

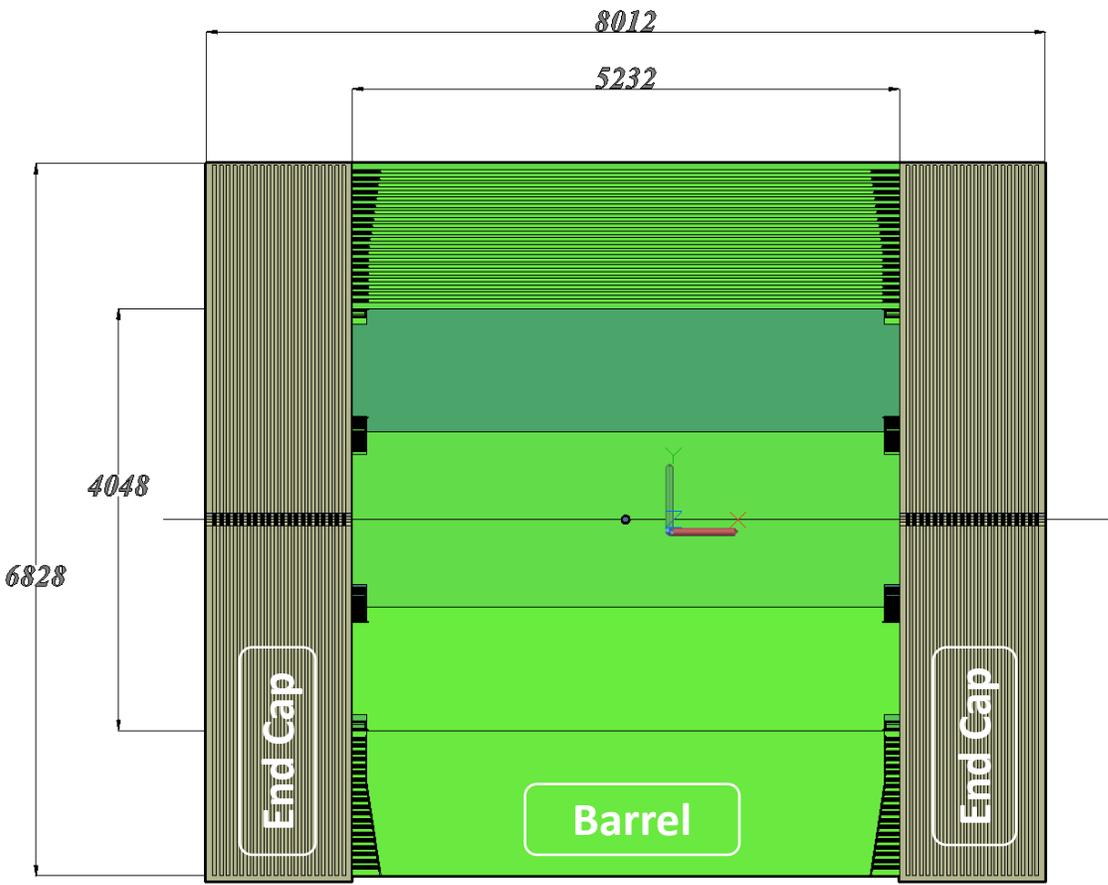
Range System Status Report

G. Alexeev
on behalf of SPD Muon Group

- **Main results:**
 - Mechanical FEA calculations for the final version of SPD setup conducted -> new/bigger SPD size
 - Digital FDM-192 module ready for tests (reported at DAQ session by A. Nikolaev)
- **Current activities:**
 - Reconstruction of MDT's assembly area (bld. 73) is in preparation
 - Contract with Integral (Minsk) on Ampl-8.53 amplifier is under discussion
 - Full size MDT plane prototyping with stand-imitator
 - Trigger scintillators for the RS prototype ready
 - Cherenkov counter test stand put in operation (at 45 atm/CO₂)
- **Plans for the rest of 2023**
- **Conclusion**

New sizes of SPD: +10 cm/R & +/-15 cm/longitudinally, absorber structure of RS
left the same
(vertical cross section)

Main consequences of final/bigger size: 1) green light to design of solenoid, 2) more space for inner detectors, 3) higher load on support frame and infrastructure -> need to modify/strengthen them (done)



Total weight of new SPD setup: 1267 (+113) ton

Barrel: 536 (+54,4) ton (*)
End Caps: 471,3 (+23,3) ton
Support & Transportation: 119,7 (+35,3) ton
Inner detectors & Solenoid: 100 ton
Upper platform: 40 ton

.....
(*) Barrel/8 modules = 67 ton (within crane capacity)

The scope of conducted FEA calculations for the new/bigger size of SPD setup

All inner subsystems, except for solenoid, are kept with old weights

A. Samartsev:

The purpose of the calculations was to evaluate the overall ability of the RS structure, together with the detectors located inside the barrel, the equipment on the upper platform and the support-moving system as a joint force system, to bear the load from its own weight in several of the most critical (design) cases. Like that:

- the case of a fully assembled unit with closed EC doors, located on three roller sets (six bottom carts);
- a previous case on 8 jacks (one of the possible working situations) ;
- a case with End Caps doors rolled to the maximum opening on 6 carts and additional supports at the ends of long rail beams.

1. The optimal locations for pairs of carts and pairs of jacks were selected to ensure uniform distribution of loads on the supporting elements for these cases.
2. A variant of strengthening the support-transport system was selected to ensure that the parameters of the stress-strain state of the load-bearing structure are not worse than those of the old SPD version.
3. For all considered cases, stresses do not exceed 600-700 kg/cm², which is quite acceptable for 'Steel 3' material.
4. The main results of all considered options (power circuit, modeling of force and kinematic boundary conditions, selected distances for support elements) are presented on the slides.

To understand pictures:

- pink arrows and large red arrow - distributed loads from elements not considered in the power circuit (internal detectors and equipment on the upper platform) and the gravitational component;
- green arrows - modeling of supporting elements;
- the results (stresses, displacements) are shown by color spectrum, and in critical places by numerical values.

New SPD setup

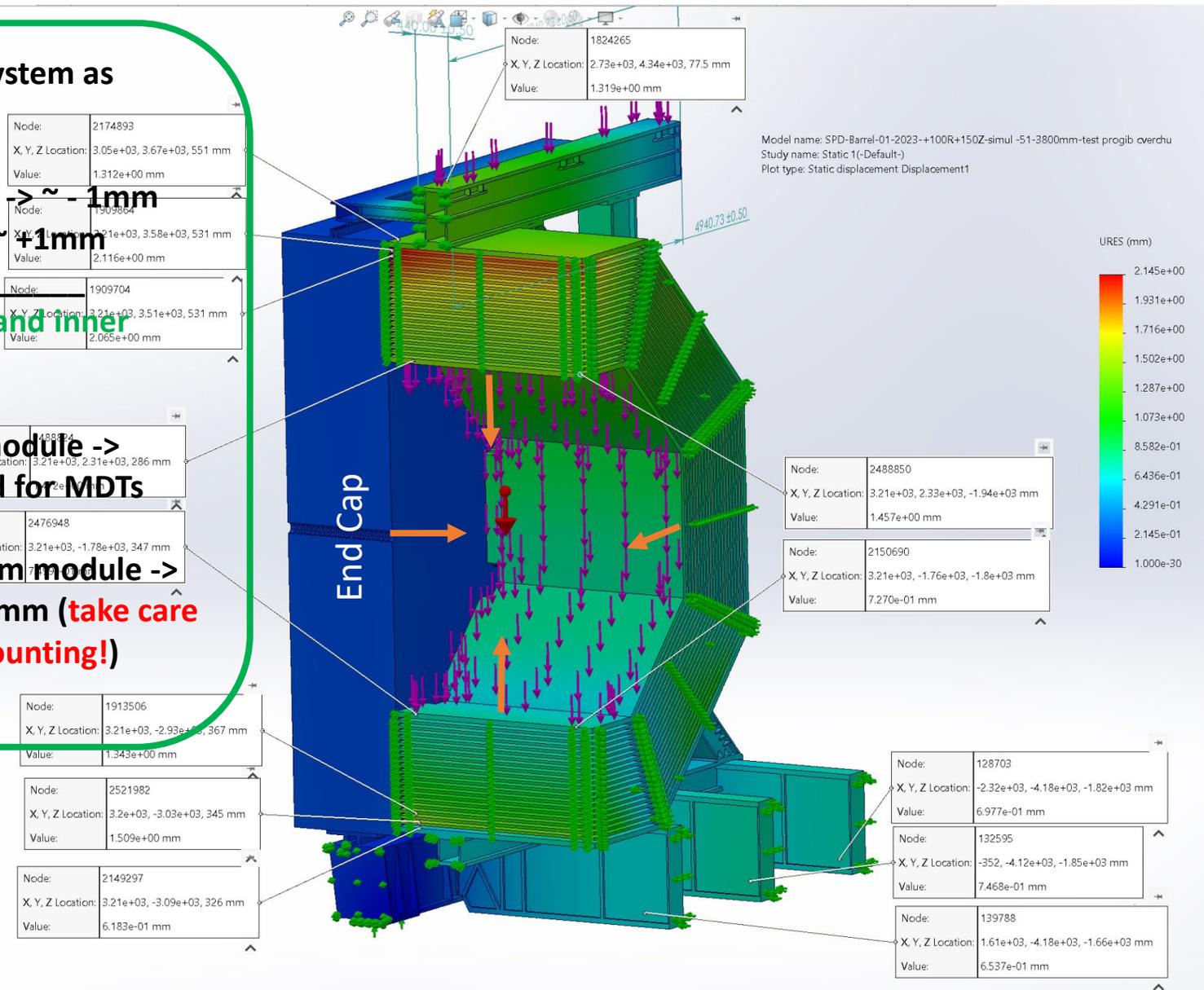
(quarter of setup is shown – due to symmetry of the simulation tasks)

New geometry of Range System as compared to 'ideal':

- Vertical inner diameter $\rightarrow \sim -1\text{mm}$
- Horizontal diameter $\rightarrow \sim +1\text{mm}$

No problems for solenoid and inner detectors!

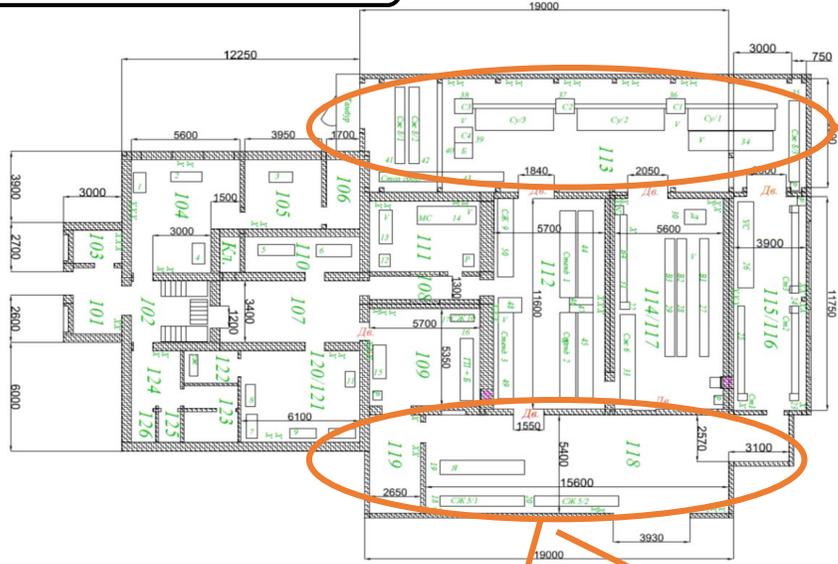
- Absorber slots in top module \rightarrow slightly increased (good for MDTs planes mounting)
- Absorber slots in bottom module \rightarrow slightly decreased $\sim -1\text{mm}$ (take care during MDTs planes mounting!)



With magnetic field additional forces (yellow arrows) setup must be considered also. They complicate picture for RS, but do not change the loads to the floor

Basis for deployment of MDTs assemble and test areas

Bld.73, 1-st floor plan



MDTs assembly area

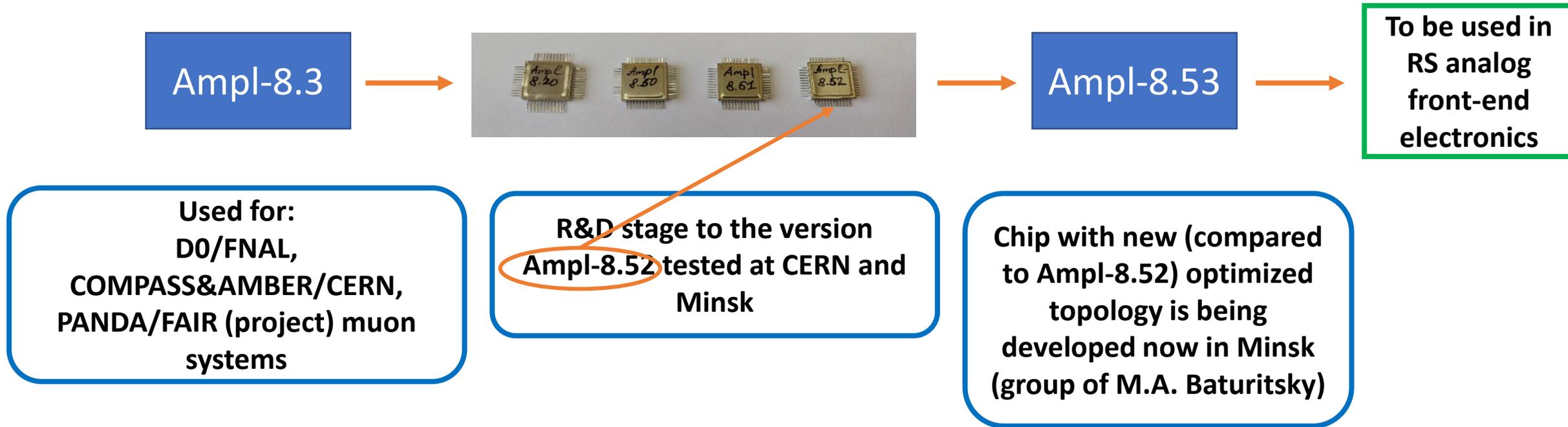


Storage area



The start of works on the building is expected in II quarter 2023 → first, JINR department will estimate the cost of reconstruction

Development of low input impedance amplifier chips: from Ampl-8.3 to Ampl-8.53

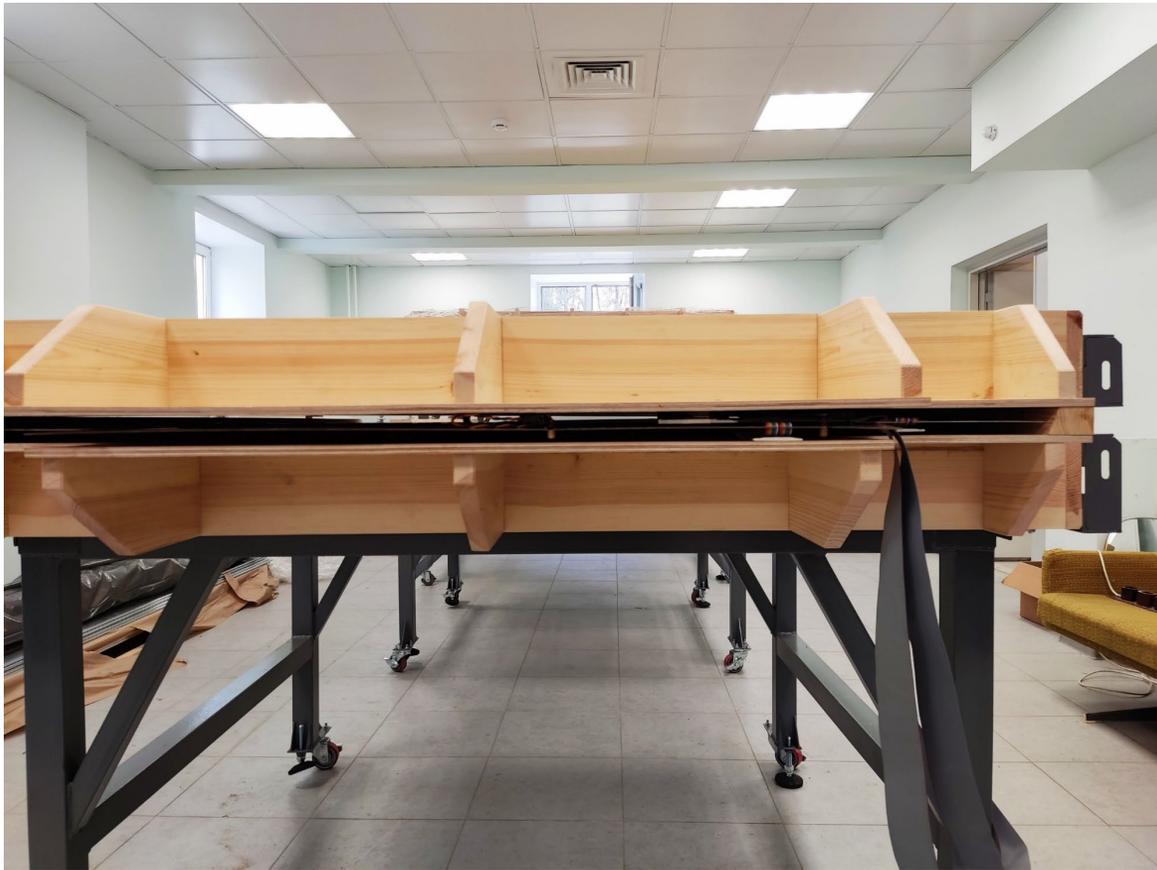


Contract with Integral (Minsk) on Ampl-8.53 amplifier preproduction is under discussion. In case of signing the contract this summer we may have first bunch of chips in summer 2024

Full-size stand-imitator to study: optimal design of MDTs detecting layer with strip board, analog front-end electronic cards deployment for wires and strips readout, cabling in/out the absorber slot



Detecting plane mockup (MDTs, strip board, analog FEE cards and cables) inside the slot 30 mm of stand-imitator: **rather dense space !**



30 mm

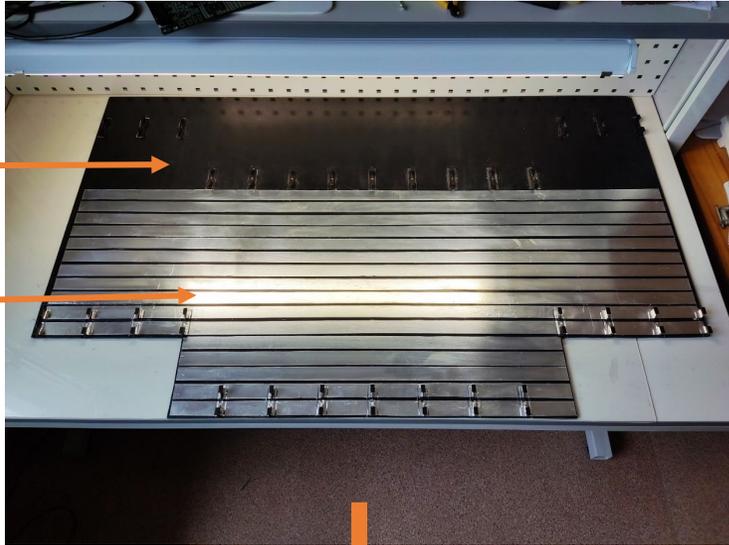


Preliminary impression after assembly of detector plane into the slot of stand-imitator -> **30 mm gap is close to practical limit**

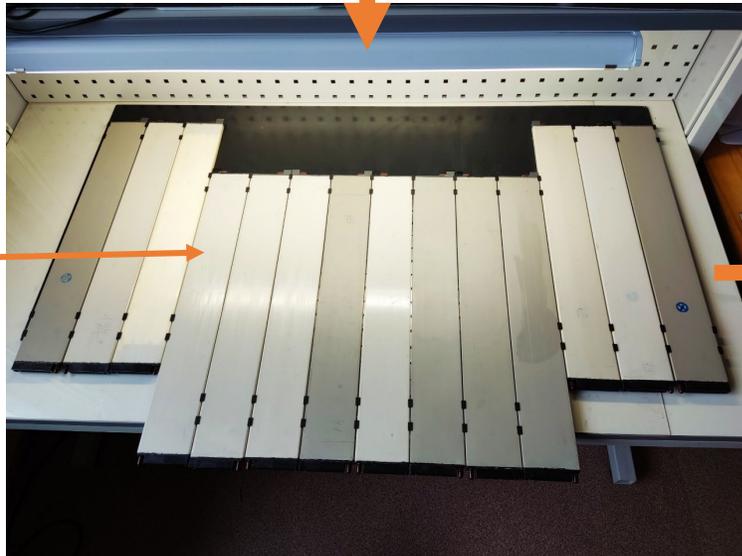
Mockup of detecting plane (MDTs, FEE cards, power distribution fiberglass board, cables)

Imitator of
honeycomb strip
board (4 mm thick)

Strips (3 cm wide)

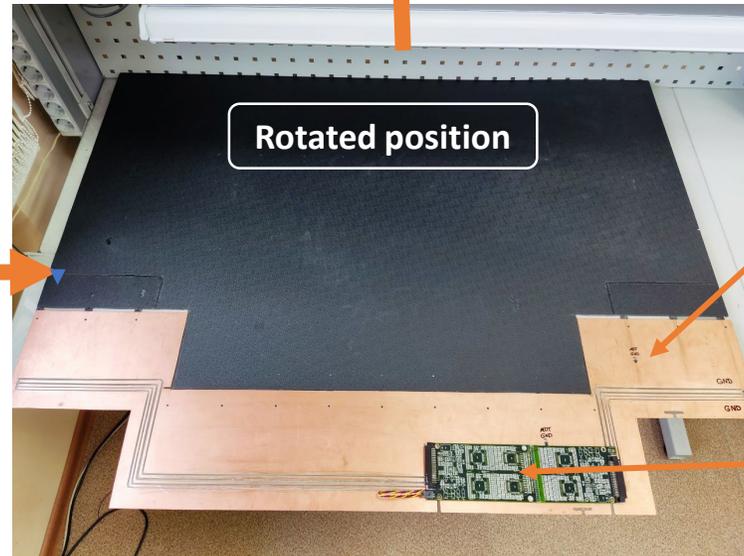


MDTs mounted onto
strip board



Ground shielding (ALU film)

Wire readout board mockup)



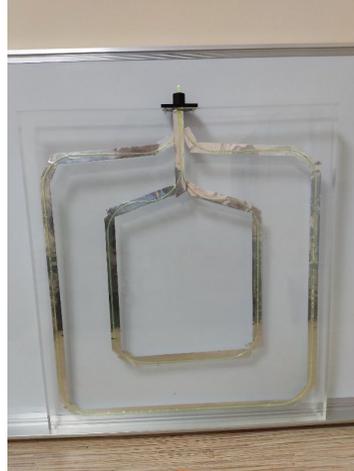
Rotated position

Power distribution
fiberglass board with HV,
LV and ground bus

Translator board mockup

Trigger scintillators for RS prototype at Nuclotron test area are ready. RS prototype is fully operational (MDT detectors, front-end analog and digital electronics, gas system) except for DAQ system (pending installation of multiplexor modules from CERN...)

Reading out the plastic scintillator with wave-shifting fibers



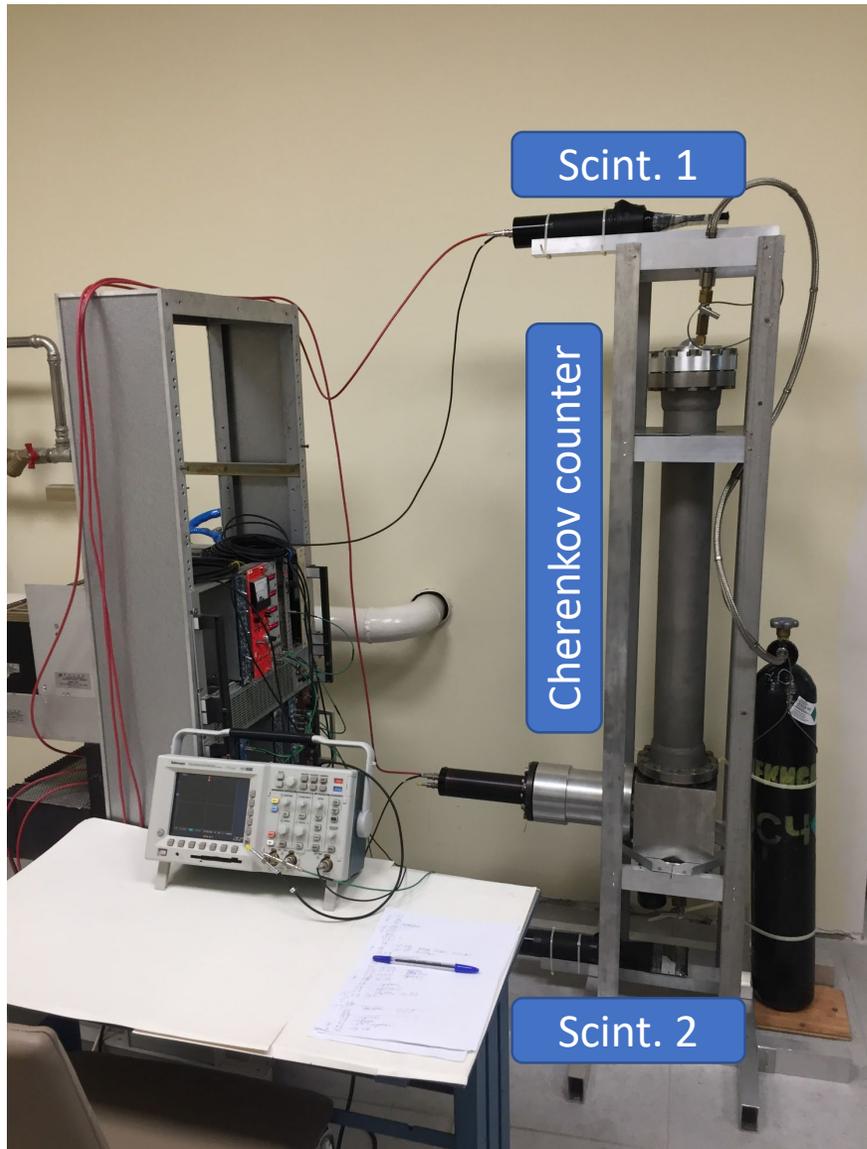
Two trigger counters 50x45x2 cm³ with Hamamatsu Photo-sensors H10720



Position of cosmic trigger counters (top/bottom) at RS prototype

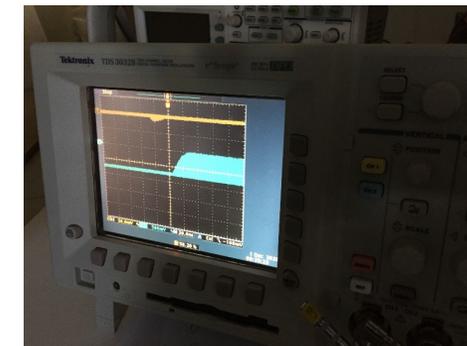
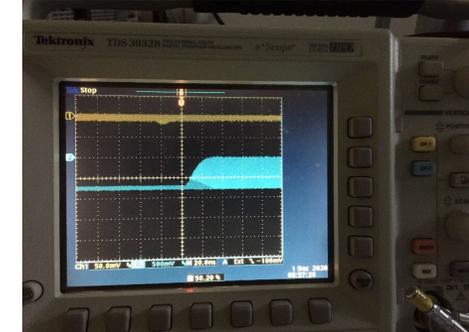
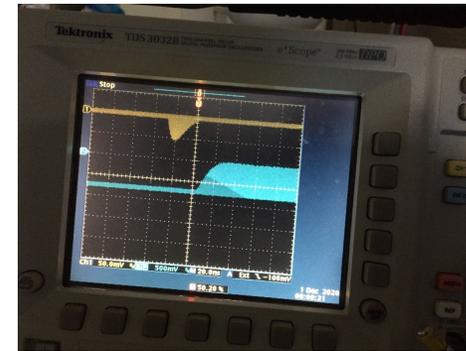


Cosmic test stand for pressurized Cherenkov counter (first Cherenkov signals are observed at high 45 atm with cosmic trigger)



Cherenkov signal

Trigger signal



Plans for the rest of 2023

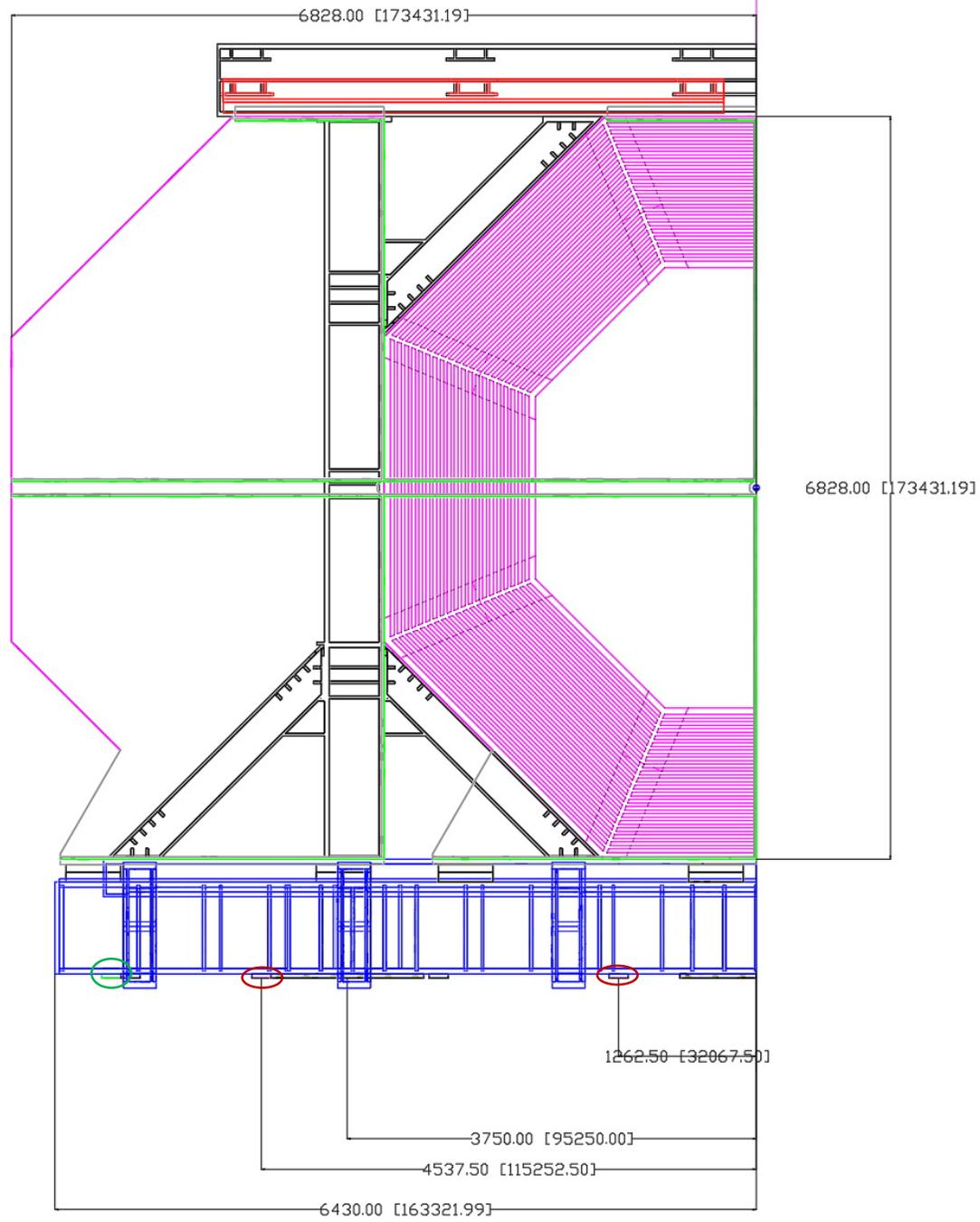
- Repeat FEA mechanical calculations for SPD setup adding magnetic forces (after getting field information from Novosibirsk team)
- Start reconstruction of bld. 73 (budget...)
- Sign the contract with Minsk on Ampl-8.53 preproduction (budget...)
- Continue MDT plane prototyping with stand-imitator
- Put RS prototype in operation with DAQ at test area (depends on availability of multiplexor modules from CERN...)
- Start study of pressurized Cherenkov counter with cosmic
- Continue PID algorithms study

CONCLUSION

RS team is generally on track. No visible 'show stoppers' are indicated at the moment. The nearest practical tasks look feasible: reconstruction of MDTs assembly building, signing of contract on amplifier chips preproduction, but require adequate funding. R&D works are progressing.

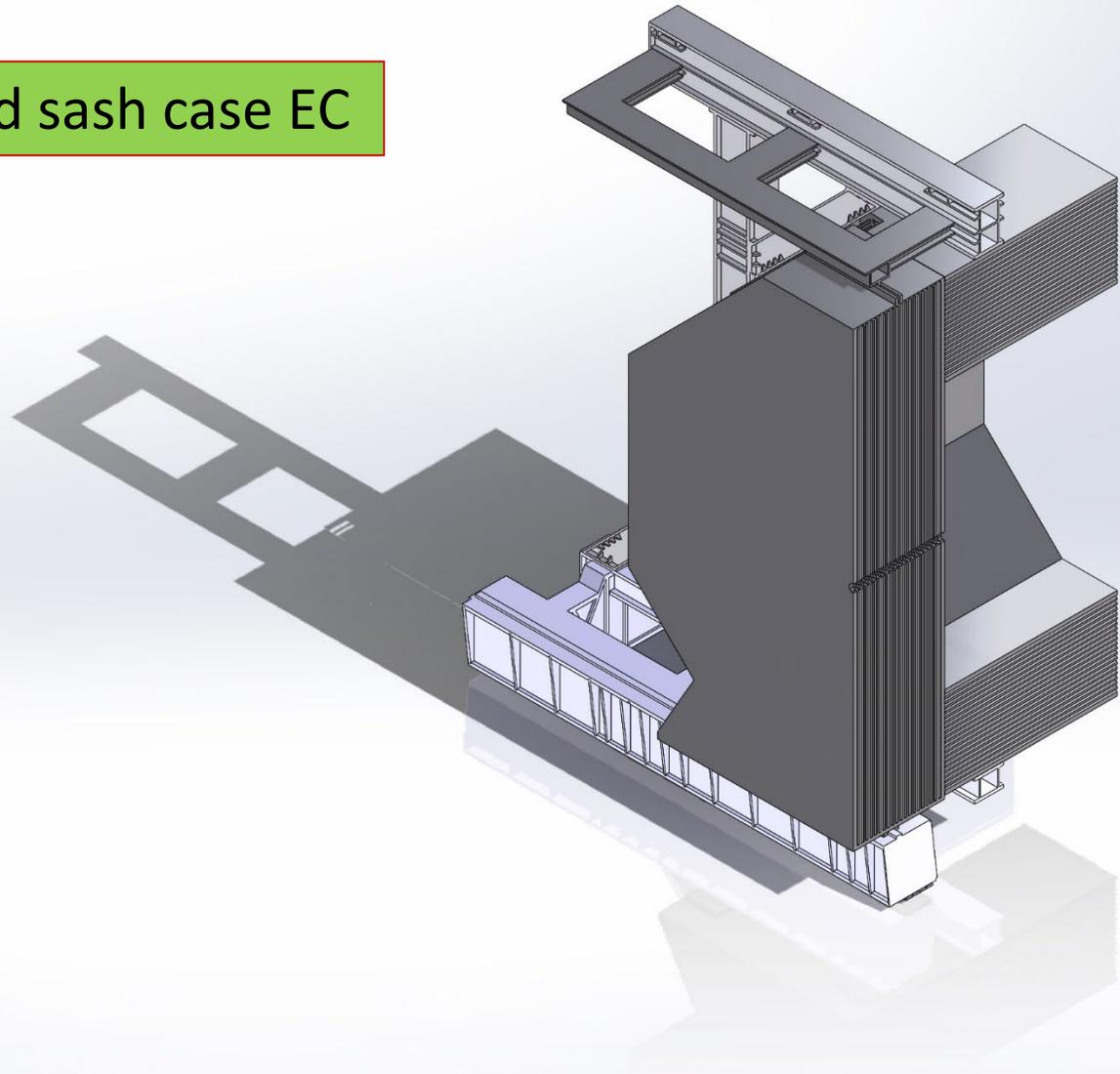
Backup slides

Distances for supporting elements in the considered cases



- SPD-Barrel-01-2023-+10C
- History
- Sensors
- Annotations
- Solid Bodies(59)
 - Material <not specific
 - Front Plane
 - Top Plane
 - Right Plane
 - Origin
 - Imported1
 - Imported2
 - Imported3
 - Imported4
 - Imported5
 - Imported6
 - Imported7
 - Imported8
 - Imported9
 - Imported10
 - Imported11
 - Imported12
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 - Imported37
 - Imported38
 - Imported39
 - Imported40
 - Imported41

Closed sash case EC



Custom Properties

Apply Reset

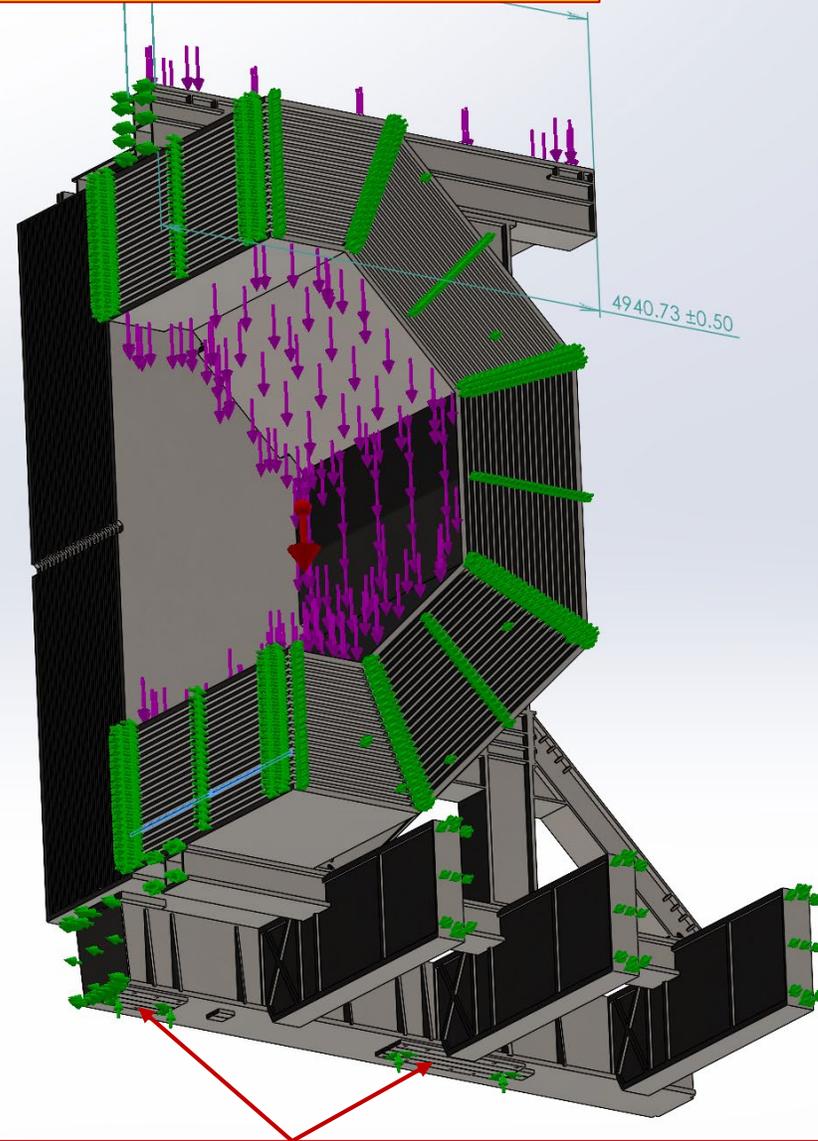
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If you already have a template, place it in the folder specified in Tools – Options – File Locations – Custom Property Files.

Press F5 to refresh the page.

Create now...

Force (loads) and kinematic (fastening of supporting elements) boundary conditions



Location of trolley supports (in the beam plane and 3750 mm from the beam plane)

Offsets along Y axis

Probe Result

Options

- At location
- From sensors
- On selected entities
- At Node number

Results

Node	Value (mm)
599453	-1.460e+00
32214	-1.463e+00
587330	-7.579e-01
32445	-7.186e-01
269777	-7.197e-01
1636733	-6.490e-01
1630398	-7.429e-01
1625764	-7.032e-01

Summary

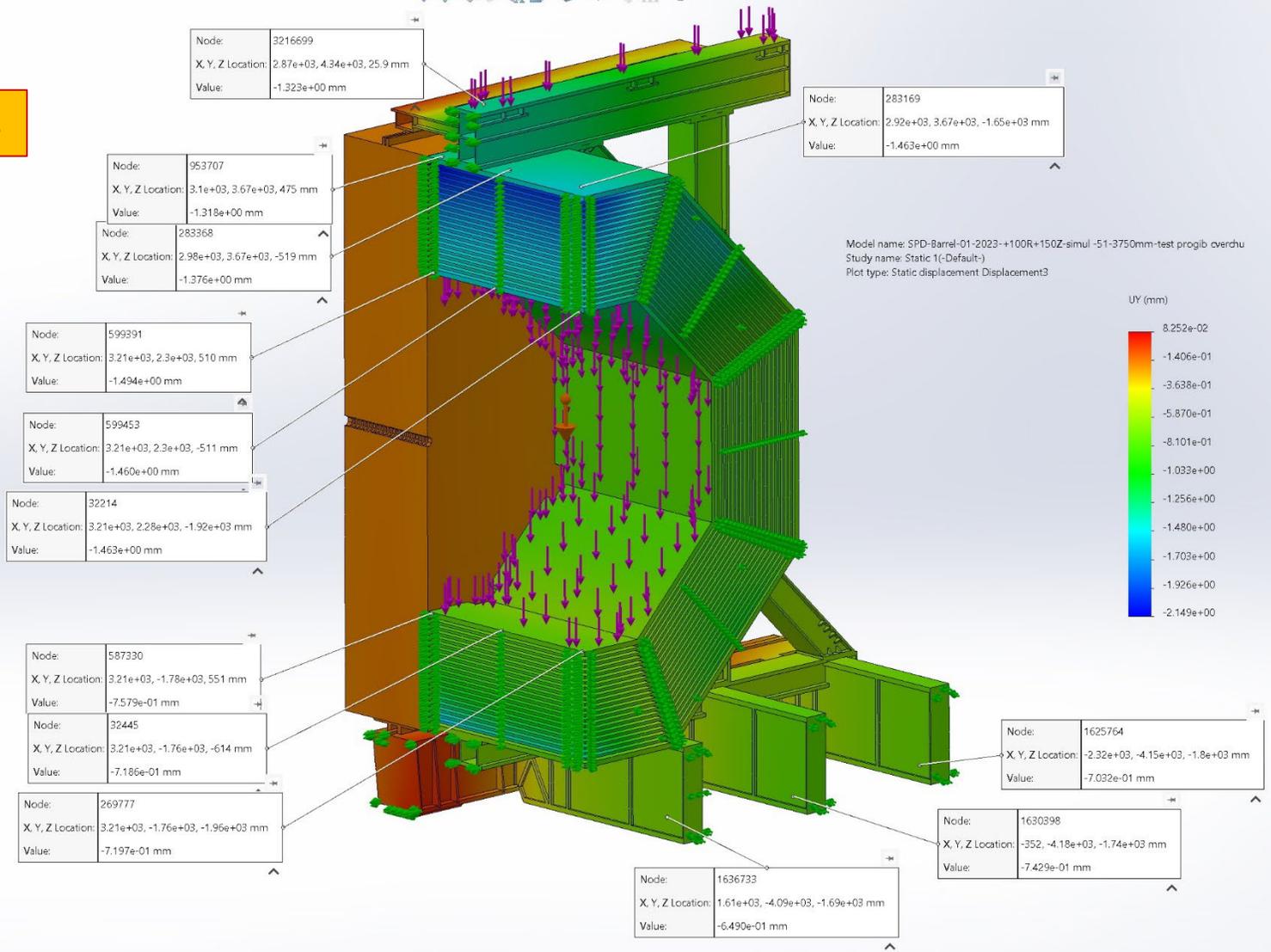
	Value	Unit
Sum	-1.419e+01	mm
Avg	-1.091e+00	mm
Max	-6.490e-01	mm
Min	-1.494e+00	mm
RMS	1.147e+00	mm

Report Options

- Show Node/Element Number
- Show X,Y,Z Location
- Show Value

Annotations

- Show Node/Element Number
- Show X,Y,Z Location
- Show Value



Custom Properties

Apply | Reset

A property page for part files was not found. Click 'Create now...' to launch the Property Tab Builder.

If you already have a template, place it in the folder specified in Tools -> Options -> File Locations -> Custom Property Files.

Press F5 to refresh the page.

Create now...

Probe Result

Options

- At location
- From sensors
- On selected entities
- At Node number

Results

Node	Value (mm)
3159596	-4.790e-01
591991	-5.336e-01
960721	-5.351e-01
979141	-5.375e-01
26545	-8.433e-16
267855	-5.816e-16
968400	-1.551e-01

Summary

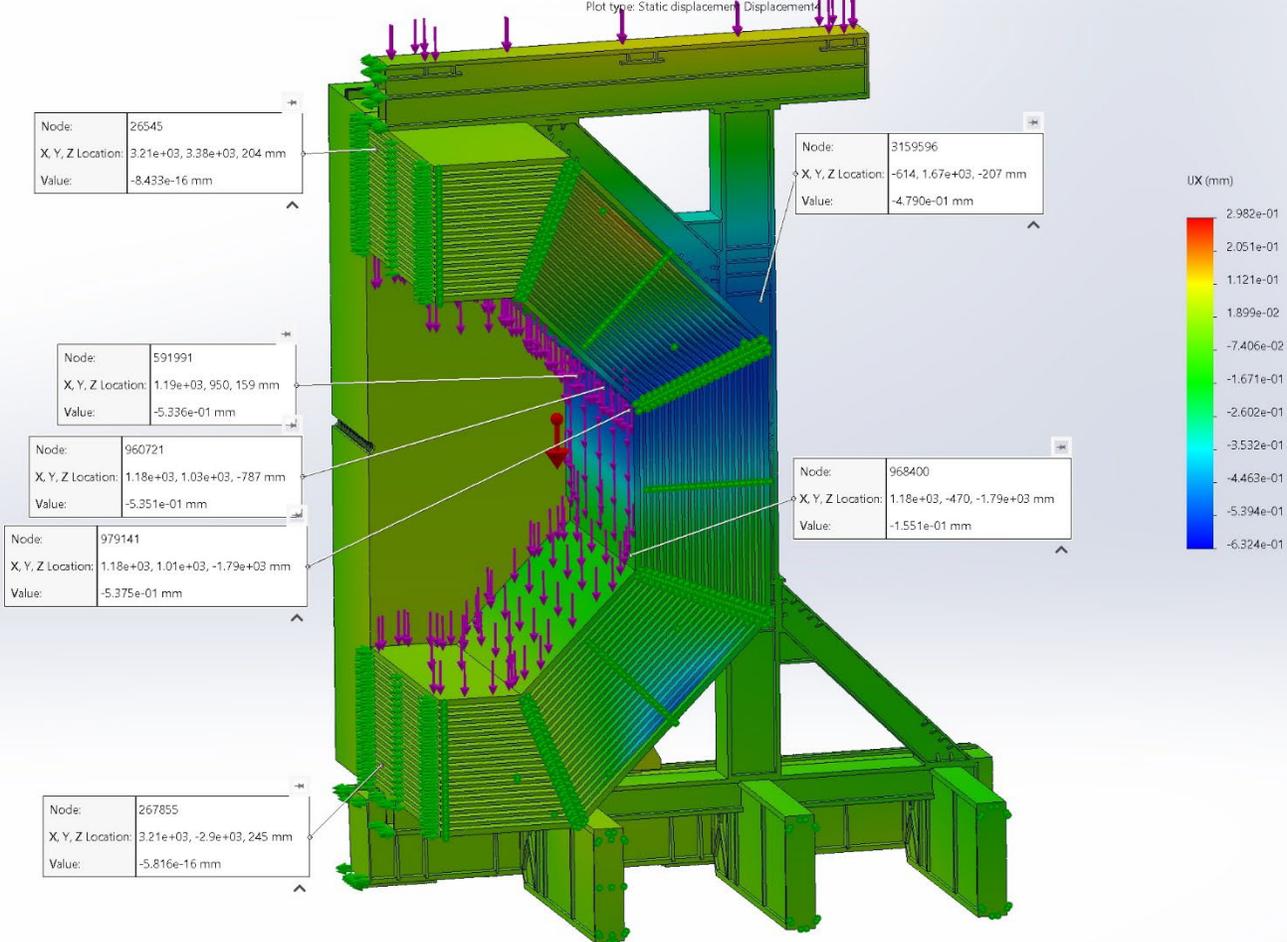
	Value	Unit
Sum	-2.240e+00	mm
Avg	-3.200e-01	mm
Max	-5.816e-16	mm
Min	-5.375e-01	mm
RMS	3.988e-01	mm

Report Options

Annotations

- Show Node/Element Number
- Show XYZ Location
- Show Value

Offsets along the X axis - deformation of inner Barrel area up to 0.53mm each side



Custom Properties

Apply Reset

A property page for part files was not found. Click 'Create now...' to launch the Property Tab Builder.

If you already have a template, place it in the folder specified in Tools -> Options -> File Locations -> Custom Property Files.

Press F5 to refresh the page.

Create now...

Stresses within normal limits: up to a maximum of 500 -600 kg / cm²

Probe Result

Options

- At location
- From sensors
- On selected entities
- At Node number

Results

Node	Value (kgf/cm ²)
1740068	3.711e+02
1647195	2.721e+02
1626409	4.546e+02
1643136	4.070e+02
14711	2.366e+02
3183211	1.584e+02

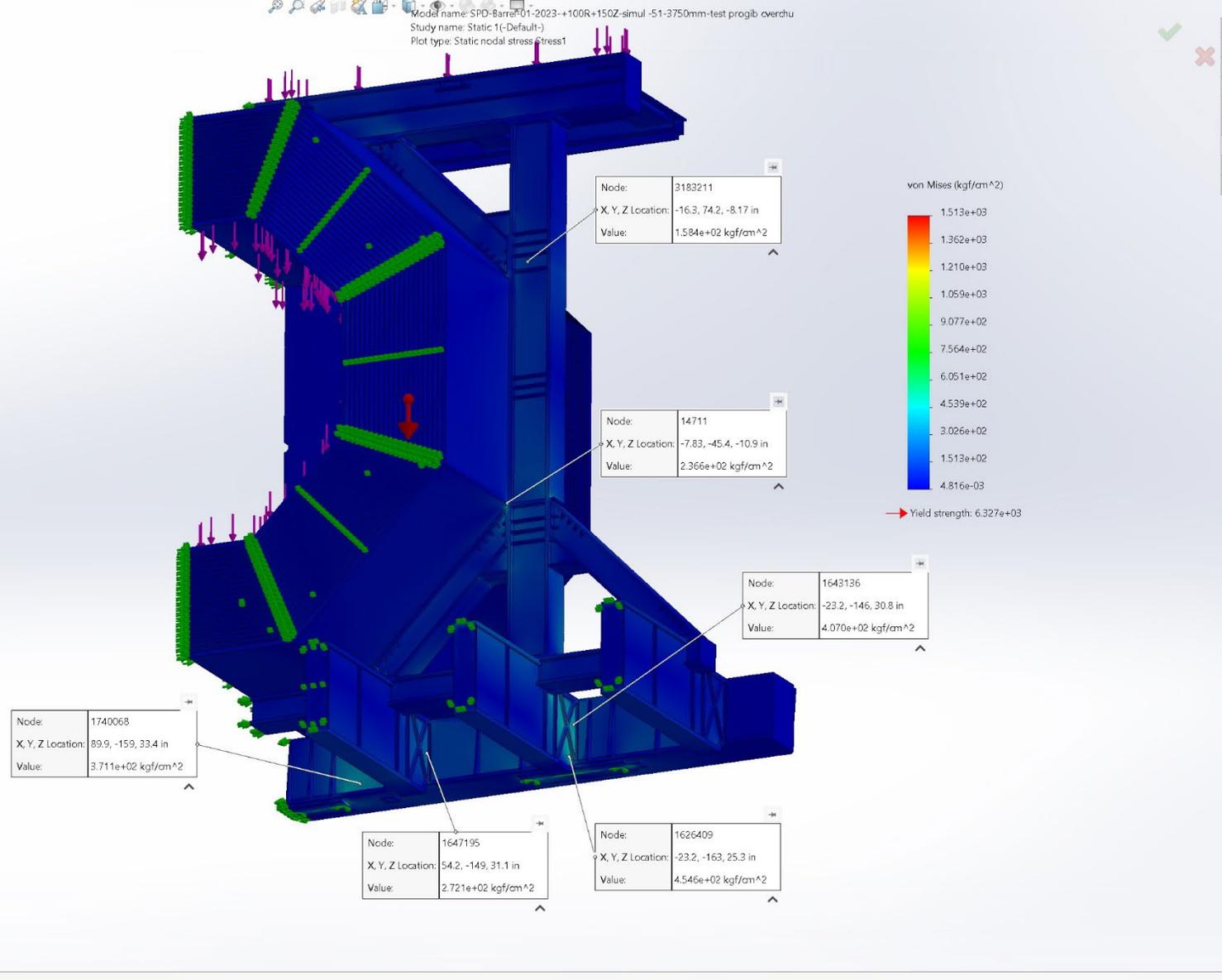
Summary

	Value/Unit
Sum	1.900e+03 kgf/cm ²
Avg	3.166e+02 kgf/cm ²
Max	4.546e+02 kgf/cm ²
Min	1.584e+02 kgf/cm ²
RMS	3.329e+02 kgf/cm ²

Report Options

Annotations

- Show Node/Element Number
- Show X,Y,Z Location
- Show Value



Custom Properties

Apply Reset

A property page for part files was not found. Click 'Create now...' to launch the Property Tab Builder.

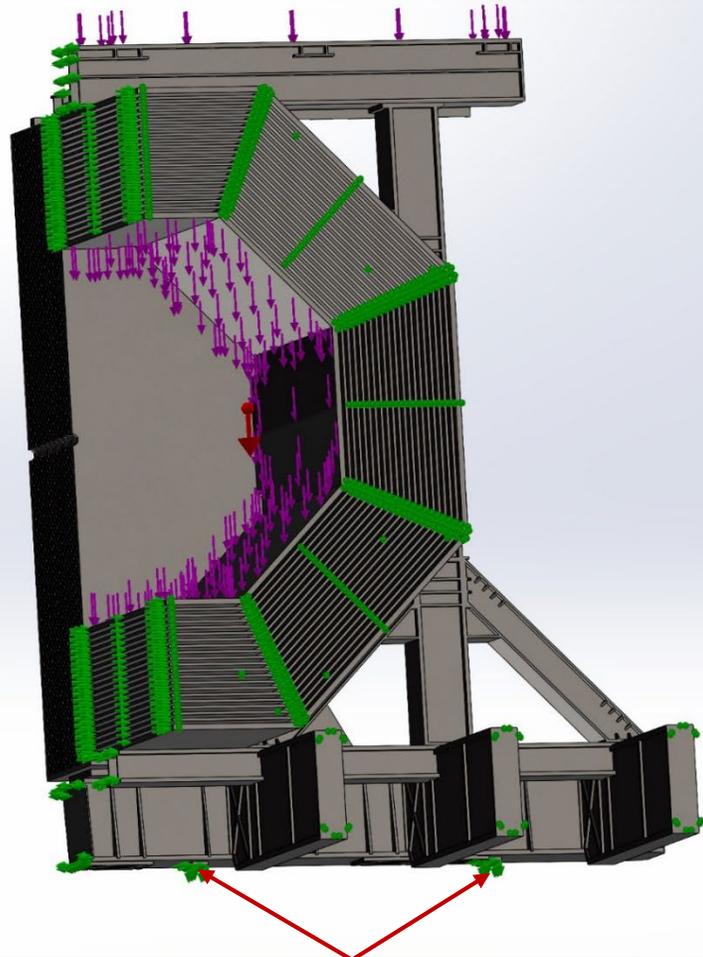
If you already have a template, place it in the folder specified in Tools – Options – File Locations – Custom Property Files.

Press F5 to refresh the page.

Create now...

More Properties...

The case of closed sashes EC, on 4 pairs of jacks. In terms of movements - the worst of the cases considered: maximum movements 2.2-2.5 mm



Location of supports for jacks (1262 and 4537 mm from the beam plane)

- Static 2* (-Default-)
- SPD-Barrel-01-2023-+10
- Connections
 - Component Interacti
 - Global Interacti
- Fixtures
 - Reference Geometry
 - Reference Geometry
 - Reference Geometry
 - Symmetry-1
- External Loads
 - Gravity-1 (~10.3 m/s
 - Force-1 (Per item: 10
 - Force-2 (Total: 25,00
- Mesh
- Result Options

Custom Properties

Apply Reset

A property page for part files was not found. Click 'Create now...' to launch the Property Tab Builder.

If you already have a template, place it in the folder specified in Tools -> Options -> File Locations -> Custom Property Files.

Press F5 to refresh the page.

Create now...

Probe Result

Options

- At location
- From sensors
- On selected entities
- Distance
- At Node number

Results

Node	Value (mm)
587950	1.002e+00
32479	9.661e-01
269837	9.673e-01
1734583	8.993e-01
1629492	1.055e+00
1624580	9.368e-01
31146	8.627e-01
633221	1.801e+00

Summary

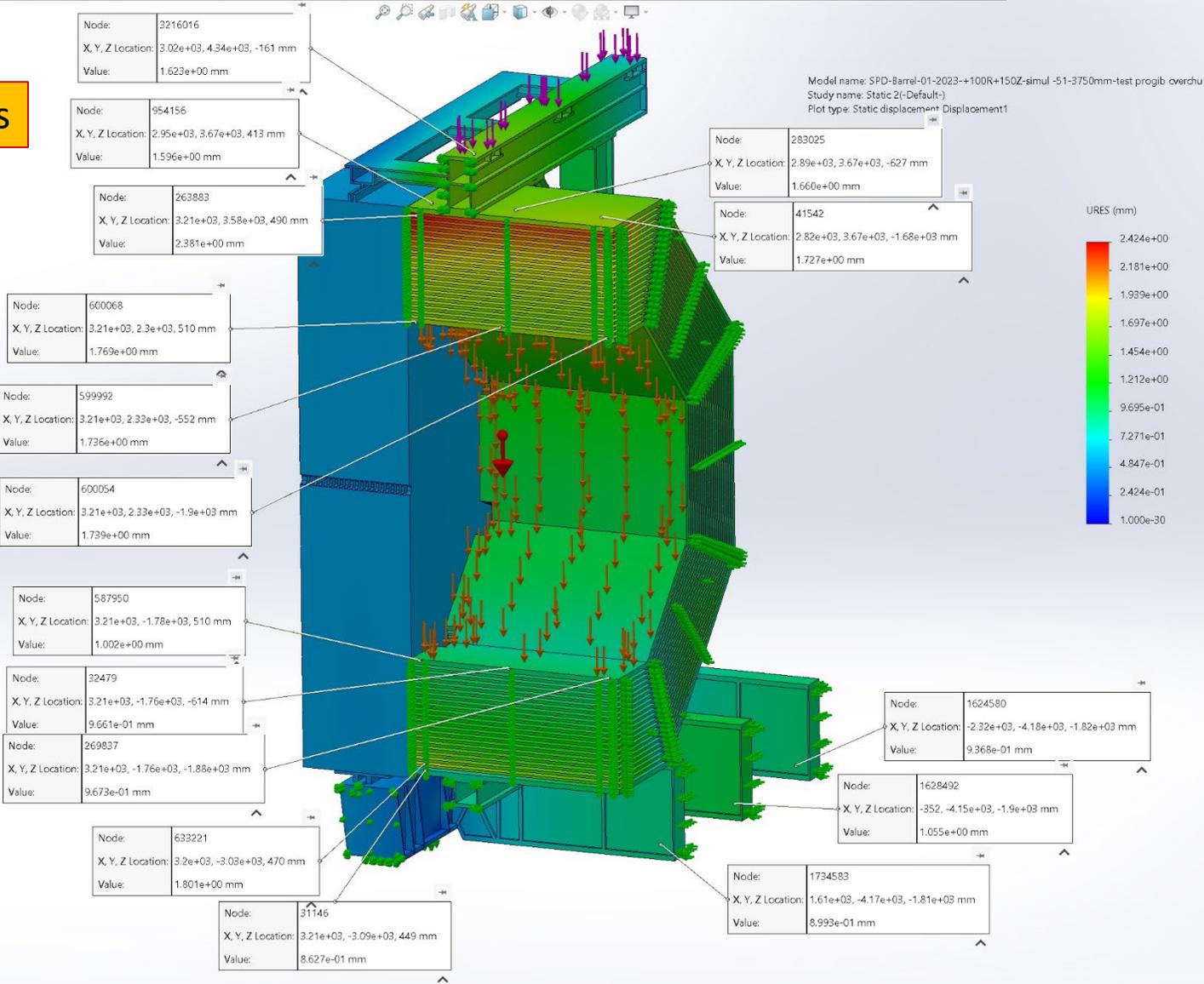
Value	Unit
Sum	2.272e+01 mm
Avg	1.420e+00 mm
Max	2.381e+00 mm
Min	8.627e-01 mm
RMS	1.488e+00 mm

Report Options

Annotations

- Show Node/Element Number
- Show XYZ Location
- Show Value

Offsets



Simulation Advisor

1 Study ✓
 2 Bodies and Material ✓
 3 Interactions ✓
 4 Mesh and Run ✓
 5 Results ✓

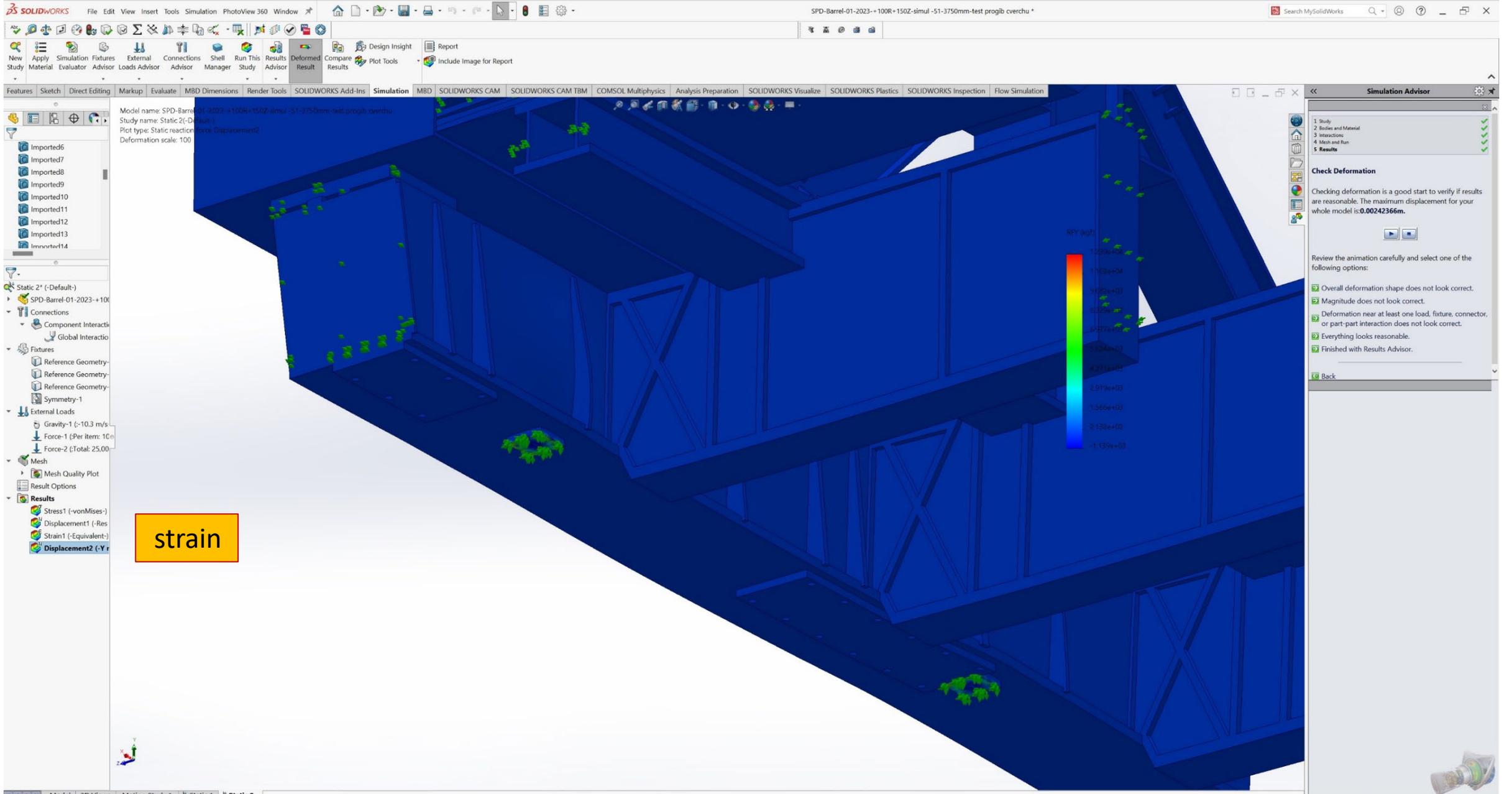
Check Deformation

Checking deformation is a good start to verify if results are reasonable. The maximum displacement for your whole model is **0.00242366m**.

Review the animation carefully and select one of the following options:

- Overall deformation shape does not look correct.
- Magnitude does not look correct.
- Deformation near at least one load, fixture, connector, or part-part interaction does not look correct.
- Everything looks reasonable.
- Finished with Results Advisor.

Back



strain

Simulation Advisor

- 1 Study ✓
- 2 Bodies and Material ✓
- 3 Interactions ✓
- 4 Mesh and Run ✓
- 5 Results ✓

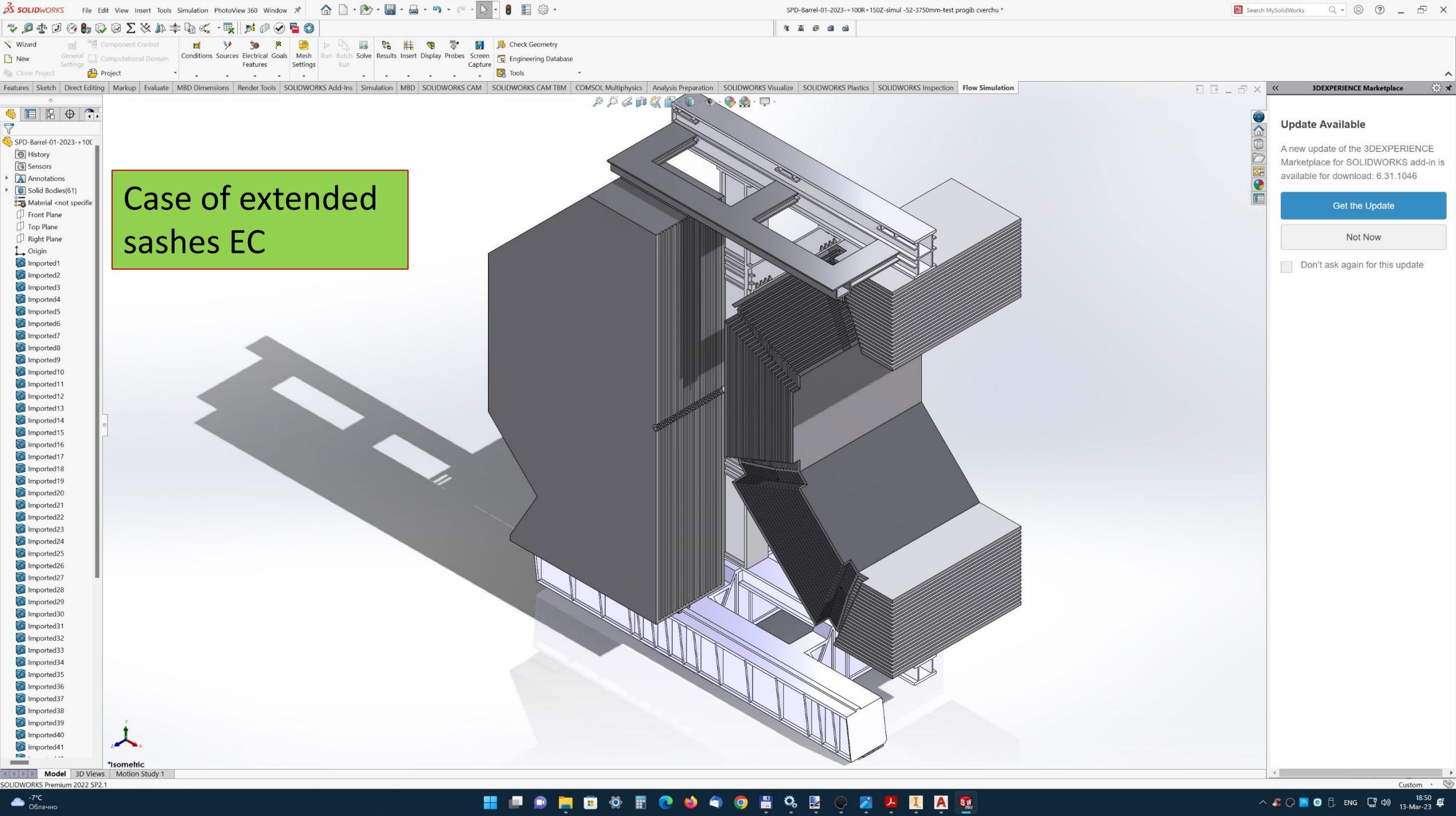
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Back



Case of extended sashes EC

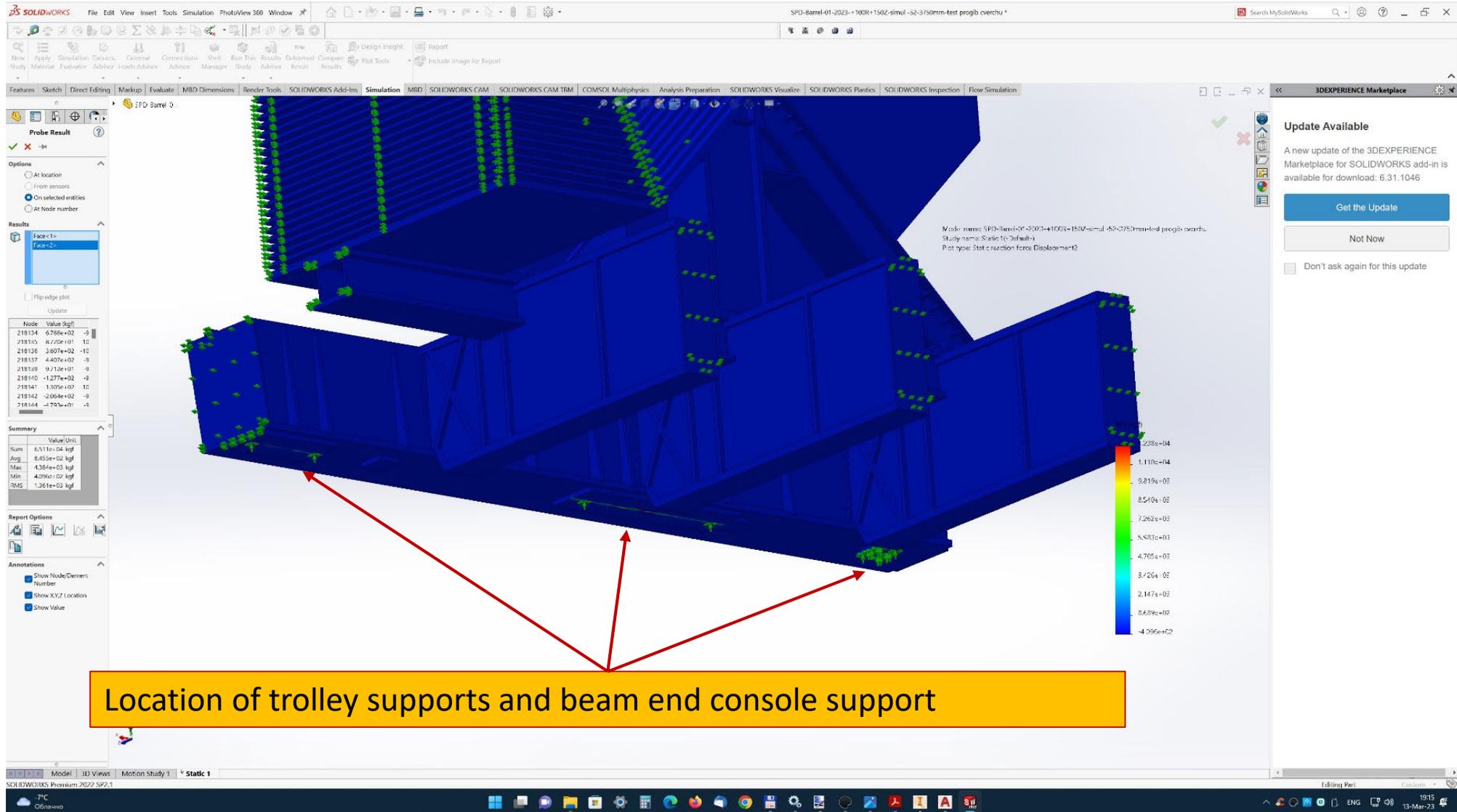
Update Available

A new update of the 3DEXPERIENCE Marketplace for SOLIDWORKS add-in is available for download: 6.31.1046

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Location of trolley supports and beam end console support

Offsets for the case of extended leaves
- the situation is slightly better than in previous cases

Probe Result

Options

- At location
- From sensors
- On selected entities
- Distance
- At Node number

Results

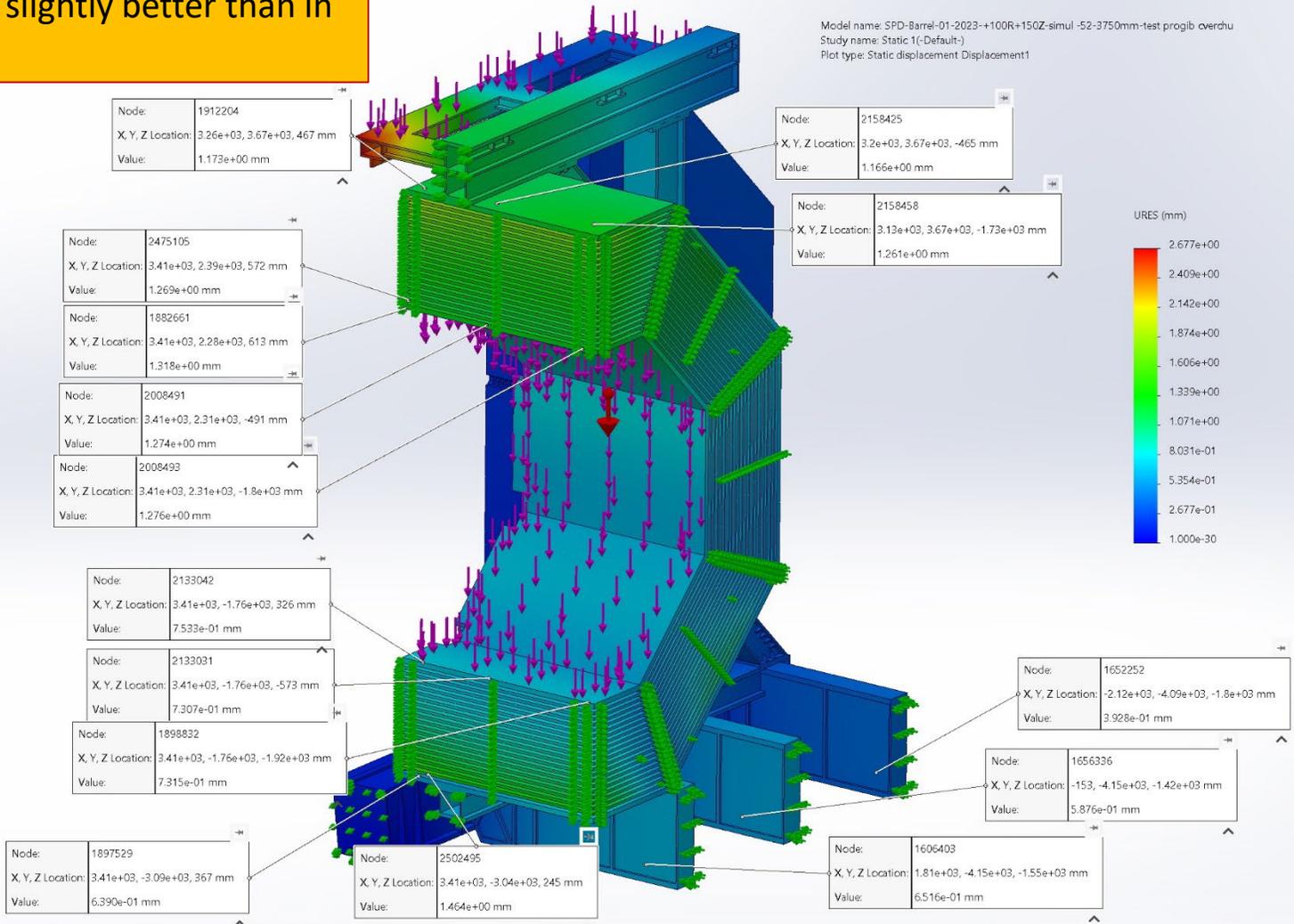
Node	Value (mm)
1899832	7.315e-01
1882661	1.318e+00
2008491	1.274e+00
2008493	1.276e+00
2475105	1.269e+00
1912204	1.173e+00
2158425	1.166e+00
2158458	1.261e+00

Summary

	Value	Unit
Sum	1.469e+01	mm
Avg	9.792e-01	mm
Max	1.464e+00	mm
Min	3.928e-01	mm
RMS	1.034e+00	mm

Report Options

- Show Node/Element Number
- Show XYZ Location
- Show Value



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ABS plastic 4 mm thick - imitates the honeycomb filler of a strip board (“air gap”) with fixed blades (in reality, the blades will not be in a line (along one strip), but in a herringbone or zigzag pattern, to blur the increase in capacity by 4-5 strips)

