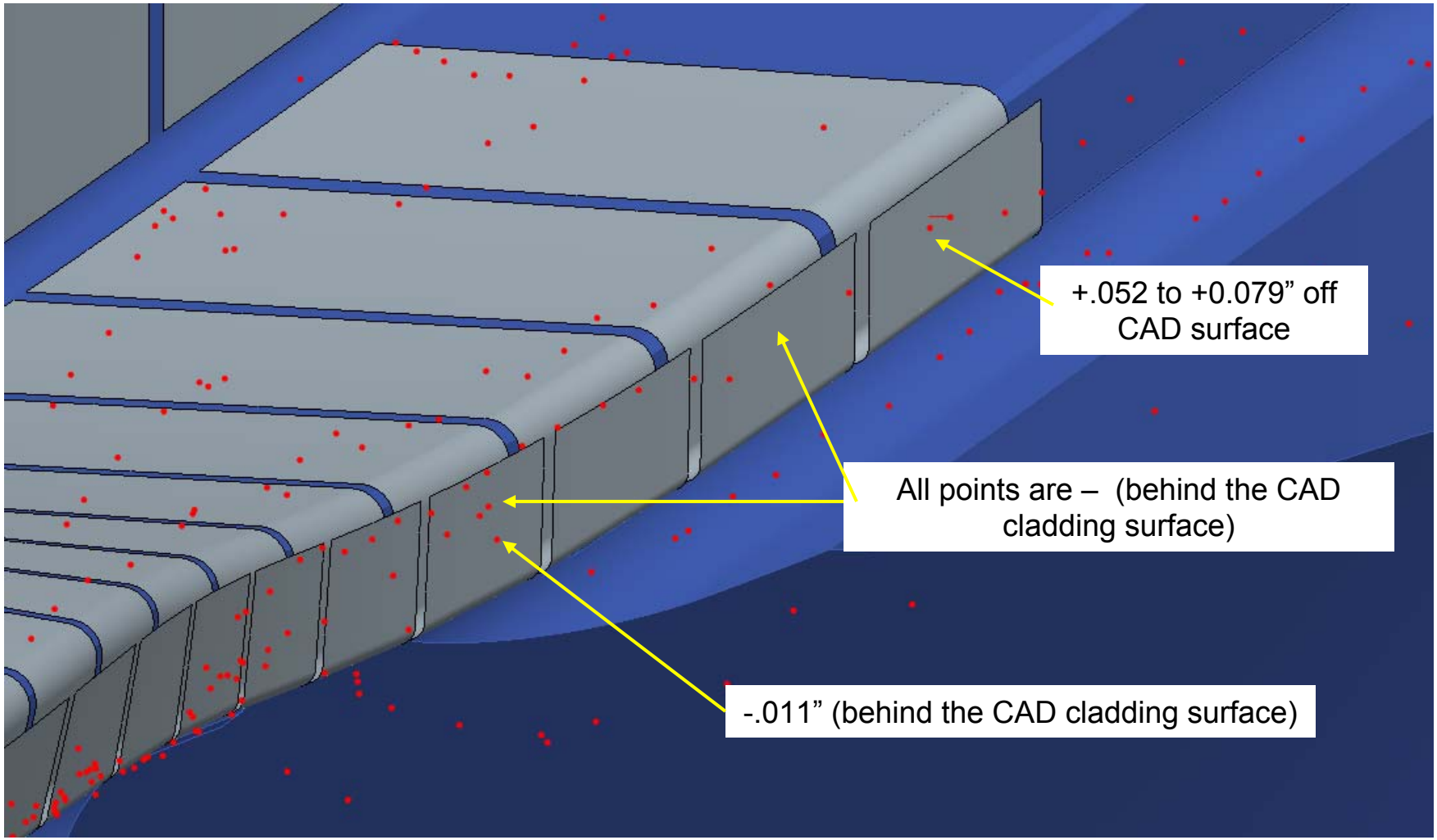


+.044"

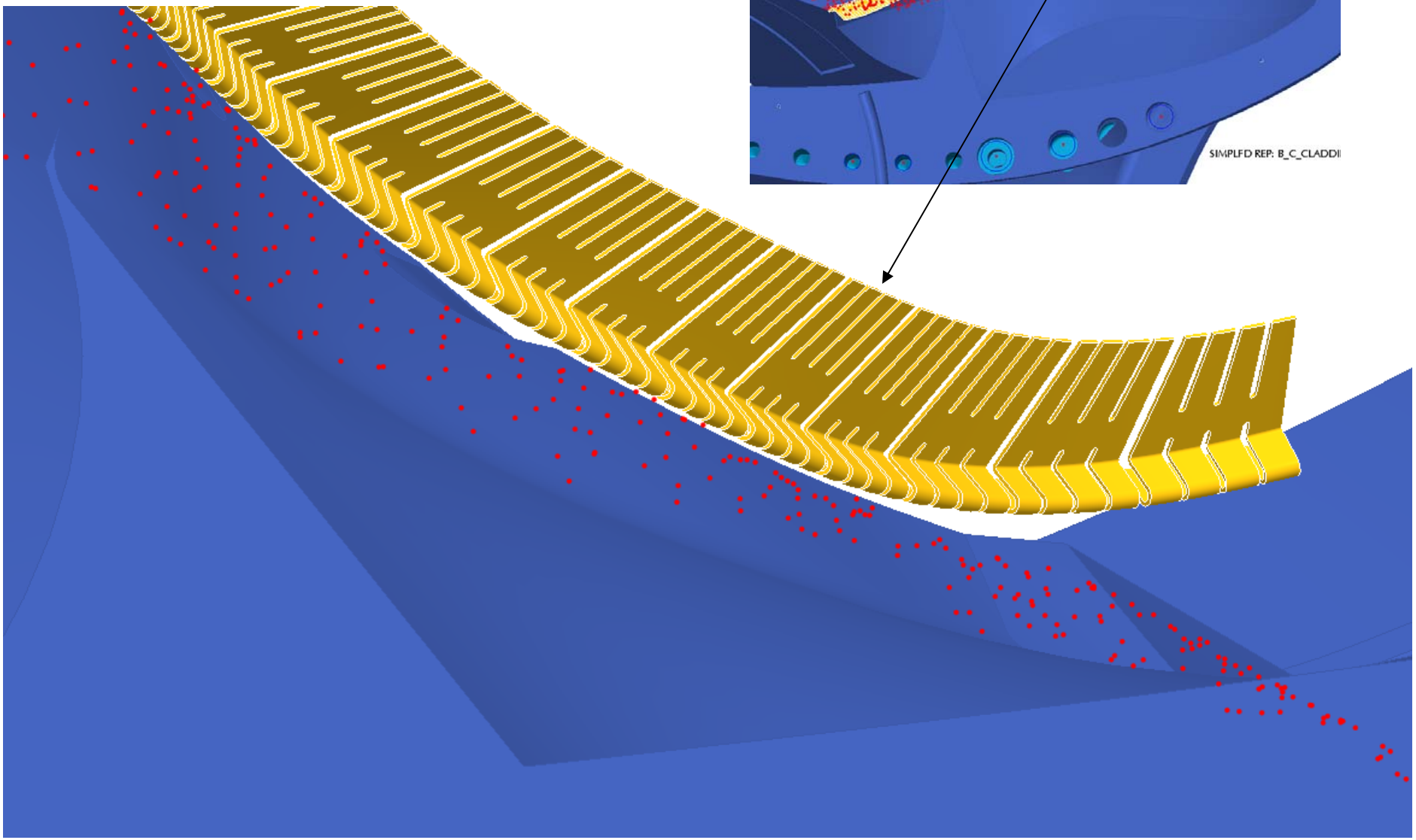
+.058" to +.044

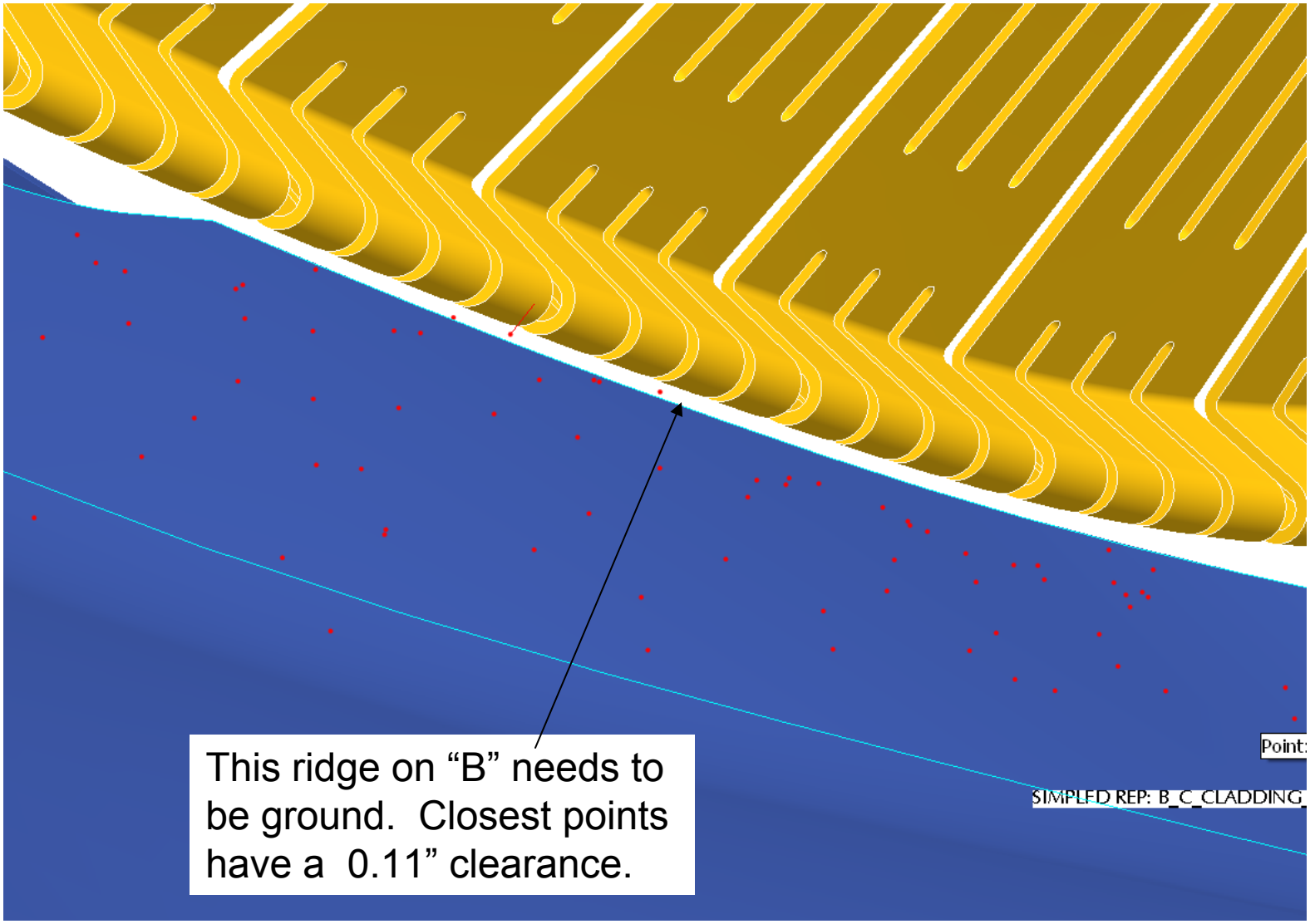

"B" MC is shown along with B1 scan points
+.050 to +0.092" off CAD surface
+.058 to +0.076" off CAD surface
+.072 to +0.092" off CAD surface

"B" MC is shown along with B1 scan points

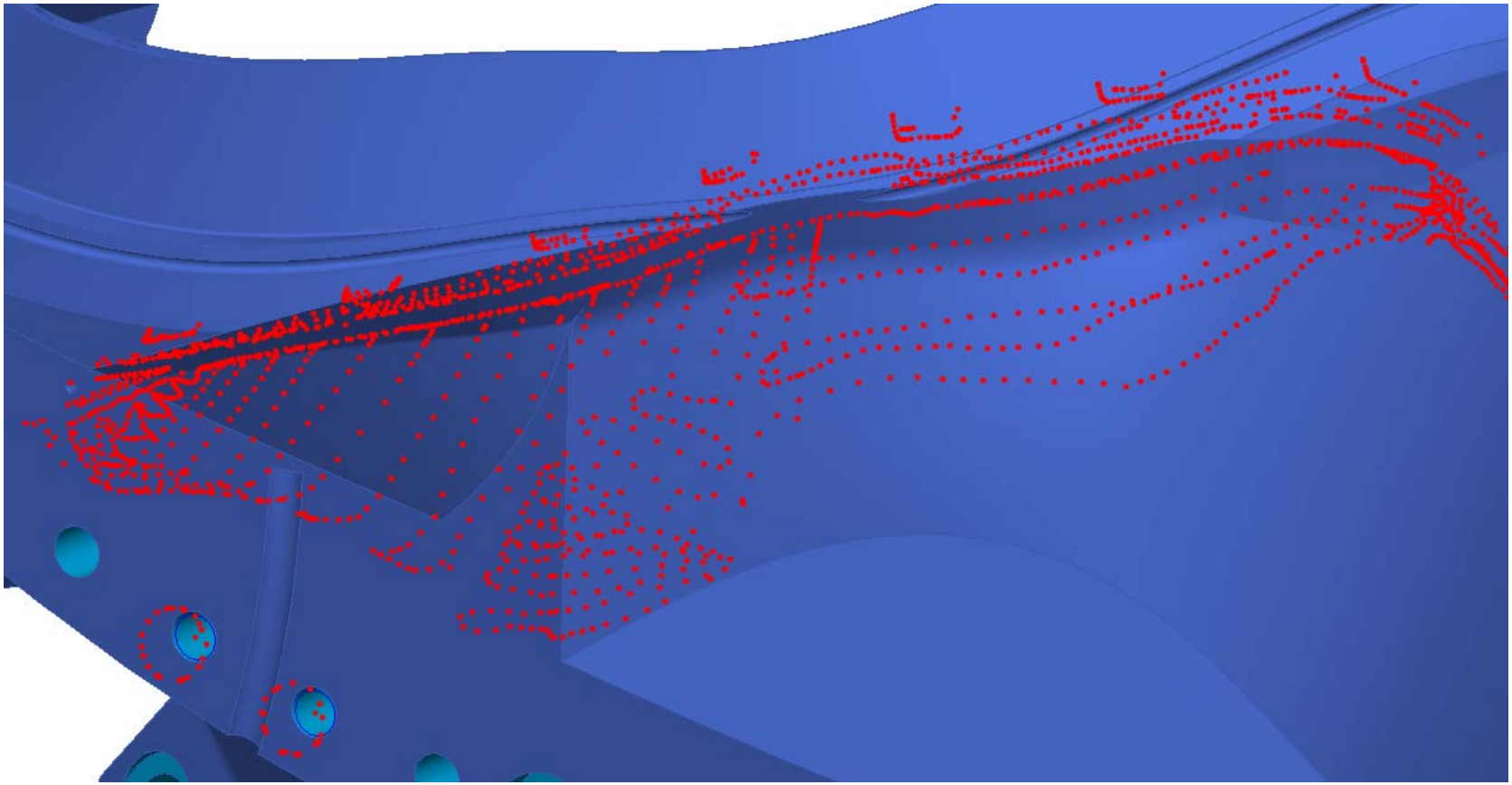


Recently scanned B1 points are shown in red shown with the CAD model of the C cladding.

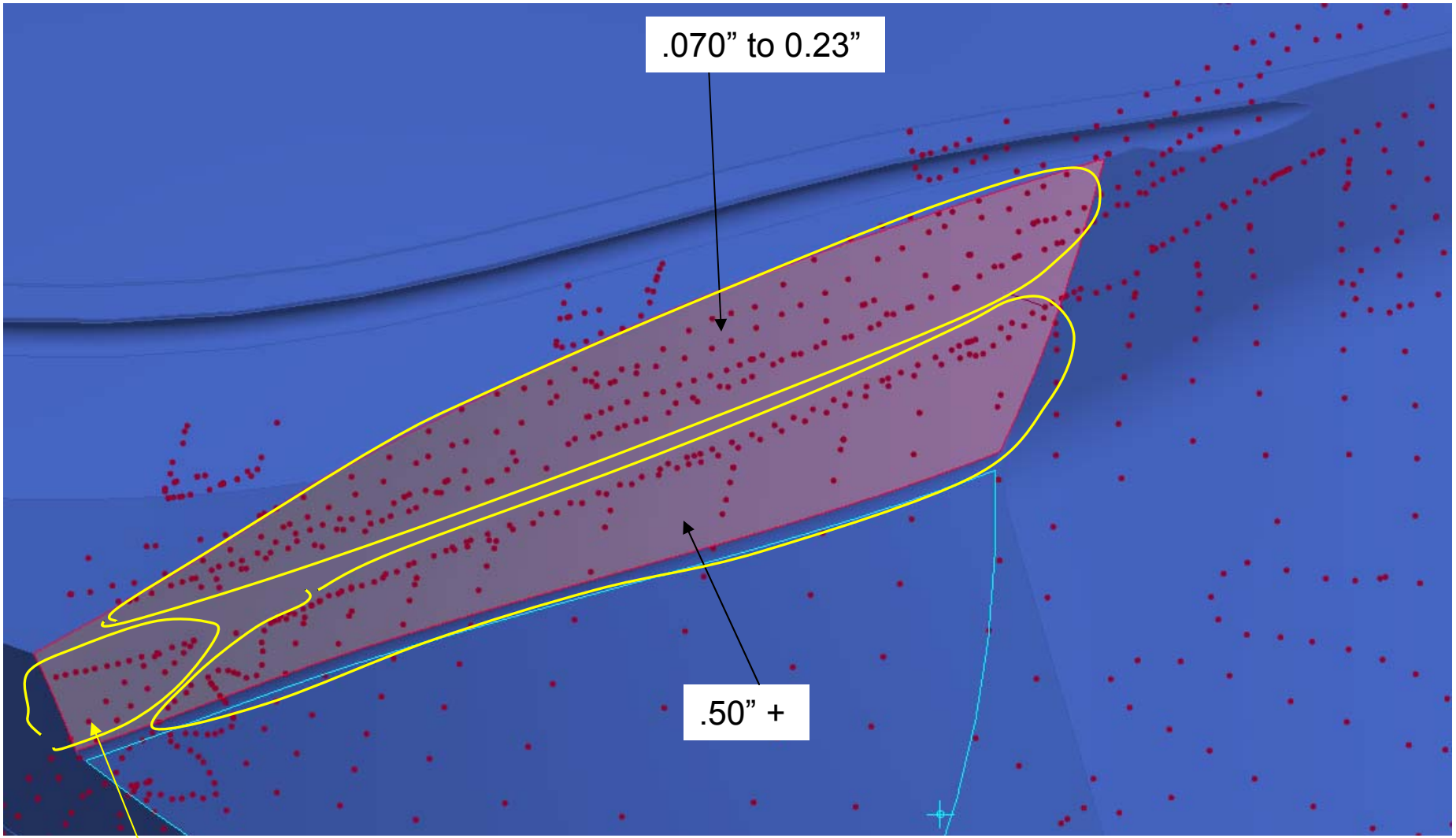



This ridge on “B” needs to be ground. Closest points have a 0.11” clearance.
SIMPLFD REP: B_C_CLADDING

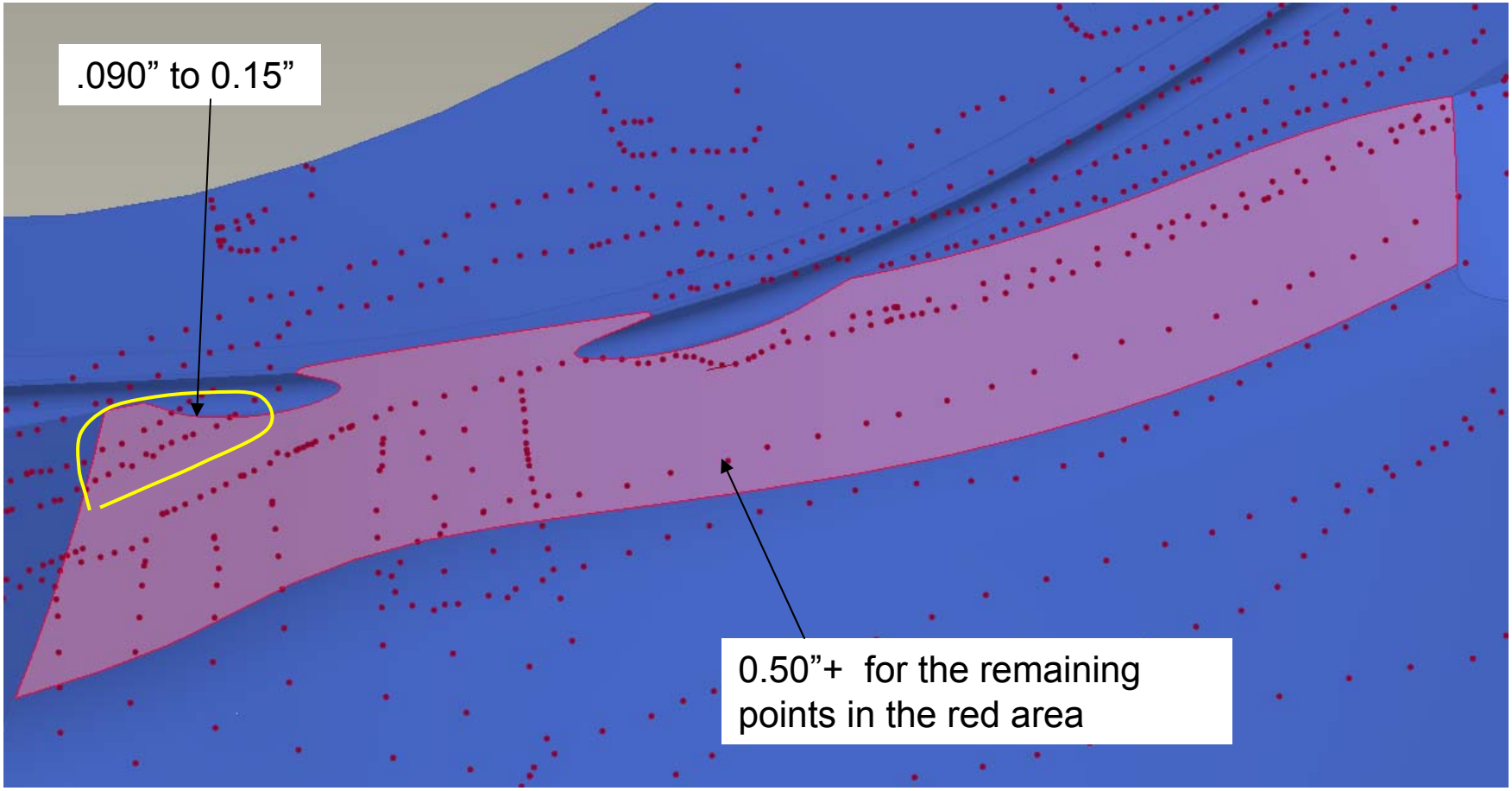
The “B” MC is the blue part shown with the recent scanned points of the “C1” MC.

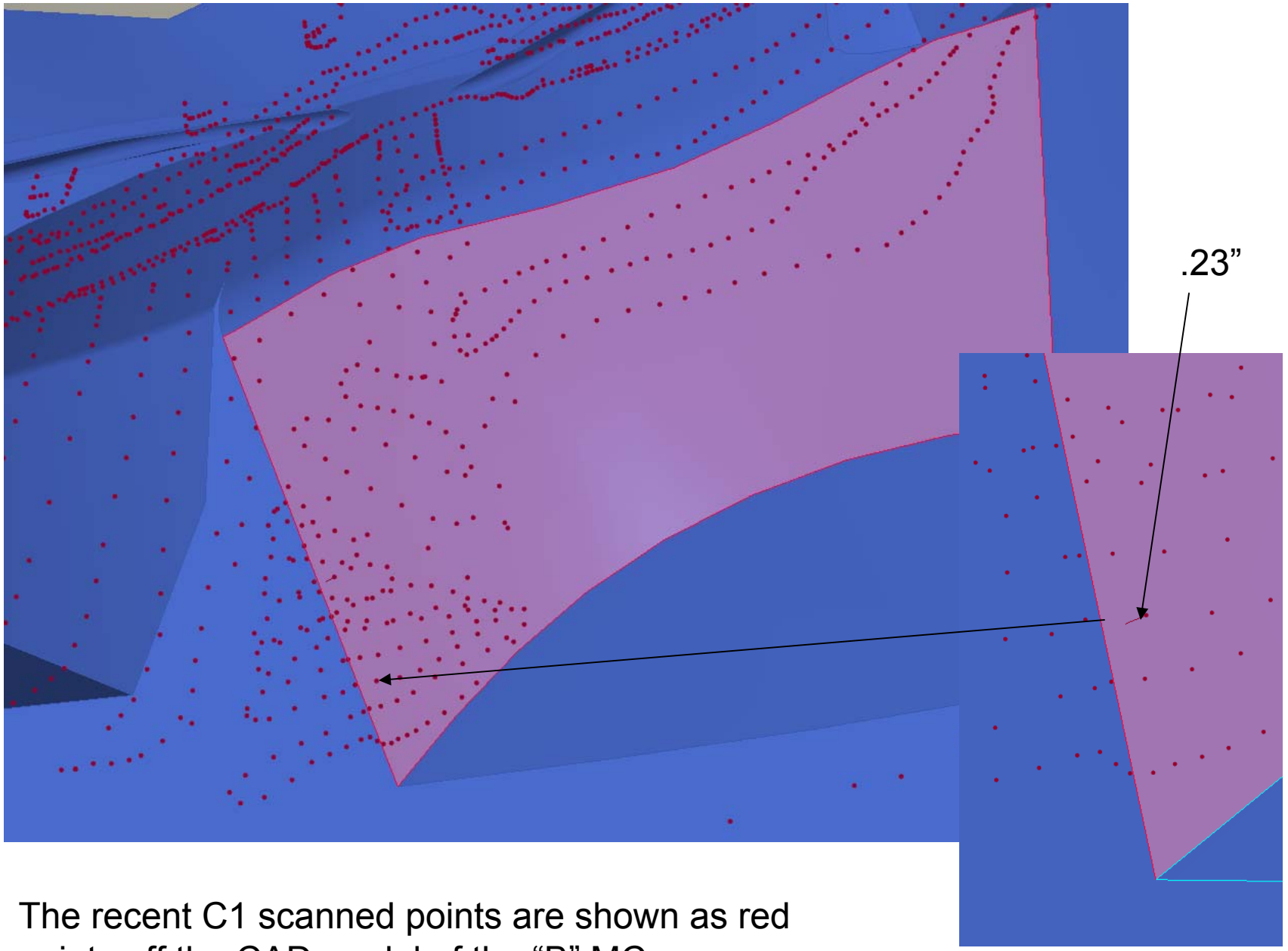


The recent C1 scanned points are shown as red points off the CAD model of the “B” MC.

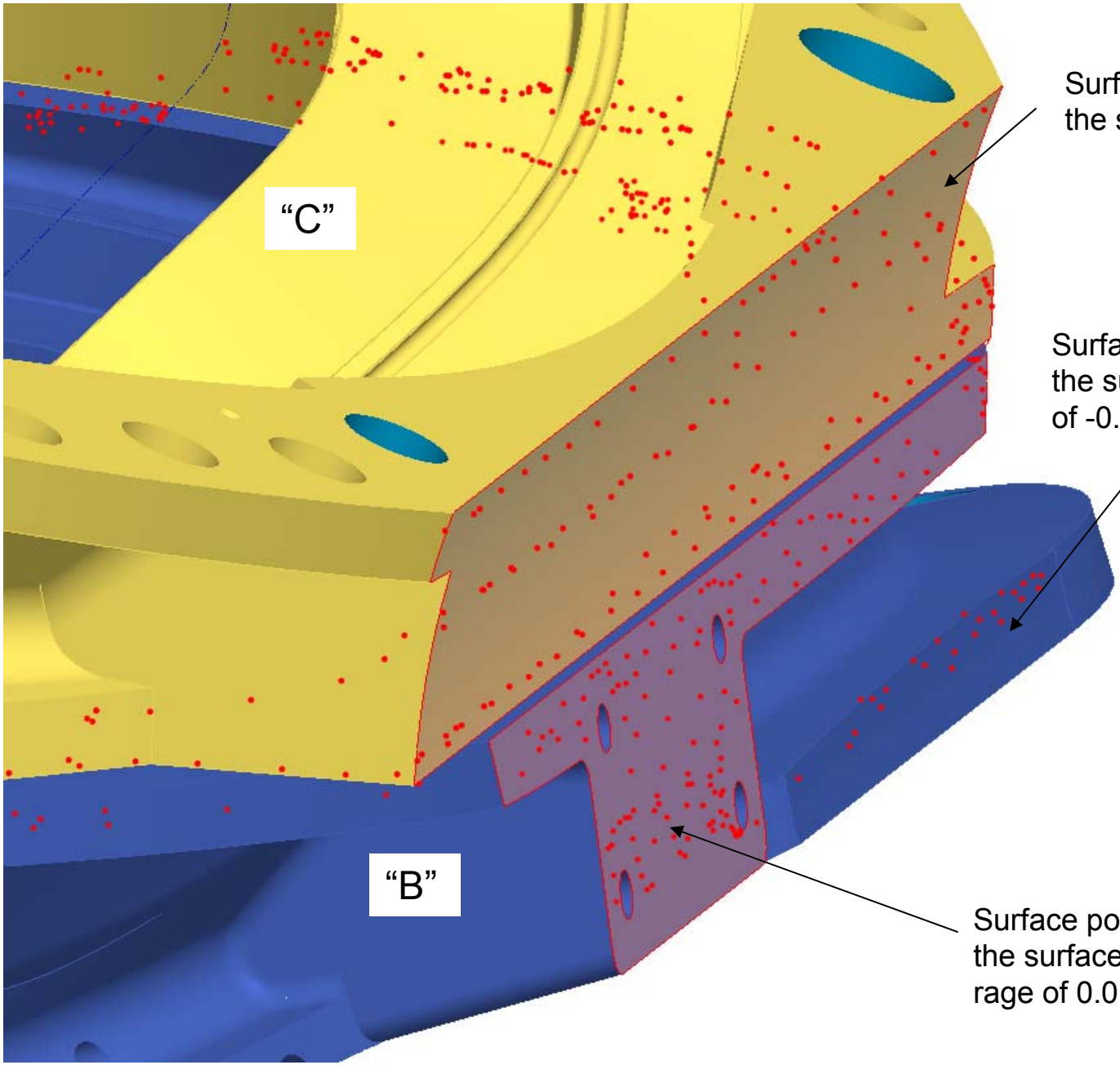


The recent C1 scanned points are shown as red points off the CAD model of the “B” MC.






The recent C1 scanned points are shown as red points off the CAD model of the “B” MC.

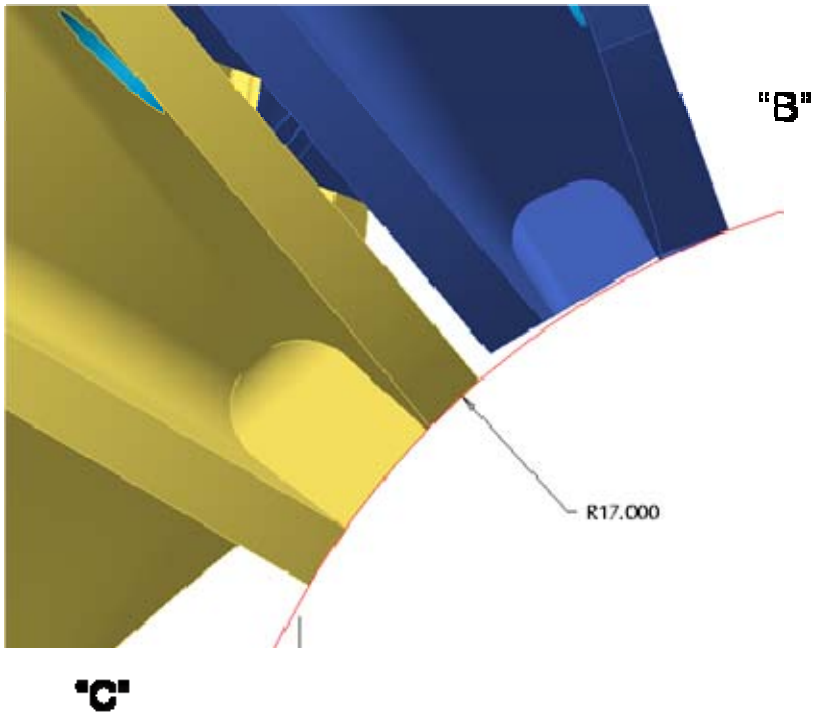


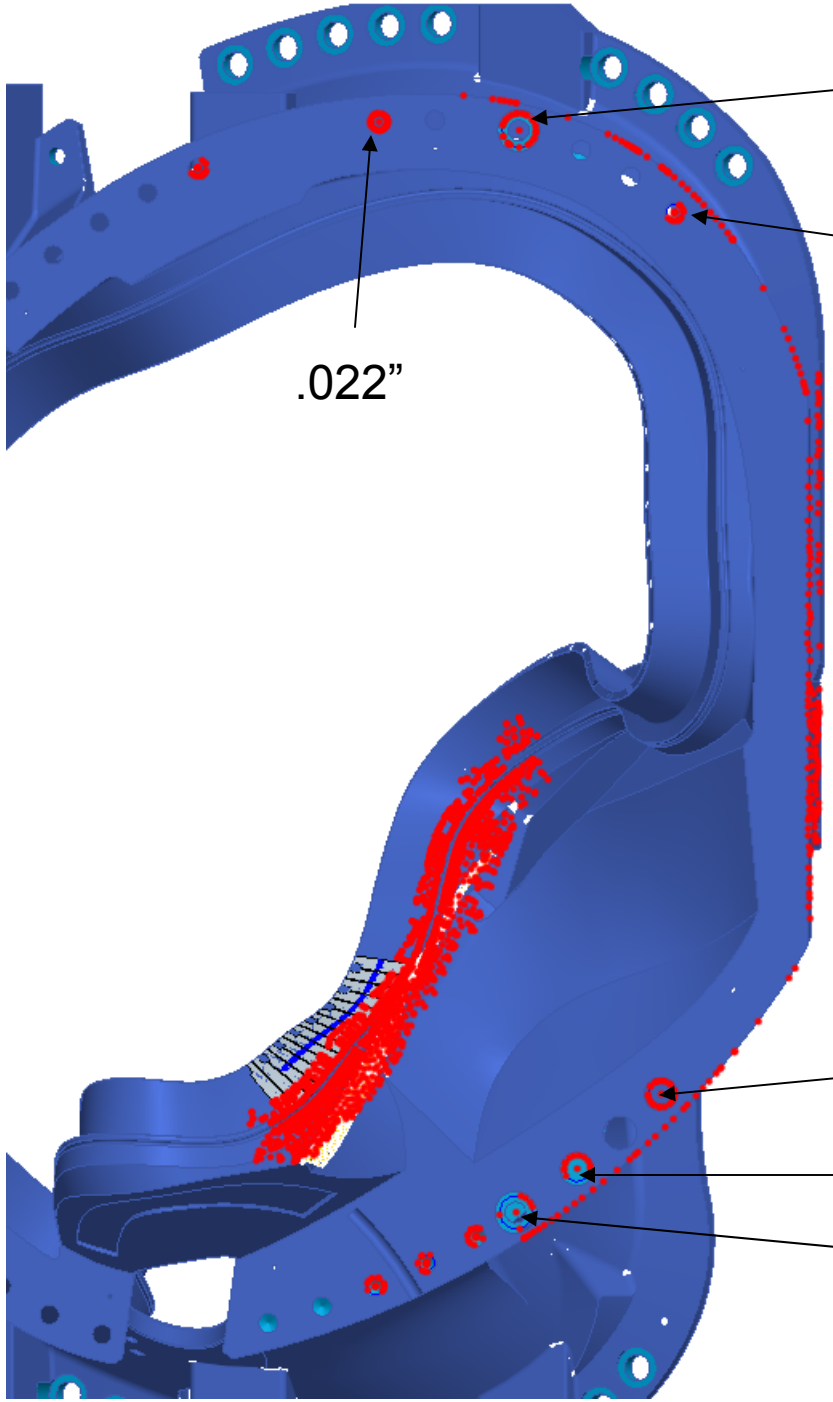

Surface points are off the surface by -0.050"

Surface points are off the surface in the rage of -0.050" to - .075"

Surface points are off the surface in the rage of 0.0 to + .029"

C – to – B interface along nose region






The values show the extent that the hole CL are out of tolerances.

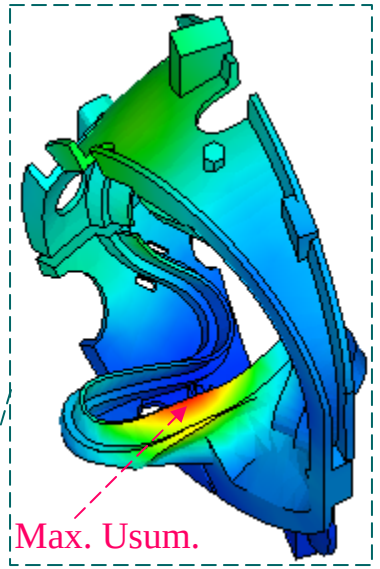
# Nonlinear Analyses of Modular Coils and Shell structure for Coil Cool-down and EM Loads

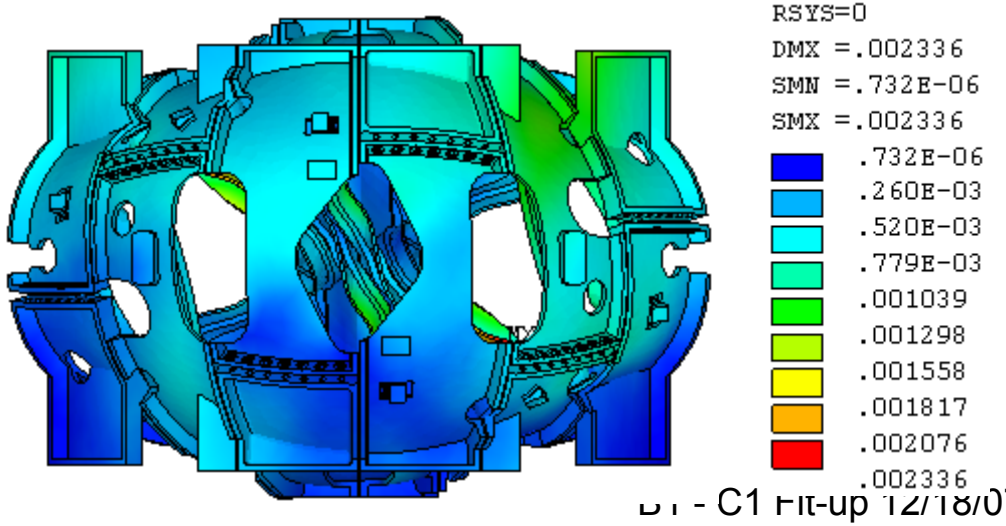
## Part 1 – Results of Shell Structure and Modular Coils

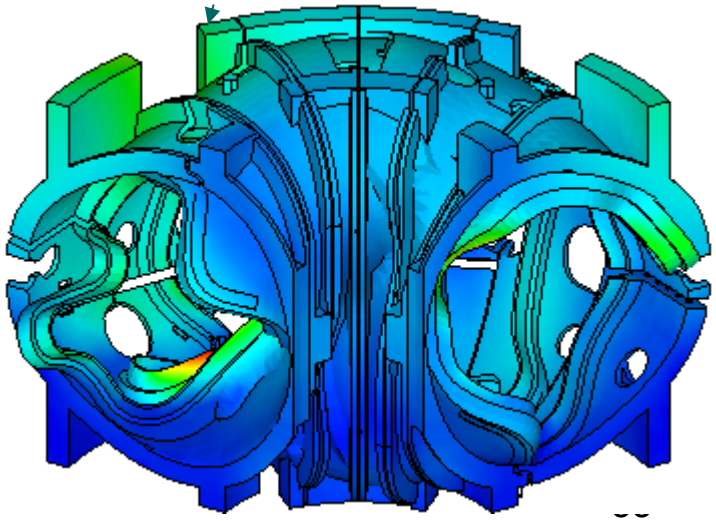
H.M. Fan
PPPL
Sept. 28, 2005

# Total Displacements of Shell - Usum

- The maximum displacement, 2.336 mm, occurs on tee in shell type B due to lateral deformation of web caused by the lateral force of the modular coil.
- Because of net vertical forces are equal and opposite with respect to the mid-span, the deformation at bottom of the mid-span is small.
- The smaller deformation at the inboard than the outboard is the result of higher shell stiffness in the inboard.
- The unit of the displacement is in meter

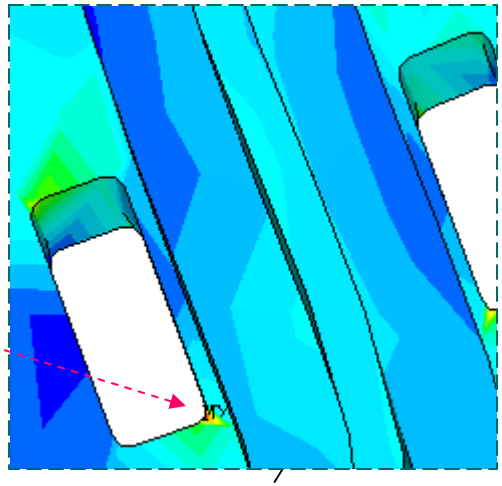


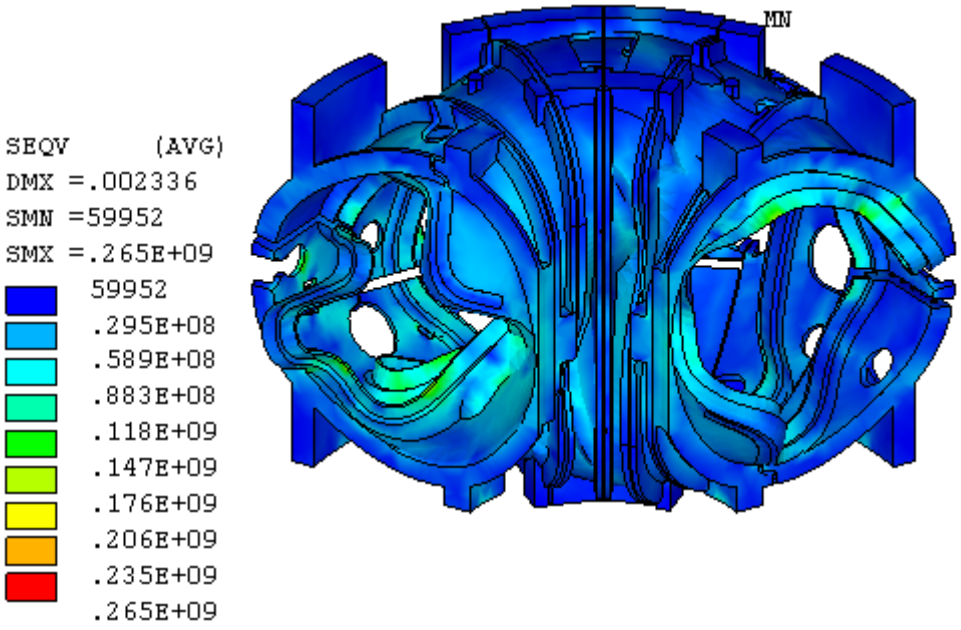



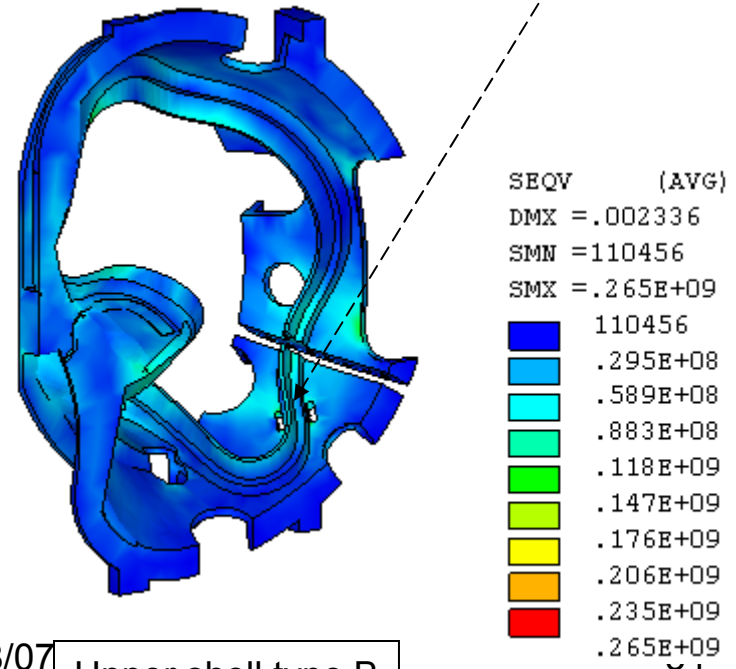



# Von Mises Stress of Shell Structure

- The maximum local von Mises stress, Seqv, occurs at the corner of lead opening in shell type B.
- The model was built without chamfers at the lead openings. With chamfer, the local stress will be greatly reduced.
- The next slides will display some high stress areas




Unit of stress in pascal

B1 - C1 Fit-up 12/18/07

Upper shell type B