Plasma Science as a Part of NSF/Engineering's Mission

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Directorate of Engineering

U.S. National Science Foundation

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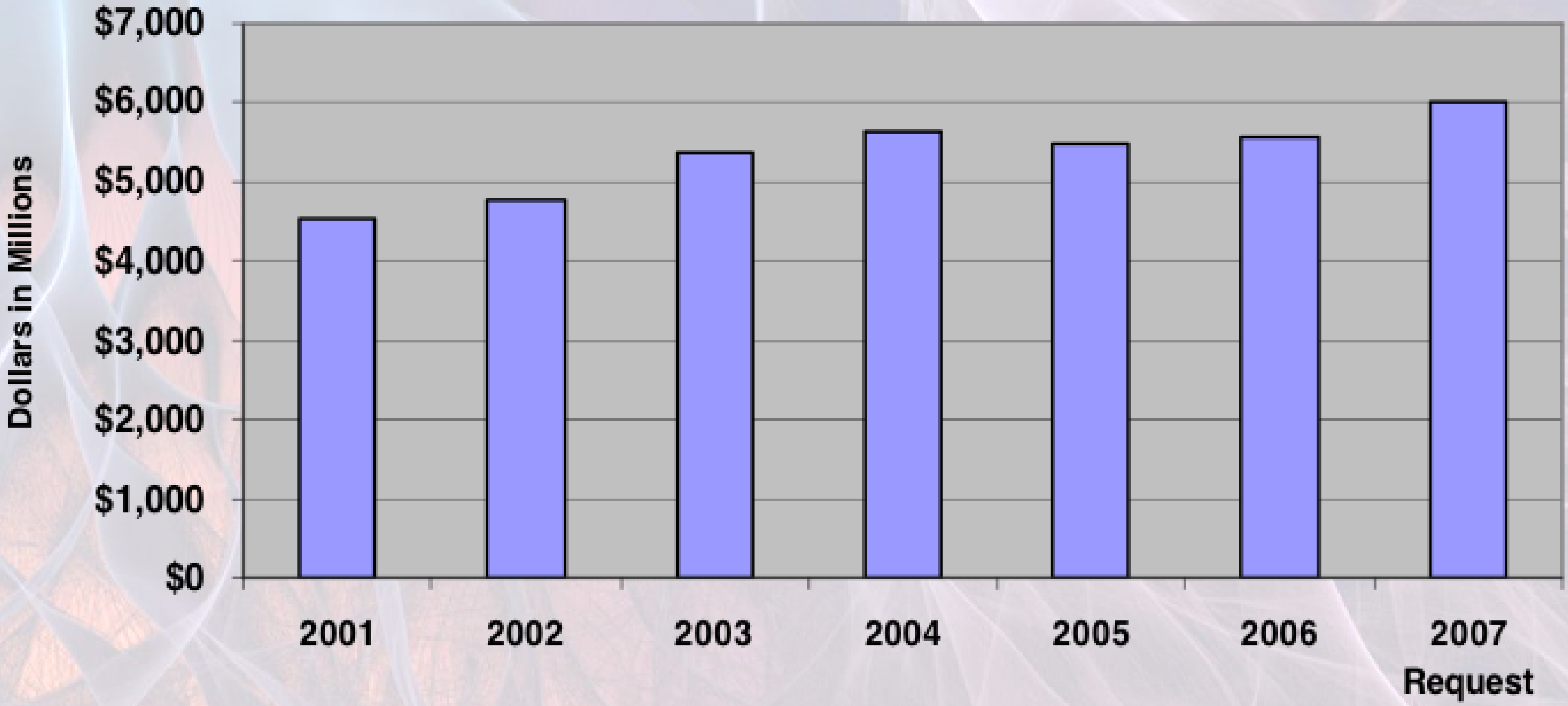
NSF is about fundamental knowledge, but the science in NSF/ENG is driven by problem-solving.

- Plasma processing and diagnostics are commercially, technologically, and scientifically important.
- Both combustion and plasma research are within the ENG/CFP program.
  - The engineering science of combustion and of plasmas has great overlap.
  - Flames are thermal plasmas, sometimes containing particulates.
  - Among their applications, each may be used for material synthesis or for surface treatment.

NSF Budget 2001-2007

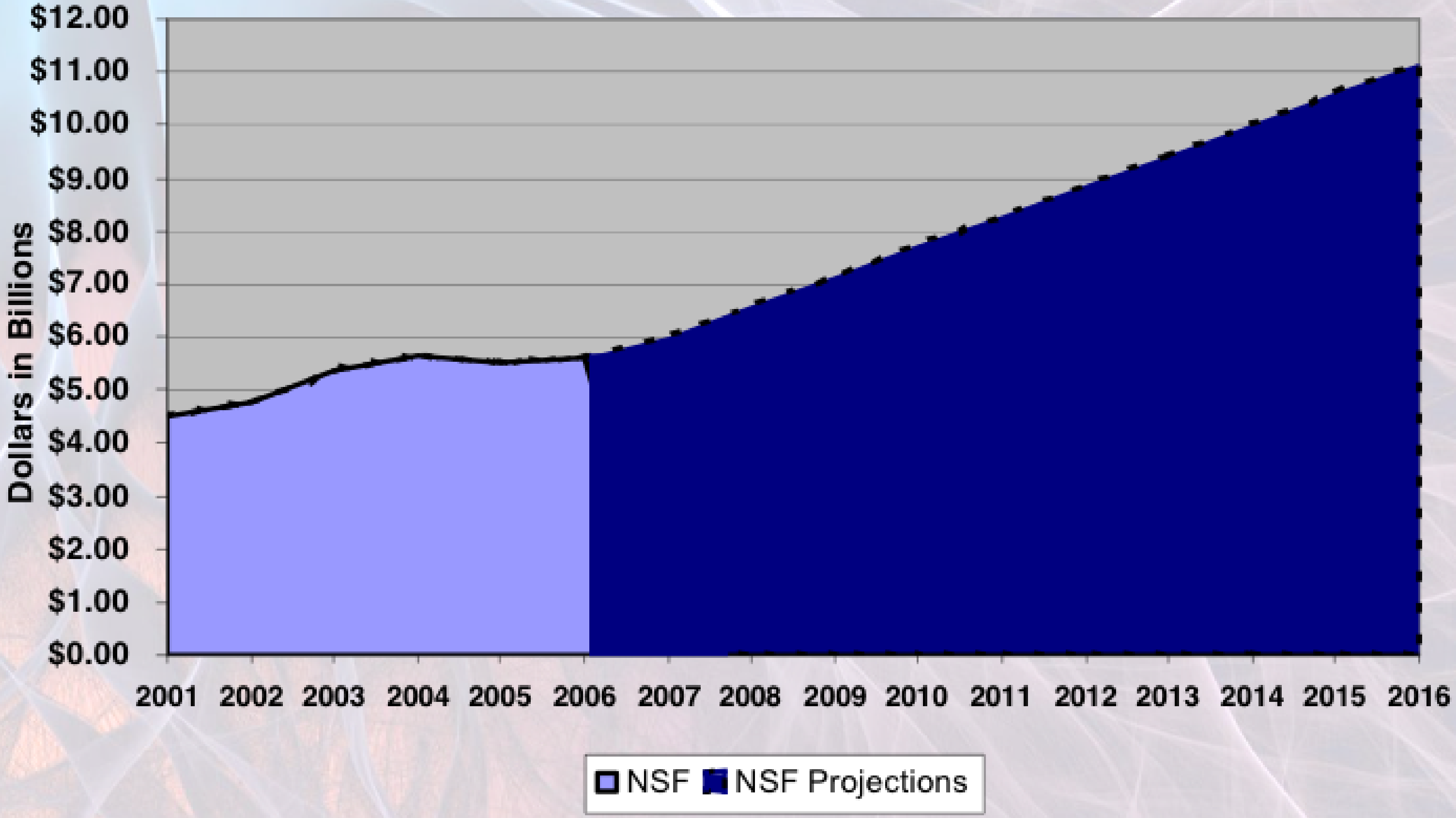
FY 2007 Request $6.02 billion

(+ $439 million or 7.9 percent from FY 2006)



Congress & the White House agree: Increase needed in physical science & engineering.

ACI-Driven NSF Budget Projections



National Science Foundation

FY 2006 through FY 2016 budgets are estimates based on White House data.

NSF Research and Related Activities

FY 2007 Request by Directorate (Dollars in Millions)

	FY 2006 Current Plan	FY 2007 Request	Amount Change	Percent Change
Biological Sciences	$576.69	$607.85	$31.16	5.4%
Computer & Information Science & Engineering	496.41	526.69	30.28	6.1%
Engineering (includes SBIR/STTR)	580.92	628.55	47.63	8.2%
Geosciences	702.83	744.85	42.02	6.0%
Mathematical & Physical Sciences	1,085.45	1,150.30	64.85	6.0%
Social, Behavioral & Economic Sciences	199.91	213.76	13.85	6.9%
Office of Cyberinfrastructure	127.12	182.42	55.3	43.5%
Office of International Science and Engineering	34.52	40.61	6.09	17.6%
U.S. Polar Research Programs	322.68	370.58	47.9	14.8%
U.S. Antarctic Logistical Support Activities	66.66	67.52	0.86	1.3%
Integrative Activities	137.12	131.37	-5.75	-4.2%
Arctic Research Commission	1.17	1.45	0.28	23.9%
Total, R&RA	$4,331.48	$4,665.95	$334.47	7.7%

Totals may not add due to rounding.

Combustion, Fire, and Plasma program: Core budget is $4.4 million per year.

- Typically two CAREER Awards at $400,000 for five years.
- Conferences, workshops, panels, REU supplements, SGER ~$200,000.
- About $3.4 million to unsolicited and other proposals (new and continuing) with typical sizes $240K-300K (3-yr duration).
- This would seem to imply a portfolio of about $15 million with an active total of 40-50 research awards.

CFP funding goes beyond its core budget.

- Currently, CFP participates in 67 active research awards at $28 million funding.
  - PI's also win awards through NSF solicitations like ITR ($1.8 million, 5 yr), NER ($100K, 1 yr), and NIRT ($1-1.2 million, 4 yr).
  - Participate in NSF-DOE Plasma Research solicitation.
  - Other awards are co-funded with other programs.
- CFP's plasma-research portfolio has 19 awards totaling $5.5 million, including one NIRT.

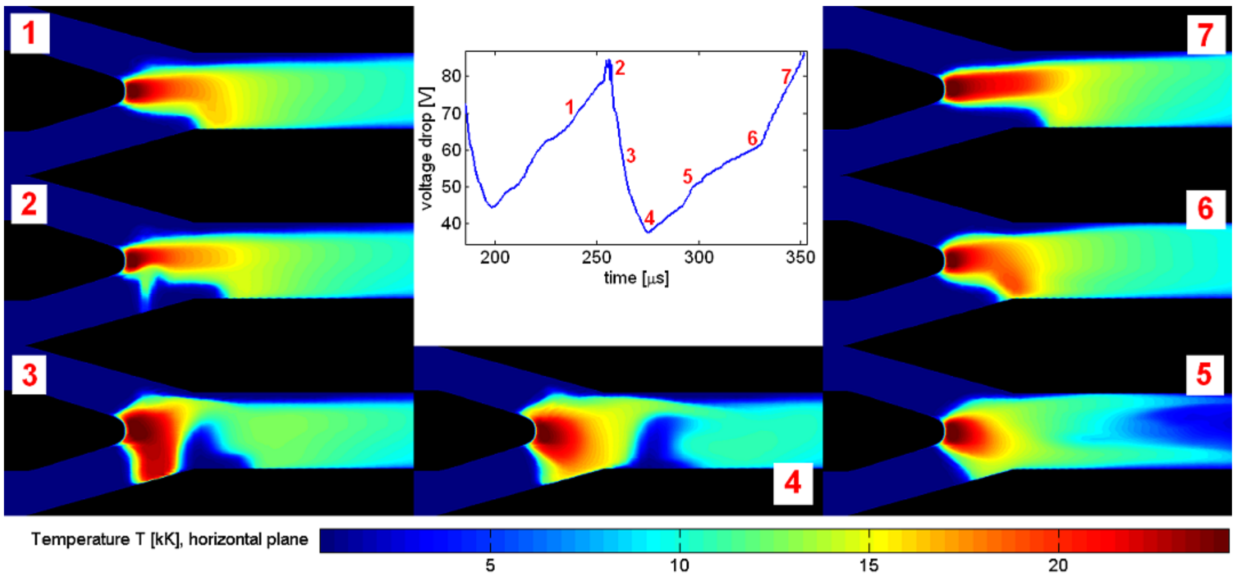
A wide range of plasma-research topics…

NIRT: Nanotechnological Manufacturing: Nanostructured Polymers Designed for Plasma/Energetic Beam Templating of Materials	Oehrlein (U Maryland College Park)
Etching of Dielectrics: Fundamental Plasma-Surface Interactions Through Mass-Filtered, Energy-Tuned Ion Beams	Giapis (Caltech)
Laser-Induced Plasma Based Diagnostics	Hahn (Florida)
Fluid Dynamic Characterization and Control of Turbulent Plasma Jets	Heberlein (Minnesota)
Atmospheric Pressure Plasma Processing of Polymers: Plasma Dynamics and Nanoscale Plasma-Surface Interactions	Kushner (Iowa St)
Pulsed Corona Discharge in Supercritical Carbon Dioxide: Fundamentals and Applications	Kennedy (Ohio St)
The Power Balance of Plasmas at Extreme High Pressure	Lawler (Wisconsin-Madison)
Collaborative Research: Plasma-Surface Interactions in Hydrogen Plasma-Induced Transitions from Carbon Nanotubes to Diamond Nanostructures	Maroudas (UMass), Aydil (Minnesota)
Quantifying Plasma-Surface Interactions: Charge Exchange, Energy Losses, Fragmentation, and Reactions	Giapis (Caltech)
Fundamental Physical and Chemical Investigations of Electron-Beam Plasmas	Dibble (SUNY Env Sci/Forestry)
Systematic Studies of Plasma Reactions on Dynamic Surfaces, Using a Novel Rotating Substrate	Donnelly (Houston)
CAREER: Electron Fluid Dynamics in a Hall-effect Accelerator: Using Fundamental Research to Enhance Education and Technology	King (Michigan Tech)
Collaborative Research: GOALI: Nanocrystal Formation and Morphology in Nonthermal Plasmas	Zachariah (Maryland), Kortshagen (Minnesota)
SGER: Coating Carbon Nanotubes with Aerosol Nanoparticles Produced from a Mini-Arc Plasma Source	Chen (Wisconsin-Milwaukee)

Fluid Dynamic Characterization and Control of Turbulent Plasma Jets

Heberlein (Minnesota)

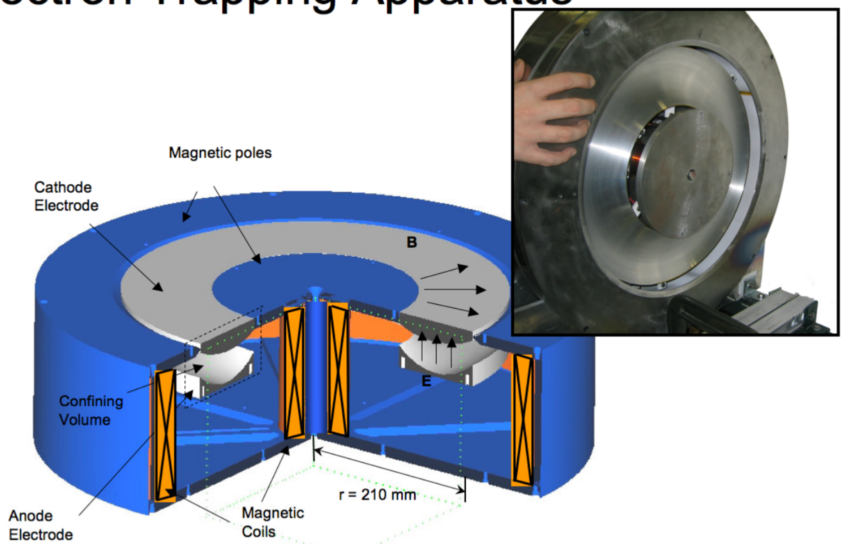
- To control plasma-spray deposition, we have to understand its instabilities.
- New multiscale FEM model of arc reattachment model gives a realistic simulation of the flow inside plasma torches.



- Model can be used as a design tool to predict performance and effect of plasma torch design changes, allowing efficient optimization of plasma spray coating equipment and processes.

CAREER: Electron Fluid Dynamics in a Hall-Effect Accelerator: Using Fundamental Research to Enhance Education and Technology (King, Michigan Tech)

Electron Trapping Apparatus

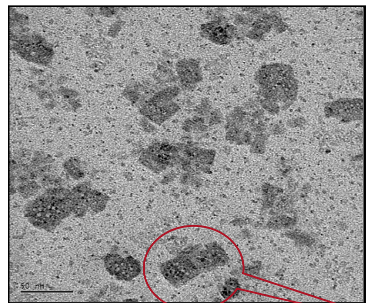


- Project seeks to understand anomalous leak rates of plasma across magnetic field lines in an attempt to account for the discrepancy between observation and theory.
- Investigators have designed, constructed, and tested a novel apparatus for inducing anomalous diffusion in a very controlled manner.

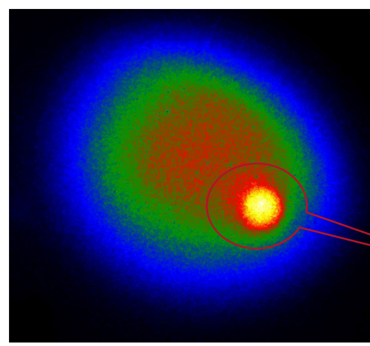
Laser-Induced Plasma-Based Diagnostics

Hahn (Florida)

- Image and quantify atomic emission from single micron-scale aerosol particles within laser-induced plasmas.
- The goal: Analysis of trace materials, notably airborne particles.

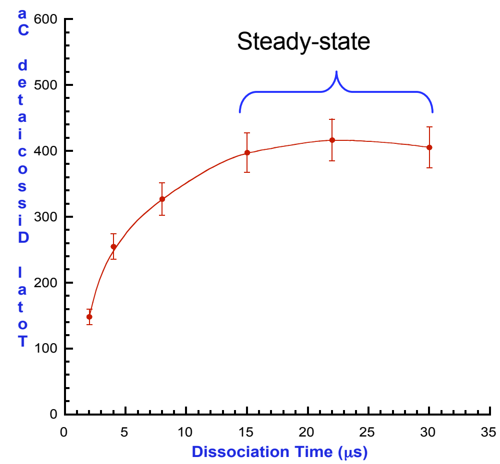


Designed nanoparticles (e.g. Mg-Cd)



Laser-induced plasma

Atomic emission imaging of single-particle dissociation within a laser-induced plasma

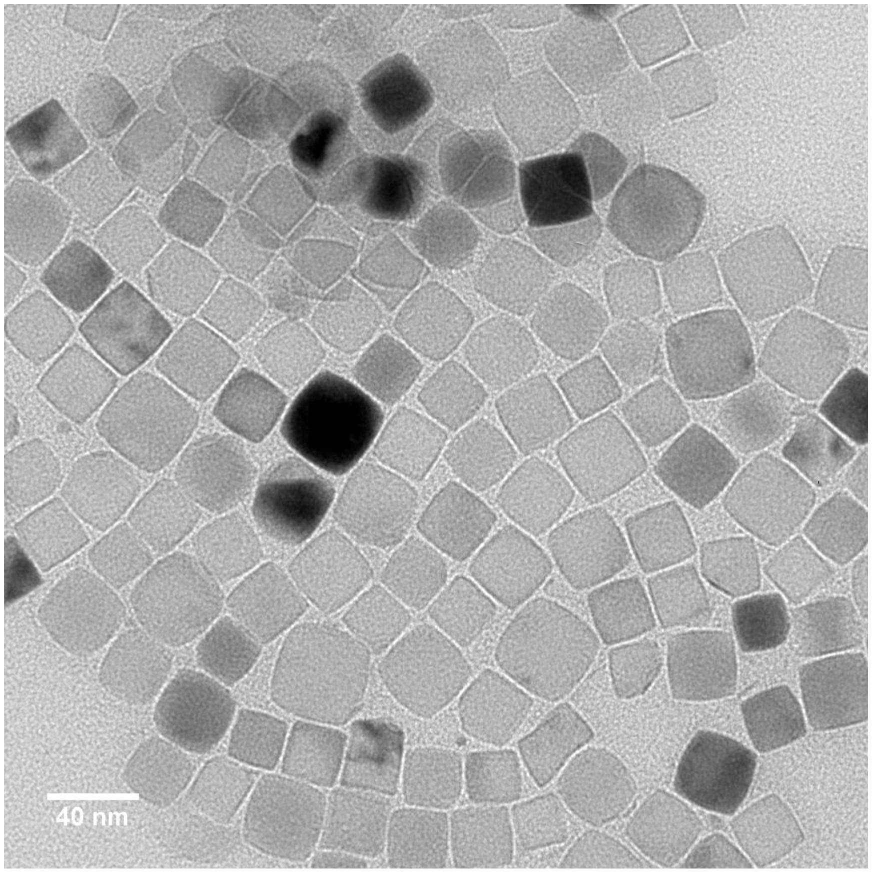


Measurement of single particle dissociation time-scale within the laser-induced plasma

- Applications: laser-induced plasma spectroscopy and laser-ablation / inductively coupled plasma / mass spectrometry (LA-ICP-MS).

Collaborative Research / GOALI: Nanocrystal Formation and Morphology in Nonthermal Plasmas

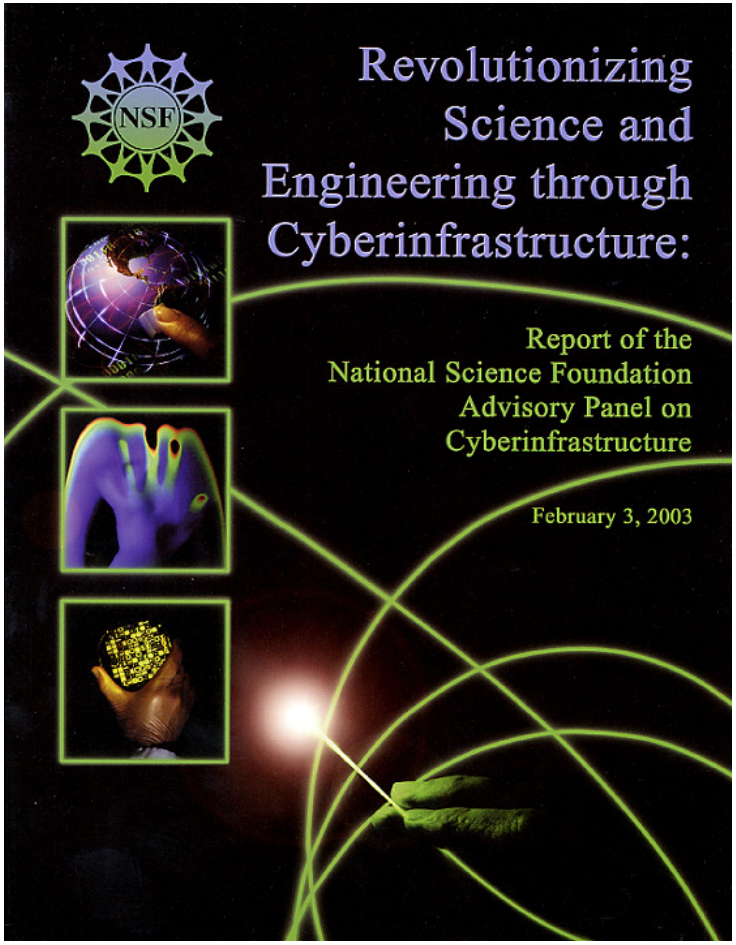
Zachariah (Maryland), Kortshagen (Minnesota); Innovalight, Inc.



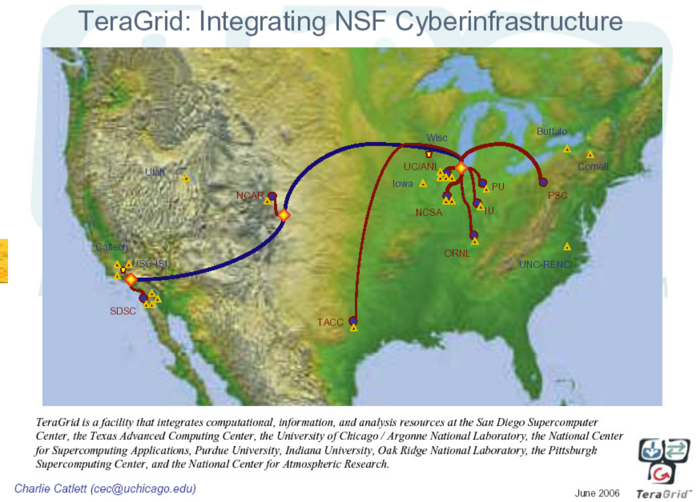
- May allow higher-efficiency solar cells.
- Possible cheaper fabrication by solution deposition of conductive films.
- This is apparently the first process that produces silicon crystals of a cubic shape.
- Hypothesis: Anisotropic hydrogen etching of heated Si, initially spherical, transforms particles into nanocubes.

Consider a new aid - Cyberinfrastructure.

- CI = Computers, codes, networks, and their use as infrastructure for the “Knowledge Economy”.
- We’ve long used these elements, but the newness is using an integrated system of hardware, software, data resources, and data services.
- This organizing concept aids new types of scientific / engineering research and education.



How do we best use CI?



- More powerful computing:
  - Grid-based computing
  - "Simulation-Based Engineering and Science"
  - "Cyber-Enabled Discovery and Innovation"
- Different ways of collecting and processing data.
  - Remote sensor networks and remote experiments.
  - Data workflows (Make data depositories, not data graveyards).
- More effective collaboration and information transfer:
  - Interactive data archives.
  - Threaded discussion.
  - "Virtual organizations" (gateways, hubs, collaboratories).

Virtual Organizations (VOs) can transform research.

- Typical elements:
- Created by a group whose members and resources may be dispersed globally, yet who function as a coherent unit through the use of cyberinfrastructure.
- Extend beyond small collaborations and individual departments to encompass wide-ranging activities and groups.
- Provide shared access to centralized or distributed resources, such as community-specific sets of tools, applications, data, and sensors, and experimental operations, often in real time.

See examples that show mixtures of data, computing, education, and collaboration tools.

- **Wat**er and **E**nvironmental **R**esearch **S**ystems and CyberCollaboratory, www.cleaner.org
- Network for Earthquake Engineering Simulation, www.nees.org
- National Nanotechnology Infrastructure Network, www.nnin.org
- Network for Computational Nanotechnology, www.nanoHUB.org
- Process Informatics Model, www.prime.berkeley.edu

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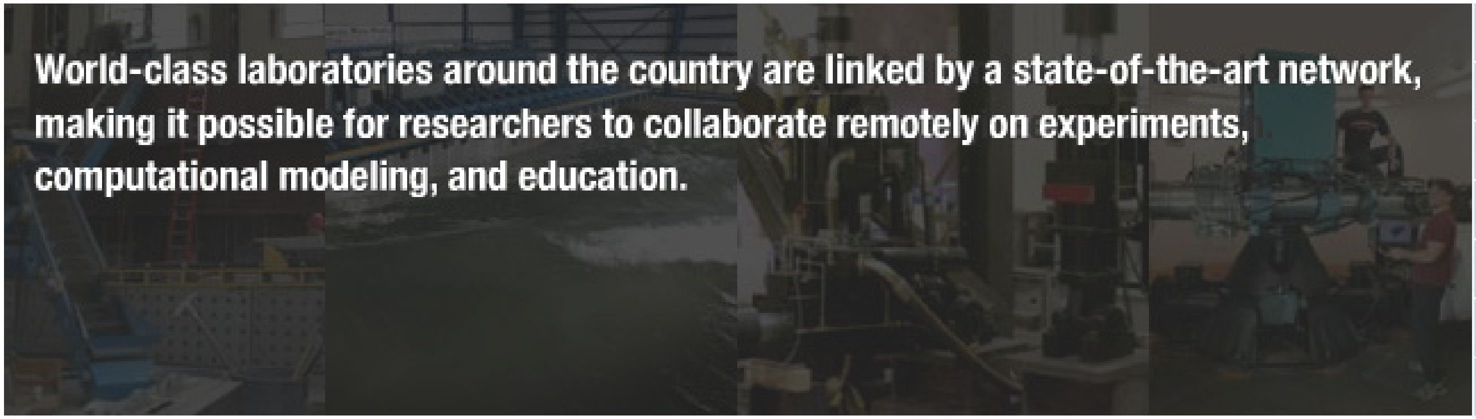

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2007 NEES Awards Competition
NEES community members are encouraged to submit entries for 2007 NEES awards to be presented at the Annual Meeting Banquet on June 20th in Snowbird, Utah. Awards will be given in recognition of outstanding effort in one of four categories for the 2006-07 year: *Most Effective Education, Outreach & Training (EOT) Activity (3 awards), Best IT Innovation, Best Experimental Site Innovation, and Outstanding Service to Researchers*. Nominations may be made by earthquake engineering researchers unaffiliated with a NEES site/NEES research project or by affiliated researchers and staff. More...

Job Opening
Deputy Executive Director

NEES Consortium, Inc. (NEESinc) is seeking a Deputy Executive Director (DEx) for its Davis, CA headquarters. The DEx provides strategic support to the Executive Director with

The NEES Activities Web Interface

NEES Site Activities provides information about current research at the Networks research facilities. Explore earthquake engineering experiment lists and view live video feeds. Click here to see it in action.

Calendar

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26-27 Apr 2007	Hybrid Simulation Workshop at nees@berkeley →
30 Apr 2007	NEES REU Program Summer 2007 Application Deadline →


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PrIMe
Process Informatics Model

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About PrIMe

PrIMe—Process Informatics Model—is a new approach for developing predictive models of chemical reaction systems that is based on the scientific collaboratory paradigm and takes full advantage of existing and developing cyber infrastructure. The primary goals of PrIMe are collecting and storing data, validating the data and quantifying uncertainties, and assembling the data into predictive models with quantified uncertainties to meet specific user requirements. The principal components of PrIMe include: a data **Depository**, which is a repository of data provided by the community, a data **Library** for storage of evaluated data, and a set of computer-based tools to process data and to assemble data into predictive models. Two guiding principles of PrIMe are: ***open membership***—a qualified individual or industrial organization can register to participate in the project; and *open source*—all submitted data, tools and models will be in the public domain.

»

New action: Solicitation 07-558, Engineering Virtual Organization (EVO) Seed Grants

- Letter of Intent required - deadline May 31, 2007.
- Deadline for full proposal: July 3, 2007.
- Funding date: By October 1, 2007.

Two-year seed grants, up to $200,000.

- Must establish an engineering virtual organization, enabled by CI, potentially including international participants.
- Must deploy its prototype EVO implementation.
- Must create a conceptual design of its full implementation, drawing upon:
  - Articulated research and education goals of a research community to advance new frontiers.
  - Advances made by other scientific and engineering fields in establishing and operating VOs and their associated CI.
  - Commercially available CI tools and services.
  - CI tools and services emerging from current federal investments.

To close:
What opportunities, specifically in this program?

- Encourage stretching across even more disciplinary boundaries.
  - Applying plasma science to diverse technologies.
  - Bridging the computer scientist / engineering scientist gap.
  - Broader opportunities: Linking plasma scientists with materials scientists.
- Encourage new science for systems-level solutions.
- Encourage more representative student populations.