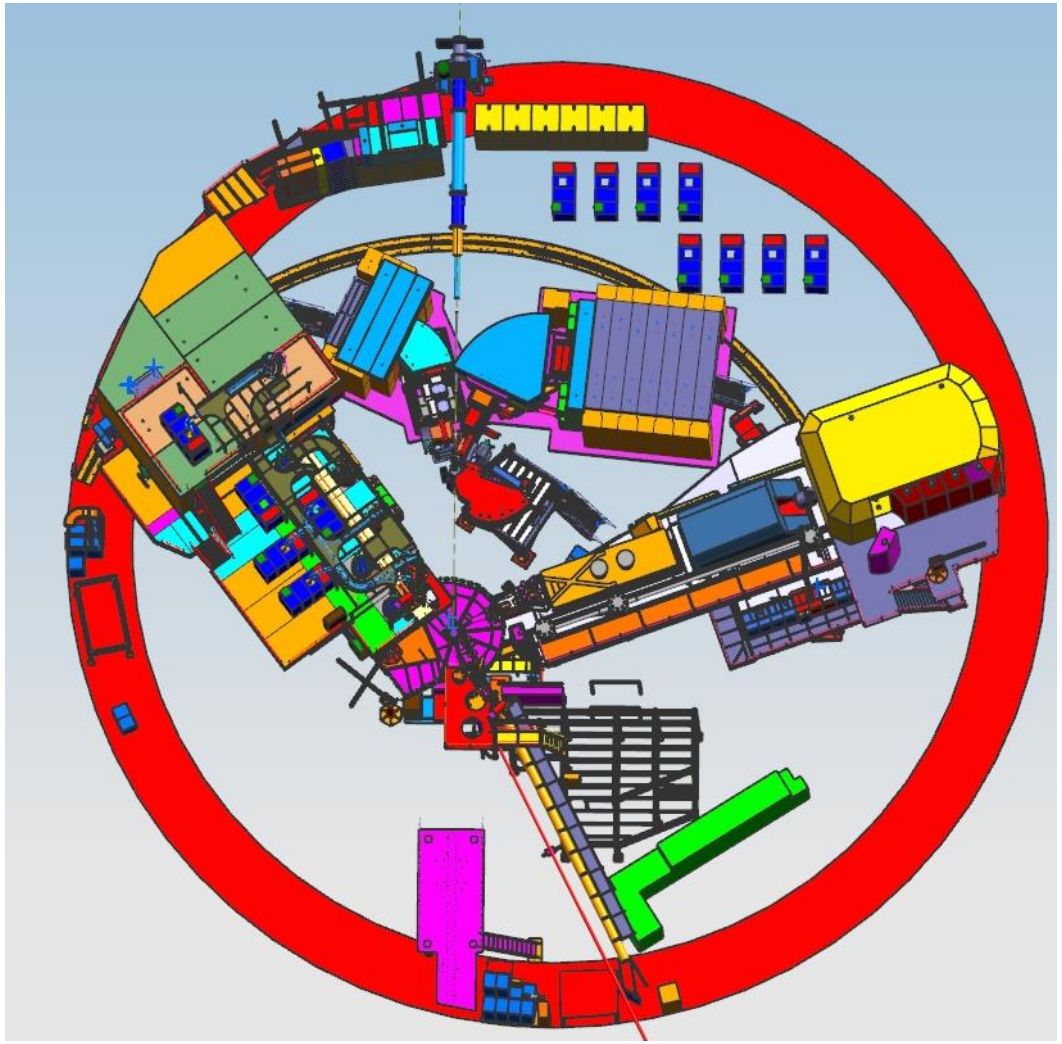
# Hyper-Nuclear Hall C March 2027 - updates

## HES, HKS & ENGE in Hall C



March 22, 2024

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Jefferson Lab

U.S. DEPARTMENT OF ENERGY | Office of Science

JSA

# Topics for March 22, 2024

- Power supplies for all magnets – being researched.
- Floor space layout updated – Target has been moved upstream, 7.5m from pivot.
- ENGE installation – Options being considered to keep the ENGE intact.
- New Sieve slits in front of PCS magnets being designed
- ENGE - New detector at exit of ENGE for calibration with alpha source at pivot
- PCS magnet factory test and vacuum test results being reviewed
- Calculating stray fields along beamline underway

# Magnet / PSU

| Magnet | Current (Specs) (A) | Voltage (Specs) (V) | Magnet LCW (L/min) | Magnet LCW pressure (MPa) | PSU Manufacturer | PSU Water Flow (L/min) | PSU Power (KVA) |
|---|---|---|---|---|---|---|---|
| HES E Dipole | 1,065 | 233 | 150 | 0.5 | | | |
| HES E Q1 | 800 | 110 | 41 | 0.5 | BigBite PSU | | |
| HES E Q2 | 800 | 110 | 41.4 | 0.5 | | | |
| HKS Dipole | **1,254** | **252** | **135.1** | **0.67** | | | |
| HKS Q1 | **875** | **160** | **49.6** | **0.36** | Inver-Power SOS Quad | | |
| HKS Q2 | **450** | **55** | **17.3** | **0.38** | Danfyisk | | |
| ENGE | **331 (500)** | **50 (130)** | **50** | **1.0** | | | |
| PCS (e') | 1,700 | 120 | 100 | 0.16 | | | |
| PCS(e') corr | 1,000 | 110 | 100 | 0.16 | | | |
| PCS (k) | 1,700 | 120 | 100 | 0.16 | | | |
| PCS (k) corr | 1,000 | 110 | 100 | 0.16 | | | |




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# Notes on ENGE installation

- All scenarios presented today have the SHMS on Beam right (BR) side.
- Downstream Beam line is removed.
- ENGE installation is the first component to be installed
- Survey of the stands locations (feet) has to be done prior to moving SHMS BR
- SHMS cryolines may need to be removed or re-positioned/supported
- Discussion with outside crane vendor is ongoing, no show stoppers on any of the scenarios.

# HyperNuclear ENGE install Hall C 3/20/24

Preliminary

SHMS at 28° BR (beam right)

## Option #1

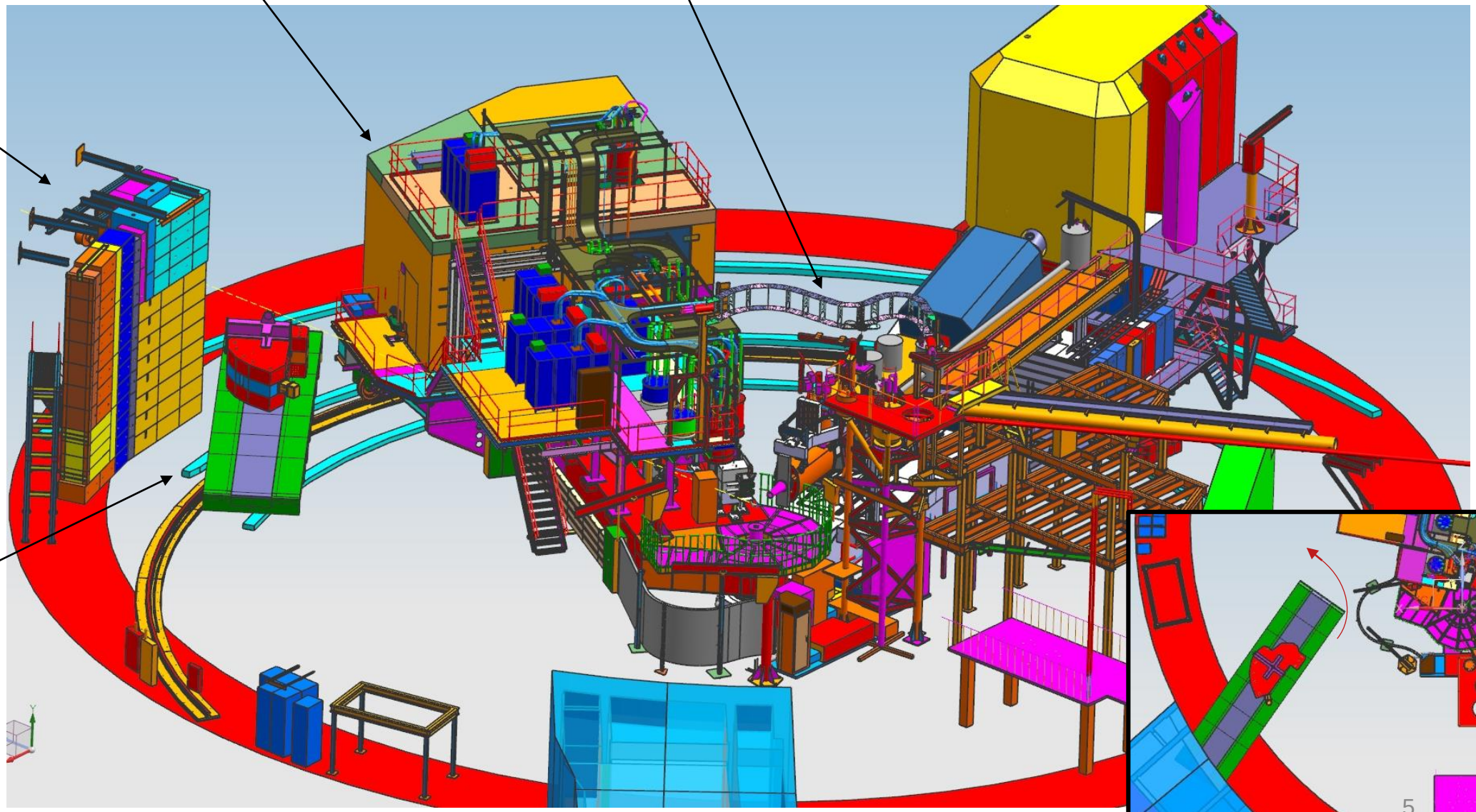
(keep shield wall intact may require removal of the SHMS's Anacoda cryoline)

SHMS cryolines have not been verified for this angle.

No change to rear shielding wall

Remote Controlled Goldhofer Trailer 40' x 10'

Magnet can be picked up at the ESB building and driven down to HallC on the trailer

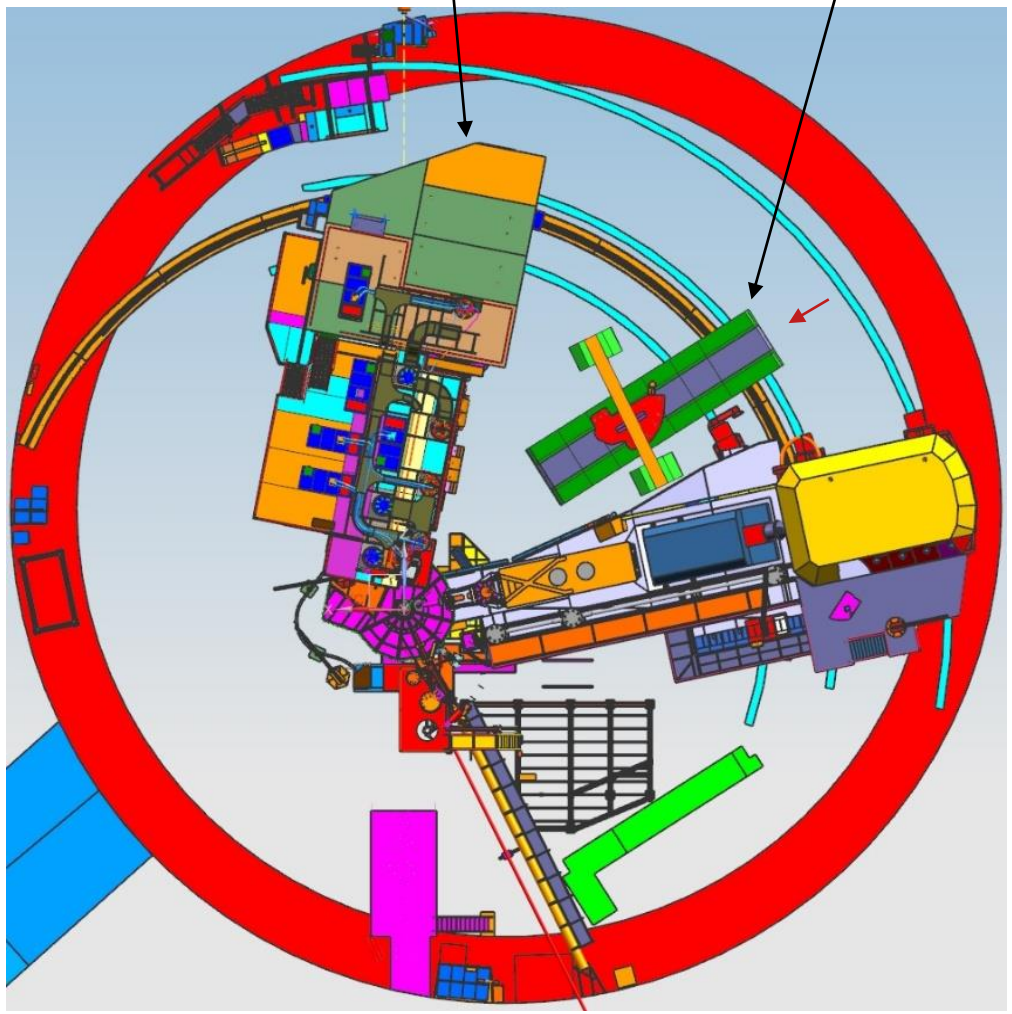


# Option #1

Unload ENGE magnet and trailer exit

SHMS at 8 BR

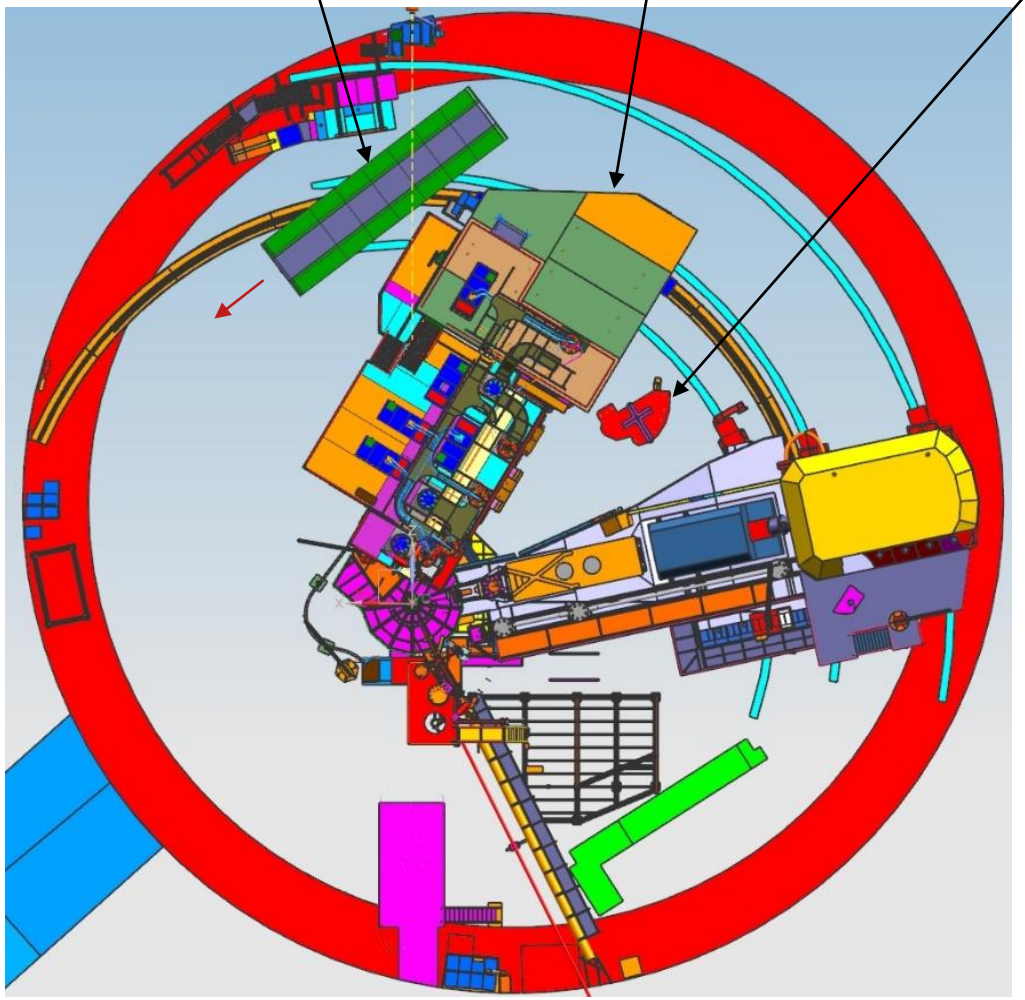
Drive trailer under lifting towers



Trailer to exit the hall

SHMS back to 28 BR

ENGE magnet on Hillman rollers



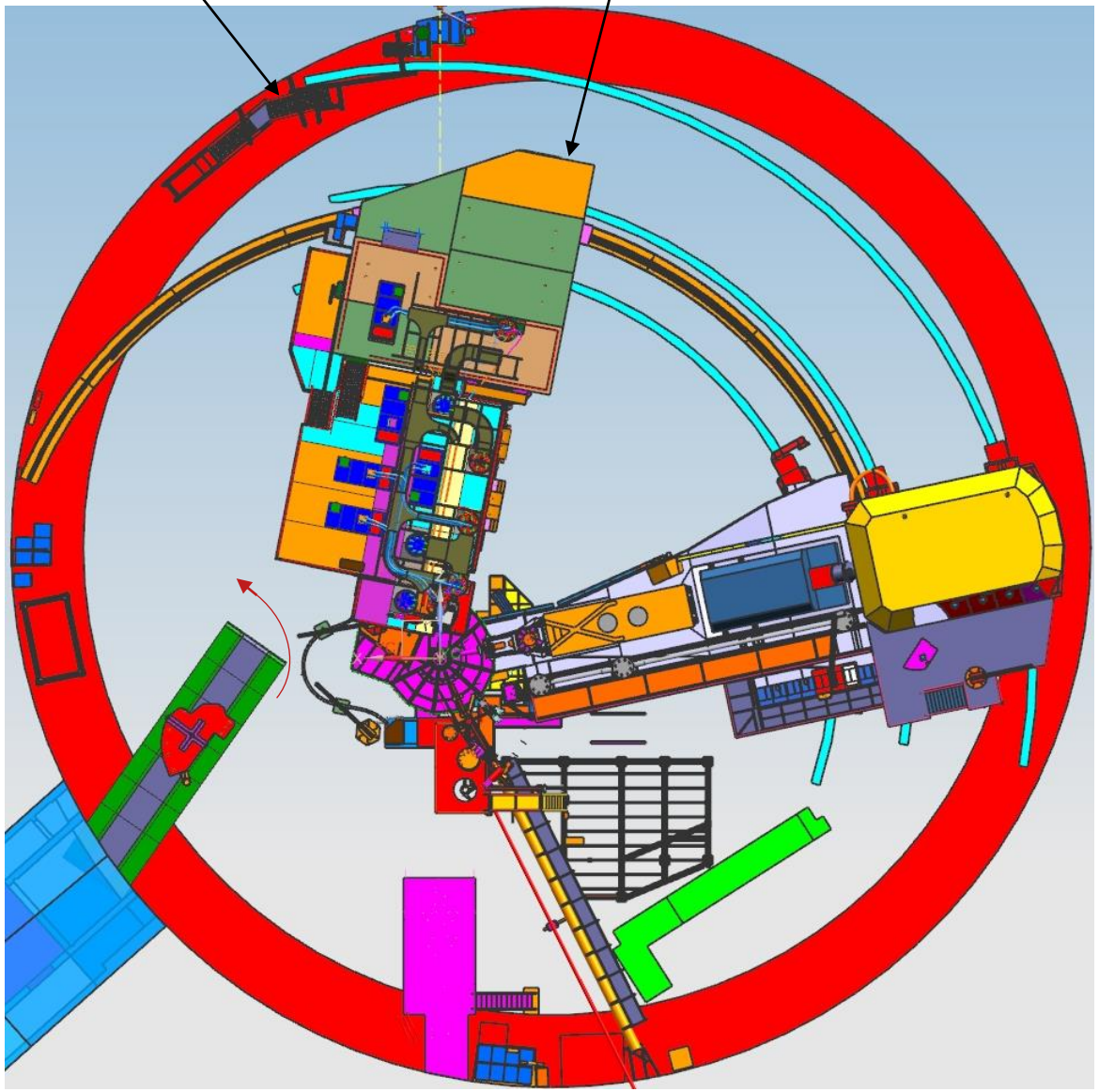
# Option #2

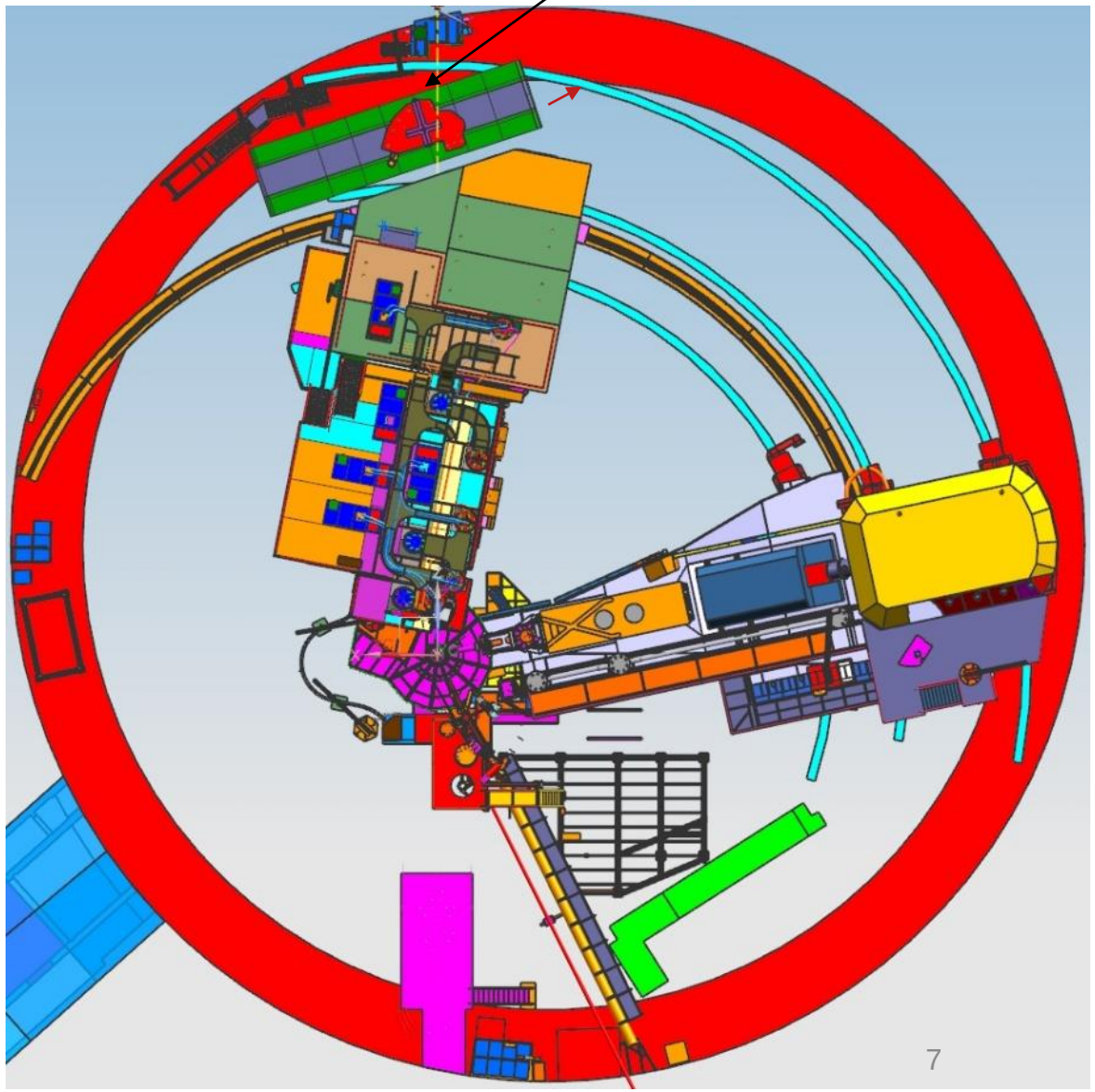
(remove shield wall blocks no change to cryolines)

Rear Shielding Wall
Blocks to be removed including vertical support frames

SHMS at 12° BR
(beam right)

Goldhofer Trailer with 2’ ft clearance each side





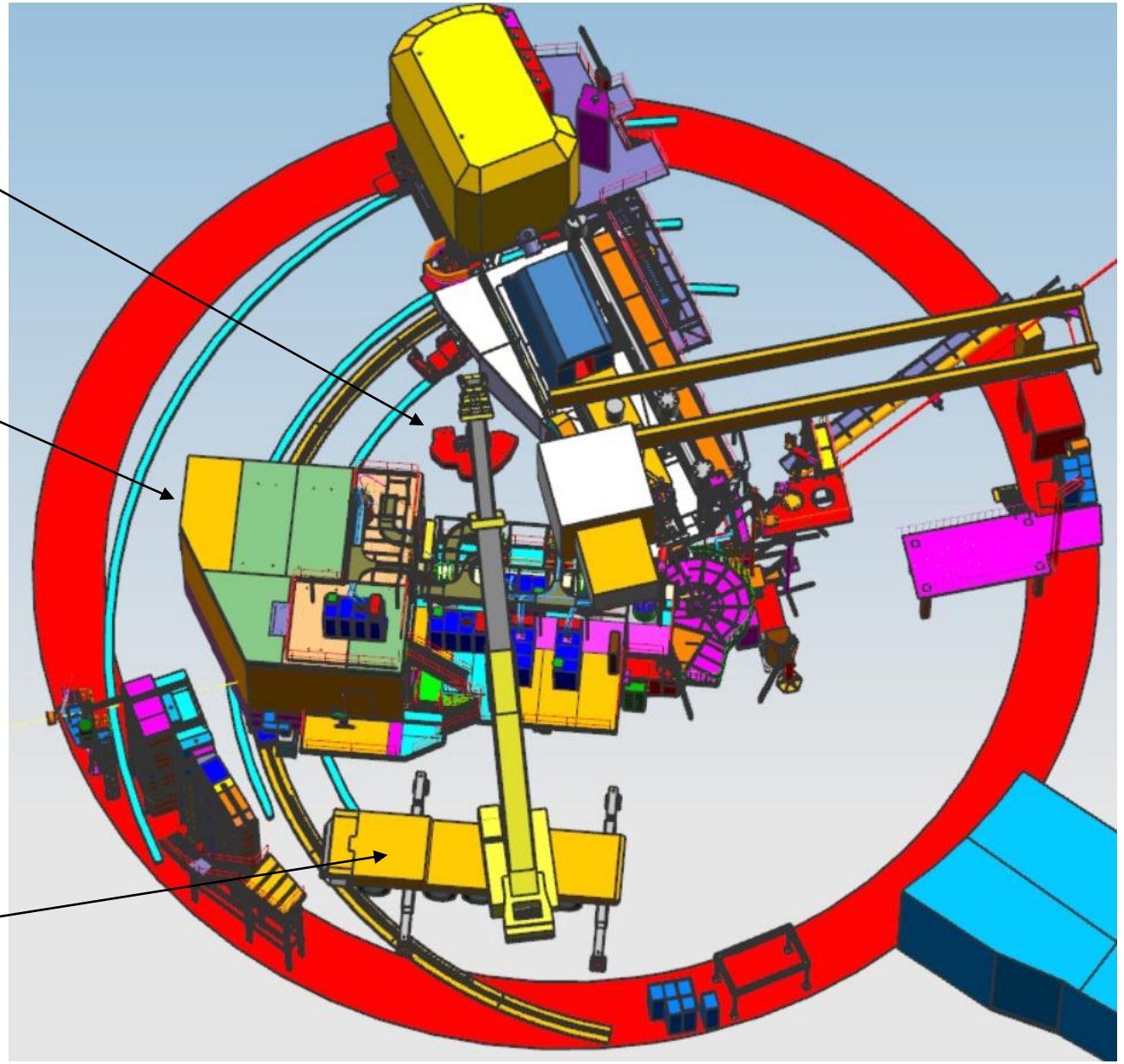
# Option #3

(using typical 175 ton crane and disassemble ENGE magnet

ENGE yoke at the limit of the crane boom (but it would work)

SHMS at 14° BR (beam right)

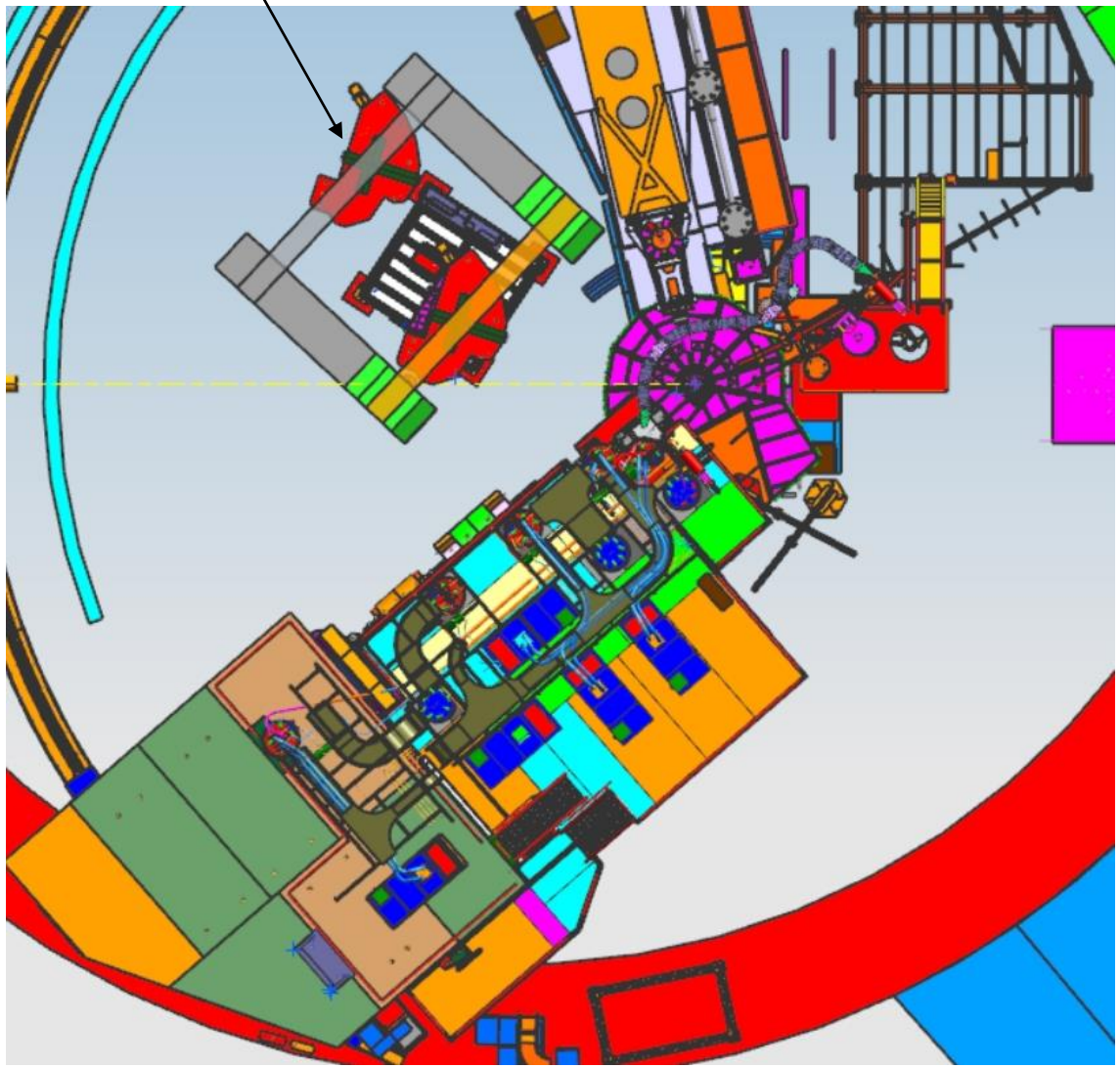
175 ton mobile crane (HallC has used it before)

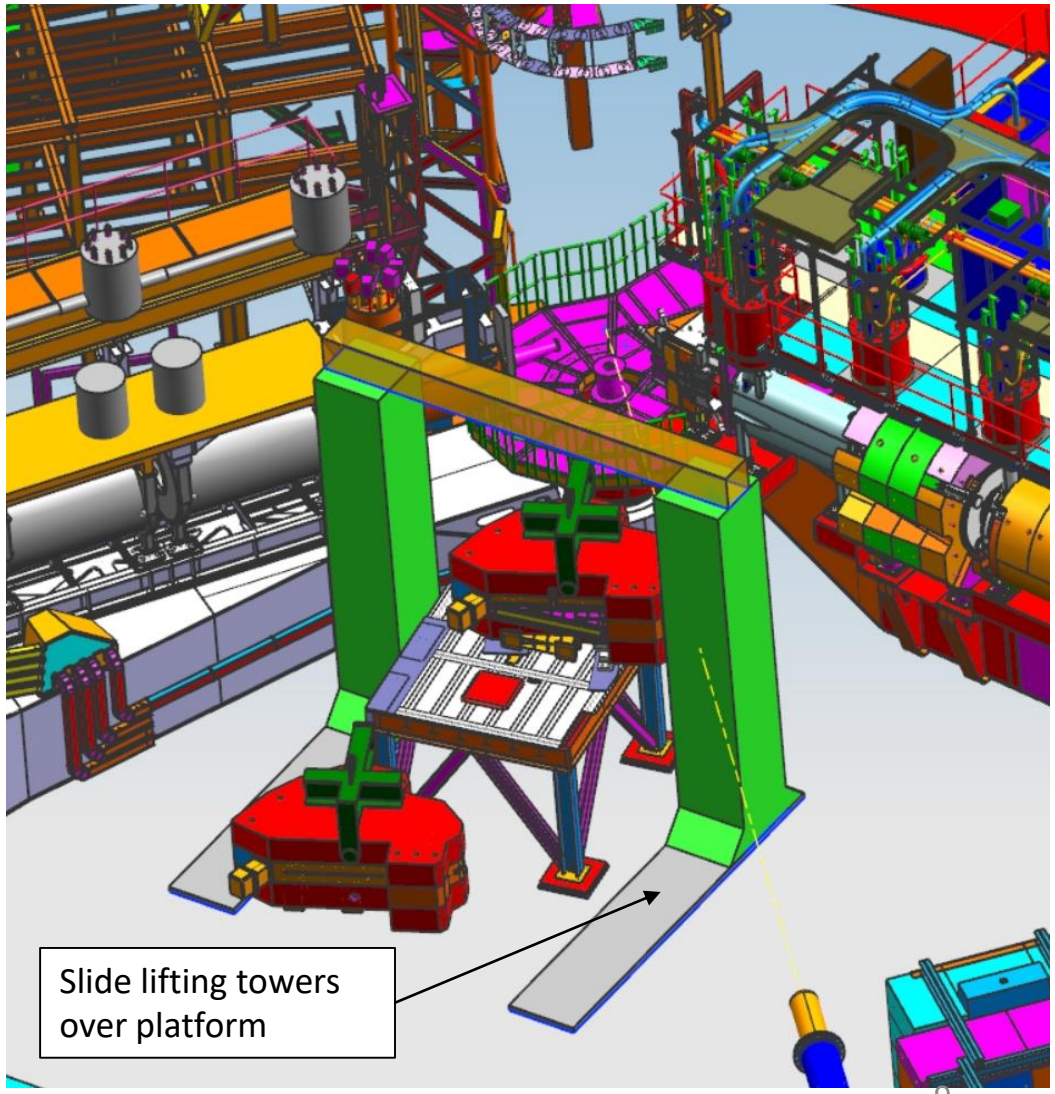


Using Hillman rollers
Roll ENGE magnet close to platform, lift with the towers

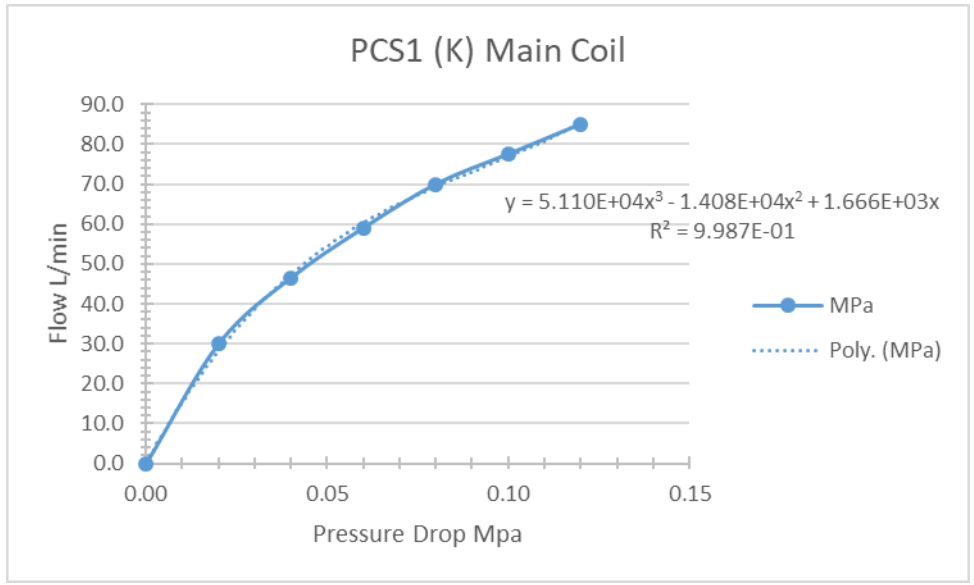
# For all options

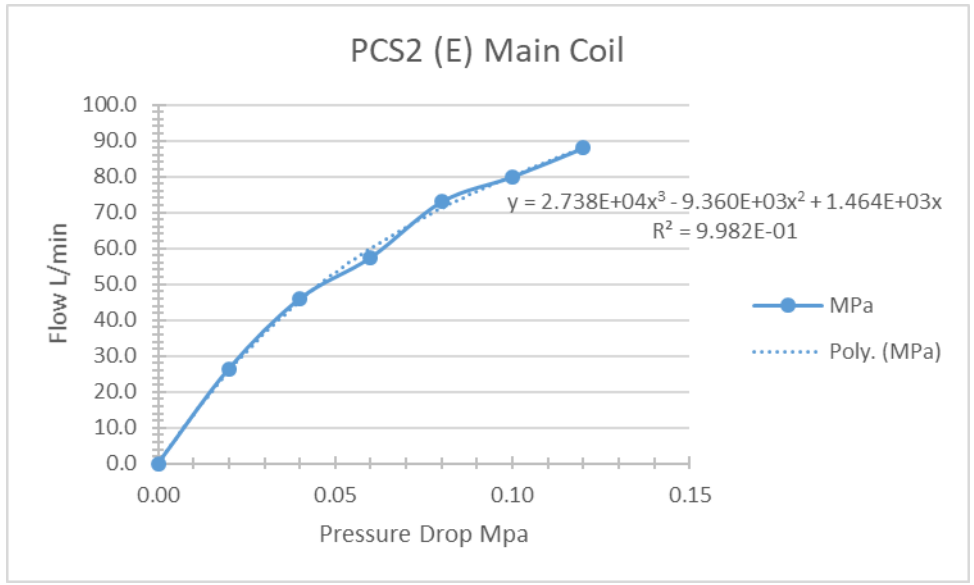
The ENGE magnet will have to be lifted on the platform by lifting towers





# PCS Magnets Factor Test

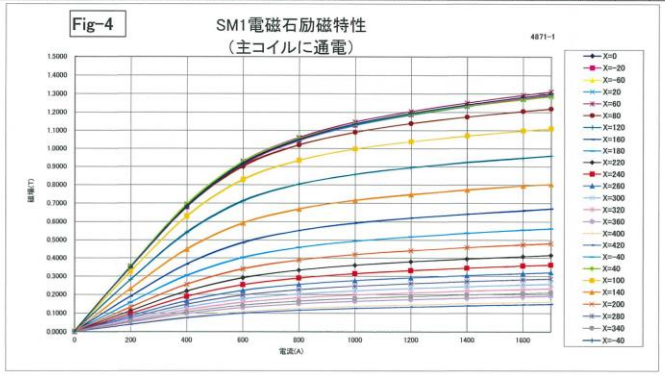



励磁特性　　主コイル　　磁場強さの単位はテスラ(T)

| | X位置 | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 電流(A) | −60 | −40 | −20 | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 320 | 340 | 360 | 380 | 400 | 420 |
| 0 | 0.0016 | 0.0016 | 0.0016 | 0.0016 | 0.0016 | 0.0017 | 0.0017 | 0.0017 | 0.0016 | 0.0014 | 0.0011 | 0.0009 | 0.0007 | 0.0006 | 0.0005 | 0.0004 | 0.0004 | 0.0003 | 0.0003 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0001 | 0.0001 |
| 200 | 0.3534 | 0.3497 | 0.3481 | 0.3484 | 0.3509 | 0.3552 | 0.3580 | 0.3511 | 0.3246 | 0.2805 | 0.2306 | 0.1889 | 0.1556 | 0.1305 | 0.1115 | 0.0963 | 0.0844 | 0.0745 | 0.0665 | 0.0597 | 0.0539 | 0.0490 | 0.0446 | 0.0408 | 0.0375 |
| 400 | 0.6879 | 0.6808 | 0.6776 | 0.6780 | 0.6825 | 0.6902 | 0.6944 | 0.6789 | 0.6267 | 0.5388 | 0.4463 | 0.3649 | 0.3015 | 0.2537 | 0.2160 | 0.1875 | 0.1640 | 0.1451 | 0.1296 | 0.1162 | 0.1052 | 0.0953 | 0.0870 | 0.0795 | 0.0730 |
| 600 | 0.9227 | 0.9136 | 0.9094 | 0.9094 | 0.9143 | 0.9223 | 0.9242 | 0.8984 | 0.8258 | 0.7096 | 0.5898 | 0.4831 | 0.4010 | 0.3385 | 0.2890 | 0.2512 | 0.2201 | 0.1949 | 0.1742 | 0.1564 | 0.1414 | 0.1285 | 0.1170 | 0.1073 | 0.0983 |
| 800 | 1.0588 | 1.0490 | 1.0440 | 1.0433 | 1.0473 | 1.0540 | 1.0520 | 1.0178 | 0.9331 | 0.8026 | 0.6667 | 0.5508 | 0.4575 | 0.3877 | 0.3319 | 0.2883 | 0.2538 | 0.2247 | 0.2012 | 0.1807 | 0.1635 | 0.1487 | 0.1355 | 0.1242 | 0.1140 |
| 1000 | 1.1441 | 1.1339 | 1.1284 | 1.1270 | 1.1299 | 1.1345 | 1.1289 | 1.0895 | 0.9969 | 0.8569 | 0.7158 | 0.5902 | 0.4930 | 0.4187 | 0.3590 | 0.3131 | 0.2750 | 0.2441 | 0.2188 | 0.1968 | 0.1781 | 0.1621 | 0.1478 | 0.1356 | 0.1244 |
| 1200 | 1.2033 | 1.1929 | 1.1870 | 1.1848 | 1.1865 | 1.1893 | 1.1806 | 1.1368 | 1.0386 | 0.8936 | 0.7477 | 0.6187 | 0.5173 | 0.4403 | 0.3780 | 0.3302 | 0.2904 | 0.2582 | 0.2314 | 0.2082 | 0.1889 | 0.1717 | 0.1568 | 0.1438 | 0.1319 |
| 1400 | 1.2510 | 1.2404 | 1.2340 | 1.2311 | 1.2315 | 1.2325 | 1.2215 | 1.1733 | 1.0703 | 0.9248 | 0.7703 | 0.6411 | 0.5373 | 0.4569 | 0.3945 | 0.3438 | 0.3031 | 0.2700 | 0.2416 | 0.2182 | 0.1975 | 0.1798 | 0.1644 | 0.1505 | 0.1385 |
| 1600 | 1.2922 | 1.2815 | 1.2746 | 1.2709 | 1.2701 | 1.2692 | 1.2555 | 1.2040 | 1.0980 | 0.9480 | 0.7931 | 0.6607 | 0.5537 | 0.4729 | 0.4075 | 0.3562 | 0.3146 | 0.2798 | 0.2514 | 0.2266 | 0.2055 | 0.1873 | 0.1709 | 0.1570 | 0.1442 |
| 1700 | 1.3112 | 1.3004 | 1.2932 | 1.2891 | 1.2876 | 1.2857 | 1.2709 | 1.2184 | 1.1097 | 0.9597 | 0.8014 | 0.6696 | 0.5618 | 0.4793 | 0.4145 | 0.3615 | 0.3199 | 0.2847 | 0.2555 | 0.2308 | 0.2090 | 0.1908 | 0.1741 | 0.1597 | 0.1471 |
| 1600 | 1.2921 | 1.2813 | 1.2746 | 1.2708 | 1.2700 | 1.2691 | 1.2549 | 1.2051 | 1.0978 | 0.9464 | 0.7936 | 0.6588 | 0.5550 | 0.4718 | 0.4074 | 0.3565 | 0.3141 | 0.2803 | 0.2510 | 0.2265 | 0.2056 | 0.1870 | 0.1710 | 0.1568 | 0.1442 |
| 1400 | 1.2509 | 1.2404 | 1.2340 | 1.2311 | 1.2316 | 1.2325 | 1.2210 | 1.1731 | 1.0711 | 0.9221 | 0.7725 | 0.6406 | 0.5368 | 0.4572 | 0.3934 | 0.3442 | 0.3032 | 0.2696 | 0.2419 | 0.2178 | 0.1977 | 0.1797 | 0.1641 | 0.1507 | 0.1383 |
| 1200 | 1.2036 | 1.1932 | 1.1872 | 1.1851 | 1.1868 | 1.1896 | 1.1811 | 1.1364 | 1.0385 | 0.8942 | 0.7453 | 0.6192 | 0.5171 | 0.4400 | 0.3781 | 0.3295 | 0.2908 | 0.2580 | 0.2314 | 0.2083 | 0.1887 | 0.1718 | 0.1567 | 0.1438 | 0.1319 |
| 1000 | 1.1450 | 1.1348 | 1.1293 | 1.1279 | 1.1308 | 1.1354 | 1.1300 | 1.0896 | 0.9969 | 0.8576 | 0.7141 | 0.5922 | 0.4929 | 0.4186 | 0.3592 | 0.3126 | 0.2755 | 0.2442 | 0.2188 | 0.1968 | 0.1781 | 0.1621 | 0.1478 | 0.1355 | 0.1244 |
| 800 | 1.0612 | 1.0513 | 1.0464 | 1.0457 | 1.0498 | 1.0562 | 1.0541 | 1.0201 | 0.9349 | 0.8031 | 0.6692 | 0.5504 | 0.4584 | 0.3882 | 0.3322 | 0.2894 | 0.2539 | 0.2251 | 0.2015 | 0.1809 | 0.1639 | 0.1488 | 0.1357 | 0.1244 | 0.1140 |
| 600 | 0.9291 | 0.9199 | 0.9157 | 0.9158 | 0.9207 | 0.9287 | 0.9304 | 0.9048 | 0.8303 | 0.7137 | 0.5926 | 0.4865 | 0.4035 | 0.3406 | 0.2908 | 0.2521 | 0.2215 | 0.1959 | 0.1752 | 0.1572 | 0.1421 | 0.1291 | 0.1176 | 0.1078 | 0.0988 |
| 400 | 0.6938 | 0.6866 | 0.6835 | 0.6839 | 0.6885 | 0.6963 | 0.7006 | 0.6852 | 0.6313 | 0.5433 | 0.4499 | 0.3671 | 0.3045 | 0.2551 | 0.2178 | 0.1888 | 0.1650 | 0.1463 | 0.1304 | 0.1170 | 0.1058 | 0.0959 | 0.0876 | 0.0800 | 0.0735 |
| 200 | 0.3554 | 0.3517 | 0.3500 | 0.3503 | 0.3528 | 0.3572 | 0.3601 | 0.3530 | 0.3265 | 0.2814 | 0.2322 | 0.1899 | 0.1562 | 0.1314 | 0.1119 | 0.0967 | 0.0848 | 0.0748 | 0.0668 | 0.0599 | 0.0541 | 0.0491 | 0.0447 | 0.0410 | 0.0375 |
| 0 | 0.0024 | 0.0023 | 0.0023 | 0.0023 | 0.0023 | 0.0023 | 0.0024 | 0.0023 | 0.0022 | 0.0018 | 0.0015 | 0.0012 | 0.0010 | 0.0008 | 0.0006 | 0.0005 | 0.0005 | 0.0004 | 0.0004 | 0.0003 | 0.0003 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |

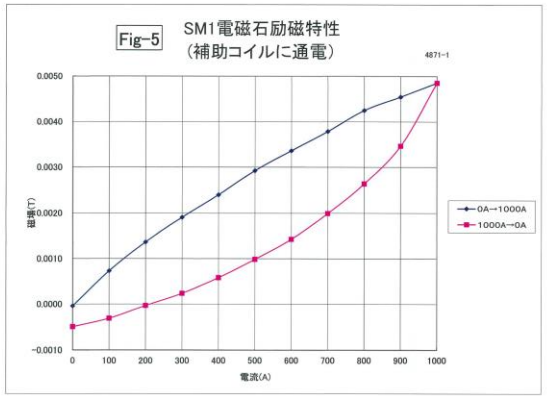
Fig−4　SM1電磁石励磁特性（主コイルに通電）




励磁特性
補助コイル

| 電流(A) | テスラ(T) |
|---|---|
| 0 | 0.0000 |
| 100 | 0.0007 |
| 200 | 0.0014 |
| 300 | 0.0019 |
| 400 | 0.0024 |
| 500 | 0.0029 |
| 600 | 0.0034 |
| 700 | 0.0038 |
| 800 | 0.0042 |
| 900 | 0.0045 |
| 1000 | 0.0048 |
| 900 | 0.0035 |
| 800 | 0.0026 |
| 700 | 0.0020 |
| 600 | 0.0014 |
| 500 | 0.0010 |
| 400 | 0.0006 |
| 300 | 0.0002 |
| 200 | 0.0000 |
| 100 | −0.0003 |
| 0 | −0.0005 |

Fig−5　SM1電磁石励磁特性（補助コイルに通電）



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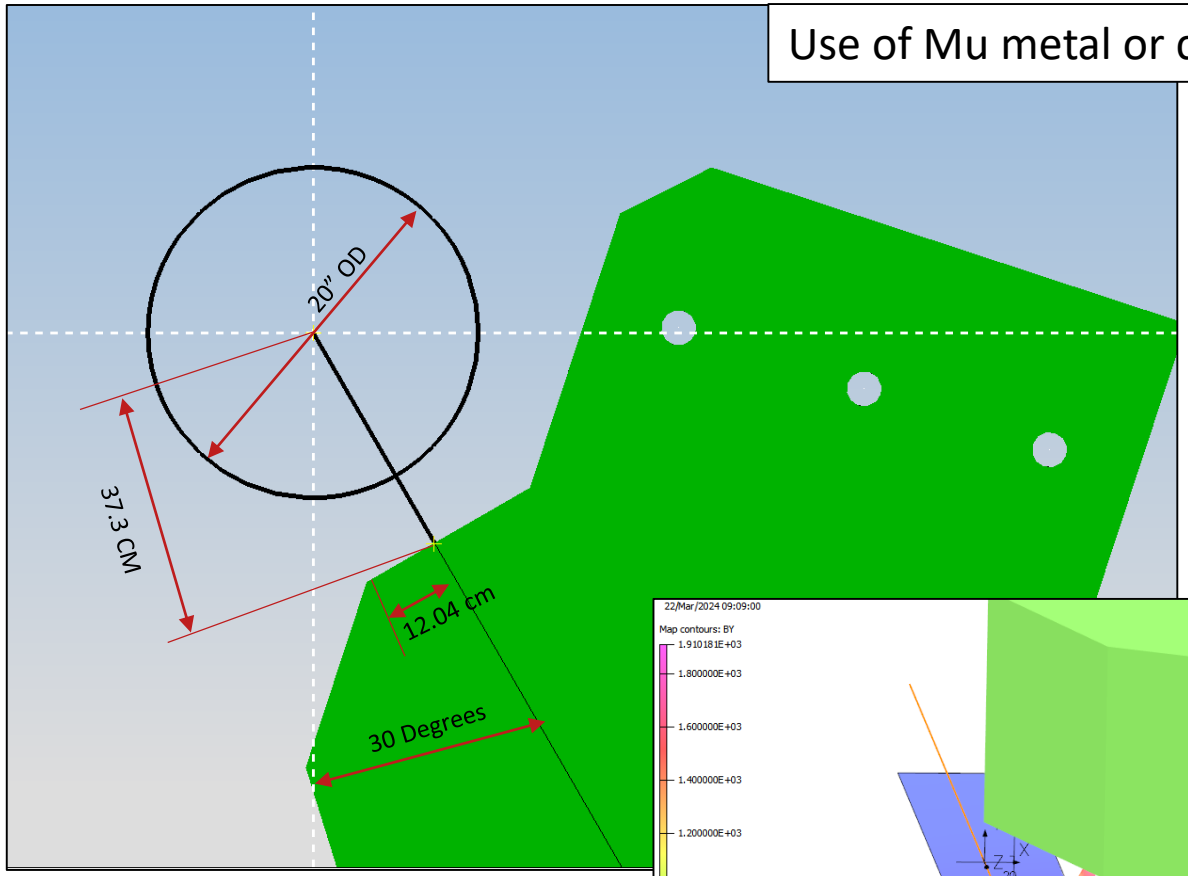
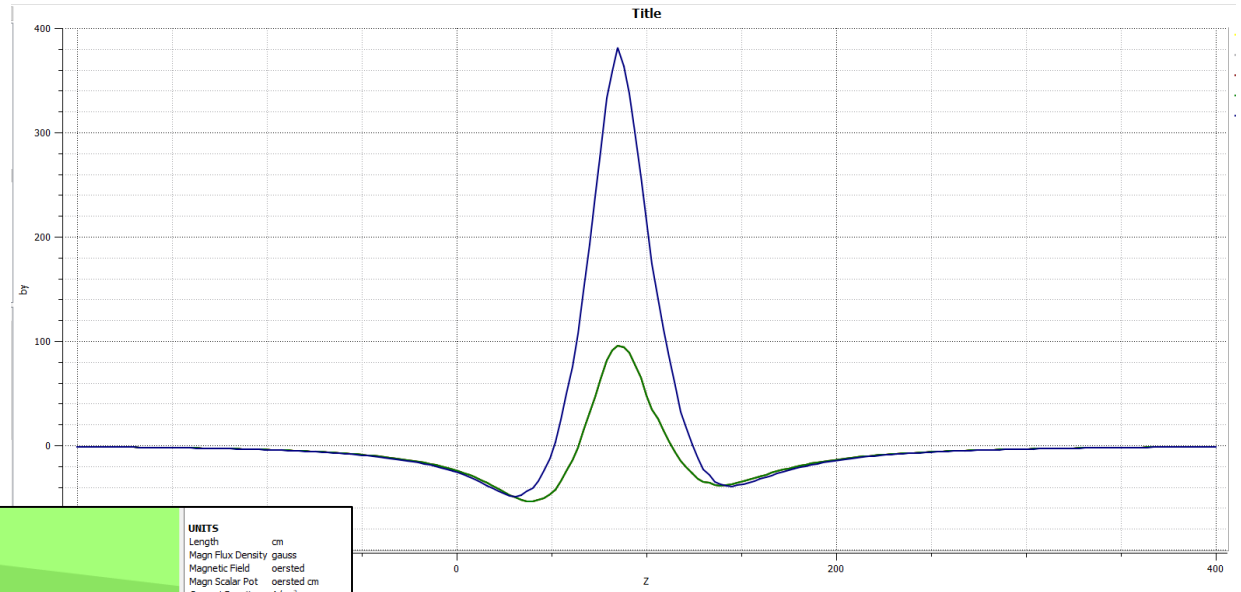
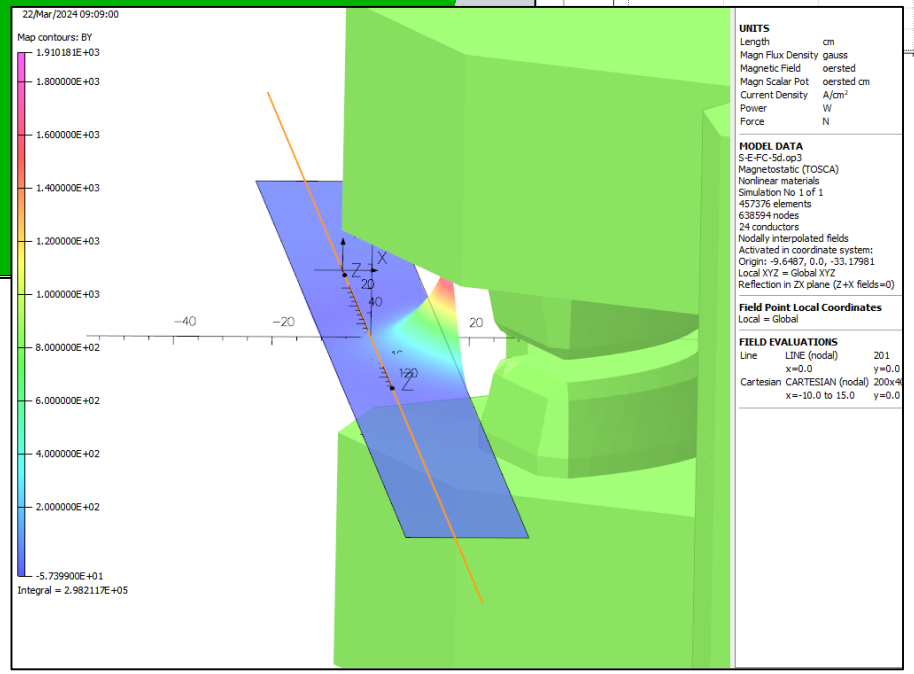
# Stray Field of ENGE Magnet

Use of Mu metal or carbon pipe to further reduce fields is being looked into




Integral By Field along beamline for a 0.5T central field is ~ 2,505 G.cm (2.5 mT.m)

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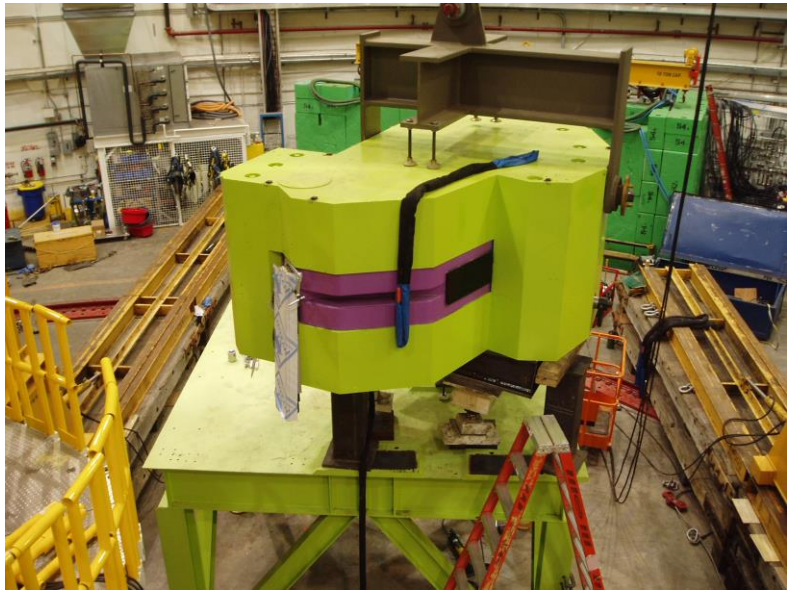
# Conclusion

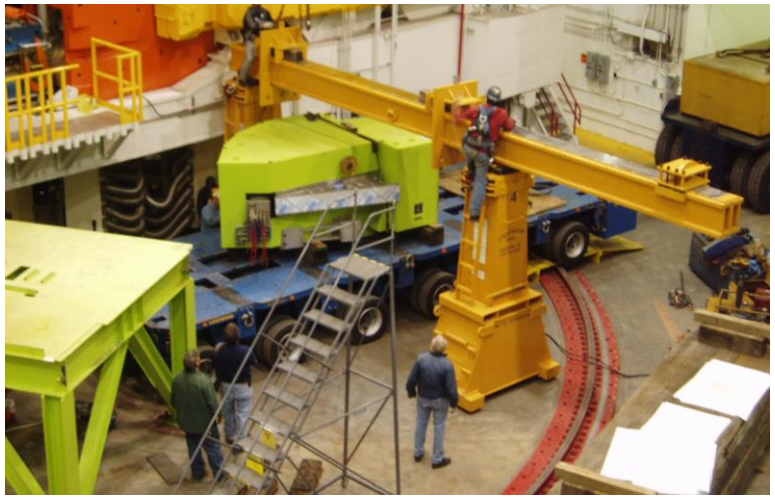
- Engineering and design work is progressing
- Power supplies sourcing is underway
- ENGE installation is under study and workable solutions are being formulated with backup plans
- Floor layout is being finalized.  HKS detector package is unchanged from previous Hall C running.
- Stray field calculations are underway – for beamline diagnostics and supports

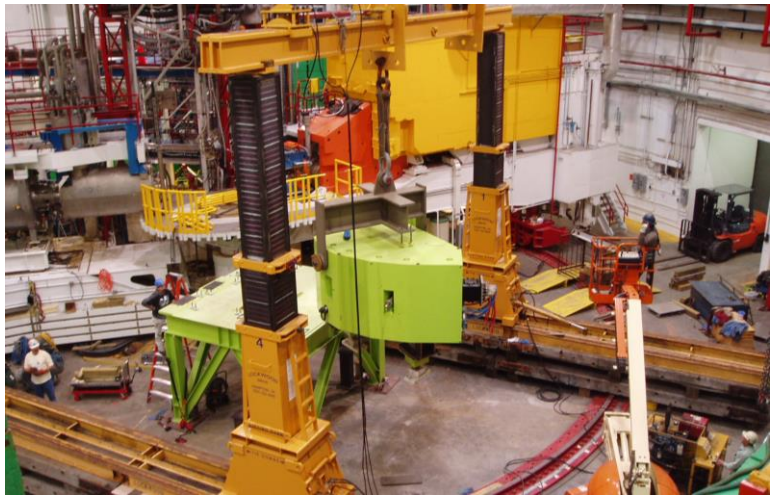
- Work still needing to be addressed:
- A common vacuum system with ENGE needs to be developed
- Target Chamber and target ladder: ENGE's view of the target is masked by target holder.
- PSUs Layout
- Cable layout
- Target chamber stand
- Cryoline supports
- Beamline components.

# Backup Slides

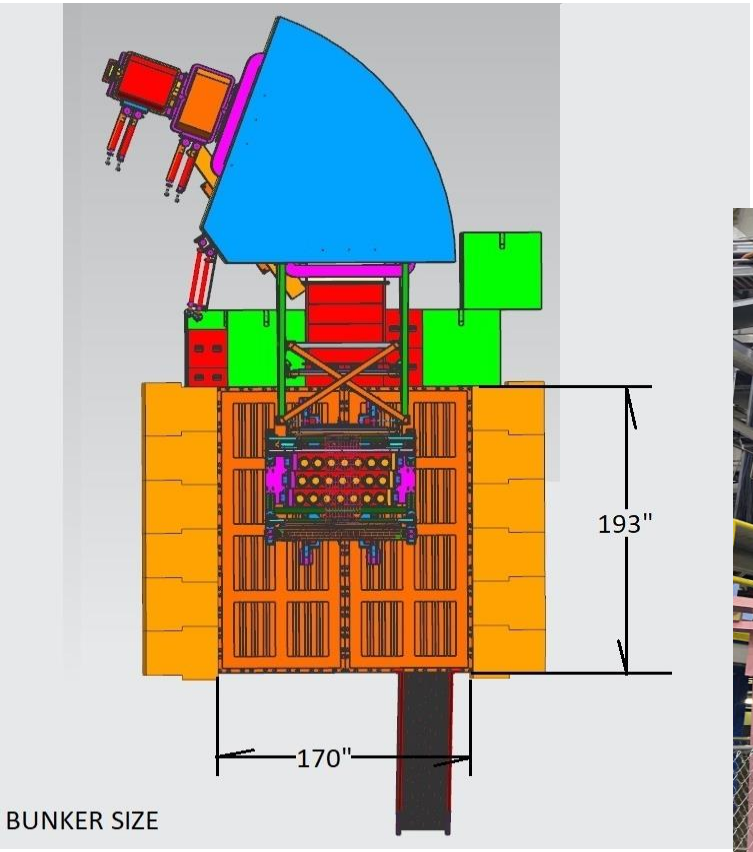
# ENGE from storage to Hall C







# HKS Detector Stands – no changes







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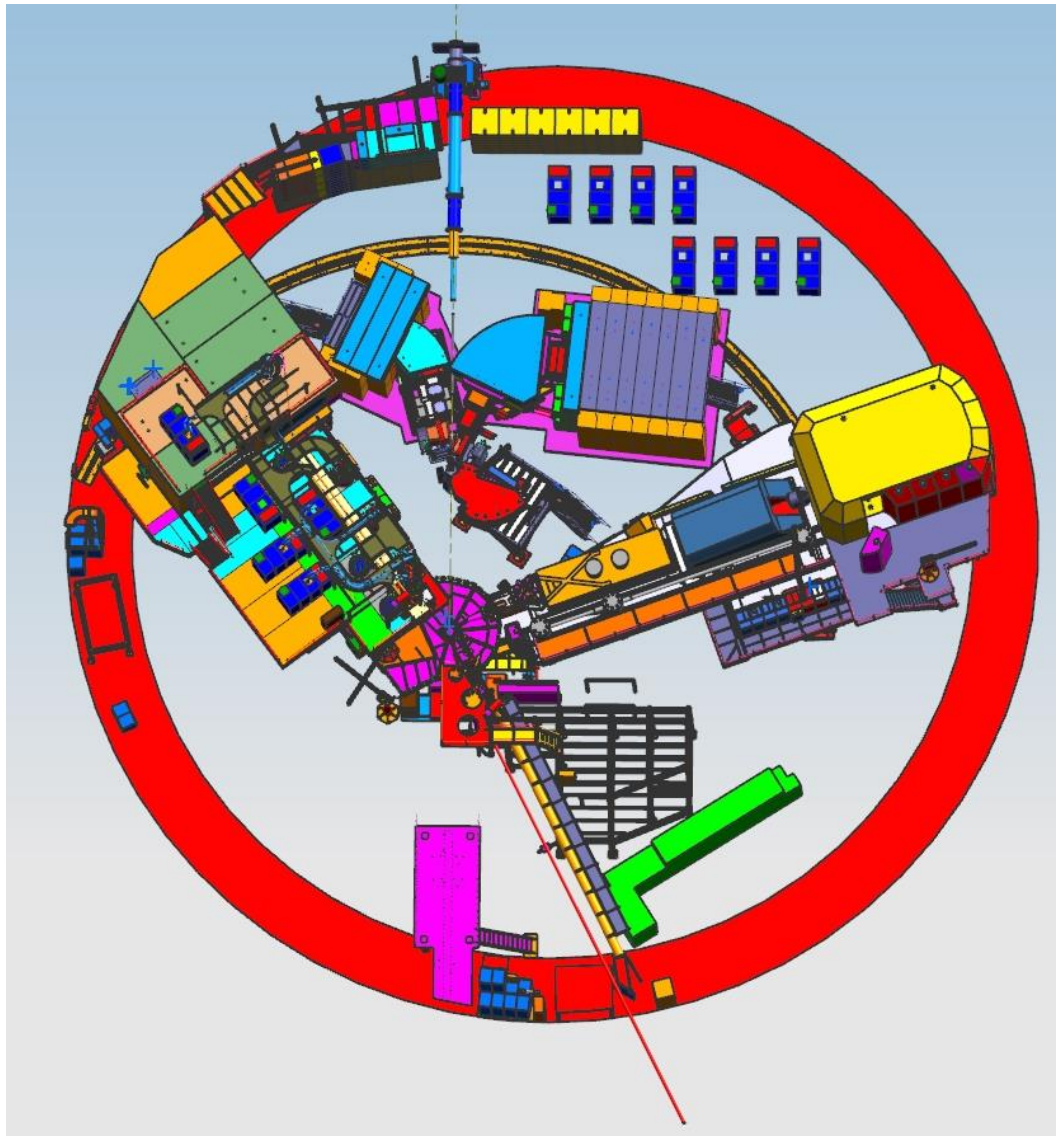

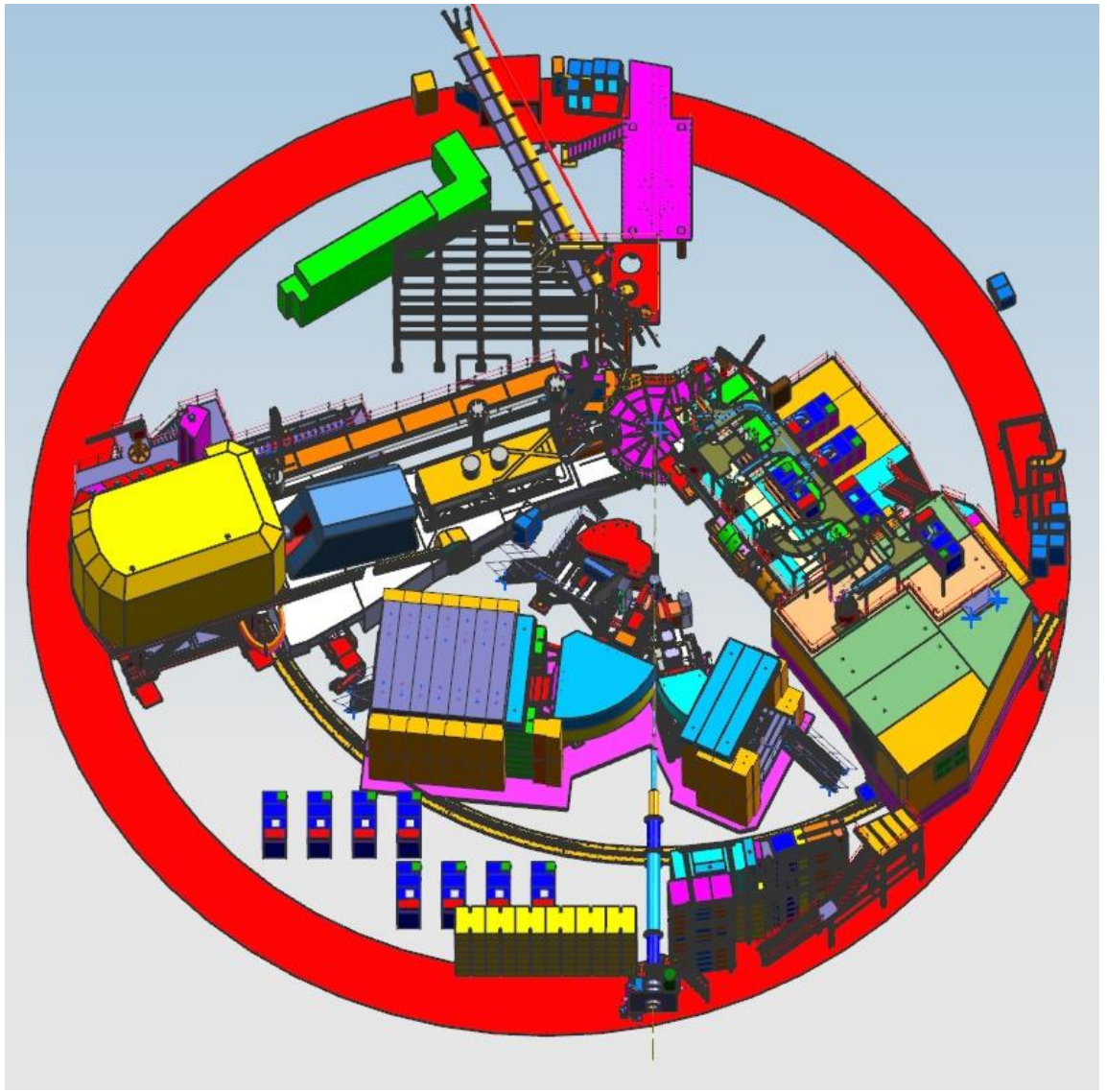

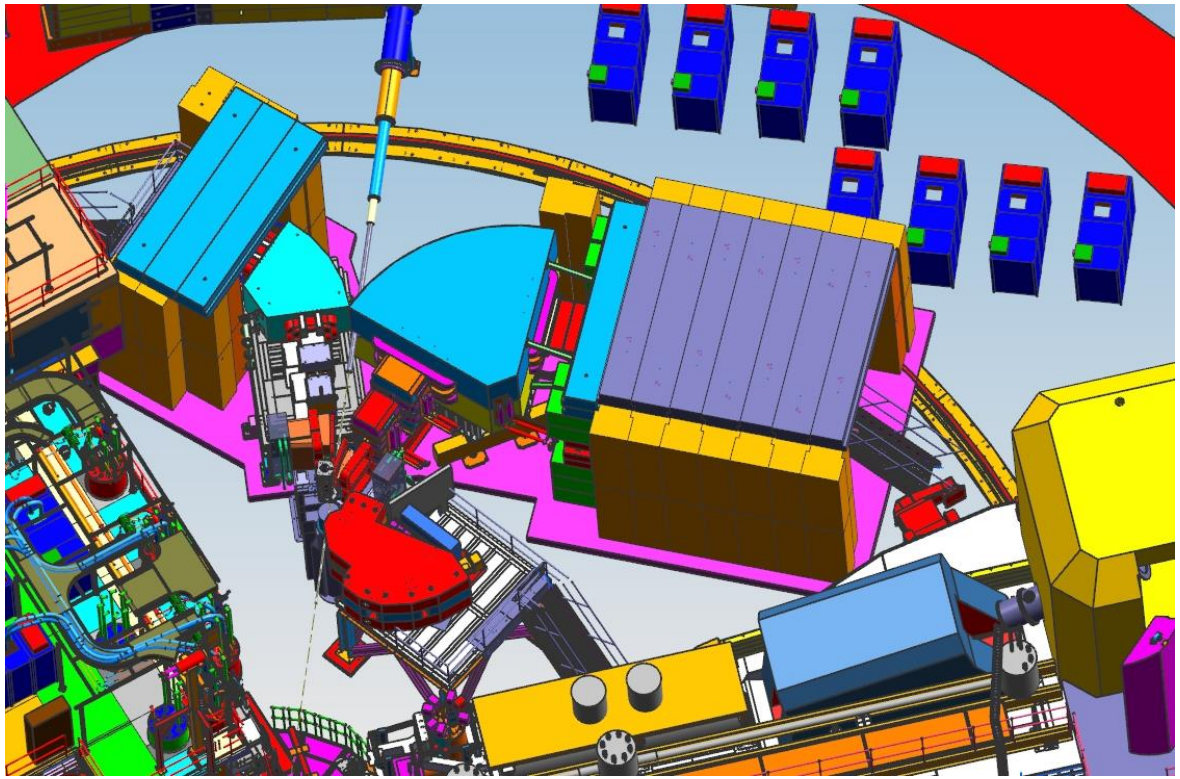

# 3D Models Available

- JT, STP files (JT are faster for viewing) (STP is for CAD use)
- You can install "CAD Assistant" on your Phone, or PC to view JT, STP files (free)
- Phone file download location its in the APP store “CAD Assistant”
- PC file download location https://www.opencascade.com/products/cad-assistant/
- Or use Jt2Go by Siemens Software (free) PC file download https://www.plm.automation.siemens.com/global/en/products/plm-components/jt2go.html
- JT files download location https://userweb.jlab.org/~metzger/HyperNuclear/

Jt2Go Website


CAD Assistant Website