

A Brief History of FTS-LR Motion

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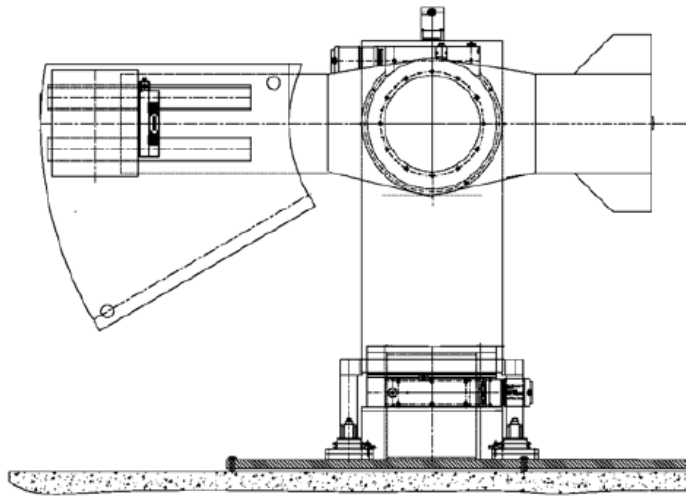
QIKR Instrument Scientist

QIKR Motion Preliminary Design Review

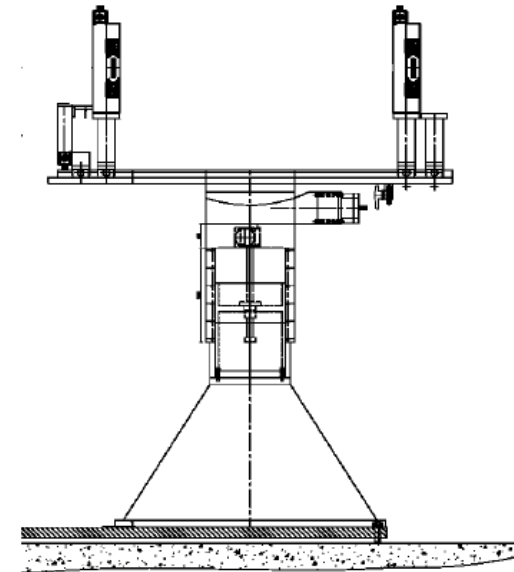
November 6, 2024

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

Original JJ-Xray design circa 2005

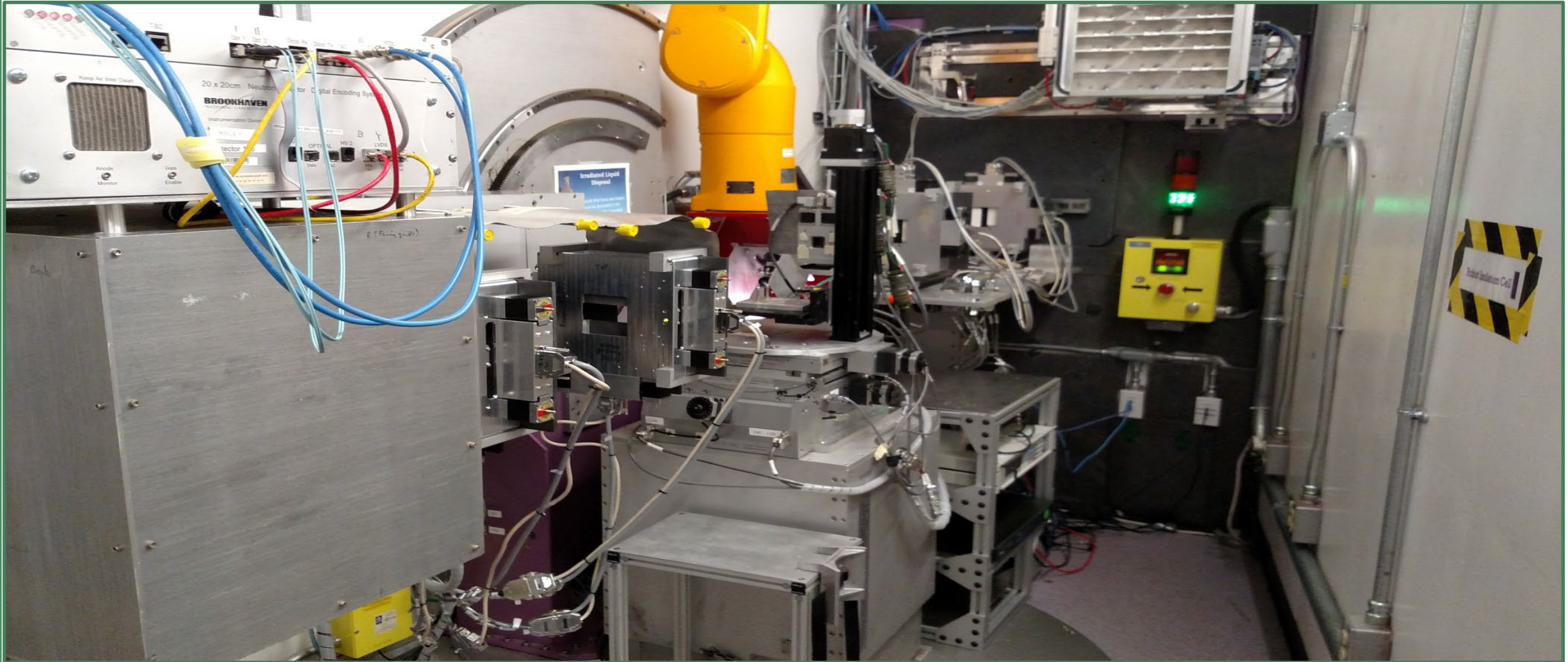


Capacity
140 kg @ 1.5 m

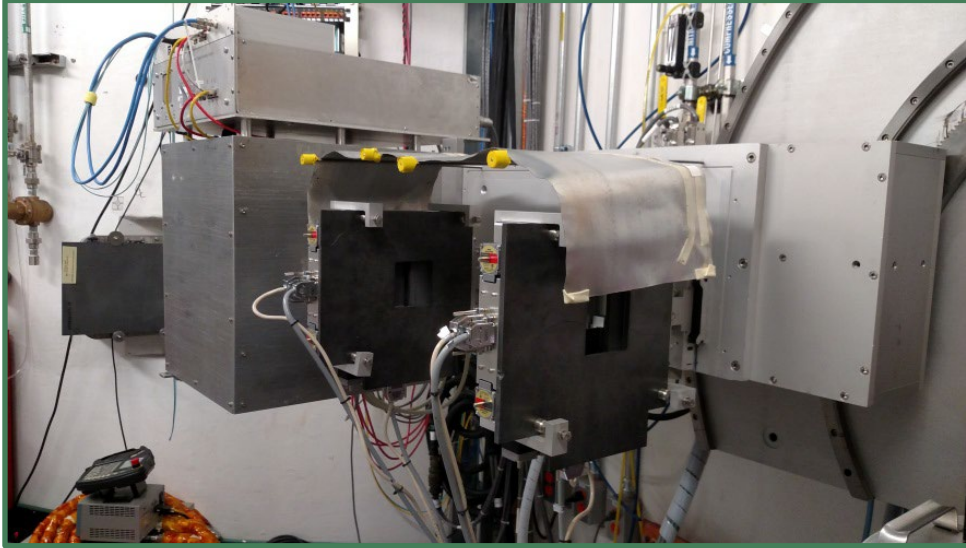


Capacity
75 kg, centered

Incident, Sample, and Detector

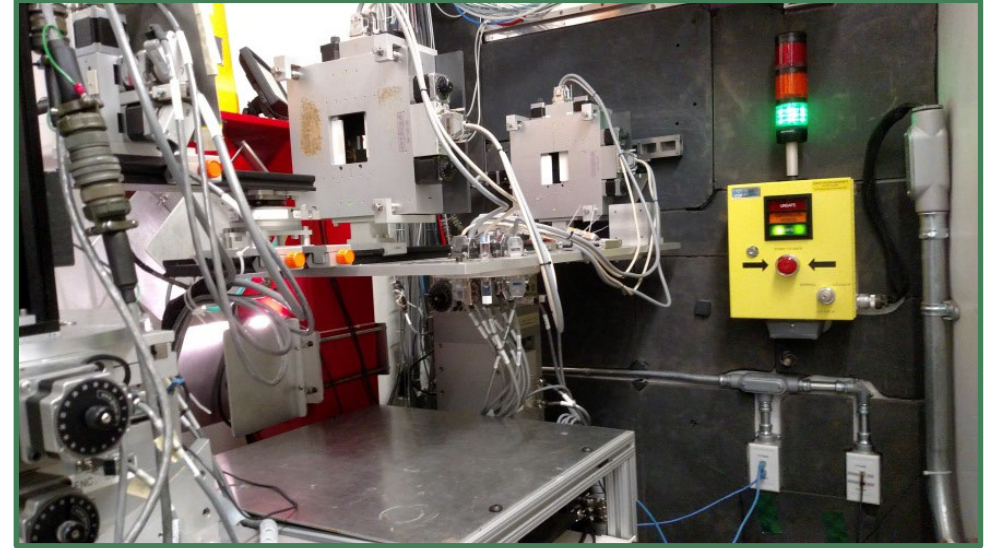


Motion components circa 2017...and issues



Detector Arm

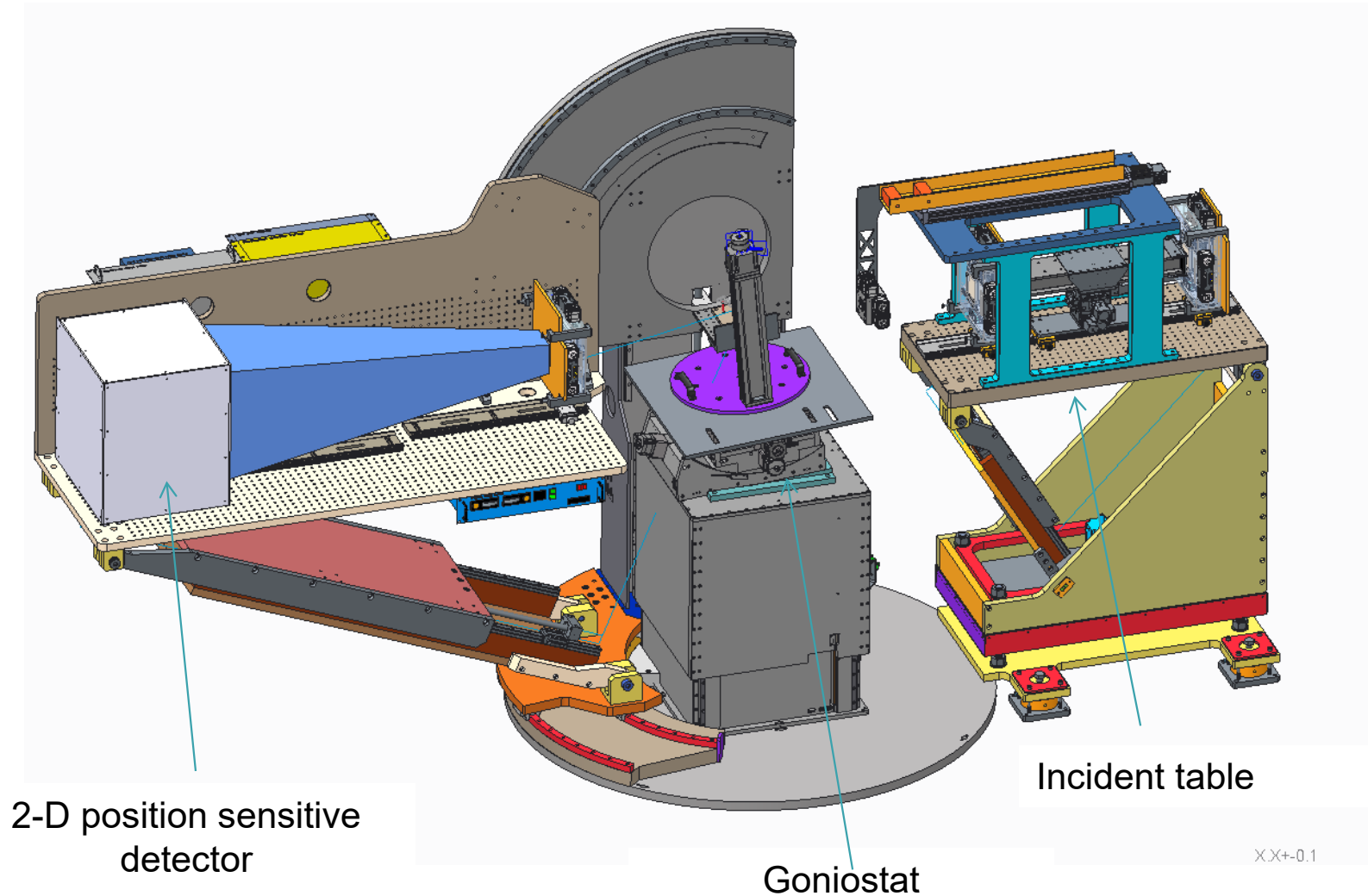
- Near weight capacity
- Rack-and-pinion system for $2\theta_d$ – large torque through small radius
- Arm flex requires motor wait intervals for settling $2\theta_d$ during alignment and data collection



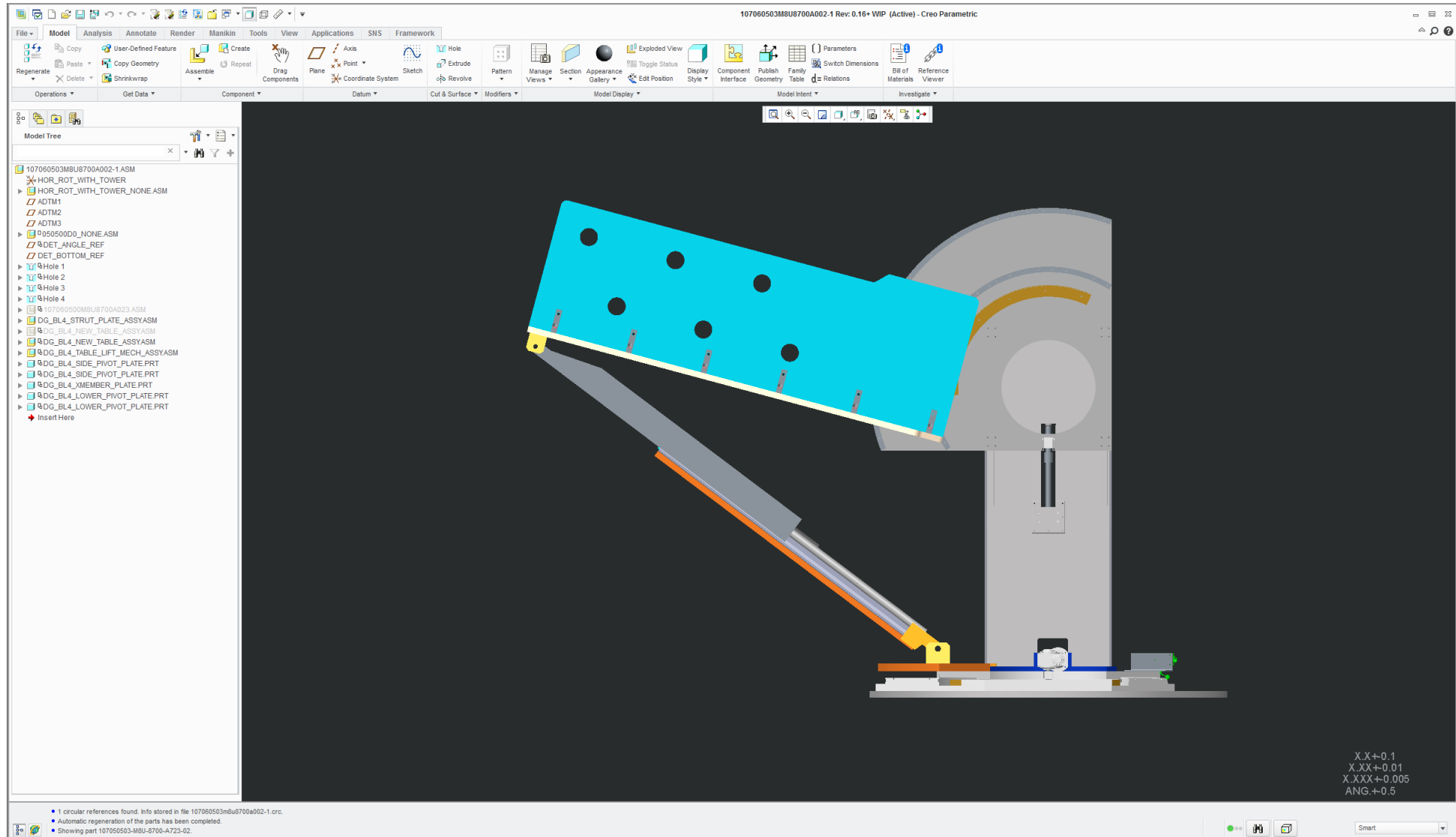
Incident Table

- At weight capacity
- Angle θ_i motion driven from narrow center arc stage
- Slits cantilevered off-center – θ_i can bind
- Component re-positioning necessitates frequent re-alignment

Proposed upgrade 2017-18



IT and DA change angle by linear motion



X.X+0.1
X.XX+0.01
X.XXX+0.005
ANG.+0.5

1 circular references found. Info stored in file 107060503m8u8700a002-1.crc.
Automatic regeneration of the parts has been completed.
Showing part 107050503-M8U-8700-A723-02.

Incident Table virtual motor

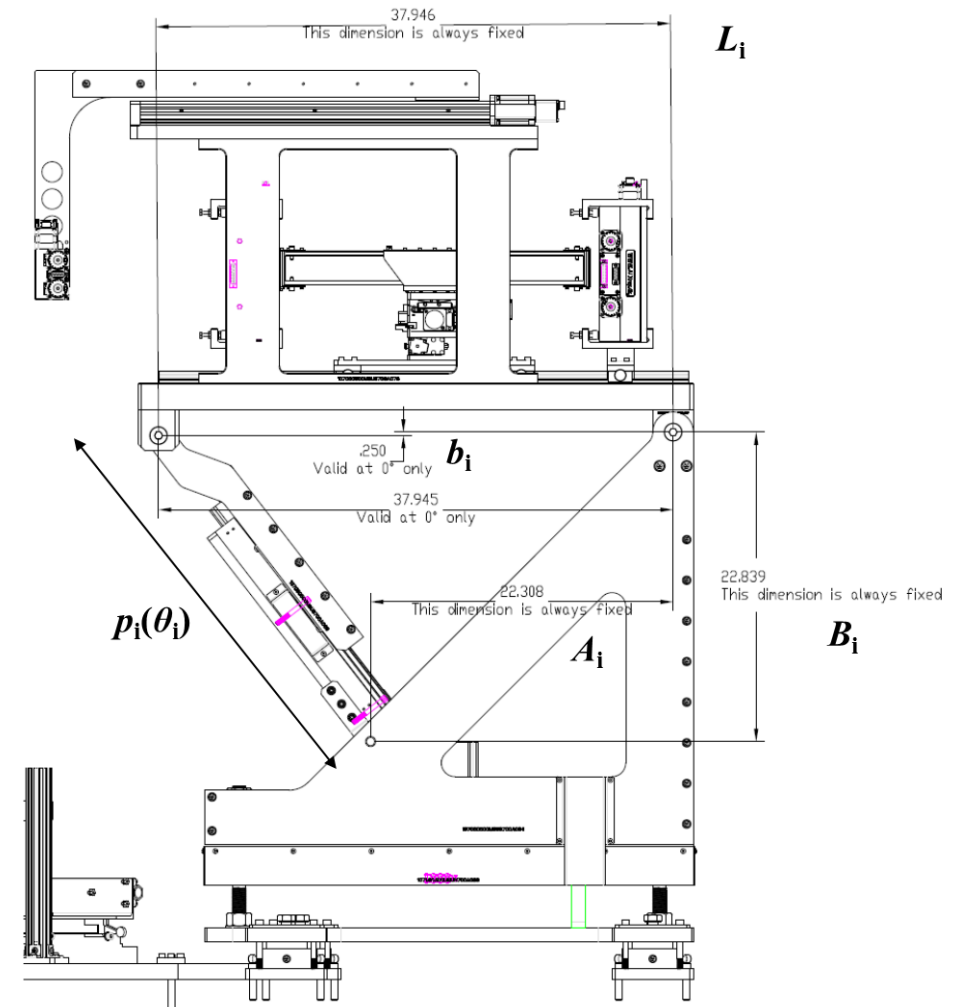
$$p_i(\theta_i) = \sqrt{(L_i \cos \theta_i - A_i)^2 + (B_i - b_i + L_i \sin \theta_i)^2}$$

$$\theta_i(p_i) = 2 \tan^{-1} \left[\frac{-(B_i - b_i) + \sqrt{(B_i - b_i)^2 + A_i^2 - C_i^2(p_i)}}{A_i - C_i(p_i)} \right]$$

where

$$C_i(p_i) \equiv \frac{p_i^2 - L_i^2 - A_i^2 - (B_i - b_i)^2}{2L_i}$$

L_i (mm)	ϑ_i (°)	p_i (mm)
963.83	0.0	697.837
A_i (mm)	-1.0	684.074
566.62	-2.0	670.454
B_i (mm)	-3.0	656.990
580.11	-4.0	643.696
b_i (mm)	-5.0	630.585
6.35		



Detector Arm virtual motors

$$p_d^2(2\theta_d) = z_d^2 + L_d^2 + A_d^2 - 2 \left[z_d \left(B_d \cos 2\theta_d - \sqrt{L_d^2 - B_d^2} \sin 2\theta_d \right) + A_d \left(\sqrt{L_d^2 - B_d^2} \cos 2\theta_d + B_d - 2\theta_d \right) \right]$$

$$2\theta_d(p_d) = \sin^{-1} \left[\frac{\beta C_d - \sqrt{\beta^2 \alpha^2 - \alpha^2 C_d^2 + \alpha^4}}{\beta^2 + \alpha^2} \right]$$

where

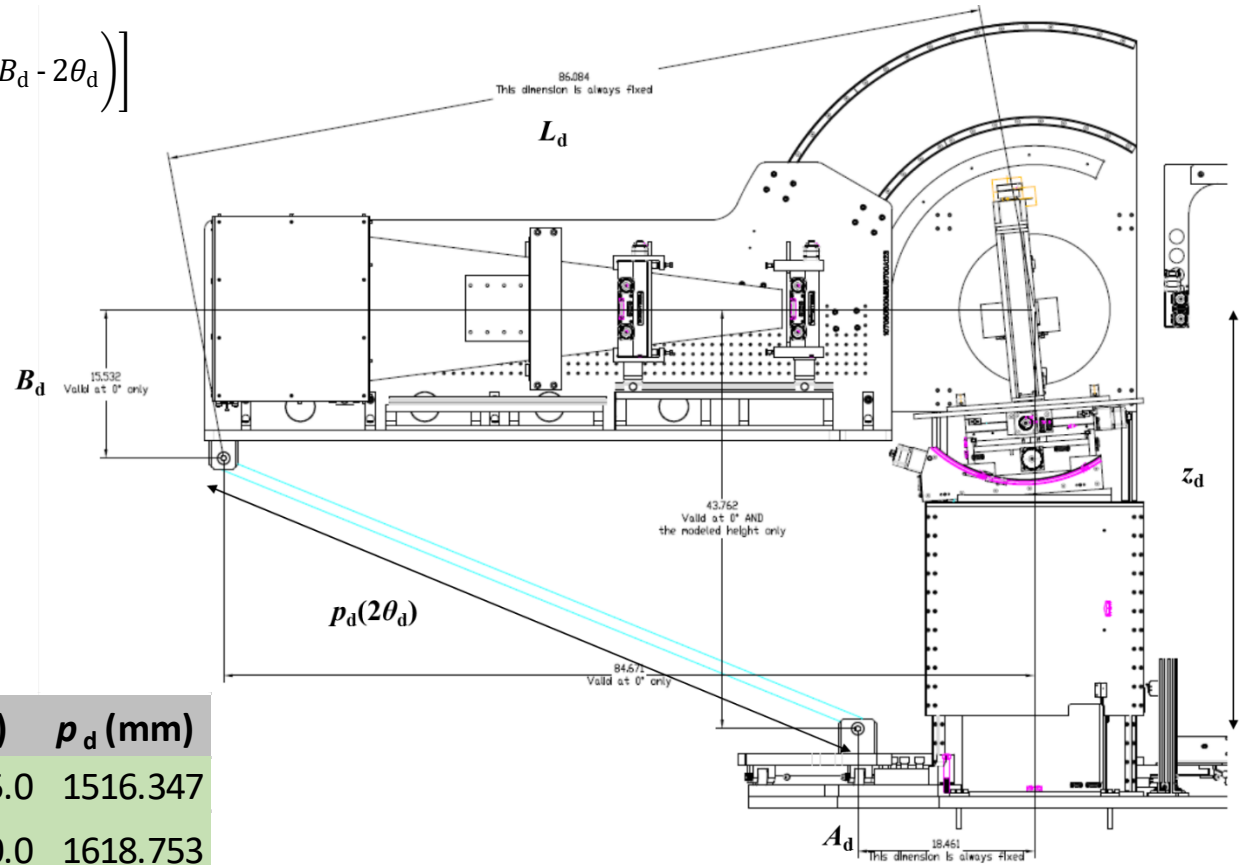
$$C_d(p_d) = \frac{p_d^2 - z_d^2 - L_d^2 - A_d^2}{2}$$

$$\alpha = z_d B_d + A_d \sqrt{L_d^2 - B_d^2}$$

$$\beta = z_d \sqrt{L_d^2 - B_d^2} - A_d B_d$$

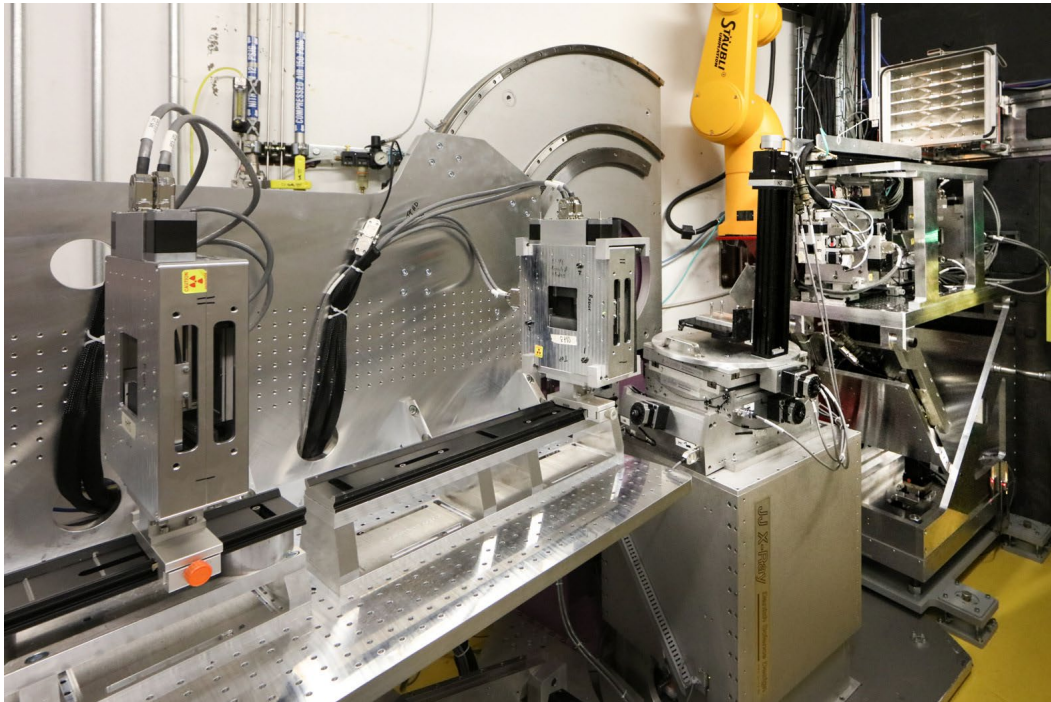
@ $z_d = 1111.55 \text{ mm} \Rightarrow$

L_d (mm)	$2\theta_d$ (°)	p_d (mm)
2186.53	-15.0	1516.347
A_d (mm)	-10.0	1618.753
468.91	-5.0	1723.061
B_d (mm)	0.0	1828.218
394.51	5.0	1933.351
z_d (mm)	10.0	2037.726
1111.55	15.0	2140.717

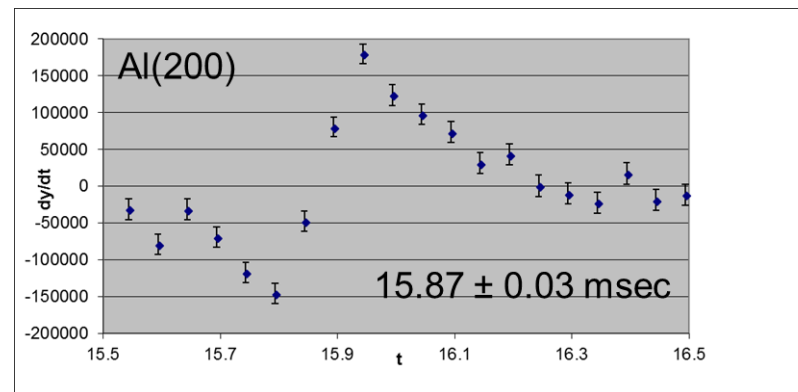
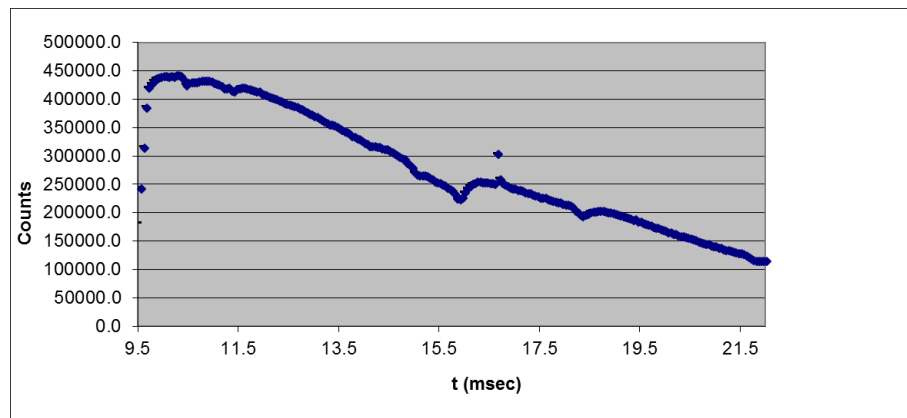
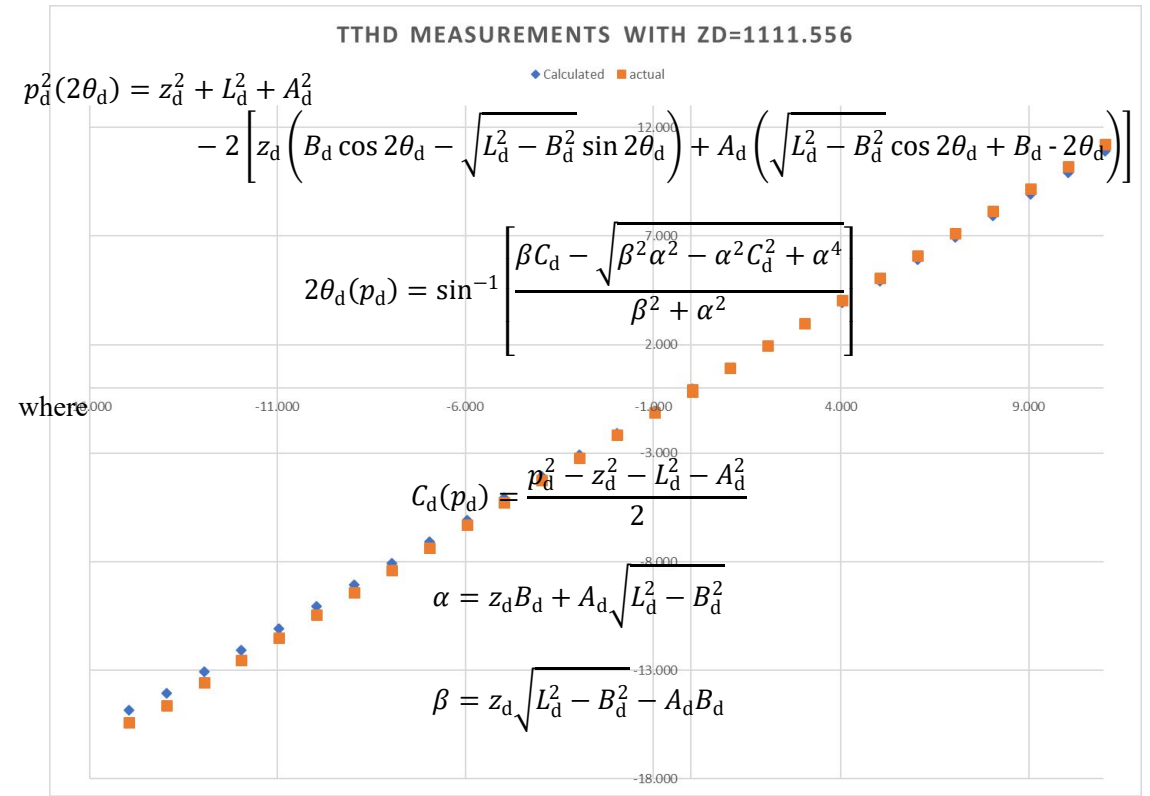


Installed 2018

Mechanical platform and cabling installed



Learning how to drive it...



$$L_{MD} = \frac{h}{m} \frac{t_f}{\lambda} \quad \left(\frac{h}{m} = 3.9561 \frac{\text{m}\cdot\text{\AA}}{\text{msec}} \right)$$

$$= 15.46 \pm 0.04 \text{ m}$$

DA mechanical issue 2021-24

