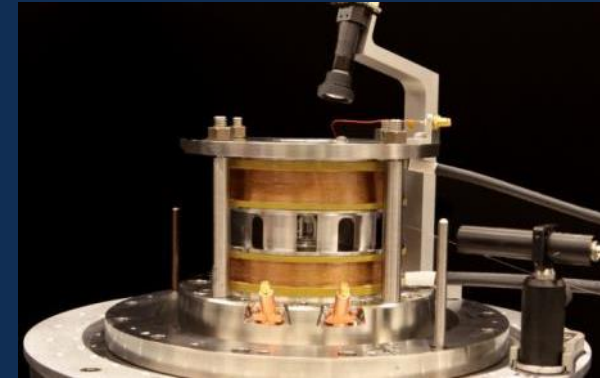
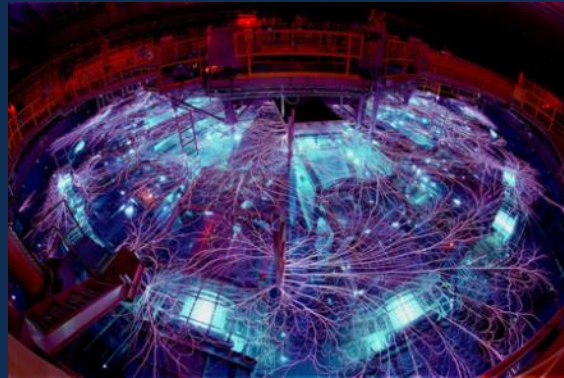
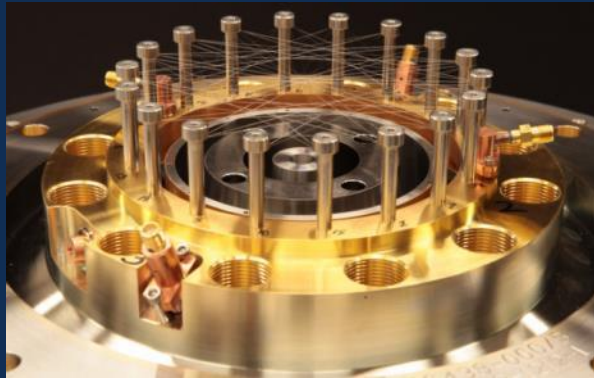
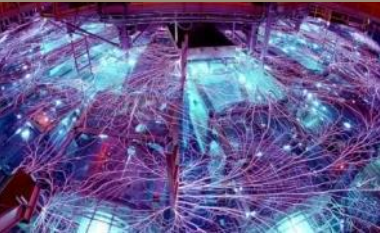


*Exceptional service in the national interest*



## 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

## Experimental Loads

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

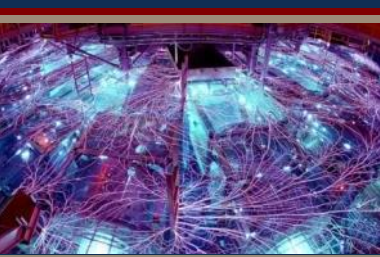
## Subsystems

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

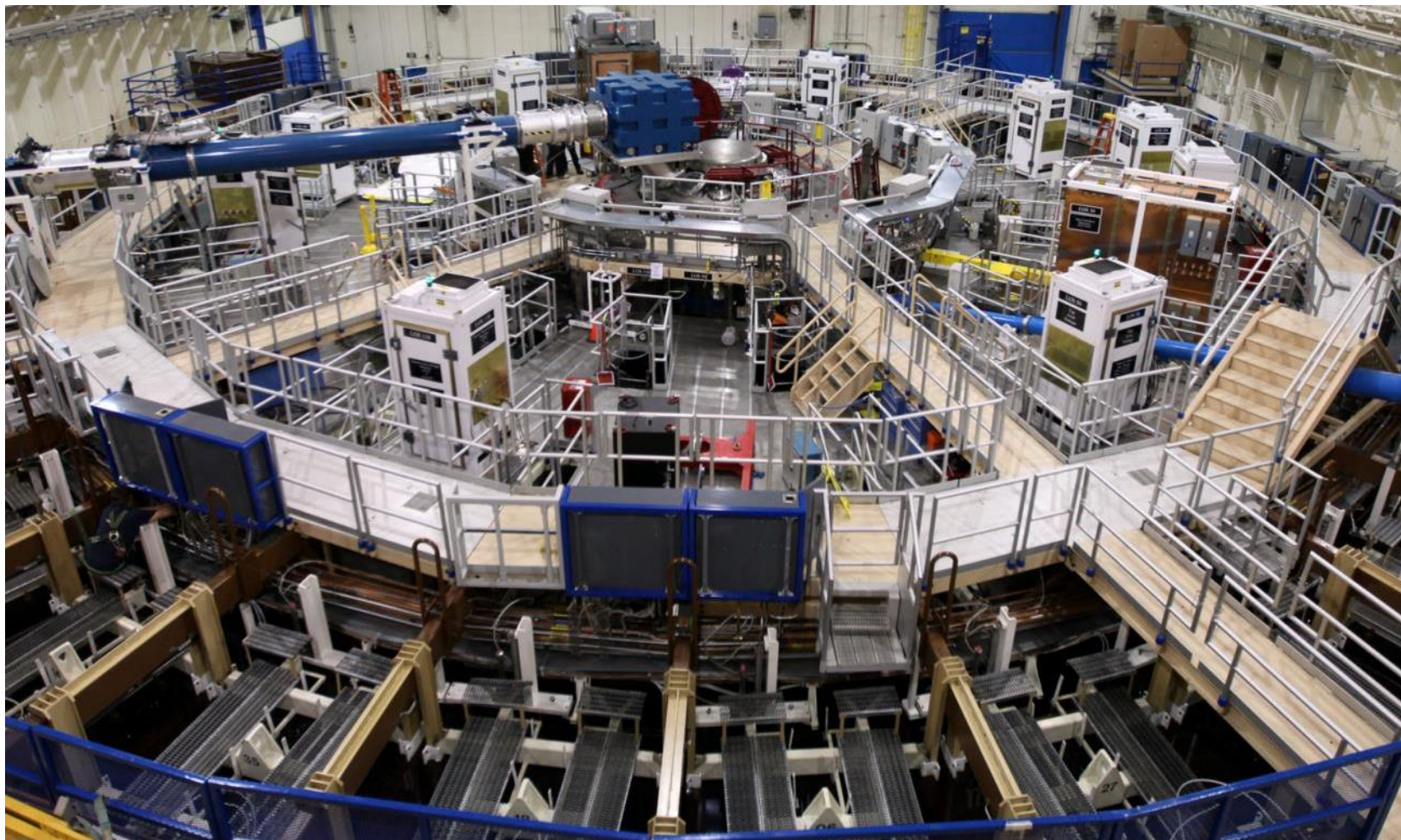
## Diagnostics

- X-Ray
- Neutron
- Optical
- ZBL Backlighter





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

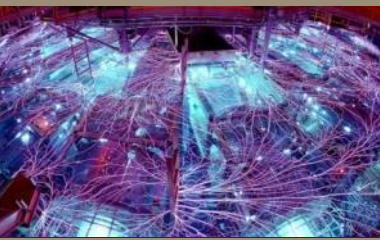


36 Marx generators  
2160 capacitors

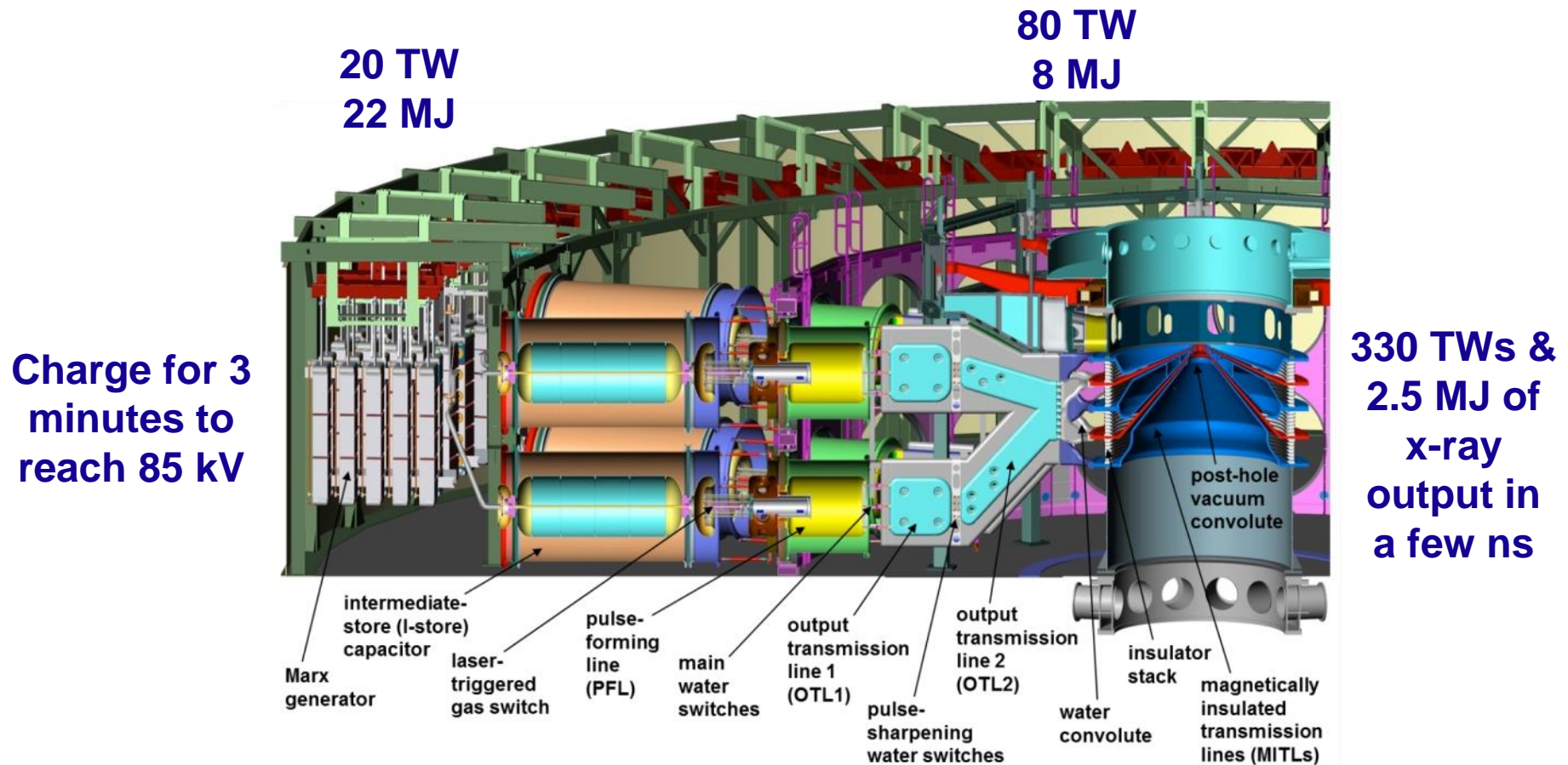
~ 1M gallons of transformer oil  
~ 0.5M gallons of deionized water

66,000 liter  
vacuum vessel

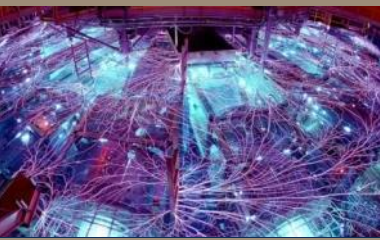




# Z compresses electrical energy in both space and time . . .

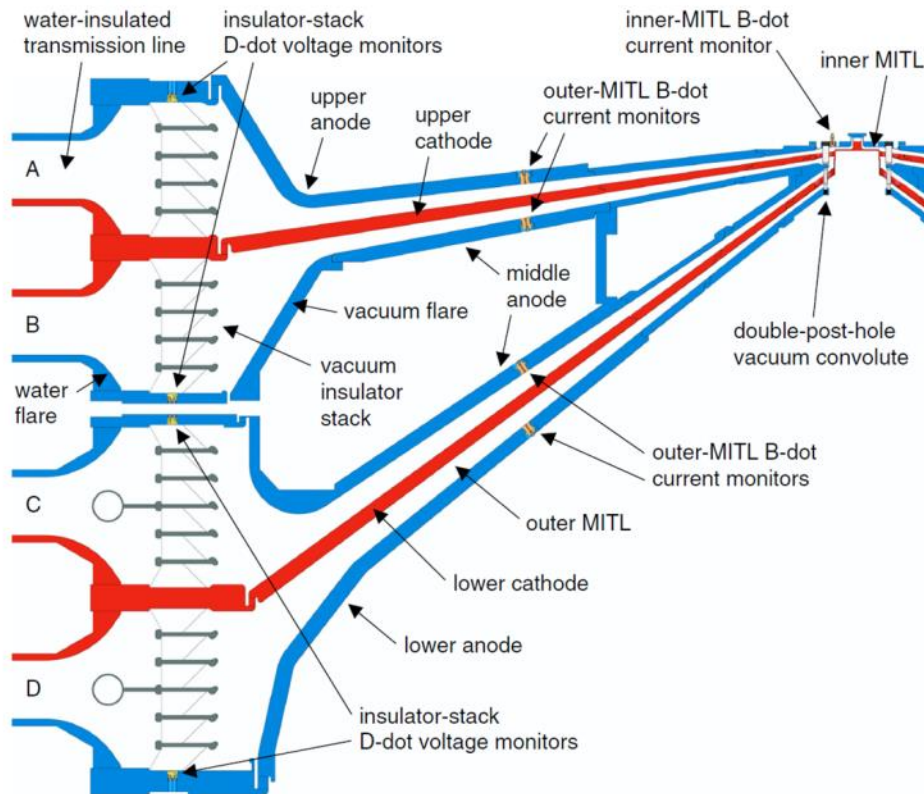


**. . . and literally shakes the earth almost every day!**

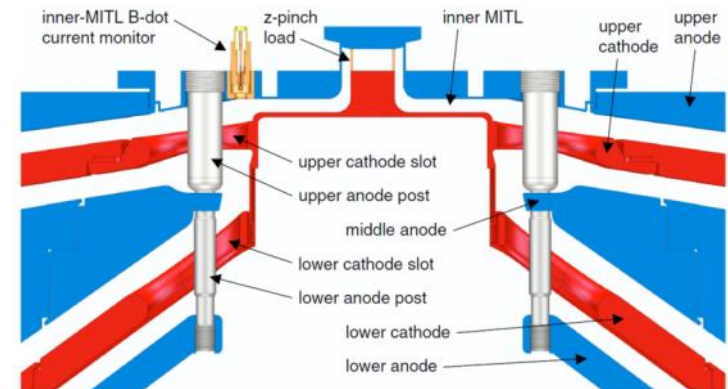


# A complex series of conductors combine currents for the load

## Z vacuum insulator stack and MITLs



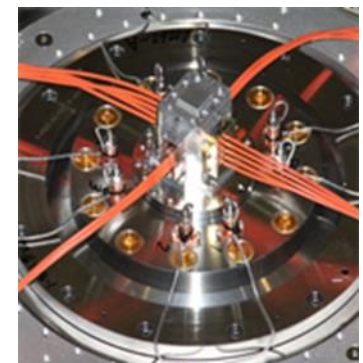
## Post hole convolute system and load



## ICF liner load



## DMP load





# Improved Information Management and Communications

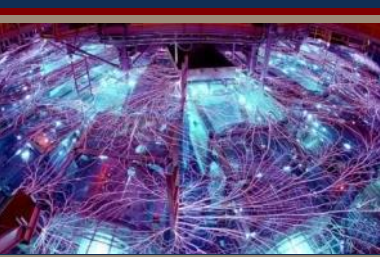
## Z Shot Schedule

**Z Shot Schedule** [Log In] Home Change Log Administration

Screened Shot Unscreened Shot From: 11/06/2015 To: 06

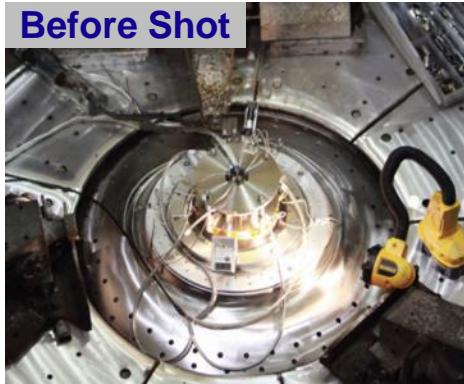
Export filtered data to Excel

| Day | Date     | Program | Experiment Name          | Hardware Set | Shot Number | Principal Investigator | Shot Director | Status   | ES&H                                | CS                                  | DS                                  | ES&H                                | Shot Type | As Check | Engineering DOC | Backup Hardware Set | Plan Type |
|-----|----------|---------|--------------------------|--------------|-------------|------------------------|---------------|----------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-----------|----------|-----------------|---------------------|-----------|
| Mon | 11/09/15 | RS      | Arriba 16a               | A0596A       | 22995       | M. Gomez               | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 11/10/15 | RS      | Arriba 16a               | A0596B       | 22996       | M. Gomez               | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 11/11/15 | RS      | Arriba 16a               | A0596C       | 22997       | M. Gomez               | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 11/12/15 | N/A     | Arriba 16a               | A0596D       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 11/13/15 | RS      | Arriba 16a               | N/A          | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 11/14/15 | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 11/16/15 | ST      | 201 Perseus (Arriba 16a) | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 11/17/15 | ST      | 201 Perseus (Arriba 16a) | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 11/18/15 | DMP     | Perseus 2                | A0596E       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 11/19/15 | DMP     | Perseus 2                | A0596F       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 11/20/15 | DMP     | Perseus 2                | A0596G       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 11/21/15 | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 11/23/15 | ST      | Perseus High 3           | A0596H       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 11/24/15 | ST      | Perseus High 3           | A0596I       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 11/25/15 | ST      | Perseus High 3           | A0596J       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 11/26/15 | ST      | Perseus High 3           | A0596K       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 11/27/15 | DMP     | Perseus 2                | A0596L       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 11/28/15 | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 11/30/15 | ST      | Perseus High 3           | A0596M       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 12/01/15 | ST      | Perseus High 3           | A0596N       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 12/02/15 | ST      | Perseus High 3           | A0596O       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 12/03/15 | ST      | Perseus High 3           | A0596P       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 12/04/15 | DMP     | Perseus 2                | A0596Q       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 12/05/15 | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 12/07/15 | DMP     | Perseus 2                | A0596R       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 12/08/15 | DMP     | Perseus 2                | A0596S       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 12/09/15 | DMP     | Perseus 2                | A0596T       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 12/10/15 | DMP     | Perseus 2                | A0596U       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 12/11/15 | DMP     | Perseus 2                | A0596V       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 12/12/15 | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 12/14/15 | DMP     | Perseus 2                | A0596W       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 12/15/15 | DMP     | Perseus 2                | A0596X       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 12/16/15 | DMP     | Perseus 2                | A0596Y       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 12/17/15 | DMP     | Perseus 2                | A0596Z       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 12/18/15 | DMP     | Perseus 2                | A05970       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 12/19/15 | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 12/21/15 | DMP     | Perseus 2                | A05971       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 12/22/15 | DMP     | Perseus 2                | A05972       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 12/23/15 | DMP     | Perseus 2                | A05973       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 12/24/15 | DMP     | Perseus 2                | A05974       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 12/25/15 | DMP     | Perseus 2                | A05975       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 12/26/15 | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 12/28/15 | DMP     | Perseus 2                | A05976       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 12/29/15 | DMP     | Perseus 2                | A05977       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 12/30/15 | DMP     | Perseus 2                | A05978       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 12/31/15 | DMP     | Perseus 2                | A05979       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 1/01/16  | DMP     | Perseus 2                | A05980       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 1/02/16  | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 1/05/16  | DMP     | Perseus 2                | A05981       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 1/06/16  | DMP     | Perseus 2                | A05982       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 1/07/16  | DMP     | Perseus 2                | A05983       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 1/08/16  | DMP     | Perseus 2                | A05984       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 1/09/16  | DMP     | Perseus 2                | A05985       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 1/10/16  | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 1/12/16  | DMP     | Perseus 2                | A05986       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 1/13/16  | DMP     | Perseus 2                | A05987       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 1/14/16  | DMP     | Perseus 2                | A05988       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 1/15/16  | DMP     | Perseus 2                | A05989       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 1/16/16  | DMP     | Perseus 2                | A05990       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 1/17/16  | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 1/19/16  | DMP     | Perseus 2                | A05991       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 1/20/16  | DMP     | Perseus 2                | A05992       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 1/21/16  | DMP     | Perseus 2                | A05993       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 1/22/16  | DMP     | Perseus 2                | A05994       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 1/23/16  | DMP     | Perseus 2                | A05995       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Sat | 1/24/16  | Weekend | Weekend                  | N/A          | N/A         | N/A                    | N/A           | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Mon | 1/26/16  | DMP     | Perseus 2                | A05996       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Tue | 1/27/16  | DMP     | Perseus 2                | A05997       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Wed | 1/28/16  | DMP     | Perseus 2                | A05998       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Thu | 1/29/16  | DMP     | Perseus 2                | A05999       | N/A         | N/A                    | Schaffner     | Approved | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | Robertson | N/A      | Planned         | N/A                 | Planned   |
| Fri | 1/30     |         |                          |              |             |                        |               |          |                                     |                                     |                                     |                                     |           |          |                 |                     |           |

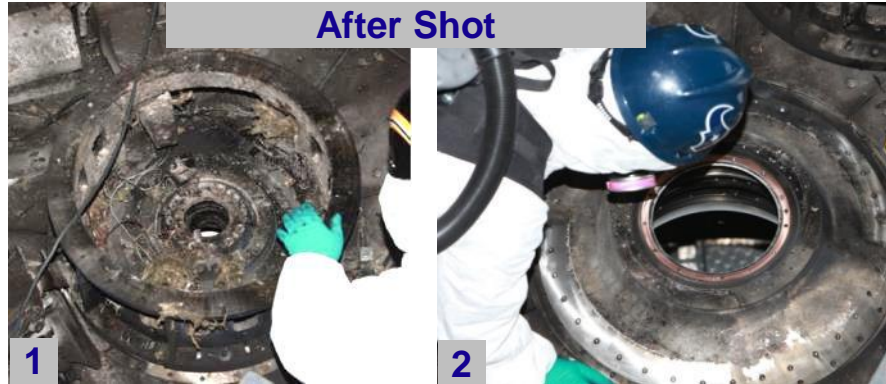


# Daily Z Activities: Unload and Refurb of Z's Center Section

Before Shot



After Shot



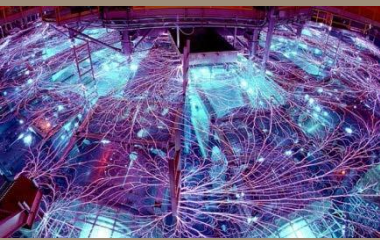
During a Z experiment several kilograms of material is destroyed and vaporized. Significant refurbishment activities are required between each shot which consist of:

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



5





# 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



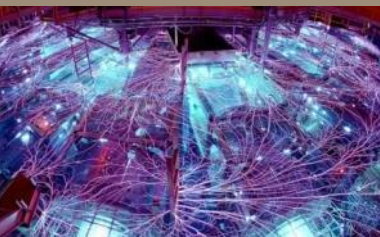
## Target and diagnostic loading



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

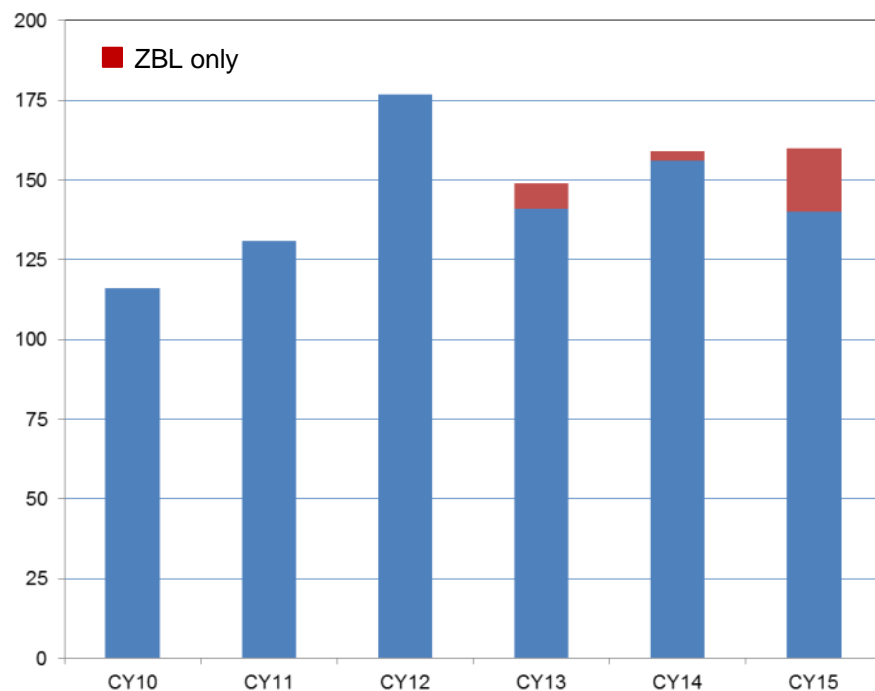






# Z Shot Rate and Shot Planning

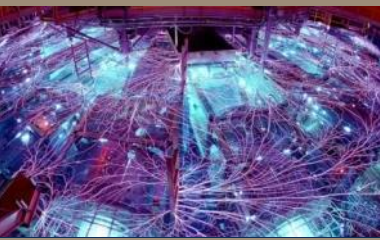
## Z Shots by Calendar Year



~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

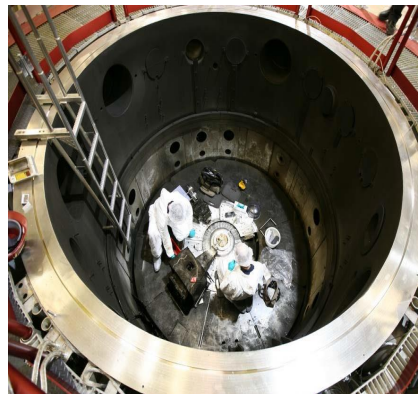
## Areas

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

## Beryllium Activities

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

Regulated Area



Regulated Area



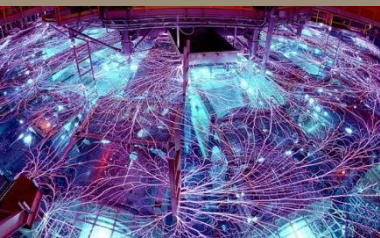
BCCA



High bay entrance  
(BOA).





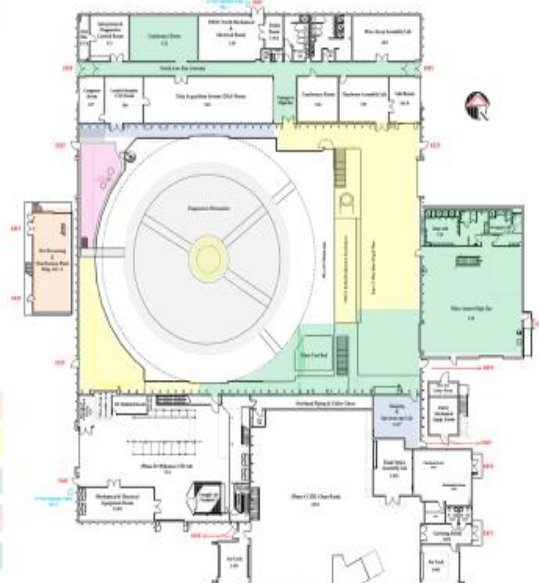


# Beryllium Housekeeping and Sampling

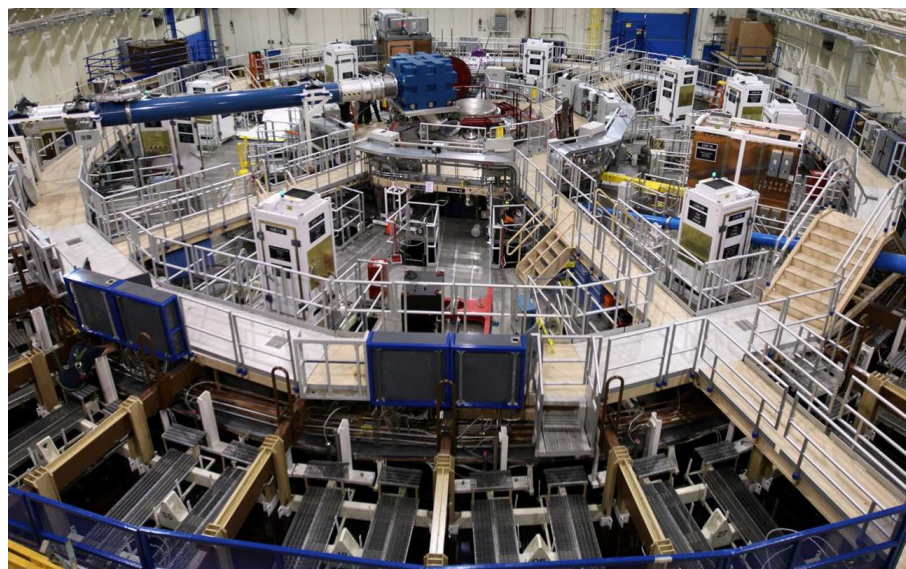
## Housekeeping

- Housekeeping maps
- Facility housekeeping standard ( $0.2\mu\text{g}/100\text{cm}^2$ )
- Clean the facility, at a minimum, quarterly
- HEPA vacuums
- Wet methods (Scrubbing Bubbles)

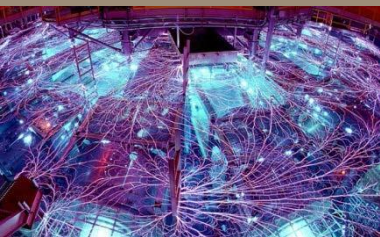
### Ground Floor



## 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  $0.2\mu\text{g}/\text{m}^3$  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

## Lowering the airborne AL by 4x

- Currently approximately 40% of the PBZ samples exceed  $0.05\mu\text{g}/\text{m}^3$  in the Regulated Areas
- For 15 months PBZ have remained below  $0.2\mu\text{g}/\text{m}^3$

## Lowering the surface action level by 2x

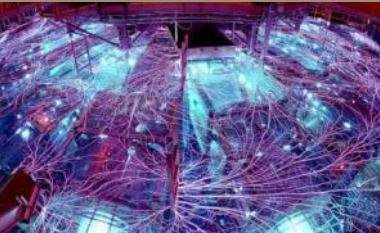
- Vacuum chamber does not meet the surface action level of  $1.5\mu\text{g}/100\text{cm}^2$  or the current AL
- Access is restricted to train and qualified individuals
- Safer to leave in current state than disturb surfaces

## Mandatory medical screening

## Potential Mission Impacts if Sandia is Driven Below the AL

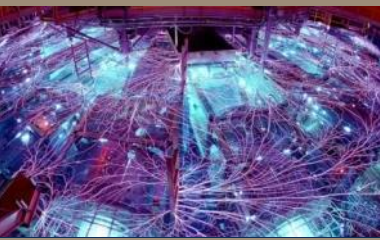
- Unacceptable mission impacts (e.g. a beryllium target mass limit that excludes classes of experiments required to generate specific material property data)
- Operational impacts (reconfigure the facility)
- Multimillion dollar automated options (estimated 3-5 years and \$5-25M)
- Disposable hardware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





# 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?

