

RF Extremity Fingers (TCLPX, TCCTPXh, TCTPXV)

Engineering actions

R.Key EN-MME-EDS



ENGINEERING
DEPARTMENT

Previously...

HiCoIDEM Meeting #33



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

Materials:

- Fingers: CuBe C17410 with silver coating
- Bake-outs effects studied considering material properties¹
- Plate where the fingers are welded: Cu OFE
- Rings: 304L with radium coating
- Stroke for stress: From the stp position the jaw moves **28 mm in beam direction and 22 mm in OUT direction**
- Stroke for fatigue: From the stp position the jaw moves 25.5 mm in beam direction and 19.5 mm in OUT direction
- Speed: 2mm/s
- Number of cycles: 20.000

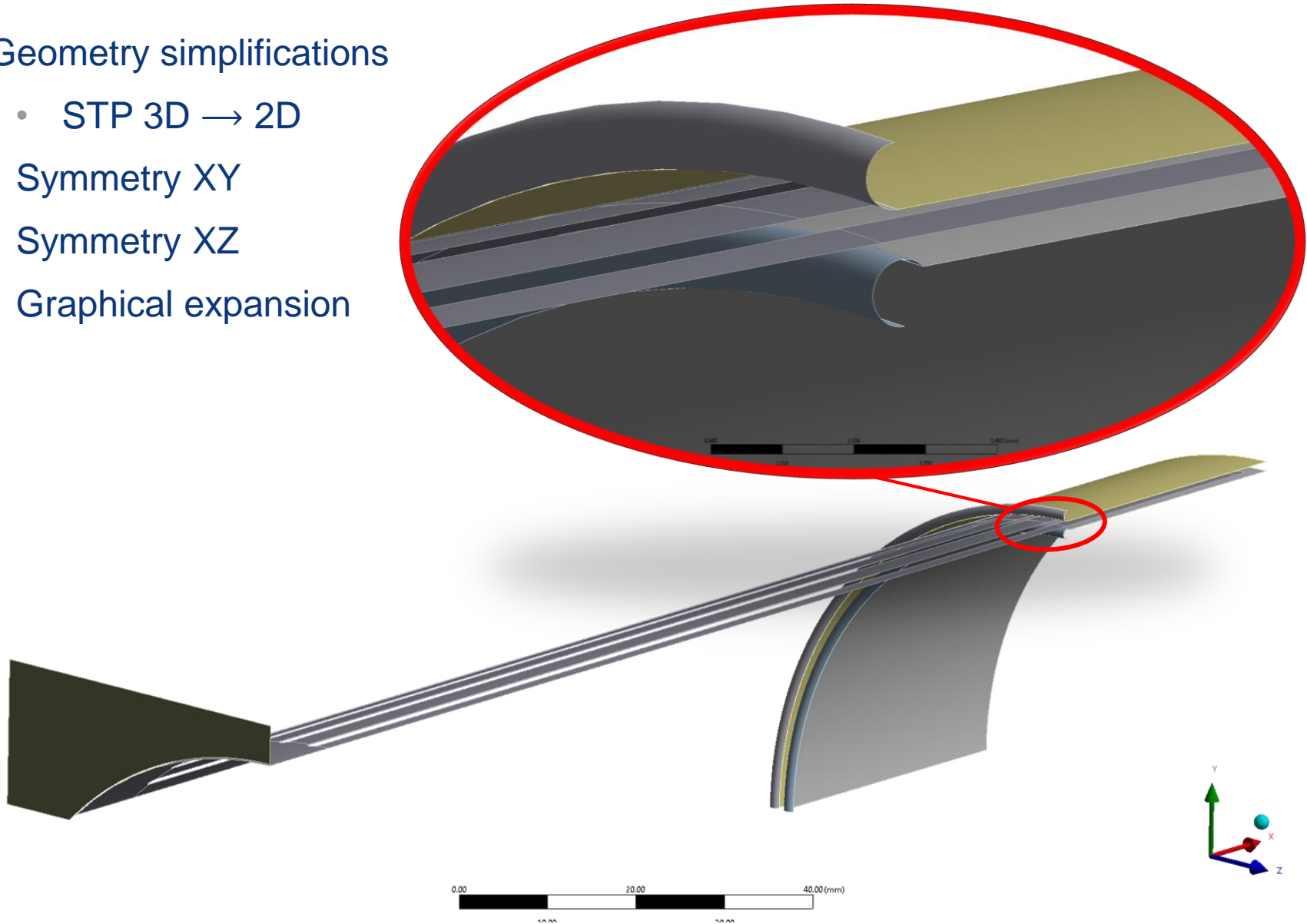
Request:

- Stress levels on fingers
- Fatigue > 20.000 cycles

¹ [1]Tensile testing of C17410 sheet before and after bakeout, J. Guardia, EN-MME-EDS, CERN, NOV 2018, [EDMS 2131206 v.1](#)

RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry simplifications
 - STP 3D \rightarrow 2D
 - Symmetry XY
 - Symmetry XZ
 - Graphical expansion



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Stress results → In-Beam direction

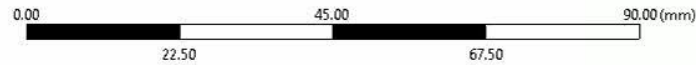
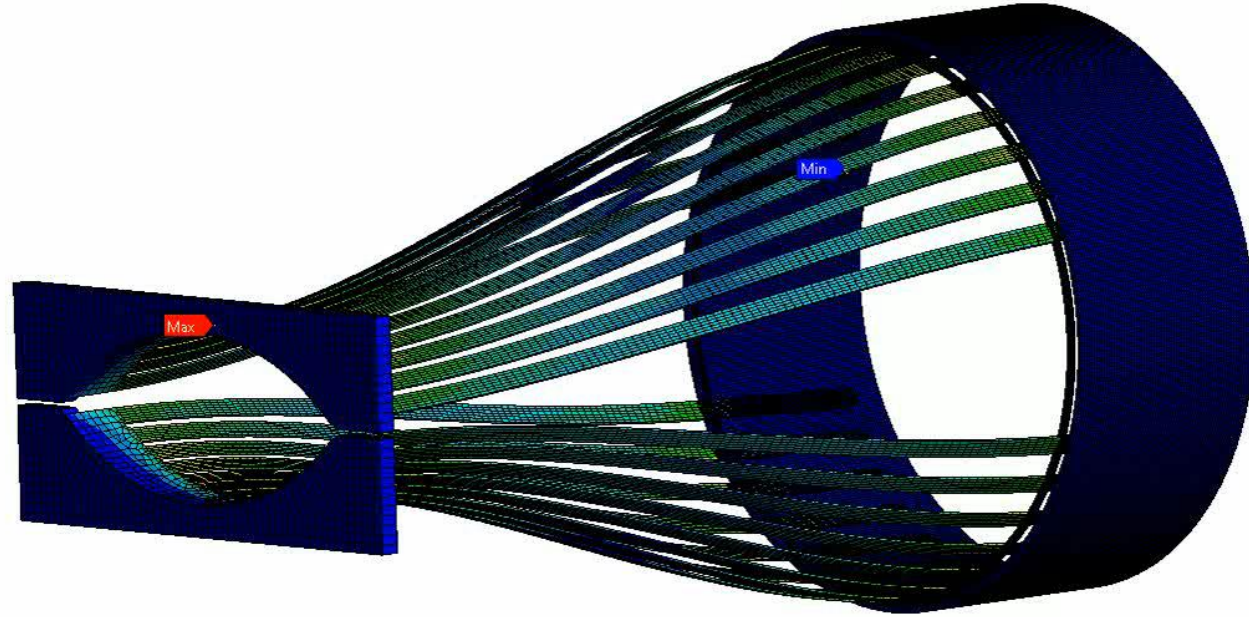
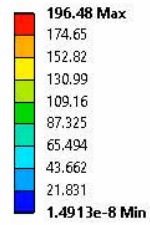
D: Static Structural - RF Exremity fingers - In beam

Equivalent Stress

Type: Equivalent (von-Mises) Stress - Top/Bottom

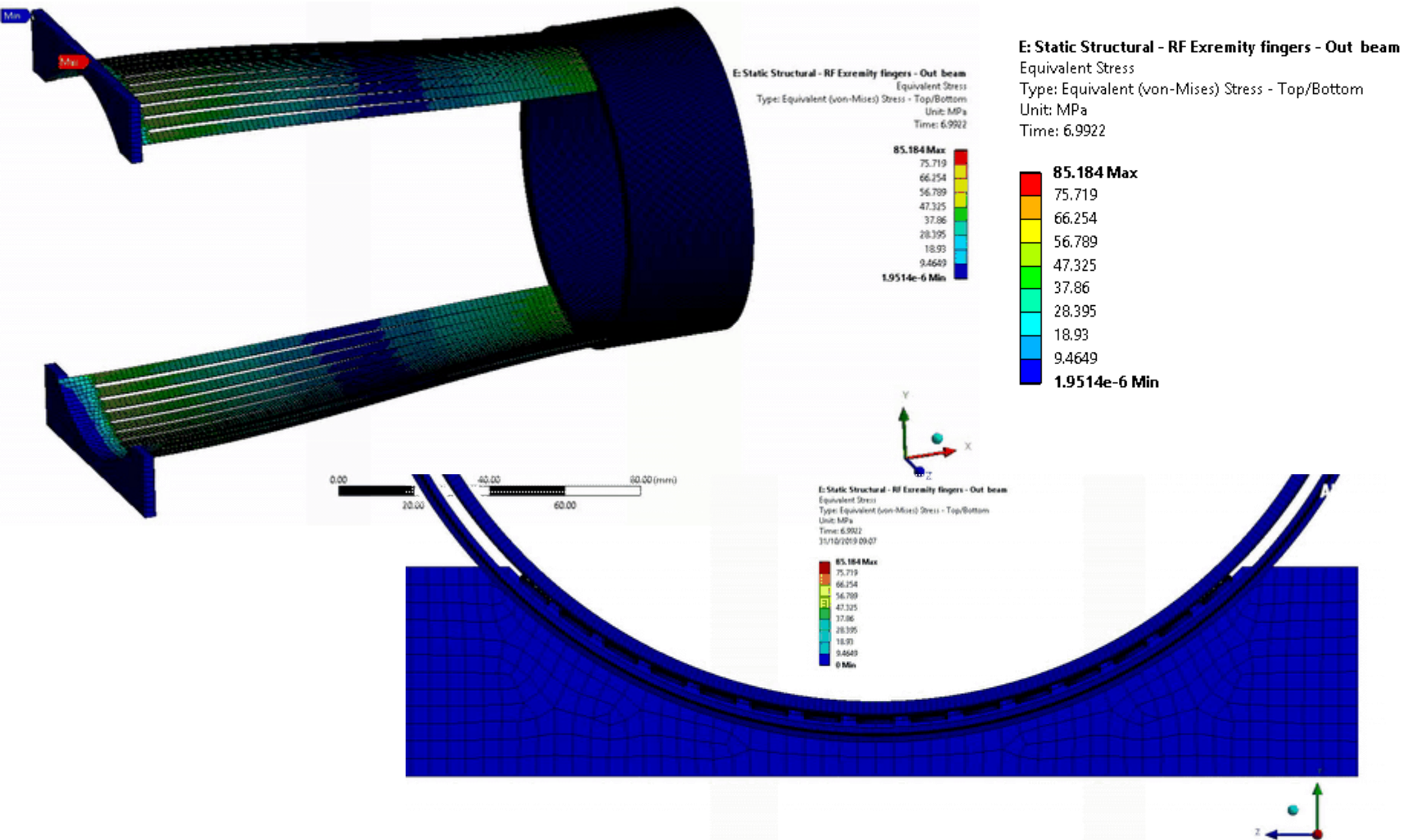
Unit: MPa

Time: 15



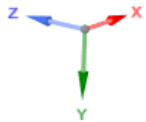
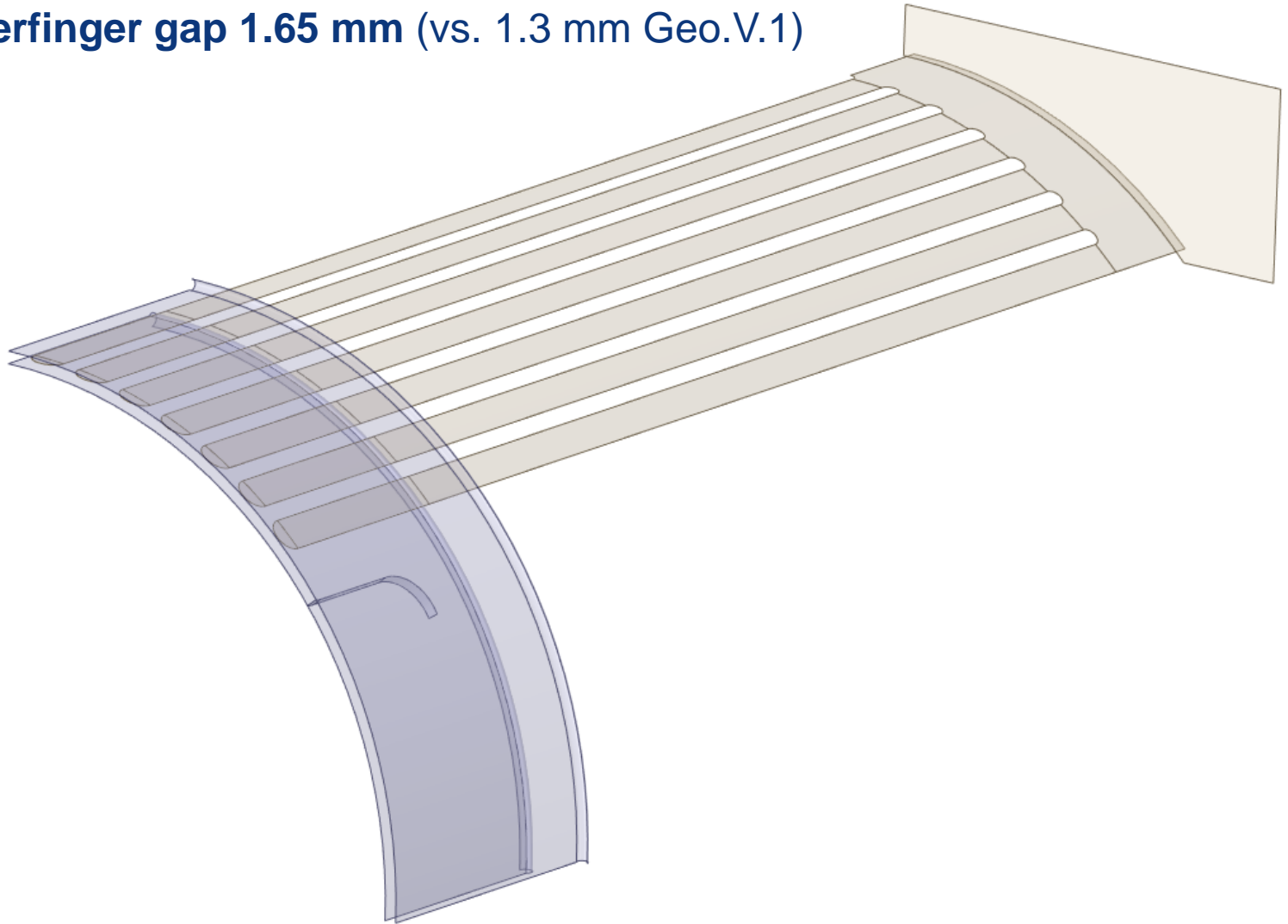
RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Stress results → Out-Beam direction



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.2 (-1 RF finger vs. Geometry V.1)
 - **Interfinger gap 1.65 mm** (vs. 1.3 mm Geo.V.1)



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

Geometries V.2 & V.3

Materials:

- Fingers: CuBe C17410 with silver coating
- Bake-outs effects studied considering material properties¹
- Plate where the fingers are welded: Cu OFE
- Rings: 304L with radium coating
- **Stoppers: 304L with radium coating**
- Stroke for stress: From the stop position the jaw moves **26.9 mm in beam direction and 22.1 mm in OUT direction**
- Stroke for fatigue: From the stop position the jaw moves **25.9 mm in beam direction and 22.1 mm in OUT direction**
- Speed: 2mm/s
- **Number of cycles: 30.000**

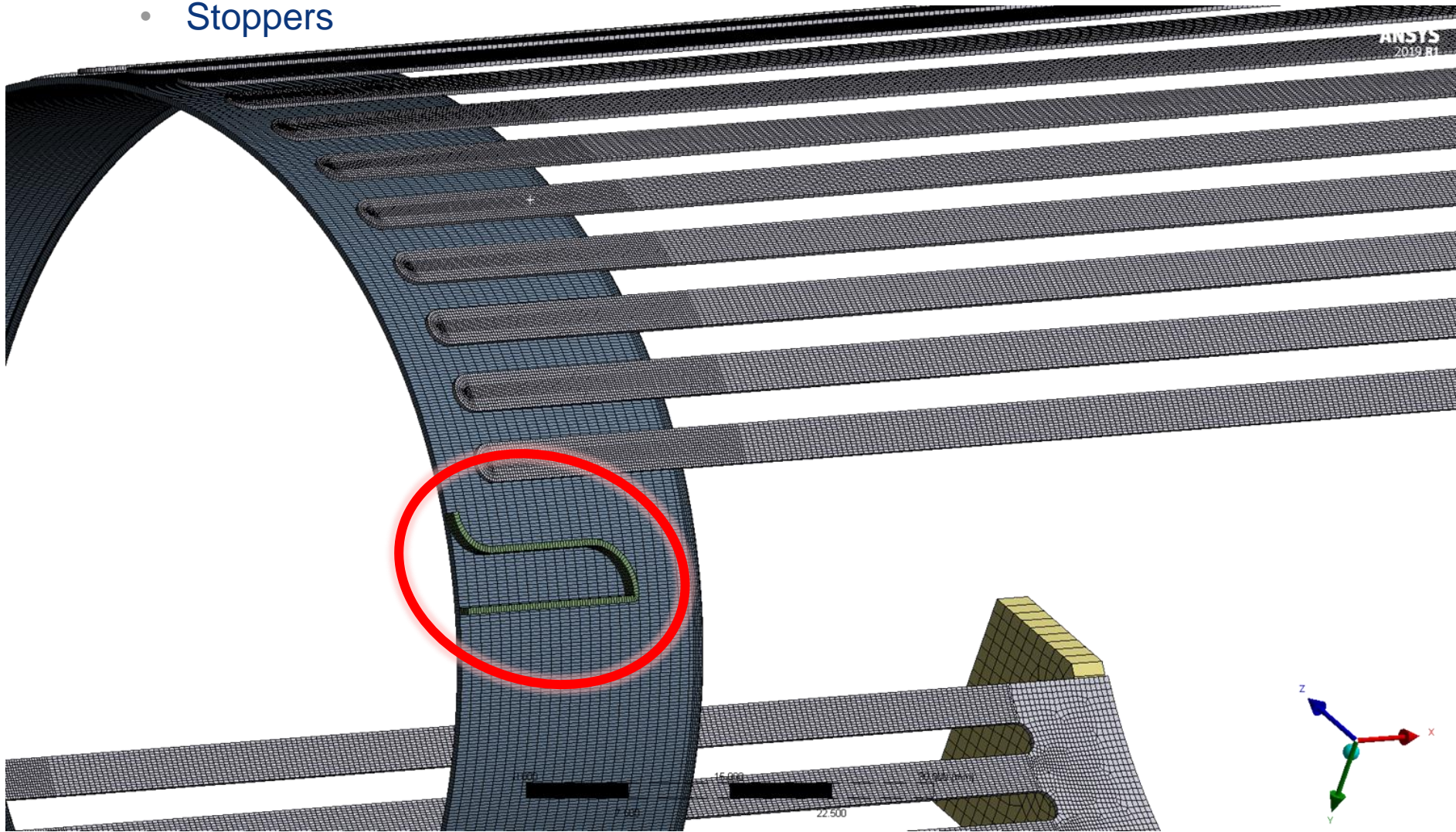
Request:

- Stress levels on fingers
- **Fatigue > 30.000 cycles**
- Contact force at the welding interface between RF Ext. Fingers and Plate

¹ [1] Tensile testing of C17410 sheet before and after bakeout, J. Guardia, EN-MME-EDS, CERN, NOV 2018, [EDMS 2131206 v.1](#)

RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

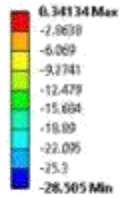
- New Features → Geometry V2 & V3
 - Stoppers



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.1 Displacements → In-Beam direction

D: Static Structural - RF Extremity fingers - In beam
Y Axis - Directional Deformation - Multiple - End Time
Type: Directional Deformation(Y Axis)
Unit: mm
Global Coordinate System
Time: 15



Geometry V.1 (Received: 24.09.19)

Status: Converged
Achieved 28 mm stroke (100%)

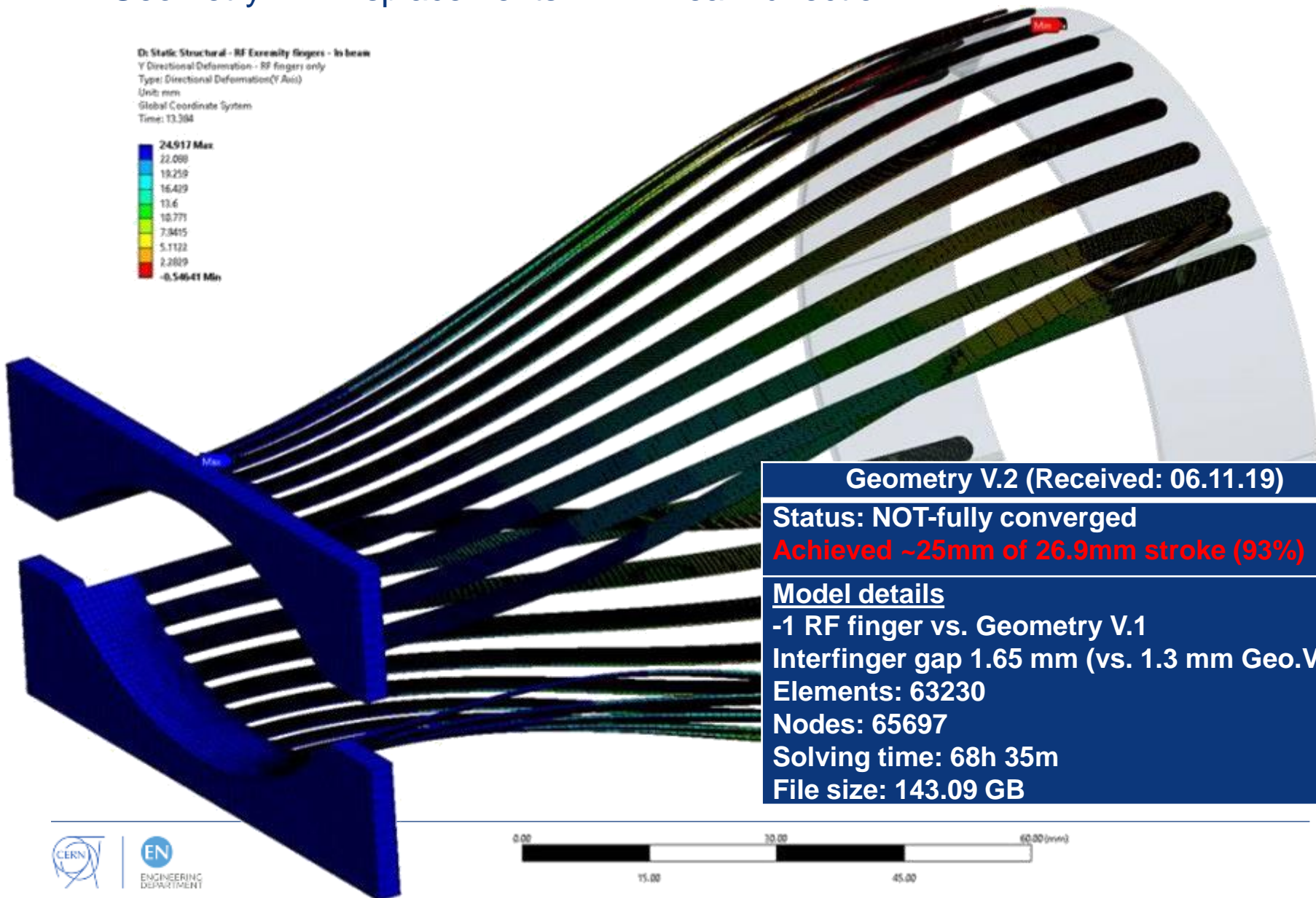
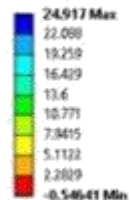
Model details
Elements: 23144
Nodes: 25451
Solving time: 10h 38m
File size: 65.707 GB



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.2 Displacements → In-Beam direction

D: Static Structural - RF Extremity fingers - In beam
Y Directional Deformation - RF fingers only
Type: Directional Deformation(Y Axis)
Unit: mm
Global Coordinate System
Time: 13.304



Geometry V.2 (Received: 06.11.19)

Status: NOT-fully converged

Achieved ~25mm of 26.9mm stroke (93%)

Model details

-1 RF finger vs. Geometry V.1

Interfinger gap 1.65 mm (vs. 1.3 mm Geo.V.1)

Elements: 63230

Nodes: 65697

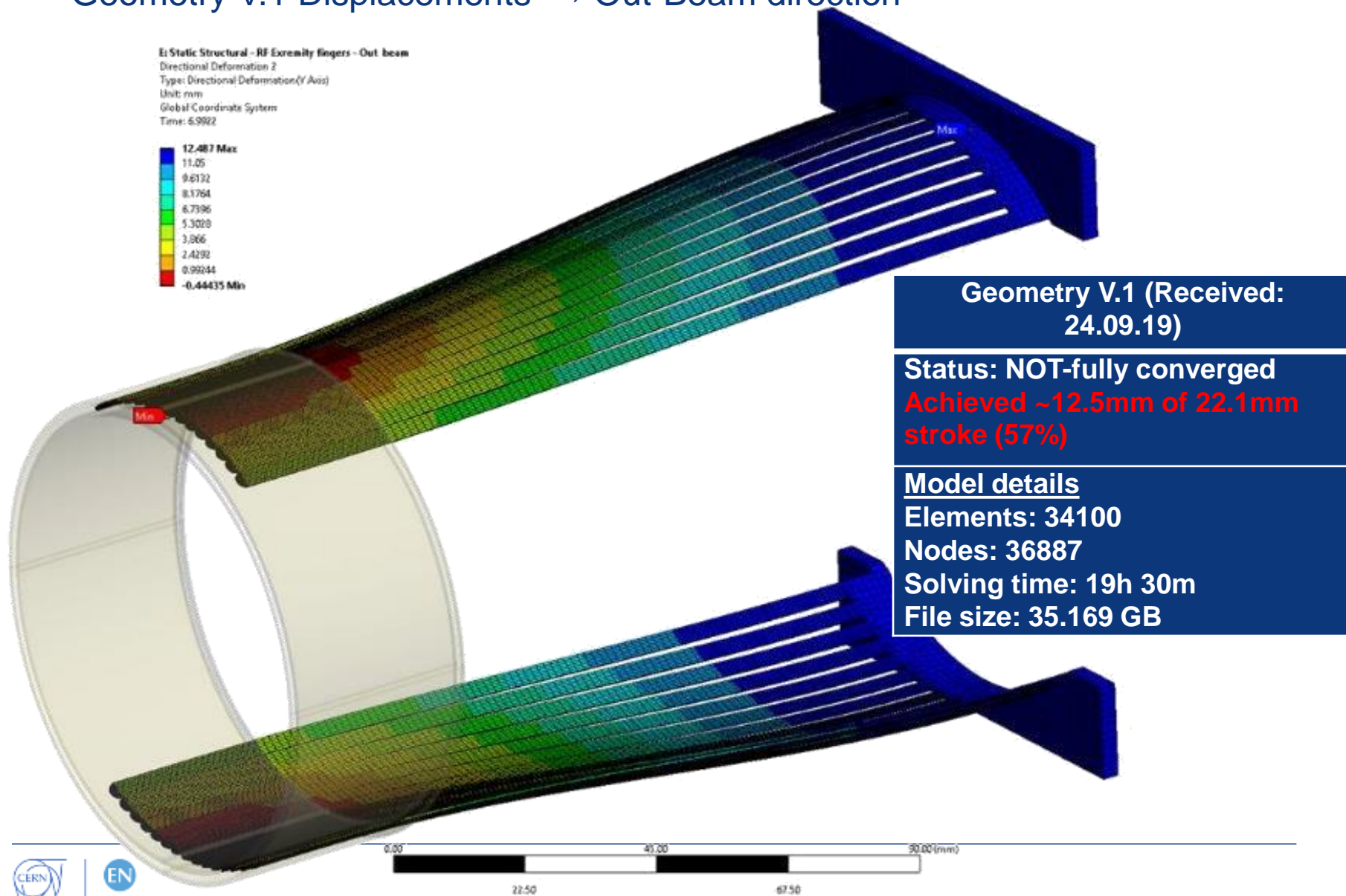
Solving time: 68h 35m

File size: 143.09 GB



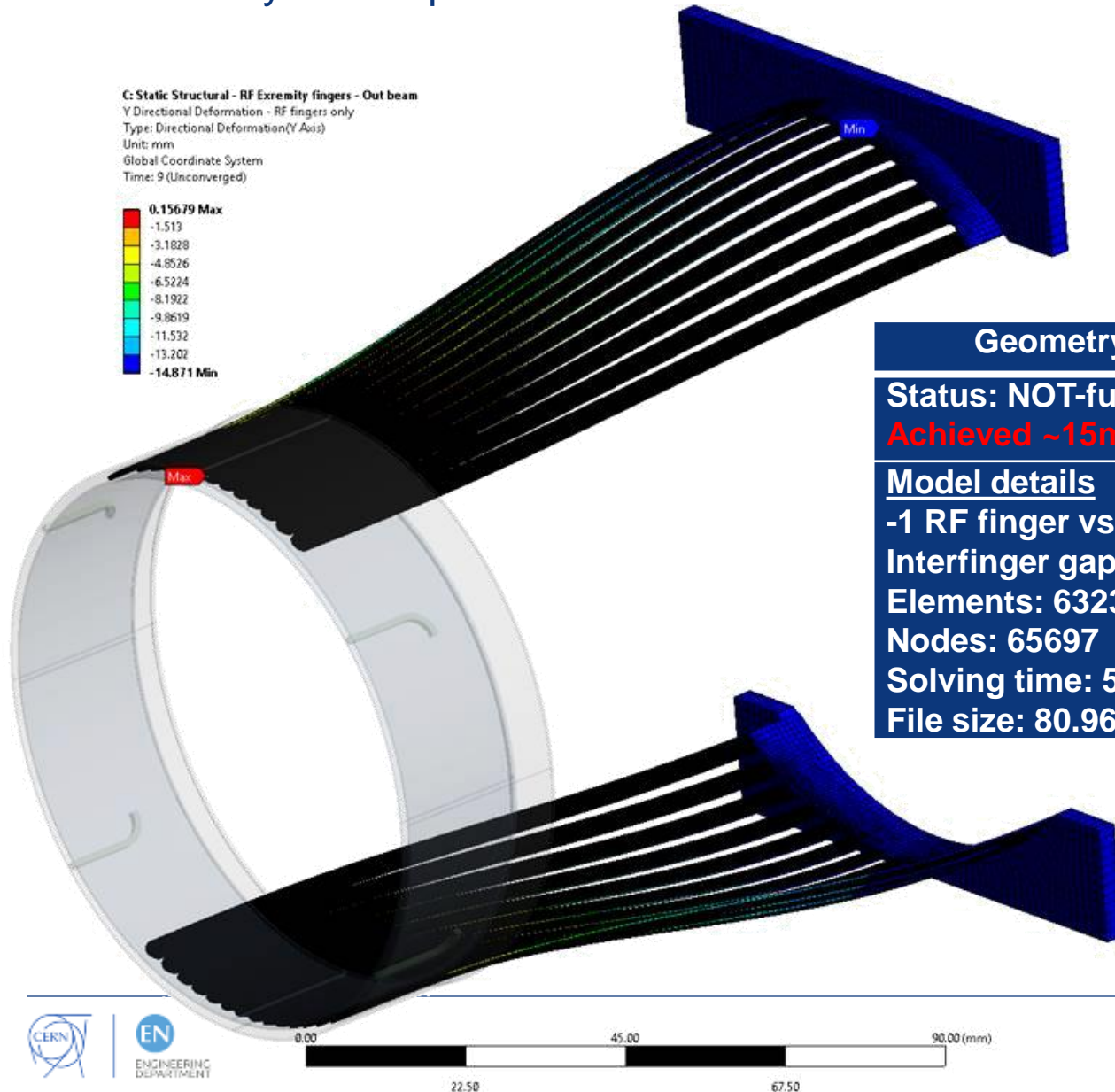
RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.1 Displacements → Out-Beam direction



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.2 Displacements → Out-Beam direction



Geometry V.2 (Received: 06.11.19)

Status: NOT-fully converged

Achieved ~15mm of 22.1mm stroke (68%)

Model details

-1 RF finger vs. Geometry V.1

Interfinger gap 1.65 mm (vs. 1.3 mm Geo.V.1)

Elements: 63230

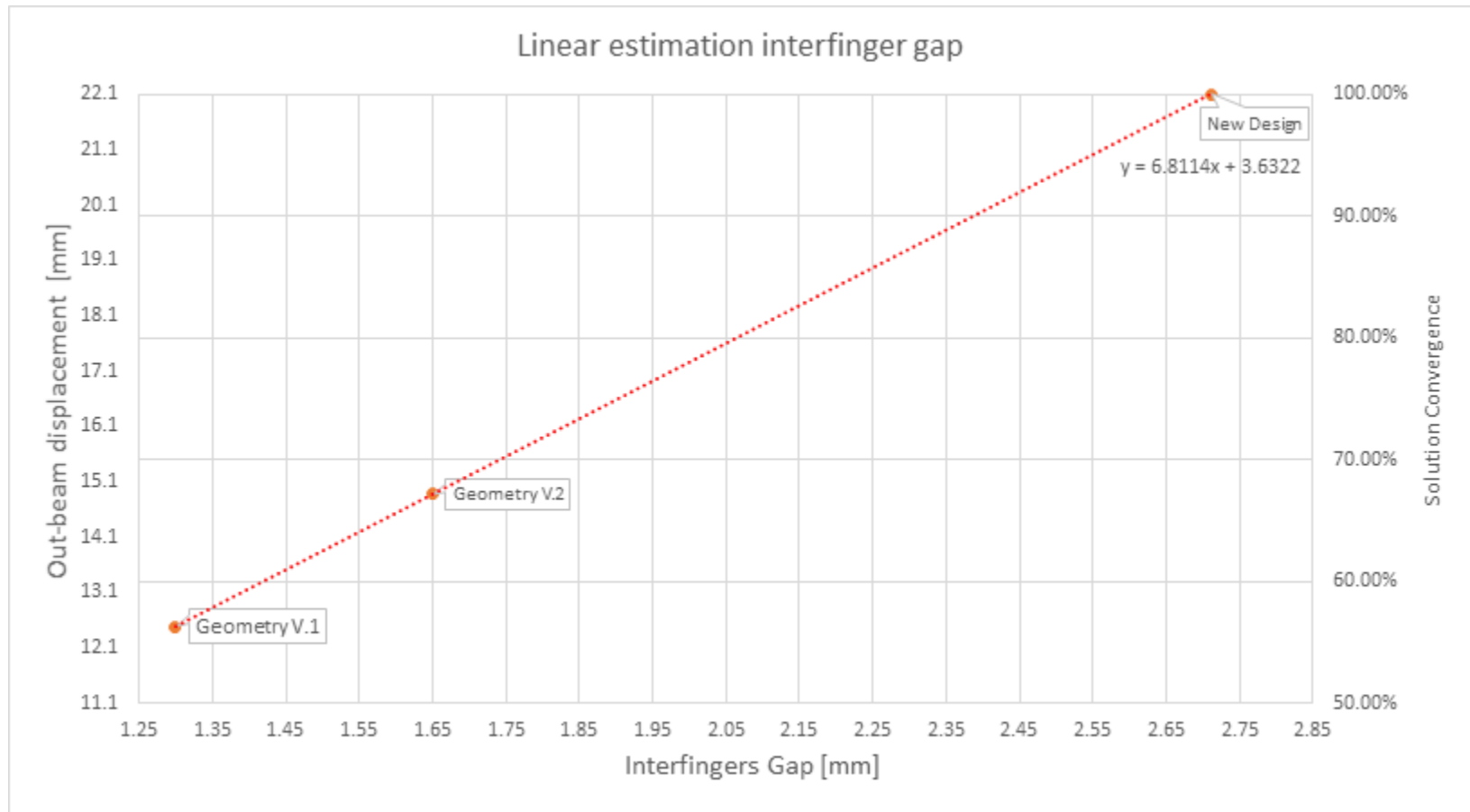
Nodes: 65697

Solving time: 56h 22m

File size: 80.964 GB

RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Out-Beam direction → Linear regression to achieve convergence

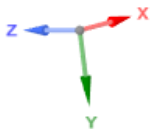
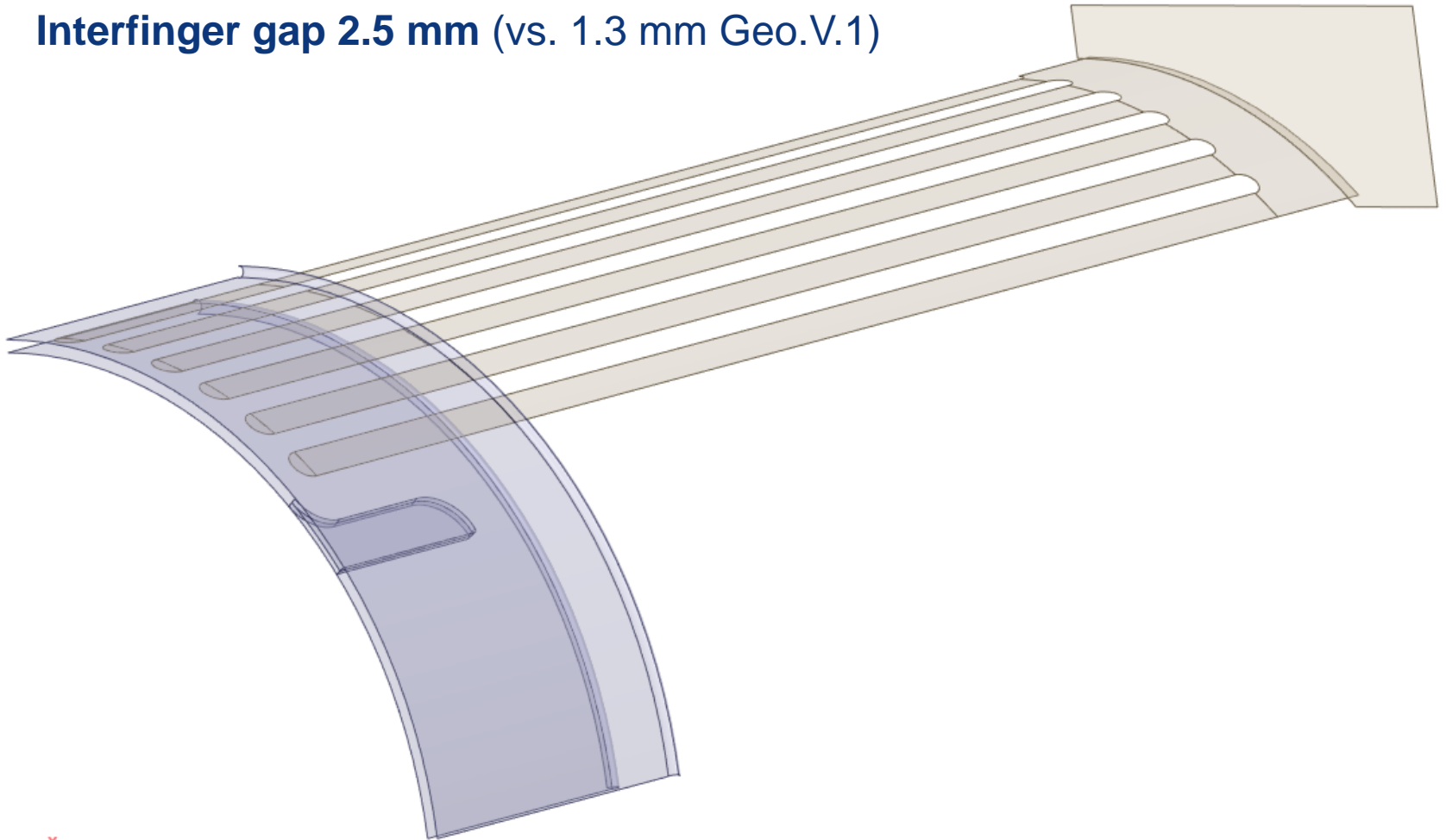


Linear estimation of the necessary interfinger gap: **2.7113 mm**

Proposed solution: remove extra 2 fingers and have a greater gap on the centre fingers that the ones located on the extremity's.

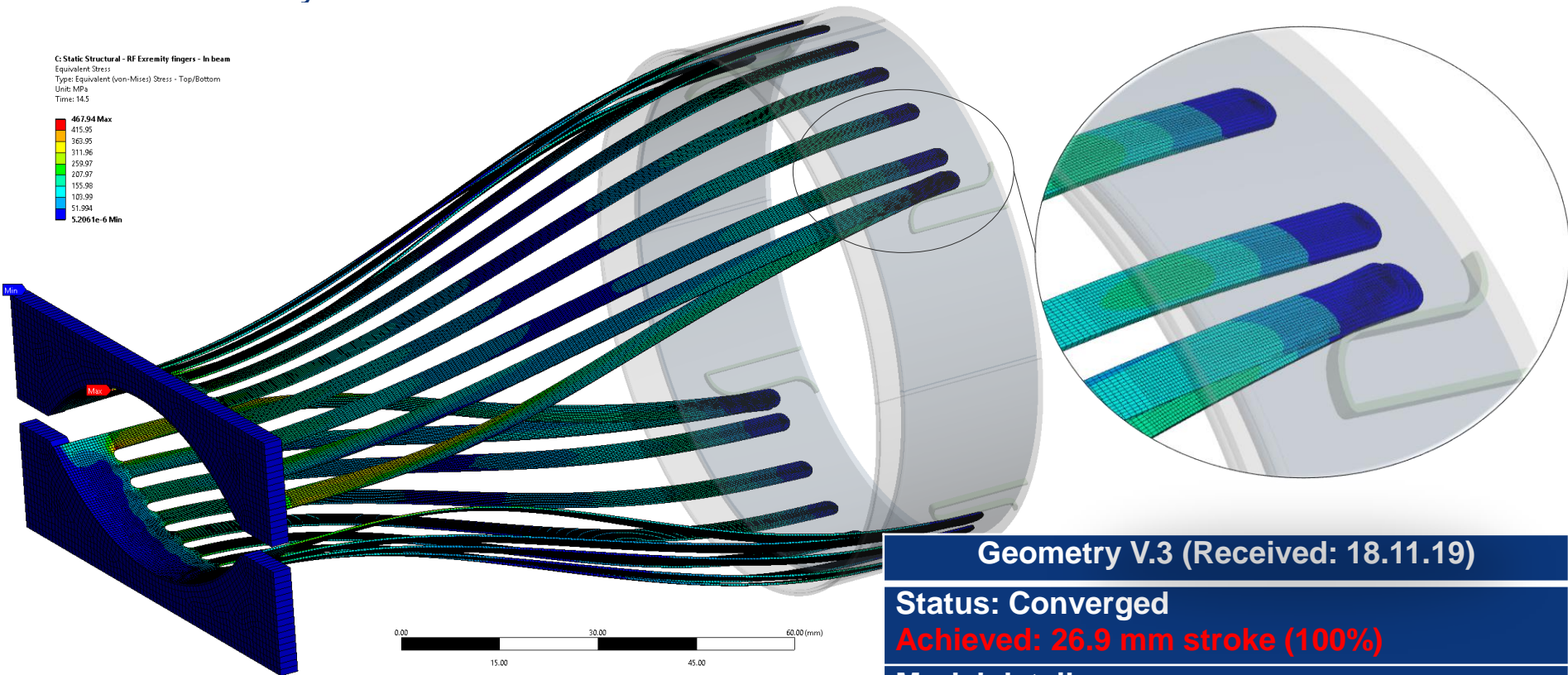
RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.3 (-3 RF finger's vs. Geometry V.1)
 - **Interfinger gap 2.5 mm (vs. 1.3 mm Geo.V.1)**



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.3 Stress results → In-Beam direction



Geometry V.3 (Received: 18.11.19)

Status: Converged

Achieved: 26.9 mm stroke (100%)

Model details

-3 RF finger vs. Geometry V.1

Interfinger gap 2.5 mm (vs. 1.3 mm Geo.V.1)

Elements: 52306

Nodes: 56641

Solving time: 18h 52m

File size: 7.6334 GB

RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.3 Stress results → In-Beam direction

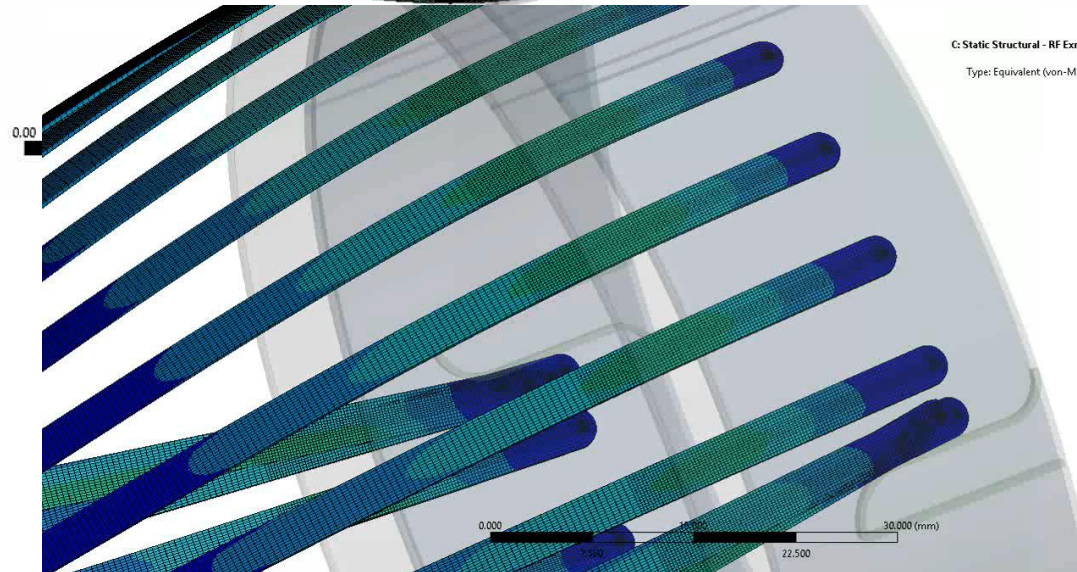
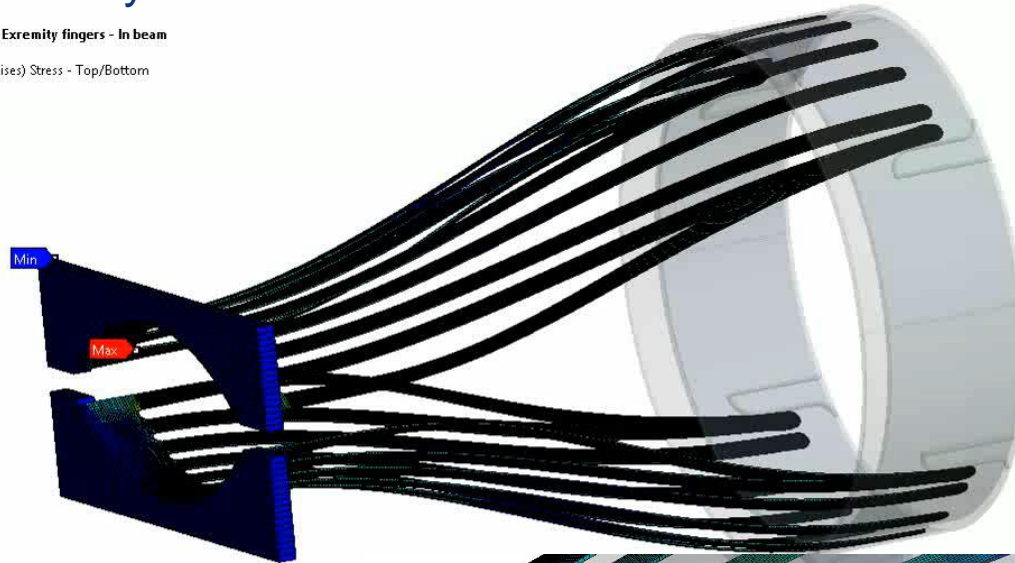
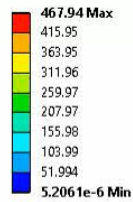
C: Static Structural - RF Exremity fingers - In beam

Equivalent Stress

Type: Equivalent (von-Mises) Stress - Top/Bottom

Unit: MPa

Time: 14.5



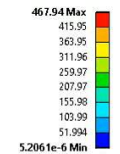
C: Static Structural - RF Exremity fingers - In beam

Equivalent Stress

Type: Equivalent (von-Mises) Stress - Top/Bottom

Unit: MPa

Time: 14.5



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

• Geometry V.3 Stress results → Out-Beam direction

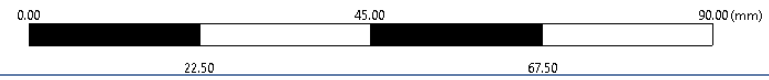
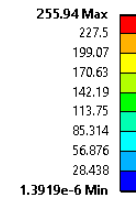


Geometry V.3 (Received: 18.11.19)

Status: Converged
Achieved: 22.1mm stroke (100%)

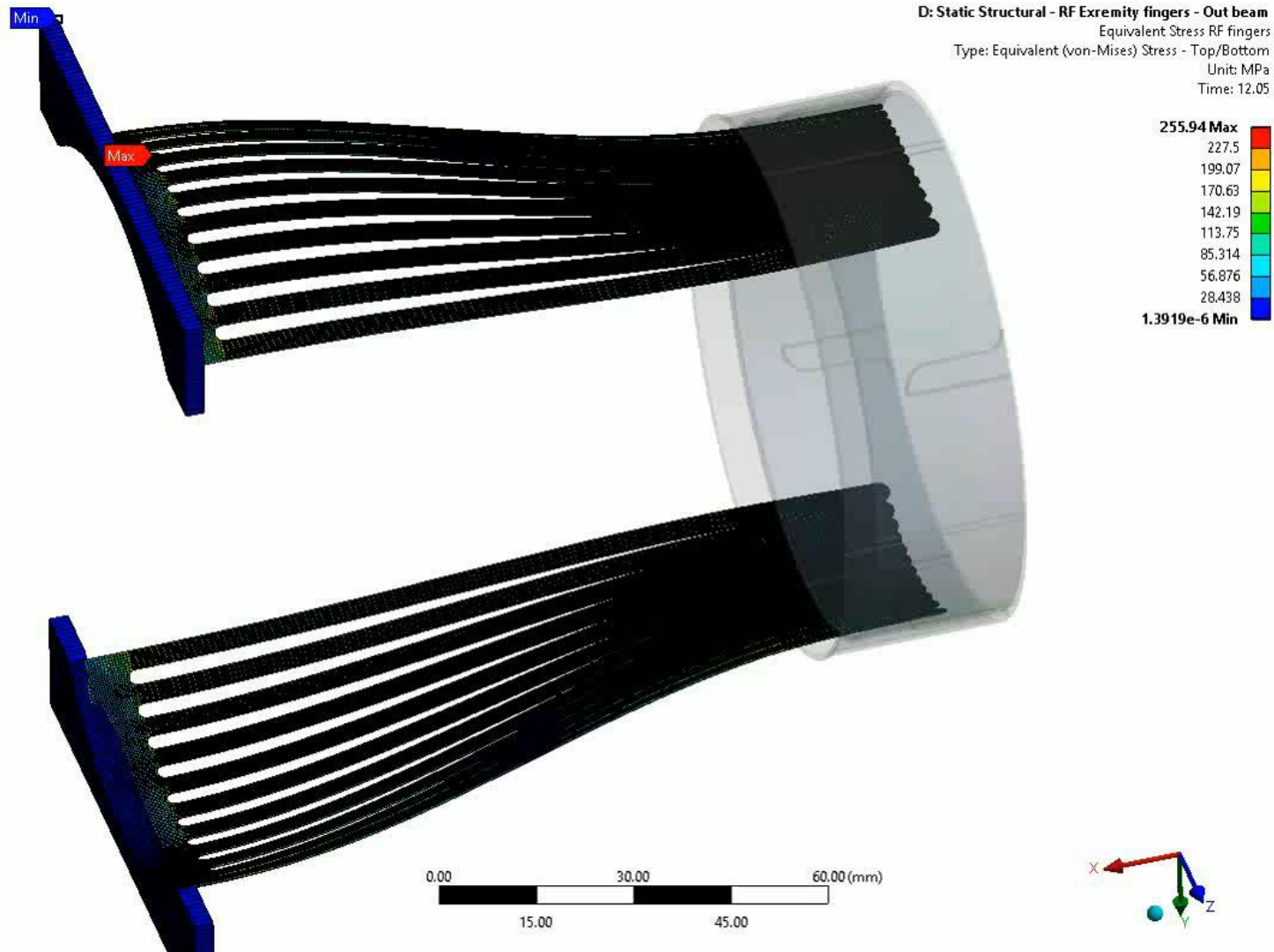
Model details
-3 RF finger vs. Geometry V.1
Interfinger gap 2.5 mm (vs. 1.3 mm Geo.V.1)
Elements: 52306
Nodes: 56641
Solving time: 49h 53m
File size: 86.651 GB

D: Static Structural - RF Exremity fingers - Out beam
Equivalent Stress RF fingers
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: MPa
Time: 12.05



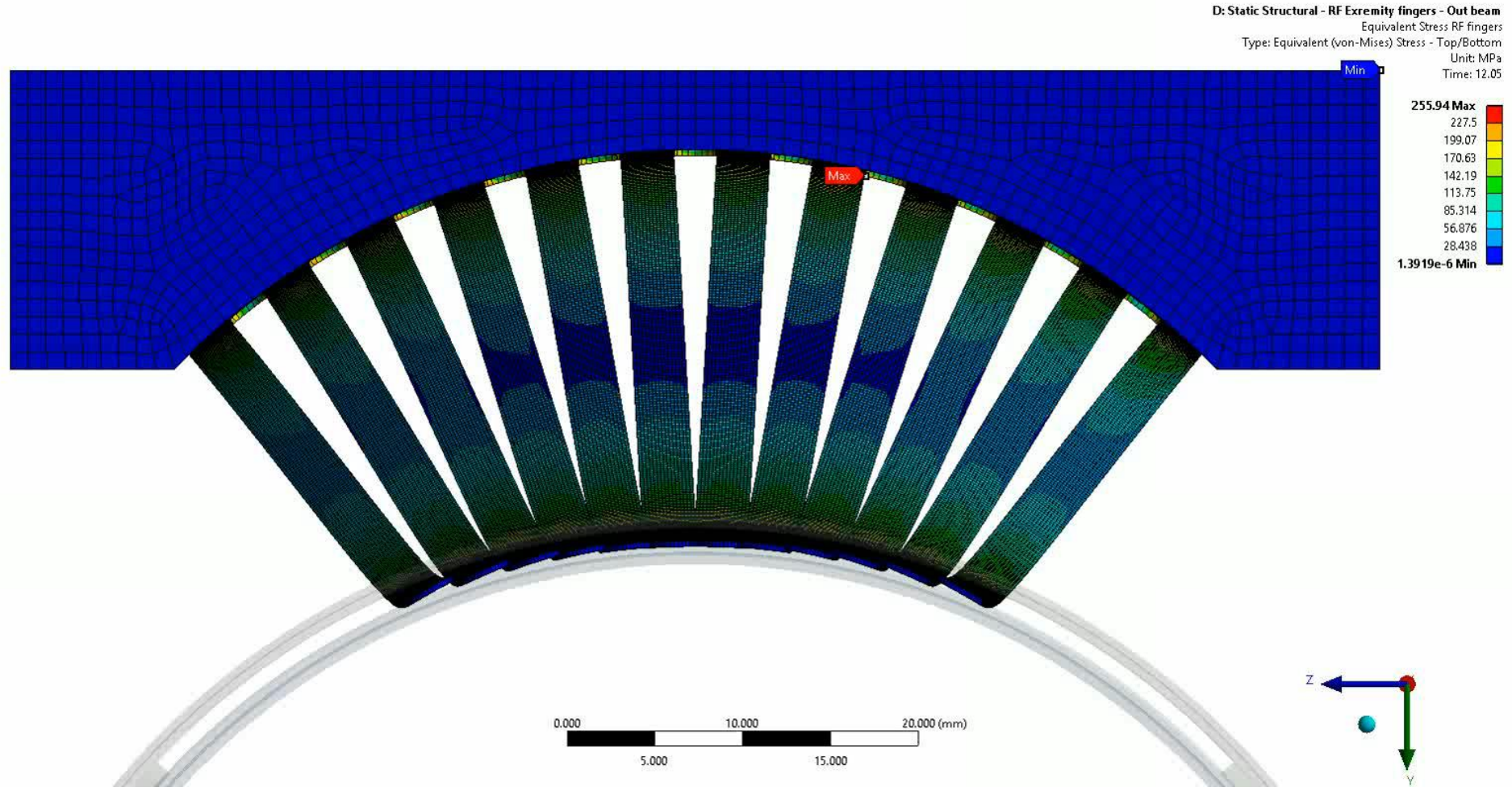
RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.3 Stress results → Out-Beam direction



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

- Geometry V.3 Stress results → Out-Beam direction



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

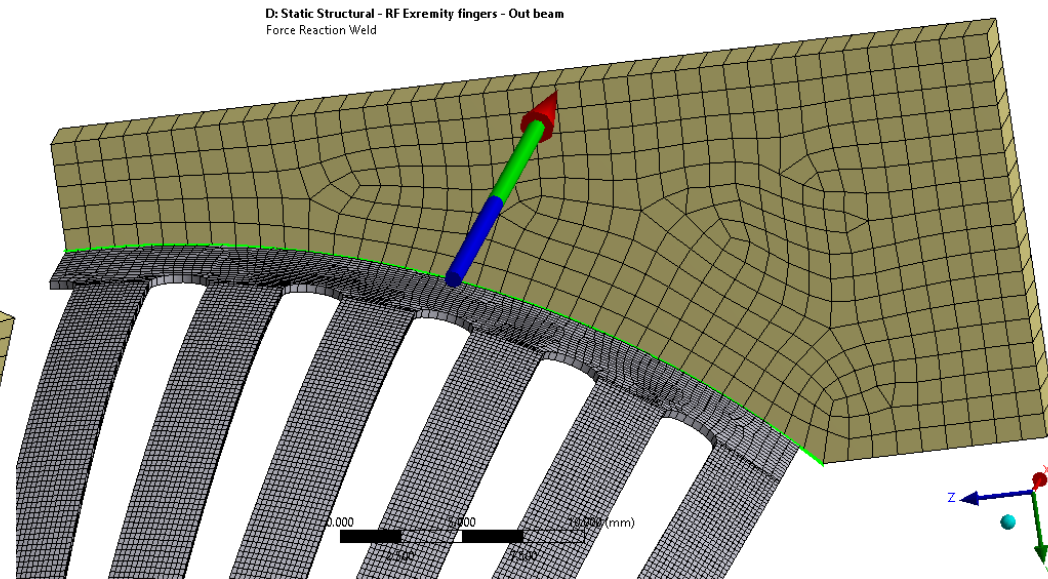
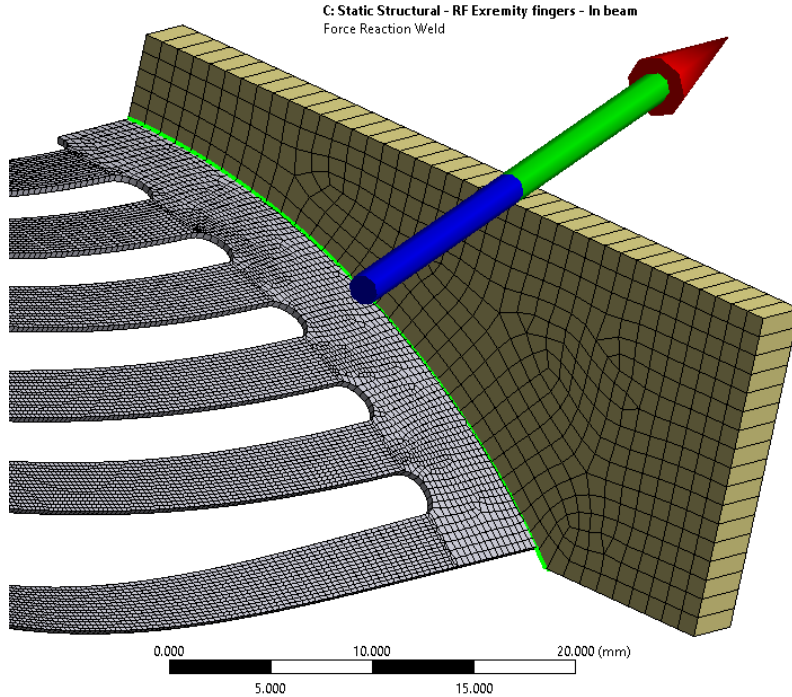
- Geometry V.3 → MAX. Force reaction @Weld

MAX. FORCE REACTION @WELD IN-BEAM

Time [s]	X [N]	Y [N]	Z [N]	TOTAL [N]
14.5	3.7387	-4.58E-01	6.63E-01	3.8246

MAX. FORCE REACTION @WELD OUT-BEAM

Time [s]	X [N]	Y [N]	Z [N]	TOTAL [N]
12.05	0.29638	-6.95E-02	-5.022E-02	0.30853



RF EXTREMITY FINGERS (TCLPX, TCCTPXh, TCTPXV)

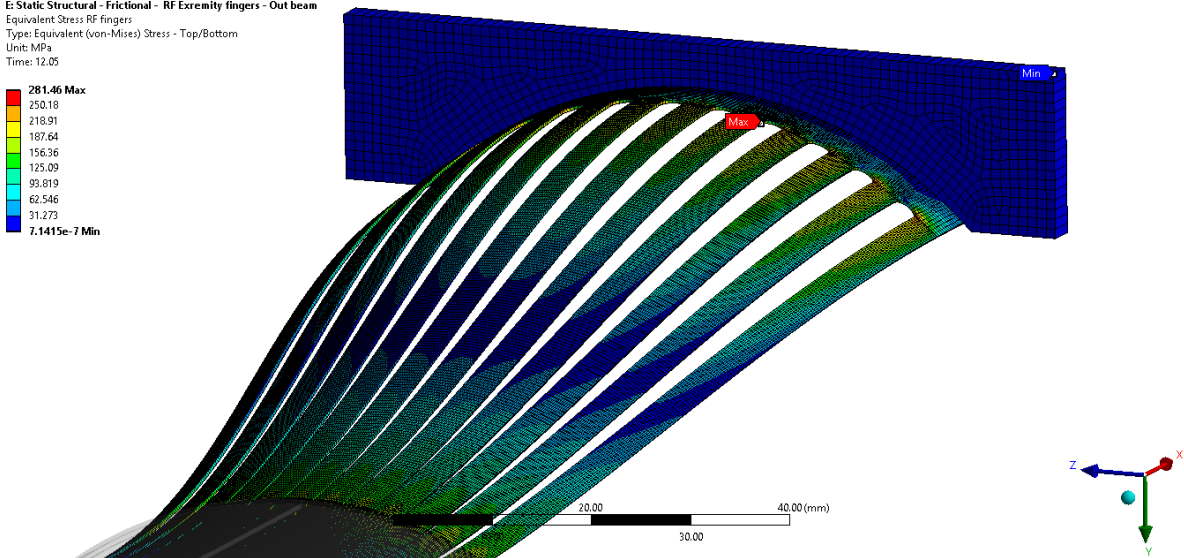
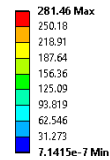
Ongoing

- Fatigue evaluation
- Introducing friction coefficient $\mu=0.15$
 - Already computed Out-beam case → **Stress higher 9.97%**
 - Currently computing In-beam

To be revised

- RF on the new geometries if accepted
- Weld safety coefficient

E: Static Structural - Frictional - RF Exremity fingers - Out beam
Equivalent Stress RF fingers
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: MPa
Time: 12.05





ENGINEERING
DEPARTMENT

Thank you!