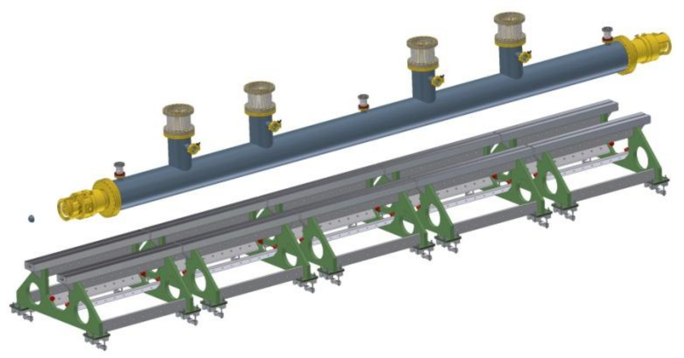
FETS Meeting @ RAL

MEBT Assembly

Support frames, vacuum manifold & alignment

By Peter Savage

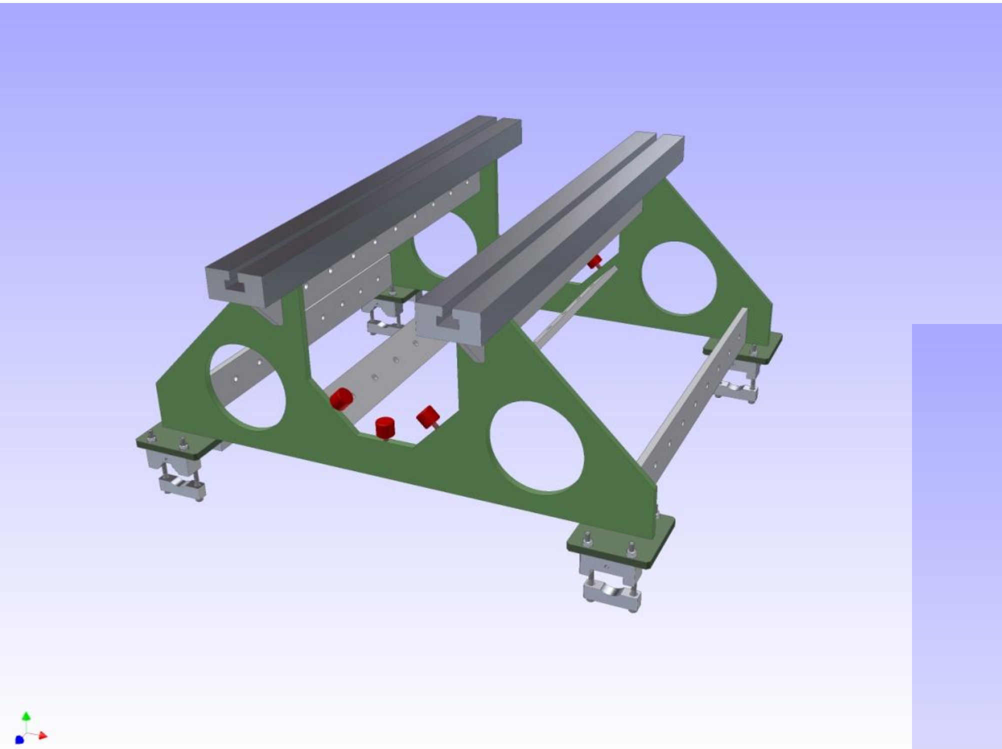
3rd July 2013

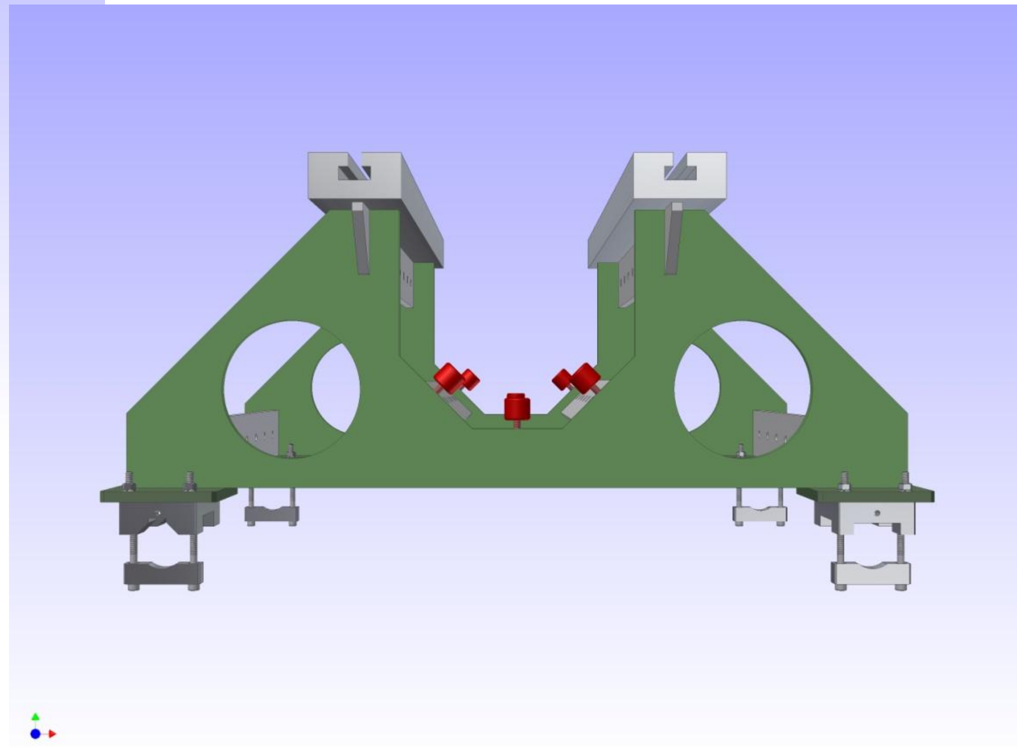


The following images are intended to show the **CONCEPT** only. Please ignore missing bolts, components floating in mid-air, component clashes etc.

Contents

MEBT support frame





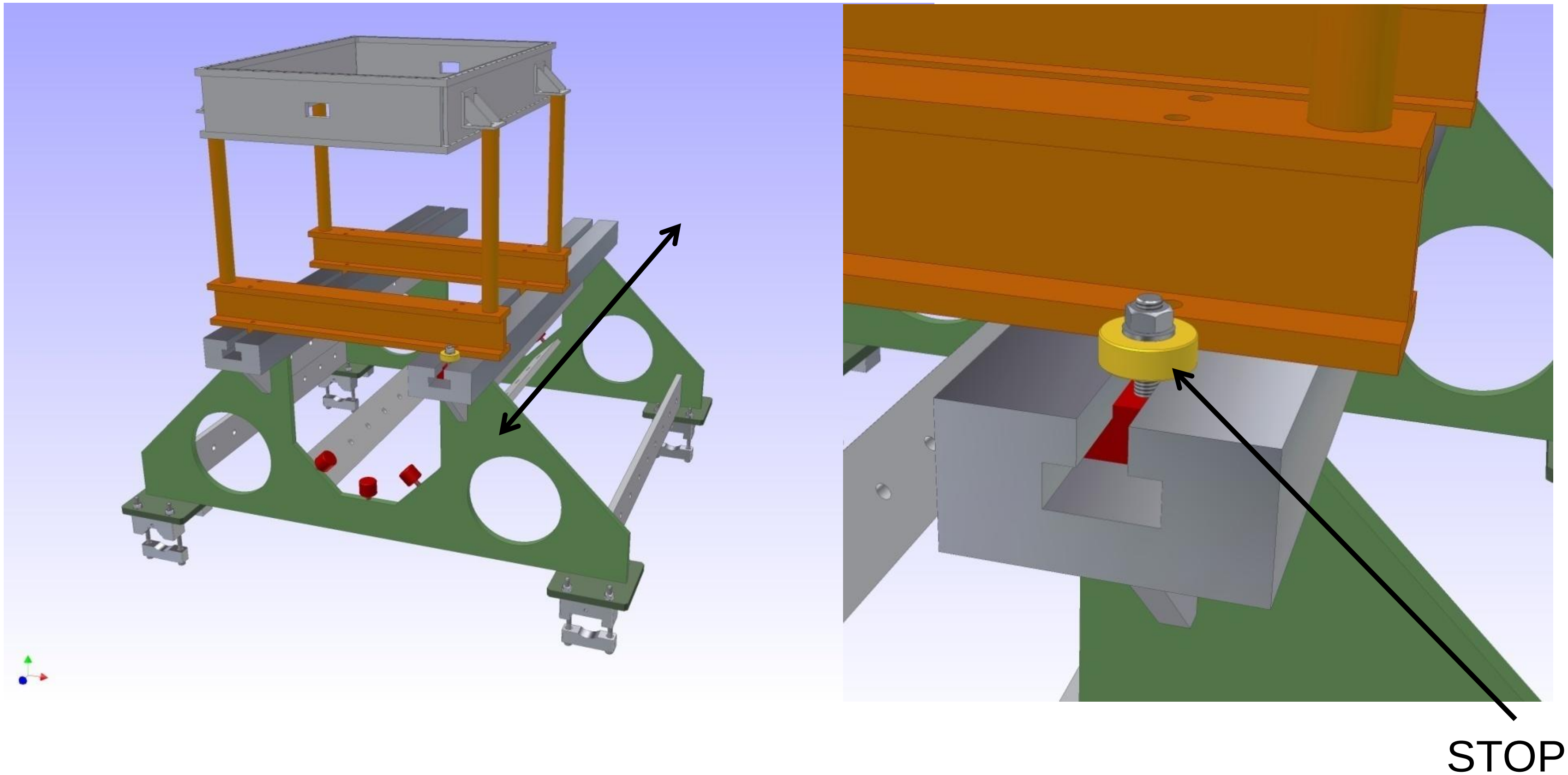
Key features:

Flatness: top faces to occupy one plane

Slot parallelism: to the beam axis

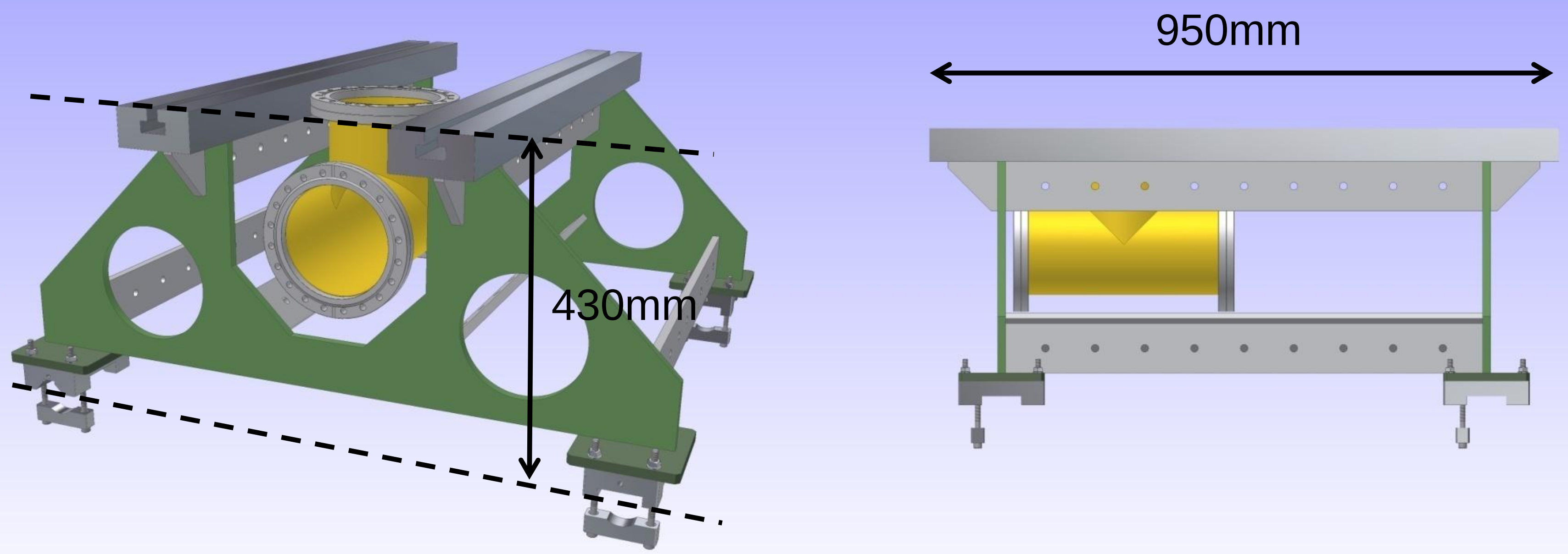
Slot separation: to each other

Showing Tee-slot concept



- MEBT components can occupy any longitudinal position
- Allows the same frame to be used for both 3xRBC and 4xRBC MEBT schemes
- Finalised positions are marked by simple ‘stops’, allowing component removal.

One MEBT support frame with a DN160CF Tee



- U-shaped design can accommodate any component spacing
- T-slots to allow flexibility in initial component placement.
- T-slot rails to be skimmed post-welding - CHANGED
- Component position to be defined by simple stops.
- Stress analysis to be done.
- Designed around vacuum manifold based upon DN200CF (bore ~ 200mm)

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Initial steps

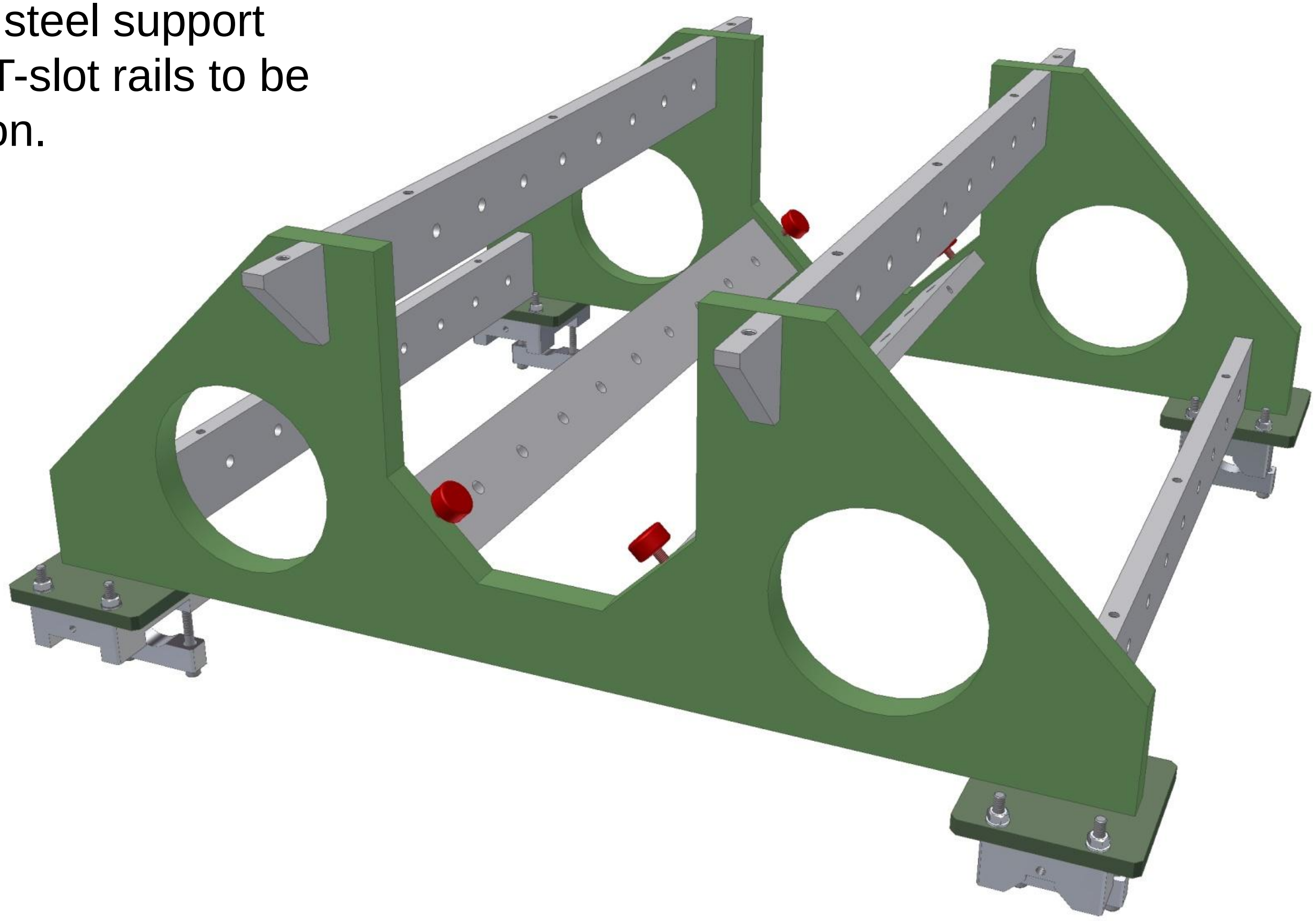
1. Produce a specification for the support frames and vacuum manifold and place in FETS Wiki.
2. Perform stress analysis to confirm design.
3. Agree rail centre to top of T-slot rail height and record in specification.
4. Agree length and number of frames.
5. Agree manifold bore diameter and flange type to be used.
6. Agree rail T-slot separation
7. Get ballpark quote for one-piece vacuum manifold to guide decision.
8. Build on design adding levels of detail

Later steps

1. Detail design – RAL contract staff?
2. Approach manufacturers for quotes
3. Manufacture
4. Inspect for height, flatness and parallelism of T-slots
5. Delivery
6. Alignment to FETS.

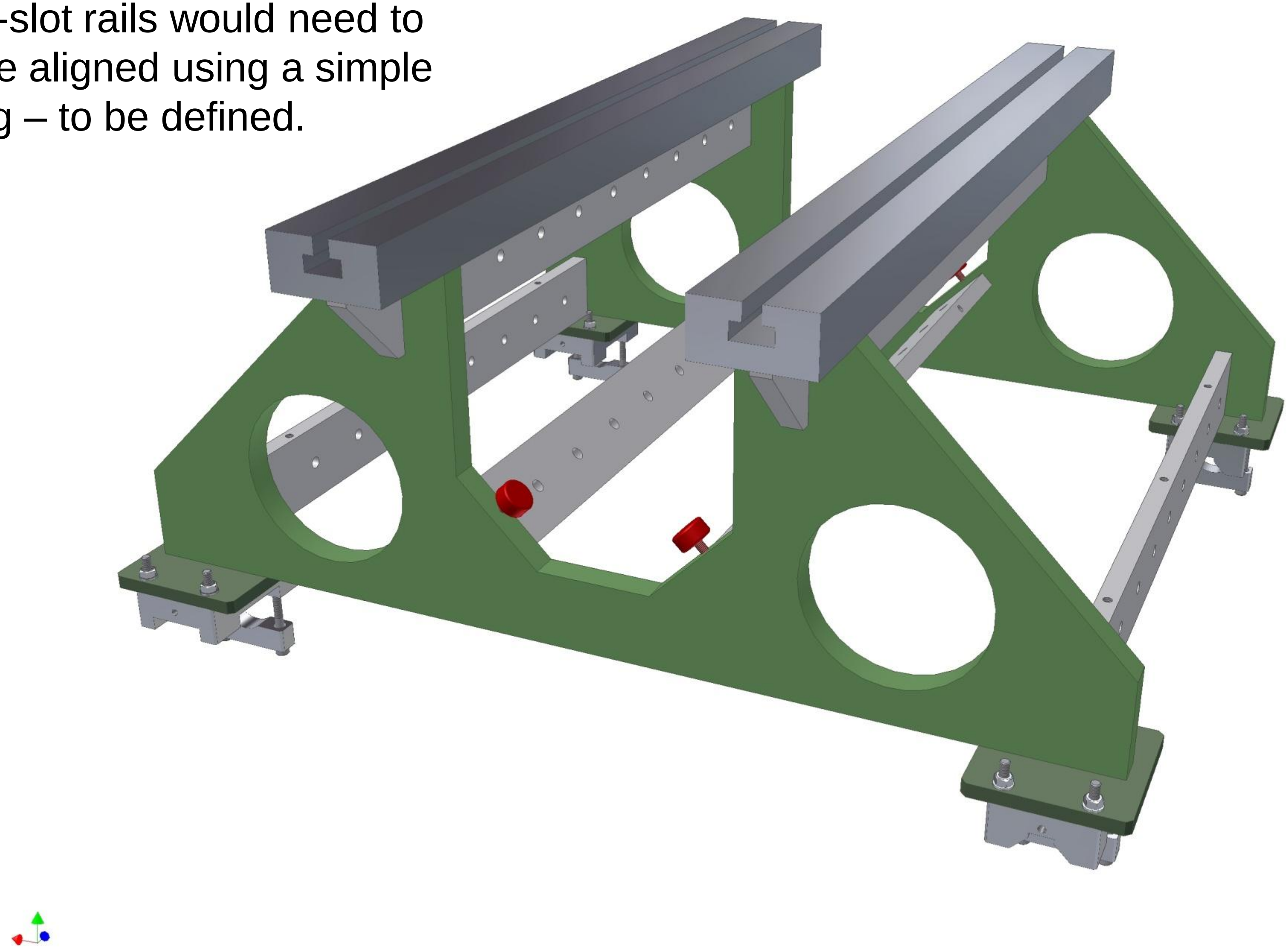
MEBT support frame

Manufacturer to make welded steel support frame. T-slot rails to be bolted on.



MEBT support frame

T-slot rails would need to be aligned using a simple jig – to be defined.



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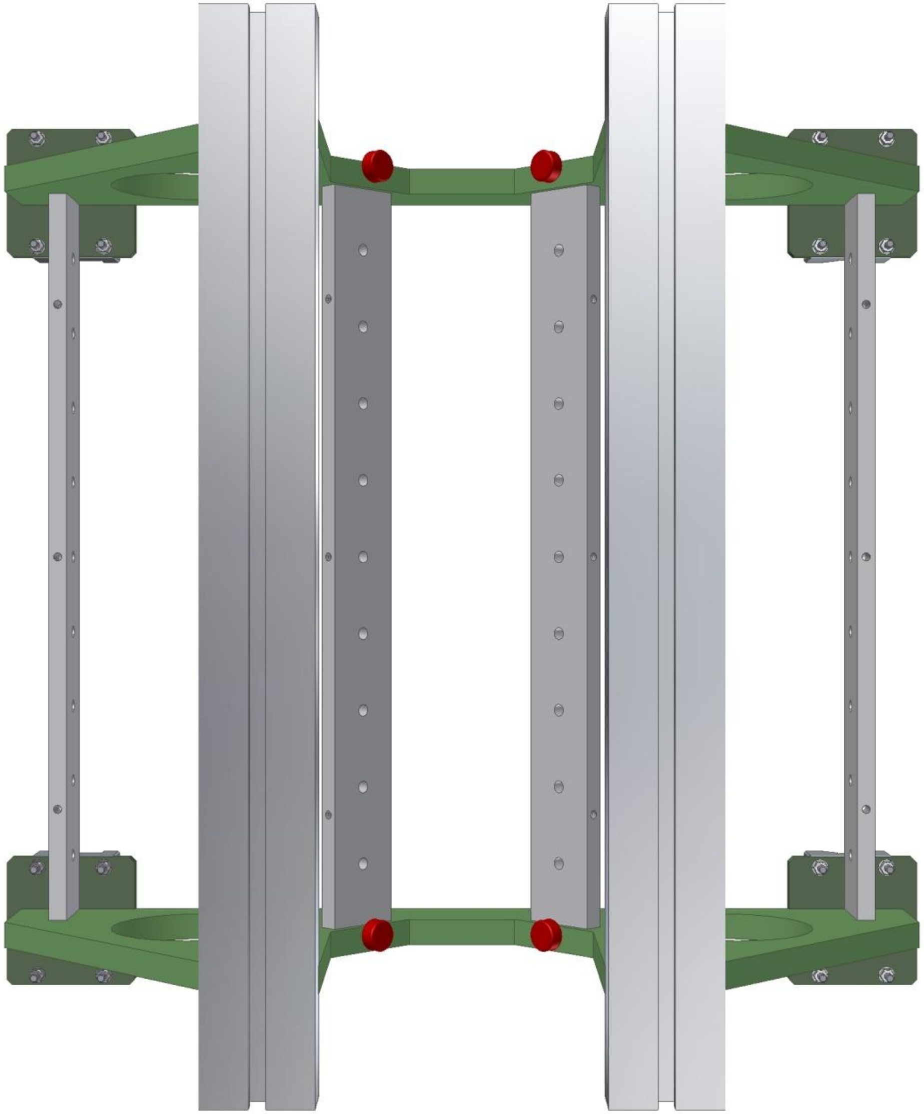
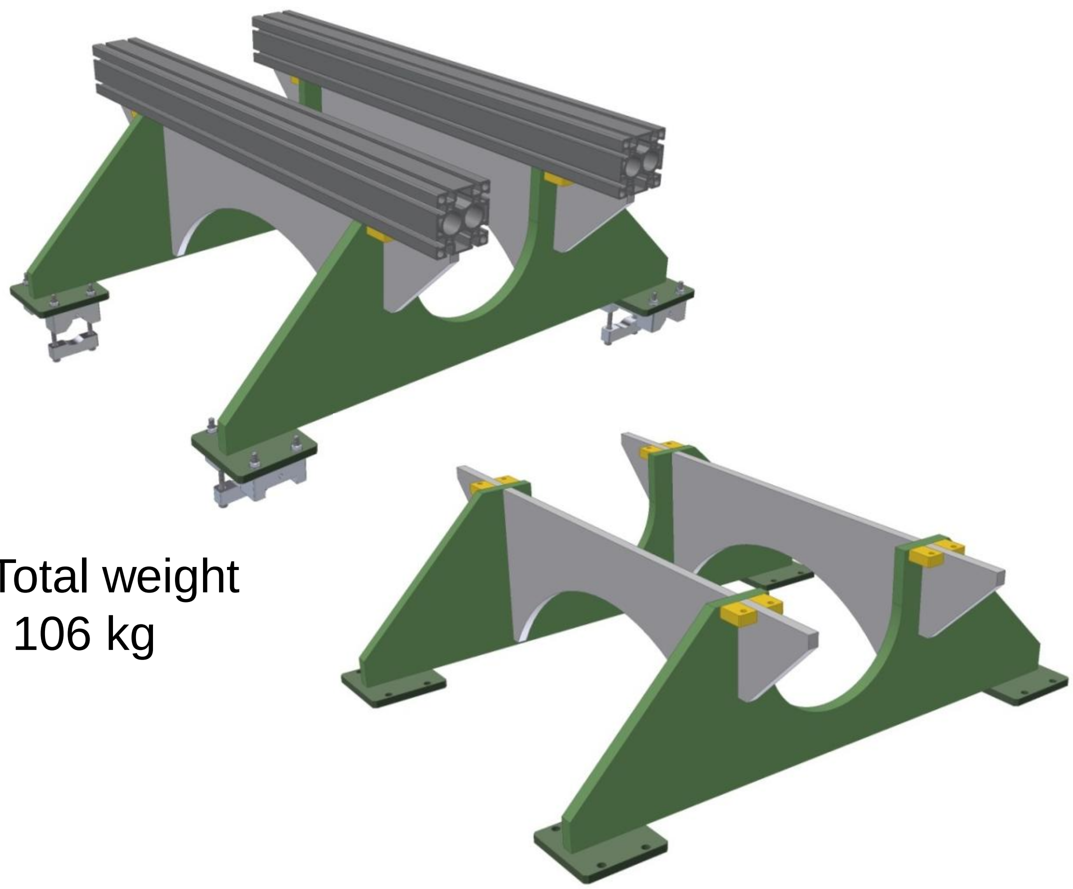
MEBT support frame

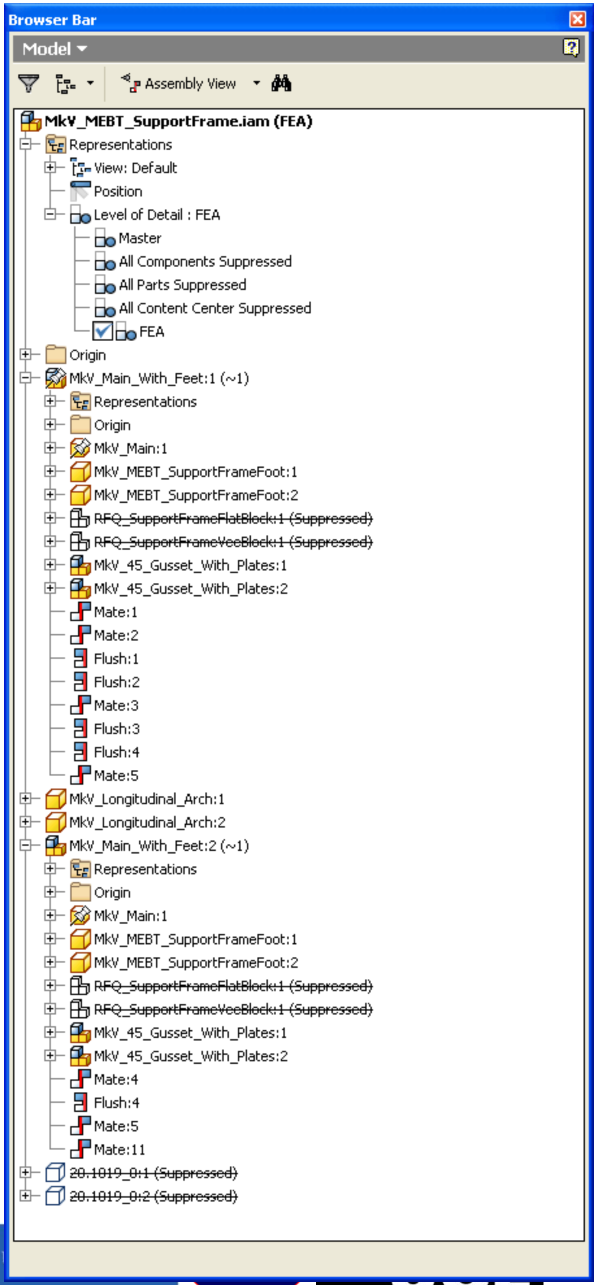


Preparing the CAD model for FEA

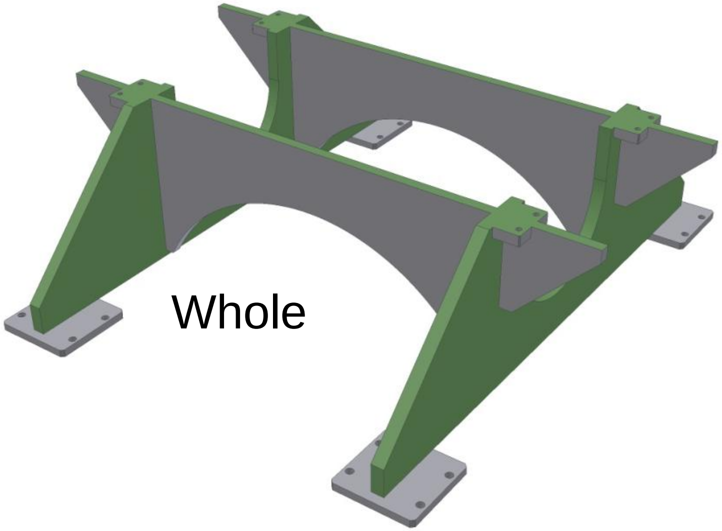


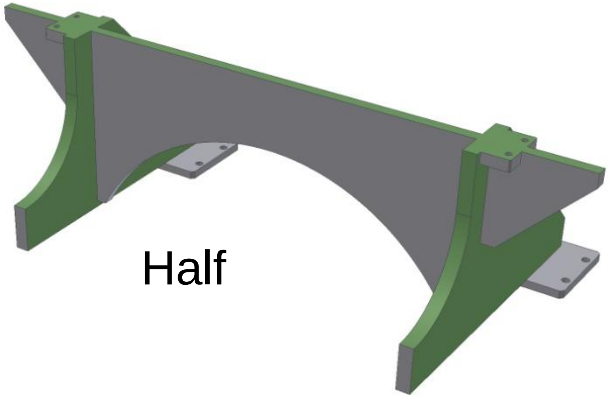
- Total weight = 106 kg

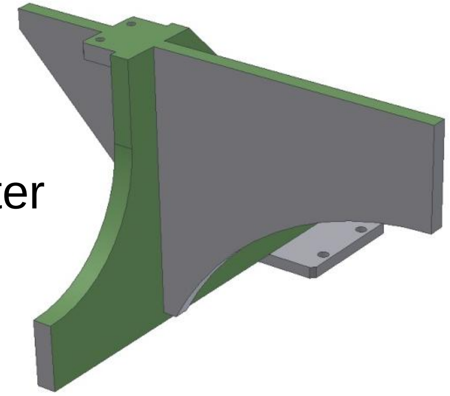
- Using assembly
- Create a new level of detail for the FEA
- Suppress features not wanted in FEA



Making use of symmetry







- Create a derived component
- Subtract to make use of symmetry

- Goal is to design a structure that is stiff enough without excessive weight – otherwise we over deform the support structures below which in-turn throws out the alignment.

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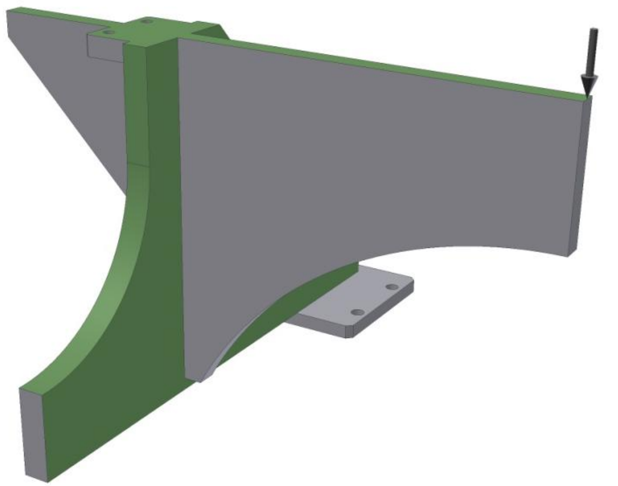
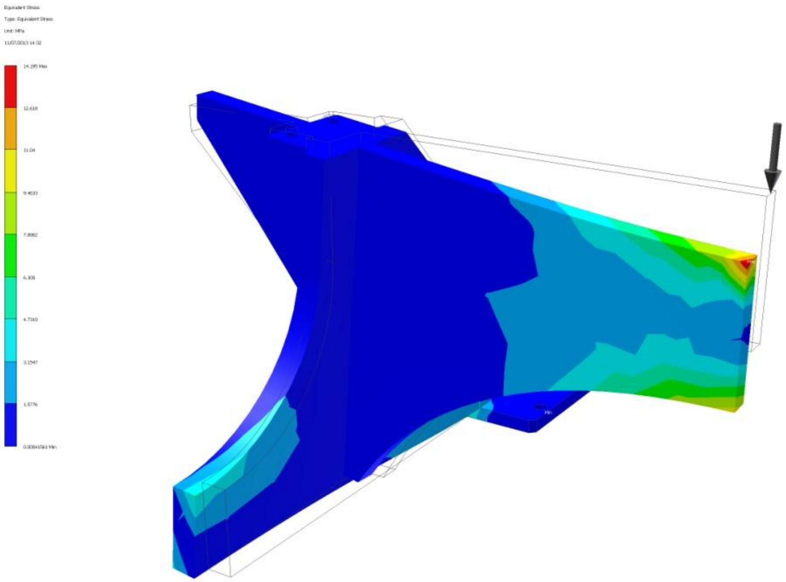
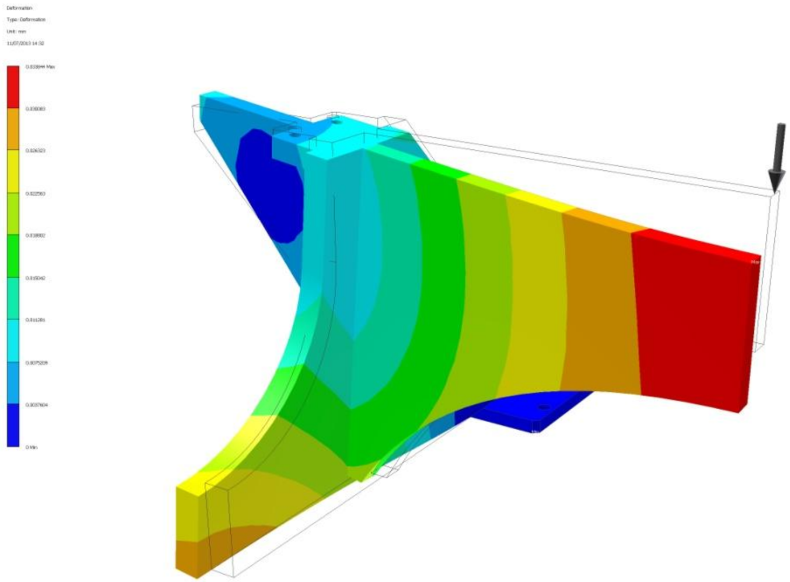
Load case 1 – Edge load



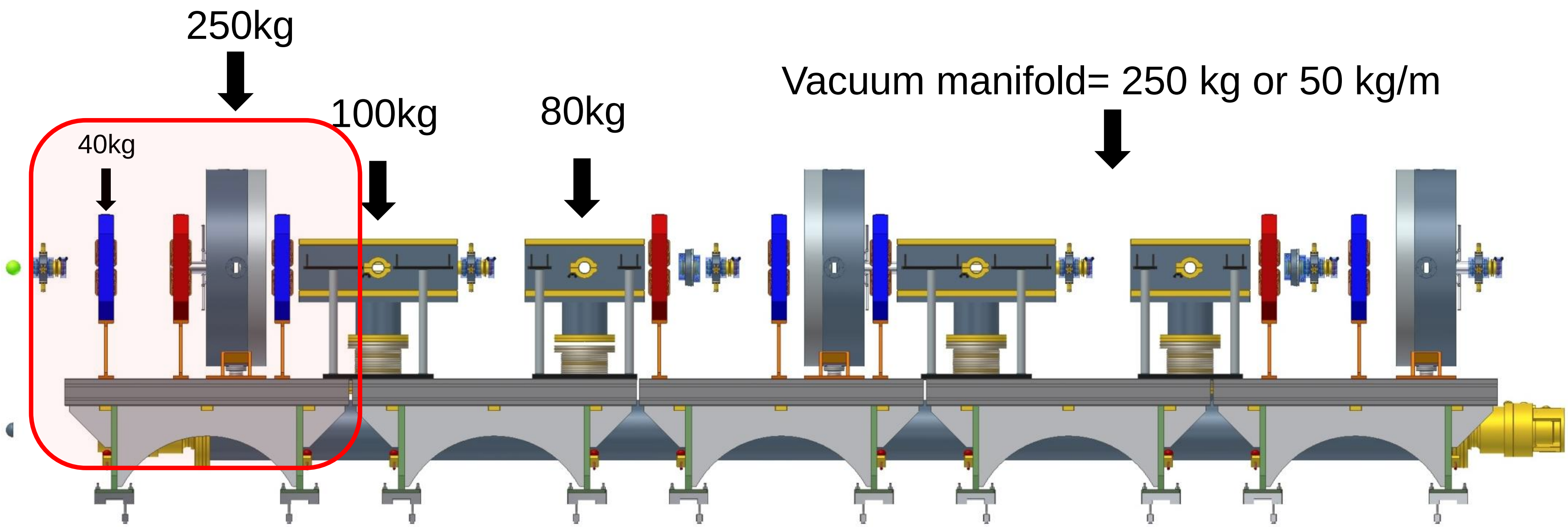




Edge load
Material: Mild Steel
Load of 100kg on centre edge (eq. 400kg)
Frictionless constraints on symmetry planes
Fixed constraint on under-side of foot

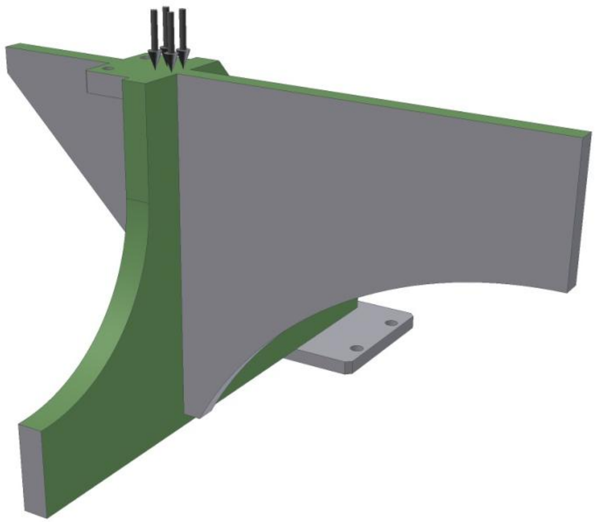
Equivalent stress = 14MPa
Maximum deformation = 0.03mm

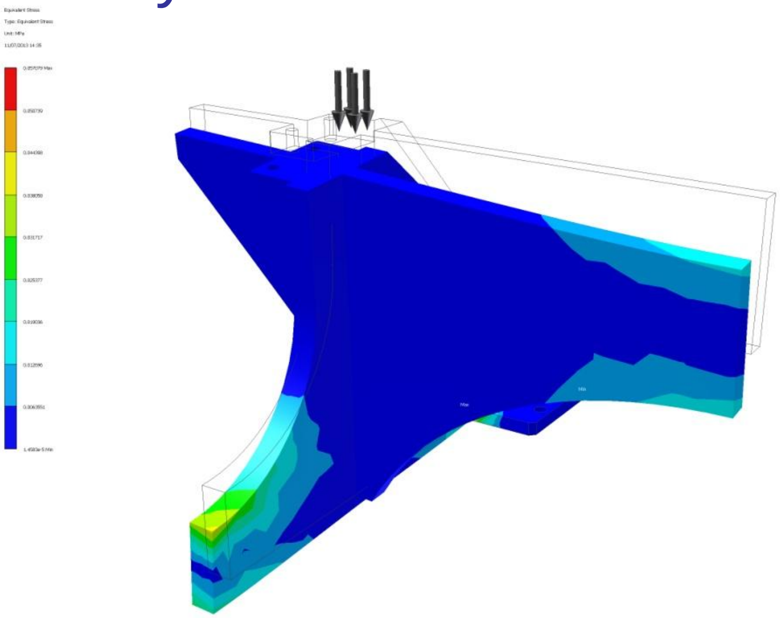
Why did I use 400kg load?

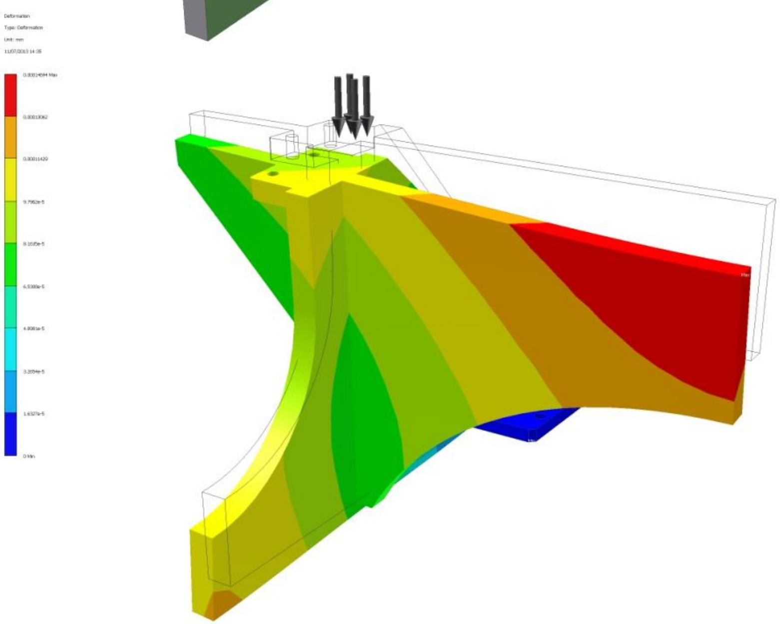


Worst case = 1 cavity + 3 quads + ½ chopper + vacuum manifold
= (1x250)+(3x40)+(1/2 x 100) + 50
= 250 + 120 + 50 + 50
= 470 kg
So my guess of 400kg is reasonable.

Load case 2 – Uniformly distributed load





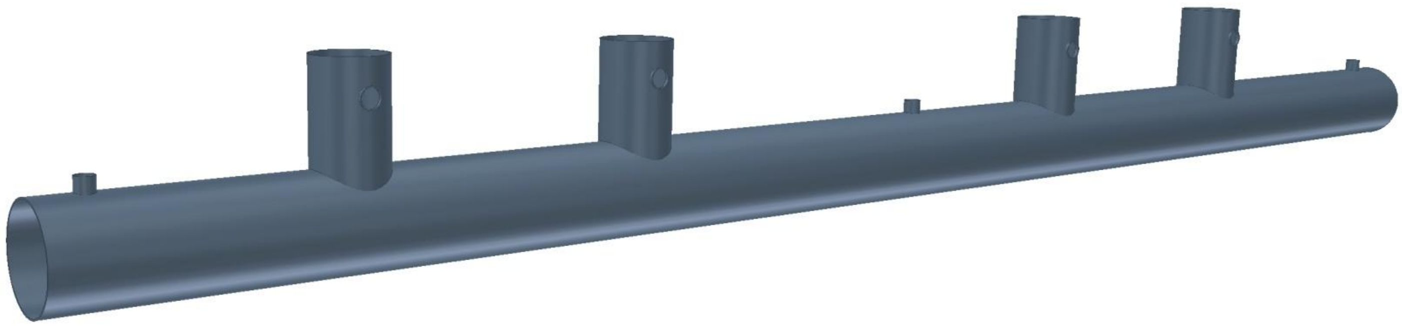


Uniformly distributed load
Material: Mild Steel
Load of 100kg on entire top surface
Frictionless constraints on symmetry planes
Fixed constraint on under-side of foot

Equivalent stress = 0.05MPa
Maximum deformation = 0.001mm

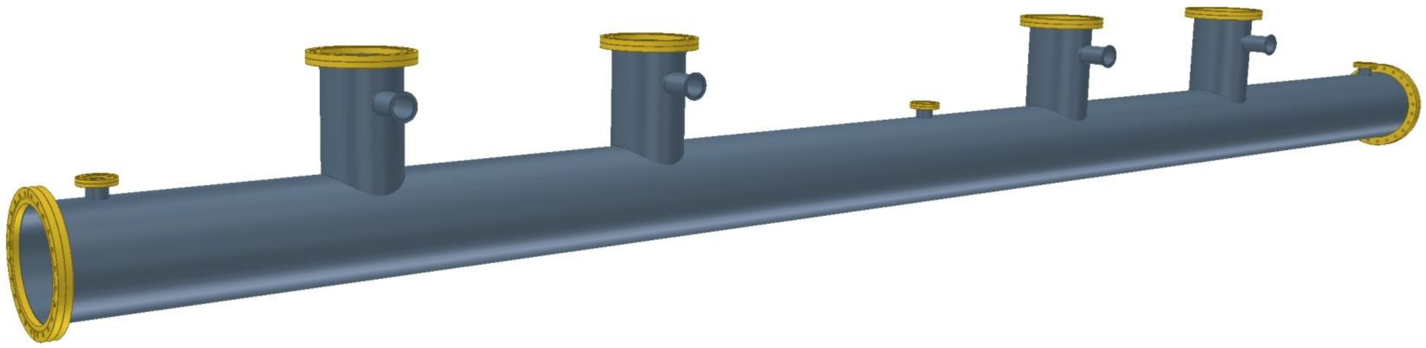
Contents

Vacuum manifold design



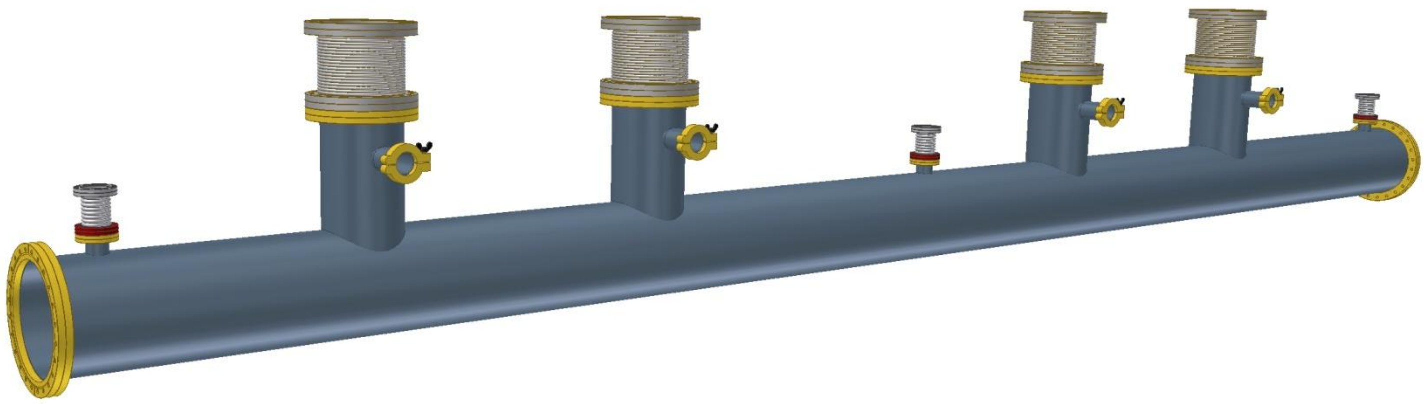
~5m long stainless steel tube (DN200CF)
3 x DN40CF tubes welded to it for the rebunching cavities
2 x DN160CF tubes welded to it for the chopper vessels
2 x DN160CF tubes welded to it for the chopper beam dump vessels

Vacuum manifold design



Weld flanges in position

Vacuum manifold design



Mount bellows and KF40 flanges
(for pressure measurement)

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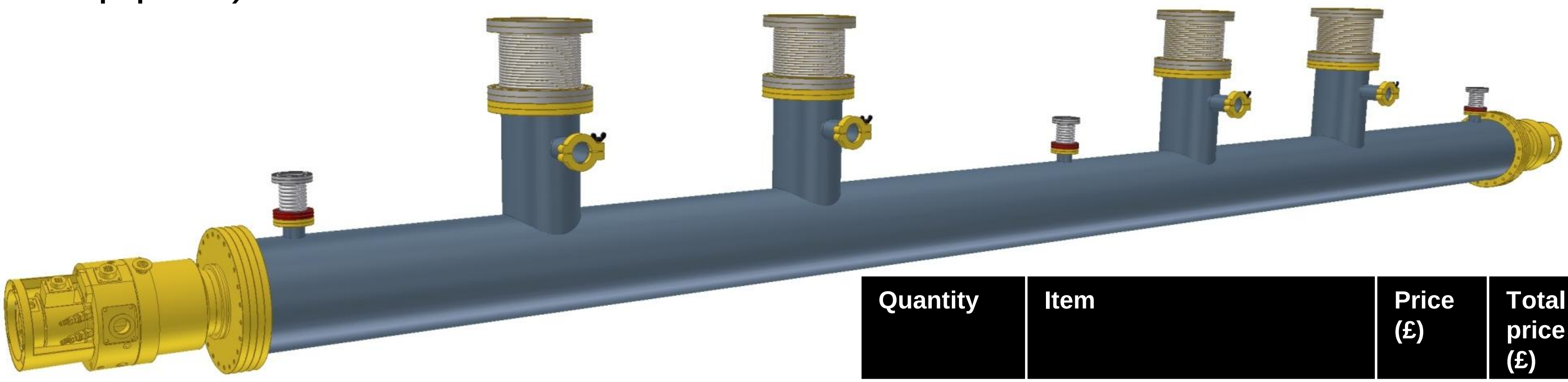
Vacuum manifold design

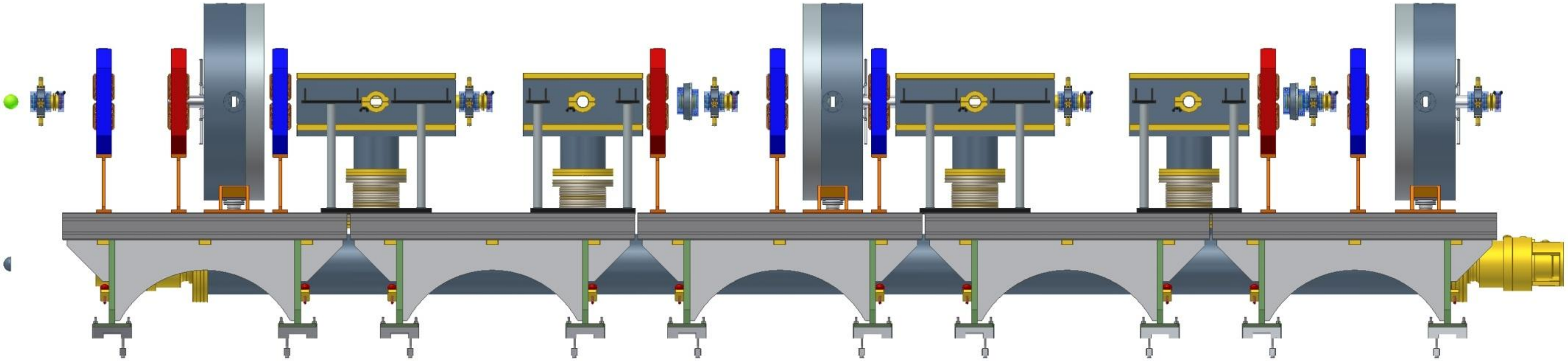
End mounted pumps = no natural path to the pumps for debris (e.g. sputtering from chopper beam dump plate)



Quantity	Item	Price (£)	Total price (£)
4	DN160CF flanges	120	480
4	DN160CF bellows	420	1680
3	DN40CF flanges	20	60
3	DN40CF bellows	80	240
4	DN40KF clamps etc	30	120
2	DN200CF flanges	180	360
2	DN200CF converter flanges	180	360
		Total	3300

Guestimated cost = £5k

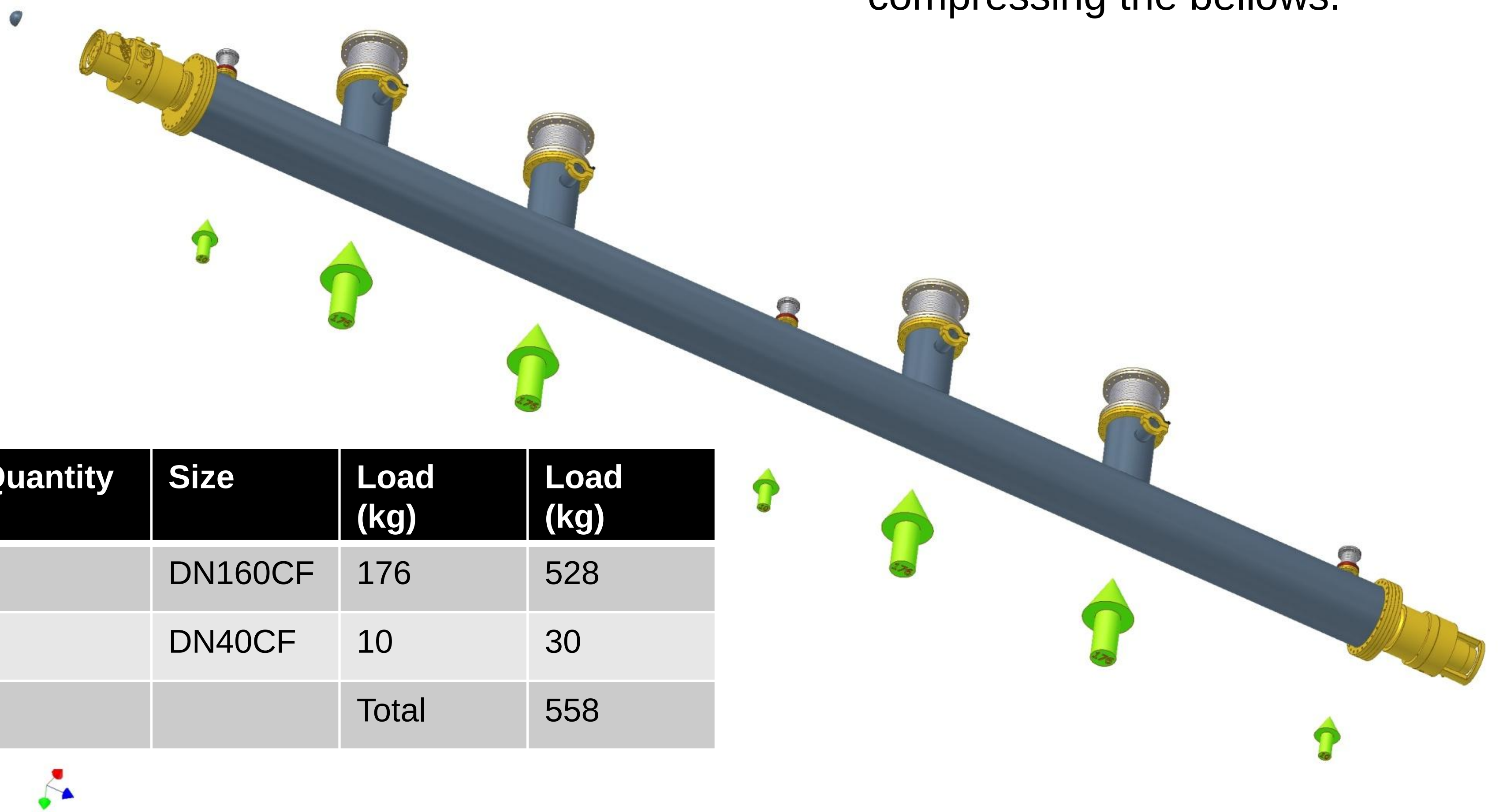
Vacuum manifold design change



DN160CF vertical vacuum tubes now part of chopper and chopper beam dump bases. This would allow the vacuum manifold build to proceed prior to knowing vessel depths.

Vacuum loading on manifold

558kg will push the manifold towards the MEBT, compressing the bellows.

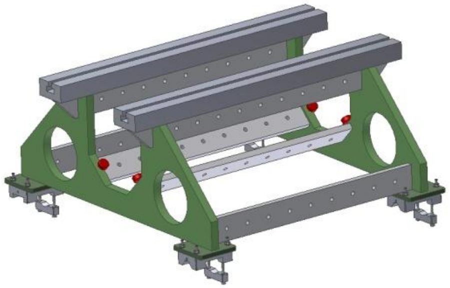


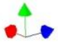
Quantity	Size	Load (kg)	Load (kg)
4	DN160CF	176	528
3	DN40CF	10	30
		Total	558

Contents

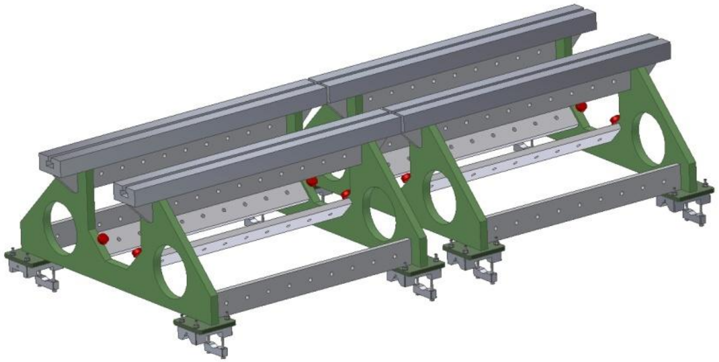
1. MEBT Support Frames
2. MEBT Vacuum Manifold
3. MEBT Assembly

MEBT support frame assembly

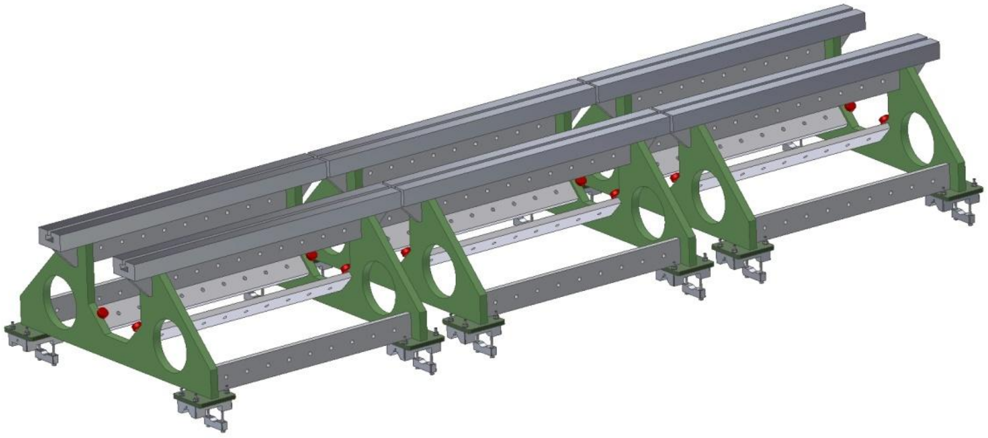




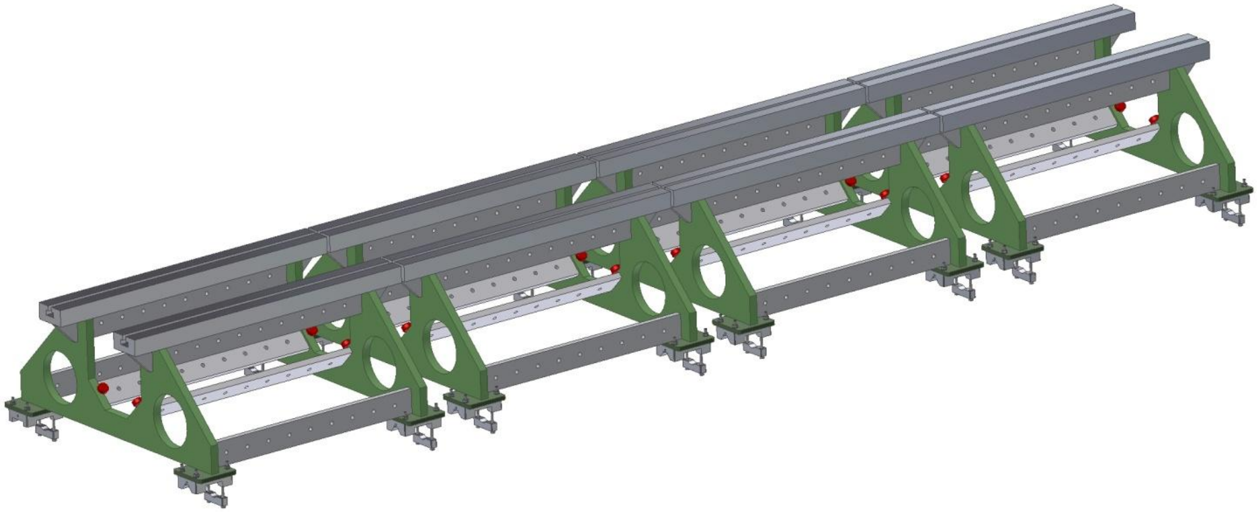
MEBT support frame assembly



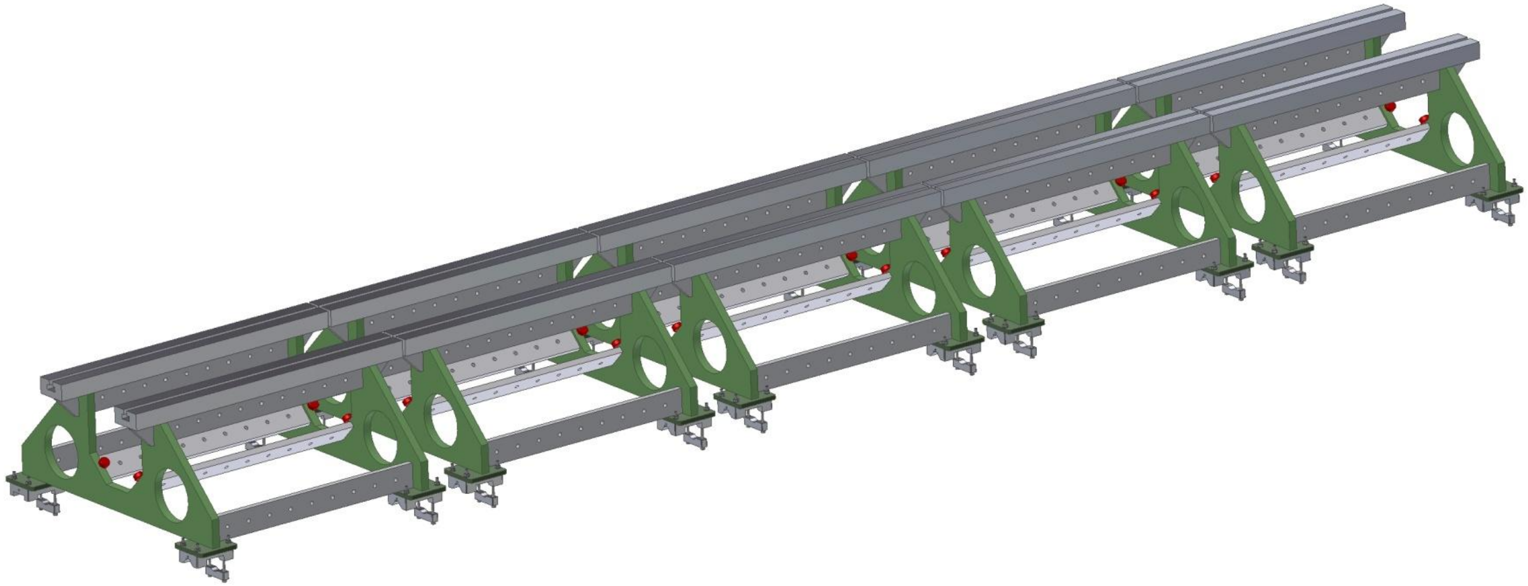
MEBT support frame assembly



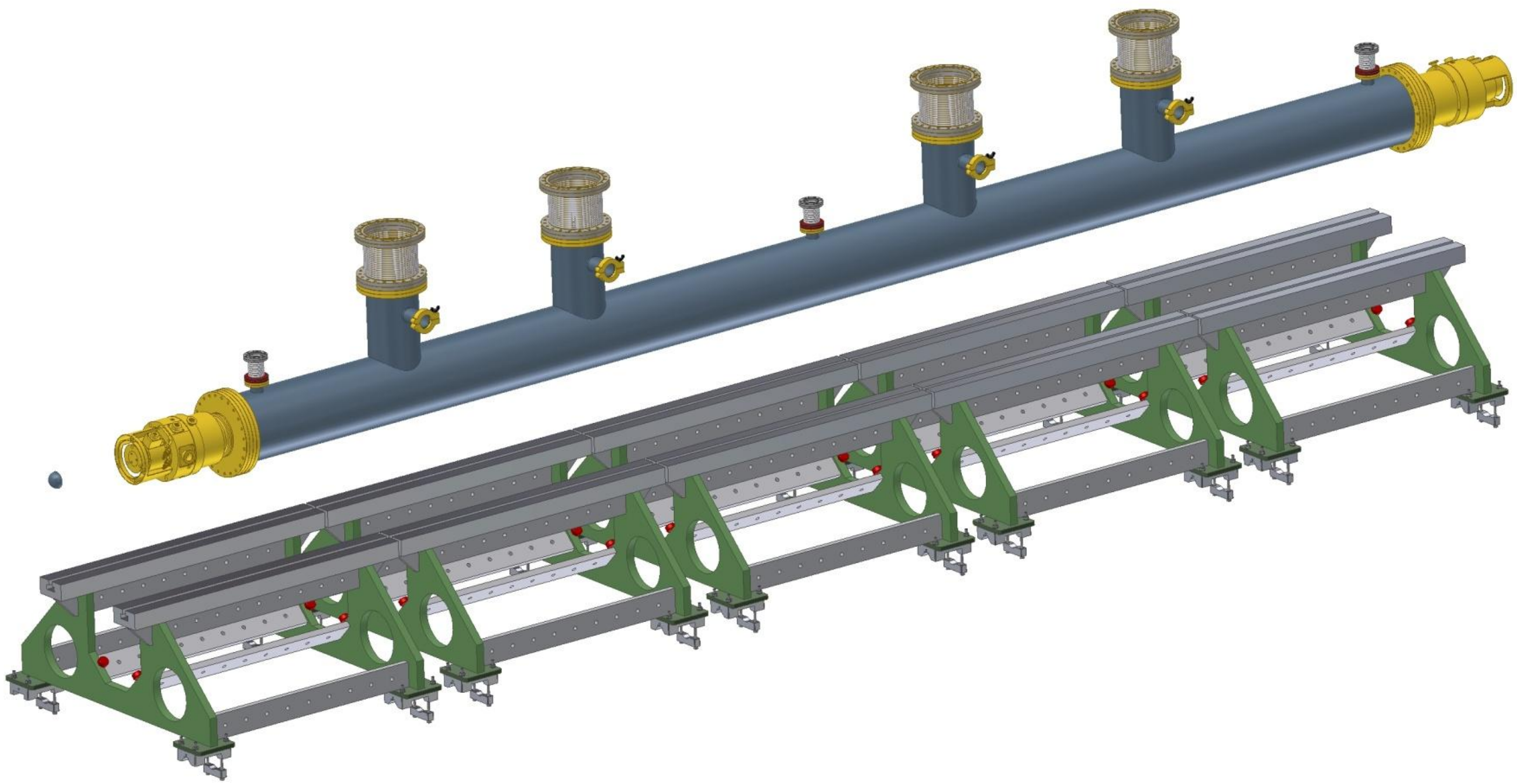
MEBT support frame assembly



MEBT support frame assembly



Lowering the vacuum manifold into position



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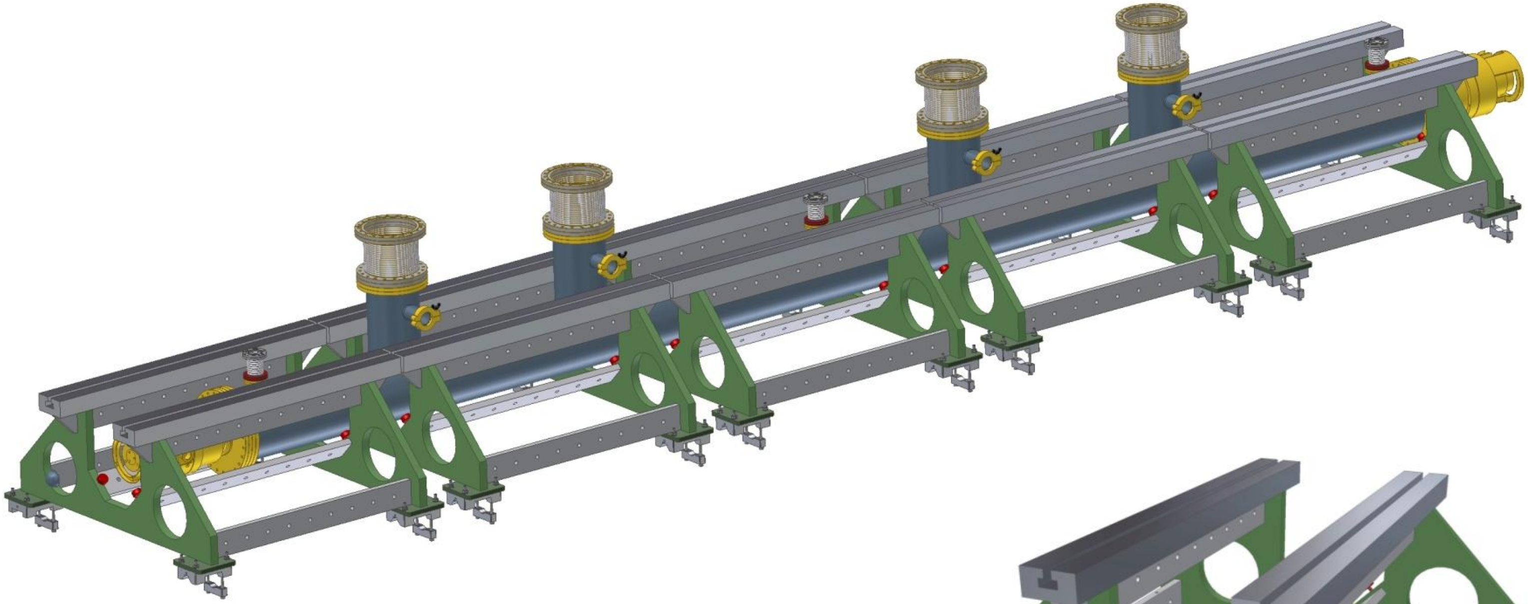
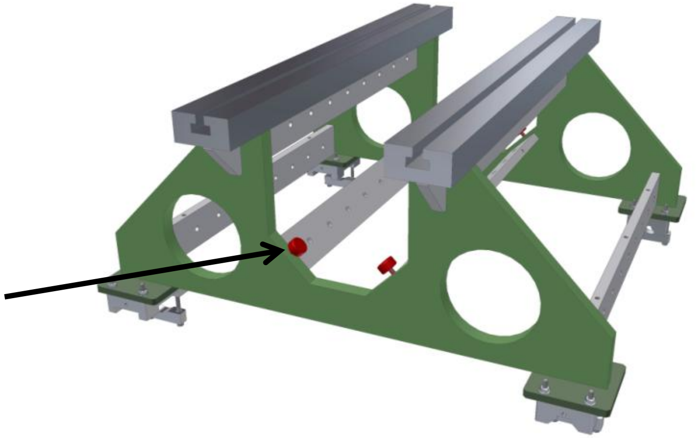
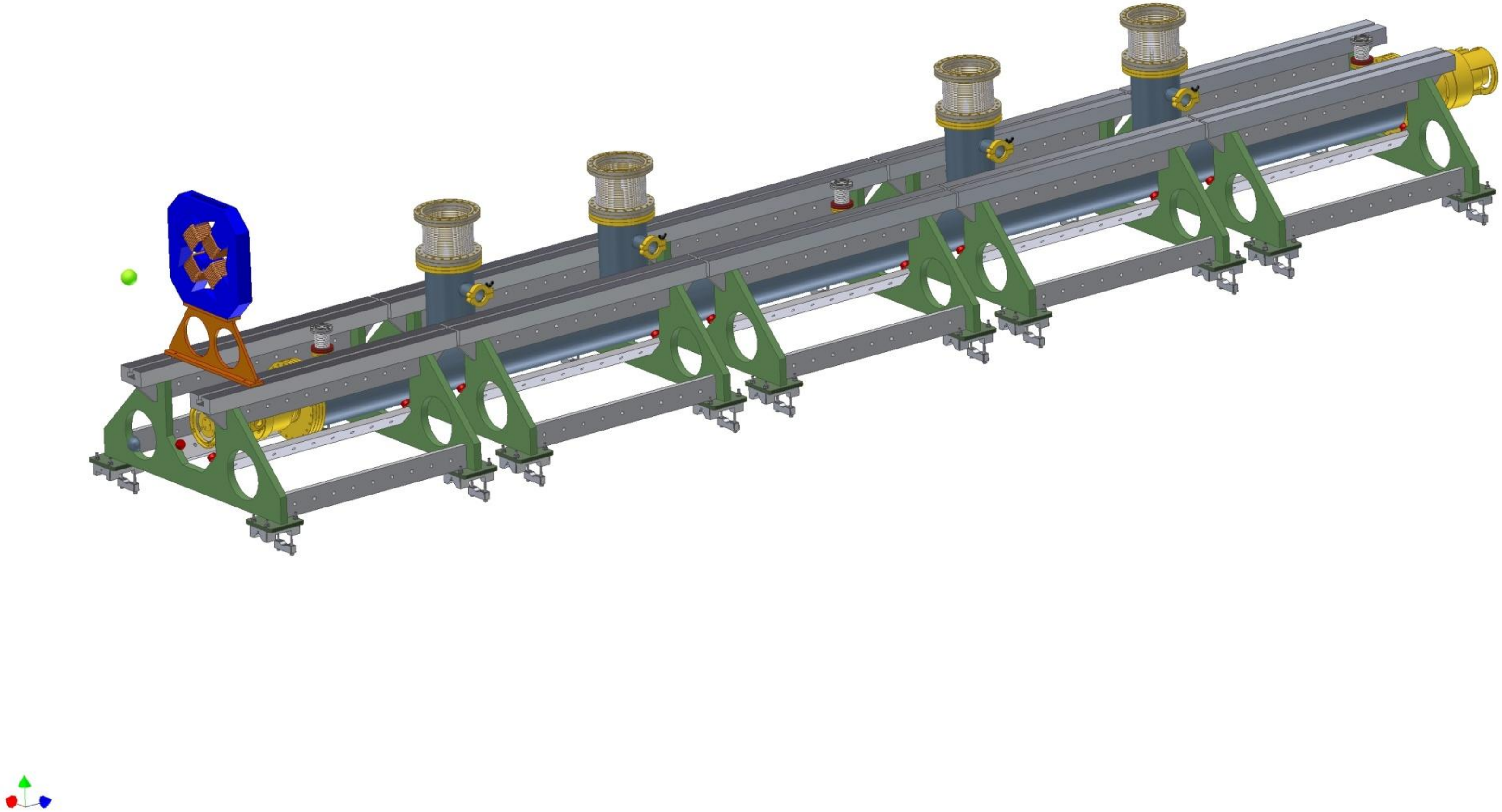
Lowering the vacuum manifold into position



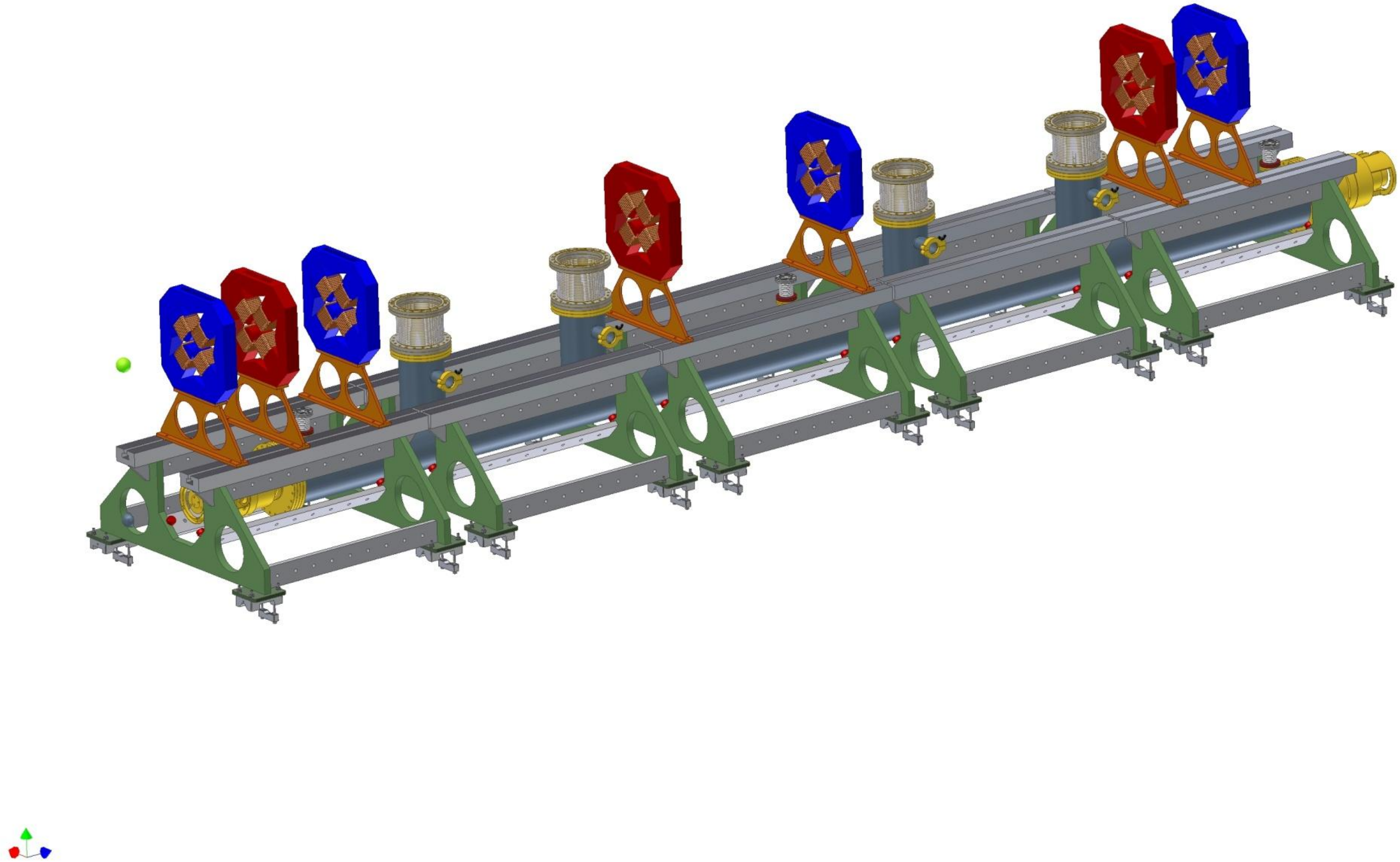


Manifold lays on rubber feet.
Adjusted so that they all support the manifold.

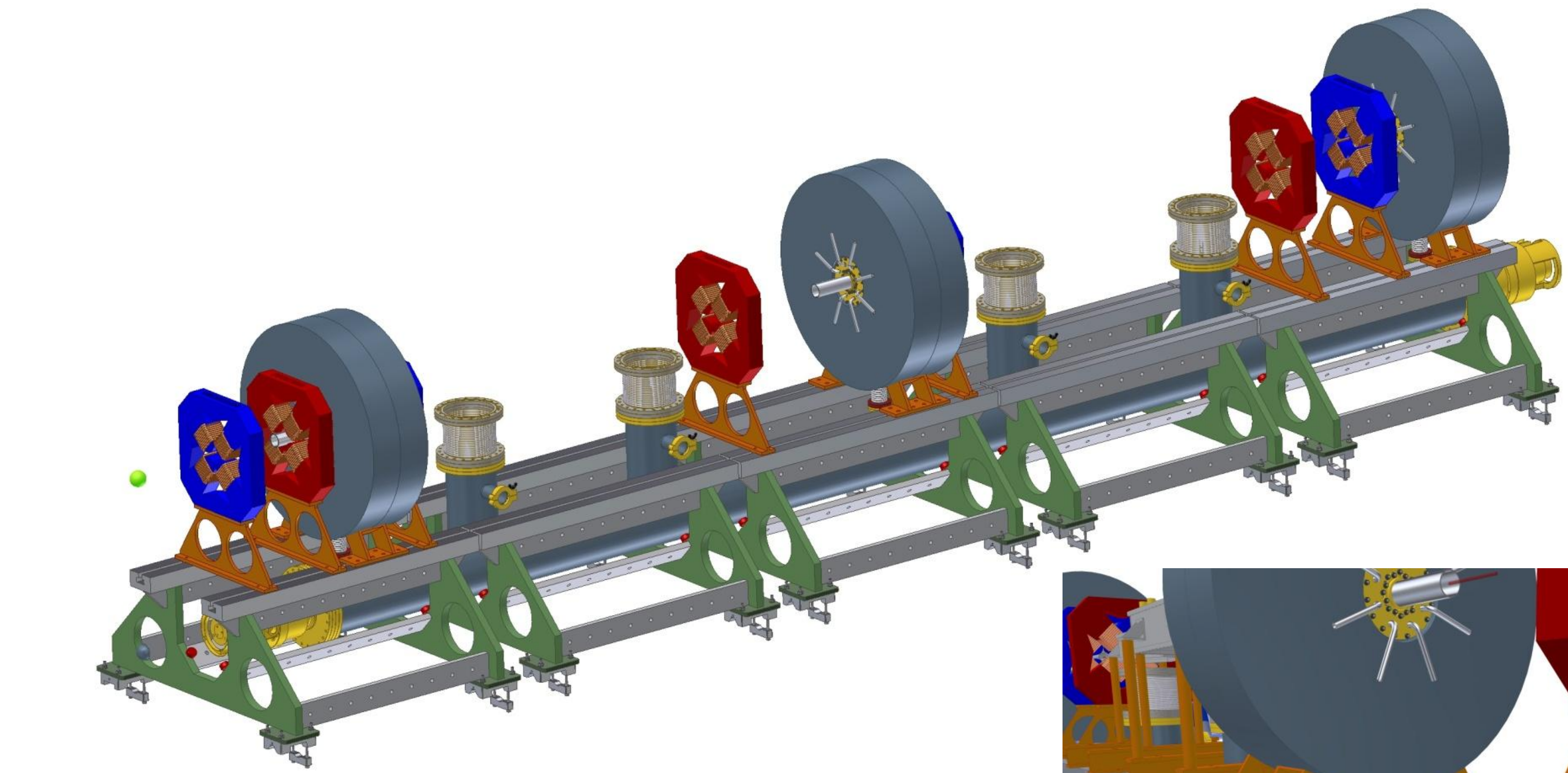
Positioning the quadrupoles

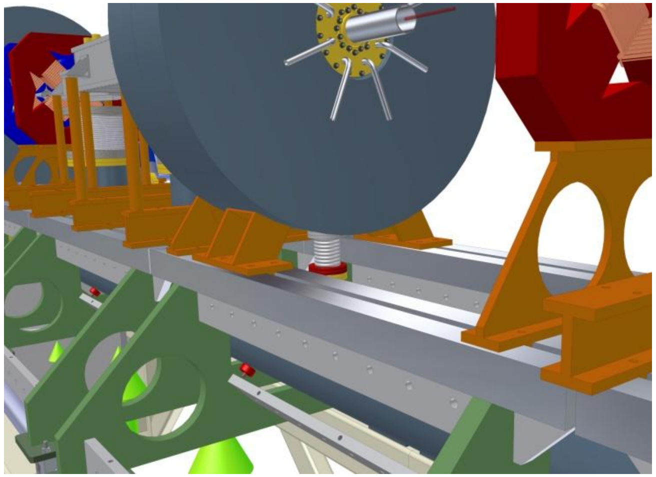


Positioning the quadrupoles



Positioning the rebunching cavities





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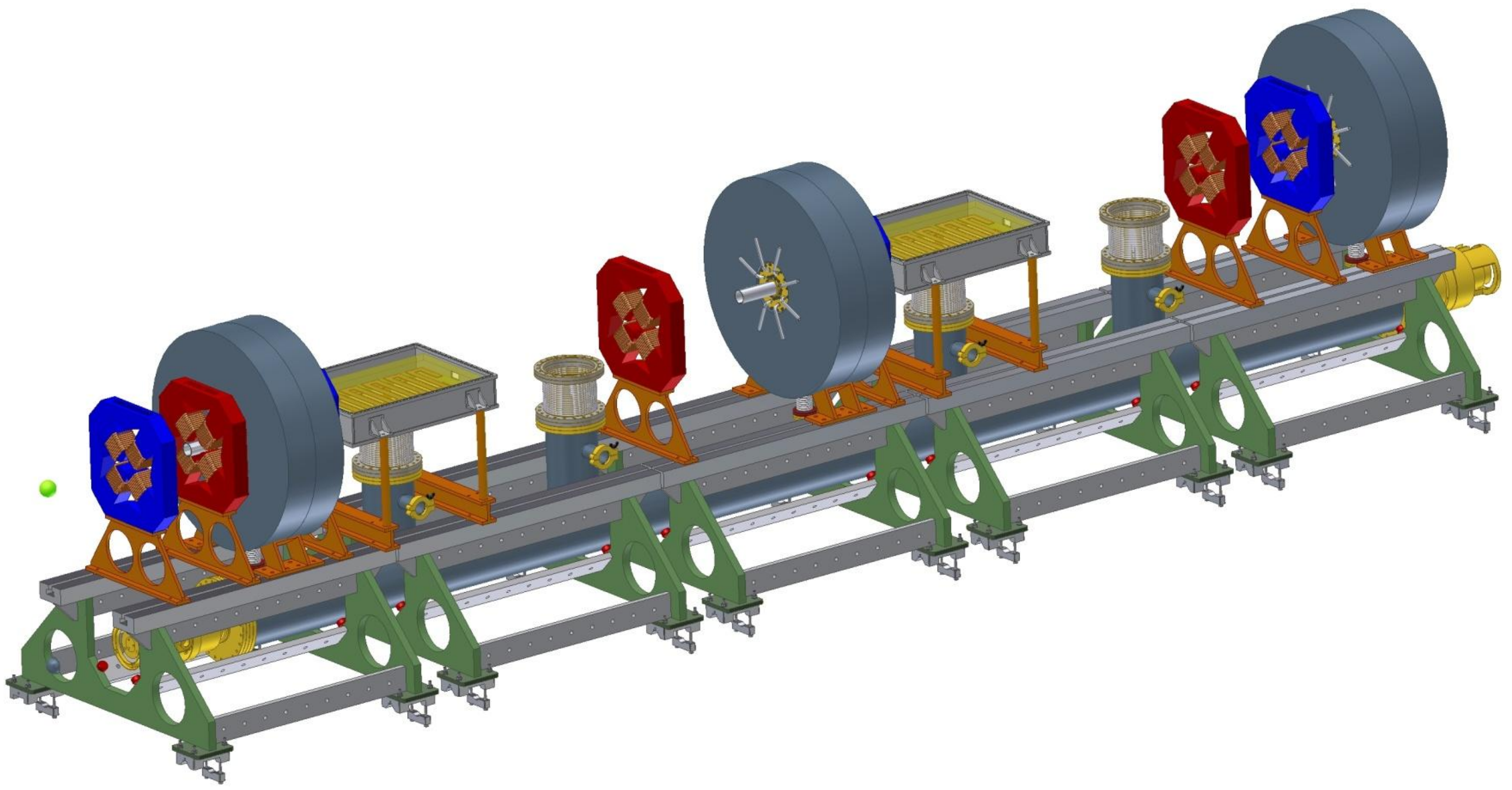
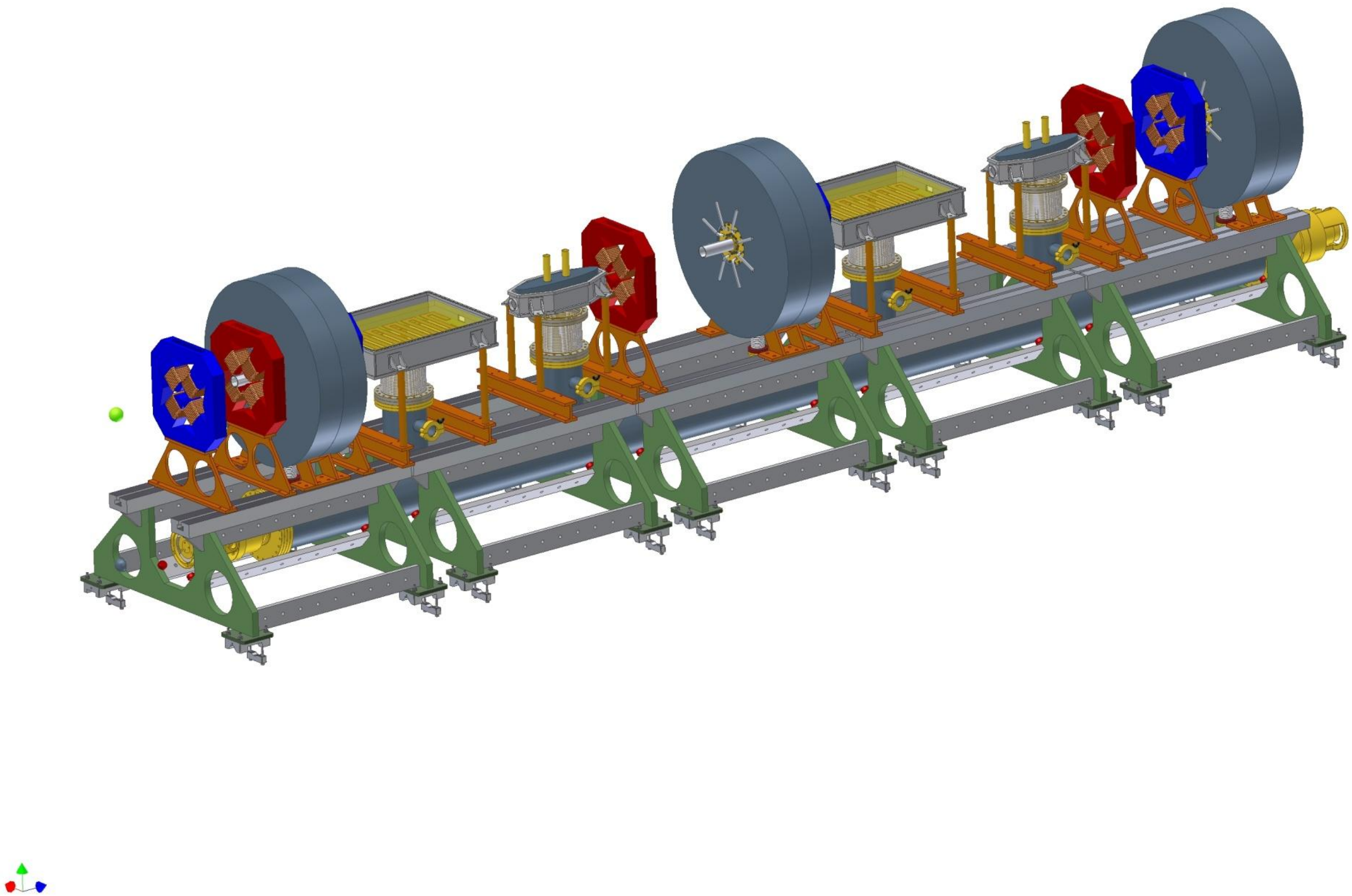
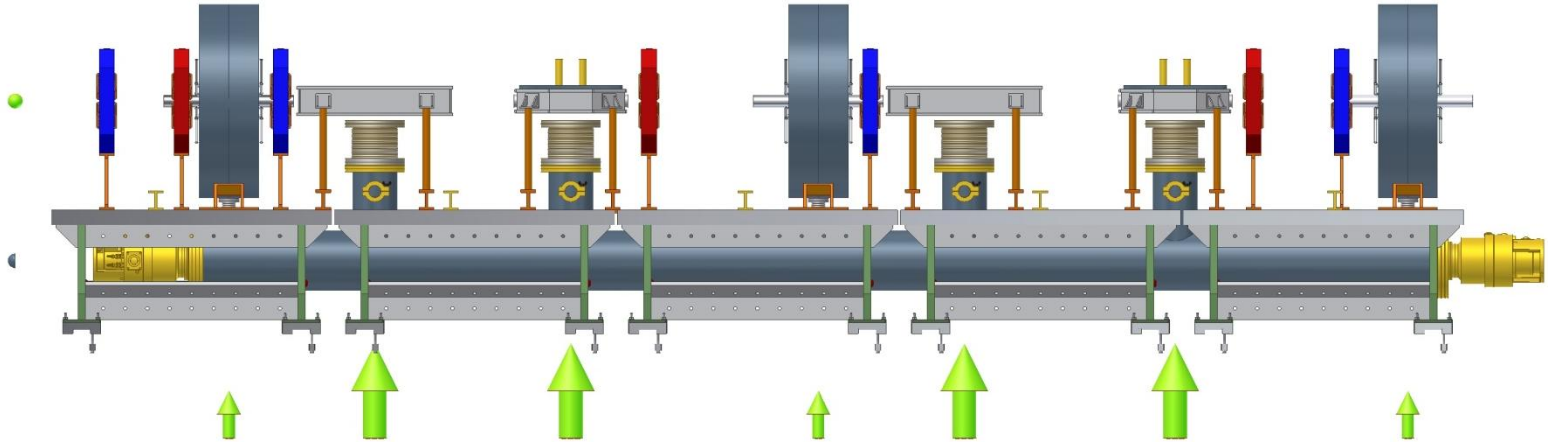
Positioning the choppers



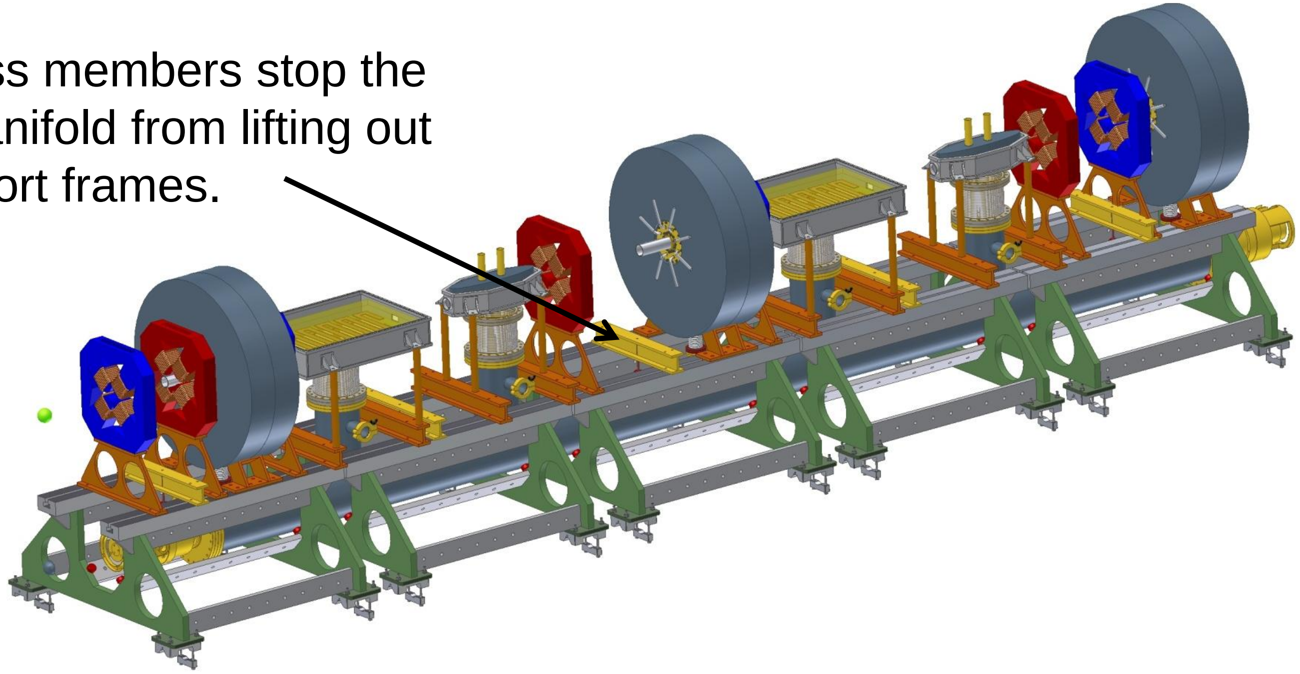
Positioning the chopper beam dumps



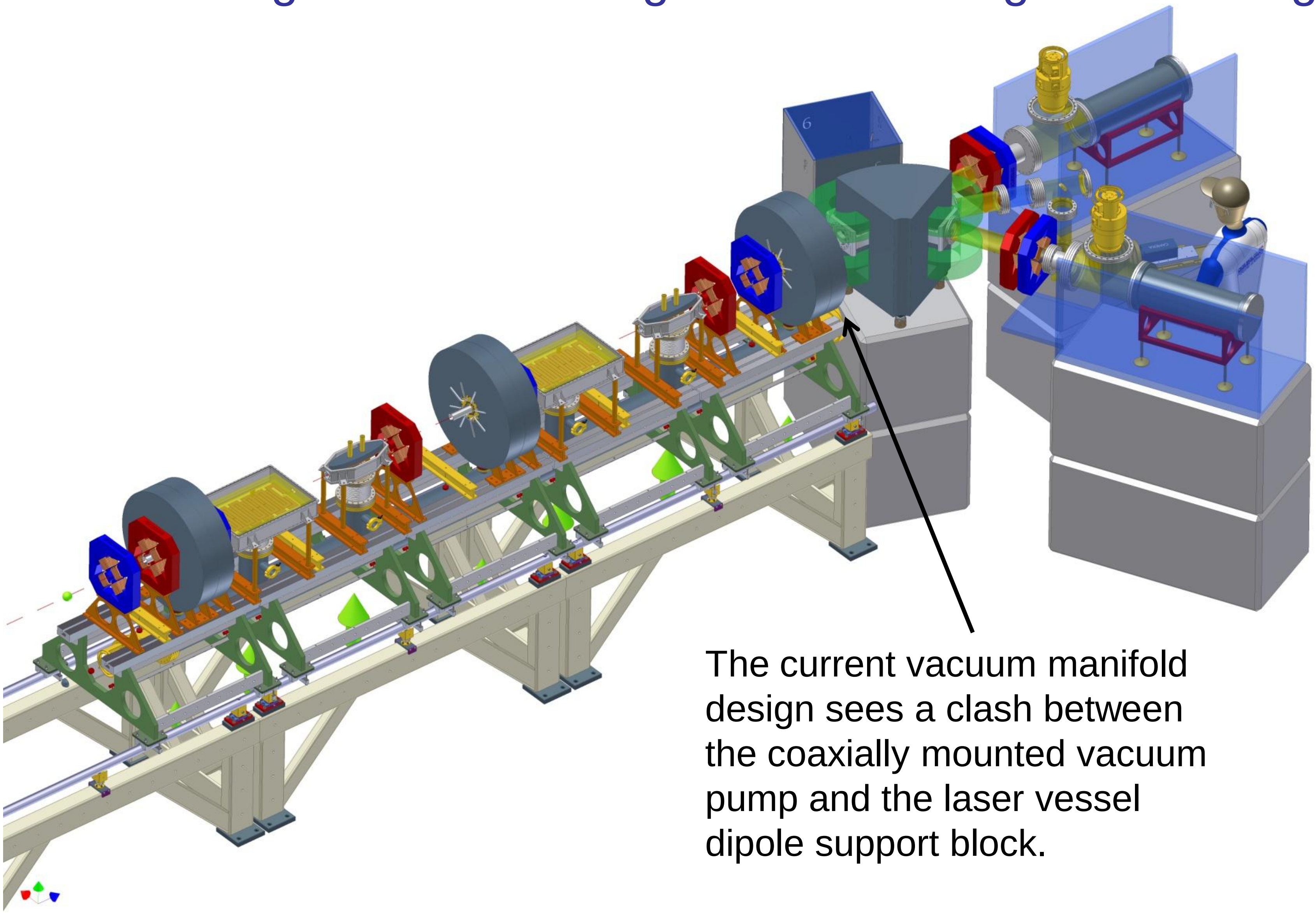
Vacuum loading on manifold



Simple cross members stop the vacuum manifold from lifting out of the support frames.



Need to integrate MEBT design with laser diagnostics design



The current vacuum manifold design sees a clash between the coaxially mounted vacuum pump and the laser vessel dipole support block.

Any questions?