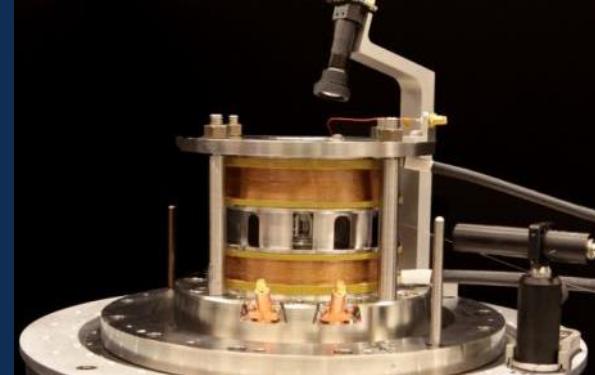
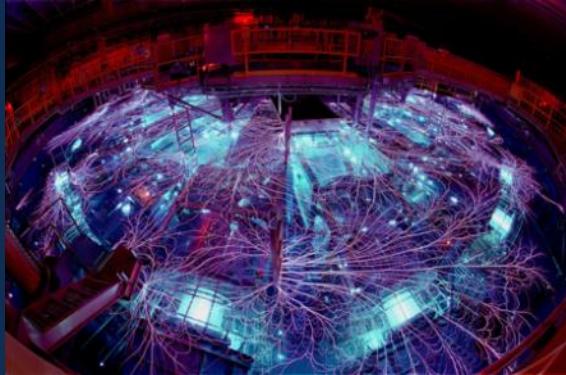
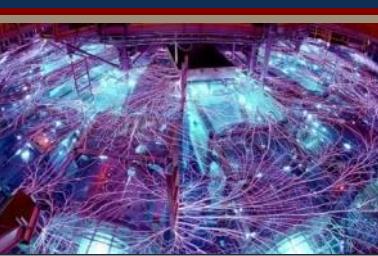


Exceptional service in the national interest



Sandia Z Machine Overview and Beryllium

**Hazel Barclay, PhD, CHP, CIH
Manager, Z Facility R&D**



Outline

Pulsed Power / Facility

- 22 MJ stored energy
- 3 MJ delivered to the load
- 26 MA peak current
- 1 - 100 Megabar
- 100 - 1000 ns pulse length
- ~1 shot per day / ~150 shots per year

Subsystems

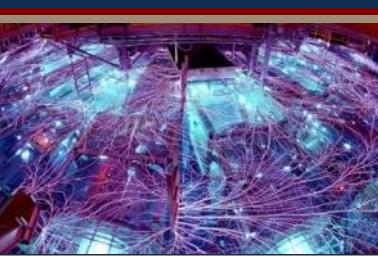
- Backlighter
- Cryogenics
- External Magnetic Fields
- Gas Fills
- Explosive Containment for High Z Materials

Experimental Loads

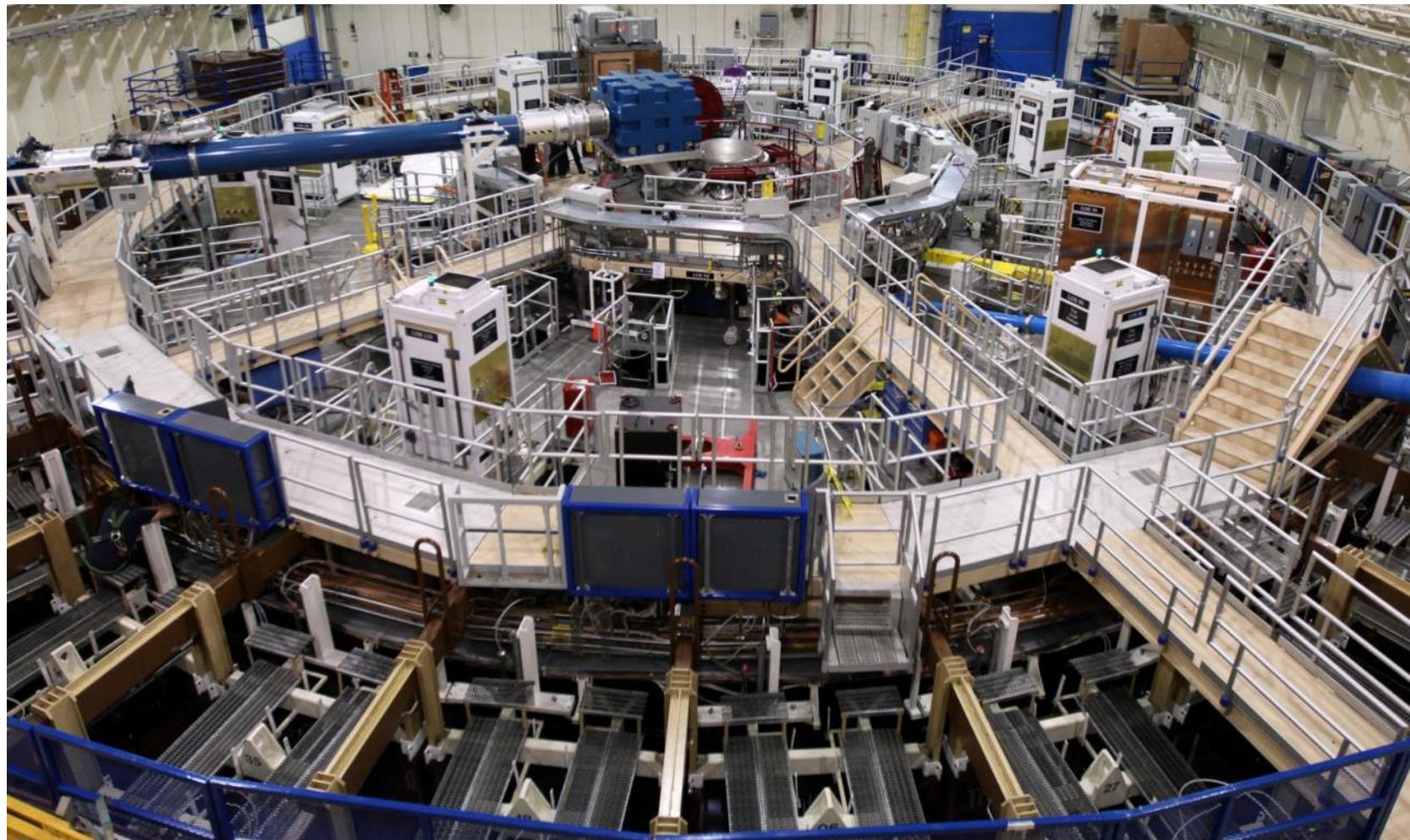
- Wire Arrays – Radiation Sciences
- Liners – Inertial Confinement Fusion, Material Sciences
- Gas Puff – Radiation Sciences
- Flyer Plates – Material Sciences
- Short Circuits – Material Sciences

Diagnostics

- X-Ray
- Neutron
- Optical
- ZBL Backlighter



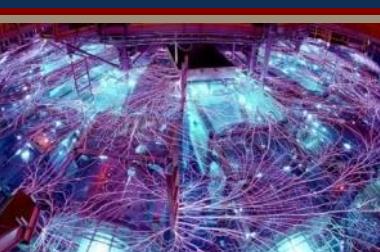
Z is a unique world class pulsed power facility at Sandia National Laboratories



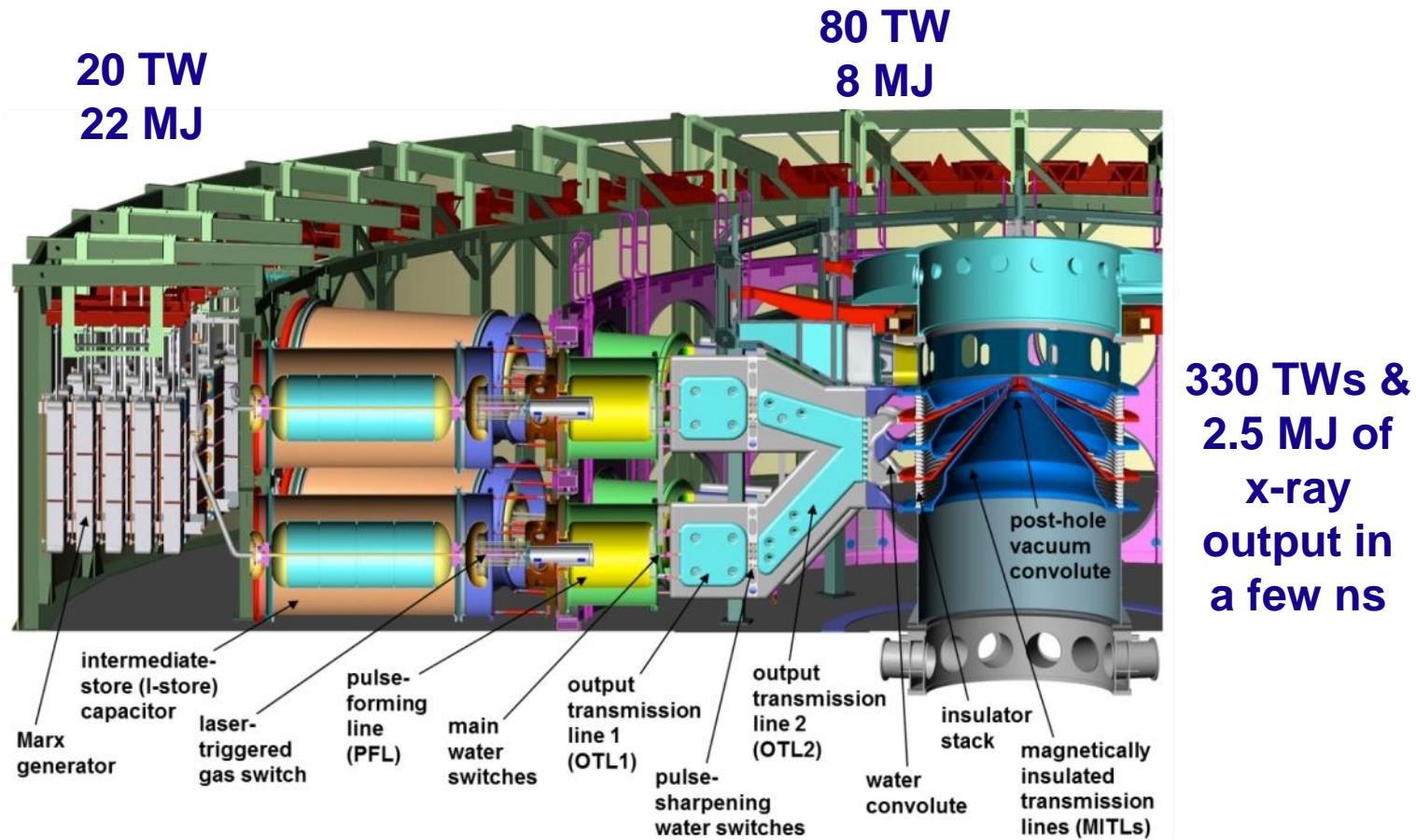
36 Marx generators
2160 capacitors

~ 1M gallons of transformer oil
~ 0.5M gallons of deionized water

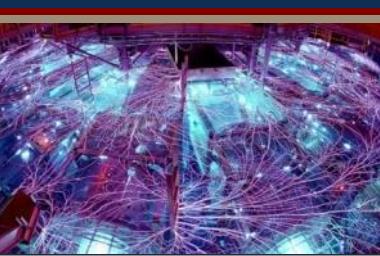
66,000 liter
vacuum vessel 



Z compresses electrical energy in both space and time . . .

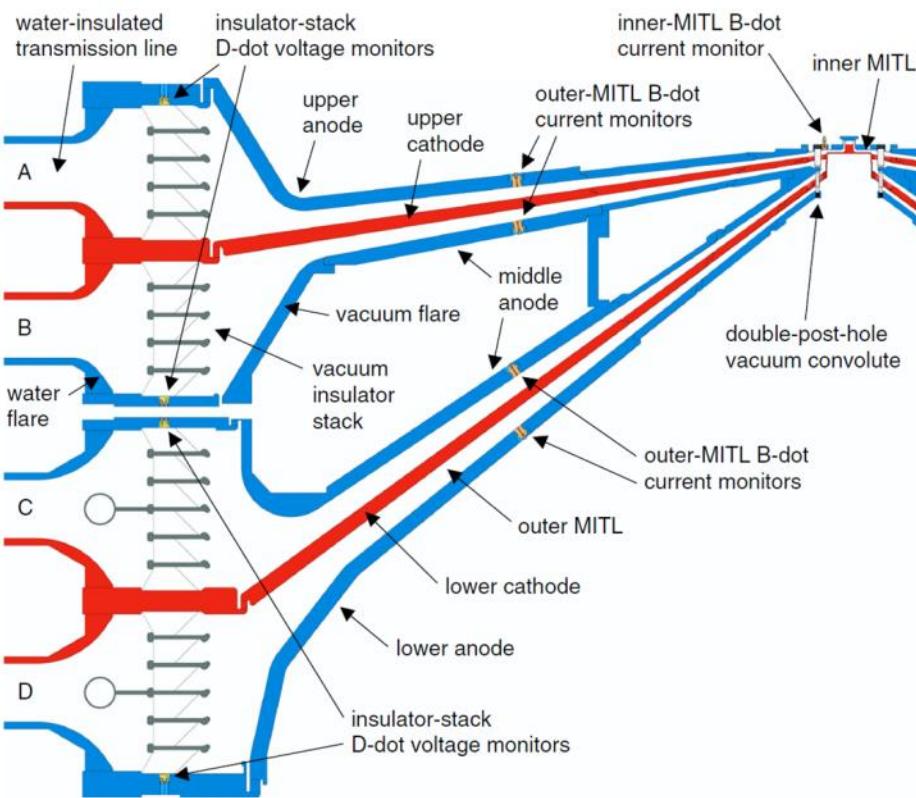


. . . and literally shakes the earth almost every day!

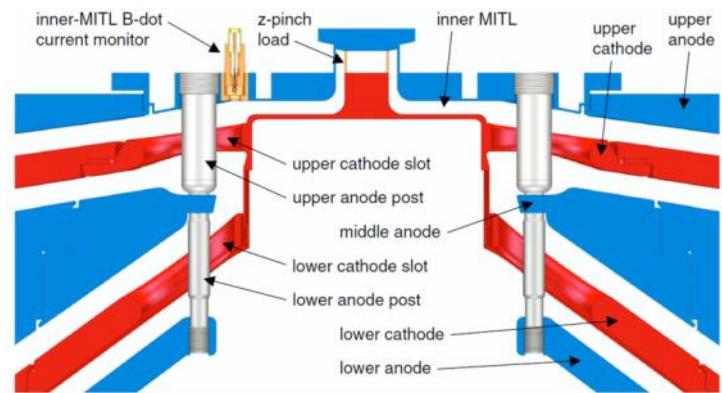


A complex series of conductors combine currents for the load

Z vacuum insulator stack and MITLs



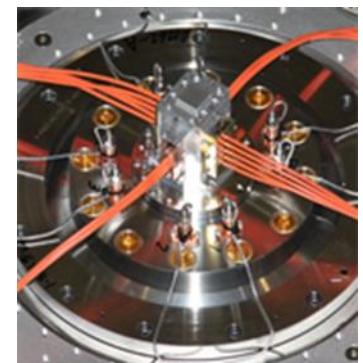
Post hole convolute system and load



ICF liner load



DMP load





Improved Information Management and Communications

Z Shot Schedule

Z Shot Schedule

Home | Change Log | Administration | Log In

Scheduled Shots | Unscheduled Shots | From: 11/06/2015 | Go | Export filtered data to Excel

Drop a column header and drag it here to group by that column.

Day	Date	Program	Experiment Name	Hardware Set	Shot Number	Principal Investigator	Shot Director	Status				Engineering Doc	Backup Hardware Set	Plan Type		
								EDS	CS	CAS	ESHE	Shot Type	File Checks			
Mon	2/01/16	NSI	Arriba 16a	A0596	Z2995	M. Gomez	Schaffner	<input checked="" type="checkbox"/>	Robertson	N/A	Planned					
Tue	2/02/16	NSI	Arriba 16a	A0596	Z2996	M. Gomez	Schaffner	<input checked="" type="checkbox"/>	Robertson	N/A	Planned					
Wed	2/03/16	NSI	Arriba 16a	A0596	Z2997	M. Gomez	Schaffner	<input checked="" type="checkbox"/>	Robertson	N/A	Planned					
Thu	2/04/16	NSI	Arriba 16a	A0596	Z2998	M. Gomez	Schaffner	<input checked="" type="checkbox"/>	Robertson	N/A	Planned					
Fri	2/05/16	NSI	Arriba 16a	A0596	Z2999	M. Gomez	Schaffner	<input checked="" type="checkbox"/>	Robertson	N/A	Planned					
Sat	2/06/16	Weekend	Weekend	N/A	N/A	N/A	N/A							N/A	N/A	None
Mon	2/08/16	ICP	285 Parameter 01a (cyclic)	N/A	N/A	N/A	N/A							N/A	N/A	None
Tue	2/09/16	ICP	285 Parameter 01a (cyclic)	A0596	A0598	Ave	Schaffner	<input checked="" type="checkbox"/>	Sauer	N/A	None					
Wed	2/10/16	DMAP	Puttering 2	A0596	A0599	P. Davis	Schaffner	<input checked="" type="checkbox"/>	Williams	N/A	Planned					
Thu	2/11/16	DMAP	Gas 16 Load	N/A	N/A	Schaffner	Schaffner	<input checked="" type="checkbox"/>	N/A	N/A	None					
Fri	2/12/16	DMAP	Gas 16 Load	N/A	N/A	Schaffner	Schaffner	<input checked="" type="checkbox"/>	N/A	N/A	None					
Sat	2/13/16	DMAP	Gas 16 Load	N/A	N/A	Schaffner	Schaffner	<input checked="" type="checkbox"/>	N/A	N/A	None					
Sun	2/14/16	ICP	Stress Test High 8	A0596	A0599	Krause	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Search					
Mon	2/15/16	ICP	Stress Test High 8	A0596	A0599	Krause	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Search					
Tue	2/16/16	ICP	Stress Test High 8	A0596	A0599	Krause	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Search					
Wed	2/17/16	ICP	Stress Test High 8	A0596	A0599	Krause	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Search					
Thu	2/18/16	ICP	Stress Test High 8	A0596	A0599	Krause	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Search					
Fri	2/19/16	DMAP	Stress 2	A0596	A0599	Schaffner	Schaffner	<input checked="" type="checkbox"/>	Debubbler	N/A	None					
Sat	2/20/16	Weekend	Weekend	N/A	N/A	N/A	N/A							N/A	N/A	None
Mon	2/22/16	ICP	Stress High 40	A0596	A0599	Angerford	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Planned					
Tue	2/23/16	ICP	Stress High 40	A0596	A0599	Angerford	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Planned					
Wed	2/24/16	ICP	Stress High 40	A0596	A0599	Angerford	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Planned					
Thu	2/25/16	ICP	Stress High 40	A0596	A0599	Angerford	Schaffner	<input checked="" type="checkbox"/>	C. Angyan	N/A	Planned					
Fri	2/26/16	DMAP	Stress 1	A0596	A0599	Schaffner	Schaffner	<input checked="" type="checkbox"/>	N/A	N/A	Planned					
Sat	2/27/16	Weekend	Weekend	N/A	N/A	N/A	N/A							N/A	N/A	None
Mon	2/29/16	DMAP	Fracture 2	A0596	A0599	Schaffner	Schaffner	<input checked="" type="checkbox"/>	Debubbler	N/A	None					
Tue	3/01/16	DMAP	Fracture 2	A0596	A0599	Schaffner	Schaffner	<input checked="" type="checkbox"/>	Debubbler	N/A	None					
Wed	3/02/16	DMAP	Fracture 2	A0596	A0599	Schaffner	Schaffner	<input checked="" type="checkbox"/>	Debubbler	N/A	None					
Thu	3/03/16	DMAP	Fracture 2	A0596	A0599	Schaffner	Schaffner	<input checked="" type="checkbox"/>	Debubbler	N/A	None					
Fri	3/04/16	DMAP	Unseeded	N/A	N/A	Schaffner	Schaffner	<input checked="" type="checkbox"/>	N/A	N/A	None					
Sat	3/05/16	DMAP	Platinum Stress Raeme	A0596	A0599	Schaffner	Schaffner	<input checked="" type="checkbox"/>	Debubbler	N/A	None					

Lab-Wide Z Status Page



Z ES&H Page

Z Shot Planning

ES&H and Security Review

EXPERIMENT NAME: Harding 16a | HARDWARE SET NUMBER: A0596C | SHOT DATE: Sep 12, 2016 | SHOT NUMBER: Z2999

ES&H

ES&H Review Performed

If there are notes they shall be entered below into Special Operational Notes

Supporting Documents

Type: File Name:

Vaporized Material List

ICF/Harding 16a A0596C: ALUMINUM ALLOY 5.9 g, BERYLLIUM 708 mg, EPOXY <250 mg, GLASS 117 mg, PVC 470 mg, STAINLESS STEEL ALLOY 710.6 g, TUNGSTEN ALLOY 328 mg

Security

Z Diagnostic Request System

Diagnostics & Subsystems

Diagnostics & Subsystems Request

Overall Status: OK Overall Quality Code: 0% OK

Principal Investigator: M. Gomez Co-Principal Investigator: N/A

Shot Number: [Copy from](#) Shot Number: [Hardware Set](#) [Copy](#)

Hardware Set Number: A0526A [Copy from](#) Shot Number: [Hardware Set](#) [Copy](#)

[All Lights](#)

2 - EXPERIMENT OVERVIEW

3 - DIAGNOSTICS

4 - OTHERS

5 - SUBSYSTEMS & LIDS

6 - CHAMBER

LOS 50: PCD, XRD, TEP, BOLO, nTOF

LOS 210: PCD/XRD/BOLO, nTOF

LOS 270: nTOF

LOS 310: Be Probe

LOS 330: TREX

ZBL: Backlighting, Preheat

LOS 130: NA 1 2

LOS 150: nImager

LOS 170: PCD/XRD/BOLO, MLM

LOS 210: NA 1 2

LOS 270: nTOF

LOS 310: Be Probe

LOS 330: TREX

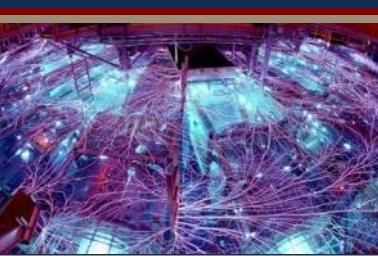
ZBL: Backlighting, Preheat

Bottom: nTOF, 4-A, 4-B, 4-B, 4-B, 10-A, 10-B

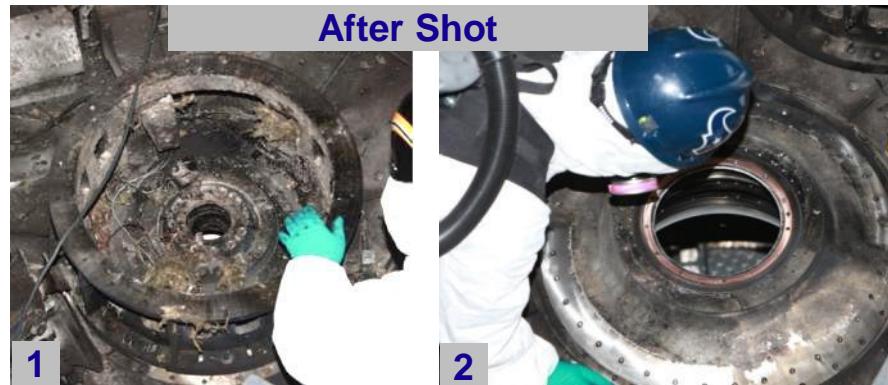
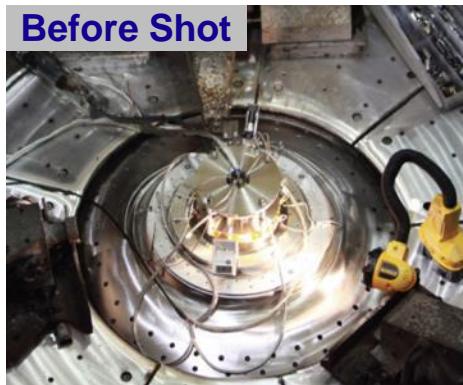
AXIAL - PODD: NA 1 2

CHAMBER: Activation Samples, CRITR, VISAR, PDV, Shock Breakout, SVS, SV33, TIPC

Not Requested: Requested with No Configuration: Requested with Configuration Submitted: Requested with Configuration Submitted and Approved: * Required

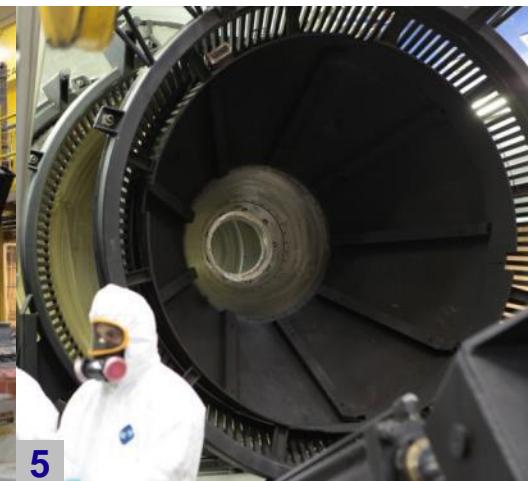


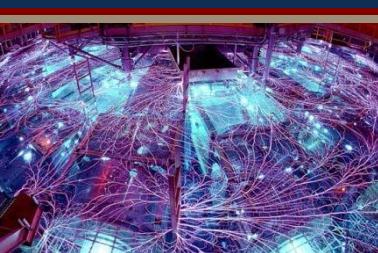
Daily Z Activities: Unload and Refurb of Z's Center Section



During a Z experiment several kilograms of material is destroyed and vaporized. Significant refurbishment activities are required between each shot which consist of:

1. Removal of in-chamber diagnostics and blast shield
2. Removal of Post Hole Convolutes
3. Removal of Magnetically Insulated Transmission Lines (MITL)
4. MITLs are flipped and placed into a HEPA filtered 'garage'
5. Cleaning / Grinding of MITLs and plastic insulator stack. All work requires Tyvek and Respirators due to Beryllium exposure





Daily Z Activities: Load and Downline Preparation

- Fill ~0.5 million gallons of water
- Fill ~1.0 million gallons of oil
- Water dive to remove bubbles from critical surfaces
- Install MITLs

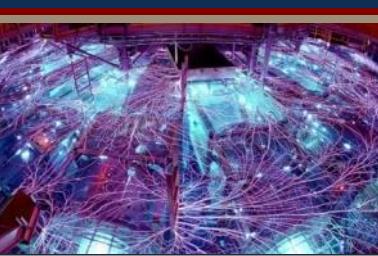
Wire array transport



Target and diagnostic loading

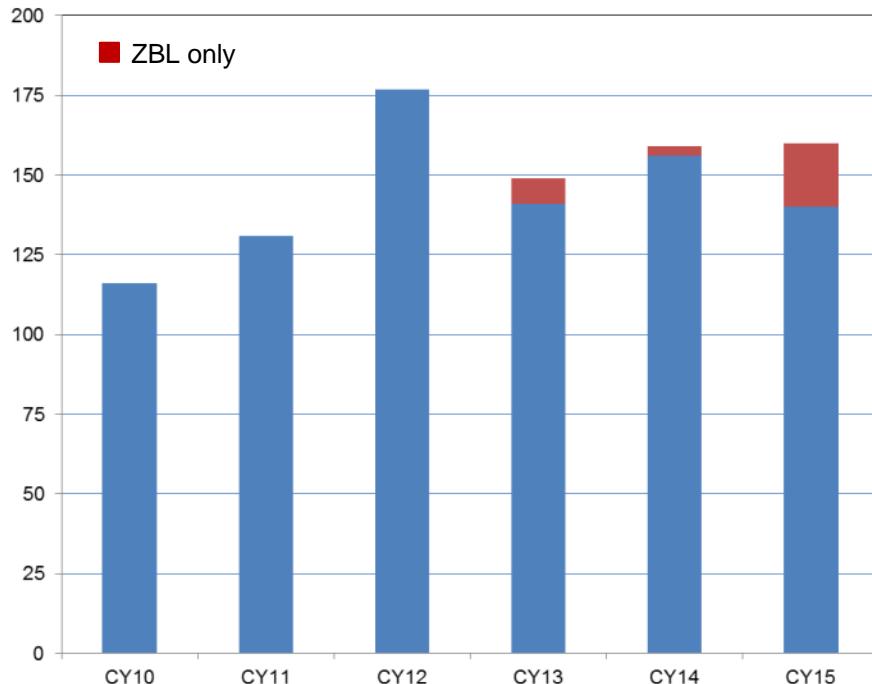


- Install Load Hardware
- Install Diagnostics
- Install FOA (Final Optics Assembly), Align Diagnostics
- Pump down vacuum chamber
- Checklists and fire Z!



Z Shot Rate and Shot Planning

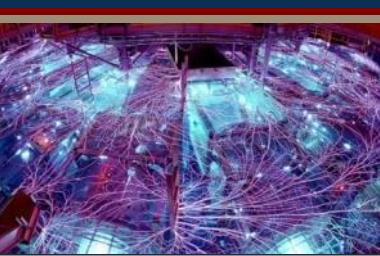
Z Shots by Calendar Year



~550 Shot Days were requested by LANL, LLNL, and SNL in CY15 – 3X more shot requests than available!

Z Shot Planning

- Typically plan for 140 – 160 shots a year based on budget
- Single shift operation:
 - 6 am work day start
 - 5 pm shot window closes
- Nominally 1 shot per shot day
 - 3 – 6 days for containment shots
- Most maintenance performed in parallel with daily shot preparations
- External PIs work with internal PIs for planning and execution



Beryllium

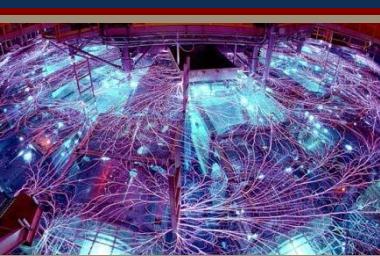
Areas

- Beryllium Operational Areas (BOA)
- Beryllium Contamination Control Areas (BCCA)
- Regulated Areas

Beryllium Activities

- Grinding (Shrouded)
- Scotchbrite
- Wet wiping
- Movement of large equipment



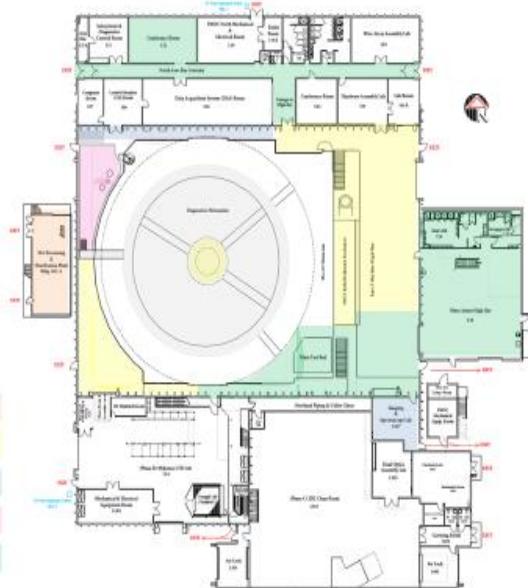


Beryllium Housekeeping and Sampling

Housekeeping

- Housekeeping maps
- Facility housekeeping standard (0.2ug/100cm²)
- Clean the facility, at a minimumm, quarterly
- HEPA vacuums
- Wet methods (Scrubbing Bubbles)

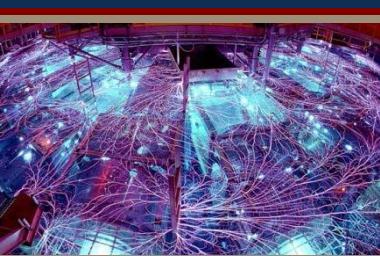
Ground
Floor



Sampling



- Monthly Z facility wipe sampling (Z and adjacent locations)
- Quarterly IH program wipe sampling
- Quarterly IH program PBZ sampling
- Z facility hired contractor PBZ, area air monitoring, and witness plate sampling for 3 months



NOPR—Z Mission Impact

Adoption of the OSHA PEL

- In May/June 2015 seven PBZ samples were greater than 0.2ug/m³ which resulted in Regulated Areas
 - Workers already wearing respirators
 - Postings were updated from Beryllium Operational Activity Areas to Regulated Areas
 - Showers and entry/exit logs were new for workers

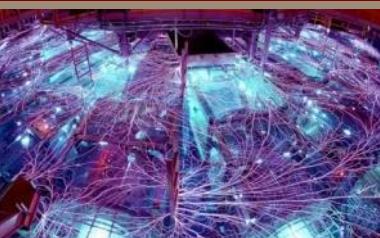
Potential Mission Impacts if Sandia is Driven Below the AL

- Unacceptable mission impacts (e.g. a beryllium target mass limit that excludes classes of experiments required to generate specific material property data)
- Operational impacts (reconfigure the facility)
- Multimillion dollar automated options (estimated 3-5 years and \$5-25M)
- Disposable hardware (up to \$21M and 250,000lbs of beryllium contaminated mixed waste)
- Increase already existing attraction and retention challenges for Z operational role

Lowering the surface action level by 2x

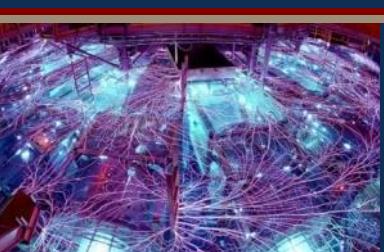
- Vacuum chamber does not meet the surface action level of 1.5ug/100cm² or the current AL
- Access is restricted to train and qualified individuals
- Safer to leave in current state than disturb surfaces

Mandatory medical screening



Sandia's Actions

- Did not comment on the NOPR (supporting BHSC comments)
- Sandia is preparing a Program Response for NNSA
- Where economically and programmatically feasible continue to reduce beryllium in the facility.



Questions?

