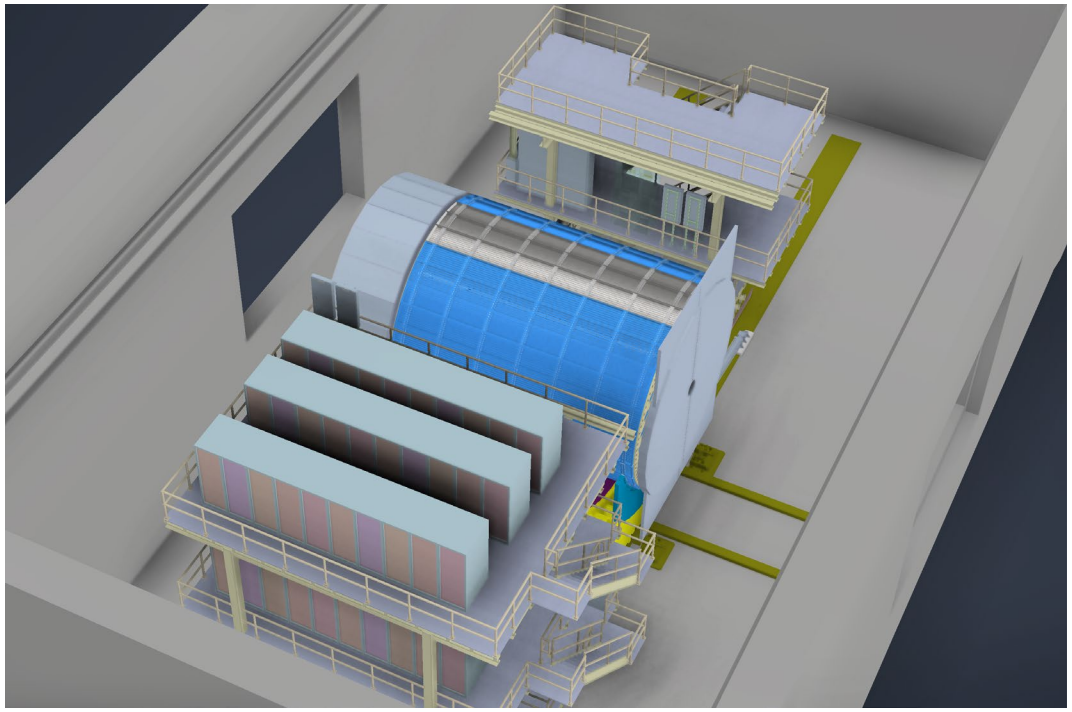
Geometry database and updates of ECCE as reference detector in CAD and Sketchup

Silvia Dalla Torre, Or Hen, Tanja Horn, John Lajoie, Bernd Surrow

In collaboration with the EIC Project Team

Global Layout

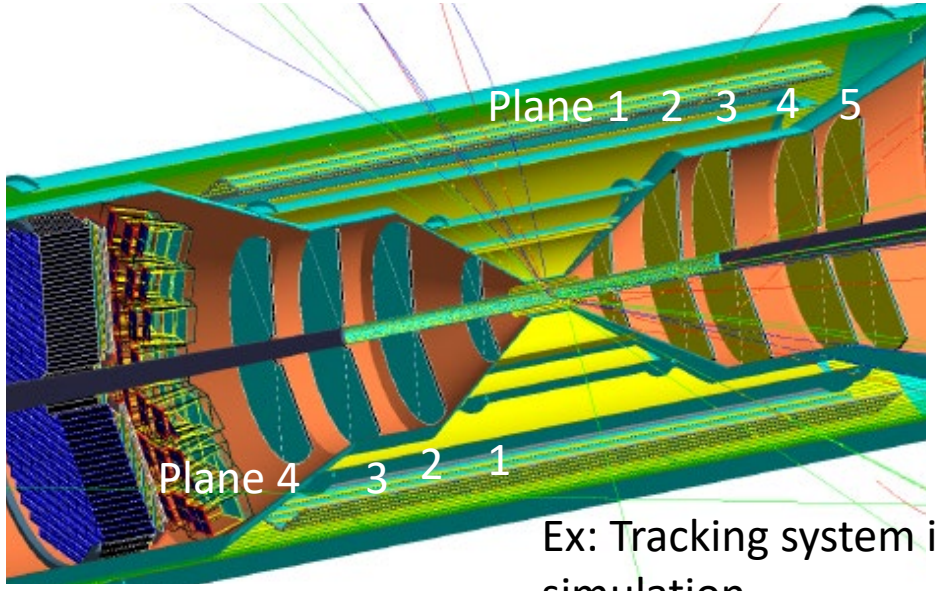
- Global Detector Positions – starting point for simulation studies
- Reference Detector 1 in Sketchup
- Reference Detector 1 in CAD



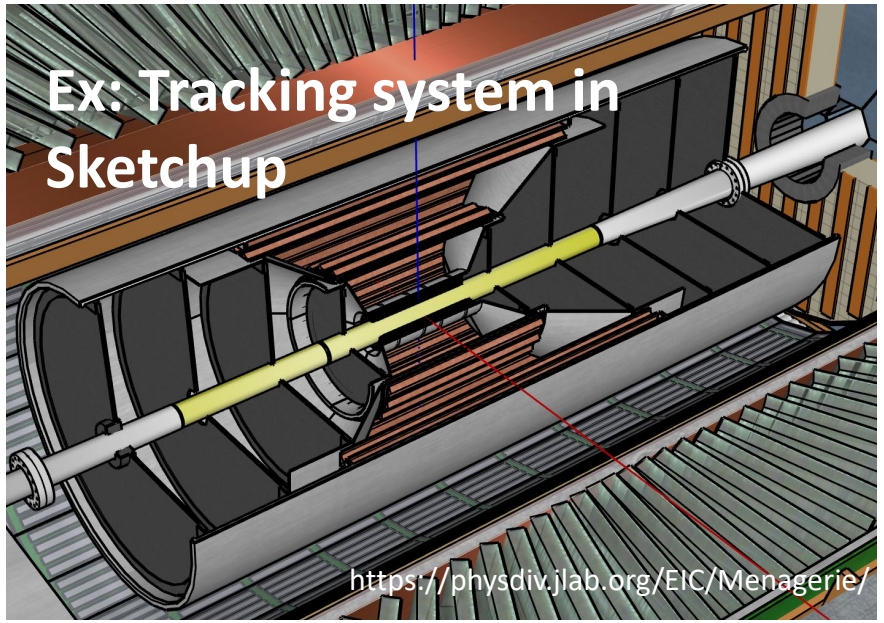
Global Detector Positions

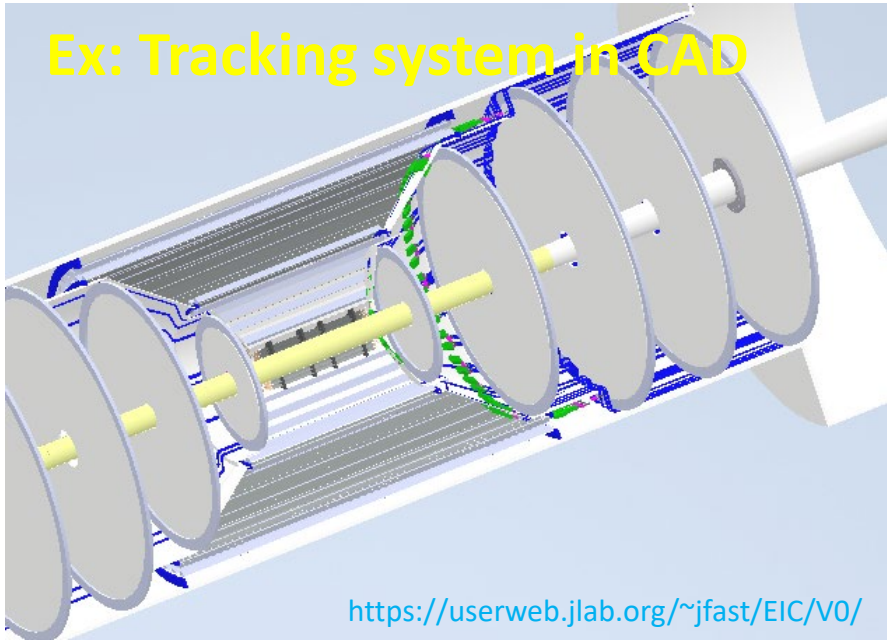
Needed for simulation studies of joint WGs and also for advancing the design

- ❑ Verified the positions of the detector subsystems in simulation and mechanical models
- ❑ Created table of global positions (radial, longitudinal along z, etc.) and materials



Ex: Tracking system in Geant4 simulation





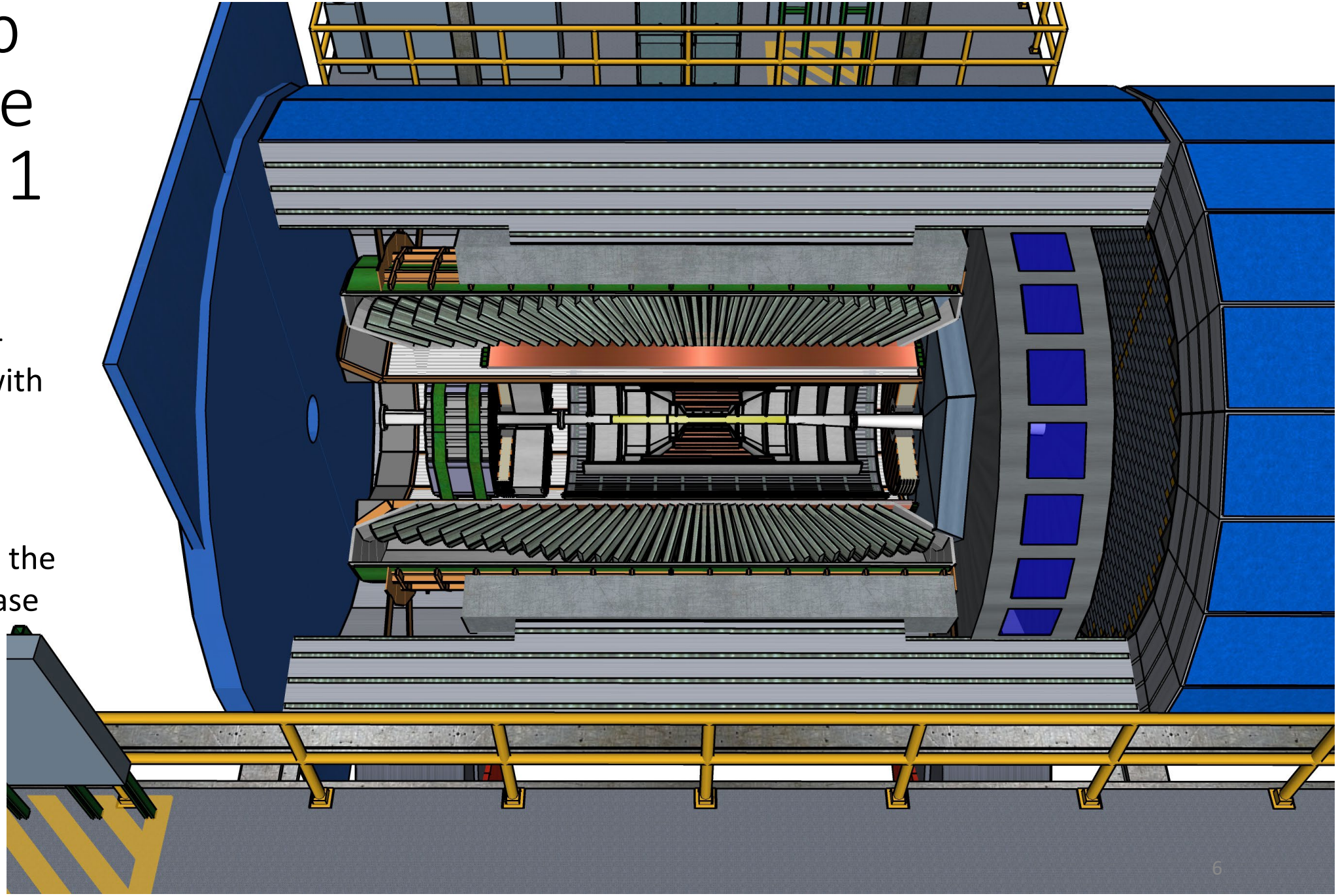
Region	Component	Sub-Component	Length (cm)	Inner Radius (cm)	Outer Radius (cm)	Offset from Center (cm)	Physical Start (cm)	Physical End (cm)	Volume (m^3)	Weight (kg)	Technology	Notes
END CAP	Electromagnetic Calorimeter		38	30	190	328	366	328	4.2021943	27,165	Pb/Sc	Tower size: 1cm (1.65cm) x 1cm(1.65cm) x 37.5cm, 5cm readout Offset: measured from face nearest to interaction point Weight: estimated as 85% lead glass and 15% steel
	Service Gap											Offset: measured from location nearest to interaction point
CENTRAL DETECTOR	Barrel Hadron Calorimeter		640		267	0	320	-320	72.60	464,834	FeSc	Offset: measured from center of detector
		HD Section	*170*	*194*	*267*	*150*	*320*	*150*	*17.97*			
		Central Section	*300*	*180*	*267*	*0*	*150*	*-150*	*36.65*			
		LD Section	*170*	*194*	*267*	*-150*	*-150*	*-320*	*17.97*			
	Dual RICH		100	10		180	280	180	10.29	1,911		
		Detector Section	*80*	*10*	*195*	*200*	*280*	*200*	*9.53*			
		Aerogel Section	*20*	*10*	*110*	*180*	*200*	*180*	*0.75*			
	Solenoid Magnet		384	142	177	0	192	-192	13.47	45,956		
	EMCal Outer Support		445	134	140	-30	192.5	-252.5	2.30	3,608		
	EMCal Electronics		480	125.5	134	-45	195	-285	3.33	1,938		
	Barrel EMCal		480	80	125.5	-45	195	-285	14.10	49,463		
	EMCal Inner Support		480	79.5	80	-45	195	-285	0.12	944		
	Barrel Gem Tracker		340	77	79.5	-5	165	-175	0.42	84		
	DIRC Support		455	65	77	-257	168	-287	2.60	1,019		
	DIRC Detector											
	Barrel Time of Flight/Tracker											
	HD Time of Flight/Tracker											
	Silicon Tracker											
	Modular RICH											
	LD Time of Flight/Tracker											
	LD EMCal		60	9	63	-175	-175	-235	0.73	4,738	PbWO4	Offset: measured from face nearest to interaction point Weight: estimated as 85% lead glass and 15% steel
	Service Gap		10			-320	-320	-330	0.00			Offset: measured from location nearest to interaction point
LEPTON DIRECTION ENDCAP	Backward Field Return		20.32			-330	-330	-350.32	5.18	40,649	Iron	Offset: measured from face nearest to interaction point Weight: calculated as 100% iron.
		Return Cylinder	*20.32*	*20*	*270*	*-330*	*-330*	*-350.32*	*4.63*			
		Support Panel	*7.62*	*454*	*664*	*-336.35*	*-336.35*	*-343.97*	*0.55*			*Height: specified in outer radius* *Width: specified in inner radius*

Region	Component	Sub-Component	Length (cm)	Inner Radius (cm)	Outer Radius (cm)	Offset from Center (cm)	Physical Start (cm)	Physical End (cm)	Volume (m^3)	Weight (kg)	Technology	Notes
END CAP	Electromagnetic Calorimeter		38	30	190	328	366	328	4.2021943	27,165	Pb/Sc	Tower size: 1cm (1.65cm) x 1c .65cm) x 37.5cm, 5cm readout Offset: measured fro t to interaction point Weight: esti and 15% steel
	Service Gap		8			320	328	320				Off st to interaction point
CENTRAL DETECTOR	Barrel Hadron Calorimeter		640		267	0	320	-320	72.60	464,834	FeSc	tor ctions lastic
		HD Section	*170*	*194*	*267*	*150*	*320*	*150*	*17.97*			*raction point*
		Central Section	*300*	*180*	*267*	*0*	*150*	*-150*	*36.65*			
		LD Section	*170*	*194*	*267*	*-150*	*-150*	*-320*				*ction point*
	Dual RICH		100	10		180	280					tion point S LTCC
		Detector Section	*80*	*10*	*195*							*point*
		Aerogel Section	*20*	*10*								*oint*
	Solenoid Magnet		384									
	EMCal Outer Support		445									alance is air)
	EMCal Electronics											
	Barrel EMCal											
	EMCal Inner Support											
	Barrel Gem Tracker											om SBS Gem
	DIRC Support											here DIRC bar connects to the readout sum of sub-sections mated as 5% of total volume as steel (balance is air & detector)
												Readout support is triangular frame, therefore volume is halved.
	DIRC D										u bars	Detector is totally enclosed by DIRC Support. Weight: calculated as sum of sub-components
												Weight: calculated as 30% quartz (balance is air & support system)
									191			*Readout is triangular, therefore volume is halved.* *Weight: Calculated as 30% silicon(balance is air & support system)*
	Barrel Time								0.22	43	AC/LGAD	Weight: based on parametric estimate from SBS Gem
	HD Time of Fl							155.5	0.17	35	AC/LGAD	Offset: measured from face nearest to interaction point Weight: based on parametric estimate from SBS Gem
	Silicon Tracker					0	126	-102	1.50	227	MAPS	Weight: calculated as 3% aluminum and 3% silicon (balance is air)
	Modular RICH				64	-135	-135	-160	0.31	58	Aerogel	Offset: measured from face nearest to interaction point Weight: based on parametric estimate from CLAS LTCC
	LD Time of Flight/T			12	64	-161	-161	-171	0.12	25	AC/LGAD	Offset: measured from face nearest to interaction point Weight: based on parametric estimate from SBS Gem
	LD EMCal		60	9	63	-175	-175	-235	0.73	4,738	PbWO4	Offset: measured from face nearest to interaction point Weight: estimated as 85% lead glass and 15% steel
	Service Gap		10			-320	-320	-330	0.00			Offset: measured from location nearest to interaction point
LEPTON DIRECTION ENDCAP	Backward Field Return		20.32			-330	-330	-350.32	5.18	40,649	Iron	Offset: measured from face nearest to interaction point Weight: calculated as 100% iron.
		Return Cylinder	*20.32*	*20*	*270*	*-330*	*-330*	*-350.32*	*4.63*			
		Support Panel	*7.62*	*454*	*664*	*-336.35*	*-336.35*	*-343.97*	*0.55*			*Height: specified in outer radius* *Width: specified in inner radius*

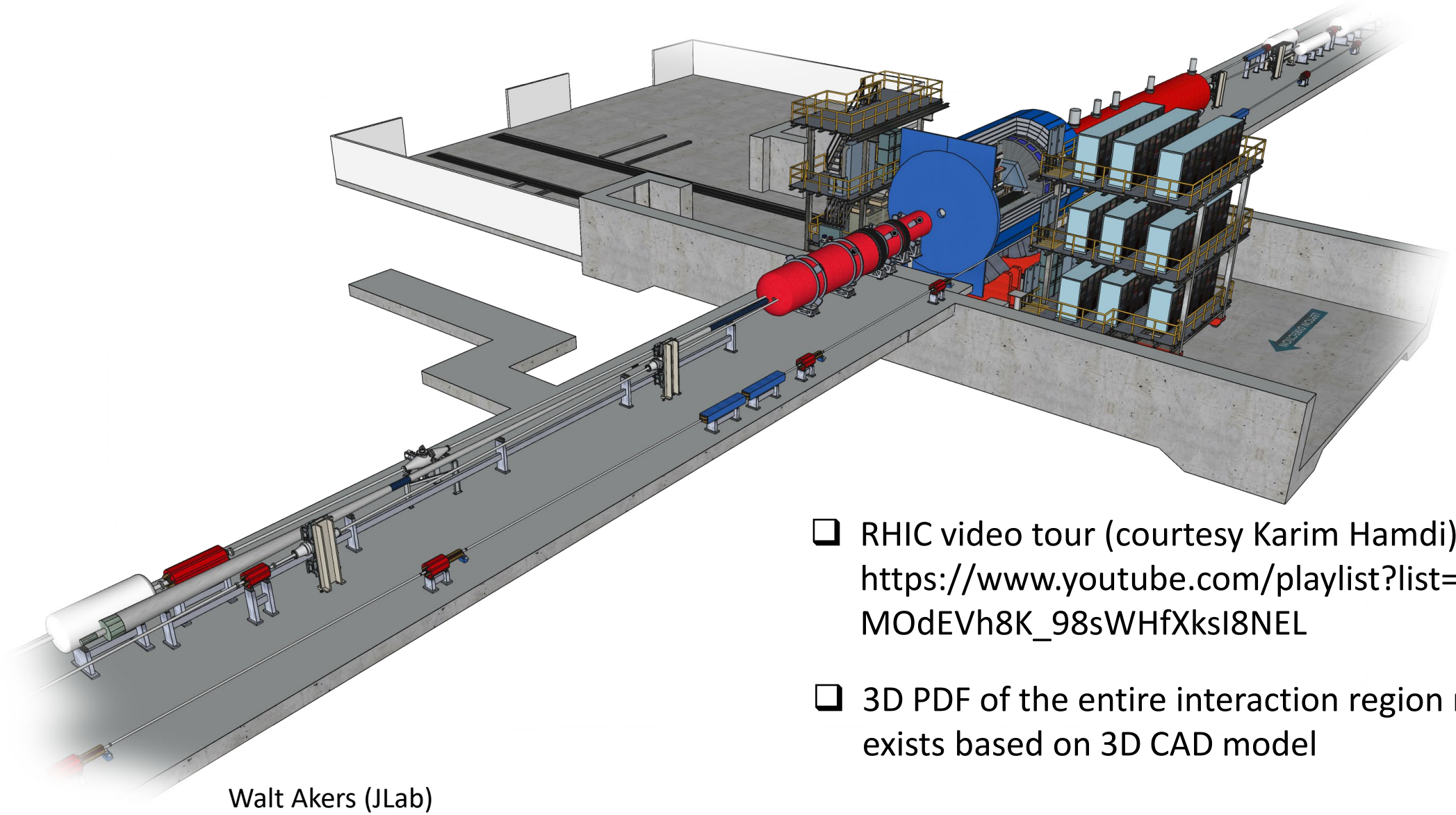
Available here:
https://physdiv.jlab.org/EIC/Menagerie/docs/DetectorParamet erTable.xlsx
and
https://wiki.bnl.gov/eic-project-detector/index.php/DetectorIntegration

Sketchup Reference Detector 1 Model

- Corrected signs – consistent now with the overall sign convention in IR
- Not backward compatible – use the most recent release



Reference Detector 1 Integration in IR

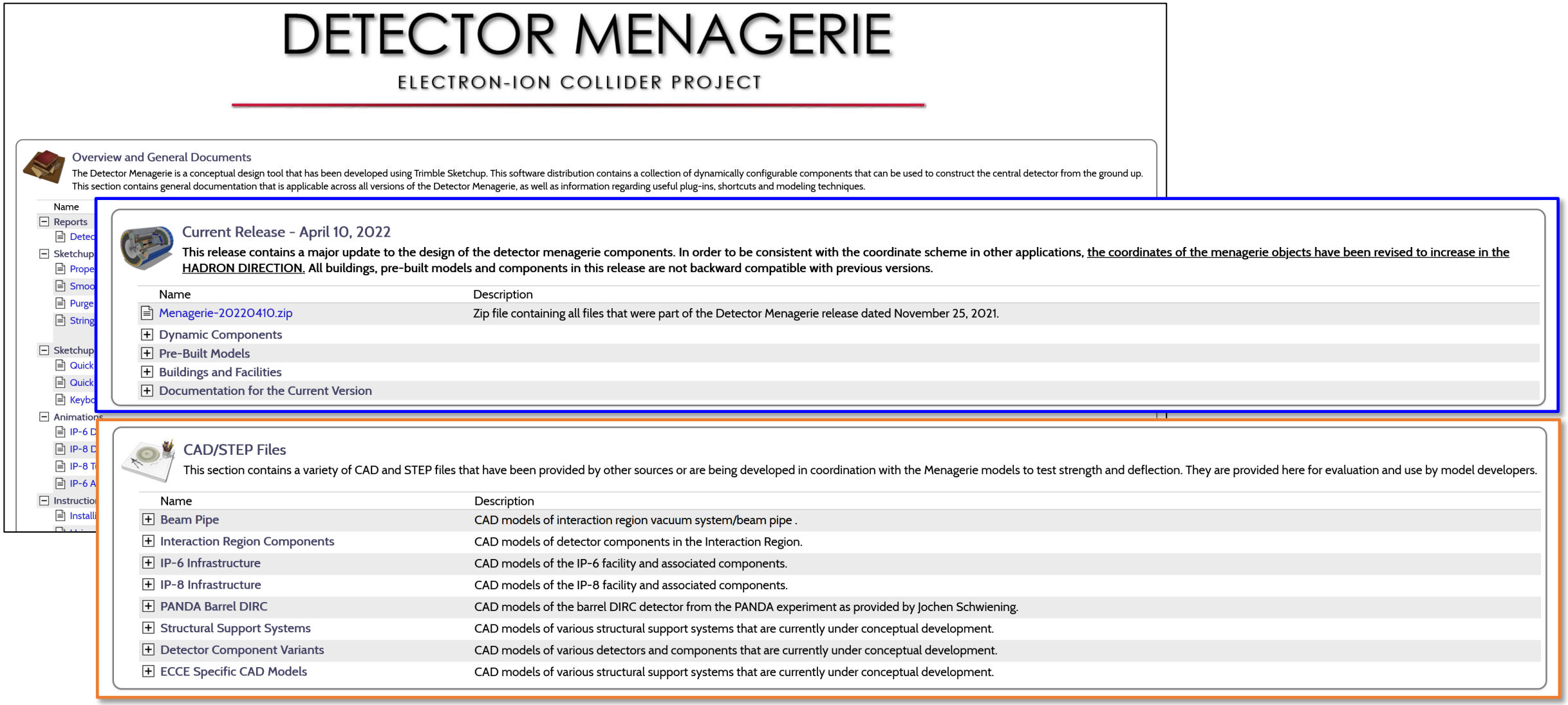


- RHIC video tour (courtesy Karim Hamdi): https://www.youtube.com/playlist?list=PL23NZHucsUMOdEVh8K_98sWHfXksI8NEL
- 3D PDF of the entire interaction region now exists based on 3D CAD model

Walt Akers (JLab)

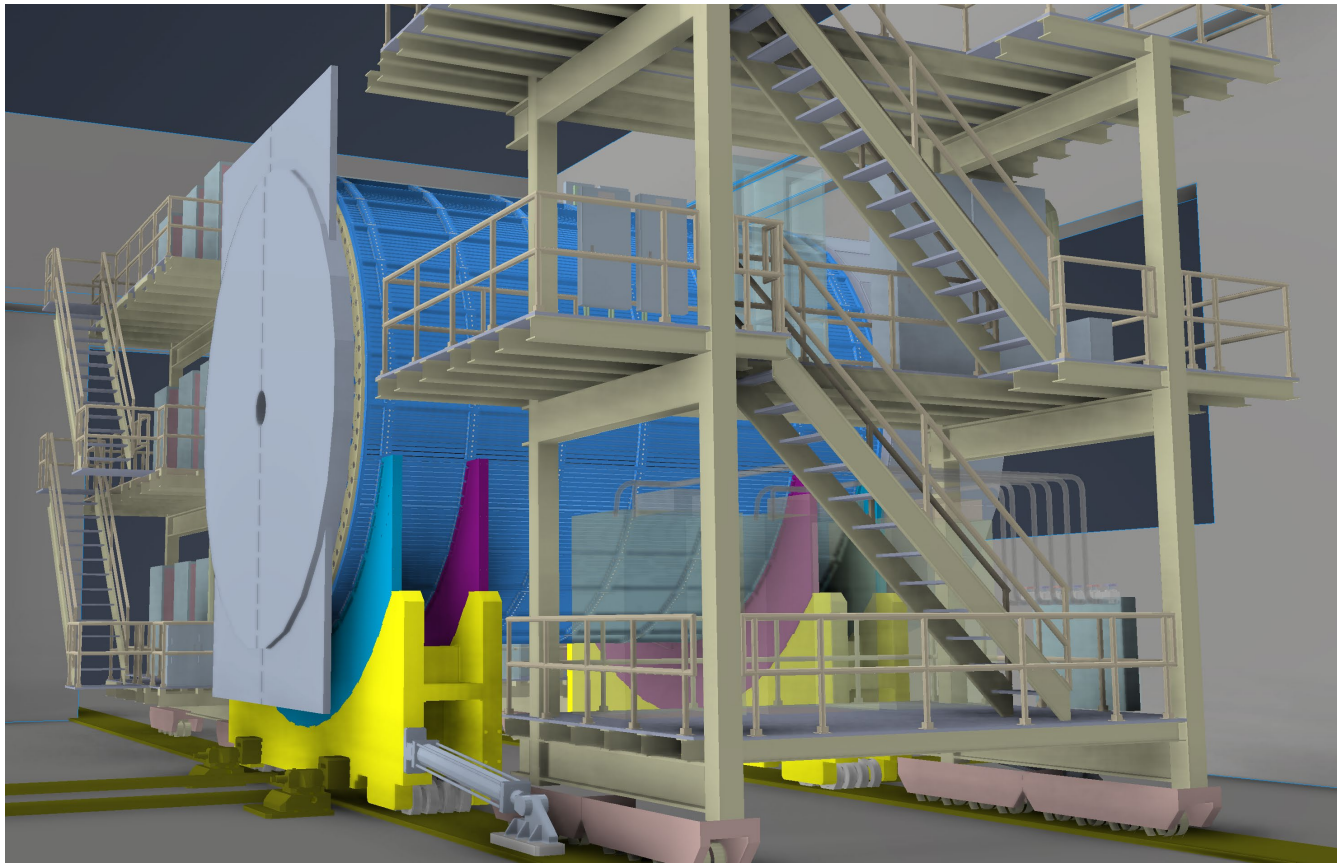
Repository Sketchup Detector Model and CAD/STEP Files

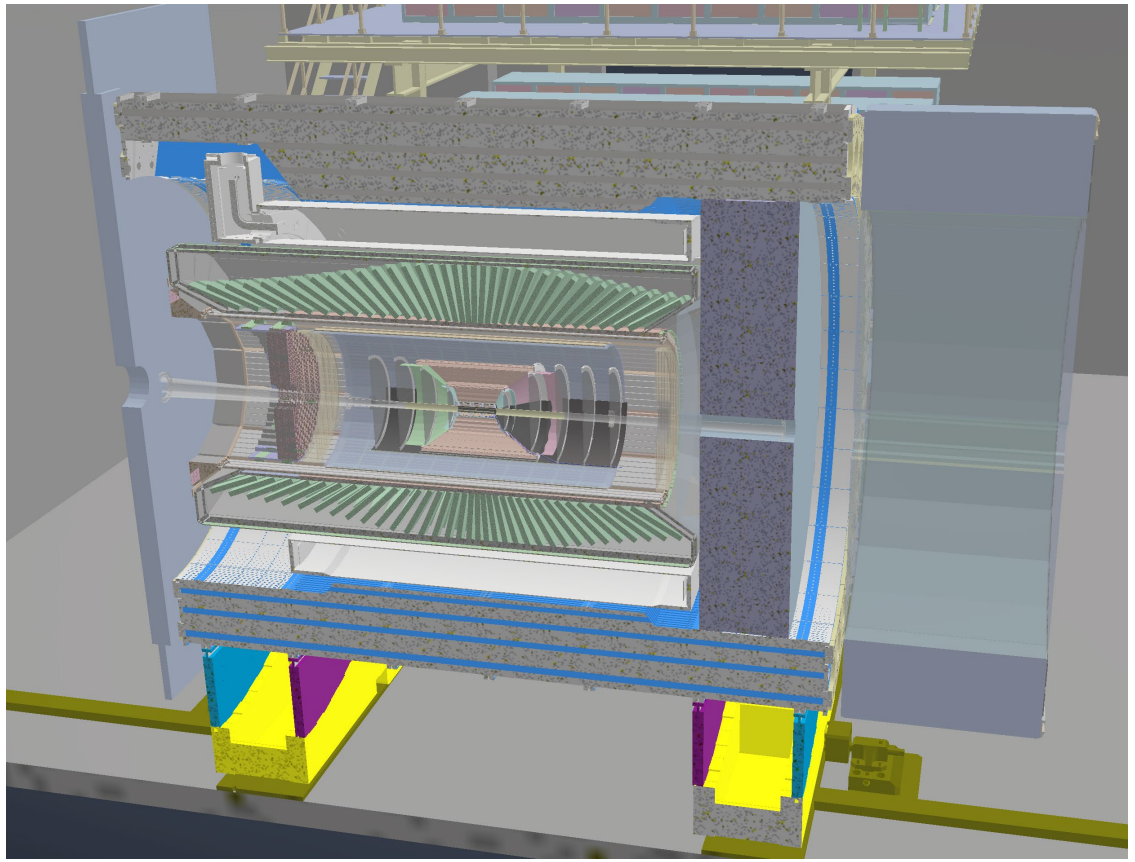
https://physdiv.jlab.org/EIC/Menagerie/



Reference Detector 1 – CAD layout

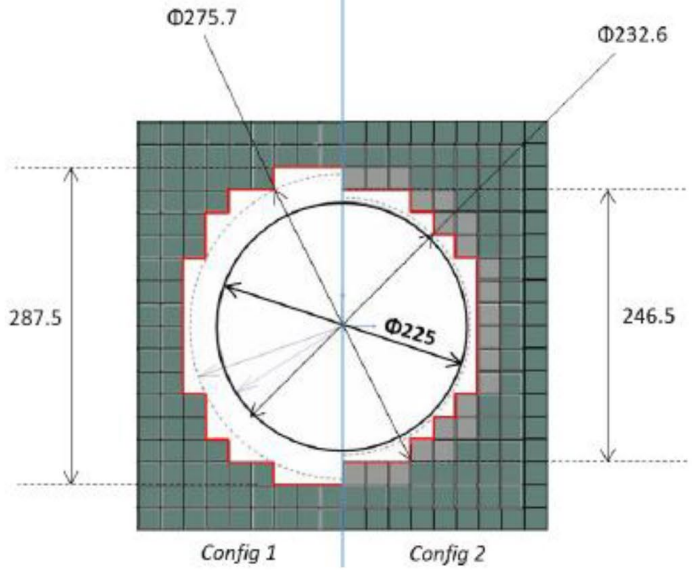
- ❑ CAD implementation of Reference Detector 1 has started
- ❑ EIC is taking an overarching system integrating approach, and can make like this much progress with EIC user input

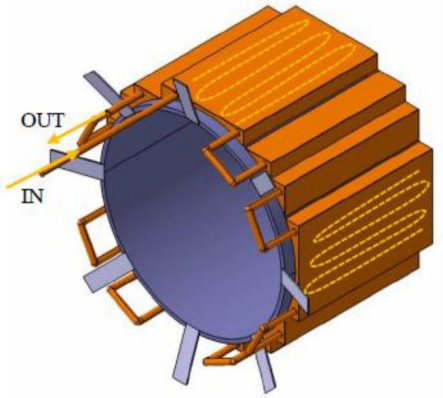




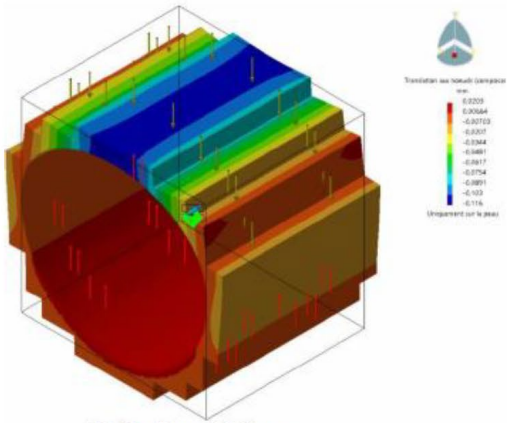
E&D Example: Backward EM Calorimeter (EEEMCal)

- Initial concept (Josh Crafts, CUA)
- Frame, cooling system, inner calo (IJCLab-Orsay)

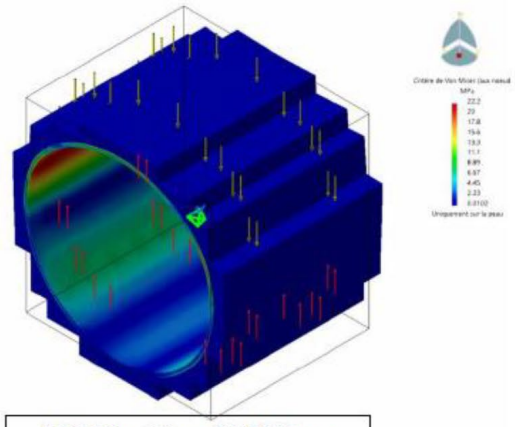




Cooling



Deflection < 0.1 mm

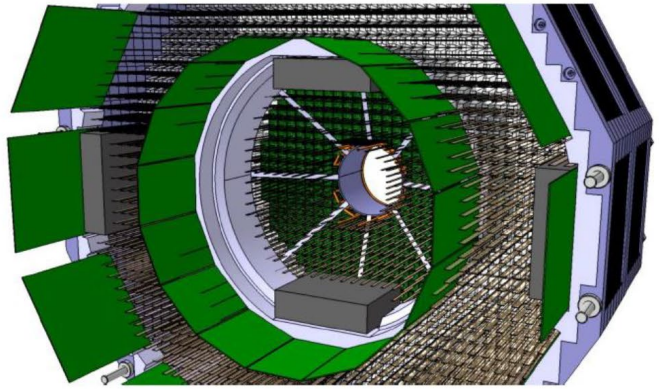


22.2 Mpa < Inox Yield Stress

EEEMCal

(Electron Ion Collider - EIC)

Mechanical design & Integration



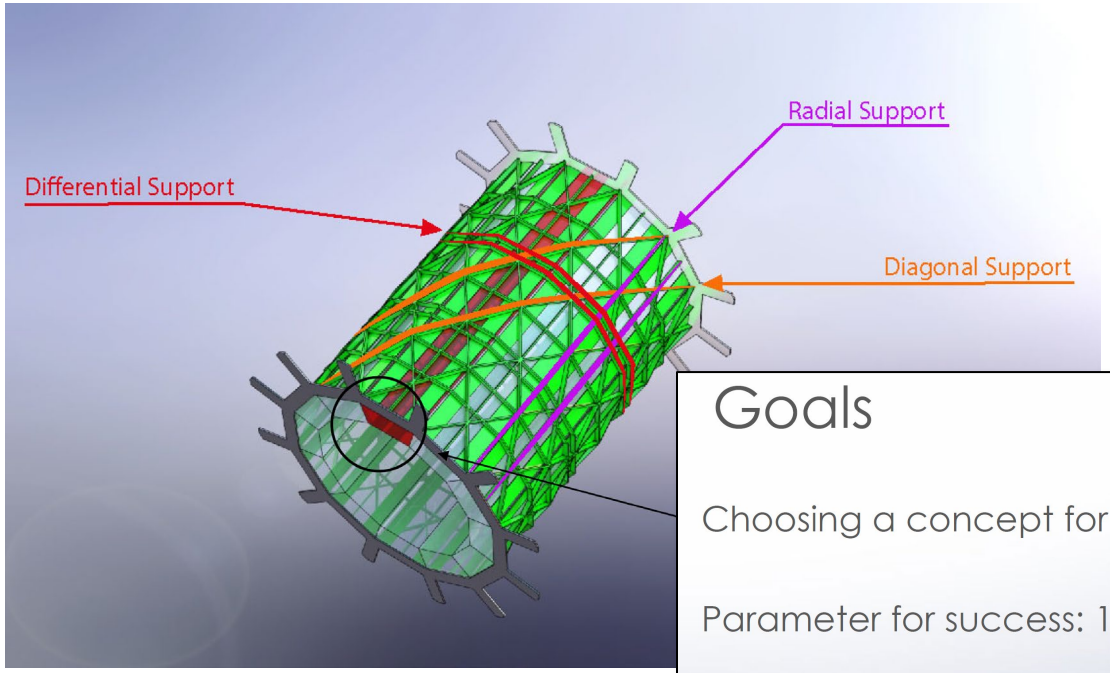
Date: 14/10/2021

Julien BETTANE
(IJCLab/Mechanical department)

Version: 1.2

E&D Example: Barrel Support Structure

Barrel ECAL support FEA analysis (Avishay Mizrahi, MIT)



Goals

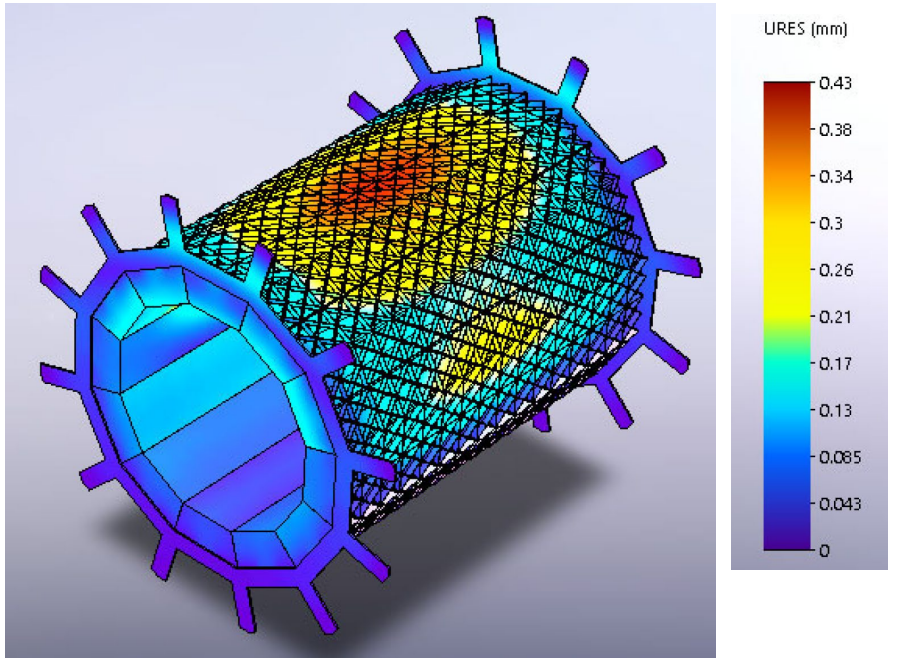
Choosing a concept for mesh design

Parameter for success: 1mm max Deflection.

Constraints:
- Paramagnetic material.
- 19mm max thickness for each beam.

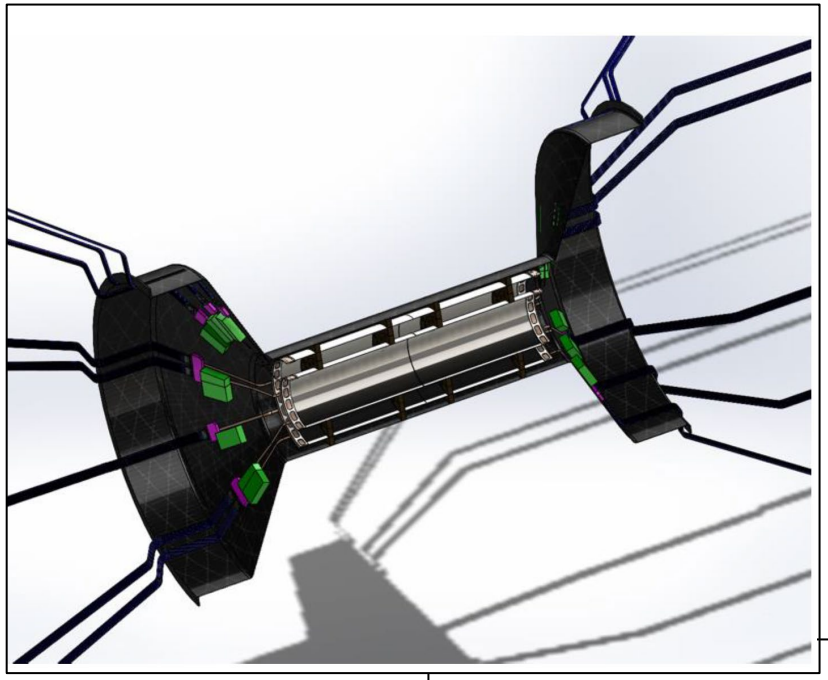
Nice to have:
- Lightweight
- Symmetric shape (easier to manufacture)

One promising option

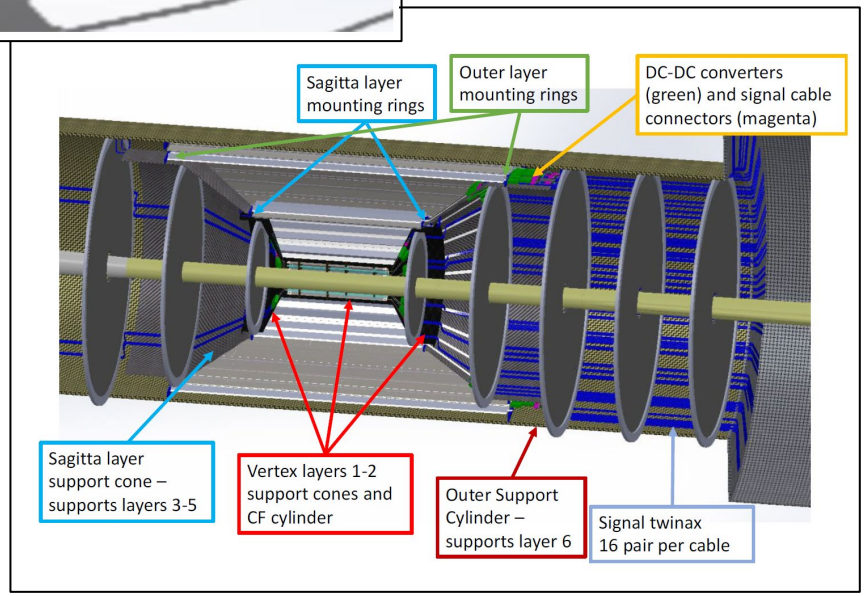


- Volume: 0.571 m^3.
- Works with Aluminum, Titanium and stainless-steel alloys.
- Uniform width to all beams (6.5mm).

E&D Example: Si Tracker



Si barrel and disks (EICSC in collaboration with JLab)



EIC Silicon Tracker CAD Model Release Notes

Version 0
September 3, 2021

Purpose:
The purpose of developing a more detailed CAD model for the EIC silicon tracker is to support more refined estimates of material locations and mass for simulations efforts and to begin developing realistic structural support concepts with conceptually feasible installation scenarios. As previously discussed, this CAD model will be updated on a regular schedule with feedback from the user base and will be followed with a costing model that can be adapted to each proto-collaboration configuration.

Data format and release location:
The CAD model native format is SolidWorks 2021. Files can be provided in a number of other formats. Native SolidWorks (.zip file is a Pack-and-Go of the assembly), EASM (free 3D viewer available), and STEP files are available at https://userweb.jlab.org/~jfast/EIC/V0/. PDFs are also available at this location.

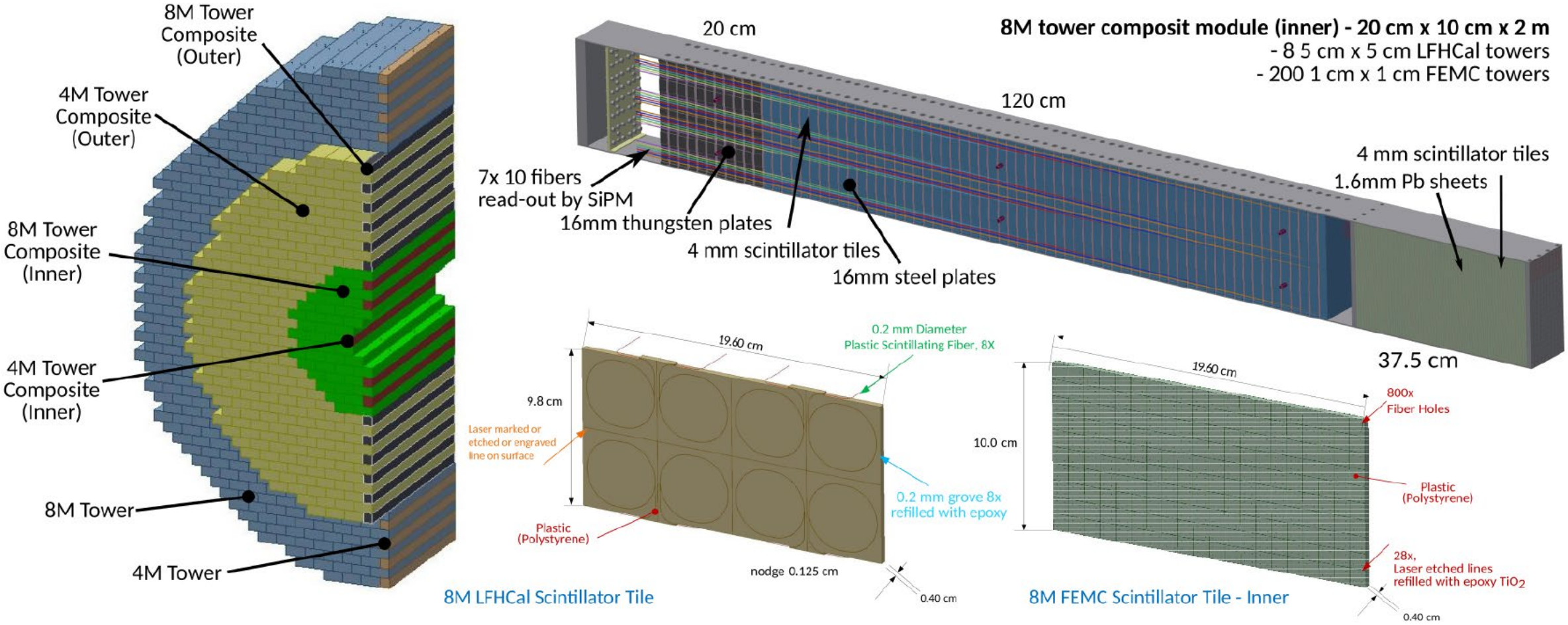
Individual part files can be exported in various formats, e.g. for import into GEANT – please contact Jim Fast at jfast@jlab.org. For the latest material budgets, contact Leo Greiner at lcgreiner@lbnl.gov.

Version 0:
The goal of Version 0 was to recreate something very closely resembling the all-silicon tracker form the Yellow Report including representative structural supports for the silicon. The original intent was not to include services explicitly until Version 1, but we have a somewhat advanced version of the barrel including partial services at Version 0. It is expected that in the following weeks, a parameterization of the service needs (as was done in the YR process) based in a DC-DC converter powering architecture will be released to aid in the addition of services.

Below are figures showing the current full model with some annotation to help guide people and one of just the vertex layers.

E&D Example: Forward Calorimeter

Assembly, stacking, modules (ORNL)



Summary

- More User contributions to E&D exist (dRICH/INFN, hpDIRC/GSI, …)
- Collaboration between EIC PM and user expertise has led to good progress
- Reference Detector 1 exists in Sketchup and starting in CAD
  - Sketchup: integration and assembly, installation, maintenance
  - CAD: detailed engineering for construction
- Geometry database should provide consistency of detector envelopes between simulation, Sketchup, and CAD