SiD

An All-silicon Detector for the ILC

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Ringberg

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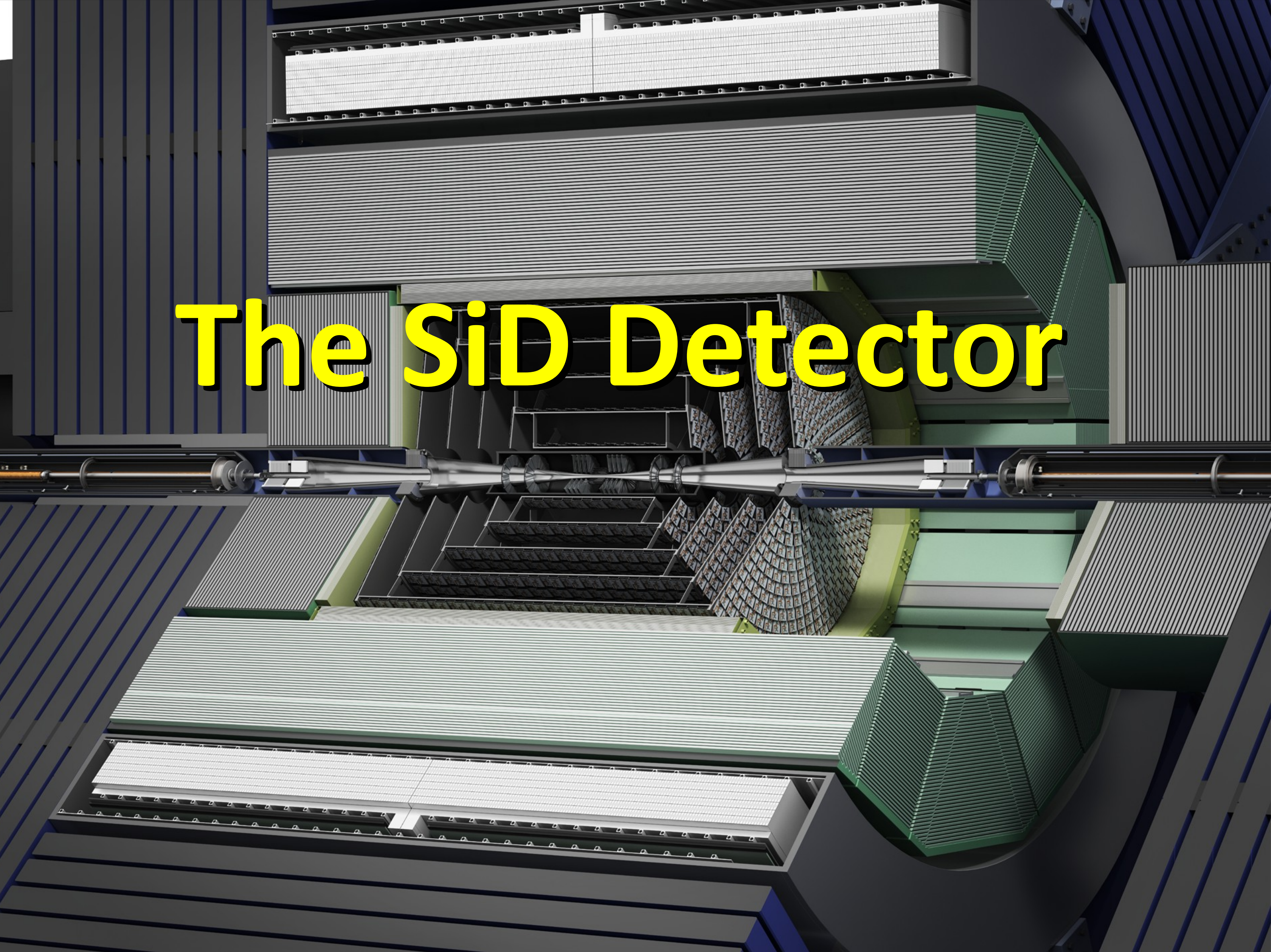
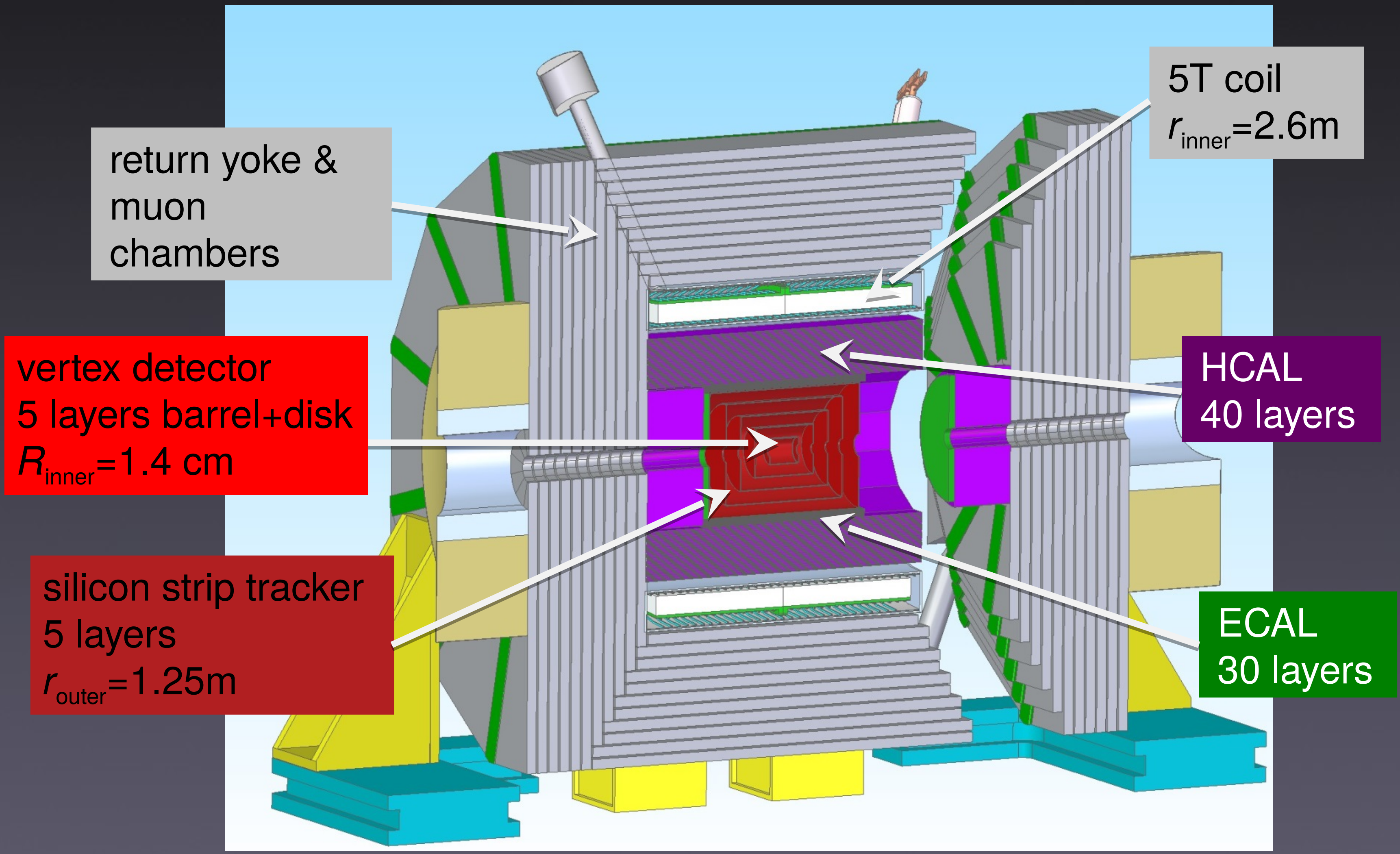

The SiD Detector

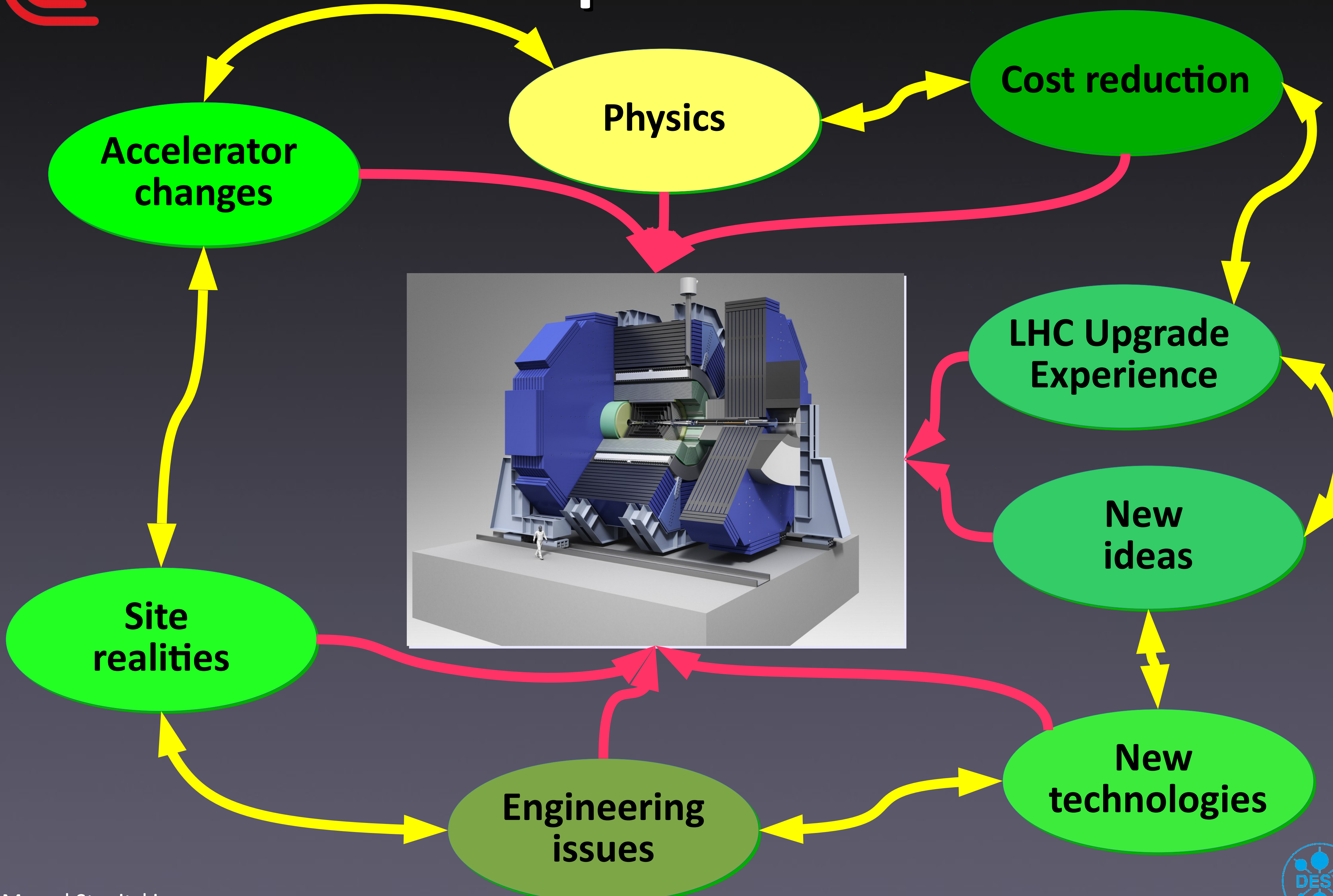
The SiD Detector

- SID Rationale
  - A compact, cost-constrained detector designed to make precision measurements and be sensitive to a wide range of new phenomena
- Design choices
  - Compact design with 5 T field
  - Robust silicon vertexing and tracking system with excellent momentum resolution
  - Highly granular Calorimetry optimized for Particle Flow
  - Time-stamping with single bunch crossing resolution
  - Iron flux return/muon identifier is part of the SiD self-shielding
  - Detector is designed for rapid push-pull operation

Overall Layout

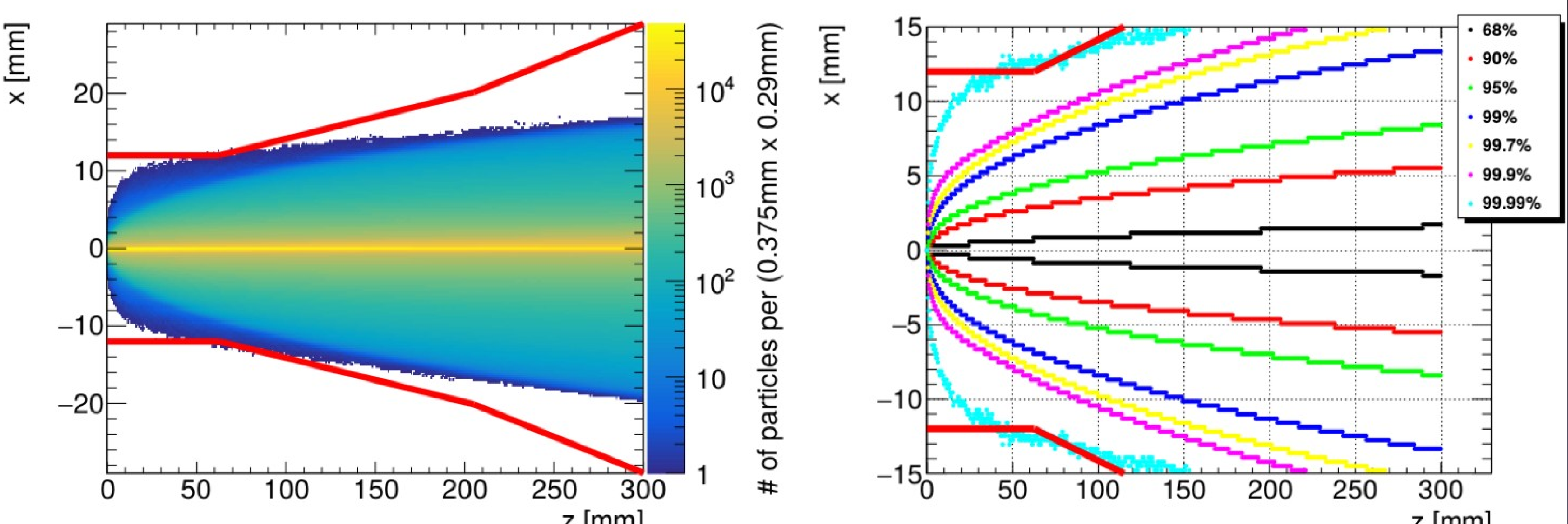


Re-Optimization



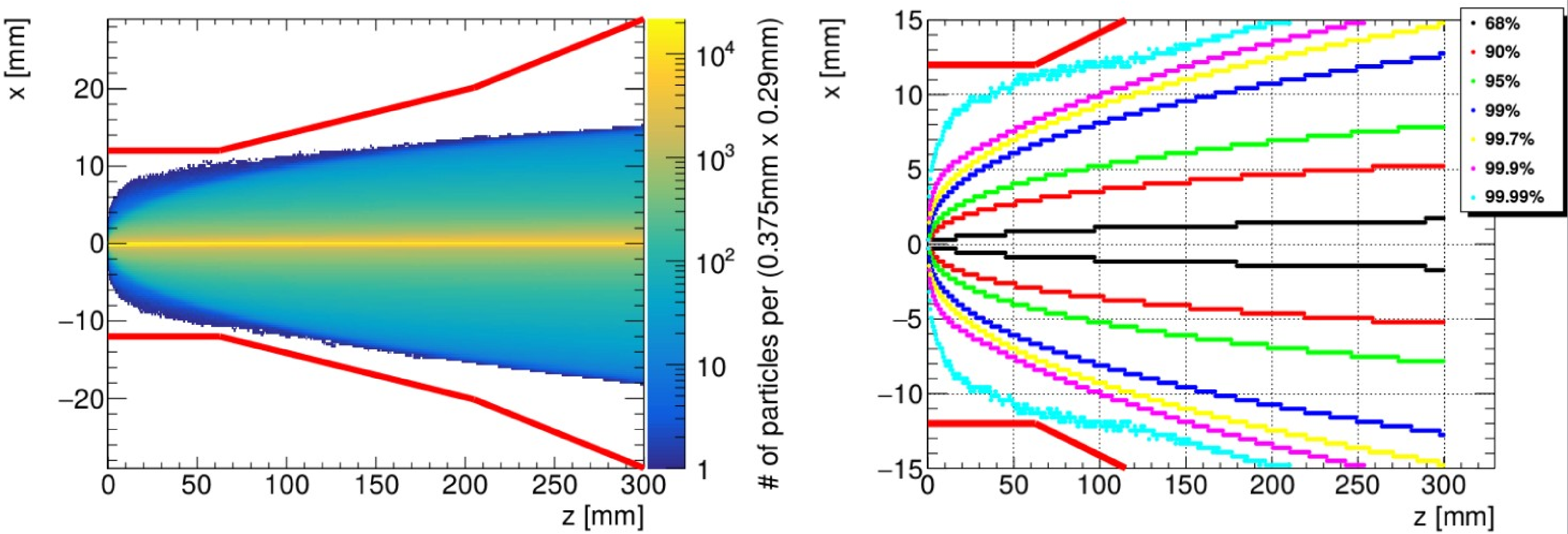
Beam Backgrounds - 500 GeV

e^-:$\Delta p/p$=0.124%, e^+:$\Delta p/p$=0.070%
β_x^*=11 mm, β_y^*=0.48 mm
σ_x^*=474 nm, σ_y^*=5.9 nm



Beam Backgrounds - 350 GeV

e^-:$\Delta p/p$=0.158%, e^+:$\Delta p/p$=0.100%
β_x^*=16 mm, β_y^*=0.34 mm
σ_x^*=683.5 nm, σ_y^*=5.9 nm

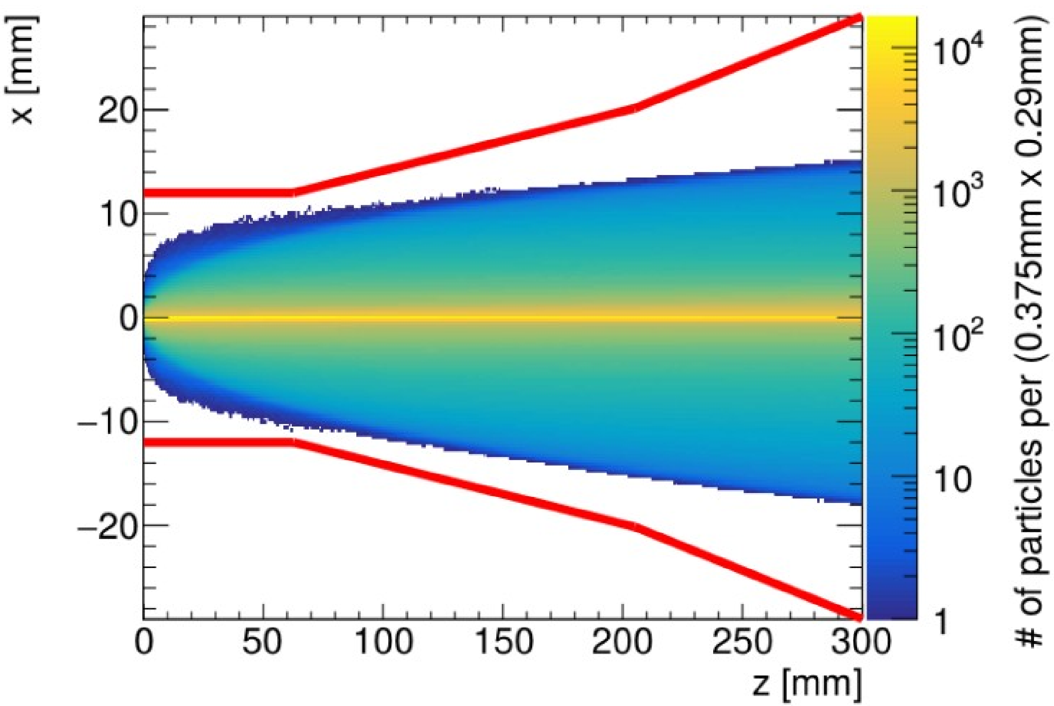


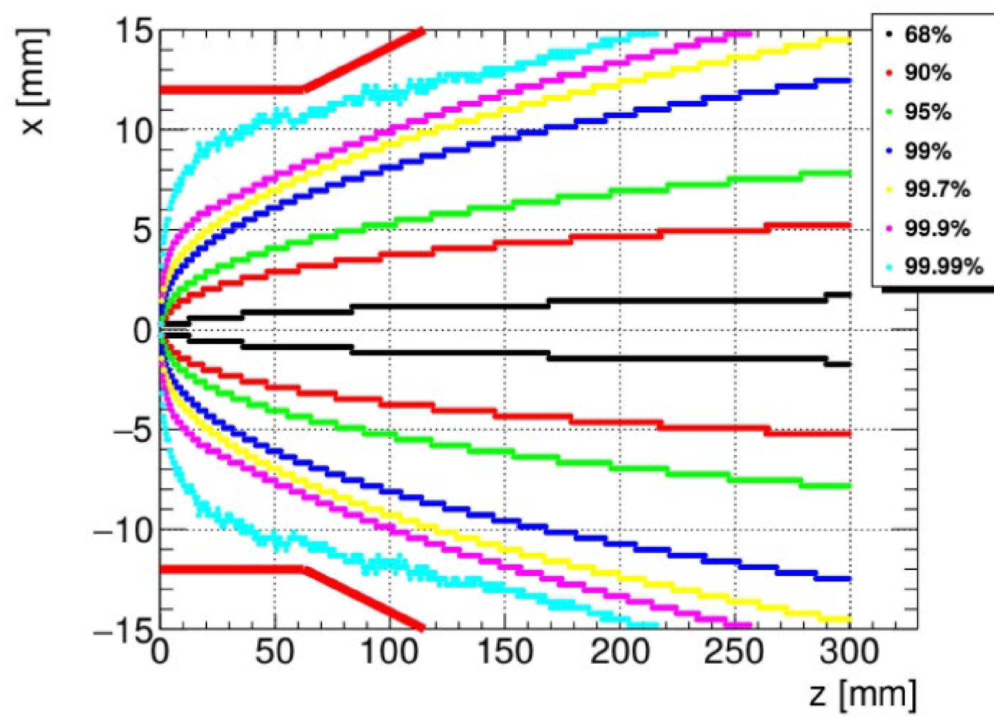
Beam Backgrounds - 250 GeV

e^-:$\Delta p/p$=0.190%, e^+:$\Delta p/p$=0.152%

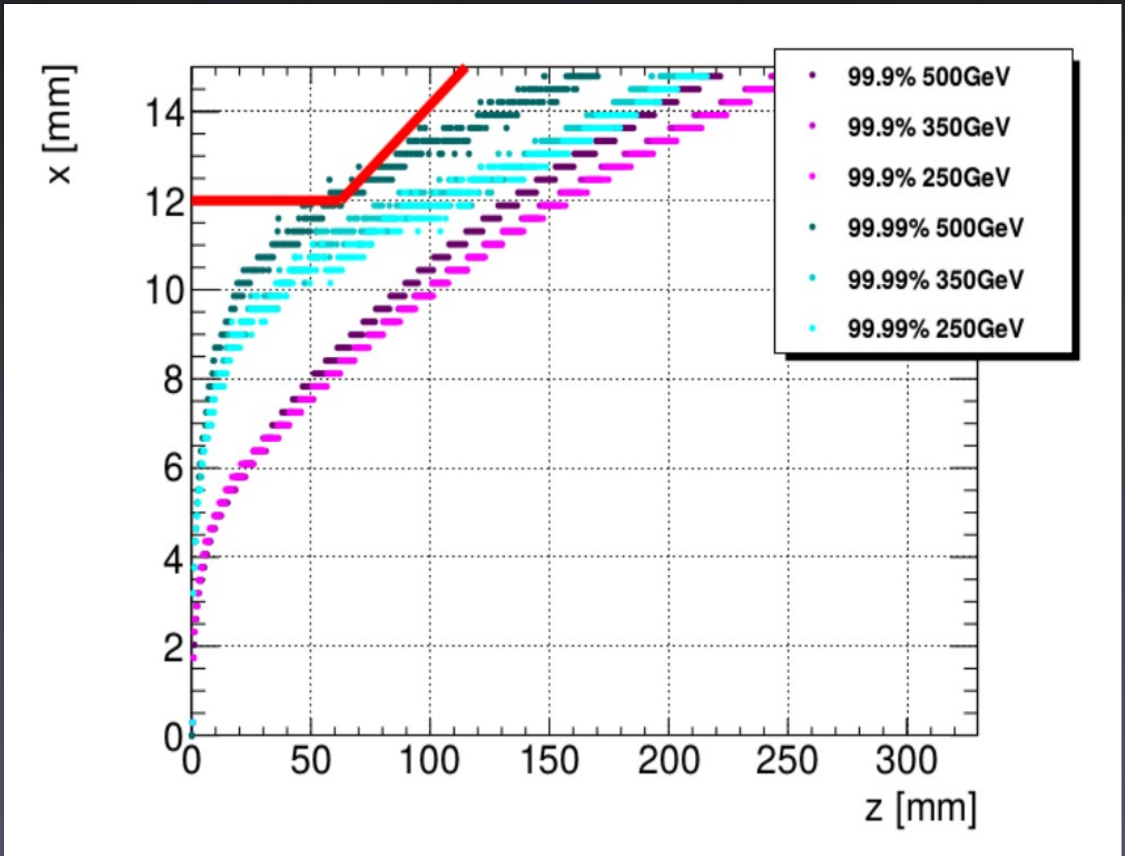
β_x^*=13 mm, β_y^*=0.41 mm

σ_x^*=729 nm, σ_y^*=7.7 nm



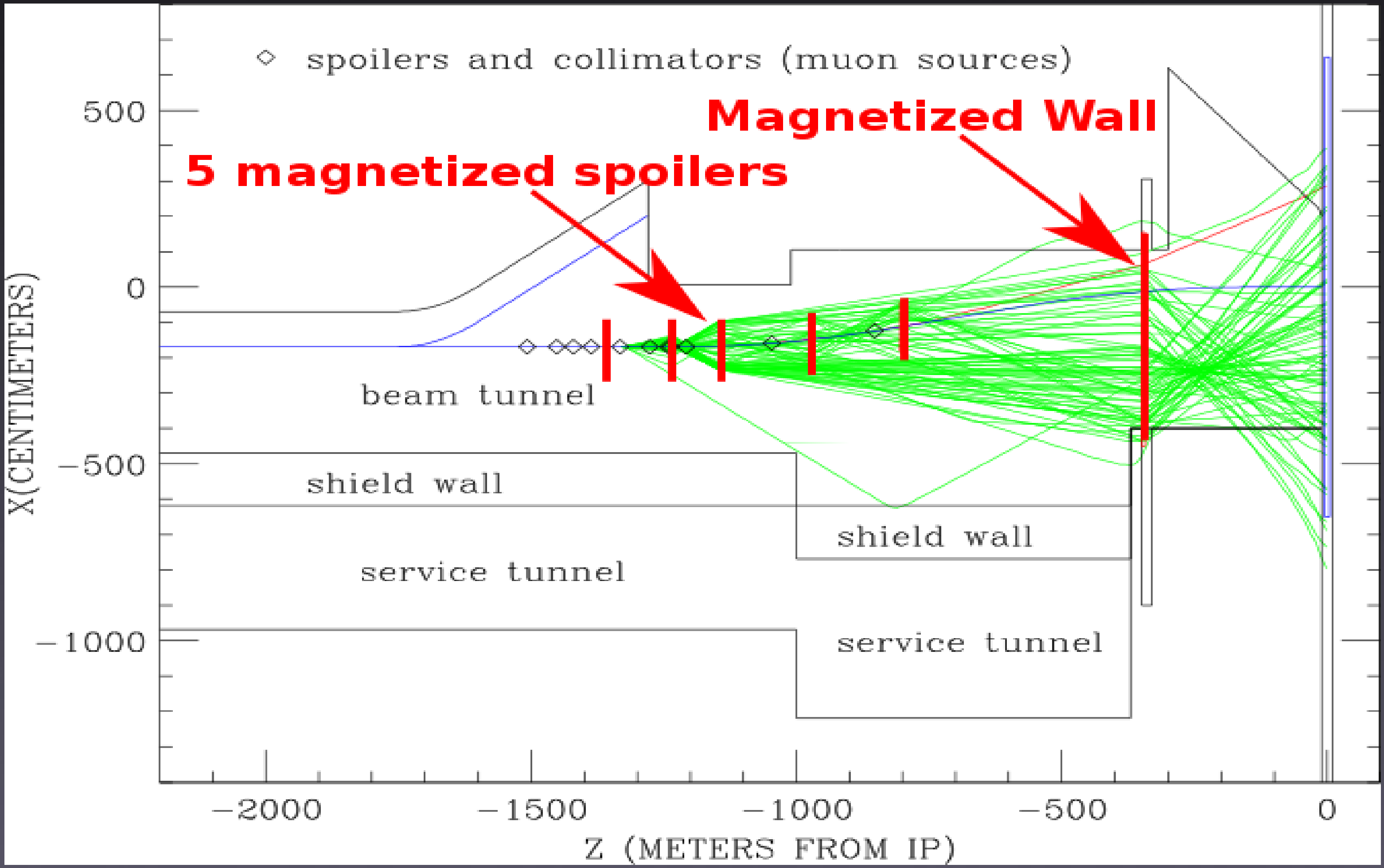


Summarizing…

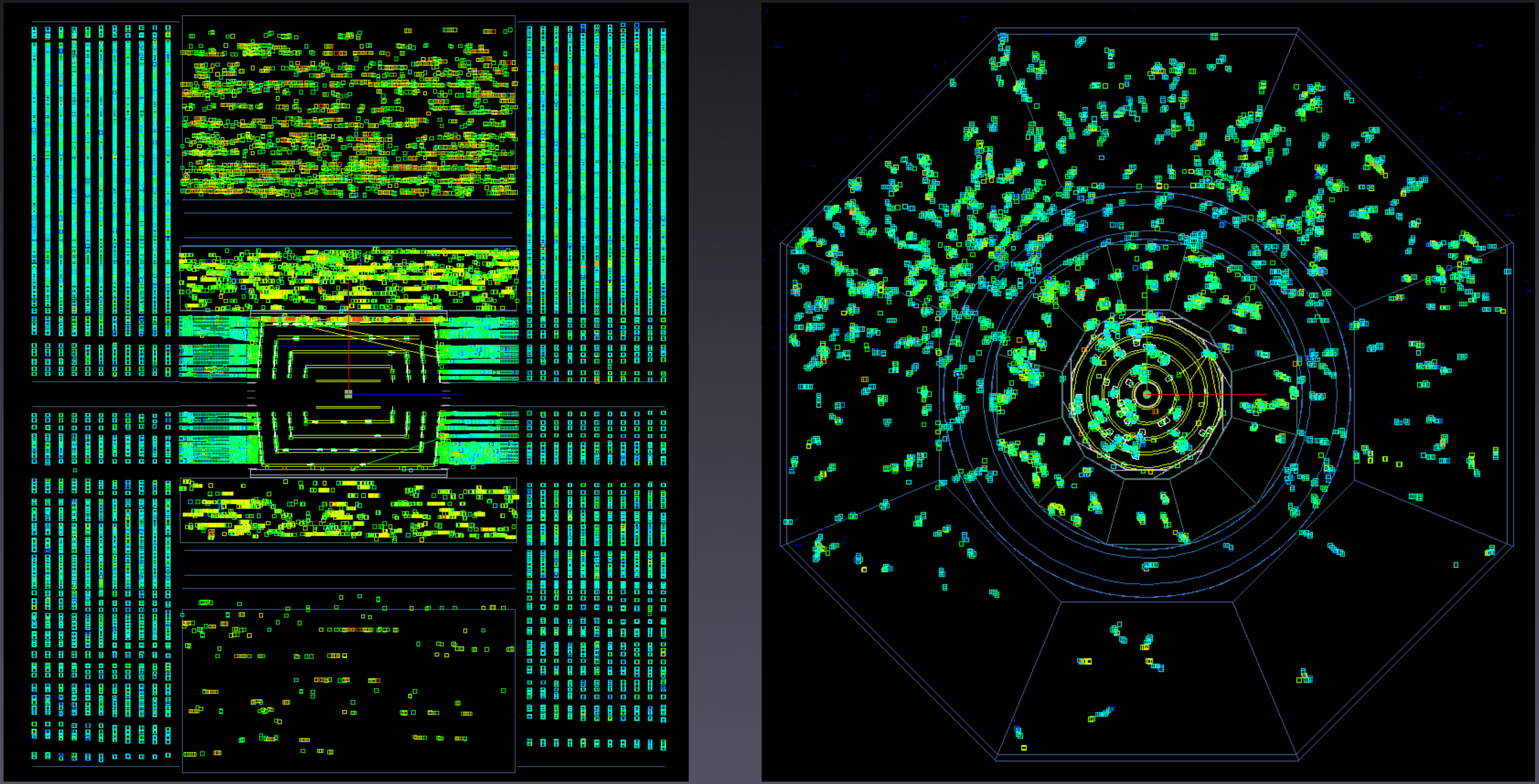


- Potential to reduce beam pipe radius
  - Especially for lower energies
  - Could suit well to “staging” approach
- Next steps
  - Occupancy studies
  - Physics impact

Muons from the BDS

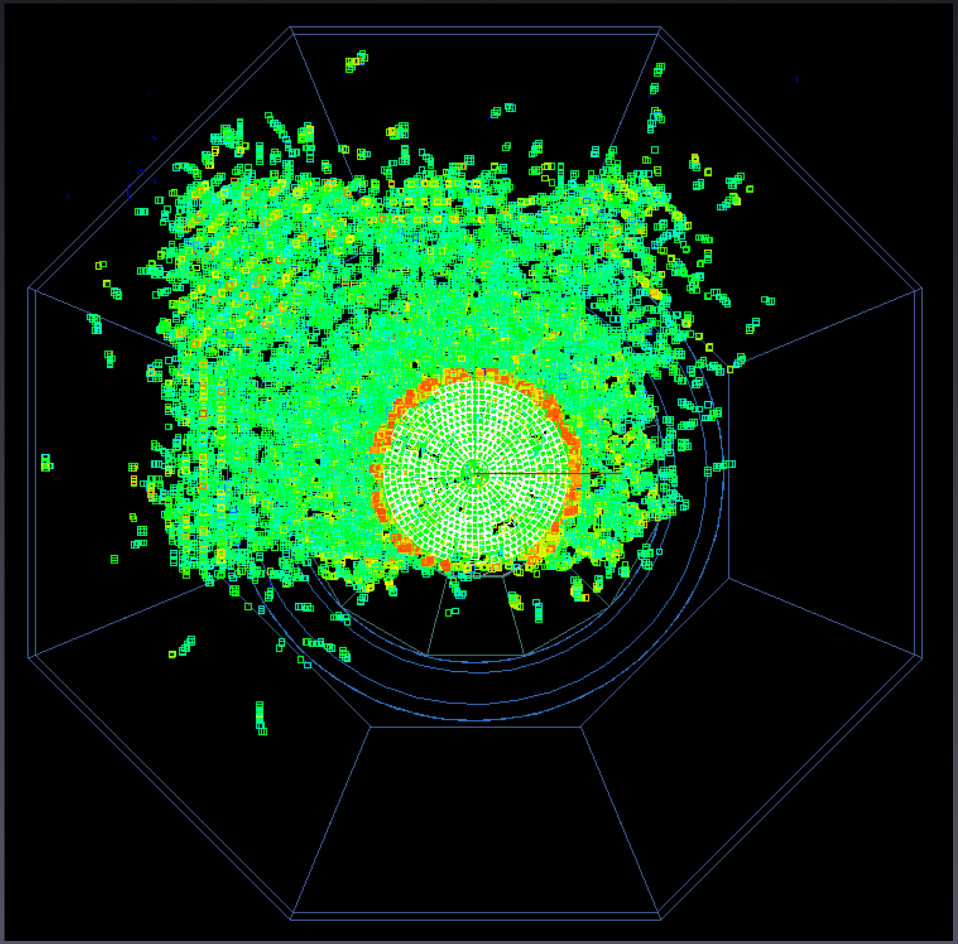


Why Time-Stamping is still good for you

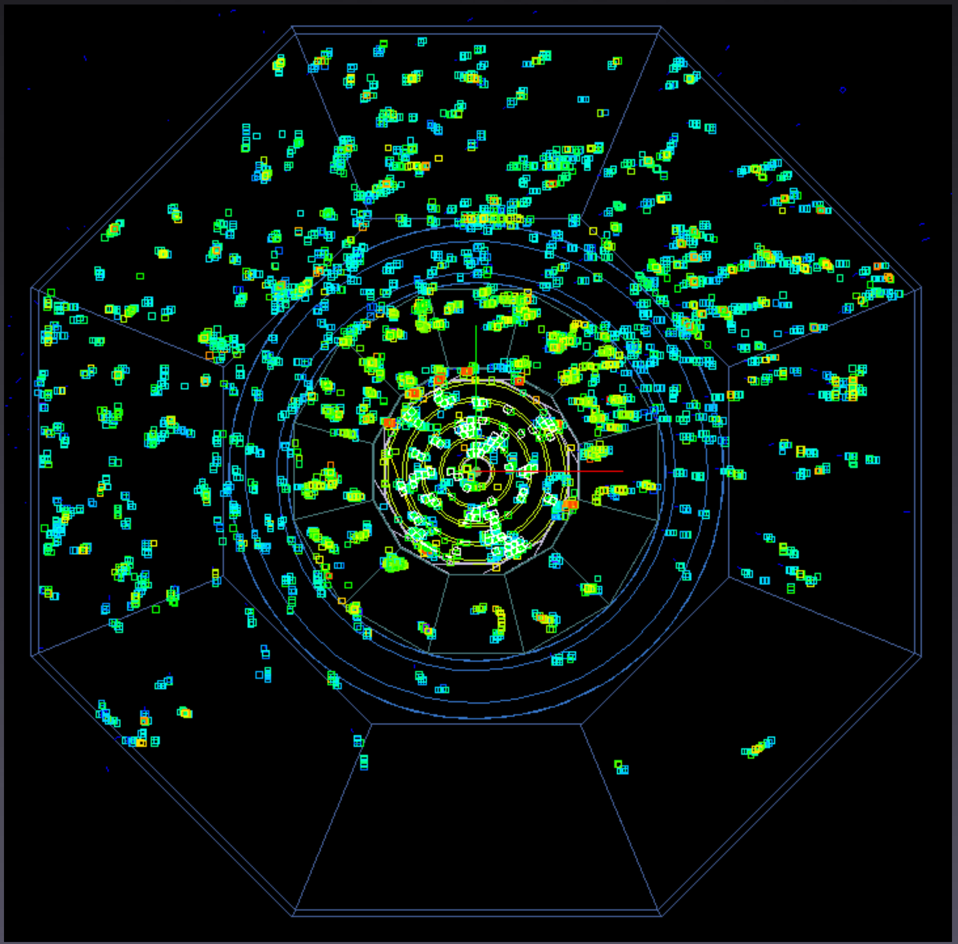


Background Hits from upstream muons generated in the Final Focus over the entire bunch train

Give me the wall



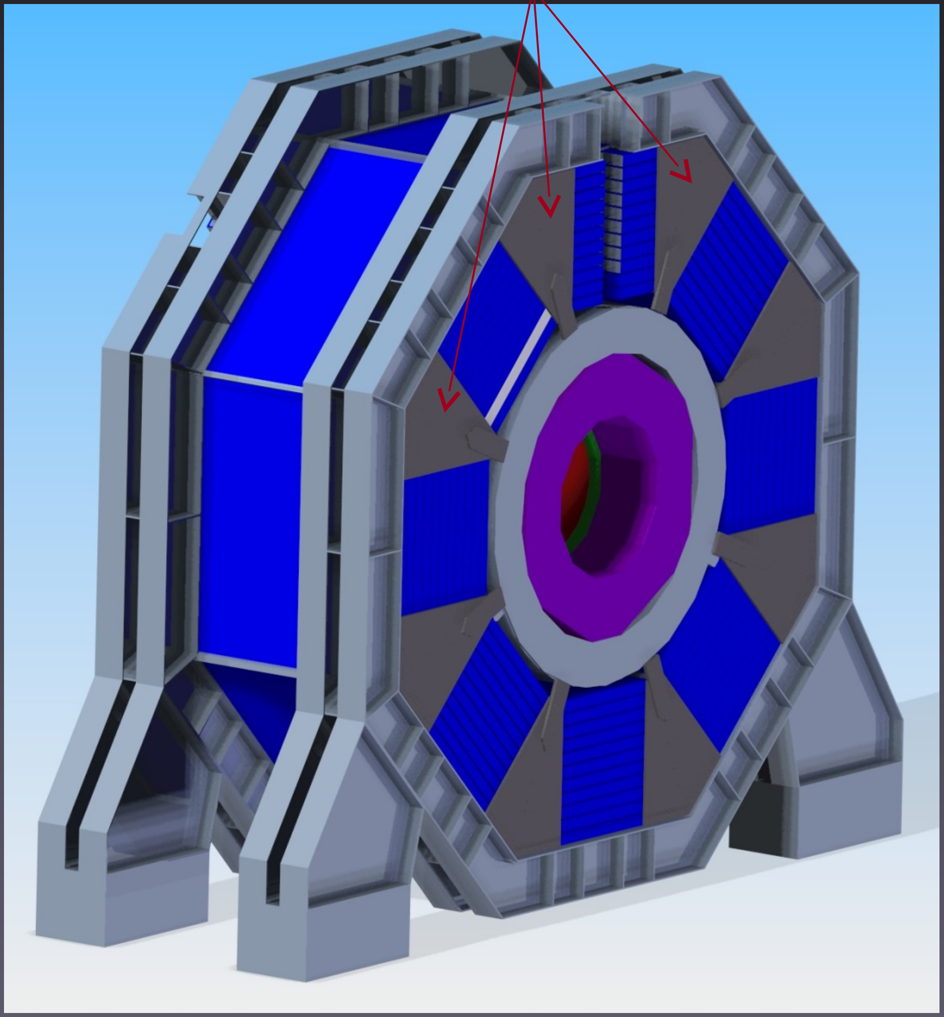
Spoilers only



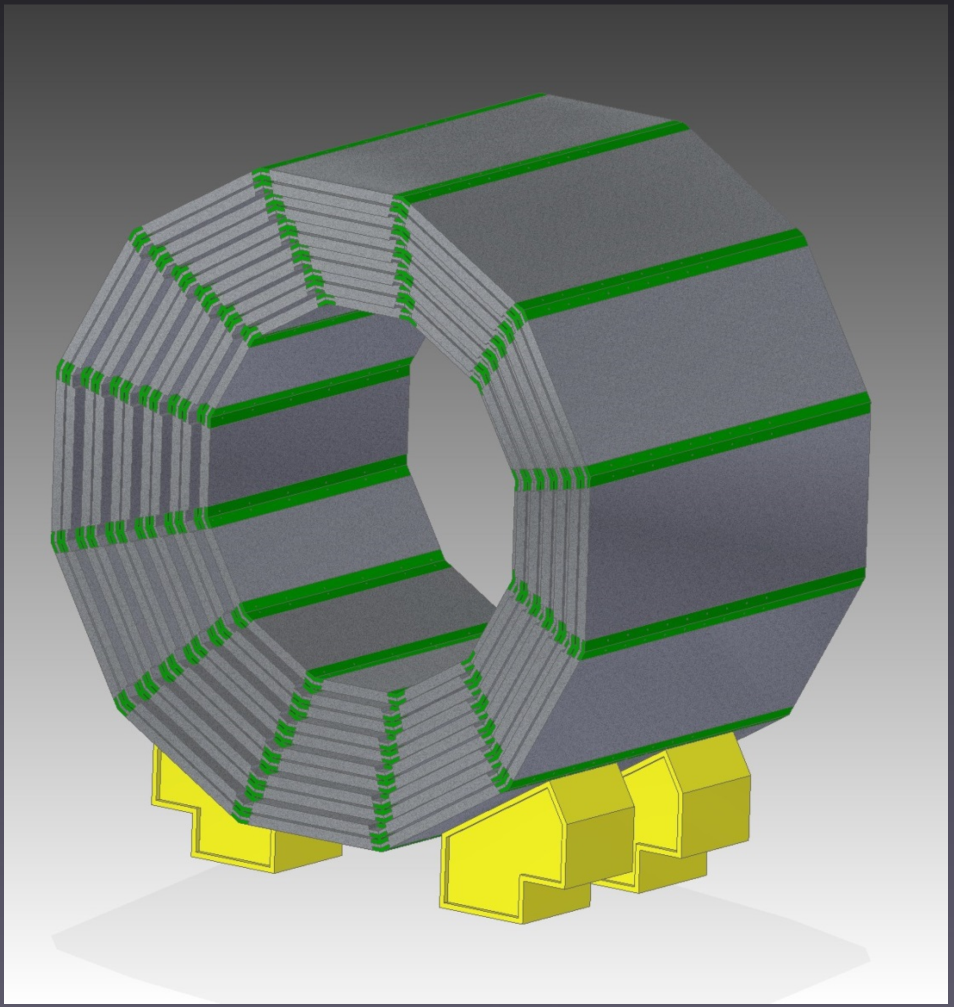
With Spoilers and Wall

Impact of the site-selection

DBD Barrel Design

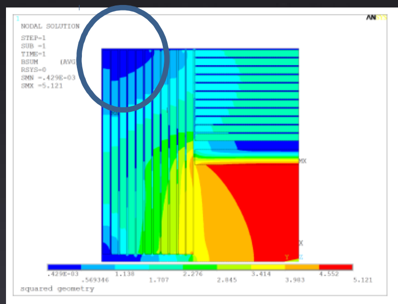


New Design

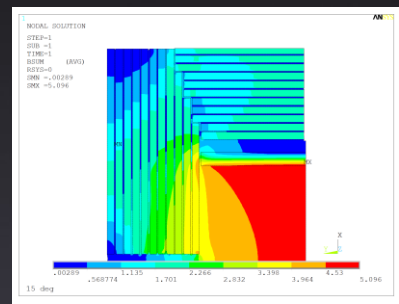


B Field – 11 plates, each 200 mm thick

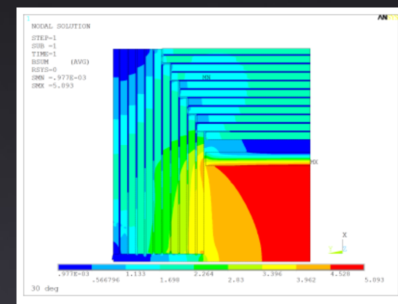
0° Baseline



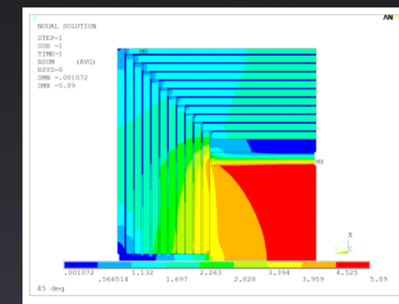
15°



30°

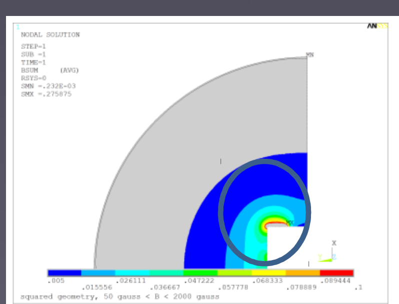


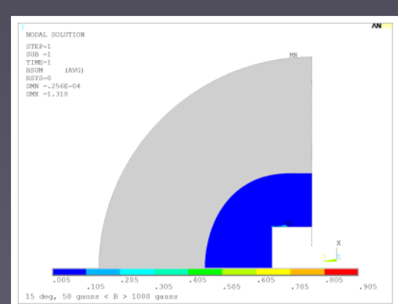
45°

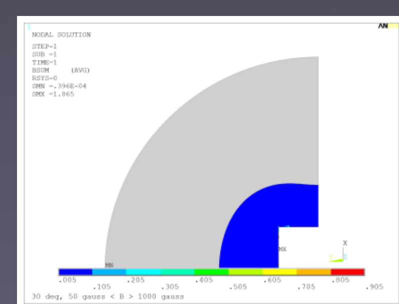


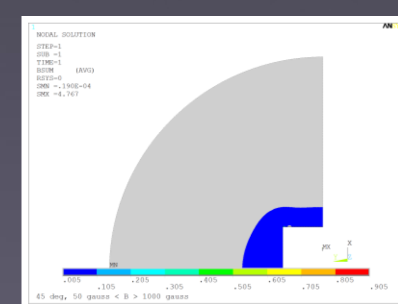
Red=5.1 Tesla; Blue=4.3 Gauss: More efficient use of iron at 45°

- Red=1 kG; Blue=50 Gauss; Gray ends at 30m:
- 50 G fringe field extends less
- Lower field on surface of yoke where electronics will reside as interface goes from 0 to 45°
- The larger the angle, the heavier the barrel will get, 30 degrees a good compromise



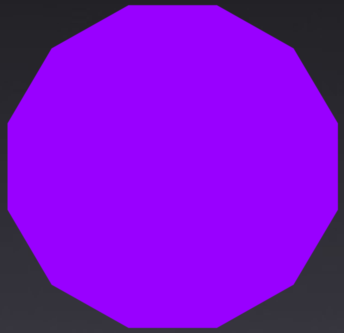






All Plates < 30 t in 12 Sided Design

				R (m)	Width (mm)	Weight (tons)	Accrued Sector Weight	Accrued Barrel Weight
L	5900		Plate 1	3454	1851	17	17	204
Thickness	200		Plate 2	3694	1980	18	35	423
Gap	40		Plate 3	3934	2108	19	55	656
			Plate 4	4174	2237	21	75	903
			Plate 5	4414	2365	22	97	1164
			Plate 6	4654	2494	23	120	1440
			Plate 7	4894	2623	24	144	1729
			Plate 8	5134	2751	25	169	2033
			Plate 9	5374	2880	27	196	2351
			Plate 10	5614	3009	28	224	2684
			Plate 11	5854	3137	29	253	3030



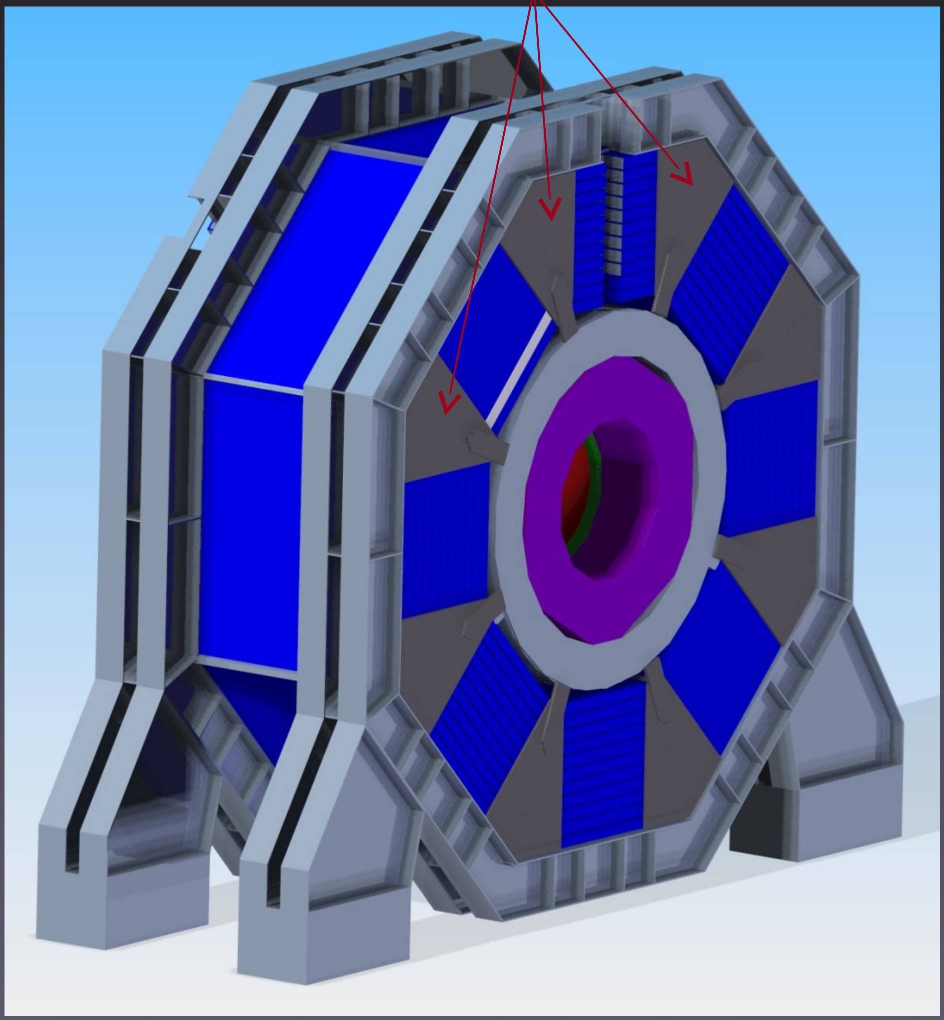
12 edges

				R (m)	Width (mm)	Weight (tons)	Accrued Sector Weight	Accrued Barrel Weight
L	5900		Plate 1	3454	2861	26	26	211
Thickness	200		Plate 2	3694	3060	28	55	436
Gap	40		Plate 3	3934	3259	30	84	676
			Plate 4	4174	3458	32	116	931
			Plate 5	4414	3657	34	150	1200
			Plate 6	4654	3855	35	185	1484
			Plate 7	4894	4054	37	223	1782
			Plate 8	5134	4253	39	262	2095
			Plate 9	5374	4452	41	303	2423
			Plate 10	5614	4651	43	346	2766
			Plate 11	5854	4850	45	390	3123

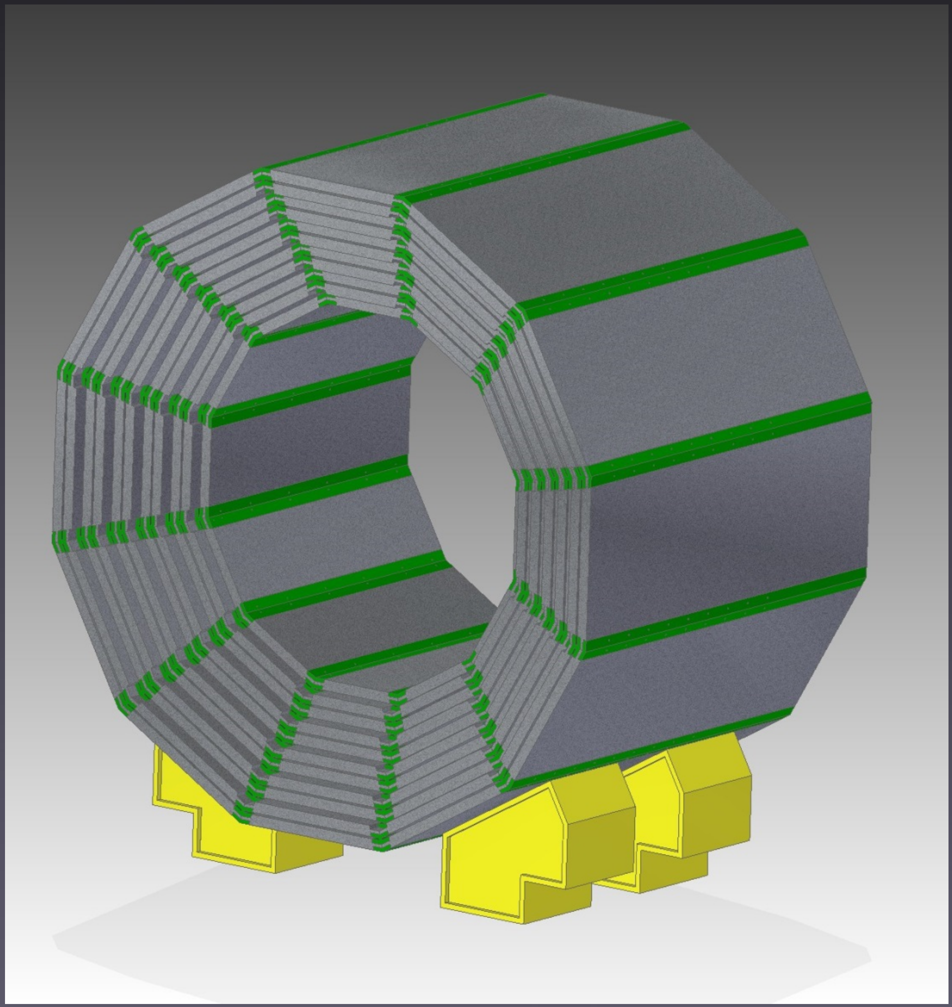
8 edges

Feet Instead of Arches
Edge-Edge Connectors in ϕ to Handle Changing Plate Lengths

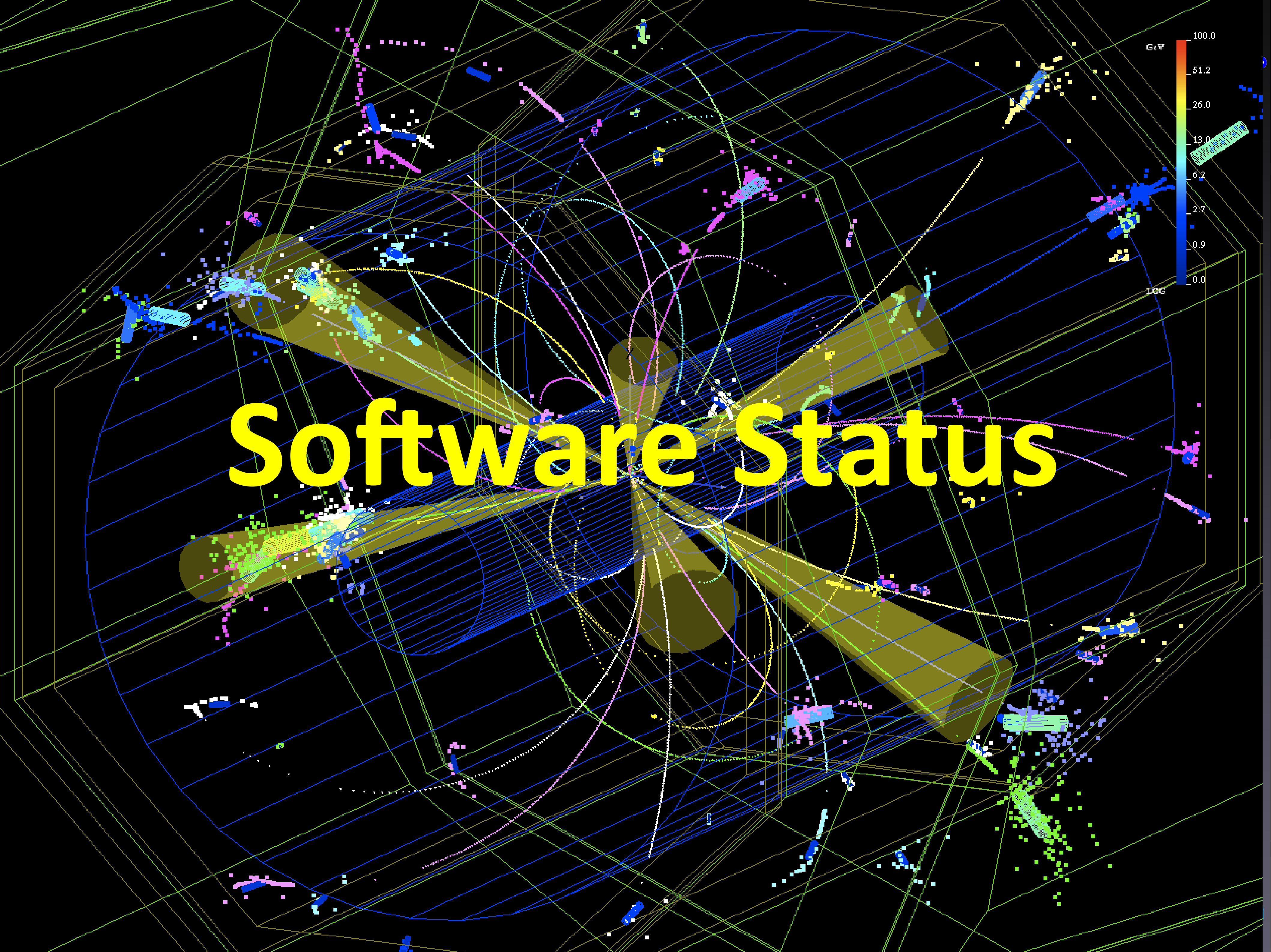
DBD Arches with Plates Joining Layers



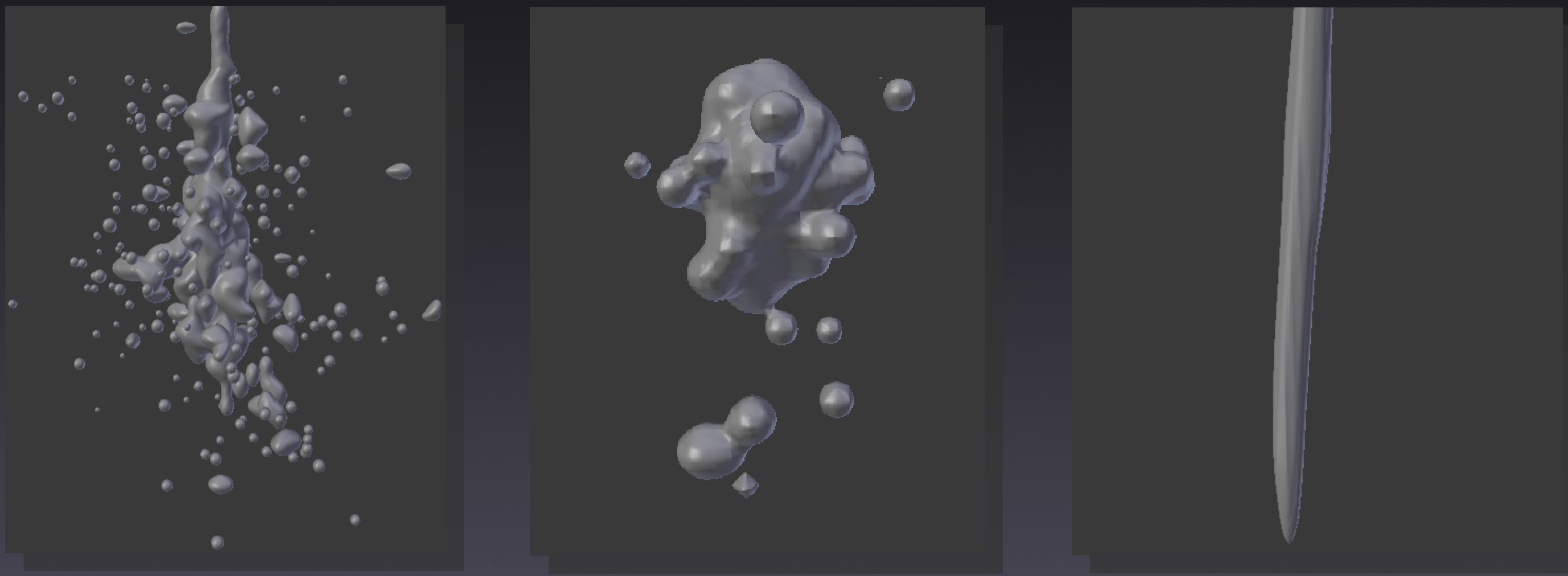
Support Feet & Plates with Connectors



Software Status



Calorimeter Reconstruction

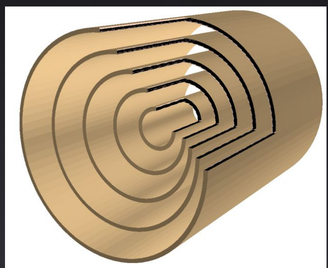


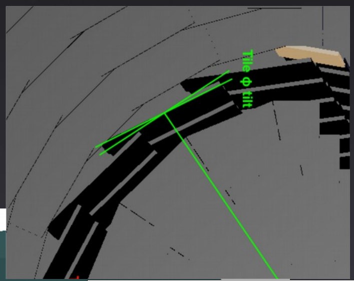
Pion (50 GeV) | Electron (50 GeV) | Muon (50 GeV)

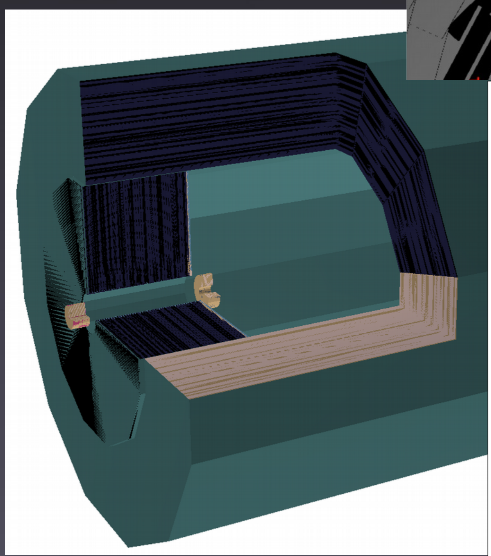
- Particle calorimeter hits form characteristic shapes
- Mesh conversion results in easily quantifiable geometric information
  - Volume to surface area ratio, Number of parts, Energy density, Volume vs. convex hull volume

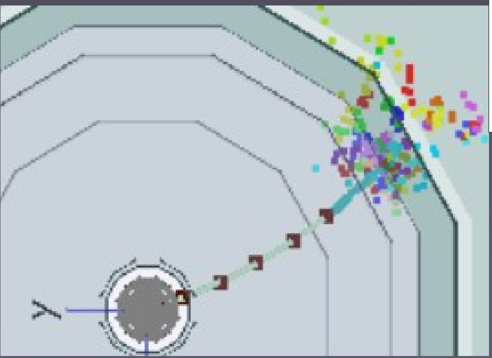
DD4HEP Status

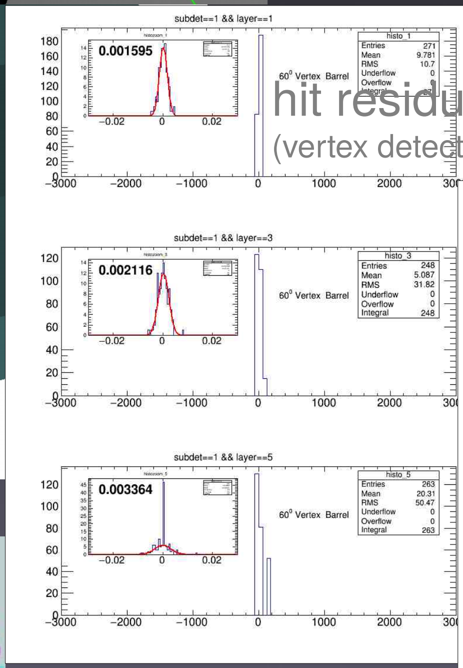
- Current Status
  - Implemented geometry and drivers
  - Updated to latest digitizers
  - commissioning full conformal pattern recognition (as implemented by CLICdp) & Pandora PFA

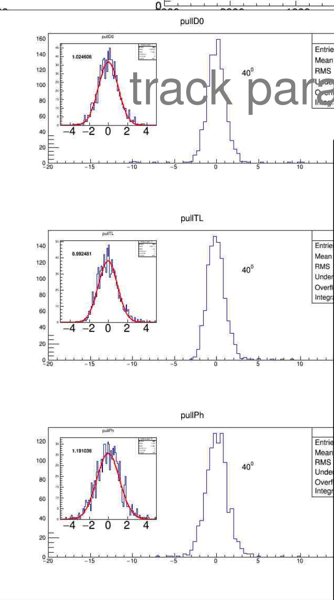


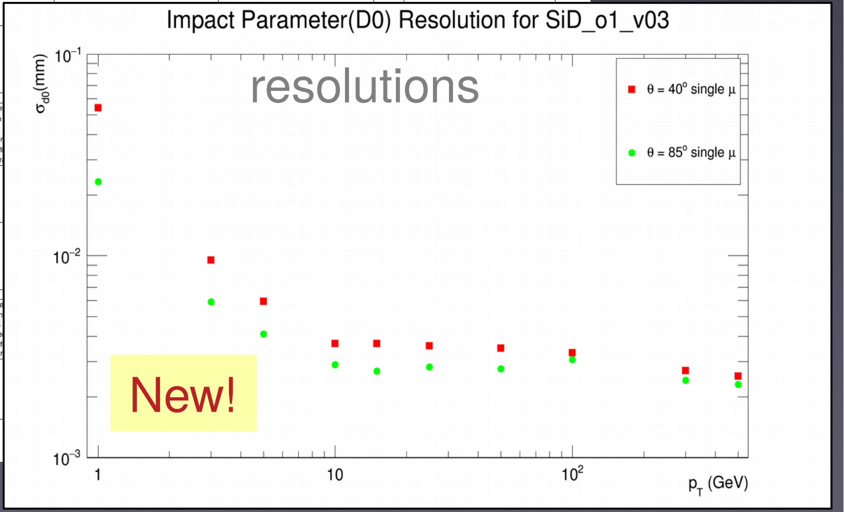








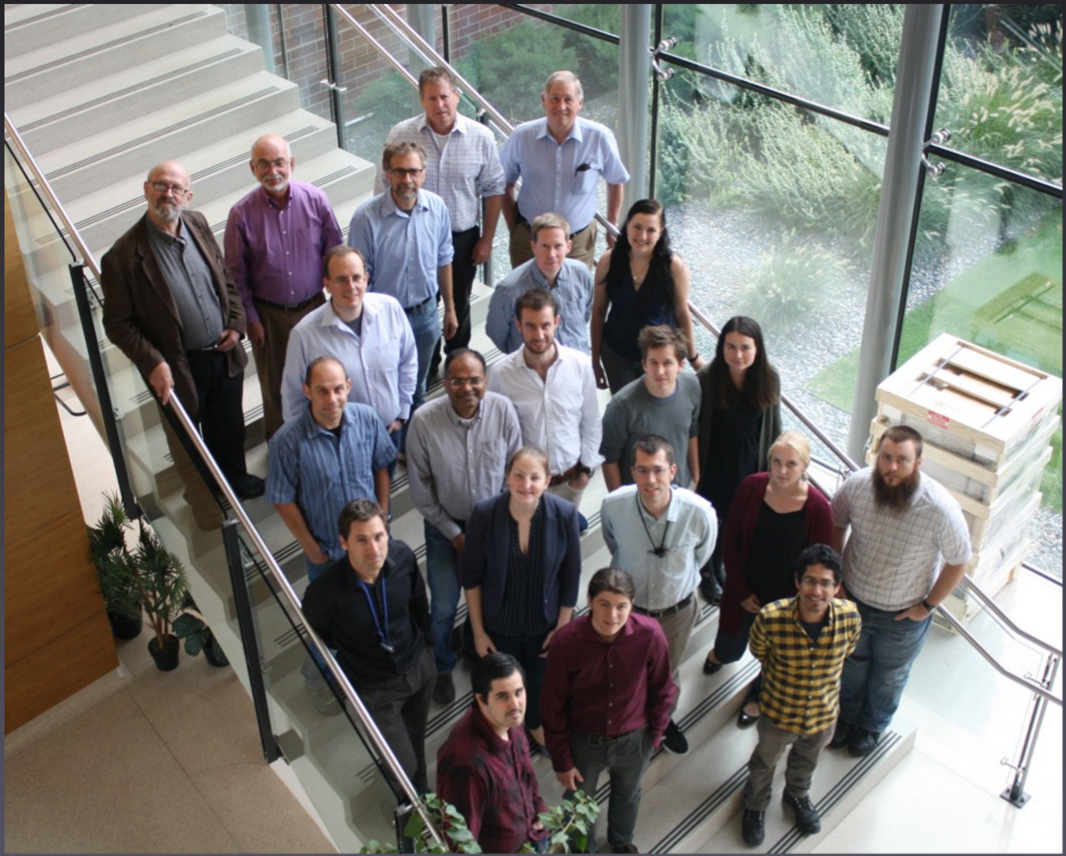




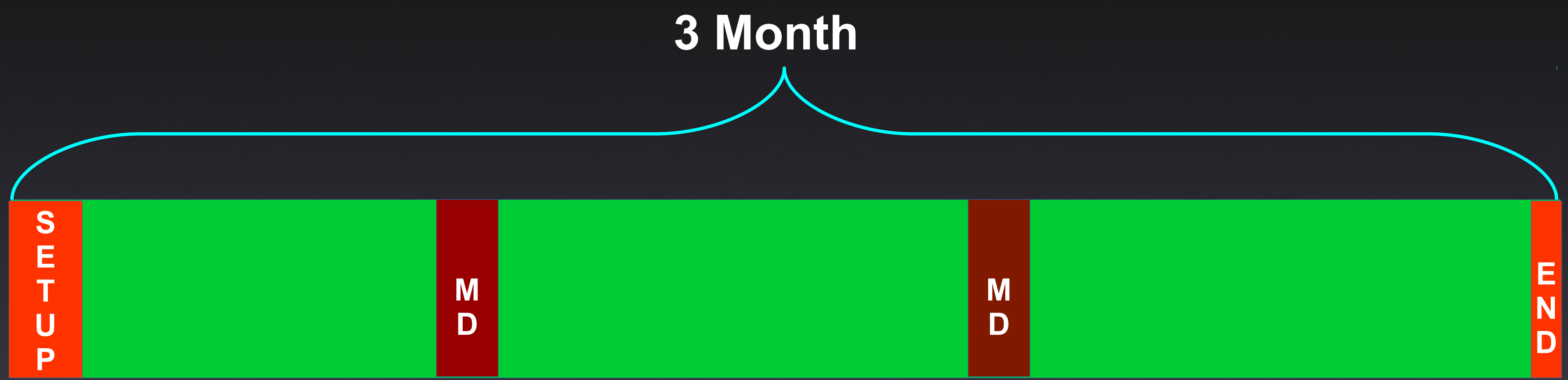
Relies on close collaboration/support from CLICdp and ILD developers

Dedicated Software Workshop

- Meeting at Pacific Northwest National Laboratory
  - Richland, WA
- Good attendance
- "Working" Workshop
  - Less talks
  - Lots of tutorials
- Big thanks to
  - Jan Strube & Aidan Robson for organizing

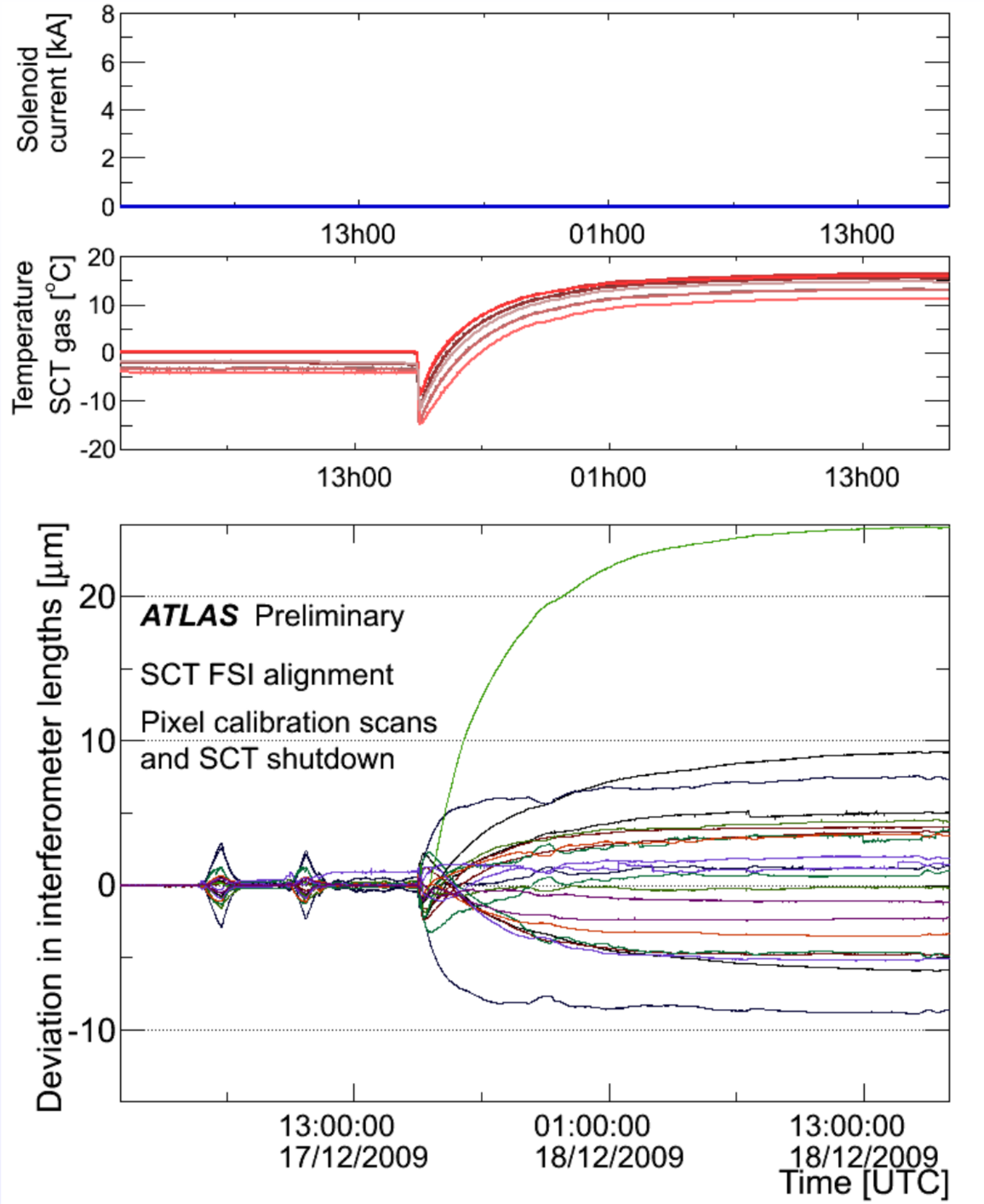


A possible Run Plan



- Running scenario
  - 3 Month Running per Detector
  - 2 MD Weeks
  - Setup, Tunings, End-Of-Run 1-2 Weeks
  - 8 Weeks with ~ 90 % machine availability for physics (That is ambitious)→ 7 weeks of data
- Alignment Periods
  - Initial (In the garage position)
  - Setup (After move into beam position)
  - During MD
  - Gorilla in the room: "Stability between bunches..."

FSI experience



Plot 5: Pixel Scans and SCT shutdown

Event: Two calibration scans in the silicon pixel detector (Pixels), followed by the shutdown of the silicon strip detector (SCT).
Up to **+/- 3µm** between the two smallest SCT barrels, closest to the Pixels.
The effect is reduced between the middle and outer pairs of SCT barrels.

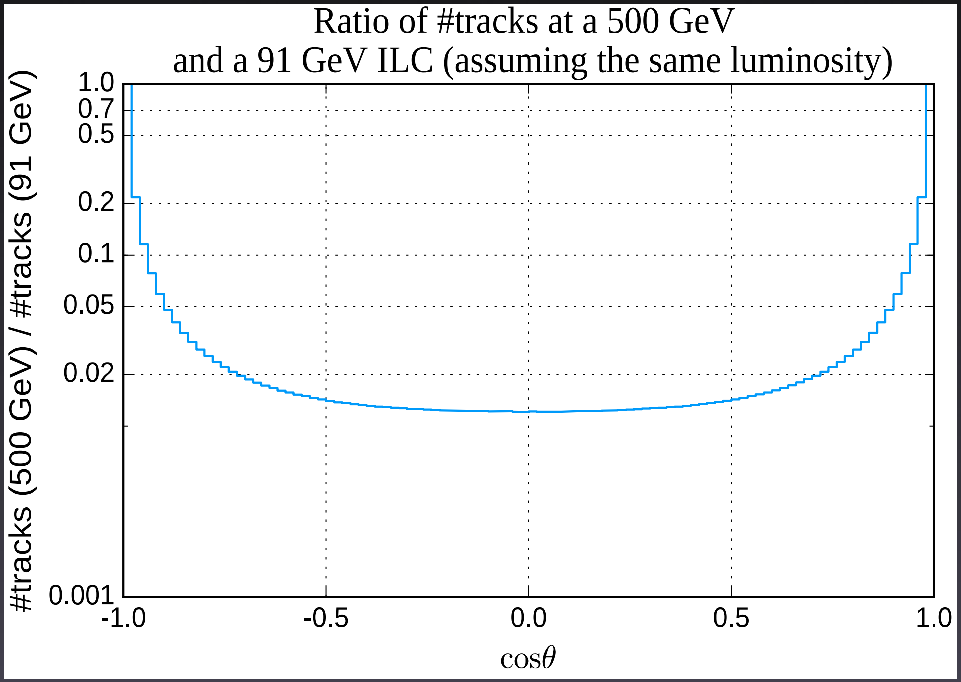
Heat dissipated in the Pixels by these scans appear to cause small deformations which propagate via the support structure to the SCT.

With the cooling off, the SCT warms gradually and after 24hrs the temperatures and movements tend to flatten.

The largest movement, of +25µm, may be due to thermal expansion of cooling pipe close to interferometer components.

Why no Z calibration run

- With $Lumi_Z = 0.01\ Lumi_{500\ GeV}$
  - Just not competitive
- If there is more Luminosity ?
  - A Z run after every push-pull ?
  - After every MD?
- Moving the machine from 500 GeV to 91 GeV and back
  - Non trivial (several Days/few weeks)
- With the desired accuracy
  - need to have other means of alignment
- SiD has started to look at different strategies to augment alignment
  - ATLAS-like FSI
  - Changes to electronics to increase efficiency for comics
  - Currently back-of-the-envelope calculations only



SiD does not request any running at the Z for calibration purposes, as we don't have a case. SiD however requests, that machine design will not be altered in way, which would prevent Z running at all

Summary

- SiD is compact detector design for the ILC
- A lot of activity in detector R&D and in optimization
  - but limited by effort and funding available
- SiD and ILC are in a "hold pattern"
  - Awaiting a decision
  - Dedicated Funding will only become available post this
  - SiD Webpage http://silicondetector.org/

Waiting for that green light from Japan !!!