Cyber-Enabled Discovery and Innovation (CDI)

The NEW NSF Initiative

Dr. Sirin Tekinay
Program Director, Communications Foundations
National Science Foundation

Cyber-Enabled Discovery and Innovation

Enhancing American competitiveness by enabling discovery and innovation through the use of computational thinking

- **Cyber-Enabled:**

Enabled by "computational thinking"

- **Computational thinking refers to:**
  - **Computational concepts, methods, models, algorithms, and tools**
- **Discovery and Innovation:**

Multi-disciplinary research seeking contributions to more than one area of science or engineering, by innovation in, or innovative use of computational thinking

CDI is Unique within NSF

- five-year initiative
- to create *revolutionary* science and engineering research outcomes
- made possible by *innovations* and *advances* in computational thinking
- emphasis on *bold*, multidisciplinary activities
- *radical*, *paradigm-changing* science and engineering outcomes through computational thinking

Transformative Research

- NEW in NSF Review Criteria:
  - To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts?
- ADDITIONAL CDI REVIEW CRITERIA:
    - The proposal should define a bold multidisciplinary research agenda that, through computational thinking, promises paradigm-shifting outcomes in more than one field of science and engineering.
    - The proposal should provide a clear and compelling rationale that describes how innovations in, and/or innovative use of, computational thinking will lead to the desired project outcomes.
    - The proposal should draw on productive intellectual partnerships that capitalize upon knowledge and expertise synergies in multiple fields or sub-fields in science or engineering and/or in multiple types of organizations.
  - potential for extraordinary outcomes, such as,
    - revolutionizing entire disciplines,
    - creating entirely new fields, or
    - disrupting accepted theories and perspectives

    ... as a result of taking a fresh, multi-disciplinary approach.

Special emphasis will be placed on proposals that promise to enhance competitiveness, innovation, or safety and security in the United States.

Long-term Funding for Cyber-enabled Discovery and Innovation

- All NSF directorates and programmatic offices are participating in this activity (*subject to budget approval*)

Request FY 2008	FY 2009	FY 2010	FY2011	FY 2012
$52M **min $26M in Solicitation**	$100M ? In solicitation	$150M	$200M	$250M

Three CDI Themes

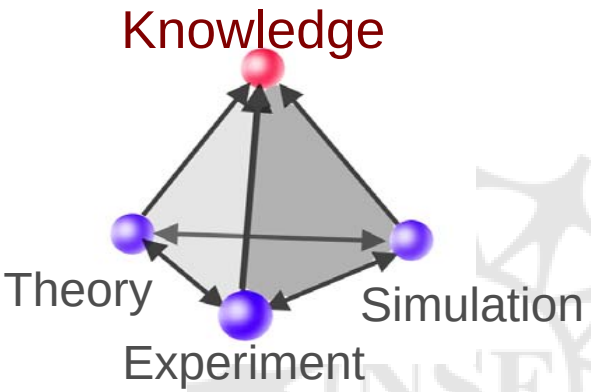
CDI seeks transformative research in the following general themes, via innovations in, and/or innovative use of, computational thinking:

- **From Data to Knowledge:** *enhancing human cognition and generating new knowledge from a wealth of heterogeneous digital data;*
- **Understanding Complexity in Natural, Built, and Social Systems:** *deriving fundamental insights on systems comprising multiple interacting elements;* and
- **Building Virtual Organizations:** *enhancing discovery and innovation by bringing people and resources together across institutional, geographical and cultural boundaries*.

From Data to Knowledge

Extracting useful information and deriving new knowledge from data efficiently, while accounting for the presence of uncertainty and dependency, leads to several sub-themes in which transformative ideas are needed:

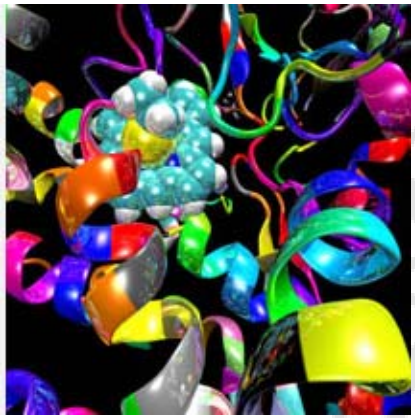
- Modeling
- Operations on data
- Algorithms
- Human interaction with data



Understanding Complexity in Natural, Built, and Social Systems

Identifying general principles and laws that characterize complexity and capture the essence of complex systems is one of the major challenges of 21st century science. Attaining the breakthroughs, to overcome these challenges, requires transformative ideas in the following areas:

- Simulation and Computational Experiments
- Methods, Algorithms, and Tools



Virtual Organizations (VOs)

Advances in VOs bring together domain needs with algorithm development, systems operations, organizational studies, social computing, and interactive design. VOs provide flexible boundaries, memberships, and lifecycles, which can be tailored to particular research problems, users and learner needs or tasks of any community. VOs provide opportunities for:

- Remote access
- Collaboration
- Education and training

CDI Philosophy

- Contributions to more than one area of science or engineering, by development or innovative use of computational thinking
  - Multidisciplinary projects stimulating advances in computational concepts, methods, models, algorithms, and tools
- "Business as usual" need not apply
  - *"Projects that make straightforward use of existing computational concepts, methods, models, algorithms and tools to significantly advance only one discipline should be submitted to an appropriate program in that field instead of to CDI."*
- No place for incremental research
- Untraditional approaches and collaborations welcome

Types of Projects

- CDI defines research modalities
- Project size not measured by $$
- Projects classified by magnitude of effort
- Three types are defined: Types I, II, and III.
- Type III, center-scale efforts, will be supported in the future.

Type I Projects

- focused aims that tackle discrete, high-risk problems that, once resolved, may enable transformative breakthroughs in multiple fields of science or engineering through computational thinking
- research and education efforts roughly comparable to that of up to two investigators with summer support, two graduate students, and their research needs (e.g., materials, supplies, travel), for a duration of three years

Type II projects

- multiple major aims that tackle complementary facets of complex solutions for advancing multiple fields of science and engineering through computational thinking.
- several intellectual leaders, multidisciplinary teams
- significant education component
- likely to be distributed collaborative projects with more extensive project coordination needs
- greater effort than in Type I, and, for example, roughly comparable to that of up to three investigators with summer support, three graduate students, one or two other senior personnel (post-doctoral researchers, staff), and their research needs (e.g., materials, supplies, travel), for a duration of four years

Type III Projects

- collaborative research, potentially distributed across several institutions
- may involve center-type activities, demanding substantial coordination efforts
- greater effort than in Type II in terms of scope and in the order of magnitude of expected outcomes
- Type III projects will not be supported in FY08, but in the future years, subject to the availability of funds

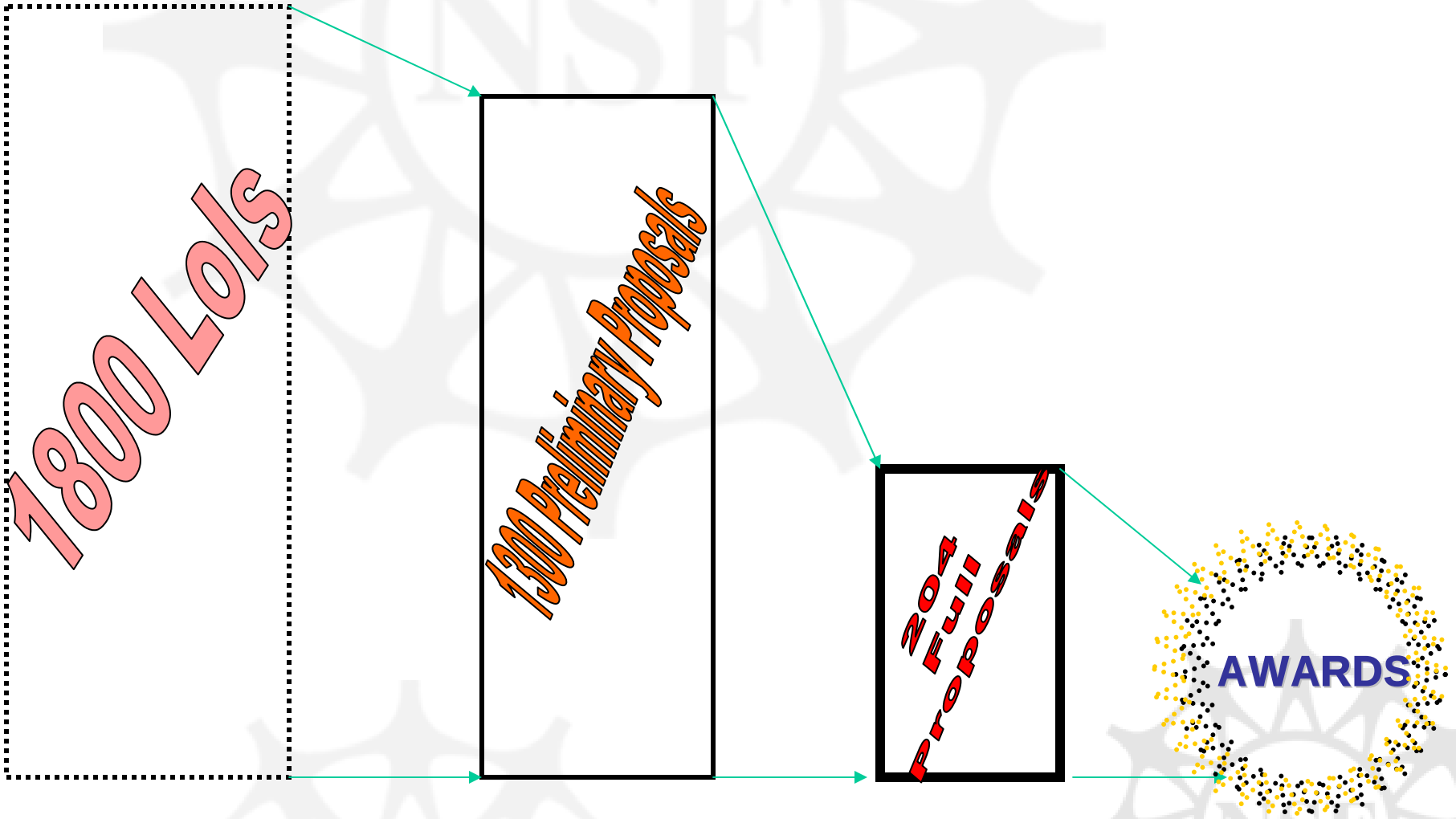
Broadening Participation

- diversity of sciences and engineering, academic departments
- underrepresented groups in STEM
- collaborations with industry in order to match
  - scientific insights with
  - technical insights

International Collaborations

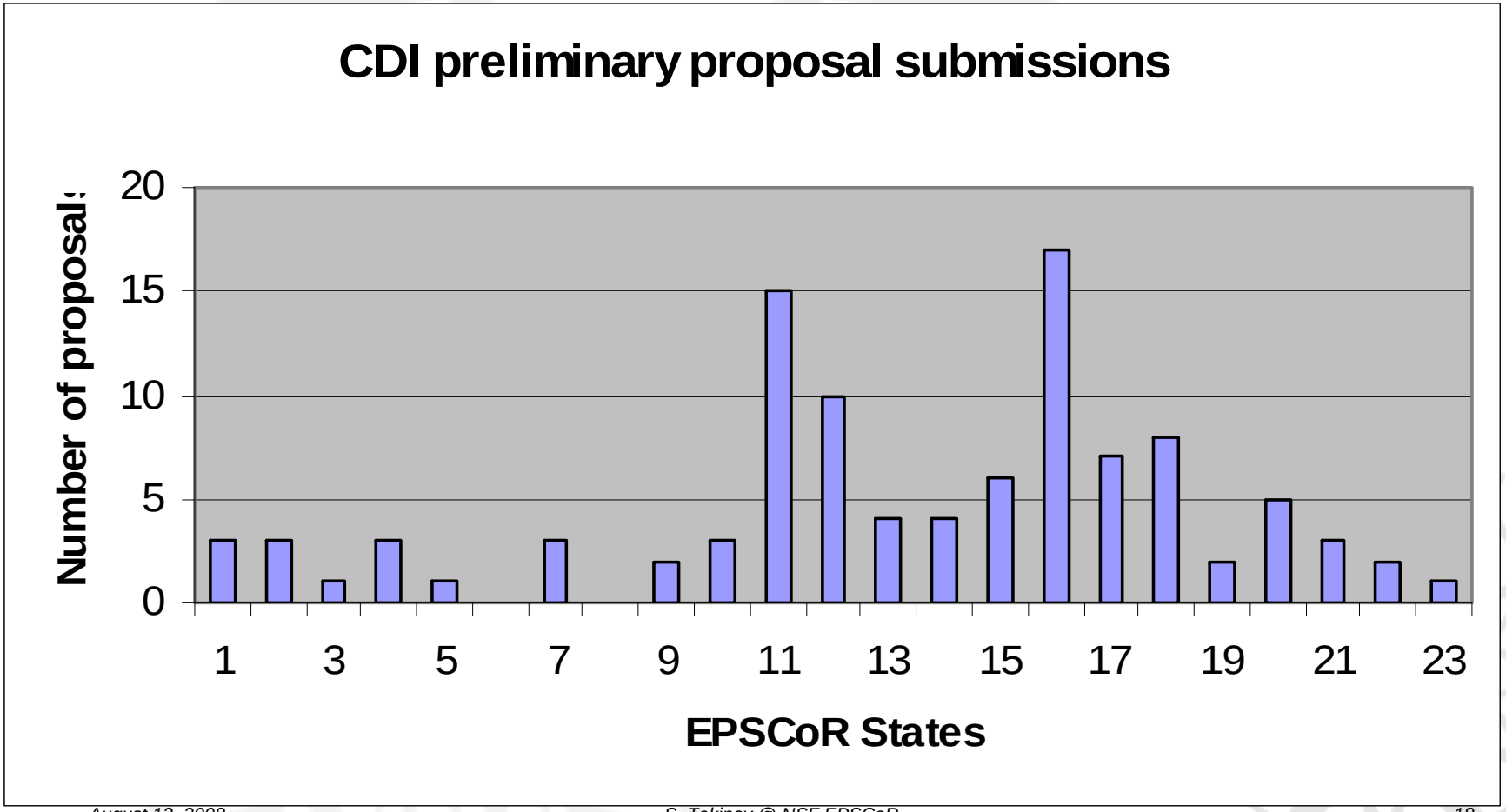
- involve true intellectual partnership in which successful outcomes depend on the unique contributions of all partners, U.S. and foreign
- engage junior researchers and students in the collaboration, taking advantage of cyber environments to prepare a globally-engaged workforce
- in conducting research in all of the major components of the CDI
- create more systematic knowledge about the intertwined social and technical issues of effective VOs, changing both the practice and the outcomes of science and engineering research and education.

NSF awards are, in principle, limited to support of the U.S. side of an international collaboration. In almost all cases, international partners should obtain their own funding for participation.


1800 LoIs
1300 Preliminary Proposals
204 Full Proposals
AWARDS

EPSCoR Participation

- Two no-shows, median: 3 prelim proposals per EPSCoR state
- Total number of submissions: 103 out of 1300



More Information on CDI:

- CDI Overview, References, Calendar of Events, FAQ:
  - http://www.nsf.gov/crssprgm/cdi/index.jsp
- Contact the CDI Working Group:
  cdi@nsf.gov ; (703)292-8080

What Would You Like To Do?

- Dream
- Dream bigger
- “Team up;” form intellectual partnerships
- Submit proposals
- Participate in the Review Process