Proposal Writing: Hints for maximizing your chances for getting beam time

General background on how DOE user facilities function and evolve –
(Making sausage isn’t always pretty but we like it anyway)

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• No equations! No singing!
• Scientists spend a lot of time writing proposals, reviewing proposals and giving presentations.
X-ray and Neutron Sources (mostly DOE)

Advanced Light Source  Advanced Photon Source  National Synchrotron Light Source

NSLS-II

CHESS

NIST NCNR

Stanford Synchrotron Radiation Laboratory
Linac Coherent Light Source
Manuel Lujan Jr. Neutron Scattering Center
High Flux Isotope Reactor
Spallation Neutron Source

Also 5 DOE Nanoscience Centers (BNL, SNL/LANL, ORNL, ANL, LBNL)
3 DOE Electron Microscopy Centers (ANL, LBNL, ORNL)
X-ray and Neutron Sources Available Worldwide

Science Continues to Go Global

◆ Light Sources summarized at www.lightsources.org
  ~59 facilities
  • European Synchrotron Radiation Facility (ESRF), Grenoble, France
  • SPRING-8, Japan
  • CLS, SLS, SOLEIL, DIAMOND, BESSYII, Taiwan, Shanghai, Pohang, …

◆ Neutron Sources summarized at www.neutronsources.org
  ~43 centers:
  • Institut Laue-Langevin (ILL), Grenoble, France
  • JSNS at J-PARC, Japan
  • China Spallation Neutron Source (~2018)
  • European Spallation Source (ESS), Lund, Sweden (~2019)
BES Scientific User Facilities

(from Pat Dehmer presentation)

- 4 Synchrotron Radiation Light Sources
- Linac Coherent Light Source
- 4 Neutron Sources
- 3 Electron Beam Microcharacterization Centers
- 5 Nanoscale Science Research Centers
- 3 Special Purpose Centers

Also 4 Advanced Scientific Computing Centers
BES Facilities Construction ~30 Years

Near Future?
BESAC – Basic Energy Sciences Advisory Committee

LCLS-II (ultrafast, high rep)
APS Upgrade (ultrabright MBA)
SNS 2nd Target (cold neutrons)
Free Electron Laser

Ongoing evaluations - Subject to change?

From P. Dehmer, Office of Science Update, Feb 28, 2013
Operating Budgets for the BES Scientific User Facilities

BES FY2013

- Materials Sciences & Eng: $347M (22%)
- Chem, Geo & Energy Bio Sciences: $308M (20%)
- Scientific User Facilities: $849M (55%)
- Construction: $47M (3%)
- Total: $1551M
FY 2013 BES Budget Appropriation

- **Research programs**
  - Energy Innovation Hubs (+$4.8M)
  - Energy Frontier Research Centers
  - Core Research (- $5.5M)

- **Scientific user facilities**
  - Synchrotron light sources (-$6.8M)
  - Neutron scattering facilities (-$3M)
  - Nanoscale Science Research Centers (-$2.3M)
  - NSLS-II early ops (+$22M)

- **Construction and instrumentation**
  - National Synchrotron Light Source-II (-$87.5M) and NEXT instrumentation
  - Spallation Neutron Source instruments (-$11.5M)
  - Advanced Photon Source upgrade
  - Linac Coherent Light Source-II (+$15M*)

*Includes $22.5M of prior year carryover*
More than 300 companies from various sectors of the manufacturing, chemical, and pharmaceutical industries conducted research at BES scientific user facilities. Over 30 companies were Fortune 500 companies.
Users by Facility at the Light Sources

Synchrotron Light Sources Serve >11,000 Users/Year
Users by Discipline at the Light Sources

Percent of Users

Fiscal Year

- Life Sciences
- Chemical Sciences
- Geosciences & Ecology
- Applied Science/Engineering
- Optical/General Physics
- Materials Sciences
- Other

Total Number of Users
Neutron User Community and Research Growing

Number of Unique Users

Fiscal Year

Research Area
- Physical
- Materials
- Life
- Geo and Molecular/Environ
- Chemical
- Applied

Actual

Planned
ORNL Home to many User Facilities (acronym required)

- BTRIC - Building Technologies Research and Integration Center
- CNMS - Center for Nanophase Materials Sciences
- CSMB - Center for Structural Molecular Biology (Bio-SANS)
- CFTF - Carbon Fiber Technology Facility
  - HFIR - High Flux Isotope Reactor
- MDF – Manufacturing Demonstration Facility
- NTRC - National Transportation Research Center
- OLCF - Oak Ridge Leadership Computing Facility
- Safeguards Laboratory (SL)
- SHaRE - Shared Research Equipment (TEM, merging in CNMS)
  - SNS - Spallation Neutron Source

Also, 2 EFRC’s (Energy Frontier Research Centers), 1 Energy Hub (Nuclear Modeling and Simulation)
Basics of the facility proposal systems

- All the DOE (NIST & NSF) neutron and x-ray sources offer access to beam time through an experimental proposal system. “General Users (GU)”.

- Proposal submission is done through a web-based application. When and how often proposals are submitted varies by facility.
  - APS and NSLS three times (“cycles”) per year.
  - SNS/HFIR and ALS two times per year

- All proposals are peer-reviewed and rated, and beam time is allocated using the scores of these reviews. Once time has been allocated, the beamline staff schedule the proposals.
Amount of general user time available

**APS/NSLS/SSRL/ALS**
- All beamlines offer GU beam time.
- Most DOE/NSF funded beamlines provide 80-100% of their time to general users.

**SNS/HFIR**
- Amount varies by instrument.
- ~75% of time will be for general users.

For most, you can search facility websites by technique or by beamline. Quality of proposal websites varies.
### Upcoming Proposal Deadlines: [www.lightsources.org/deadlines](http://www.lightsources.org/deadlines)

<table>
<thead>
<tr>
<th>X-ray sources</th>
<th>Deadlines</th>
</tr>
</thead>
<tbody>
<tr>
<td>APS</td>
<td>July 11, 2014</td>
</tr>
<tr>
<td>ALS</td>
<td>First Wednesday in Sept 2014</td>
</tr>
<tr>
<td>LCLS</td>
<td>February 11, 2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neutron sources</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HFIR/SNS</td>
<td>~Sept 2014</td>
</tr>
<tr>
<td>LANSCE/Lujan?</td>
<td>contact user office?</td>
</tr>
<tr>
<td>NIST-NCNR</td>
<td>contact user office?</td>
</tr>
</tbody>
</table>

- At most facilities, these are hard deadlines:
- APS always at Friday midnight (12:05 → next cycle)
- Inside Tip: Starting APS application process early (without submitting) gives you a lower ID #.
Users Get Started with Assistance of the Instrument Scientists

- Study instrument web pages
- **Contact an Instrument Scientist to discuss your research**
  - What is the research problem?
  - Which instrument(s) are appropriate? (scores?)
  - How mature is the research project (risk, size)?
  - What is the material – sample composition, form, size, availability?
  - What are the experimental conditions (temperature, pressure, magnetic field, etc)?
  - What will be measured?
  - Probability of success? Impact? Significance?
  - How will results be presented and to whom?
  - What is the timeline?
Instrument Scientists Assist First-time and Returning Users

- Provide technical advice, guidance, and assistance
  - Instrument options
  - Sample and experiment preparation
  - Number of experiment days
  - Logistics (scheduling, transporting and storing samples)
  - Proposal preparation tips and assistance
  - Experiment team members
  - Data analysis
  - Publication considerations
Submitting a proposal

Facilities have link on home page

NSLS-II
NSLS shuts down 9/30/14
Different types of proposals allow facility flexibility

Each facility has particular systems or proposal modes:

**APS**
- **GUP** - General User Proposal. A "rapid-access beamtime request" against a submitted proposal can be considered for any unallocated general user time during the current run.
- **PUP** – Partner User Proposal - Groups whose work involves a greater degree of collaboration with the APS. (e.g. major new instrumentation).
- **11-BM User Program** – Accepts user proposals for both on-site experiments and for the rapid-access mail-in service (~60% of user beamtime reserved for mail-in samples). Very easy – they send you capillary tubes. This capability is not obvious on the GUP website.

**CHESS – Cornell (just received new NSF funding)**
- **Express-Mode proposals** are for a single visit of limited duration to CHESS to perform a straightforward experiment. Express-Mode proposals undergo a rapid on-line review process to enable users to quickly gain access to beam time.
- **Feasibility Study** proposals are to test an idea or procedure at one of the CHESS stations.

**NSLS ➔ NSLS-II**
- **MAIL-IN EXAFS Service at Beamline X18B**
  Prepare your samples according to their thickness guide and mount on standard holder. Transmission mode. Charges are ~$100/hr.
Different types of proposals allow facility flexibility – cont.

**NIST NCNR**
**MAIL-IN SAMPLES FOR POWDER DIFFRACTION**
We will accept proposals for experiments on the BT1 powder diffractometer on "mail-in" samples. That is, samples may be mailed to NCNR staff, who will execute the data collection.

**QUICK ACCESS PROPOSALS**
If a user feels that beam time is required very soon to carry out important measurements that cannot be delayed, a proposal may be submitted requesting expedited access. The proposal will be reviewed by the BTAC, and held to a substantially higher standard than regular proposals.

**Crystallography** is somewhat a separate, self-contained community
• A separate proposal system at APS.
• Highly automated for mail-in measurements.
• Beamtime relatively available.
Proposal forms at SNS and APS

Each proposal system will ask very similar questions
Questions asked

- Proposal Title
- General Info (Title, Experimenters, Funding source, etc.)
- Abstract - What is the scientific importance of the proposed research?
- Why do you need the facility to do this research?
  - Neutron vs. X-rays
  - Why do you need an insertion device beamline instead of a bending magnet?
  - Spallation source vs. reactor source
  - Hard X-rays vs. Soft X-rays
- Why do you need the beam line (and/or instrument)?
  - Particular technique or sample environment
- What previous experience / results do you have (pubs important)?
- Describe the proposed experiment(s), including samples and procedures. Show that you’re prepared.
- Justification of the amount of time requested. Don’t be greedy or unrealistic about time needed. Ask beamline staff.
General Information
Proposal: General information

- Pick a good title. Specific and to the point is better than spectacular and vague.
  - Good: “XAS study of Fe valence in CaFe2As2 under pressure”
  - Bad: “Understanding superconductivity in superconductors”

- Is it thesis related? Is there a deadline?
  - Will push your proposal up if scores are close

- Fill in the abstract. Do not just upload a PDF document!
  - More work for reviewer.

- Do upload a publication from previous work (include previous proposals).
  - Shows you made good use of beam time. Becoming more important.
  - Do not upload a 20 pages of supplemental information (figures often help, couple of plots with text OK)
Proposal: Experimenters page

- Use the “find” feature
- List everyone involved in experiment
- Even theorists are useful
### Experiment Description

**Proposal: GUP-10325**

Please specify the funding source(s) for your proposed research:

- [ ] DOD (specify)
- [ ] DOE, Office of Basic Energy Sciences
- [ ] DOE, Office of Biological and Environmental Research
- [ ] DOE, Other (specify)
- [ ] Foreign (specify)
- [ ] HHMI
- [ ] Industry
- [ ] NASA
- [ ] NIH
- [ ] NSF
- [ ] Other (specify)

Specify Other:

What is the scientific or technical purpose and importance of the proposed research? (limit: 500 words)

Why do you need the APS for this research? (limit: 100 words)

Why do you need the beamline you have chosen? (limit: 100 words)

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**Note guidance!**

Don’t write one sentence or 1000 words.
Experimental Details

- Give background information why it is important.
  - Science at facilities is very diverse. Reviewer is not necessarily an expert on your subject. Try to capture imagination of reviewer with basic idea.
  - @ APS each committee gets ~60 proposals each cycle (~700 total/cycle)

- Clearly state what you want to measure and how
  - Give details. Temperature range, X-ray Energy, Sample geometry
  - What sample characterization has been done already? (XRD, SEM, etc.)
  - Reviewer needs to judge if experiment is feasible
    - Does x-ray energy match laser penetration depth
    - % of dilute atoms OK for fluorescence measurements

- Why use x-rays or neutrons?
  - Neutron vs. X-rays
  - TEM, Mössbauer, Laser Raman, etc.

- Justify the amount of beam time requested (ask instrument scientist!)
Proposals are valid for two years, but need to put in beam time request each cycle.

- Chose multiple beamlines.
  - SAXS (12-ID, 5-ID, 15-ID)
  - XAFS (20-BM, 10-ID, 12-BM)
  - General Diffraction

- Don’t list only one week that you can come. Holidays?

- Special sample environment / detectors will place more constraints on schedule.
  - GE amorphous Si detector
  - Magnet
  - ....
Ratings for APS Proposals

Table 1. Definition of Ratings Used in Reviewing General User Proposals

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Extraordinary</td>
<td>The proposal involves highly innovative research of great scientific importance. Proposed research will significantly advance knowledge in a specific field or scientific discipline. Considerable societal relevance is demonstrated. The radiation characteristics of the APS are highly desirable for the success of the proposed work.</td>
</tr>
<tr>
<td>2 - Excellent</td>
<td>The proposed research is of high quality and has potential for making an important contribution to a specific field or scientific discipline. The work is cutting edge and is likely to be published in a leading scientific journal. The radiation characteristics of the APS are important to the success of the proposed work.</td>
</tr>
<tr>
<td>3 - Good</td>
<td>The proposed research is near cutting-edge and likely to produce publishable results. Impact on a specific field or scientific discipline is likely. Synchrotron radiation is essential to accomplish the intended goals of the research. The proposed work will greatly benefit from access to the APS.</td>
</tr>
<tr>
<td>4 - Fair</td>
<td>The proposed research is interesting but may not significantly impact a specific field or scientific discipline. Publication may or may not result from this research. Synchrotron radiation is required, but the proposed work could be performed at other facilities.</td>
</tr>
<tr>
<td>5 - Poor</td>
<td>The proposed research is not well planned or is not feasible. Results would not make important contributions to fundamental or applied understanding, and work is not likely to result in publication. The need for synchrotron radiation is not clear.</td>
</tr>
</tbody>
</table>

APS proposals are rated on a scale from 1 to 5
Average score is ~2.2
Cut off score for receiving beam time varies by beamline (1.5 - 2.2)

Proposal “ageing” (score improves by 0.2 each cycle it does not receive time). This is needed for getting time at some oversubscribed beamlines, so long-term planning is needed. But you have to remember to request beamtime again for every cycle.
### Proposal Review Panels

<table>
<thead>
<tr>
<th>High Pressure</th>
<th>Instrumentation</th>
<th>Imaging/ Microbeam</th>
<th>Macromolecular Crystallography</th>
<th>Scattering Applied Materials</th>
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</thead>
<tbody>
<tr>
<td>Stanislav Sinogeikin, Chair</td>
<td>Tim Graber, Chair</td>
<td>Patrick LaRiviere, Chair</td>
<td>John Rose, Chair</td>
<td>Robert Suter, Chair</td>
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<tr>
<td>Ercan Alp</td>
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<td>Maria Baldini</td>
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<tr>
<td>Bin Chen</td>
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<tr>
<td>Przemyslaw Dera</td>
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<tr>
<td>Lars Ehm</td>
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<tr>
<td>Ravi Kumar</td>
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<tr>
<td>Barbara Lavina</td>
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<tr>
<td>Sang-Heon (Dan)</td>
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<tr>
<td>Shim</td>
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<tr>
<td>Heather Watson</td>
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<tr>
<td>Keith Brister Wenjun Liu</td>
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<tr>
<td>Darren Dale</td>
<td></td>
<td></td>
<td>Arnon Lavie</td>
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<td>Matthew</td>
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<td>Anne Mulichak</td>
<td>Armand Beaudoin</td>
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<td>Ginder-Vogel</td>
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<td>Dillon Fong</td>
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<td>Xiaojing Huang</td>
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<td>Dileep Singh</td>
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<tr>
<td>(guest)</td>
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<td></td>
<td>Mike Toney</td>
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<td>Tony Lanzirotti</td>
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<td>Lisa Miller</td>
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<td>Mark Pfeifer</td>
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<tr>
<td>Martina Ralle</td>
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<tr>
<td>Xianghui Xiao</td>
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</tbody>
</table>

*If multiple possibilities - Look at members & Ask staff*
ALS provides cutoff scores – Helps you know what to expect

Beamline cutoff scores

<table>
<thead>
<tr>
<th>Beamline</th>
<th>% Beam Time Allocated / Requested</th>
<th>Cutoff Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4 (IR)</td>
<td>38</td>
<td>2.42</td>
</tr>
<tr>
<td>2.1 (NCXT)</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>4.0.2 (EPU)</td>
<td>39</td>
<td>2.02</td>
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<tr>
<td>4.0.3 (Merlin)</td>
<td>30</td>
<td>2.00</td>
</tr>
<tr>
<td>5.2.2.2 (Polymers XAFS)</td>
<td>38</td>
<td>1.90</td>
</tr>
<tr>
<td>5.4 (IR)</td>
<td>45</td>
<td>2.42</td>
</tr>
<tr>
<td>6.0.1 (Femtosecond)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>6.0.2 (Femtosecond)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>6.1.2 (Soft X-Ray Microscopy)</td>
<td>49</td>
<td>1.80</td>
</tr>
<tr>
<td>6.3.1 (Materials Sciences)</td>
<td>22</td>
<td>1.92</td>
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<tr>
<td>6.3.2 (Calibration and Standards)</td>
<td>66</td>
<td>2.12</td>
</tr>
<tr>
<td>7.0.1 (XPS, SXF, SPES)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>7.3.3 (SAXS)</td>
<td>38</td>
<td>1.88</td>
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<tr>
<td>8.0.1 (SXF)</td>
<td>20</td>
<td>1.74</td>
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<tr>
<td>8.3.1 (XPS)</td>
<td>93</td>
<td>2.78</td>
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<tr>
<td>8.3.2 (Tomography)</td>
<td>44</td>
<td>2.08</td>
</tr>
<tr>
<td>9.0.2 (Chemical Dynamics, Coherent Imaging)</td>
<td>66</td>
<td>2.25</td>
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<tr>
<td>9.3.1 (APSD/AMC, High-Pressure XPS)</td>
<td>41</td>
<td>2.66</td>
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<tr>
<td>9.3.2 (APSD/AMC, High-Pressure XPS)</td>
<td>44</td>
<td>1.86</td>
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<tr>
<td>10.0.1 (HERS/AMO)</td>
<td>23</td>
<td>1.88</td>
</tr>
<tr>
<td>10.3.2 (Micro XAFS)</td>
<td>40</td>
<td>1.86</td>
</tr>
<tr>
<td>11.0.1 (Magnetic Microscopy, Spectromicroscopy, PEEM3)</td>
<td>28</td>
<td>1.90</td>
</tr>
<tr>
<td>11.0.2 (Molecular Environmental Sciences, STXM, ambient pressure XPS)</td>
<td>23</td>
<td>1.58</td>
</tr>
<tr>
<td>11.3.1 (Small Molecule Crystallography)</td>
<td>54</td>
<td>1.93</td>
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<tr>
<td>12.0 (ARPES)</td>
<td>15</td>
<td>1.83</td>
</tr>
<tr>
<td>12.2.2 (High Pressure)</td>
<td>60</td>
<td>2.26</td>
</tr>
<tr>
<td>12.3.2 (Microdiffraction)</td>
<td>42</td>
<td>2.05</td>
</tr>
</tbody>
</table>

**Total allocation**: 41.7
Tips

- Give a concise explanation of this specific proposal
  - Provide background on importance (i.e., “bigger picture”)
  - State clearly and exactly what you are going to measure and why.
    - Reviewer want so assess likelihood of success.
- Include relevant details to experiment but do not get too verbose
  - Reviewer needs to judge not only scientific importance, but also if the experiment is feasible and if you are asking for the right instrument.
- If you are a first time user, talk to the local contact/instrument scientist.
  - Find out about details of the instrument, typical measuring times…
  - Over-subscription rate? Can a less popular instrument do the same measurements?
  - Send them the proposal ahead of time and ask for advice.
- Collaborate?
- If you have previous results from other experiments include them!
  - Home, other institution, previous experiment.
  - Sample characterization.
- Take advantage of proposal ageing. Plan ahead!
Several common pitfalls

- Proposer assumes committee is familiar with their specialty.
- Proposer writes large general vague proposal asking for multiple weeks of time. Better to write a shorter proposal with a well defined objective. Be realistic with beam time request.
- Proposer submits 2 (or more) similar proposals for related materials thinking that multiple proposals increases chances.
- Proposal deadline (for next cycle) is before scheduled beam time this cycle.

Common Reviewer comments:

- “Proposers could improve their score by including more experimental details, attaching previous results and expanding on the purpose and importance of the research.”
- “Hasn't the proposed research been published previously?”
- “We do not feel that granting 20 shifts/cycle for 2 years is consistent with the history of publication of this work.”
- “Proposer should perform initial characterization with lab sources or TEM.”
After submission

- Allow time for review and revisions
- Expect feedback several weeks from the call close
- Be ready to schedule experiment if approved
  - Identify participating team members
  - Respond to facility access approval information
  - Facilitate execution of user agreements
  - Complete required training
  - Confirm sample availability and description and laboratory needs
- Consider reviewer comments if not approved and plan to resubmit this proposal or a new proposal in the next call. Opportunities (# of facilities and beamlines/facility) continue to grow.
Join SNS HFIR User Group (SHUG)

- Chartered 1998
- Open to individuals interested in using SNS and HFIR
- Provides input to management on user concerns
- Serves as a forum for keeping the user community informed
- Acts as an advocacy group for neutron scattering science
Nearly opportunities for collaboration

- Become a user
- Join SNS/HFIR User Group (SHUG)
- Have your friends and colleagues apply to the National School on Neutron and X-ray Scattering
- Attend workshops and conferences
- Seek EPSCoR grants
  - http://www.sc.doe.gov/BES/EPSCoR/about.html
  - Promote ORISE internships, fellowships, and research participation programs http://orise.orau.gov/sep/index.htm
- Bring student groups to ORNL
- Invite ORNL scientists to your campus
Seek EPSCoR Grants

- EPSCoR State Institutions are eligible for grants to support research
  - http://www.sc.doe.gov/BES/EPSCoR/about.html
- Travel support for users from UT-ORNL Joint Institute for Neutron Sciences (JINS). Contact Takeshi Egami at egami@utk.edu
Office of Science Early Career Research Program
(for your future consideration – very good for tenure)

• **Purpose:** To support individual research programs of outstanding scientists early in their careers and to stimulate research careers in the disciplines supported by the Office of Science

• **Eligibility:** Within 10 years of receiving a Ph.D., either untenured academic assistant professors on the tenure track or full-time DOE national lab employees (no postdocs)

• **Award Size:**
  • University grants $150,000 per year for 5 years to cover summer salary and expenses
  • National lab awards $500,000 per year for five years to cover full salary and expenses

• **FY 2010 (Inaugural Year) Results:**
  • 69 awards funded via the American Recovery and Reinvestment Act
  • 1,750 proposals peer reviewed to select the awardees
  • 47 university grants and 22 DOE national laboratory awards
  • Awardees are from 44 separate institutions in 20 states

• **FY 2014:**
  • 35 scientists funded (750 applications), 17 National Labs + 18 Universities
  • Usually pre-application in Sept, Full applications from those encouraged in November.

http://science.energy.gov/early-career/
Scientific User Facilities – (mostly from Pat Dehmer presentation)

- Under construction at the time of the evaluation
  - Spallation Neutron Source
  - 5 Nanoscale Science Research Centers
  - SSRL (SPEAR3) upgrade

- Facilities underway since the evaluation
  - Transmission Electron Aberration Corrected Microscope
  - Linac Coherent Light Source
  - National Synchrotron Light Source - II

- Facilities rated longer-term priority at the time of the evaluation
  - Spallation Neutron Source power upgrade (CD-0 signed)
  - Spallation Neutron Source 2nd target station
  - Advanced Light Source upgrade
  - Advanced Photon Source upgrade
  - Restarted three times!

- What’s next in our planning?
  - Ongoing BESAC Future Science Needs and Opportunities Evaluations
Next Generation Light Source is being Debated
BESAC = Basic Energy Sciences Advisory Committee

http://science.energy.gov/bes/besac/reports/

Report of the BESAC Subcommittee on Future X-ray Light Sources
Approved by the Basic Energy Sciences Advisory Committee on July 25, 2013

Grand Challenge Science Opportunities
An exciting window of opportunity exists for the U.S. to provide a revolutionary advance in x-ray science by developing and constructing an unprecedented x-ray light source. This new light source should provide high repetition rate, ultra-bright, transform limited, femtosecond x-ray pulses over a broad photon energy range with full spatial and temporal coherence. Stability and precision timing will be critical characteristics of the new light source.

- Free Electron Laser (FEL)?
- “Ultimate” storage ring?
- Energy Recovery Linac (ERL)?

Next Big Machine – Soft XFEL?
APS/ESRF Upgrades
MAX IV Low-emittance lattice
Continue research development?

Impact of large Scientific User Facilities has grown significantly in the past ~25 yrs. They now represent ~55% of BES budget and growth will likely continue. They enable powerful new techniques, but researchers (you) have to do the science. Need good science, progress also involves enthusiasm, politics, luck & perseverance.