SAND2015-5904C

Exceptional service in the national interest

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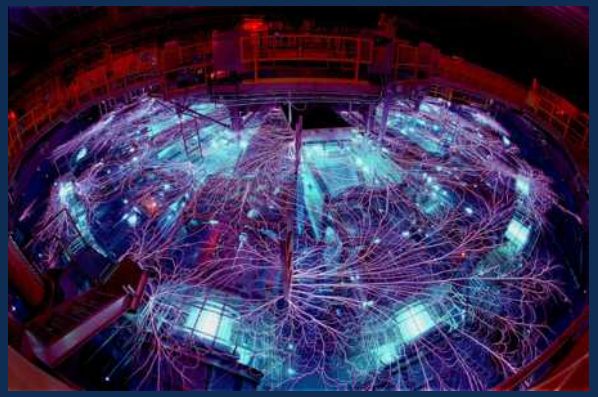

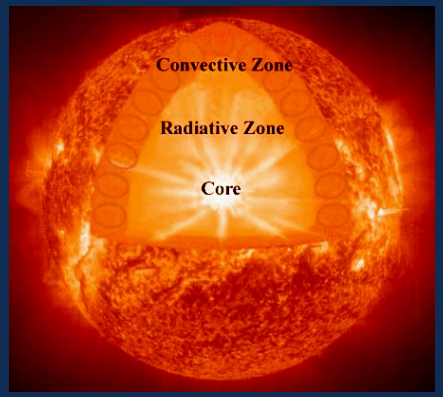

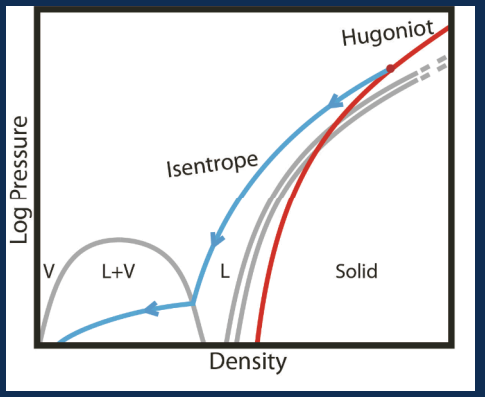

The Z Fundamental Science Program: status and future

Thomas Mattsson

Manager, HEDP Theory

Fundamental Science with Pulsed Power: Research Opportunities and User Meeting
Albuquerque, NM July 19-22, 2015

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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We are enthusiastic to continue the series of workshops on fundamental science on Z

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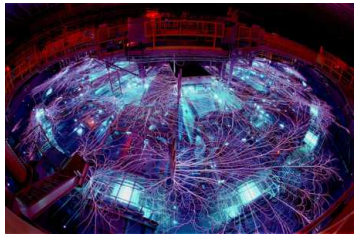
- **Workshops on fundamental science using pulsed power**
  - 2009 Hilton, Santa Fe
  - 2010 Eldorado, Santa Fe
  - 2011 Eldorado, Santa Fe
  - 2012 Andaluz, Albuquerque
  - 2014 Andaluz, Albuquerque
  - 2015 Hyatt, Albuquerque
- **Liner Fusion workshop**
  - 2012 Marriott, Albuquerque



- **Results from past workshops**
  - Launched and grew the Z Fundamental Science Program and university collaborations on liner fusion
  - New collaborations and projects
- **Objectives for 2015 workshop**
  - Forum for Z users and collaborators
  - Nucleate new collaborations and research ideas
  - Build a cohesive community for HED science that spans several areas
    - Astrophysics, planetary science, fusion, materials

The Z Fundamental Science Program engages a broad international community and has advanced HED science

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- **Resources/shots on Z over 5 years**
  - 50+ dedicated ZFS shots (~5% of all Z shots)
  - Ride-along experiments on program shots
- **Science with far-reaching impact**
  - 1 Nature, 1 Nature Geoscience, 1 SCIENCE
  - 1 Phys. Rev. Lett, 3 Physics of Plasmas, 2 Physical Review (A,B) , 9 others
- **Popular outreach**
  - National Public Radio, “All things considered”, Joe Palca 3/6/2014
  - MIT Technology review, 10/4/2012
  - Discover Magazine, 9/16/2012
  - Local TV coverage (7-KOAT, 13-KRQE) in early 2015
- **New external funding won**
  - DOE/OFES/HEDLP
- **Students and postdocs**
  - 4 M.Sc. Exam, 2 Ph.D. exams
  - 5 postdocs

The Z Fundamental Science Program has made discoveries in iron (x2), water, and hydrogen

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- **Resources/shots on Z since 2010**
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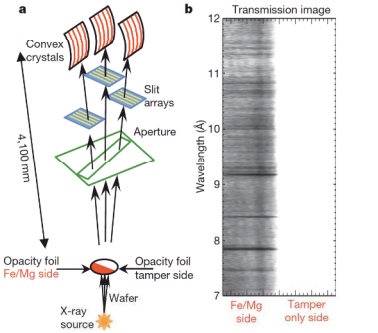


Figure 1 | Experiment diagram and example transmission image. a, Three to four spectrometers view the 'half-moon'-shaped tamped iron/magnesium sample (not to scale). Each uses multiple slits to project spatially resolved images onto a convex crystal that disperses the spectrum before recording

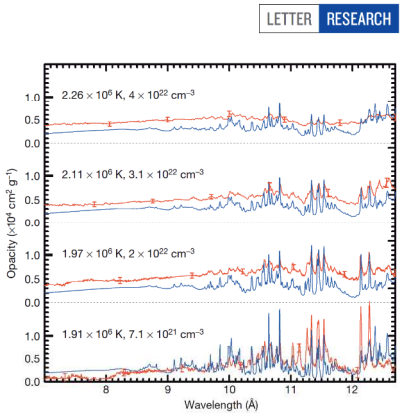


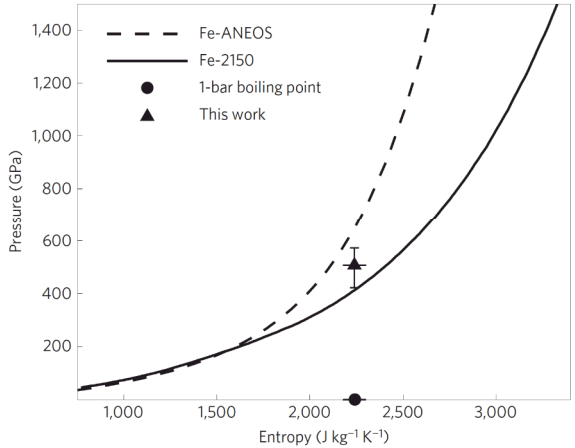
Figure 2 | Measured iron opacity spectra at four T_e/n_e values compared with calculations. The SCRAM[33] model calculations (blue lines) account for the instrument resolution. Red lines denote the measurements and the error bars

Solar opacity

Measured the iron opacity at solar conditions

Nature 2015

The Z Fundamental Science Program has made discoveries in iron (x2), water, and hydrogen



Earth and super earths
Determined iron vaporization
Nature Geoscience 2015

- **Resources/shots on Z since 2010**
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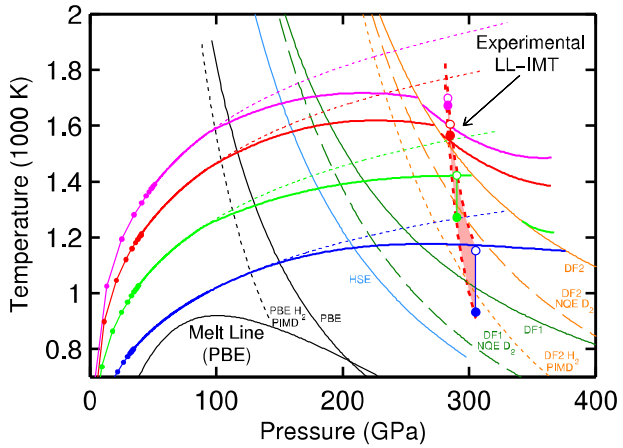
Gas Giants
Water and hydrogen
PRL 2012; SCIENCE 2015



The work behind the Z Fundamental Science Program started in 2008 with IHEDS (UT/SNL)

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ZFSP past and present

- IHEDS 2009-2010 workshops in SF
- 2010 – call for proposals and evaluation of an external international committee
- 2011 – 15 dedicated shots on Z
- 2012 – 20 dedicated shots on Z
- 2013 – NNSA/NA-11 pause
- 2014 – Restart of ZFSP
- 2014 – External review of the program and extension for CY15 shots
- 2015 – 18 shots on the schedule

The call for proposals is open and will close on 9/15/15

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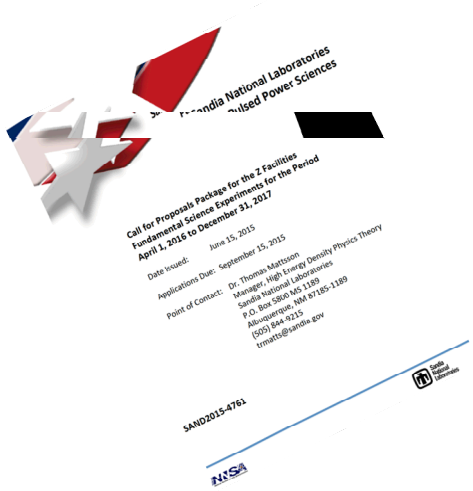
ZFSP call for proposals timeline

- June 15: call for proposals open
- July 20: workshop
- **September 15: call closes**
- October/November: evaluation and selection
  - Facility review: feasibility of experiments, safety, and diagnostics
  - Scientific review of international panel 11/10-11, 2015
  - December 11, distribution of shots
- 2016 & 2017
  - Shots scheduled for successful proposals

Purpose of the Z Fundamental Science Program

- The primary purpose of the Z-Facilities Fundamental Science Program is to provide access to NNSA's Z accelerator for HED experiments. The specific objectives of the program are to provide access to the Z accelerator and its diagnostics to a broad community of academic, industrial and national laboratory research interests, for use:
  - 1) as tools for conducting fundamental research in HED science, and
  - 2) in providing research experience necessary to maintain and grow the HED community, especially through involvement of researchers in academia



Merit review of the proposals will be done by an external international panel

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- Applications will be technically evaluated based on the four general scientific/technical criteria listed:
  - Scientific and technical soundness and quality of the proposed method/approach, and the feasibility/likelihood of accomplishment of the stated objective
  - The overall scientific/technical merit of the project and its relevance and prospective contribution to its field of research
  - The competence, experience, and past performance of the applicant, principal investigator and/or key personnel
  - The demands of the project in terms of resource requirements (equipment, beam time, etc.) and/or other requirements (facility hardware modifications, component development, etc.) vis-à-vis competing demands.

The ZFSP greatly benefits Sandia's and NNSA mission on both short- and long term

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- **Supporting HED science – resulting in students and groups active in topics of importance to the national laboratories**
- **Growth in the HED science community**
  - New funding won by teams
  - Active participation in the academic community of HED science – attracting new academic partners
  - Scientific discoveries make the field attractive
- **Direct methods development**
  - The platform for shock experiments developed jointly with Harvard/UC Davis is now our standard setup for science campaign experiments
  - The work on Fe opacity has served an important role for platform development and provides international peer review
- **Development of technical staff**
  - An opportunity for Sandia staff to do leading research and participate fully in the international research community

One plenary room (Enchantment A/B) and three smaller rooms (C,D,E) each seating 20

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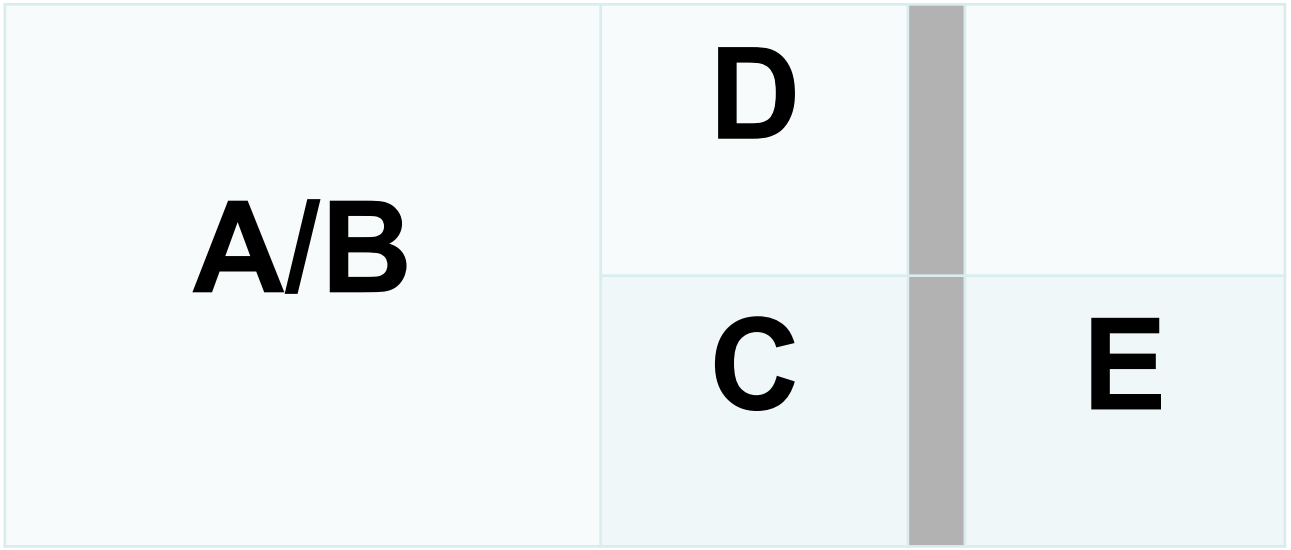

Each room has a projector/screen, and flip chart (soon if not now)

4 plenary sessions and 5 topical break-out sessions

Monday	Tuesday	Wednesday
HED Science and the Z facility A/B	MagLIF Plenary A/B	MagLIF: stagnation and burn measurements A/B MagLIF: Implosion instabilities C Planets/materials D Astrophysics E
Planetary and Materials Science Plenary A/B	Astrophysics Plenary A/B AND MagLIF: target preconditioning experiments E	Summaries of breakout sessions and closing A/B

Goals for the break-out sessions

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- **Future research directions**
  - New research directions/ideas, within existing fields - and suggestions for new topics/fields
  - Formation of new or extended collaborative teams
- **Identify key scientific development enabled by ZFSP to date (direction, capabilities, or momentum)**
- **How can we improve and support the ZFSP collaborative teams?**
  - Improvements on Z in terms of diagnostics or infrastructure or management?
- **Capture the discussions**
  - We plan to compile and release a workshop report – so expect small writing assignments!

Welcome to the ZFSP workshop 2015!

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- **Many thanks to**
  - Tamar Armijo
  - Colin Hallahan
  - Alan Wootton
  - Dan Sinars
  - Don Winget
  - Jim Bailey
  - Hyatt Regency for patience with the long approval process