SAND2011-3120P

Progress on Project Between Sandia National Laboratories and Commisariat a L'Energie Atomique

Presented by: Dr. Dillon H. McDaniel
Sandia National Laboratories

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P148: Kinetics of Solid-Solid Phase Transformations in Polycrystaline Tin

Jean-Paul Davis and Daniel Dolan
Sandia National Laboratories*

Gilles Roy and Christophe Voltz
CEA-DAM, Valduc

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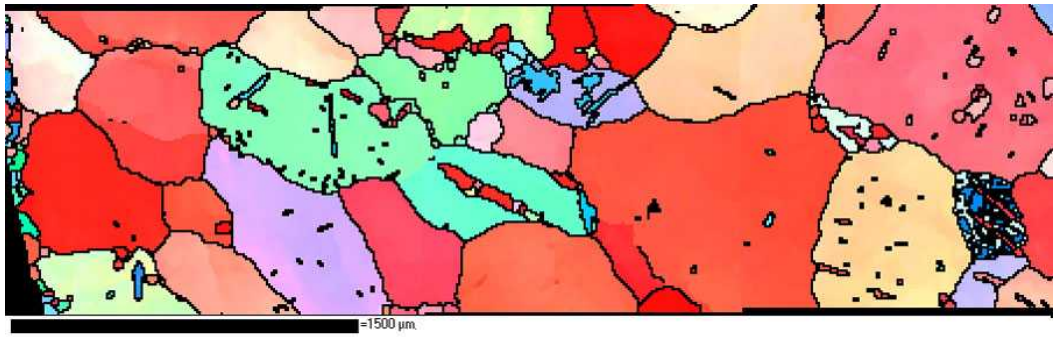
P148
Kinetics of solid-solid phase transformations in polycrystalline tin

Goal: Improve models of polymorphic phase transitions under dynamic high pressures

Approach: Tin beta-gamma transformation: low pressure (9 GPa), non-reconstructive (bct-4 → bct-2), and significant volume change (3%)

Issue: Large grain size hinders polycrystalline isentropic-compression measurements



Progress:

CEA/Valduc has produced stable fine-grained tin samples up to 16-mm diameter

- Purity 99.99%, homogeneous grain size 50-56 µm, work continuing toward 40-µm grains
- **Further work needed to quantify grain growth during transportation and for pre-heated experiments**

SNL would benefit from availability of new fine-grained samples

- Repeat Veloce pulser experiments (including pre-heat)
- Use new material on planned Z experiments (including shock-ramp)
- Share data with CEA for analysis

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Areas for discussion of possible future collaboration between CEA and the experimental material dynamics group at SNL

- **Difficult to justify formal collaboration on purely experimental work**
  - NNSA already has the best facilities to perform needed experiments

- **Two possible areas for further collaboration**
  - Development of new continuum phase transition models (with kinetics)
    - CEA staff develops/implements models
    - Close collaboration with SNL experimentalist to test models
    - Possibility of using new SNL 1-D code for model development
    - Continues/revitalizes original P148 proposal
  - Development of new diagnostics for ramp-compression experiments
    - Long-term assignment of CEA staff on-site at SNL
    - Design/implement diagnostic system for experiments at SNL
    - Technology transferred back to CEA for their own use
    - Idea in search of the right person and the right diagnostic

P167: Linear Transformer (LTD) Technology for Flash X-Ray Radiography

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*Sandia National Laboratories**

Martial Toury, Michel Caron, and Rodolphe Rosol
CEA-DAM, Polygone d'expérimentation de Moronvilliers

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P167: Linear transformer technology for flash x-ray radiography

Goal: *Improve progress toward advanced flash Radiography driver technologies*

Approach: Pool resources and exchange LTD design and performance information

Recent Progress:

- Conducted collaborative experiments at both labs
- Both facilities have been upgraded in the past two years
  - Sandia upgraded from 7 to 21 cavities.
  - CEA upgraded from 1 to 10 cavities.

Future Plans:

- Sandia is studying coupling of LTD to magnetically insulated transmission lines and radiographic diodes.
- CEA is studying reliability and maintenance requirements
- Continued co-development planned

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P 169: Iron Opacity Measurements

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C. Blancard
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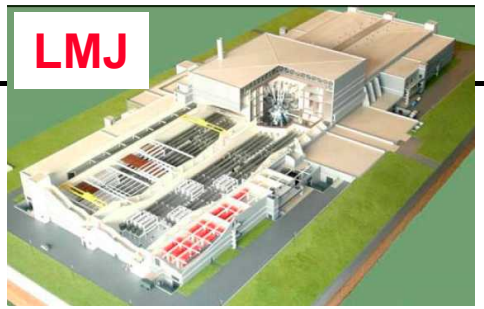
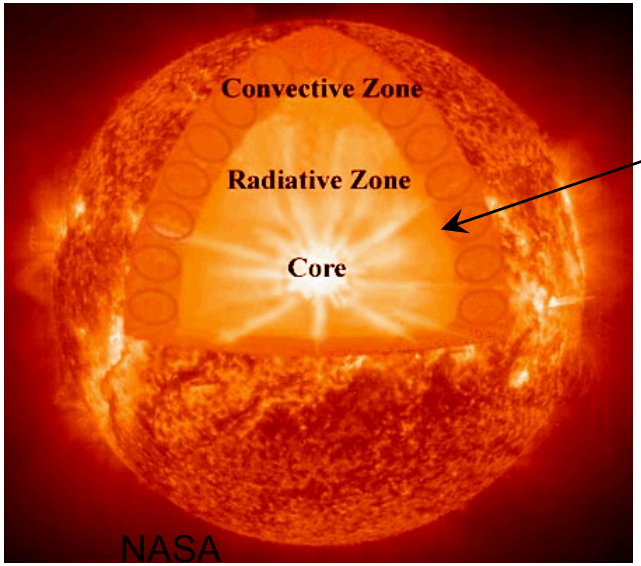
The new generation of High Energy Density facilities can create and diagnose astrophysical matter on earth





Models for solar interior structure disagree with helioseismology observations {boundary location, sound speed, density profile}

The goal for our team is to reproduce stellar interior matter at Z, measure the x-ray transmission, and answer the question: Is opacity uncertainty the cause of the disagreement?

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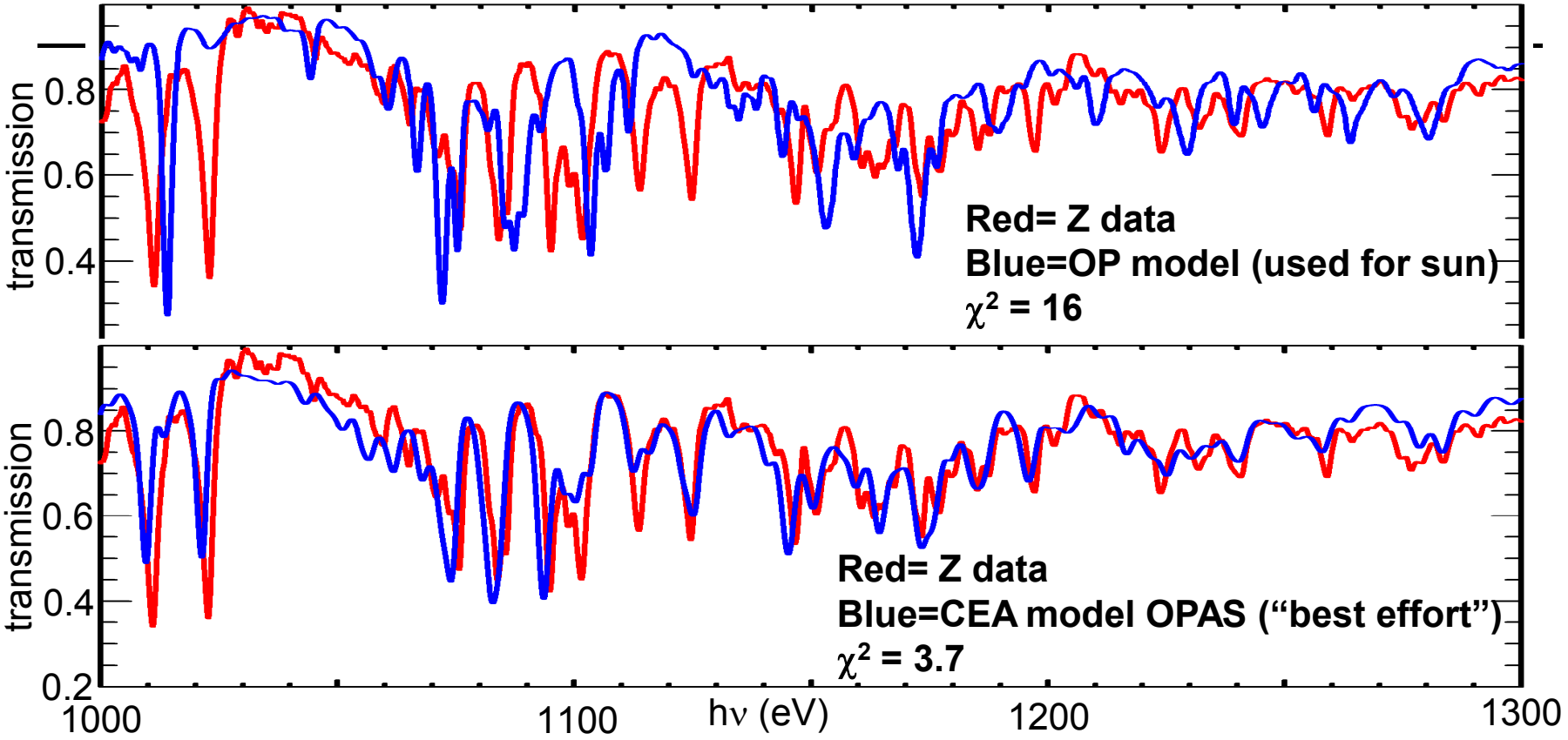
The 2007 Z data was matched well by "best-effort" models, but not by a model used in solar research



OP Rosseland mean is ~ 1.5x lower than OPAS at Z conditions.
If this difference persisted at solar conditions, it would solve the CZ problem
The 2007 Z experiment reproduced solar charge state distribution, but at lower density
Experiments and calculations at higher density are the present focus

Recent experiments raised density to within ~25% and T_e to within ~10% of CZ boundary values

Synopsis:

Stellar structure depends on opacities that are un-measured

Solar predictions do not agree with observations

Challenge: create and diagnose stellar interior conditions

Participants

Sandia: Bailey, Rochau

CEA: Blancard, Cosse, Faussurier, Gilleron, Pain, Poirier

Joint Publications: RSI (2008), Phys Plasmas (2009)

Future research:

Analysis, critique, and improvement of new experiments at solar interior conditions

Model comparisons *with a goal of understanding the underlying physics*

Possible expansion to consider:

Astrophysicists are actively developing asteroseismology, (COROT and KEPLER missions). Those investigations also require fundamental opacity and EOS information.

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P 173: Study of the Vishniac Instability and Optically Thin Radiative Blast Waves on the Z-Beamlet Laser

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Serge Bouquet
Dam-CEA

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Project Status

The project has been held up for far longer than expected by modifications to the probe laser system. It turns out that the delay times between pulses are in a difficult area between regimes. The hundreds of nanosecond regime is too long to use optical delay methods (this would require hundreds of feet of length), but too short to easily use electronic switching to achieve the delay. This has been a part time project for the laser group for several years, and a few different solutions have been attempted (including a couple of different Pockels cells and a pair of AOM systems). We finally have a solution that seems to work in the system, and are hopeful experiments can begin soon.

Due to these troubles we have not been able to gather any significant results to publish, but it appears we are finally on the verge of the experiment design working and believe the project should be continued.

We have three primary goals for this experimental series.

1.) Observation of a growing Vishniac overstability.

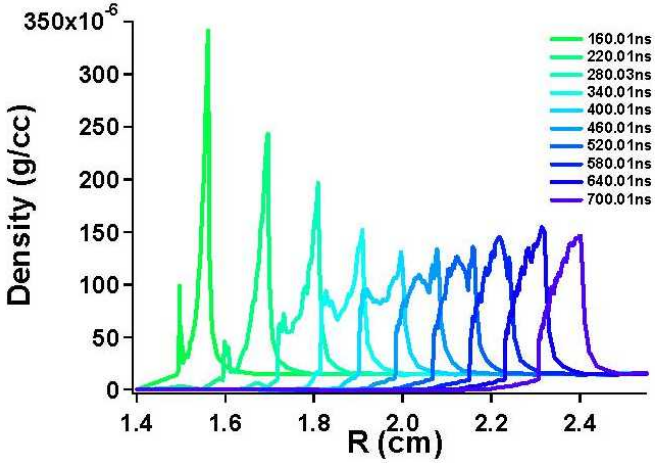
Would be the 1st time.

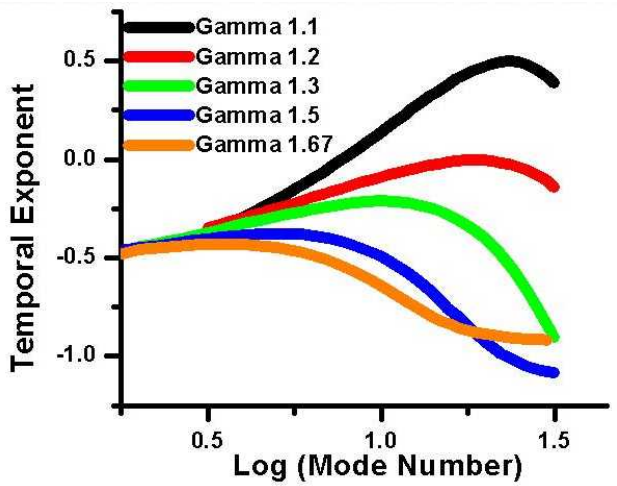
2.) Observation of an oscillating perturbation.

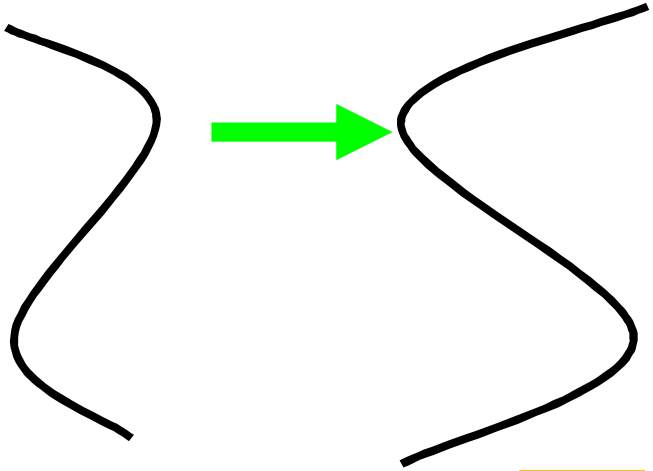
Would be the 1st time seen.

3.) Experimental determination of the hydrodynamic conditions of the blast wave as a function of time.

This allows determination of the polytropic index allowing for a better comparison of theory to experiment.







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P 174: Gas Sensors and Nanoscale Materials Characterization Platforms

R. J. Simonson, Joshua Whiting, Shawn Dirk
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Philippe Andreucci
CEA- LETI

Bruno Lebret
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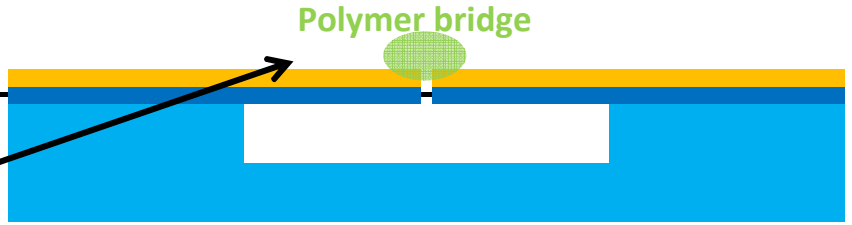
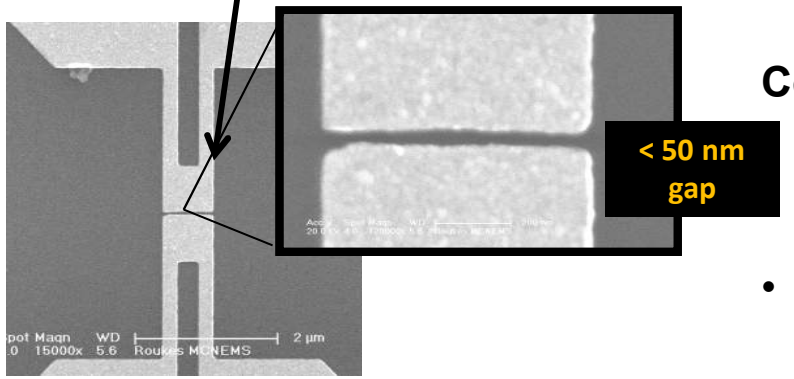
Gas Sensors and Nanomaterial Characterization Platforms – Project #174

Principal Investigators:
Sandia: R.J. Simonson
CEA/LETI: Philippe Andreucci

Collaborators:
Caltech: Dr. Ed Myers, Prof. M. Roukes



Resonators



Varying mechanical or electrical properties of materials bridging the gap will affect resonator coupling.

The basic idea: Nanoelectromechanical resonators can be coupled by polymer bridge at ~10nm length scale. Exploit these coupled resonators to:

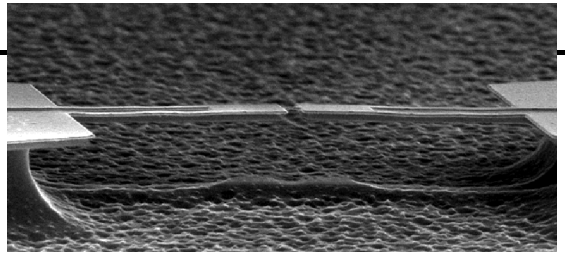
1. **Measure material properties this scale, between atomistic and continuum simulation regimes.**
2. **Create new gas sensors by observing perturbations caused by adsorption in the polymer.**

Collaboration opportunity exploits unique expertise at each partner institution:

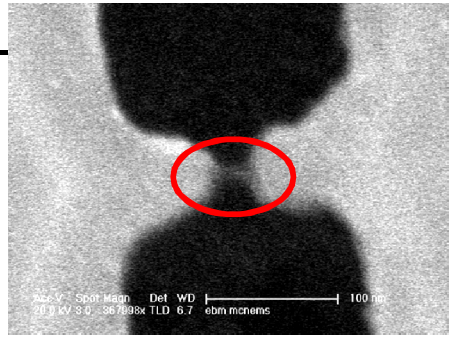
- **Sandia**: MEMS gas handling and separation, materials simulation capability
- **CEA/LETI**: NEMS fabrication and processing with 5 nm reproducibility
- **CEA/DAM** : NEMS resonator specific application
- **CalTech**: NEMS resonator mass sensor designs

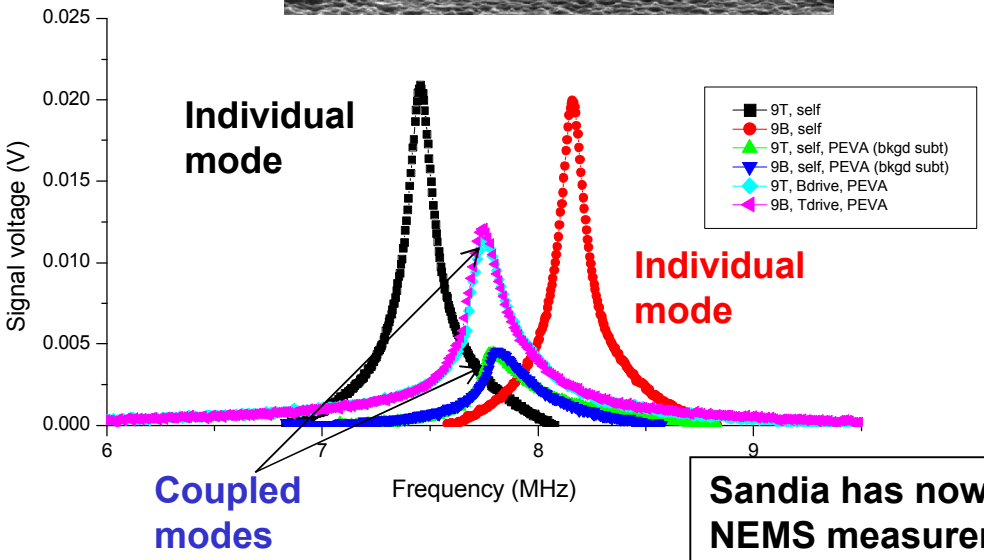
Progress to date

CEA-LETI has fabricated paired resonators…



…That have been bridged with polymers…





…That show coupled resonant modes when driven by one member of a device pair and sensed by the other.
(PEVA polymer bridge data at left from Dr. Ed Myers, Caltech)

Sandia has now duplicated the Caltech self- and cross-drive NEMS measurement capability, and has provided a gas-sensitive rubbery polymer (DKAP) that responds differently in nanogaps when compared to semicrystalline PEVA.
(DKAP data not shown here)

Next steps/future plans: Observe changes in DKAP-coupled resonator response due to controlled vapor exposures (gas sensing). Planning meeting at LETI is scheduled for 6-7-10.

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From the DGA/DOE interaction four areas of efforts are beneficial to the DOE/CEA agreement

Isentropic Compression Experiments and Technology Development

Current Amplification and Pulse Shape Modification

LTD Development for High Voltage and High Current Application

Radiation Source Development for k-Line and Plankcian Applications

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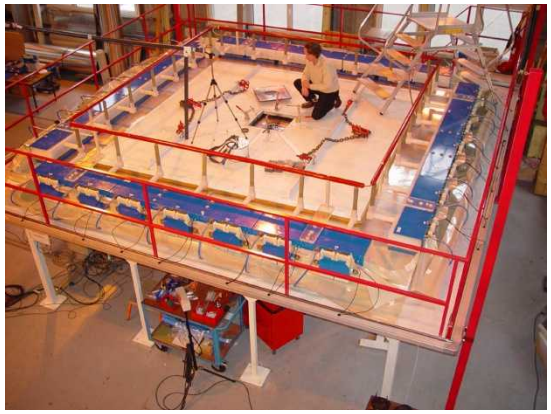
Isentropic Compression Experiments and Technology Development



Technical possible subjects of collaborations :

- Diagnostics
  - **Pyrometry – (C.Chauvin)**
    - **Low T pyrometry studies (<1300K) on both sides**
  - Collaboration on measurement of magnetic field homogeneity
  - Current measurement techniques
- **Technical Development**
  - **Preheating system –(PY Chanal):**
    - **Temperature homogeneity issues**
    - **Material choices : thermal insulation issues**
    - **Vacuum vs solid insulation**
  - Pulse shaping (Genesis on SNL side, ideas on French side)
  - new drivers developments
    - Bricks developments (switch reliability, caps)
    - Exchanges on future drivers designs
- Experimental Studies
  - Lagrangian or backward analysis
  - Maybe piggy back experiments on SNL (Z/VELOCE) and CEA Gramat Devices
  - Simulations
    - Phase transitions, magnetic field diffusion
    - Magnetic field homogeneity

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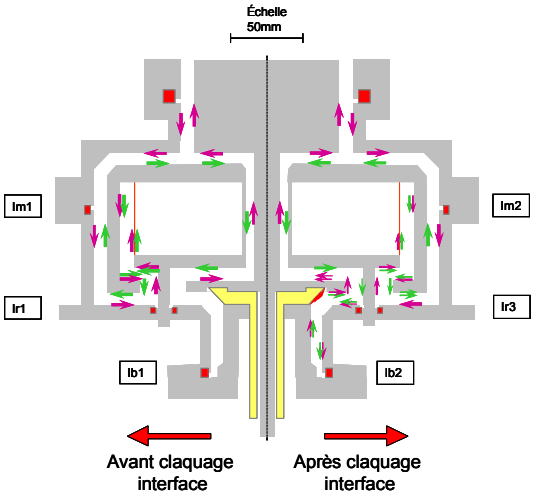
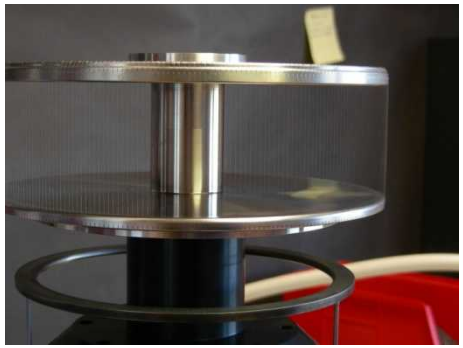
Current Amplification and Pulse Shape Modification

Technical possible subjects of collaboration :

- **Load current Multiplier**
  - CEA Gramat did some experiments on GIT12
  - SNL is funding experiments at UNR (ZEBRA)
    - Interest in exchanges on results and designs
      - Participation of CEA Gramat people to some ZEBRA experiments
    - Interest on scaling experiments to Saturn and Z design (if experiments are successful).
- **Dynamic Load Current Multiplier**
  - CEA Gramat will study DLCM concept on SPHINX
    - Triggered closing surface switch
    - Only Inductive load at the beginning
    - Post-hole convolute (~100 kV/cm)
    - Wire Array implosion as Inductive extruder.
  - SNL is interested in the concept (if successful) to be scaled on Z
  - Exchanges on the DLCM experiments
    - Participation of SNL people to some SPHINX experiments
    - Diagnostic improvement (especially voltage measurement for this scheme)
  - Simulations
    - Circuit code for analysis
    - MHD codes for extruder implosion





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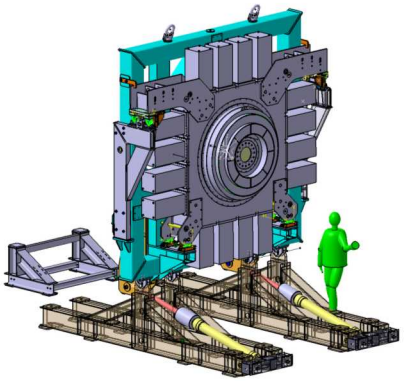
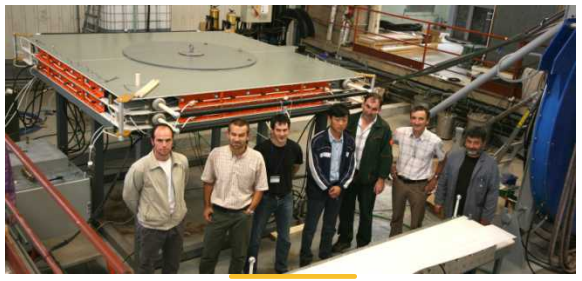
LTD Development for High Voltage and High Current Application

Technical possible subjects of collaboration :

- **LTD for High Current driver designs**
  - Both labs are interested in fast air insulated LTD technology
  - Bricks for both oil and air insulated fast LTDs are tested on both labs
    - Interest for exchanges on :
      - Switch, Caps, Solid insulation, Trigger system, Bias resistors, Magnetic cores
    - Data will be exchanged, cross participation to experiments on both labs.
  - SNL is working on a 10 oil insulated stages test bed (with waterline)
  - CEA Gramat will build a prototype air insulated 1µs LTD stage (2MA)
    - Demonstrator for future multi-MA µs driver
- **LTD for High Voltage driver designs**
  - SNL has built a 7 oil insulated stages LTD driver (plan to have a 21 stages test bed this year) for radiography.
  - Real need exist on component reliability (can be done on all existing LTD test bed)
    - Data will be exchanged, cross participation to experiments on both labs.





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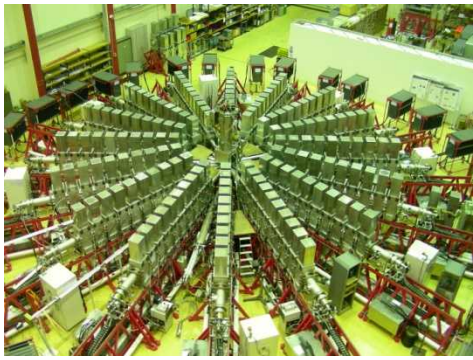
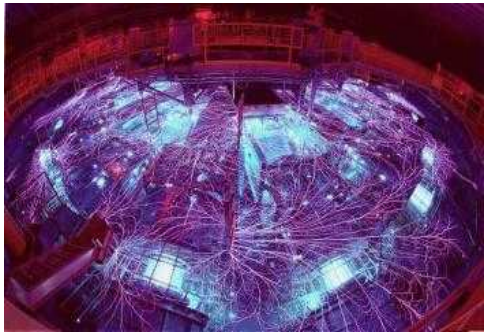
Radiation Source Development for k-Line and Plankcian Applications



Technical possible subjects of collaboration :

- **K-line sources**
  - CEA Gramat will continue Al loads characterization (800 ns implosion time) and Ar Gaz Puff(20 cm nozzle, 500 ns implosion time) optimization
    - SNL is working on a 12 cm diameter, 100 ns implosion time Gaz Puff loads for Ar and DD implosion : possible exchanges on large diameter Gaz Puff nozzle results.
  - Interest for piggy back experiments on Z k-lines shots (Ti, Cu, SS)
    - X-ray source characterization
    - Sample irradiation for code benchmark
- **Plasma jets**
  - Exchanges of data on plasma jets generation
    - CEA Gramat is studied conical array loads for astrophysics applications, several shots on SPHINX in 2010-2011
    - Several conical array shots will be done on Z at the end of 2010
  - Exchanges on plasma jets characterization techniques (diagnostics : Laser interferometry, Backlighting, Doppler shift spectrometry).
- **XUV sources**
  - Exchanges of data on XUV sources, exchange on diagnostic for XUV sources characterization.
  - Interest for Piggy Back experiments on Z with W cylindrical wire array
    - Secondary hohlraum at low T, for shock physics and iron opacity measurement
    - Similar low level experiments made on SPHINX



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