Development of a low material endplate for LP1 and ILD

Dan Peterson, Cornell
2010-04-22

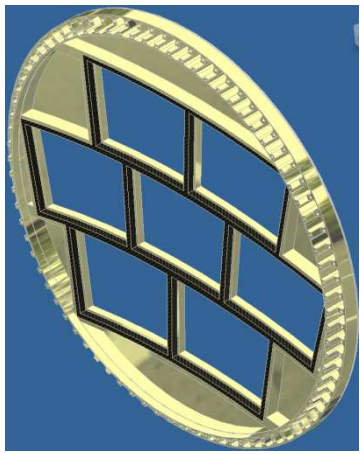
At previous meetings,

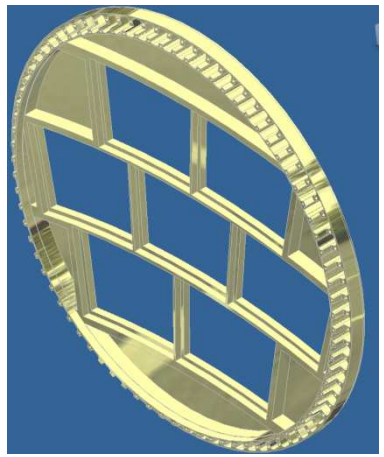
2010-04-08,
discussed the space-frame endplate design for an LP endplate
and comparison of FEA with LP1 and Al-carbon-hybrid designs,

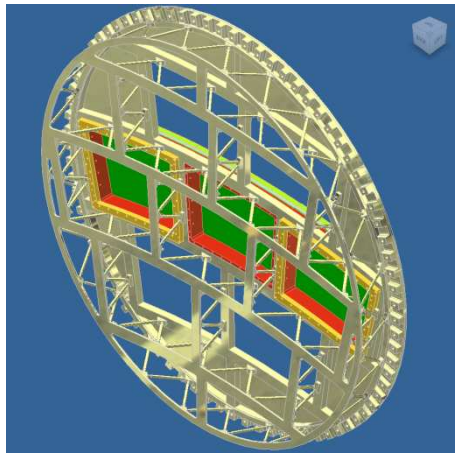
Now,
getting ready to make small prototypes to
measure ability of FEA to model properties of the space-frame

Comparison of candidate models (from 2010-04-08)

	mass kg	material $\%X_0$	deflection microns	stress Mpa (yield: 241)
LP1	18.87	16.9	33	1.5
Lightened (all aluminum)	8.93	8.0	68	3.2
Lightened (Al-C hybrid)	Al 7.35 C 1.29	7.2	< 168* (* values for the aluminum only)	< 4.8*
Space-Frame	8.38	7.5	23	4.2







Material: space-frame has slightly more material than the Al-C hybrid.

Deflection: space frame is more rigid than LP1,
~3x more rigid than the lightened (all Aluminum),
and > 3x more rigid than the Al-C hybrid.

(from 2010-04-08)

Al-C Hybrid design

The current design has 43% of the material of the current LP1
and slightly less material than the space-frame.
The deflection is somewhere around 140 microns, which might be OK.

Small prototyping is required to understand the strength of the hybrid.

A significant concern about the hybrid design is that
it does not scale well to the ILD endplate: 77cm -> 350cm.
More material will be required to maintain this rigidity at ILD.

Space-frame design

The current design has 44% of the material of the current LP1.
The deflection is 23 microns, less than LP1 at 33 microns.
This design is scalable to the ILD; strength can be maintained
by moving the back-plane further away.

This design is buildable and can be aligned. (It does not involve messy epoxy.)

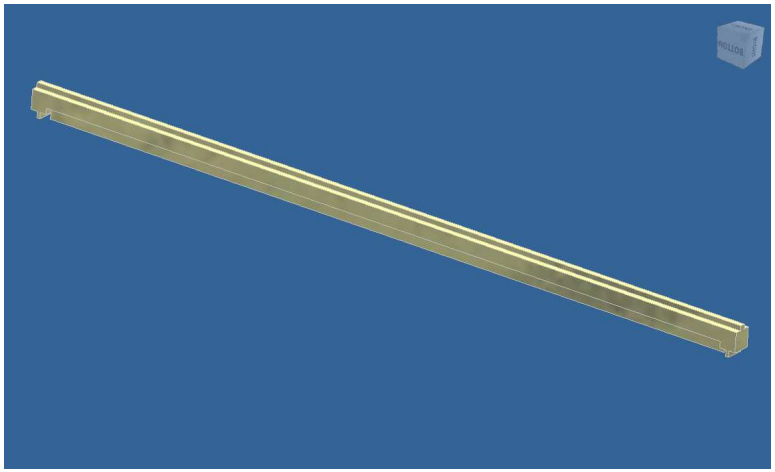
A significant concern about the space-frame design is that
the strength of the joints may not be accurately modeled.
Small prototyping is required to understand the threaded joints.

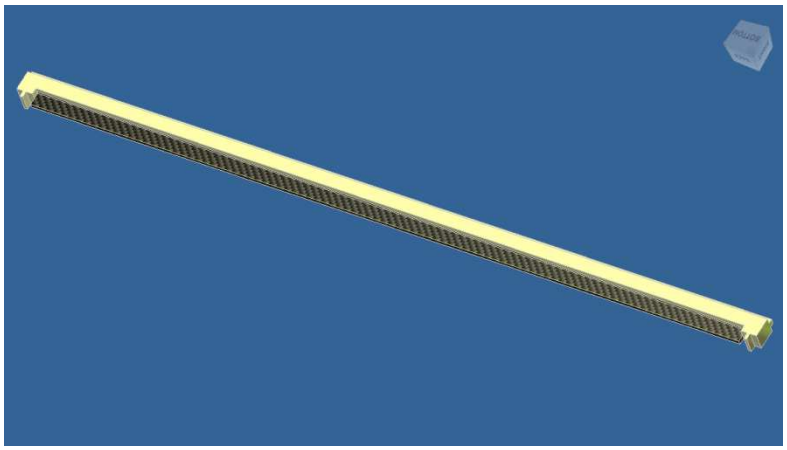
Next Plan

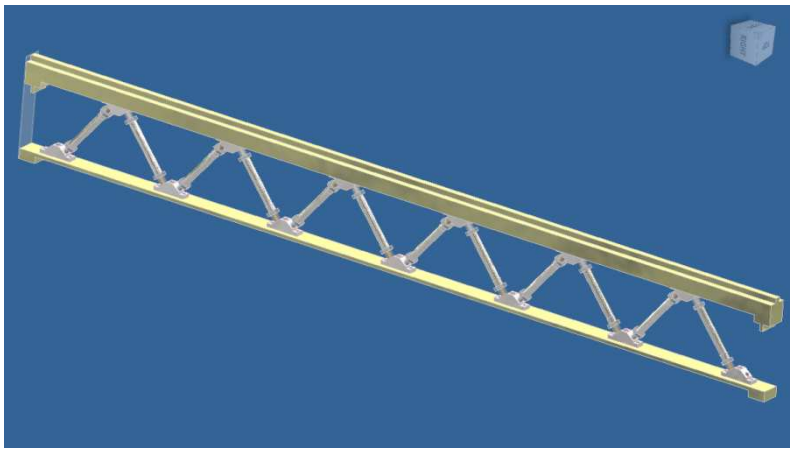
Make a series small prototype test beams that can be used for understanding the ability of the FEA to model the assembly.

(1) LP1
(2) Al-carbon-fiber hybrid discussed earlier
(3) Space frame

Each is 750 mm long
(LP1 diameter is 770mm)





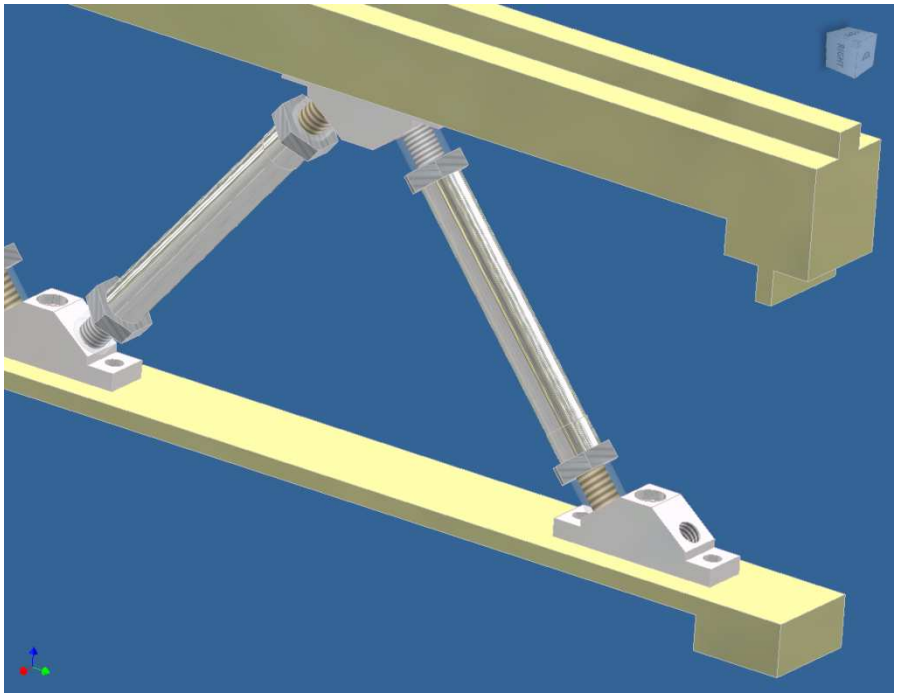


Two models have been prepared for the space-frame small prototype:

(1)assembly of individual components

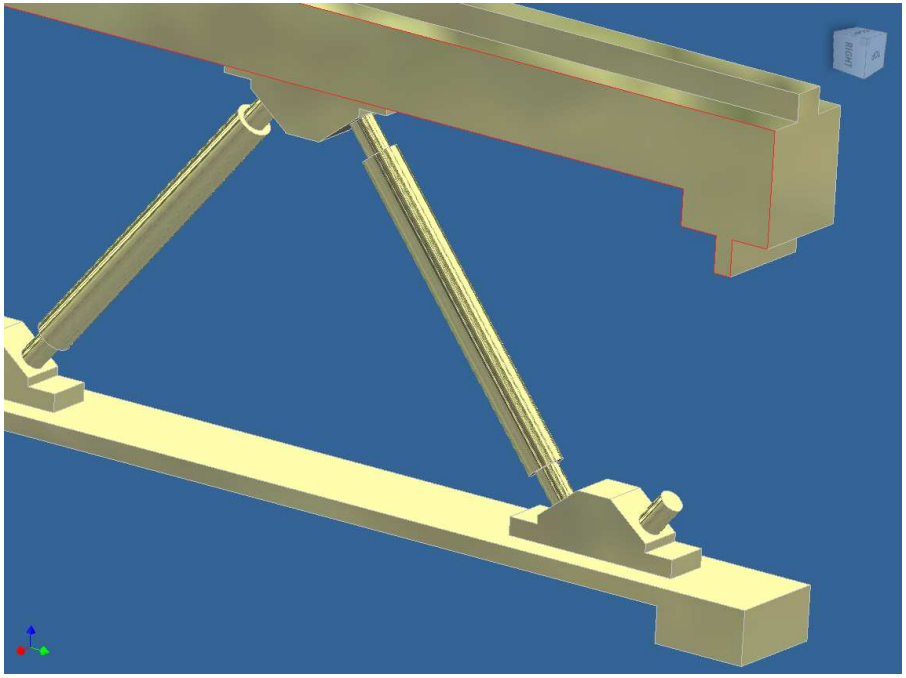
This will be used to generate the models and drawing for construction.

(I need another nut at the mount.)



(2) solid model

This is used for the FEA.

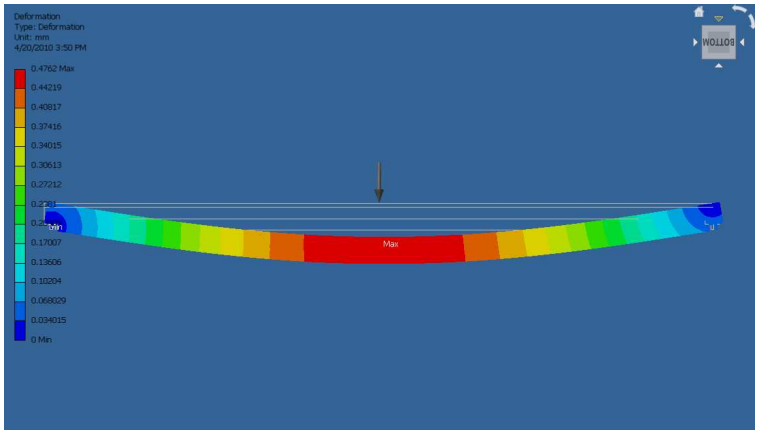


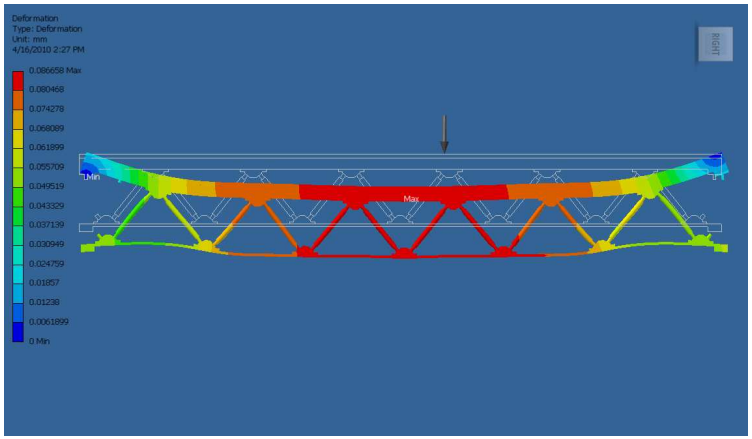
Deflections are predicted with the FEA using the usual 100N force.

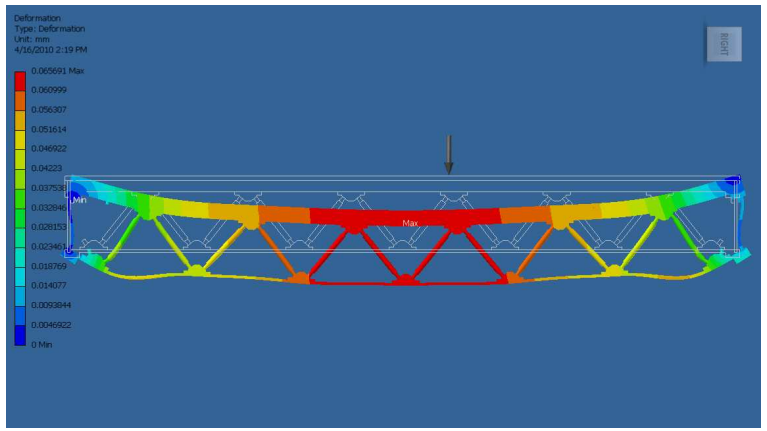
	mass kg	deflection mm	stress Mpa (yield: 241)
LP1	0.63	0.48	~7
LP1* (without module stiffener)	0.53	1.07	
channeled (for the hybrid, but without adding carbon)	0.37	1.33	
Al-C hybrid	modeling requires more work		
space-frame (without end straps)	0.76	0.09	15
space-frame (with added end straps)	0.76	0.07	14

Note: ratio (space-frame/LP1) = 0.8/.48 ~ 1/6

in the case of the LP endplate
ratio (space-frame/LP1) = 23/68 ~ 1/3







Stress results

The constraints are applied to some thin section that isolates the stress from the real part.

When measuring the part, it will not matter if the surface it held parallel to the mount, or not.

In the space frame, the maximum stress point is in one of the screws.

- The max. stress point changes with the addition of the end strap.