NCSX RFD Part I	**Number: 18-002**	**RFD Description: B/C Coil Fit Up Interferences**
Initiator: P. Heitzenroeder	**Organization: PPPL**	

List of Impacted Documents: ***(Specification, MIT/QA Plan, SOW, drawing, etc.)***
Reference drawings for cladding: SE142C-388 [Type C coil] SE142B-242 [Type B coil]. For reference only; drawings will not be revised

Cost Impact: ***(If none, so state) :*****Up to 40 M-W of technician labor for remedial work + rigging is estimated (approx. $136,000)**

Schedule Impact: ***(If none, so state:*** **The total time estimated for performing this remedial work on all type B and C castings is 15 weeks, off critical path.**

Quality Impact: ***(If none, so state):*** **NONE**

State Requirement Deviation is Requested For*:* Non-interference between parts in an assembly is an implied requirement, and the non-interference conditions are shown in the NCSX Assembly models.

Full Description of the Deviation Requested: ***(Use continuation pages, e-mails, letter, sketches, etc. as needed and include amplifying information as appropriate to support deviation request.)***
NCR-3735 dispositioned resolution of B1/C1 interferences. This RFD provides proactive modifications to remaining B/C coils to avoid future interferences. These modifications (as described in the attached power point presentation date 12/18/2007) provides guidance for modifying installation of chill plates and ground rules for grinding as needed to rectify interference between the castings at the base of the T sections.

Attachments: "Review of "B1" to "C1" interface - Response to NCR 3735 and Deviation Request to Address Remaining B-C Coil Interfaces" – PowerPoint presentation of 12/18/2007.

Initiator Signature: Phil Heitzenroeder Digitally signed by Phil Heitzenroeder DN: cn=Phil Heitzenroeder, o=MED, ou=Engineering, email=pheitzen@pppl.gov, c=US Date: 2007.12.19 16:33:41 -05'00' **Date:** _____

NCSX RFD Part III	Number: 18-002	RFD Description: B/C Coil Fit Up Interferences

RLM(s):	Organization:
Design: P. Heitzenroeder Manufacturing: L. Dudek	Design: PPPL Manufacturing: PPPL

Impact on Interfaces with Other WBS Elements/Items: ***(If none, so state)*** **None.**

Design RLM Recommendations:

☒ **Approve** ☐ **Do Not Approve**

Manufacturing RLM Rcommendations:

☒ **Approve** ☐ **Do Not Approve**

Cognizant Engineer Approval: Tom Brown

Digitally signed by Tom Brown
DN: cn=Tom Brown, o=PPPL, ou, email=tbrown@pppl.gov, c=US
Date: 2007.12.20 08:23:37 -05'00'

Additional remarks:

Should the impacted drawings be formally revised or should the "stamp" process outlined in NCSX Procedure PROC-007 be utilized and should the specification (or other documents) be updated?

☐ **No, a formal revision required to the drawing or specification is required**

☒ **"Stamp" process outlined in PROC-007 is authorized.**

- ☒ **If the change is substantial, a revision to the impacted drawings will be required after the third RFD stamp marking a substantial revision is placed on the drawing.**
- ☐ **This change is NOT substantial and no update to the drawing will ever be required => in this case the "3" RFD stamp process does NOT apply.**

Does this Change Impact Material Already Procured or Parts/Assemblies Already Assembled/Manufactured using this Material: ☒ **Yes** ☐ **No**

If "Yes", what is the recommended disposition of this material/part/assembly and what is the impact?

Will need to modify remaining B/C coils as per guidance contained in this RFD.

NCSX RFD Part III	**Number: 18-002**	**RFD Description: B/C Coil Fit Up Interferences**

RLM: **Design: Phil Heitzenroeder** **Manufacturing: Larry Dudek**	**Organization:** **Design: PPPL** **Manufacturing: PPPL**

Design RLM Signature: Phil Heitzenroeder
Digitally signed by Phil Heitzenroeder
DN: cn=Phil Heitzenroeder, o=MED, ou=Engineering, email=pheitzen@pppl.gov, c=US
Date: 2007.12.19 16:34:33 -05'00'

Manufacturing RLM Signature: Lawrence E. Dudek
Digitally signed by Lawrence E. Dudek
DN: cn=Lawrence E. Dudek, c=US
Date: 2007.12.21 07:36:16 -05'00'

Project Disposition:

☒ **Approved. No ECP required.**

Bob Simmons
Digitally signed by Bob Simmons
DN: cn=Bob Simmons, c=US
Reason: I am approving this document
Date: 2007.12.19 16:26:11 -05'00'

NCSX Systems Engineering Support Manager

☐ **Approved. ECP - assigned and processed.**

☐ **Not Approved. Reason(s) for disapproval:**

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

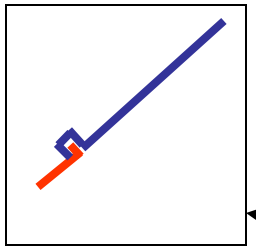
- Modify the copper cladding on B1 and C1 as shown on page 3.
  - The slides which follow this are given for reference.
- Resolve interference between MCWFs as shown in the following slide set, and as detailed in the grinding table shown on slide 17.
- Verify clearance as given below (Requirement on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

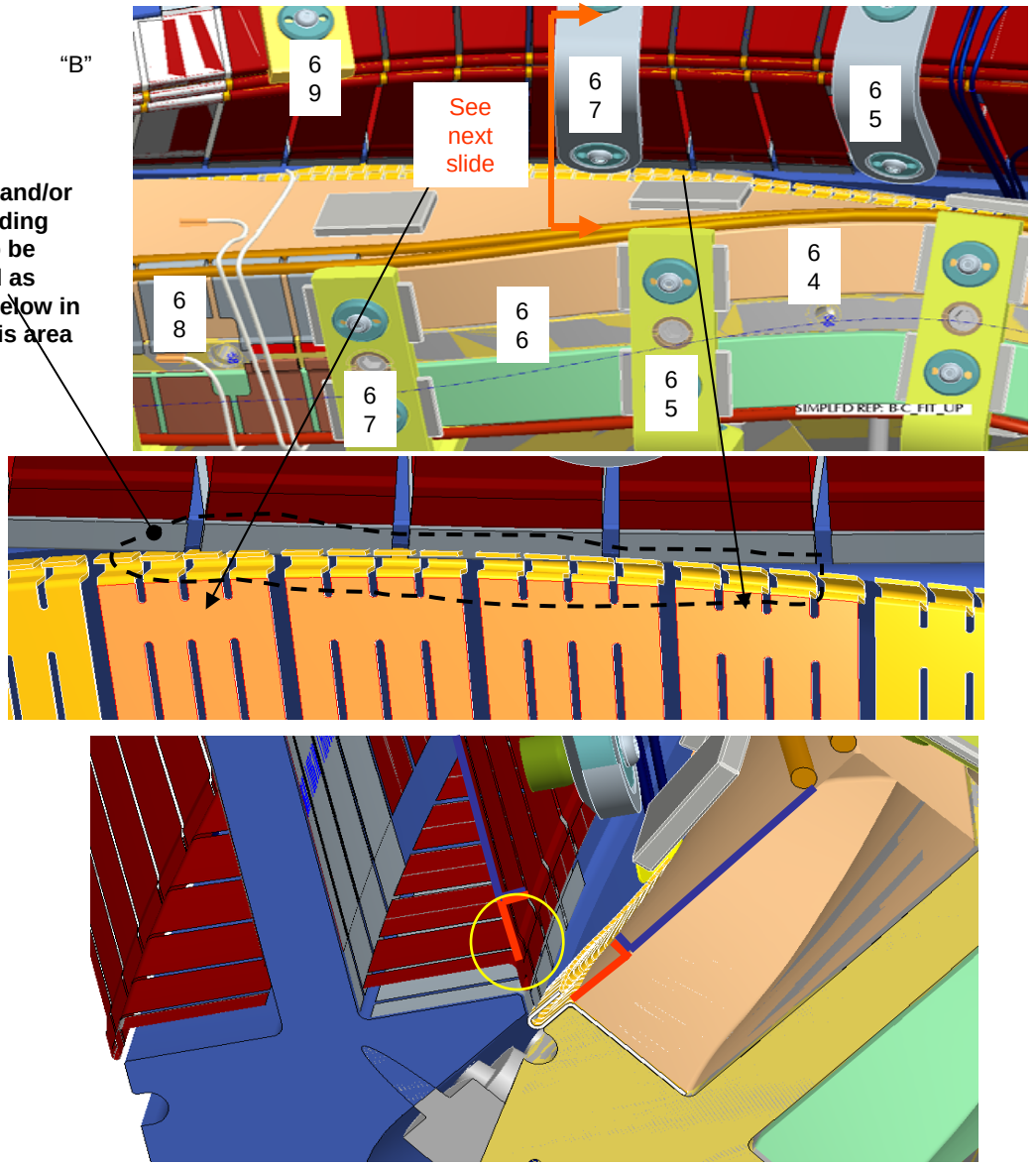
Elimination of cladding interference:



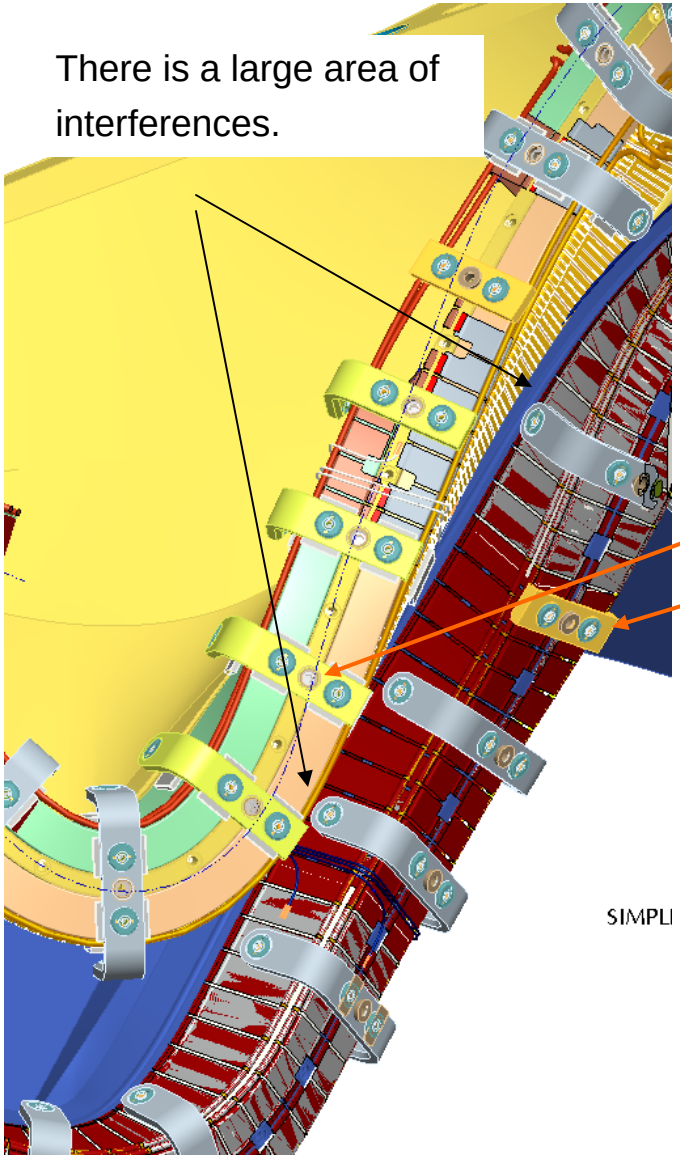
- On B coil, between clamp holes 65 & 69: and on C coil , between clamp holes 64 & 68:
  - Unbend copper crimps & straighten copper.
  - Form the copper as shown in the yellow circle. Bent out leg should be ~1/8".
  - Form the upper copper to meet the bent out leg and form a crimp U section over the lower piece.
  - Crimp the copper U.
  - Epoxy the copper to the coil and overlay the repaired region with glass – epoxy.

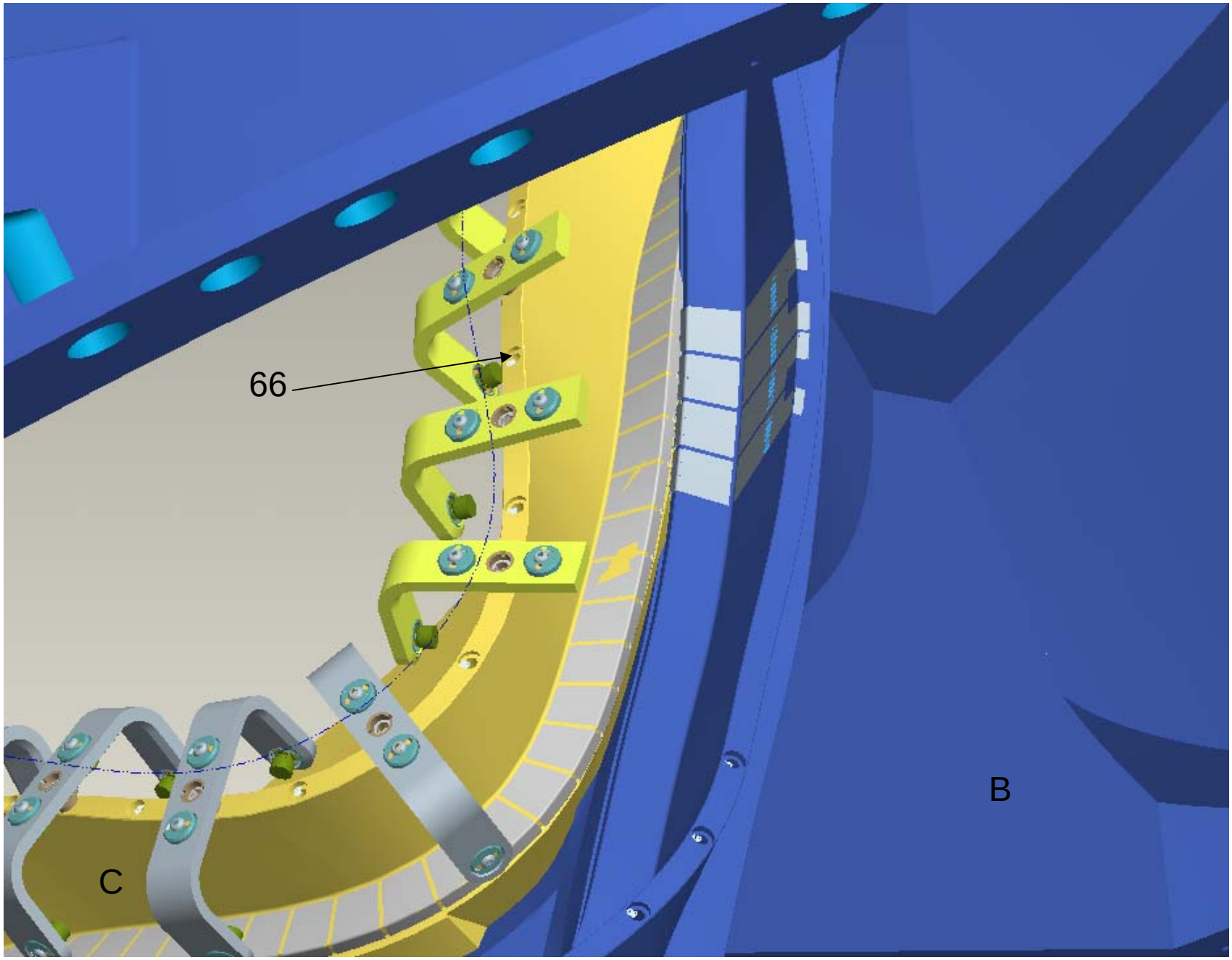
- *Every attempt should be made to avoid copper breakage*. However IF the copper breaks during the unbending operation, abandon that piece. Analyses (see slide 14) indicates that breakage of every other finger has a negligible effect on dT; ***if more than two adjacent fingers break, work shall be stopped and a NCR shall be written and dispositioned before proceeding.***

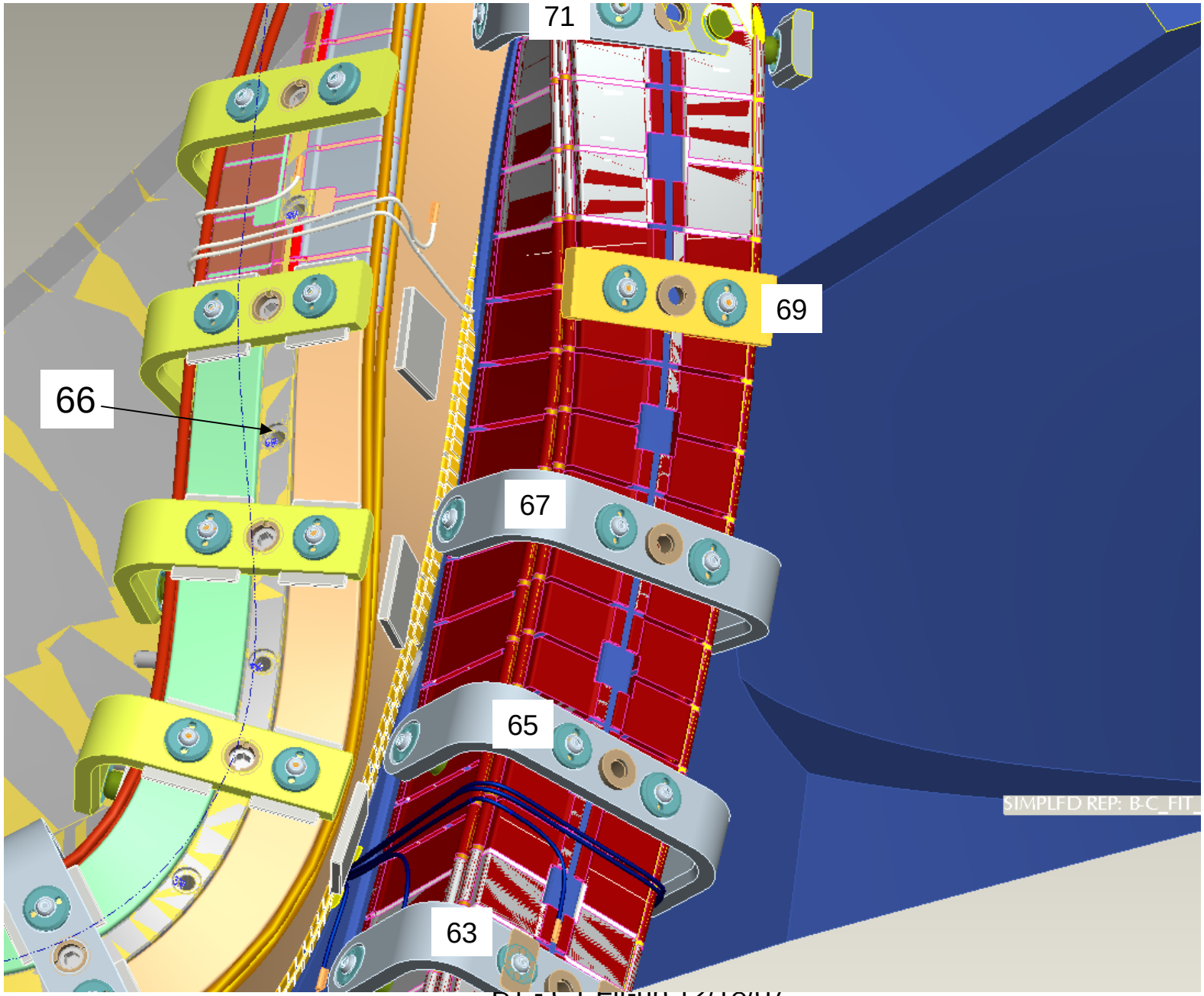
The "B" and/or "C" cladding needs to be modified as shown below in red in this area



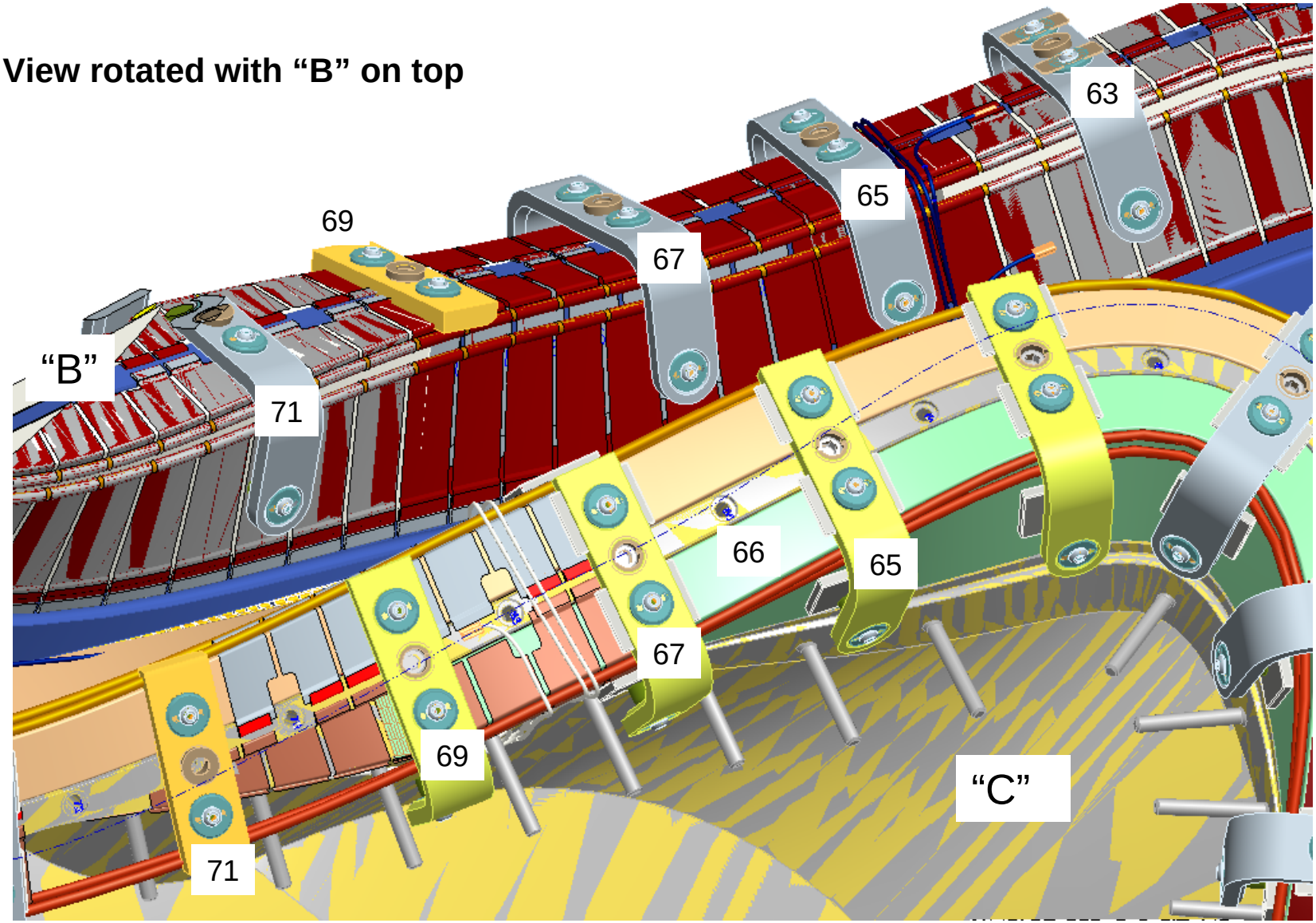
There is a large area of interferences.



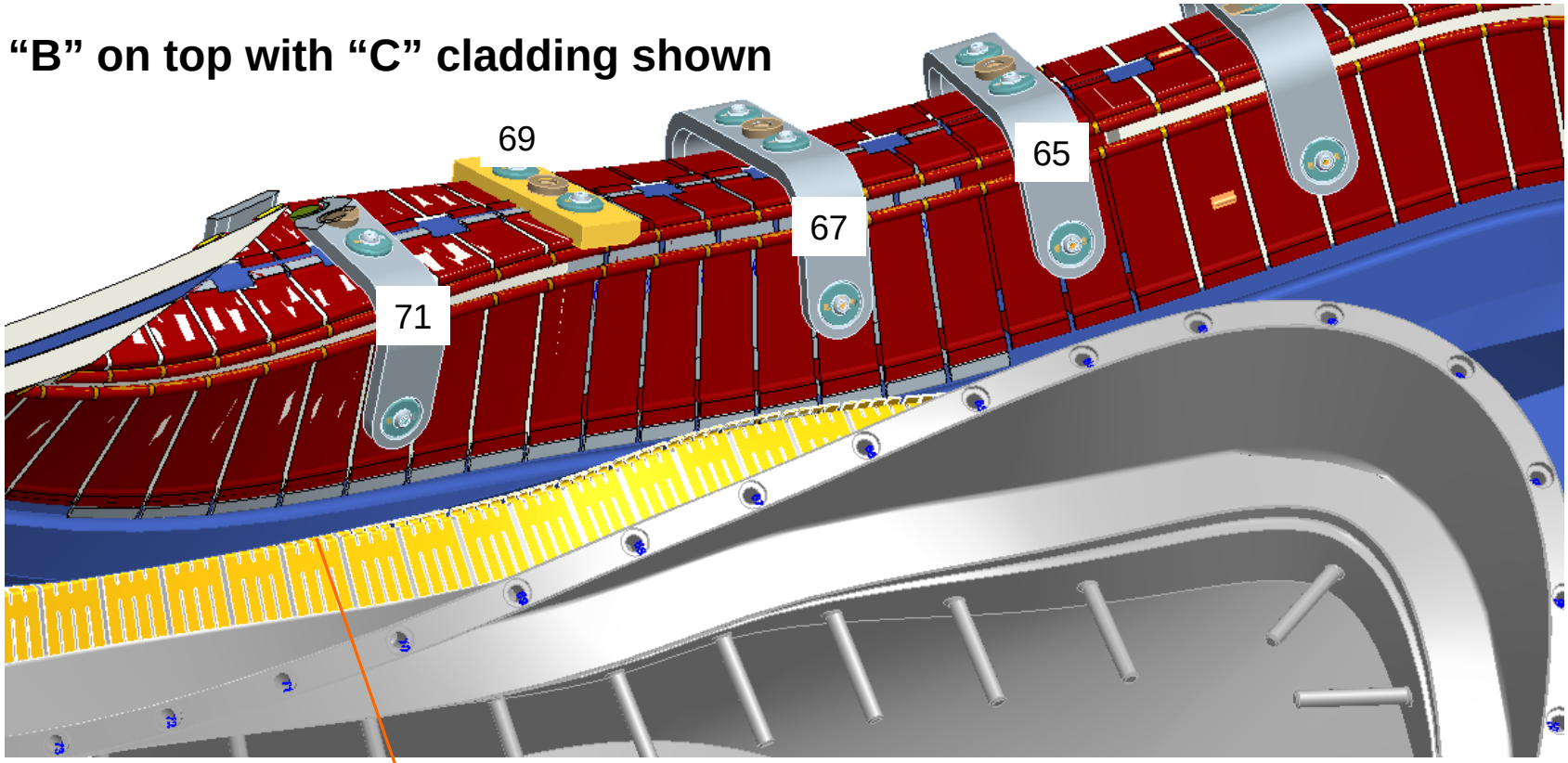

66
B
C

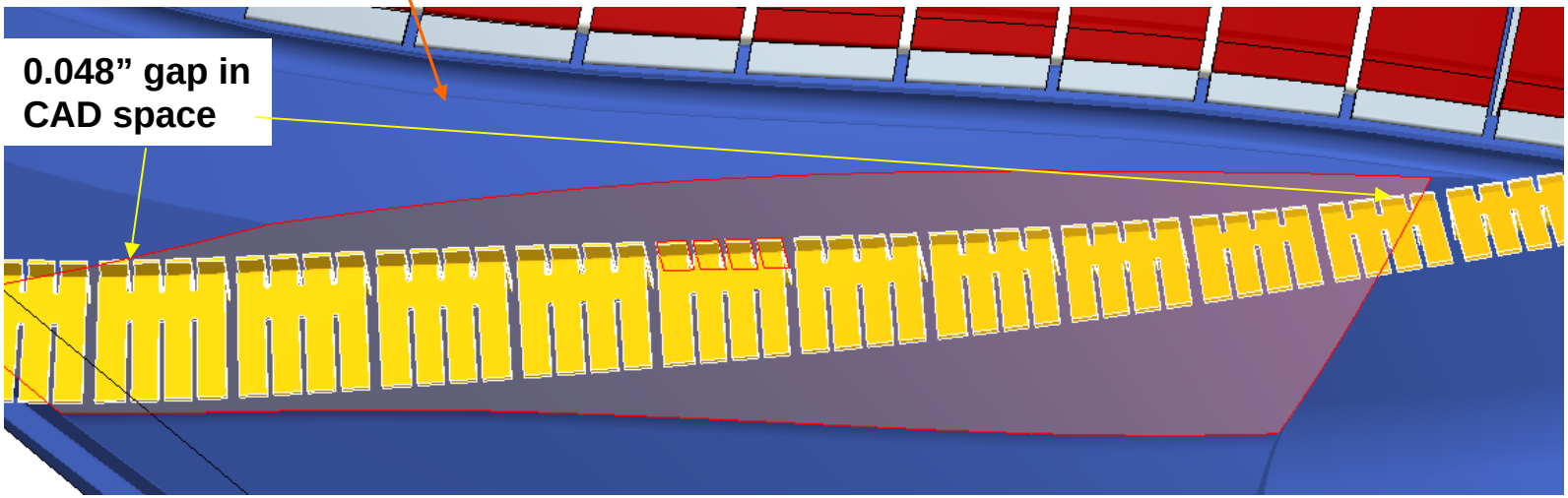

71
69
66
67
65
63
SIMPLFD REP: B-C_FIT_

View rotated with “B” on top

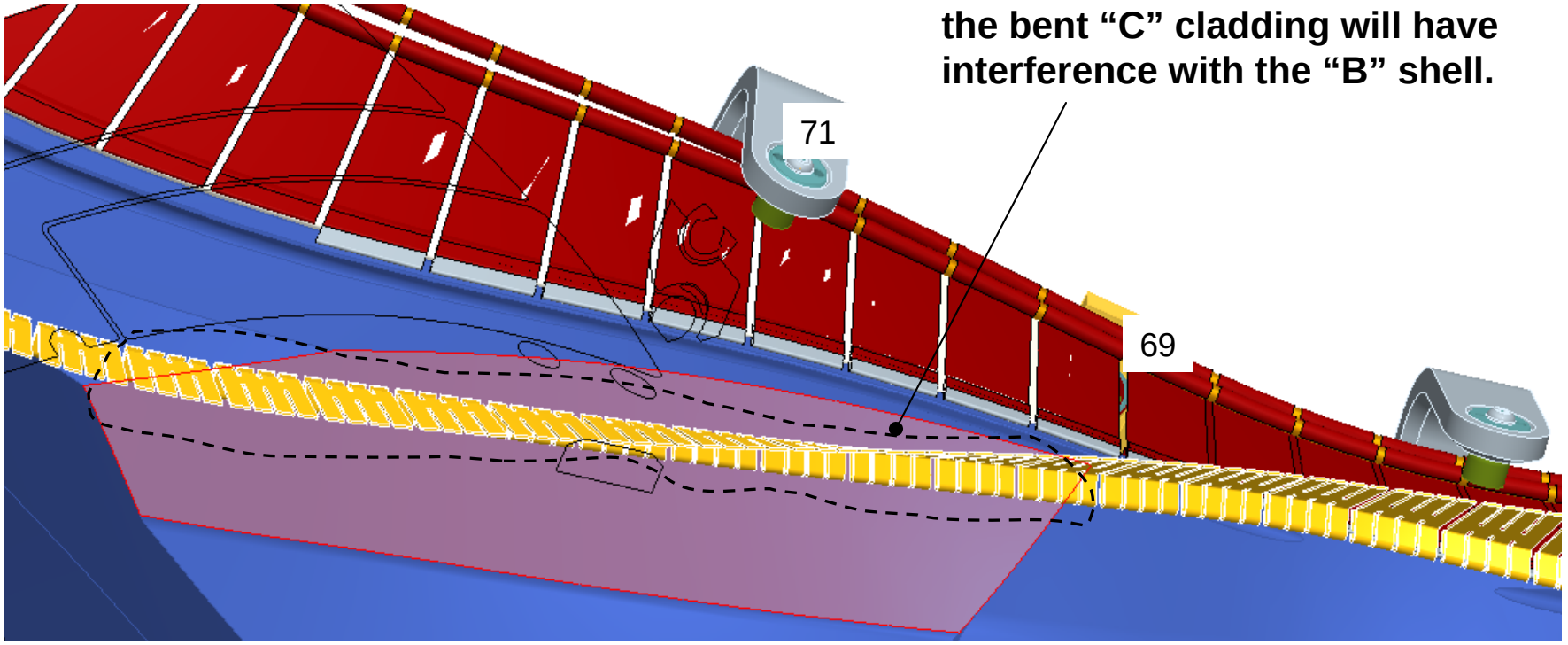


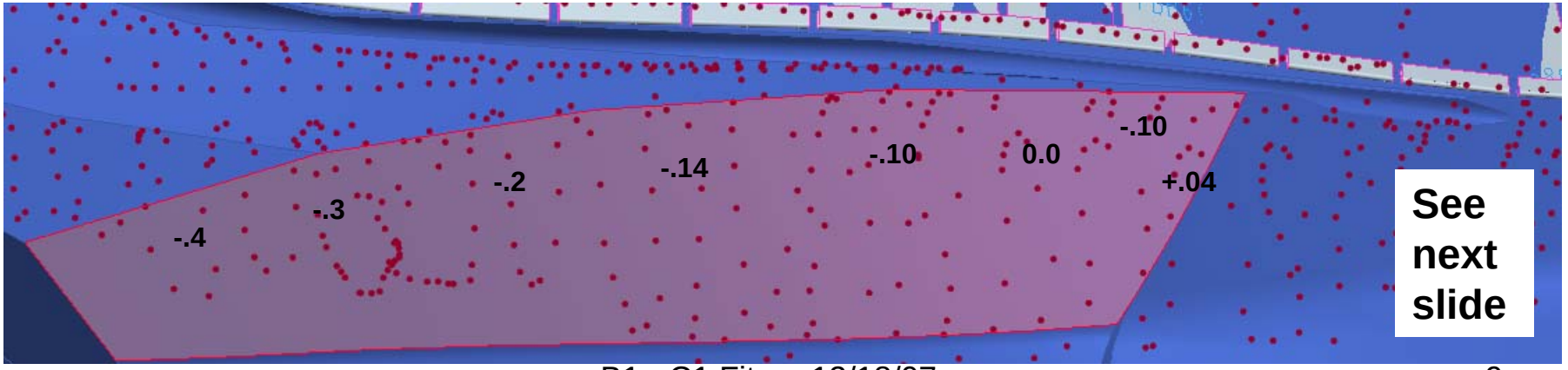
“B” on top with “C” cladding shown

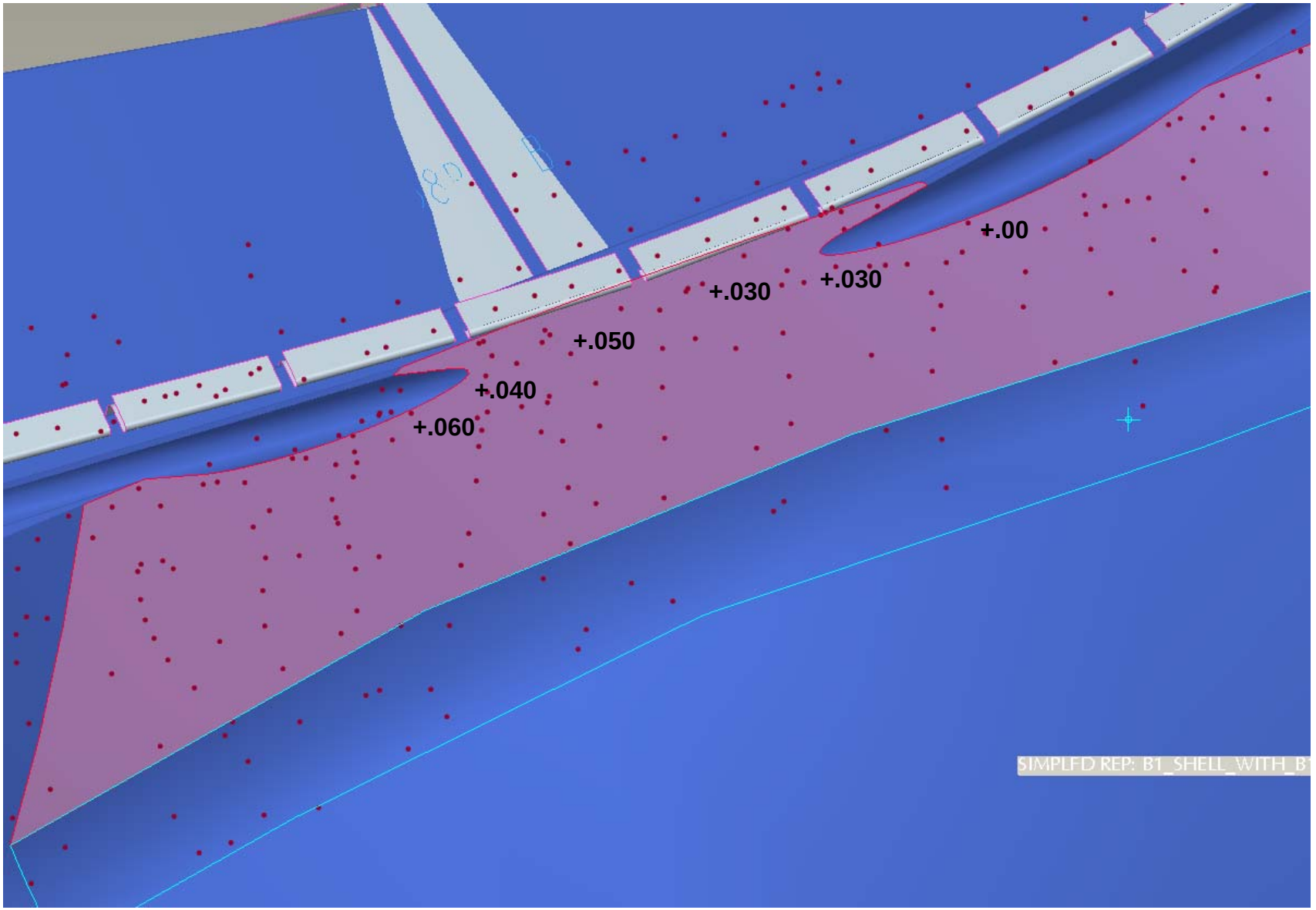


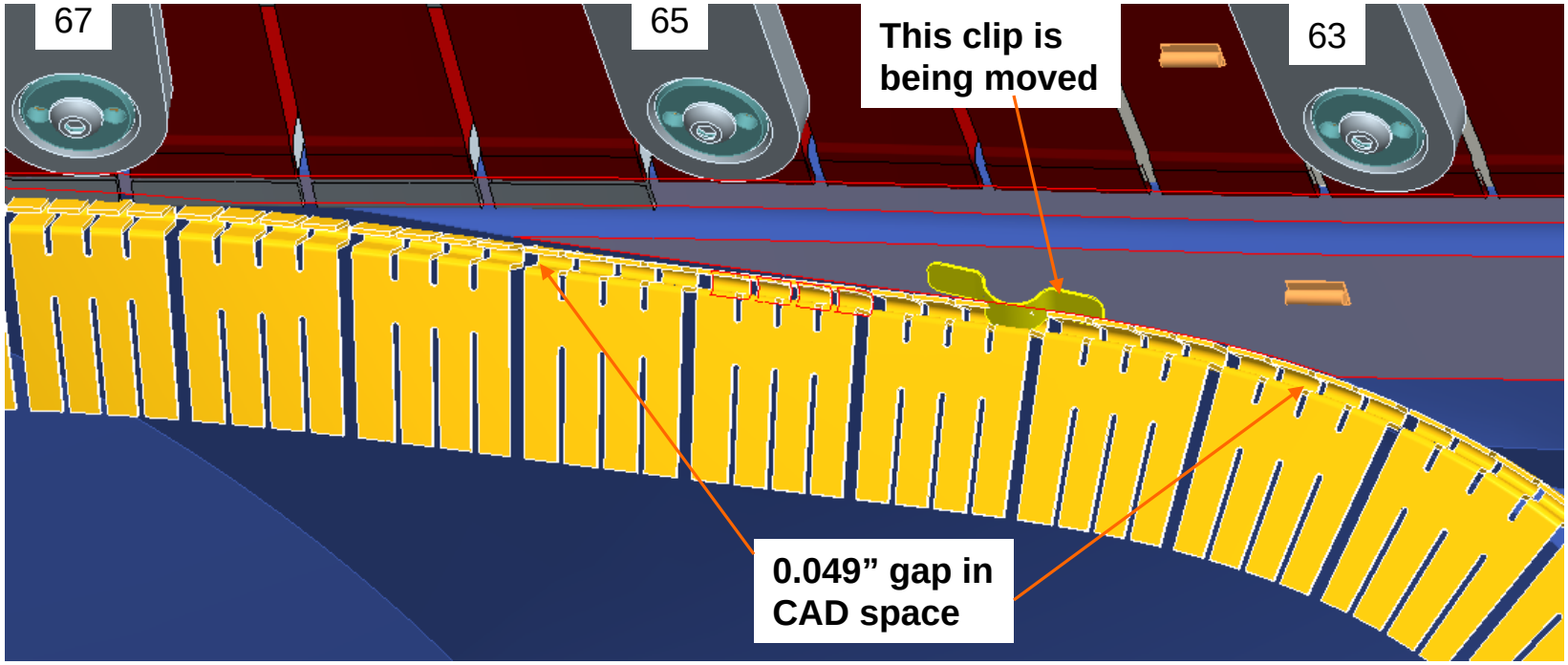


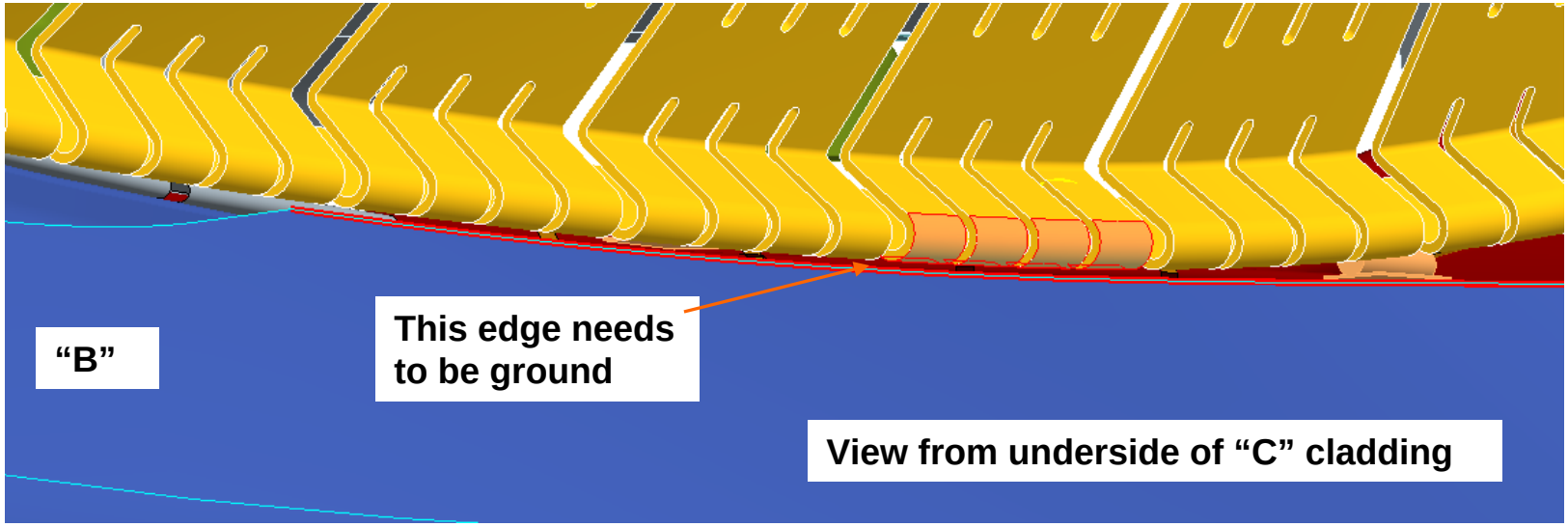
Region on the Type-B where the bent "C" cladding will have interference with the "B" shell.

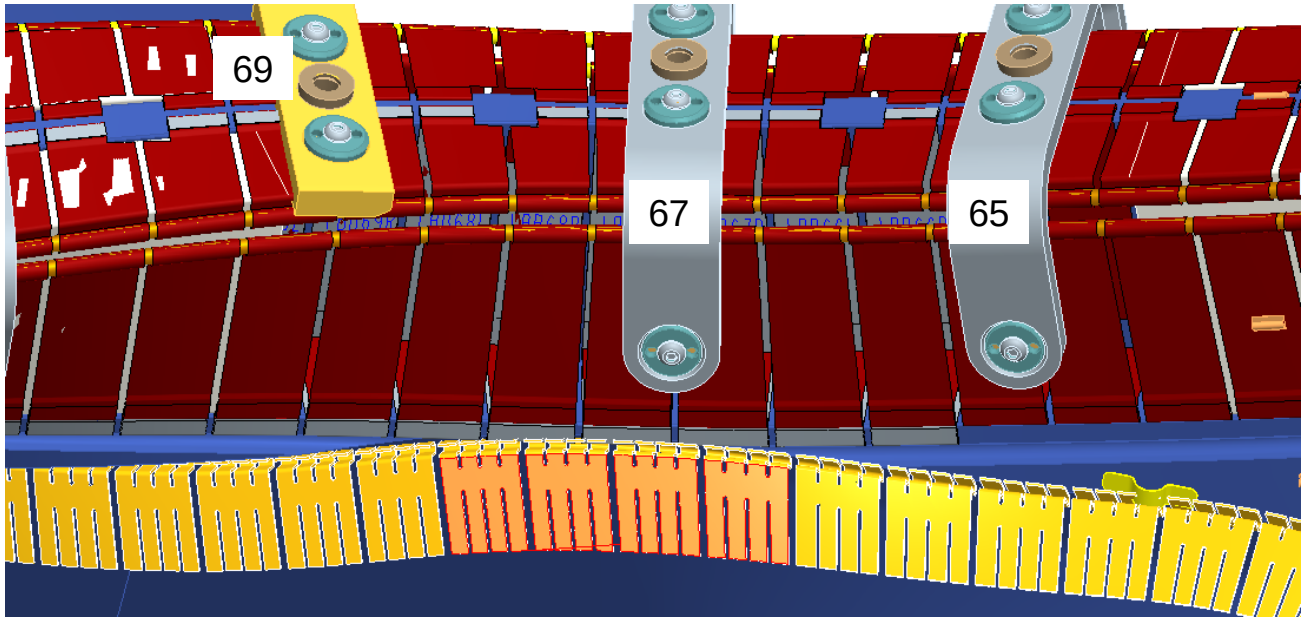





+.00
+.030
+.030
+.050
+.040
+.060
SIMPLIFD REP: B1_SHELL_WITH_B


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

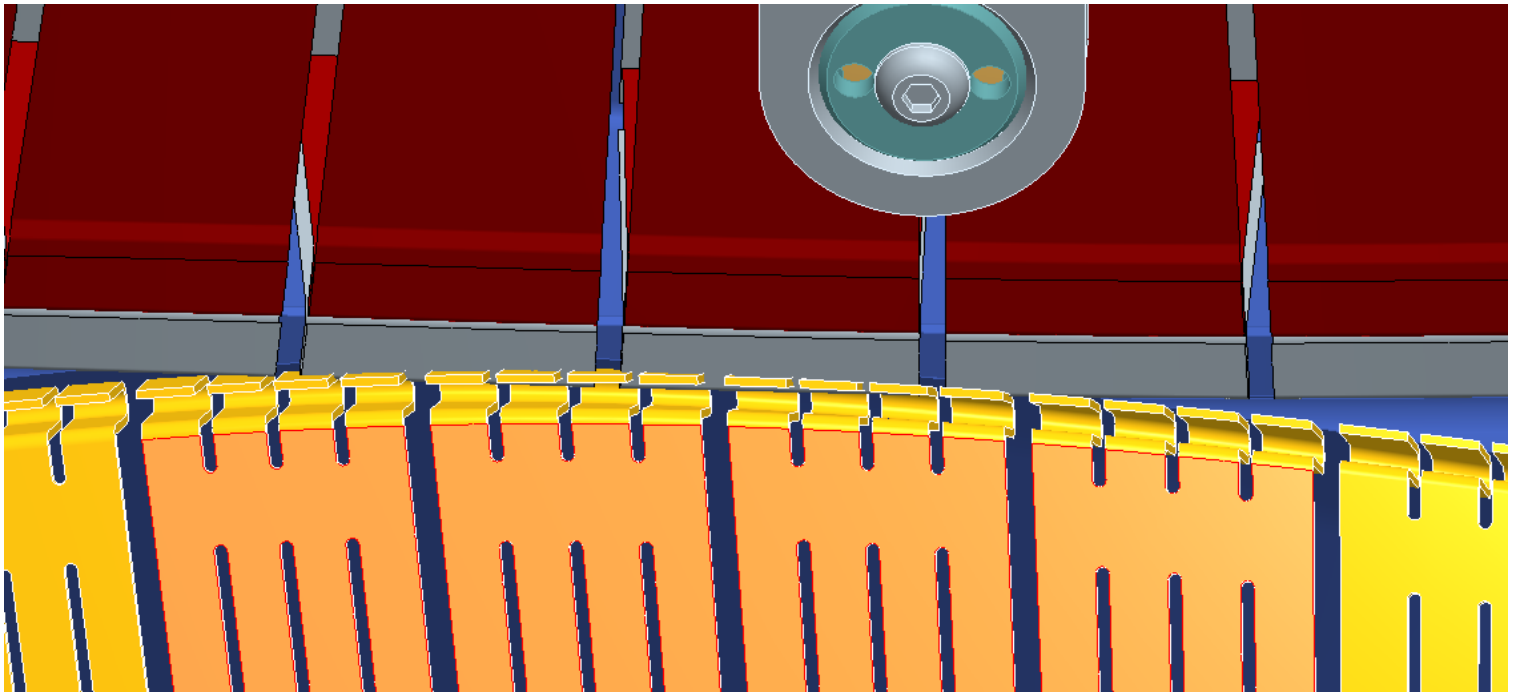

“B”
This edge needs to be ground
View from underside of “C” cladding



"B"

"C" cladding

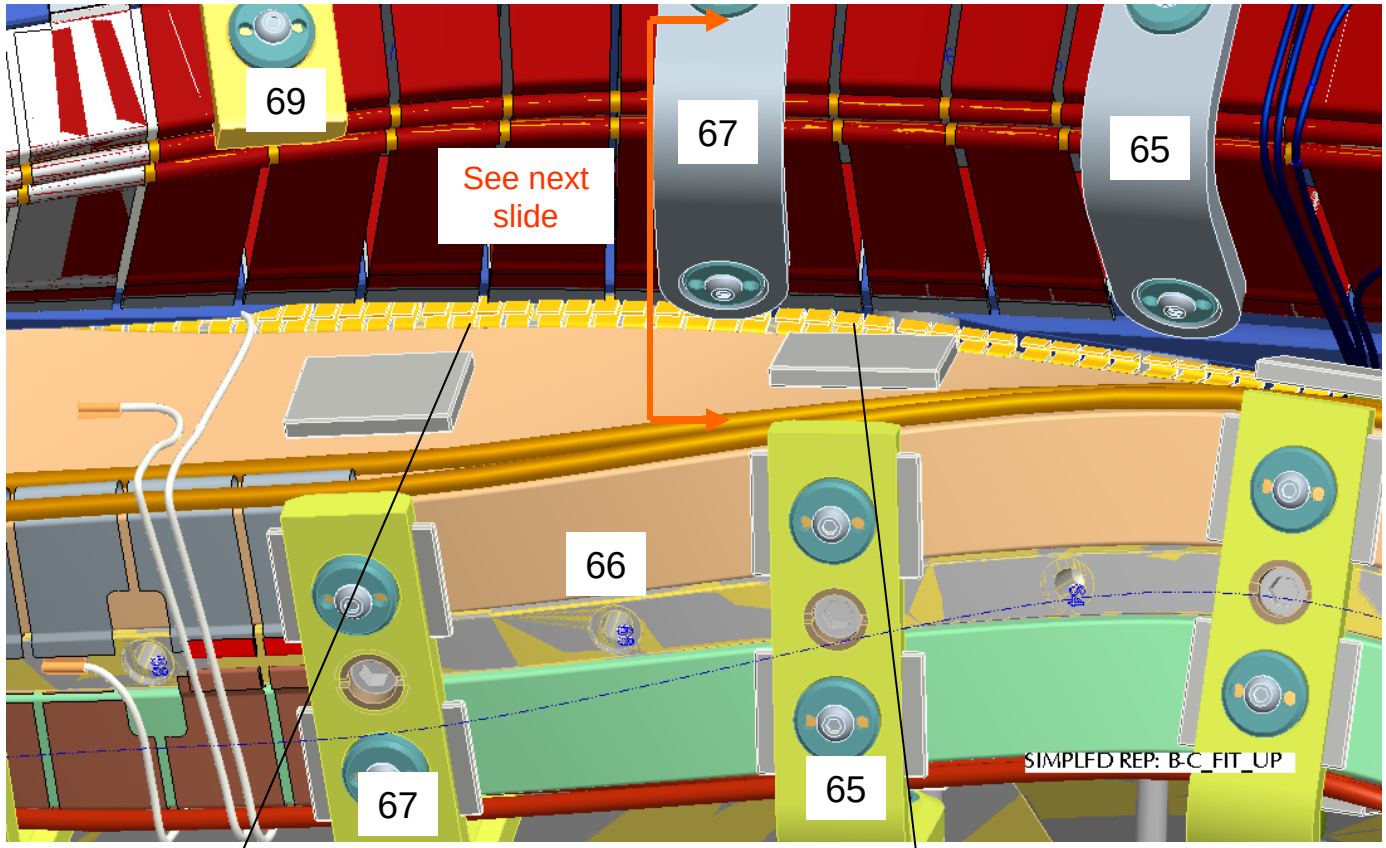
"B"

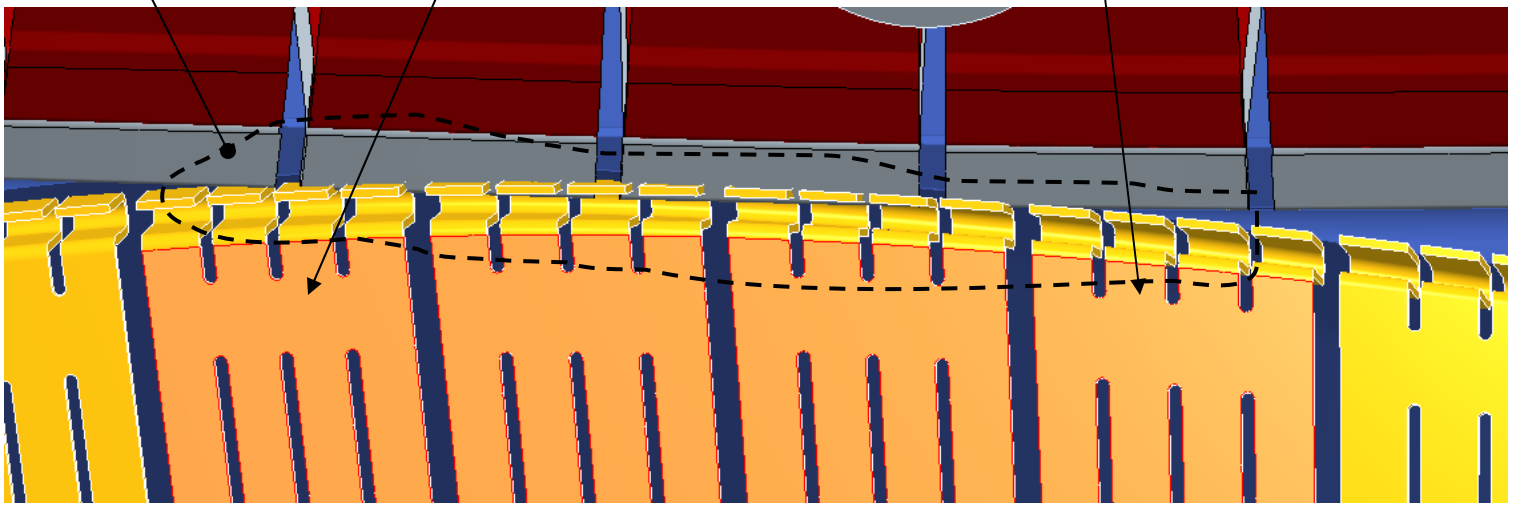


"C" cladding

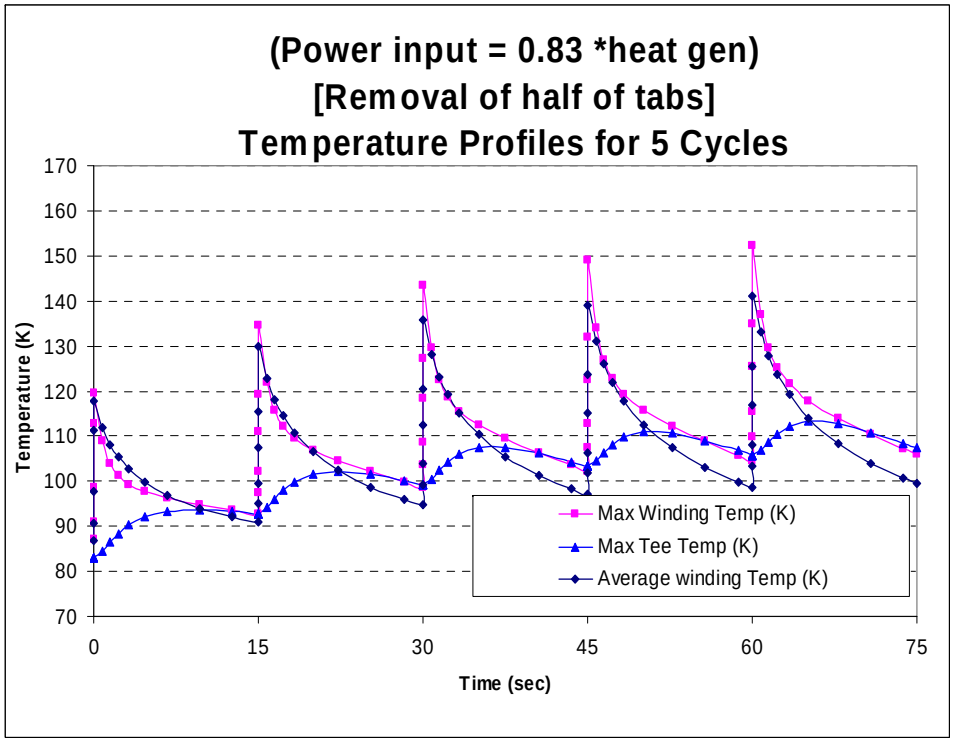
“B”

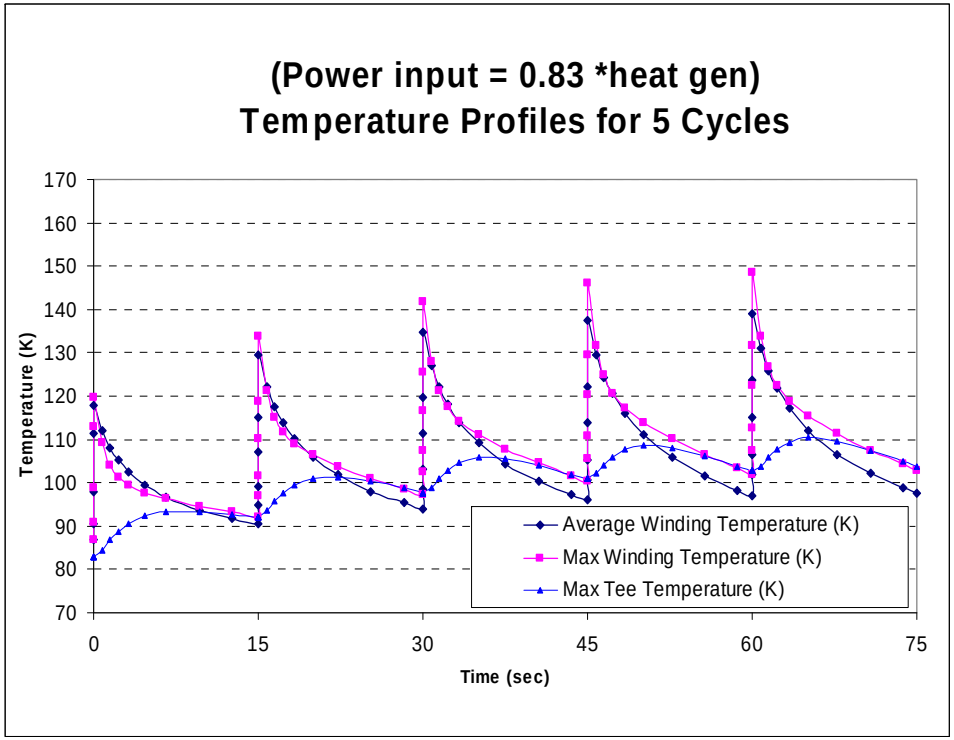
The “B” and/or “C” cladding in this area needs to be cut back.



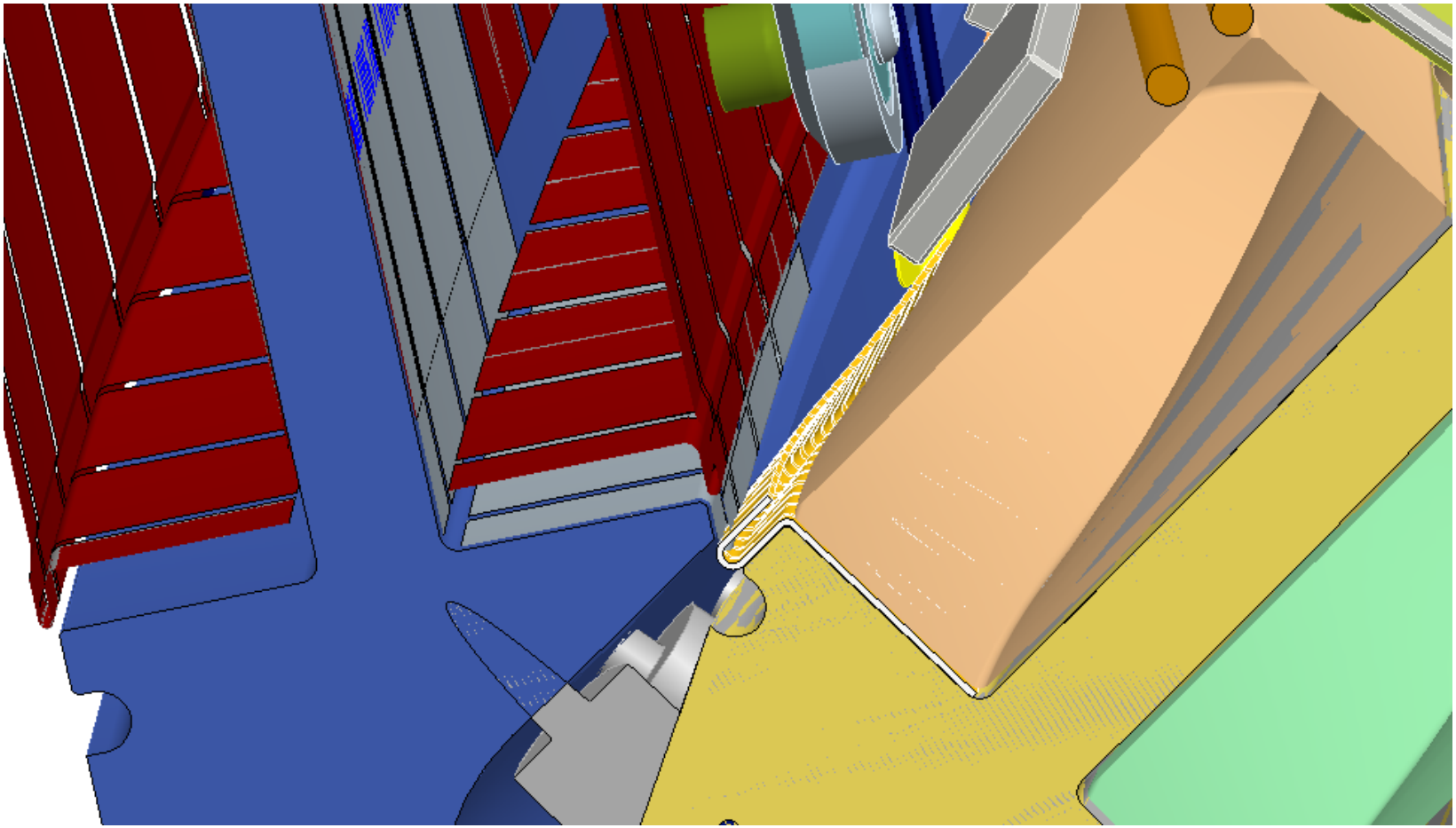


Plot comparisons (1/2 tabs connected) (K. Freudenberg analysis)

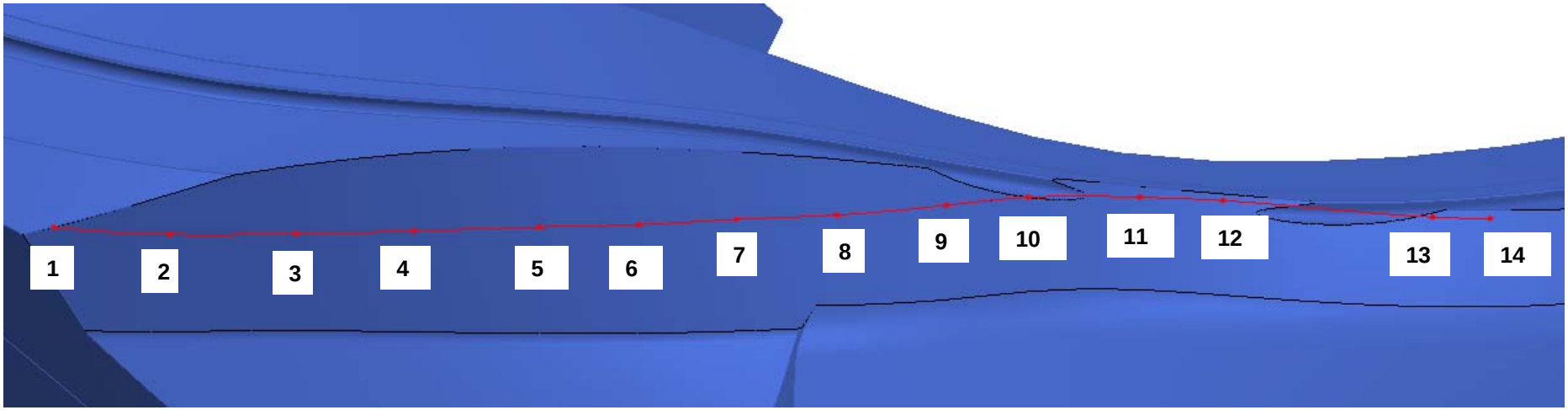


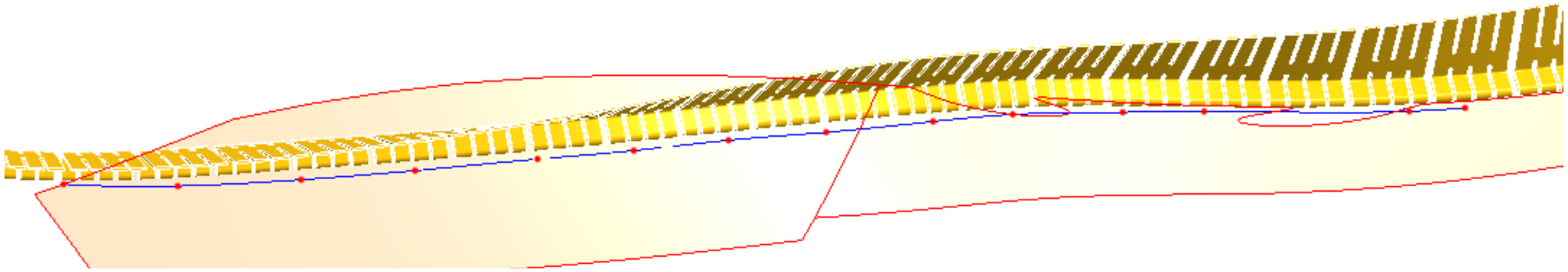


Very little change (2 degrees max)



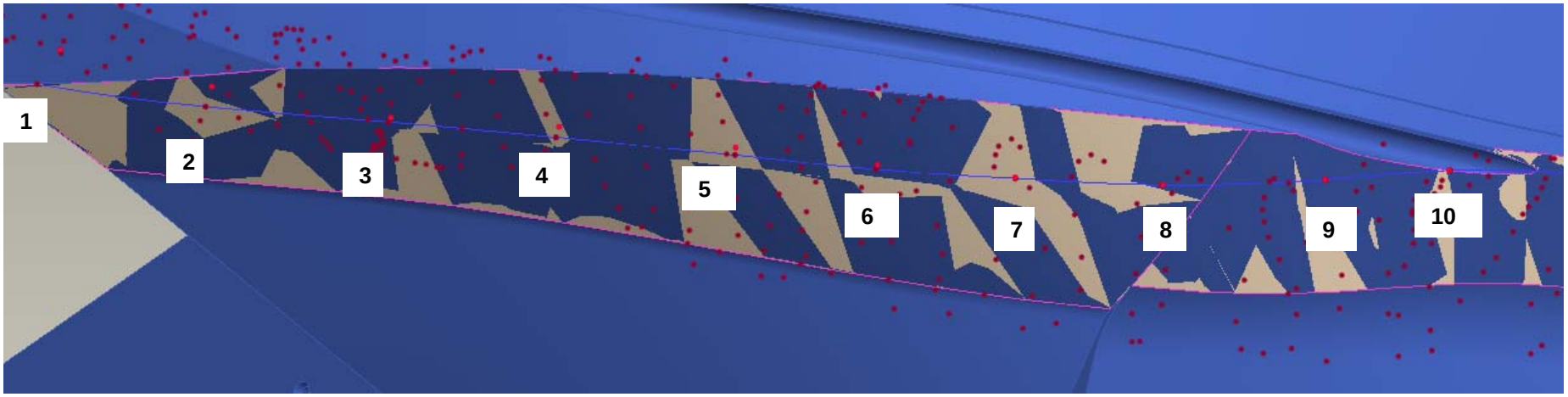
Local section view





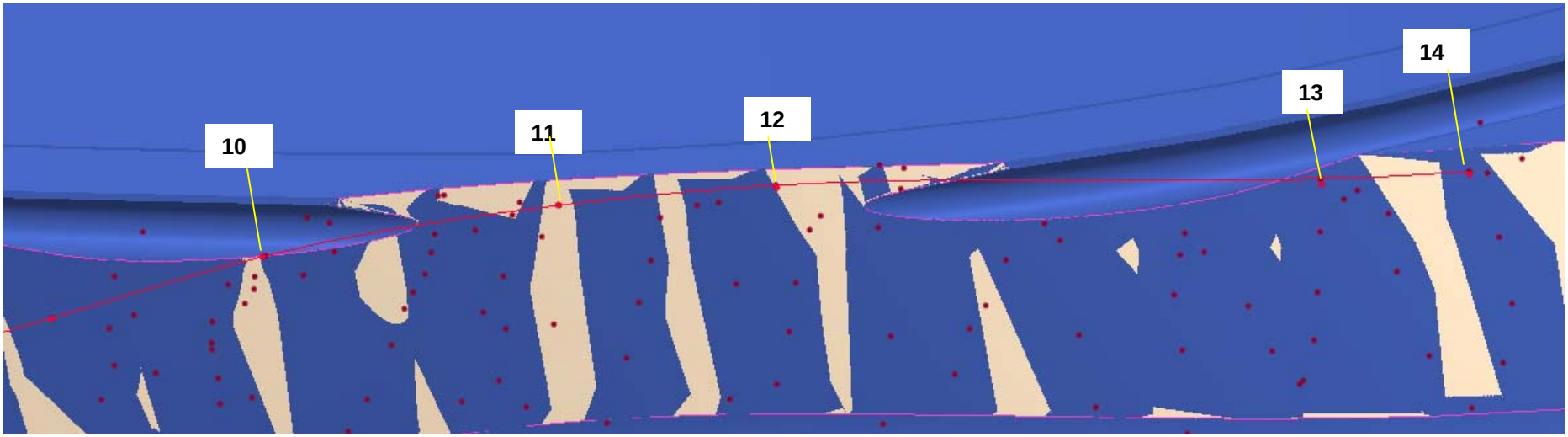
Point data relative to the "B' default coordinate system

	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

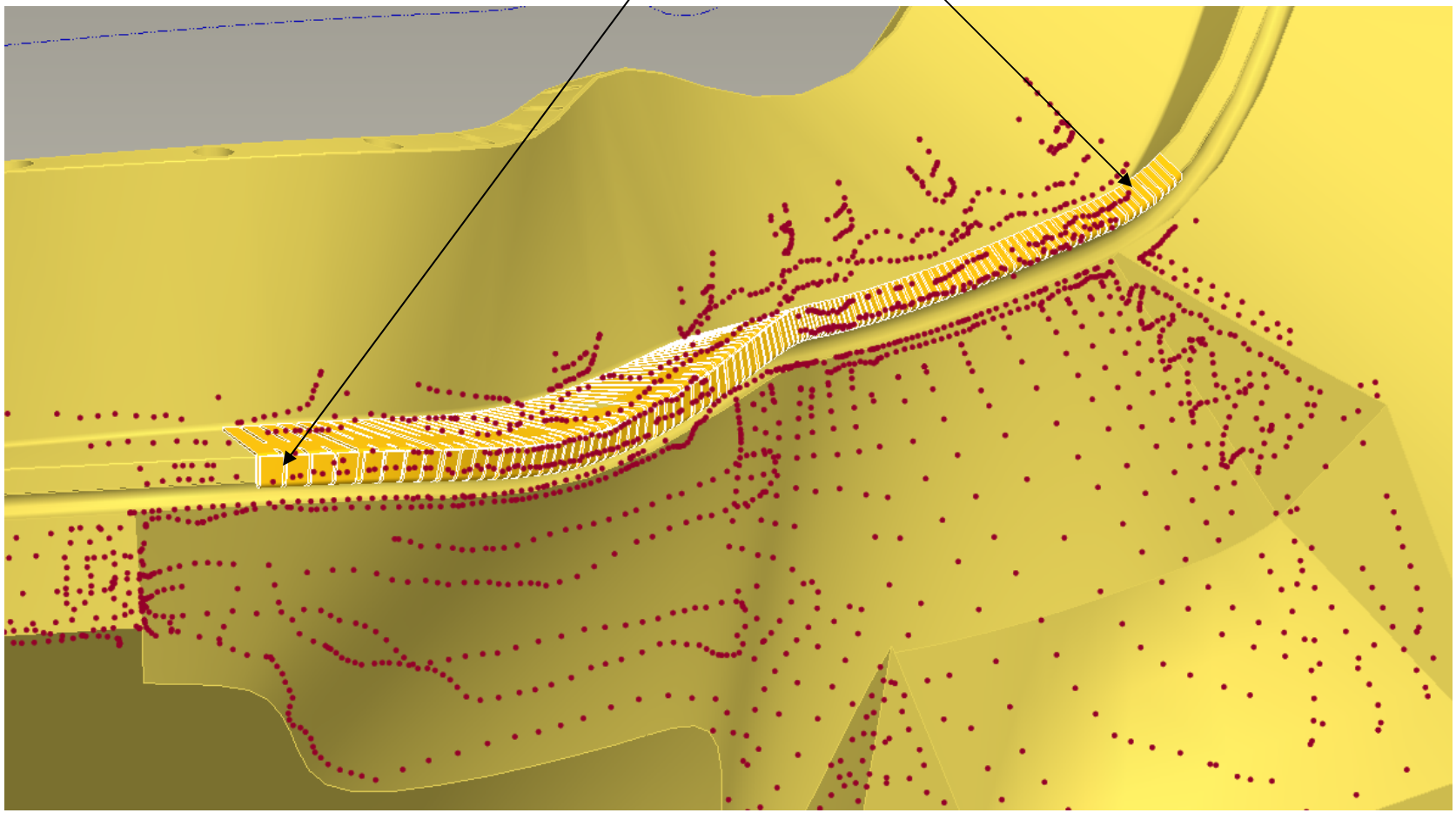


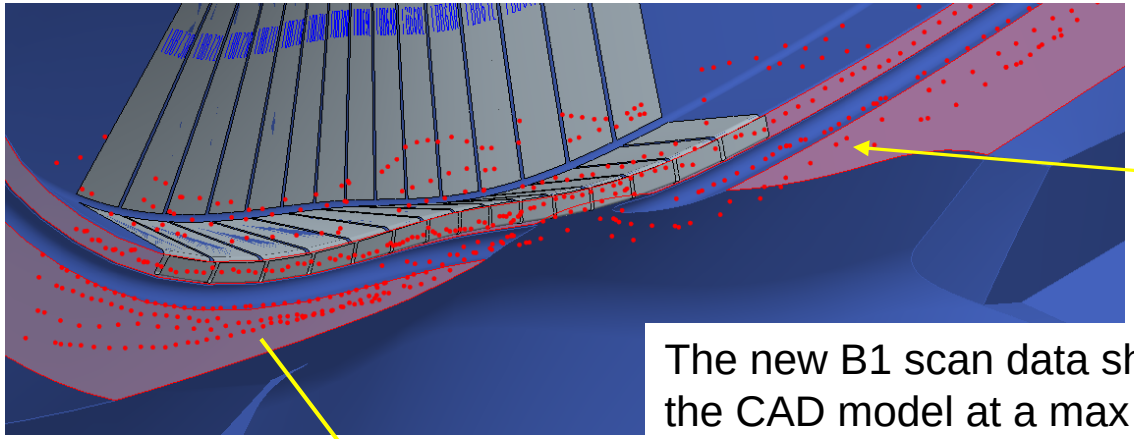
Point data relative to the "B' default coordinate system								
	FOR B1 AND C1				Currnt. Ground	Currnt	Additional grinding	Added fractional
				"B" surf to	Dist. from	"B" surf to	depth for	grinding
	X	Y	Z	"C" cladding	Met. Pts	"C" cladding	1/4" gap	depth
1	34.087	-27.853	-41.520	0.046	0.649	0.695		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 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.

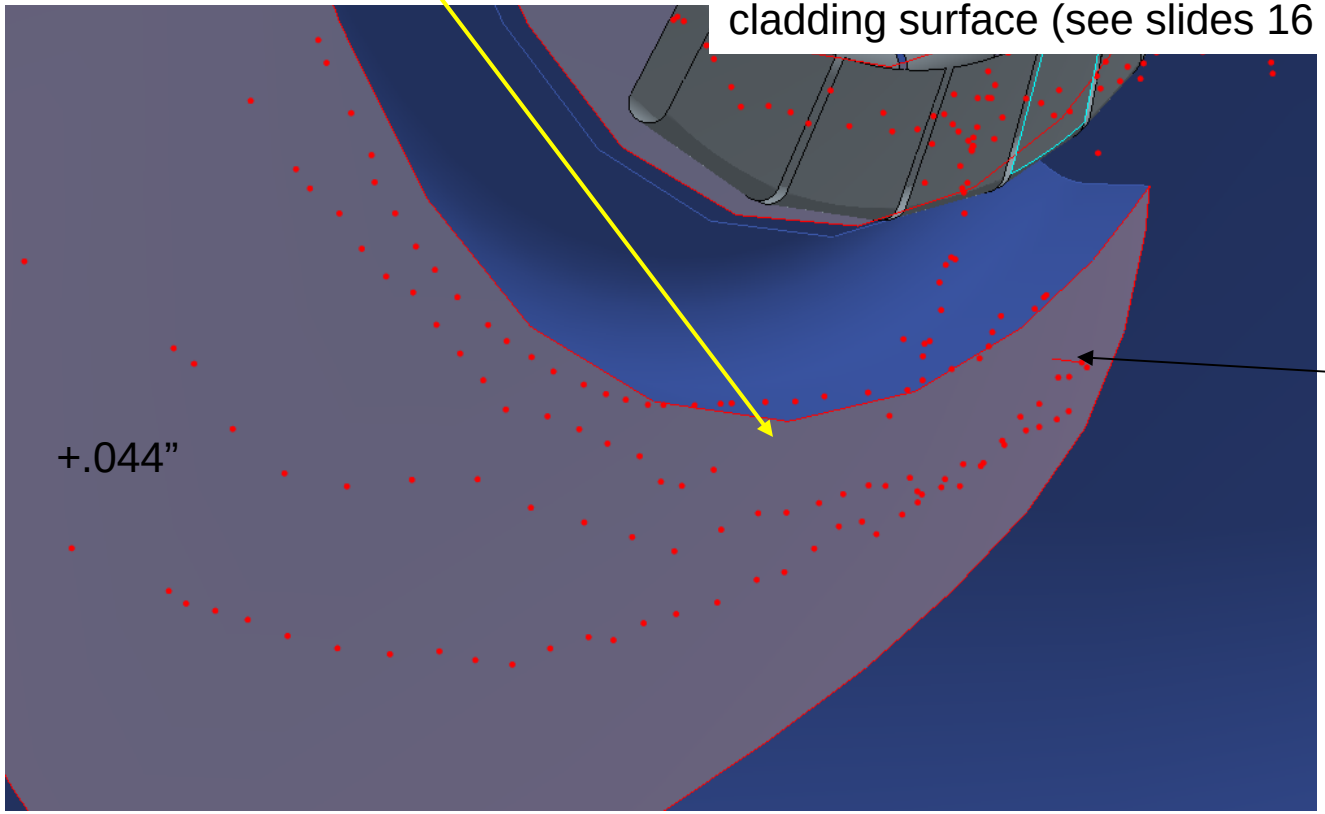




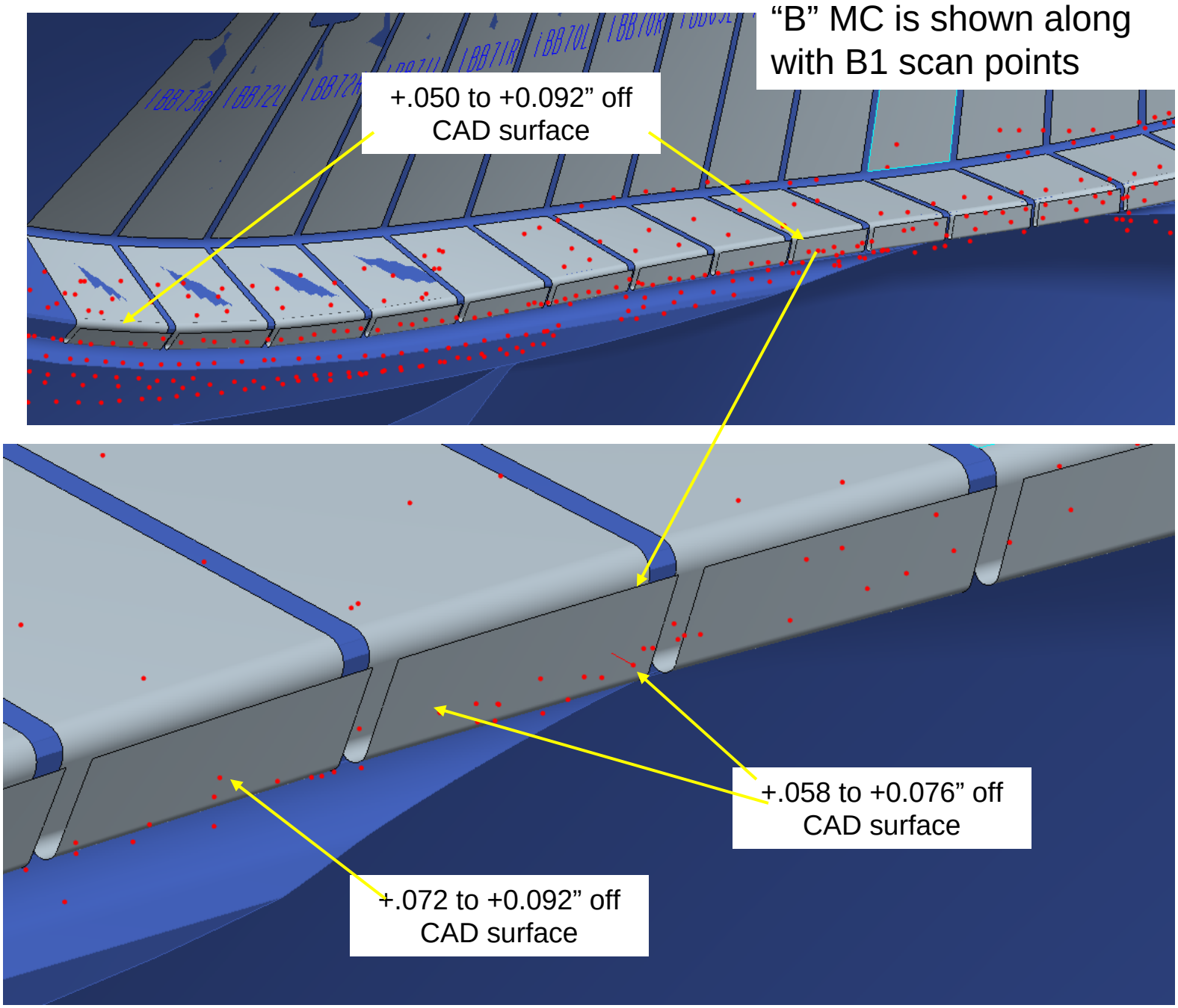
"B" MC is shown along with B1 scan points

-.050" to +.016

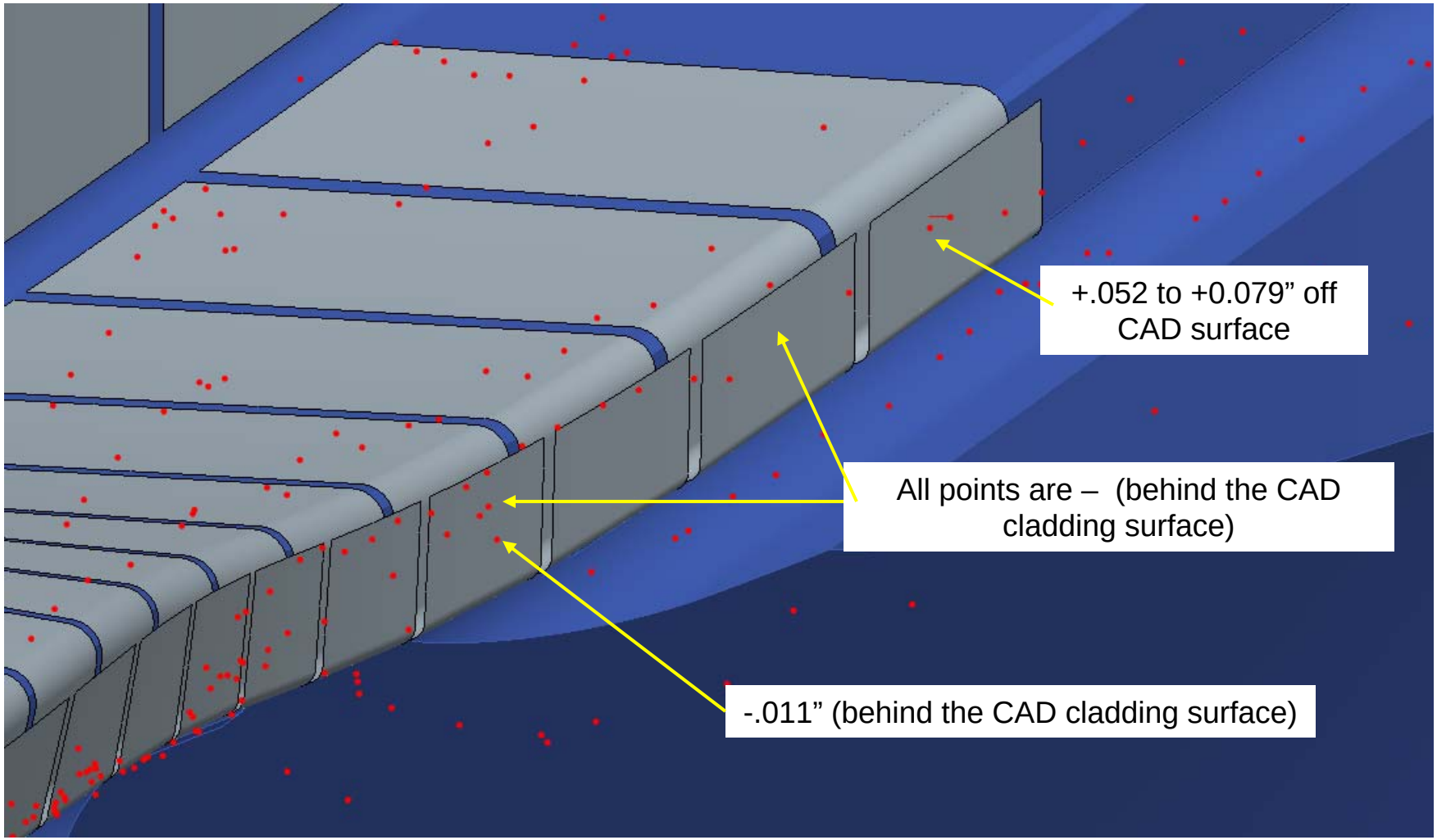
The new B1 scan data shows the surfaces are off the CAD model at a max condition on the order of +.058" and has a max value of +.092" off the cladding surface (see slides 16 and 17).



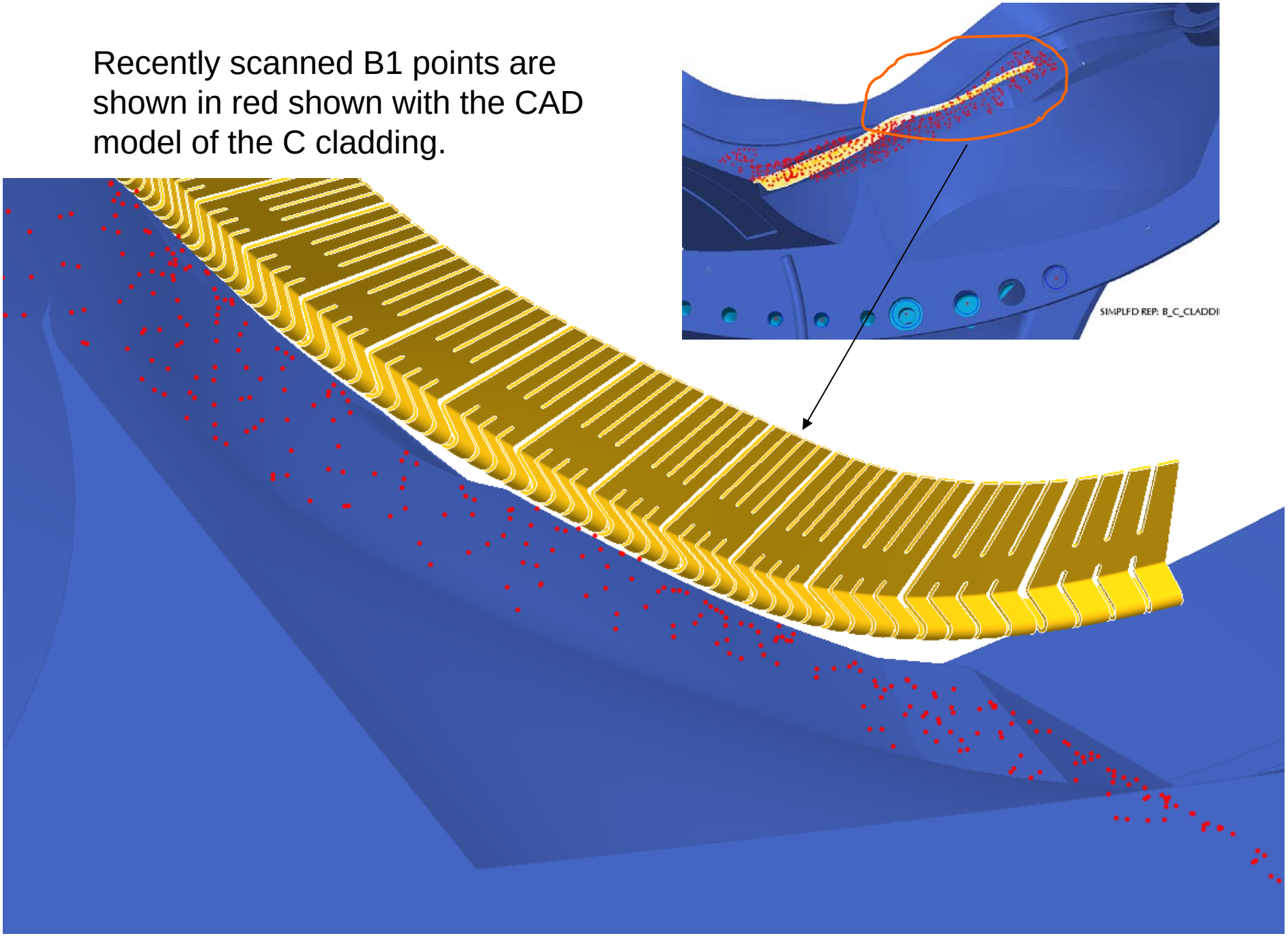
+.058" to +.044

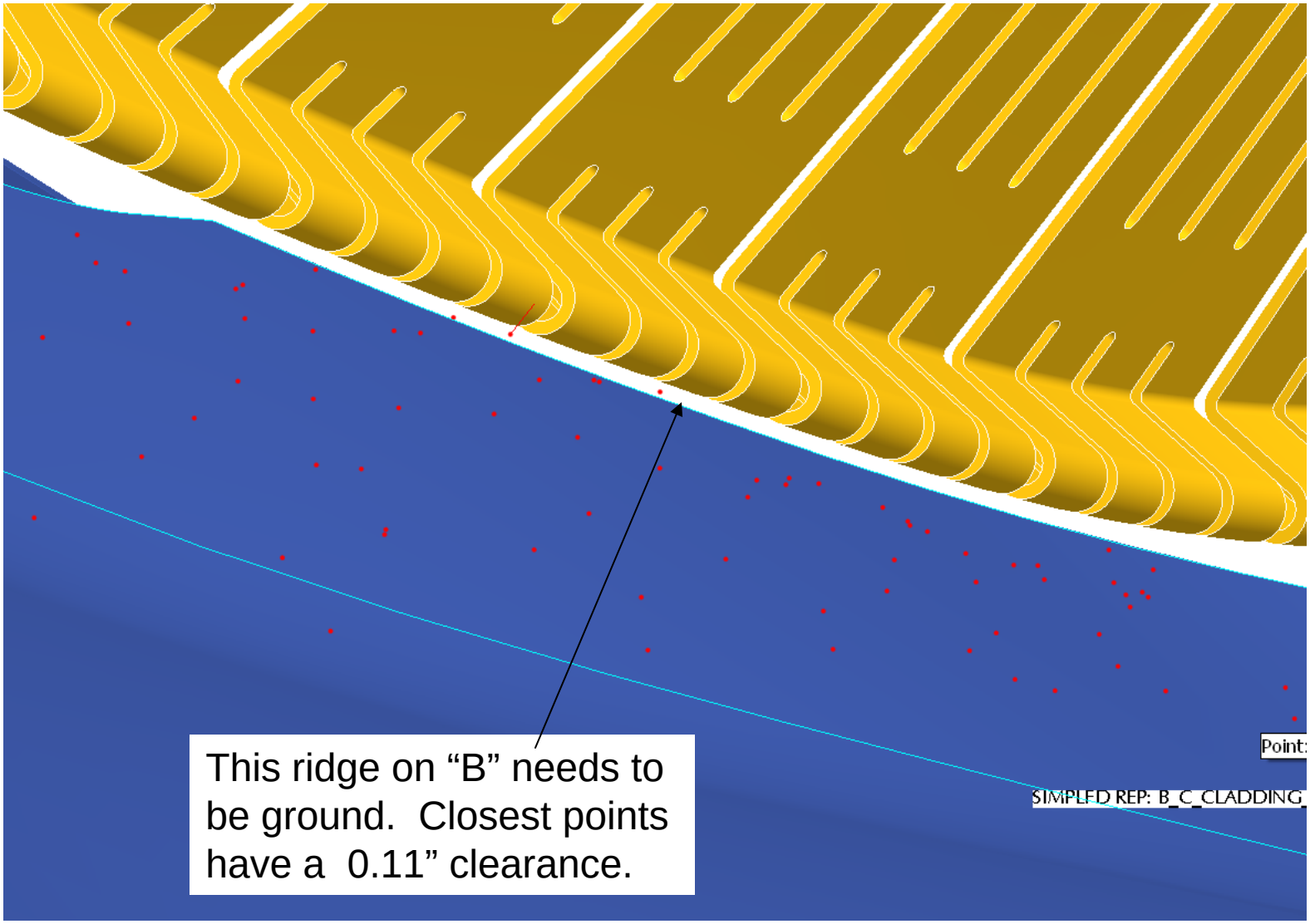

“B” MC is shown along with B1 scan points
+.050 to +0.092” off CAD surface
+.058 to +0.076” off CAD surface
+.072 to +0.092” off CAD surface

"B" MC is shown along with B1 scan points

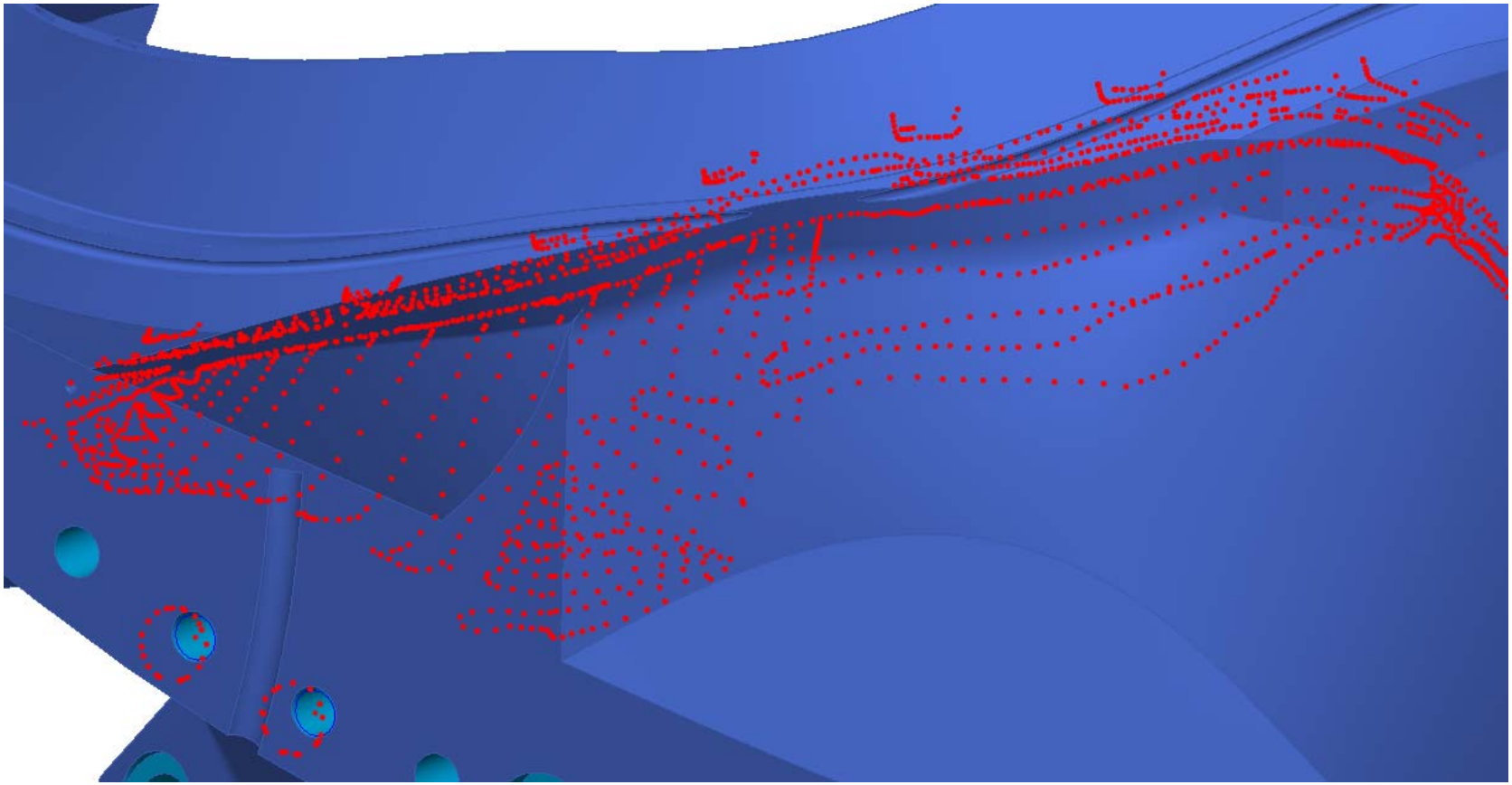


Recently scanned B1 points are shown in red shown with the CAD model of the C cladding.

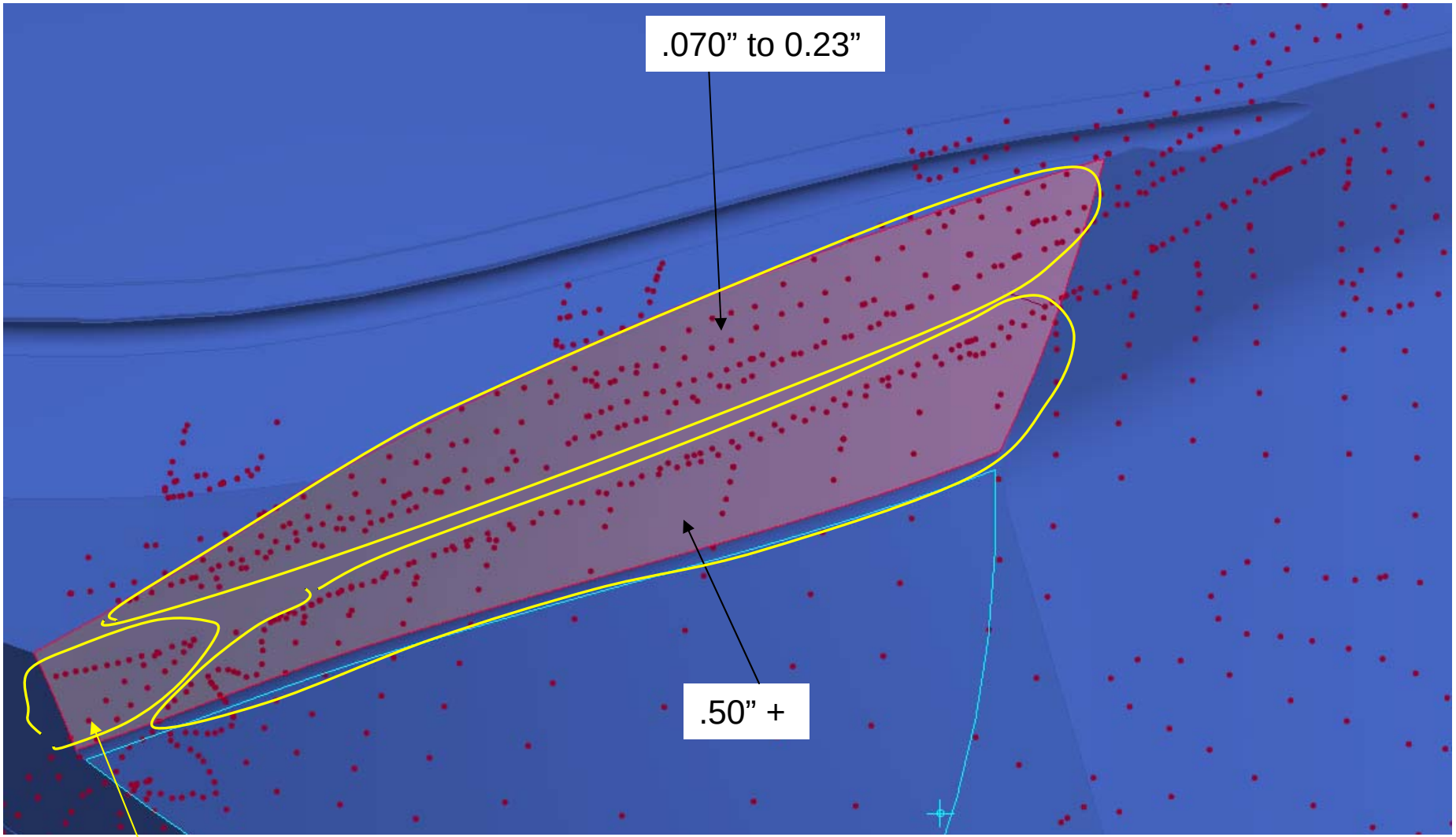



This ridge on “B” needs to be ground. Closest points have a 0.11” clearance.
Point:
SIMPLFD REP: B_C_CLADDING_

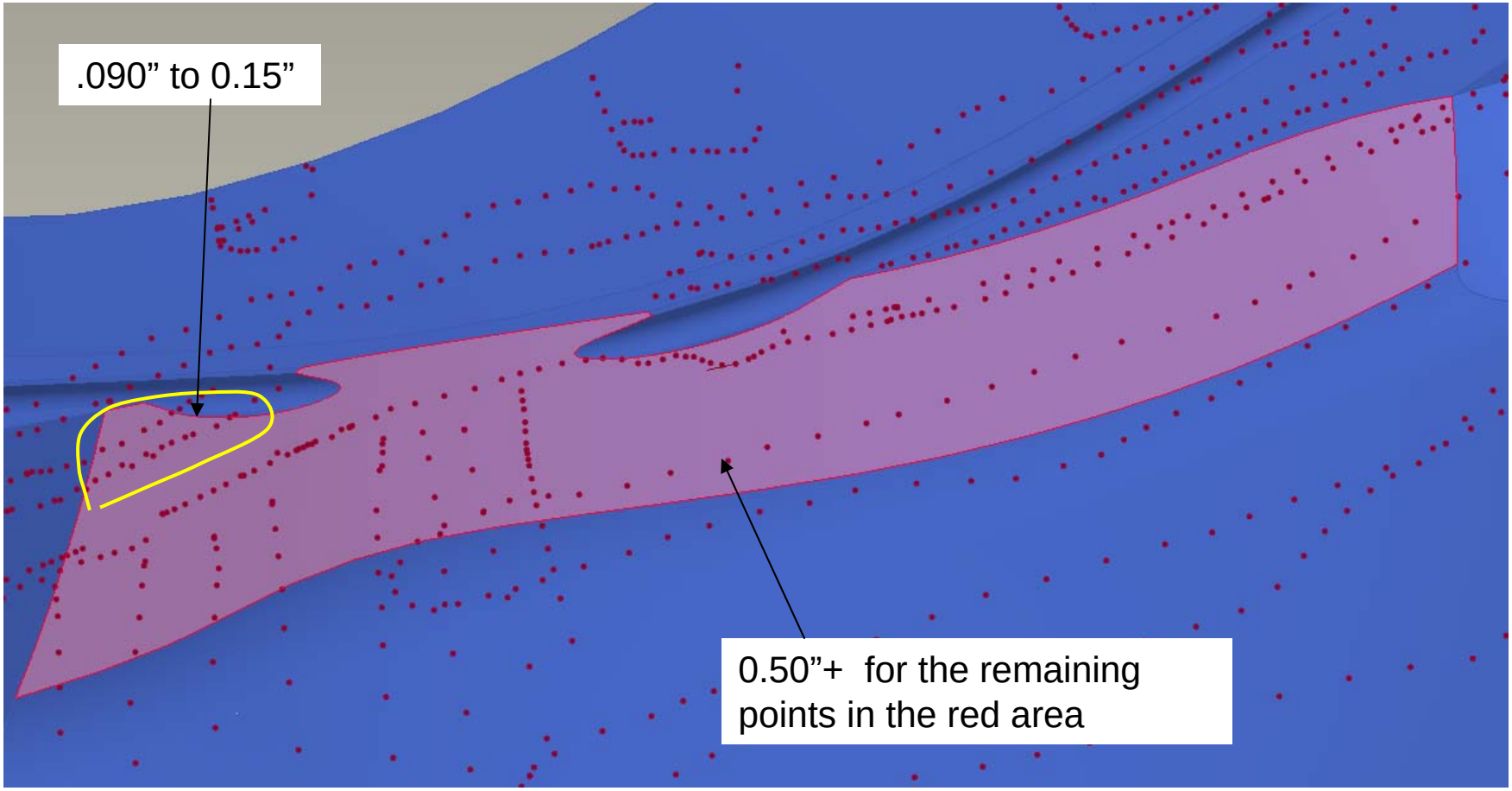
The “B” MC is the blue part shown with the recent scanned points of the “C1” MC.

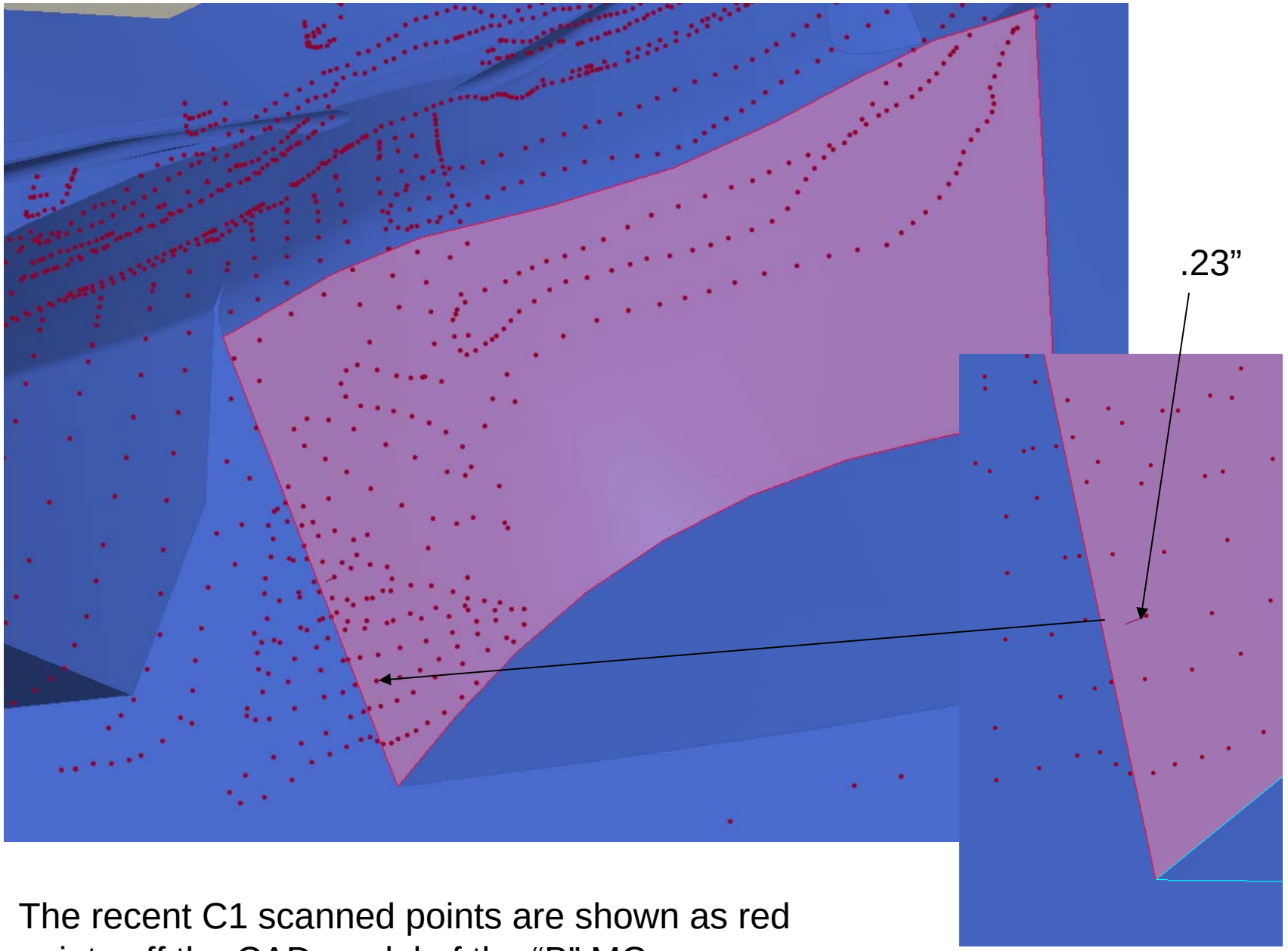


The recent C1 scanned points are shown as red points off the CAD model of the “B” MC.

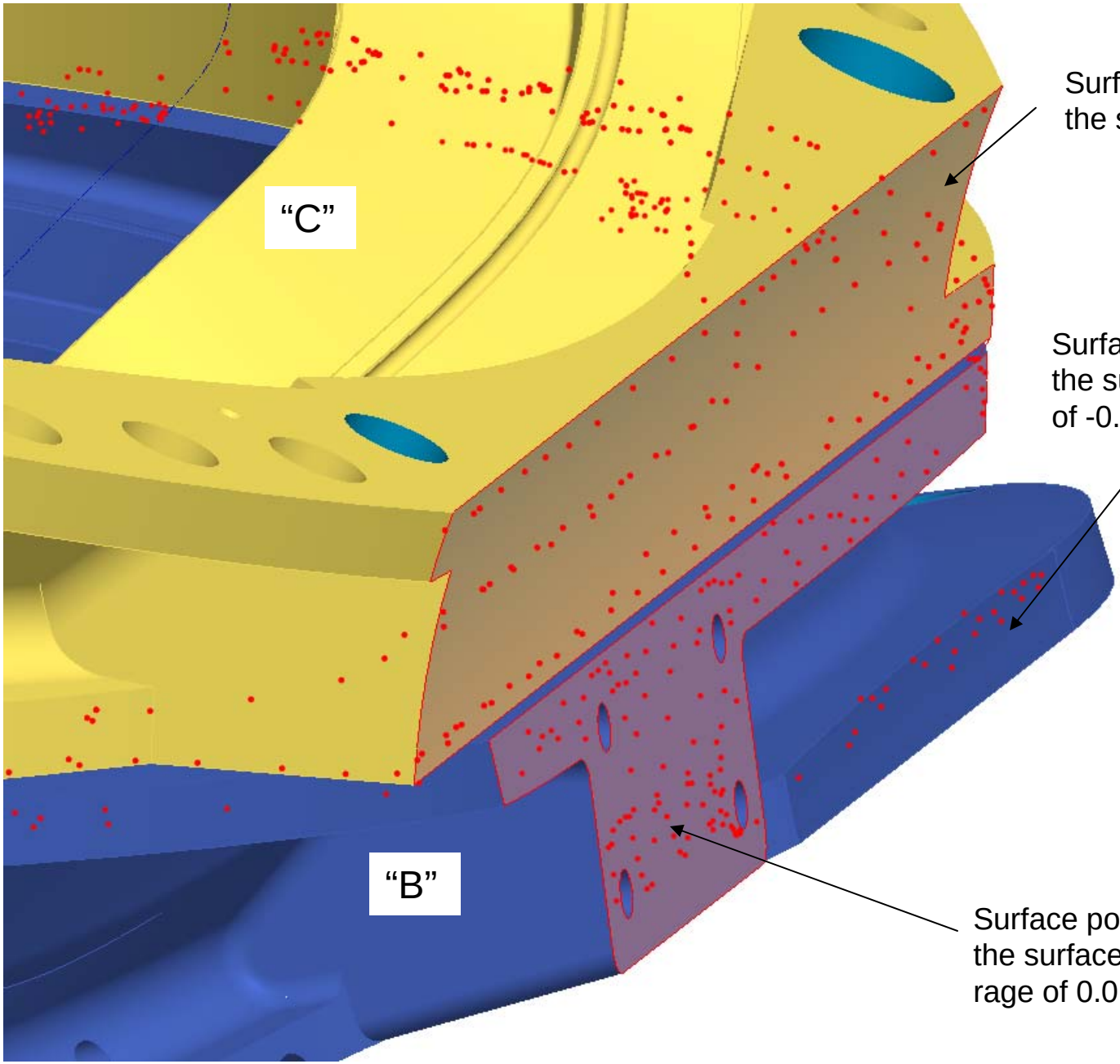


The recent C1 scanned points are shown as red points off the CAD model of the “B” MC.





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

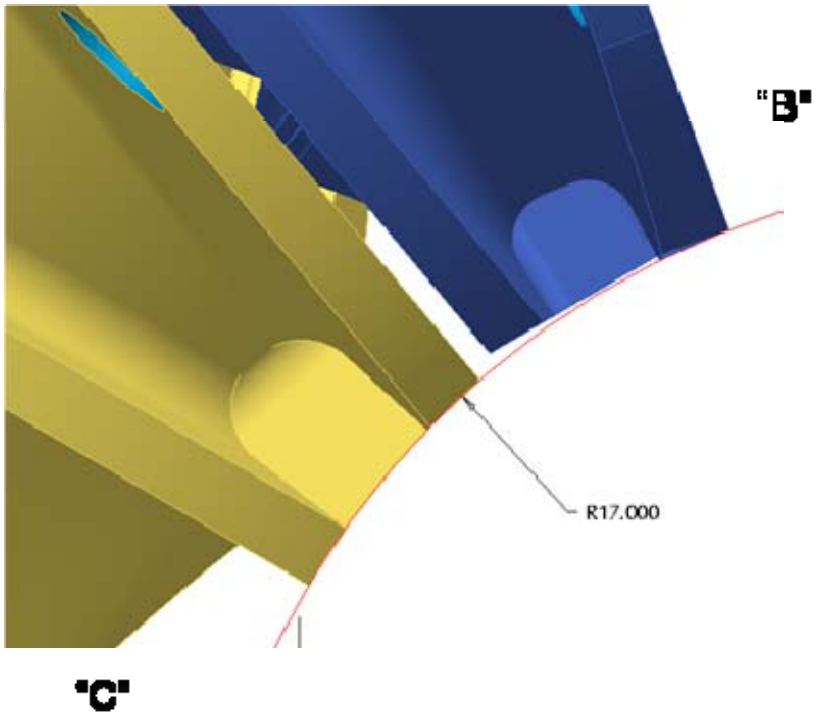


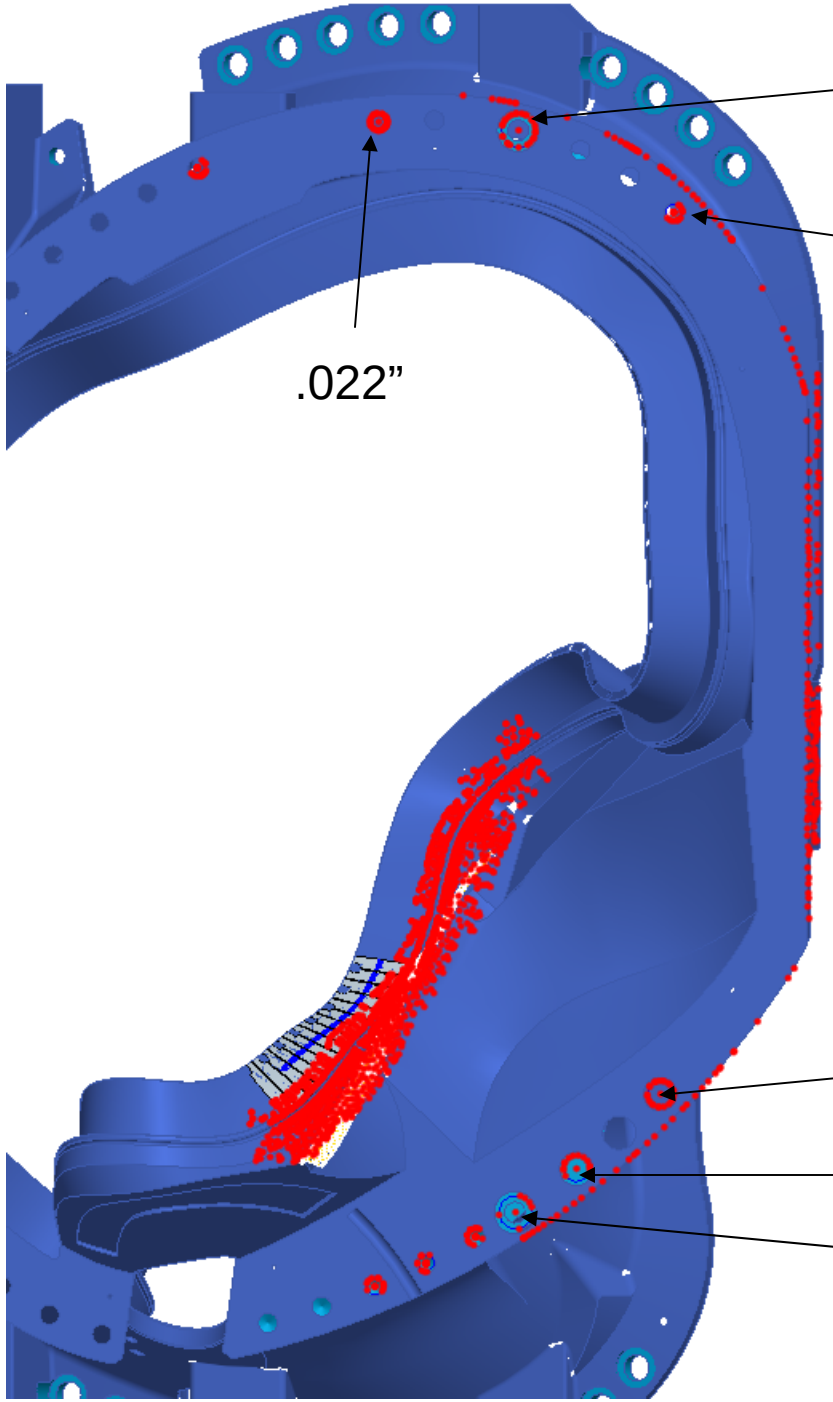
Surface points are off the surface by -0.050"

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.

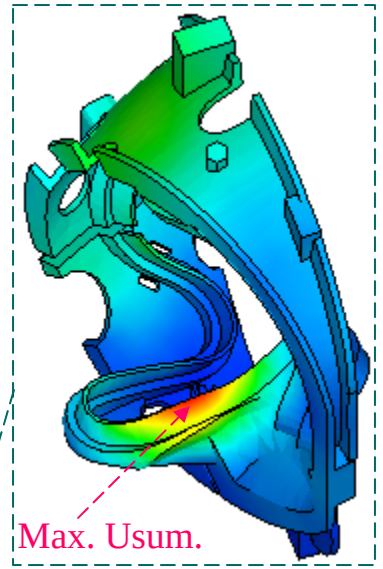
Nonlinear Analyses of Modular Coils and Shell structure for Coil Cool-down and EM Loads

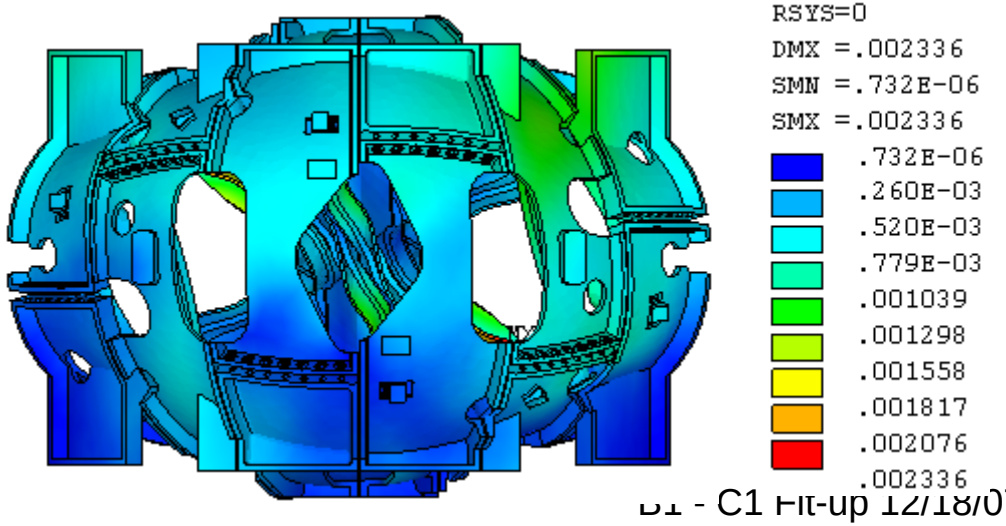
Part 1 – Results of Shell Structure and Modular Coils

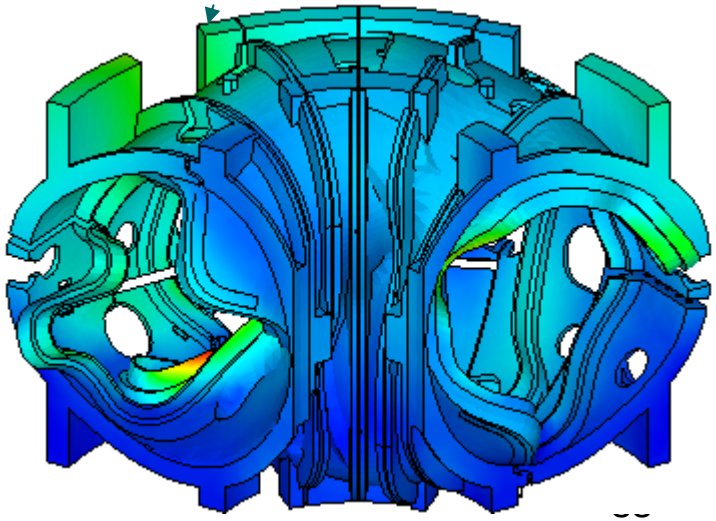
H.M. Fan
PPPL
Sept. 28, 2005

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

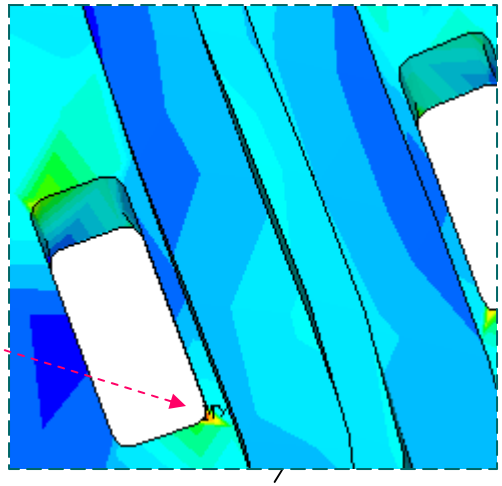


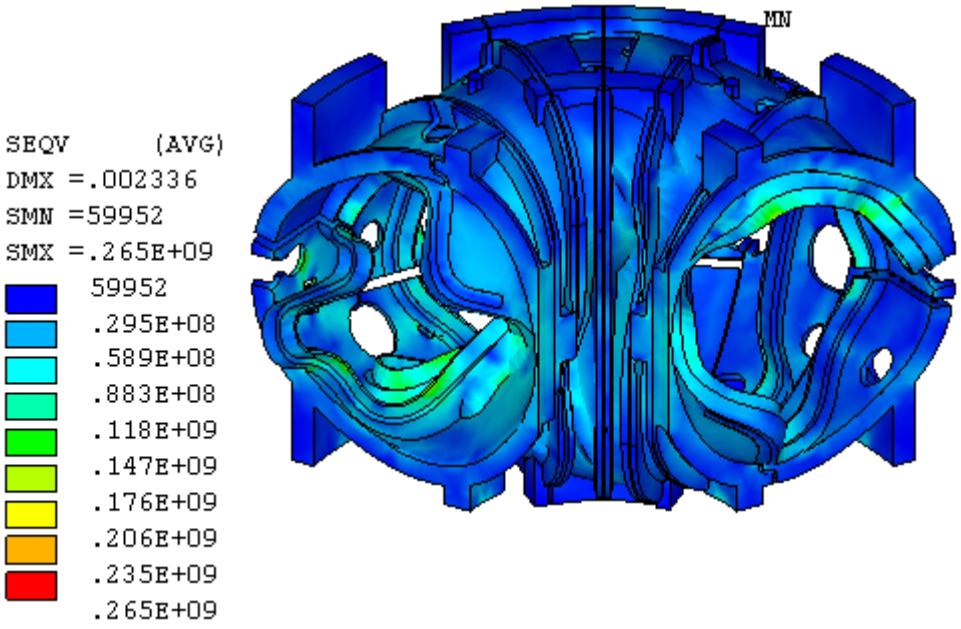


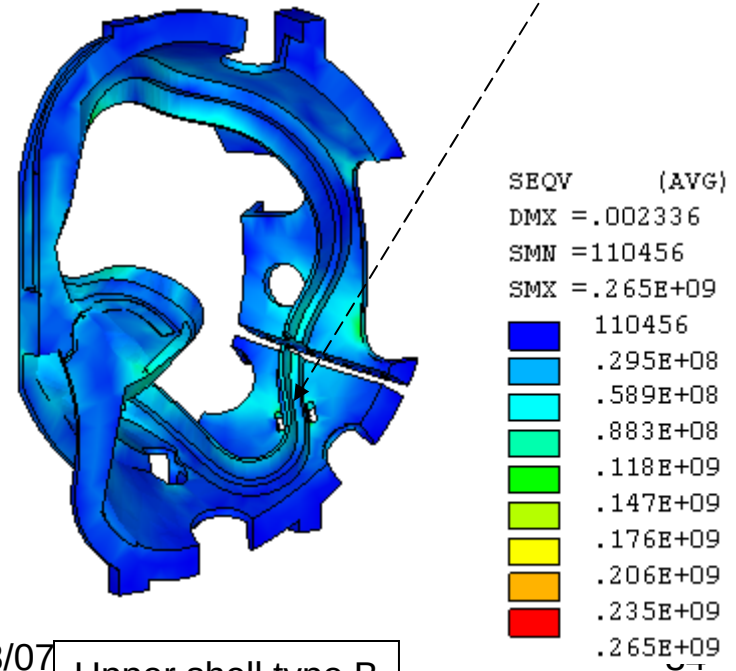


Von Mises Stress of Shell Structure

- 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