

MEDSI 2016

MECHANICAL ENGINEERING DESIGN OF SYNCHROTRON
RADIATION EQUIPMENT AND INSTRUMENTATION

Large (Metre) Scale Positioning Systems for Imaging/Therapy Programs at BMIT @ CLS

Tomasz W. Wysokinski, PhD, PEng

(on behalf of the team)

- Canadian Light Source & BMIT Introduction
- BMIT's 05-ID-2 Beamline Specs
- Positioning stages for medium and large samples:

Goal: to develop a horse capable positioning system

- Space (Pits) requirements
- Design requirements
- Operational issues

WHERE: Saskatoon – the advantage of co-location



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University of
Saskatchewan

Canadian
Light Source

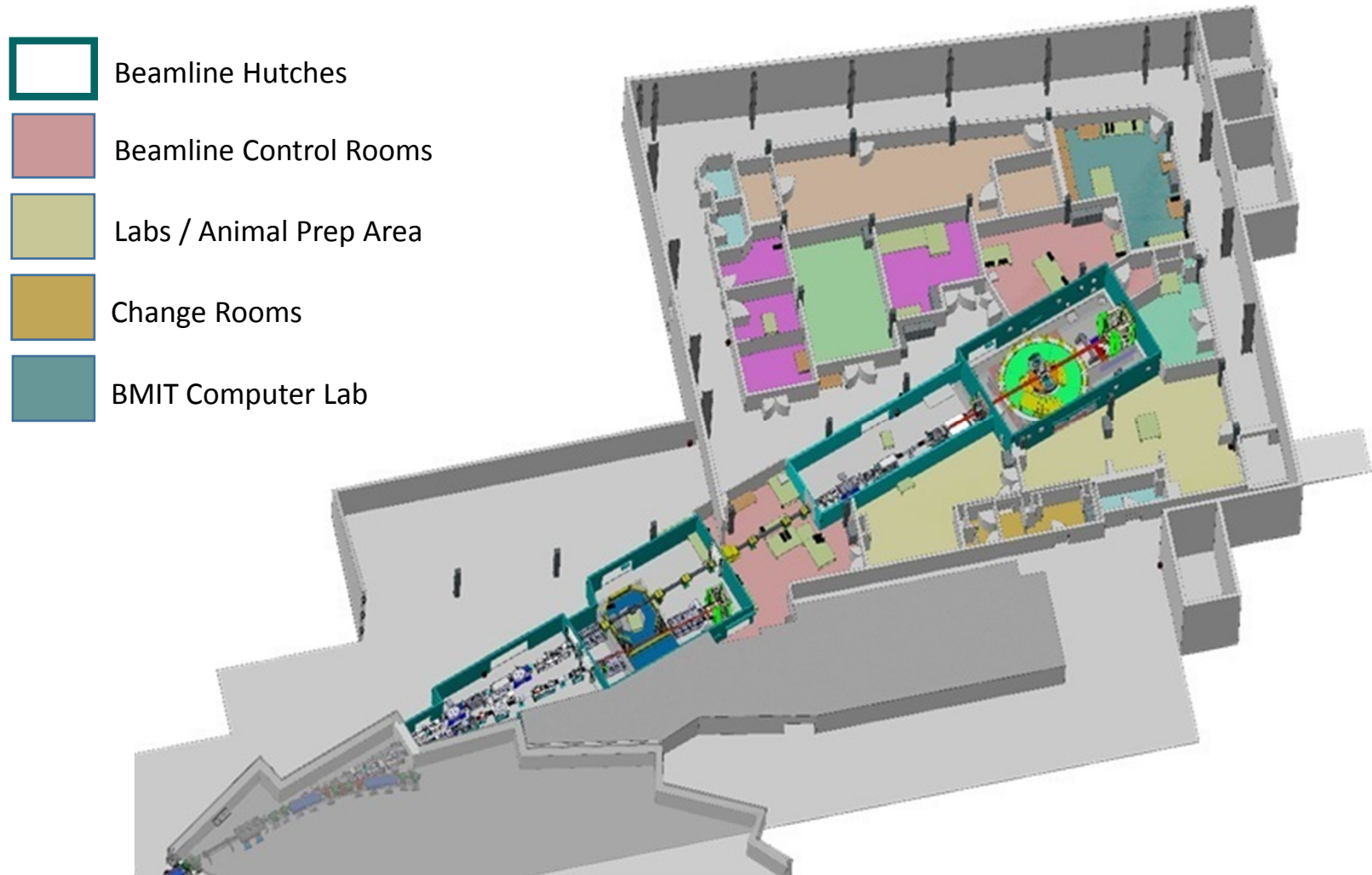


Canadian Light Source
Centre canadien de rayonnement synchrotron

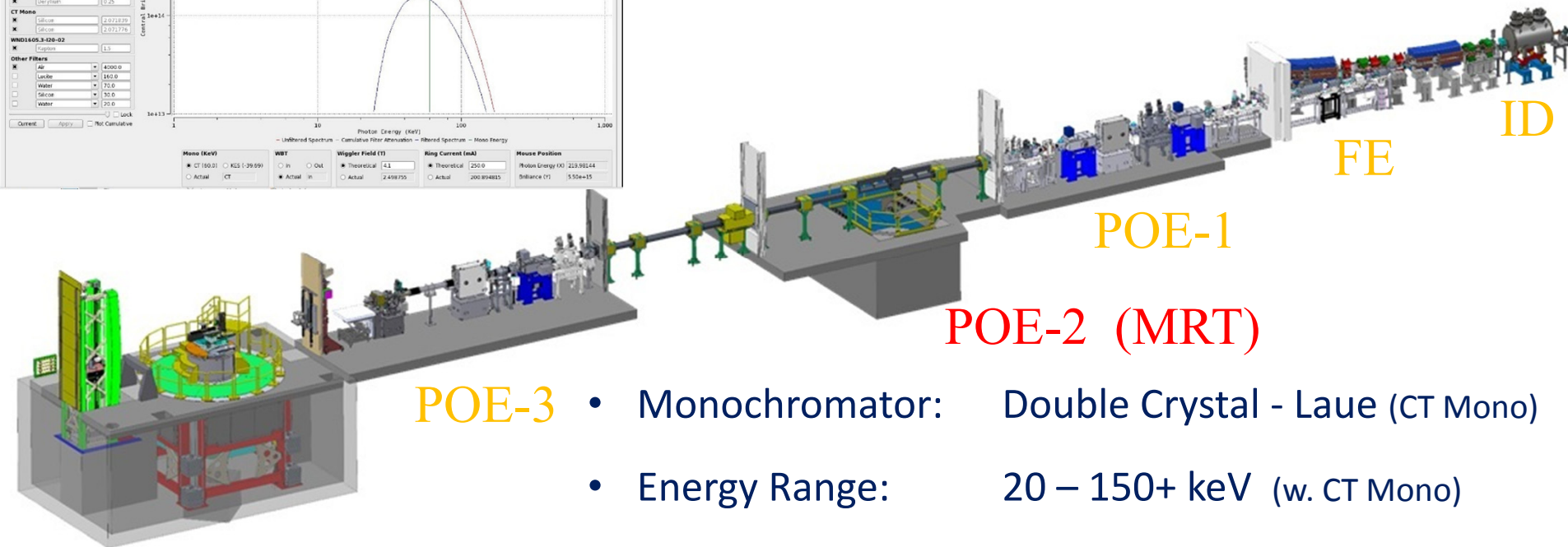
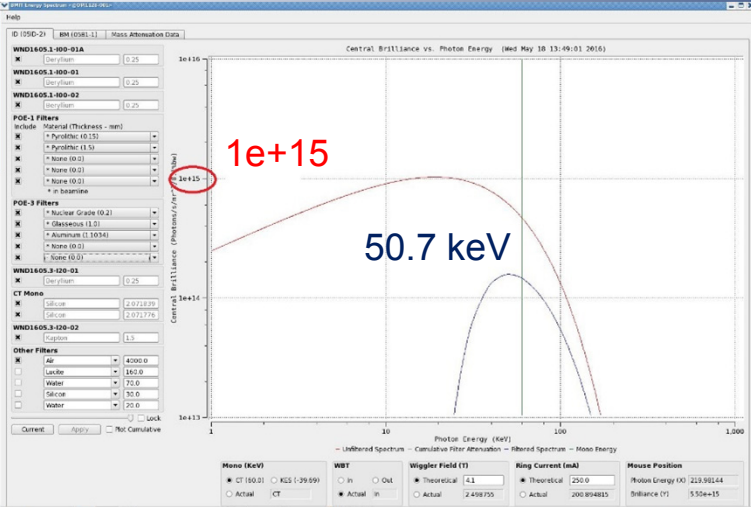
WHERE: Saskatoon – the advantage of co-location



BMIT Facility – Floor Plan



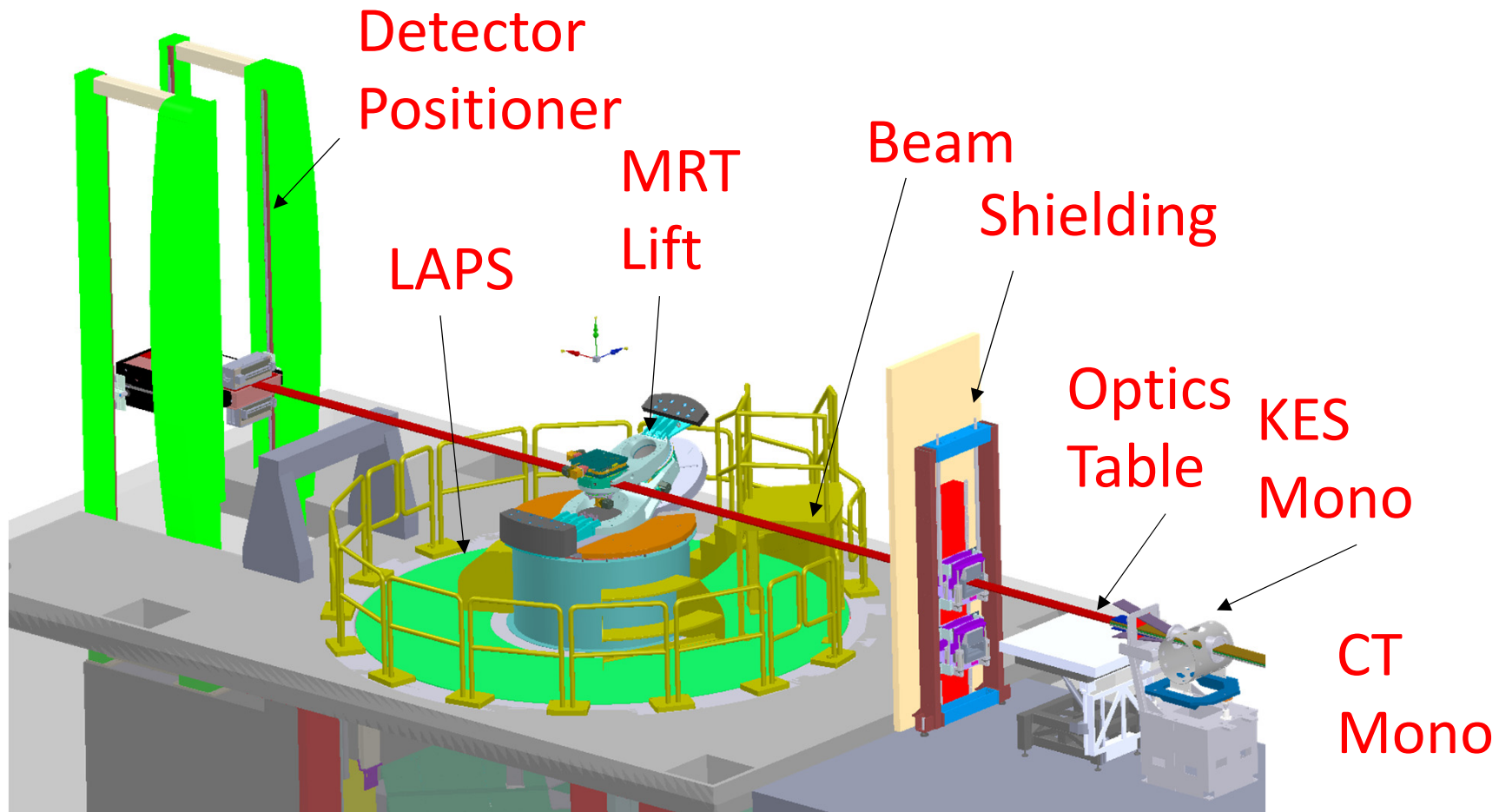
Insertion Device Beamline 05ID-2 Specs



- Monochromator: Double Crystal - Laue (CT Mono)
- Energy Range: 20 – 150+ keV (w. CT Mono)
- Resolution limit: $b_h \sim 4 \mu\text{m}$, $b_v \sim 0.5 \mu\text{m}$ @ 55m
- Max. dose rate: (2.9 GeV, 250 mA, 4.1T)
 - $\sim 1260 \text{ Gy/s}$, peak @ 76 keV (using pink beam)
 - $\sim 5 \text{ Gy/s}$ at 50 keV (mono beam)



BMIT Facility – Main Stages



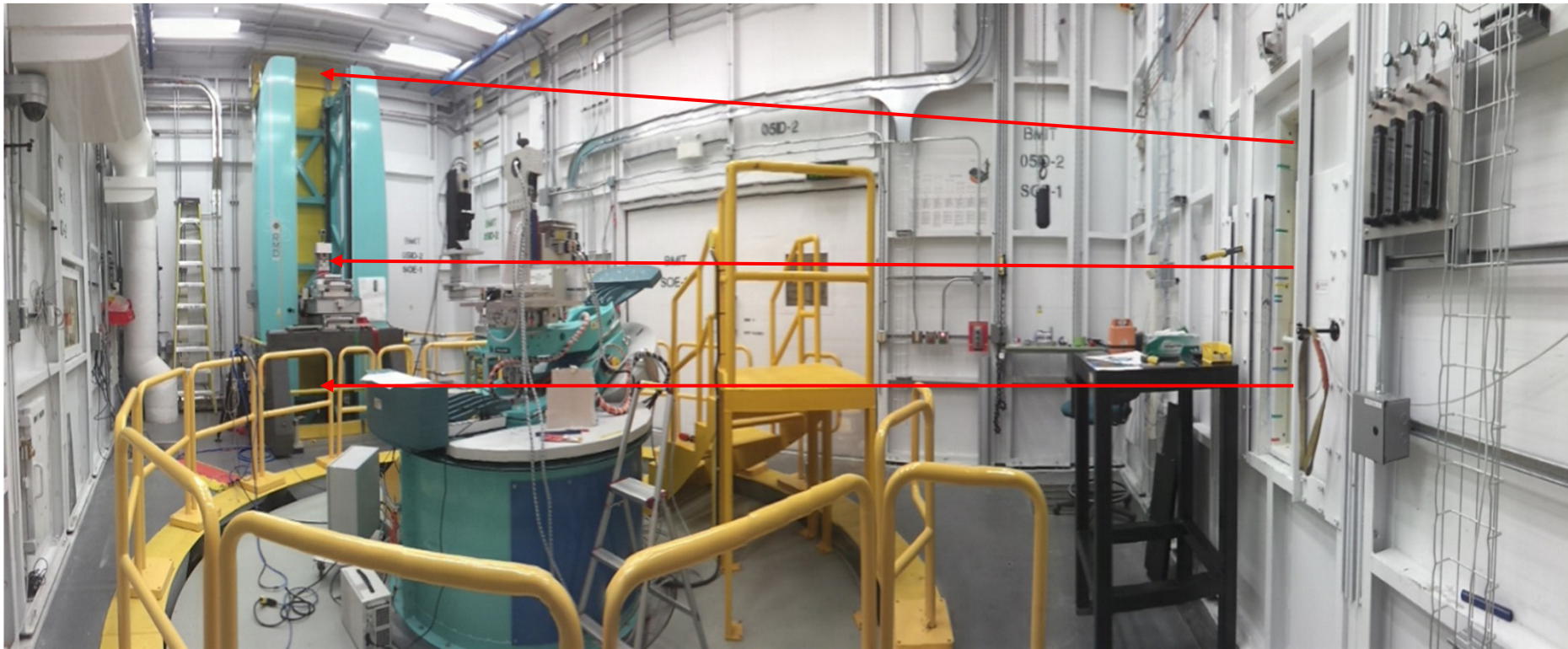
05ID-2 / SOE-1 Endstation Basement - Pit



2010-09-23

Tomasz W. Wysokinski

SOE-1 Hutch Panoramic View



POE-3

SOE-1



1.0 m
(V)

Up 13°

Down 7.5°

4.8 m
(V)

2.7 m
(V)

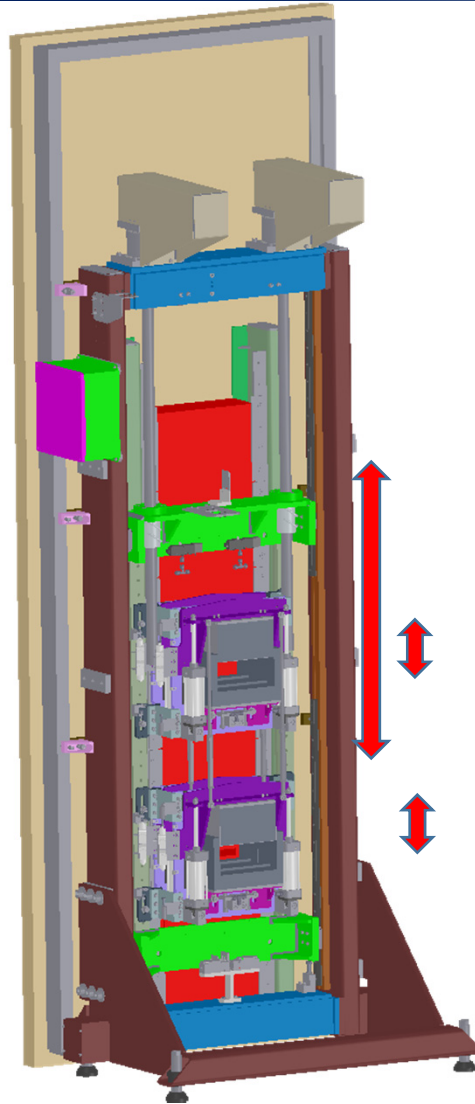
ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED	1 = 40° LUMEN CUT-OFF 22 = 40° LUMEN CUT-OFF 300 = 40° LUMEN CUT-OFF MEASUREMENT - 40° LUMEN CUT-OFF	2 = 40° LUMEN CUT-OFF 22 = 40° LUMEN CUT-OFF 300 = 40° LUMEN CUT-OFF MEASUREMENT - 40° LUMEN CUT-OFF	3 = 40° LUMEN CUT-OFF 22 = 40° LUMEN CUT-OFF 300 = 40° LUMEN CUT-OFF MEASUREMENT - 40° LUMEN CUT-OFF
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DATE	03/01/2015
PROJECT	CCLS
CLIENT	CCLS
PROJECT NO.	05D-2/ME/SF/0171550
SCALE	1:50
BY	ME
CHECKED BY	ME
APPROVED BY	ME

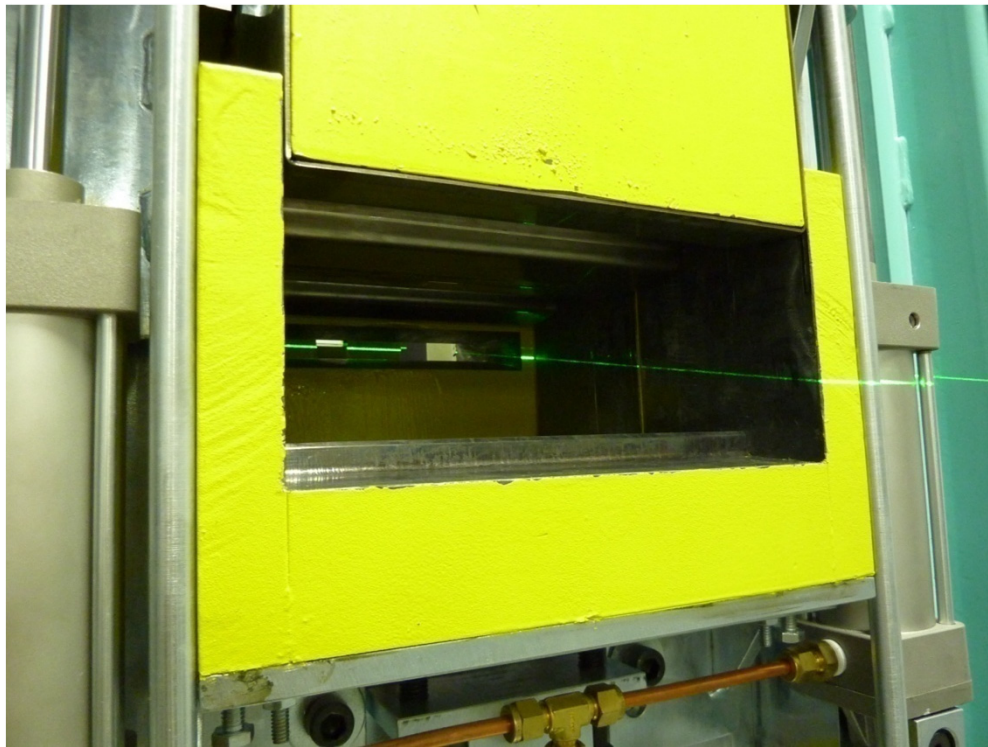
BMIT SOE
RADIATION RANGE

Moveable Shielding / Shutter Unit

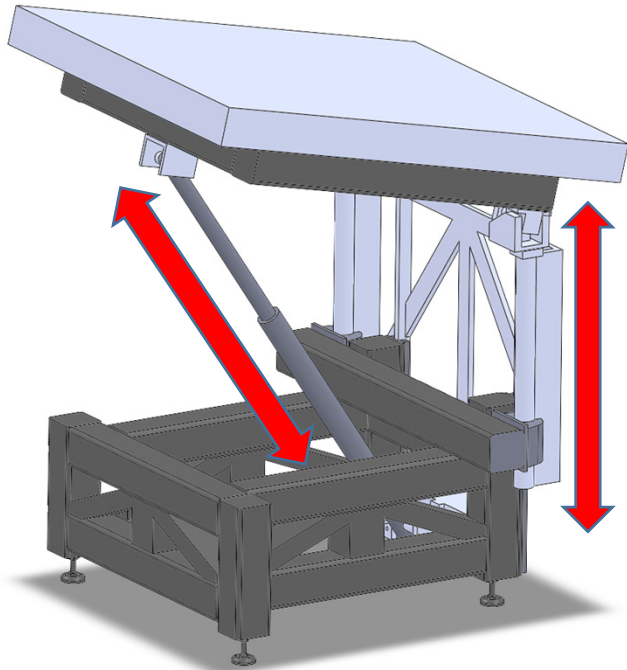


PARAMETER	VALUES
Total Mass	2650 kg (5850 lb)
Mass of moving structure	2030 kg (4475 lb)
Vertical translation stage travel range	679 mm
Travel velocity	Up to 1.33 mm/second
Resolution (V)	20 μ m

POE-3 Moveable Shielding/Shutter Unit

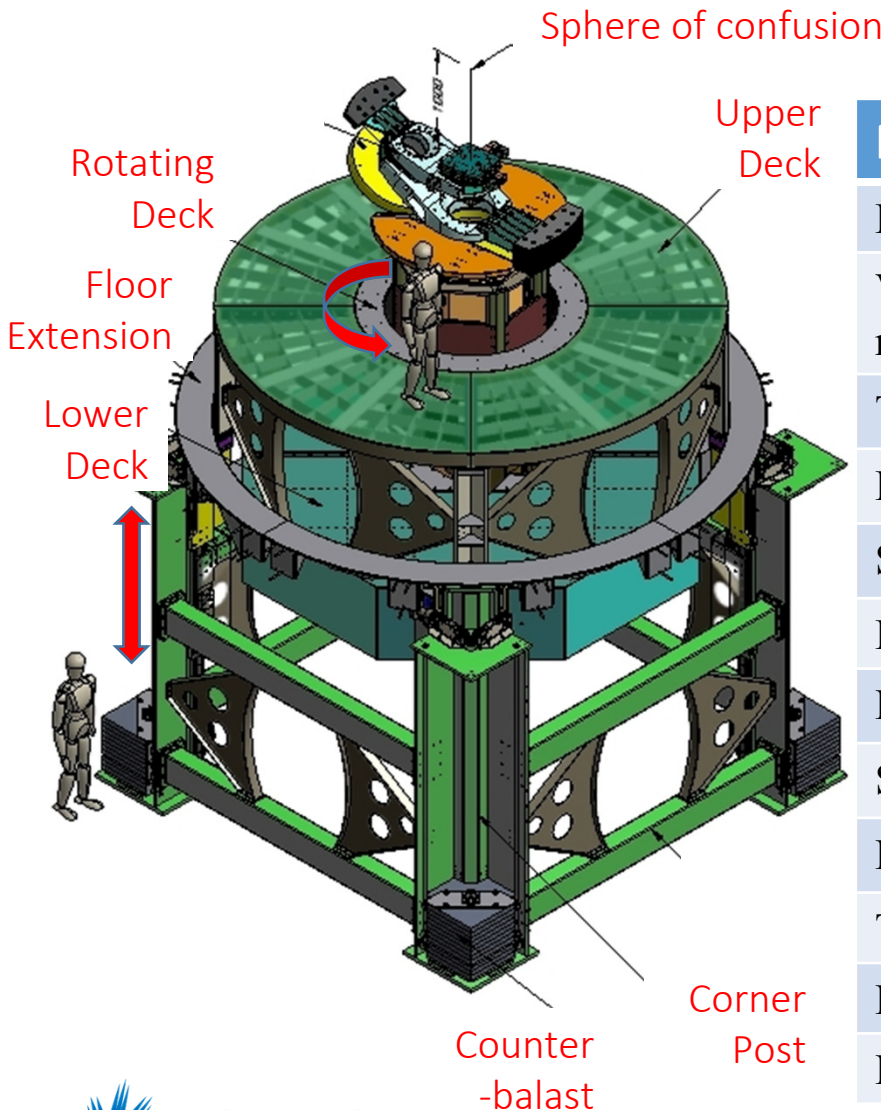


Optics Table



PARAMETER	VALUES
Total Mass	280 kg
Mass of moving structure	100 kg
Vertical translation stage travel range	0 to 240 mm
Travel velocity	Up to 1.33 mm/second
Resolution (V)	20 μ m
Angular range	-8° to +13°
Table Size	200 mm x 1000 mm x 970mm

Large Animal Positioning System



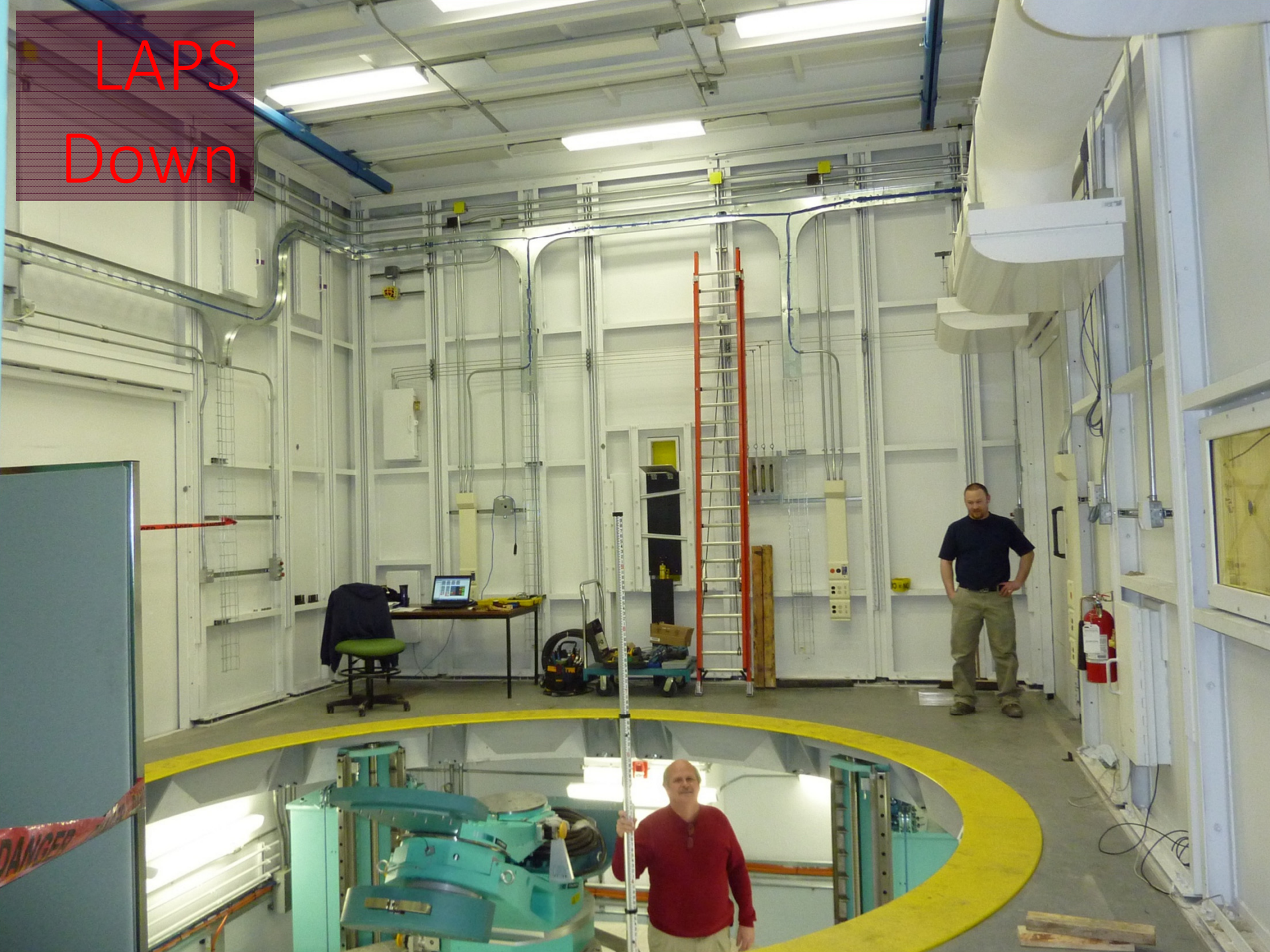
PARAMETER	VALUES
Rated Vertical Load	120 kg (265 lb)
Vertical translation stage travel range	2715 mm
Travel velocity (V)	Up to 200 mm/second
Positional accuracy	100 microns (0.0039")
Speed stability	<1% error over 300 mm
Rotational velocity	Up to 30 RPM
Mass of moving structure	~ 7937 kg (~17,500 lbs)
Specimen load	~907 kg (2,000 lb)
Mass of support structure	~ 8618 kg (~19,000 lbs)
Top platform Diameter	4620 mm
Max height	5197 mm
Min height	2497 mm



Large Animal Positioning System – installation, November 2009



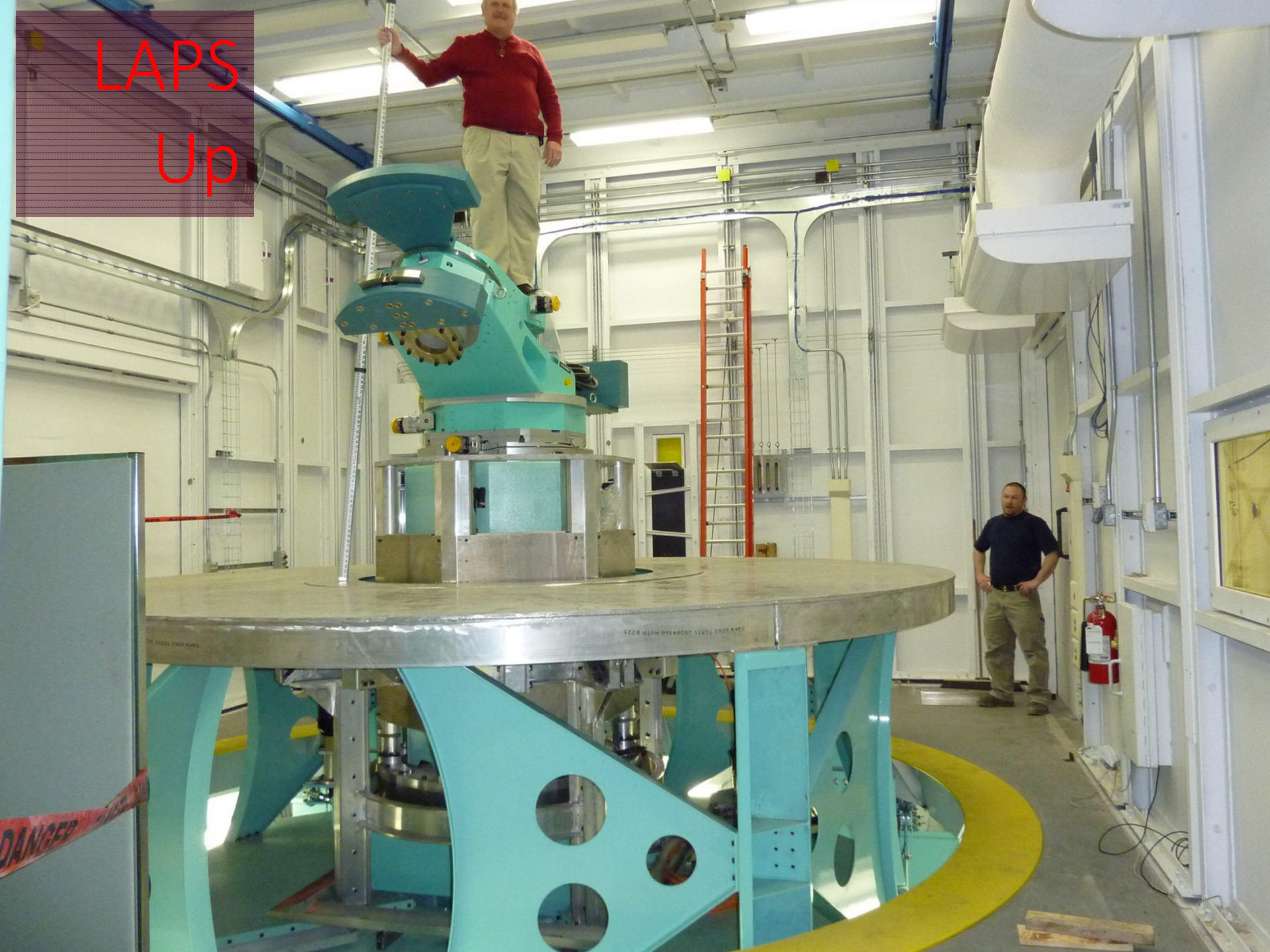
LAPS
Down



LAPS
Neutral



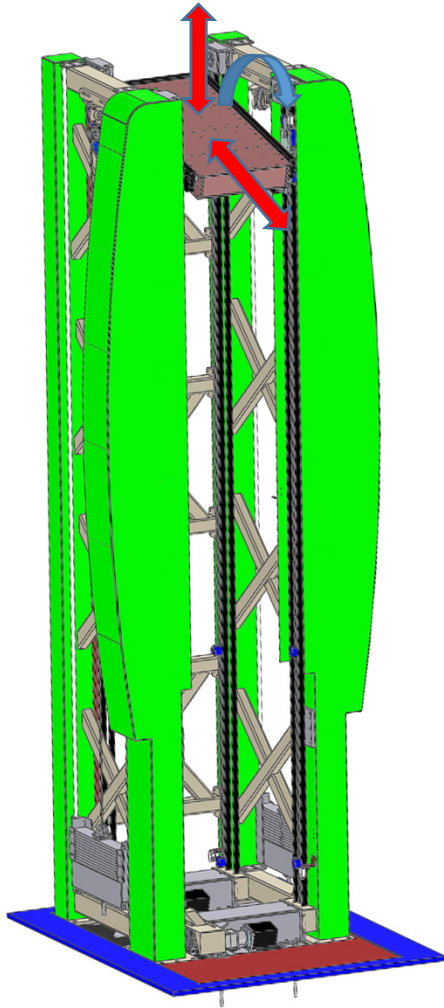
LAPS
Up



LAPS with MRT Lift

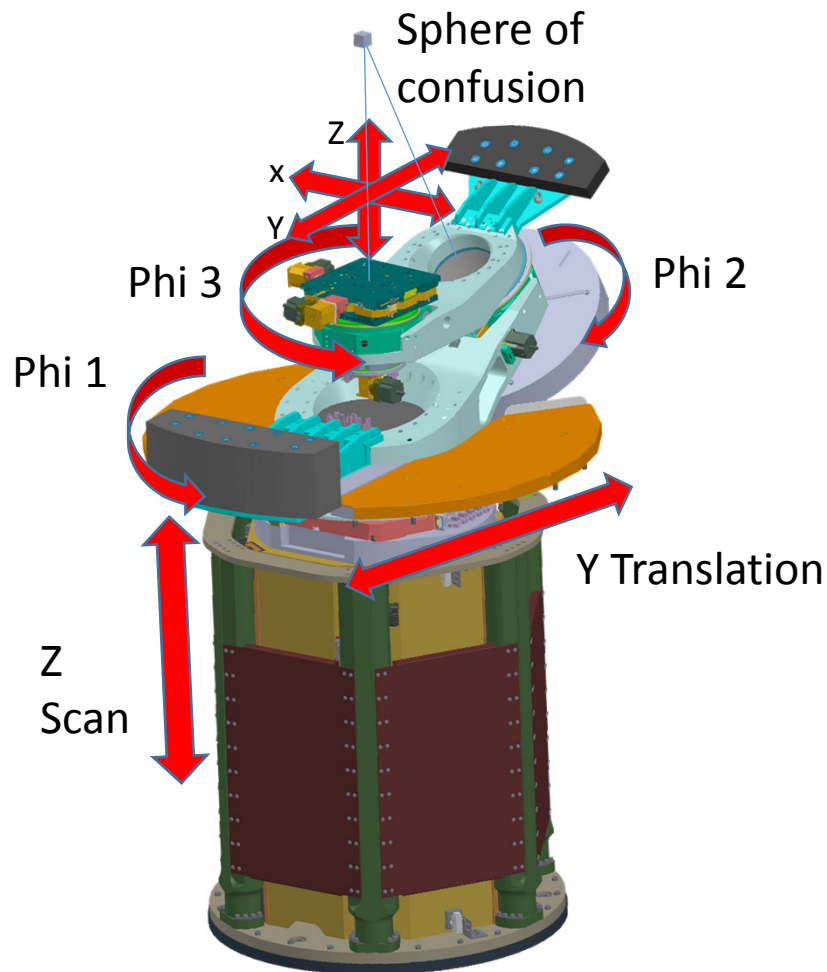


Detector Positioner - specs



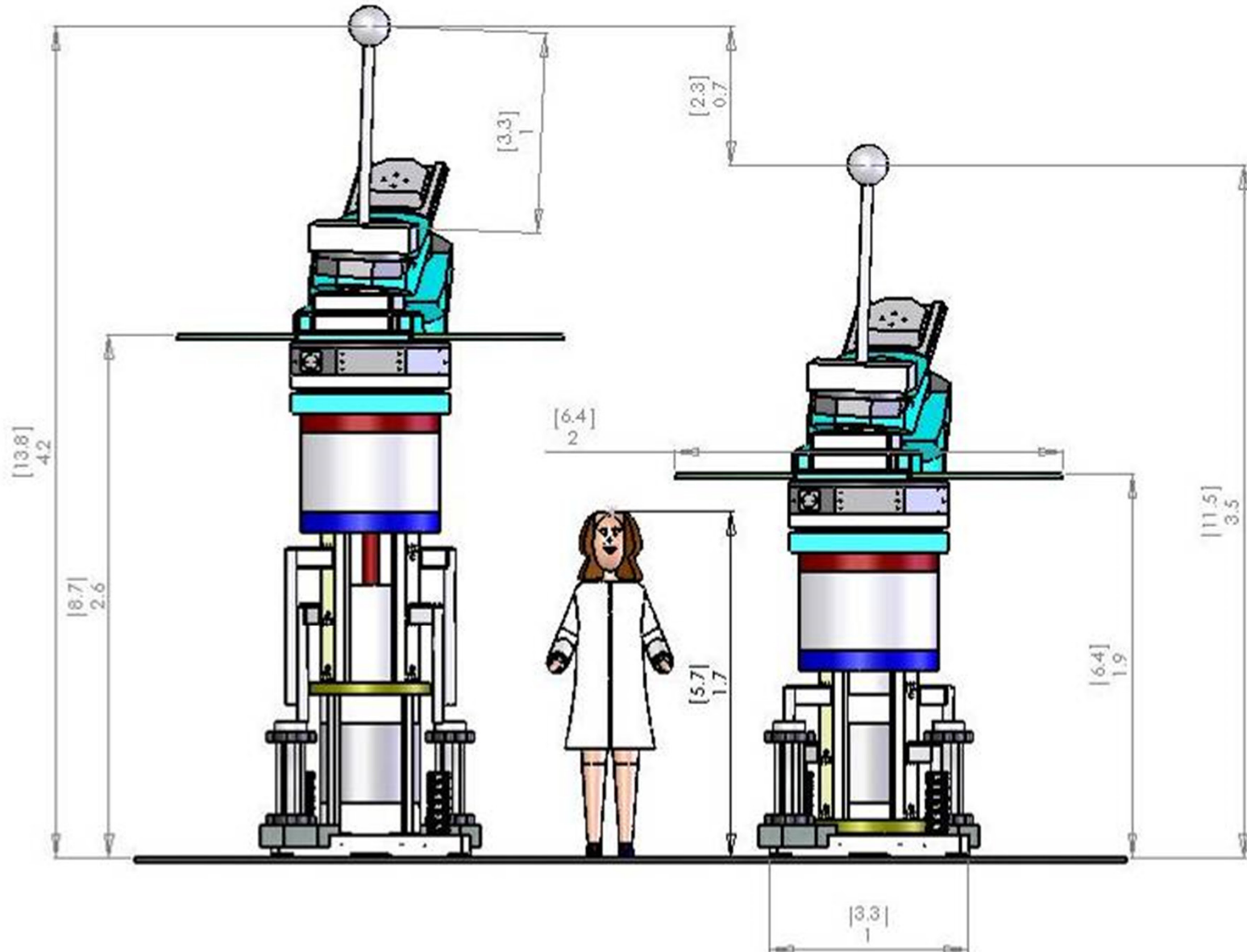
PARAMETER	VALUES
Load Capacity	320 kg (700 lbs)
Total Mass	4030 kg (8880 lb)
Mass of moving structure (table)	290 kg (640 lb)
Vertical travel range	4922 mm
Horizontal Travel Range	759 mm
Travel velocity (V)	Up to 192 mm/second
Detector Table size	680 mm Wide 1420 mm Deep
Resolution (V)	0.8 μm
Platform angle range	+ 8 °/ - 13 ° (KES)

MRT Lift - Specs



PARAMETER	VALUES
Rated Vertical Load	120 kg (265 lb)
Vertical translation stage travel range	700 mm
Horizontal translation stage range	+/- 50 mm
Goniometer Ranges (Phi 1)	N*360°
Maximum Height at lowest position	2600 mm
Maximum Weight:	2500 kg (5511 lb)
Kappa Angle	30°
X,Y sample stage range	+/- 50 mm
Z sample stage range	+/- 25 mm
Sample height above the positioning system (sphere of confusion)	1000 mm
Maximum Speed Z_{SCAN}	200 mm/s
Dynamic Stability ($\Delta y / \Delta z$) @ Z scanning speed	5 μm / 1 mm
Positional Repeatability	25 μm
Working radius	< 2500 mm

MRT Lift - Large Machine



MRT Lift - Access Issues

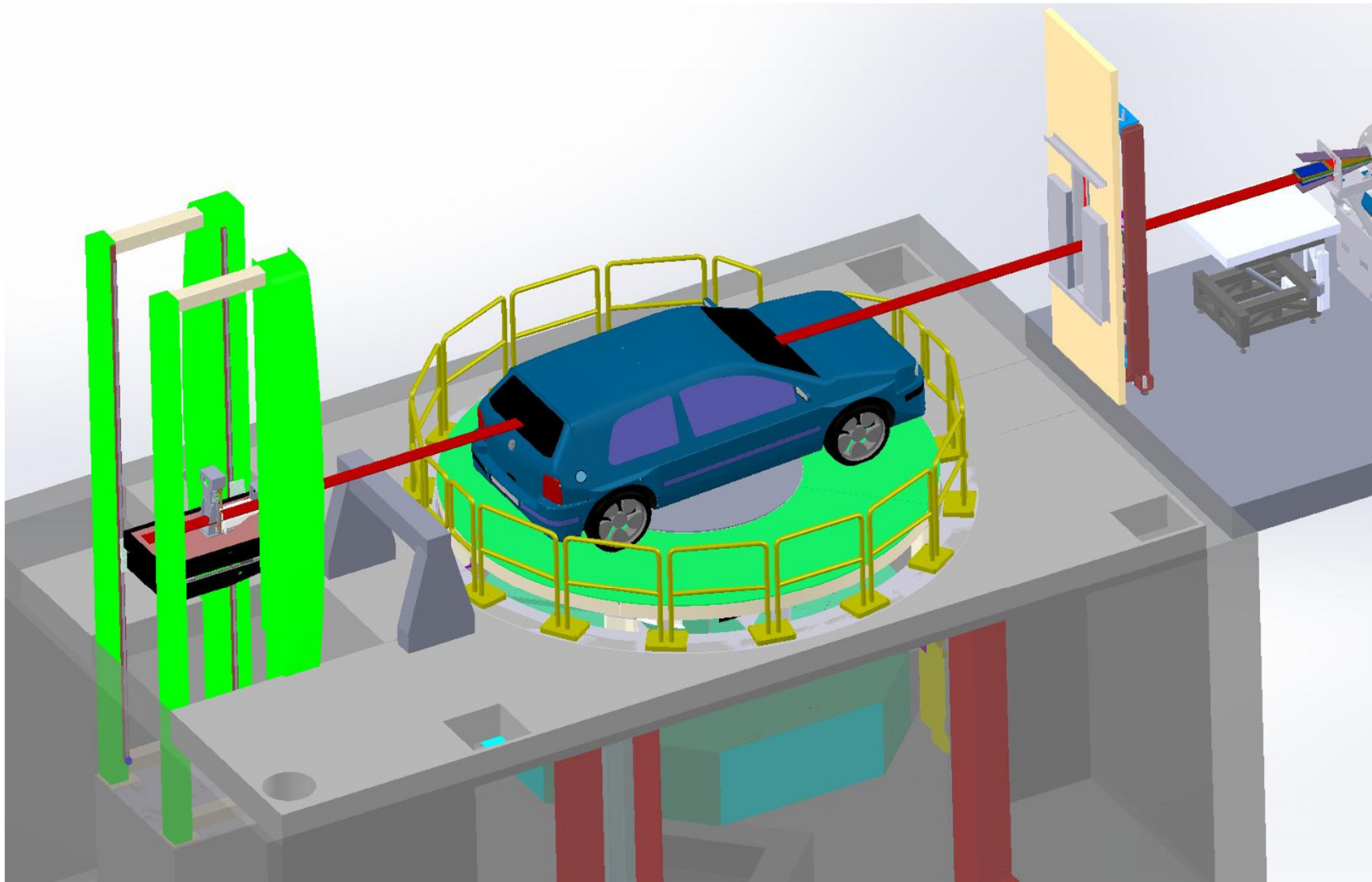
- Special steps required for sample loading
- Limited options for barriers
- Support based on the buddy system



MRT Lift – setup for *in-vivo* tests



LAPS – compact car capable (~100 hp)



Acknowledgements

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Loken Engineering, Canada
KOHZU

European Synchrotron Radiation Facility

Michel Renier

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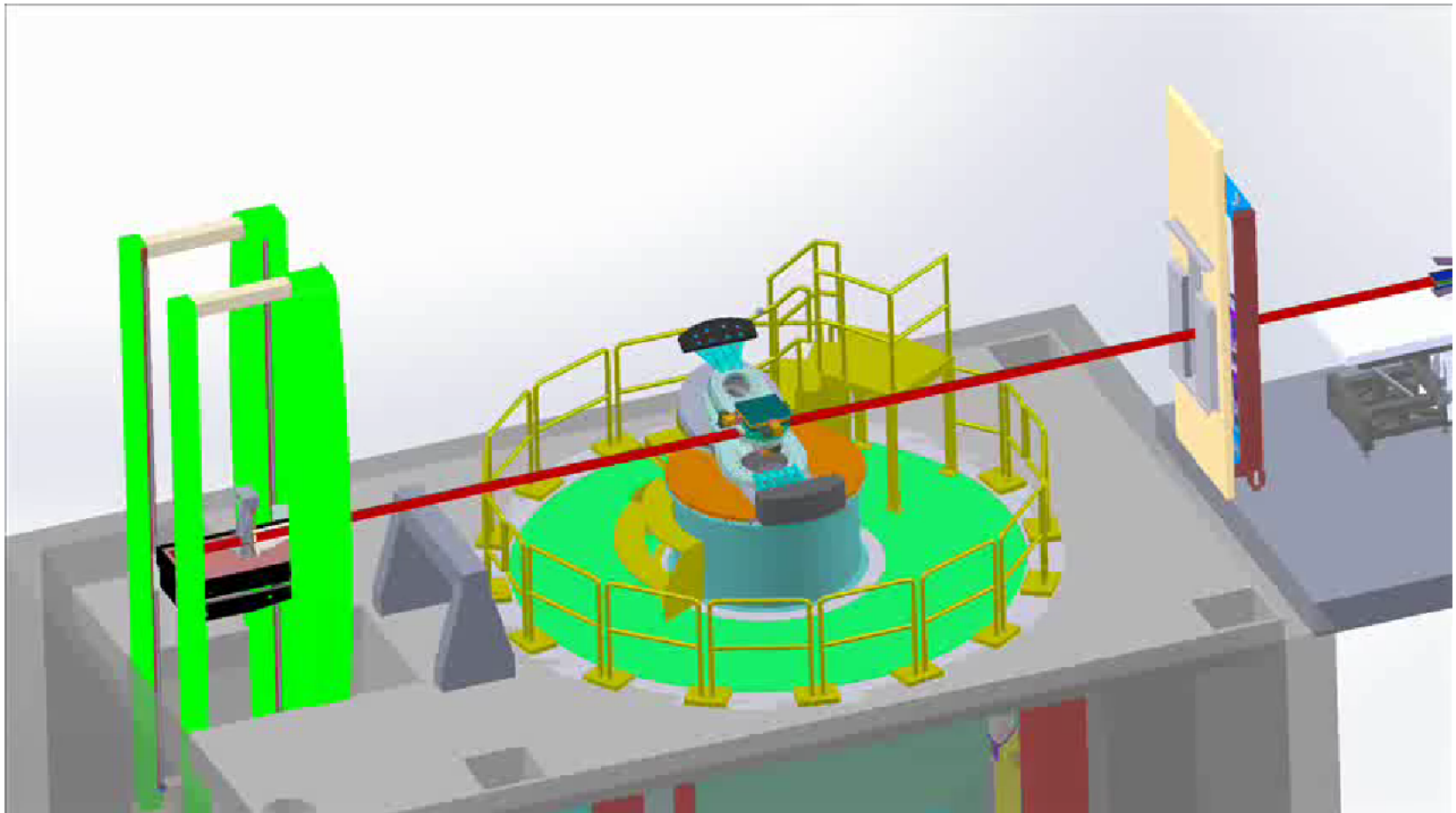
www.lightsource.ca/bmit

<http://twitter.com/05ID2>

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<http://www.youtube.com/05ID2>

Alignment modelling - issues



Tomo m-MRT

