GETTING BEAMTIME: TRICKS OF THE TRADE

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MY PERSPECTIVE

- Former beamline scientist (NIST BT-1)
- Former instrument developer (11-BM) & former group leader (x2)
- Done experiments at NSLS, HFBR, IPNS, ILL, NIST, APS
- Proposal reviewer for HFIR, SNS, NIST, APS… (site reviews: NScD, ALS, Diamond)

Presentation Outline

1. User facilities & DOE Basic Energy Sciences
2. Where can I get time
3. The review process
4. How & what to put in a proposal (& what to not do)
5. Getting help

GOVERNMENTS PROVIDE BEAMTIME FOR FREE

But it costs money (lots!) to provide. (Facilities cost $60M to $200M/yr to run.)

- The supply of time is limited. Research projects cover travel and related expenses (N.B. in some other countries, facilities may cover travel)
  - COVID has prompted beamlines to offer mail-in or remote access. (How much of that will be retained is unclear.)

- Few beamlines have sufficient availability for all interested users
  - Almost none have enough time to satisfy all requests.
  - Some beamlines get requests for x4-5 over what is available
  - In most user facilities beamlines have very little "internal" time

- To make sure access is equitable, access is granted with priorities based on externally reviewed proposals

* Free when goal of work is to publish in open literature. For proprietary research, U.S. law requires cost recovery (FWIW, cost recovery expenses are pretty reasonable, considering).

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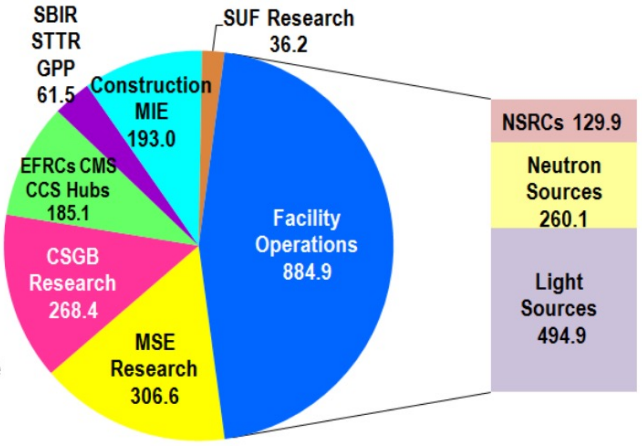
FY 2021 President's Request: $1,935.7M (-$277.3M or -12.5% from FY 2020)

Research programs Δ = -$5.9M

- Core Research ($575M) includes new investments ($73M) in critical materials, data/AI/ML, polymer upcycling, next-generation biology, microelectronics, and accelerator R&D (Direct Air Capture of CO_2 – Marks)
- Computational Materials and Chemical Sciences continue ($26M)
- Energy Frontier Research Centers continue ($115M)
- Energy Innovation Hubs continue ($44.1M)



Scientific user facilities Δ = -$66M

- Operations of 12 facilities continue at ~91% of optimal. LCLS at 97% of optimal ($884.9M).
- Facilities research continues for AI/ML; increases for accelerator R&D ($36.2M).

Construction/MIE* Δ = -$200.5M

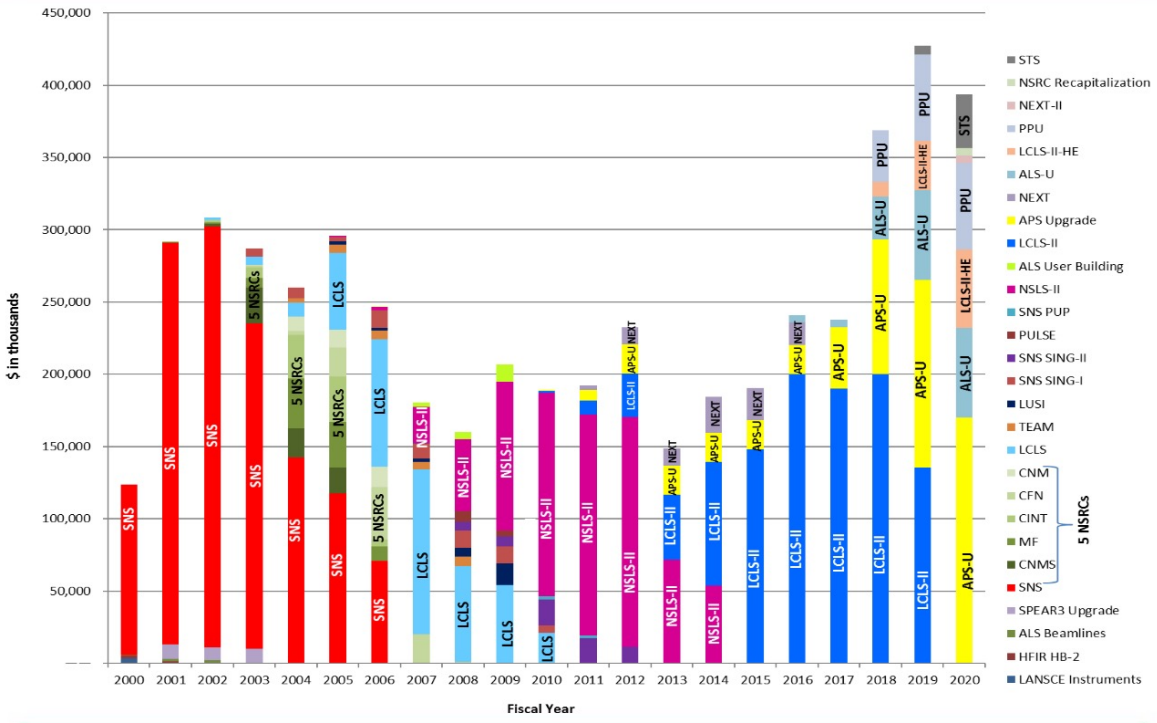
- APS-U ($150M); LCLS-II-HE ($16M); ALS-U ($13M); PPU ($8M); STS ($2M)
- MIEs: NSRC Recap ($1M); NEXT-II ($1M)
- New start: Cryomodule Repair & Maintenance Facility (CRMF) ($2M)

U.S. DEPARTMENT OF ENERGY | Office of Science

*includes OPC

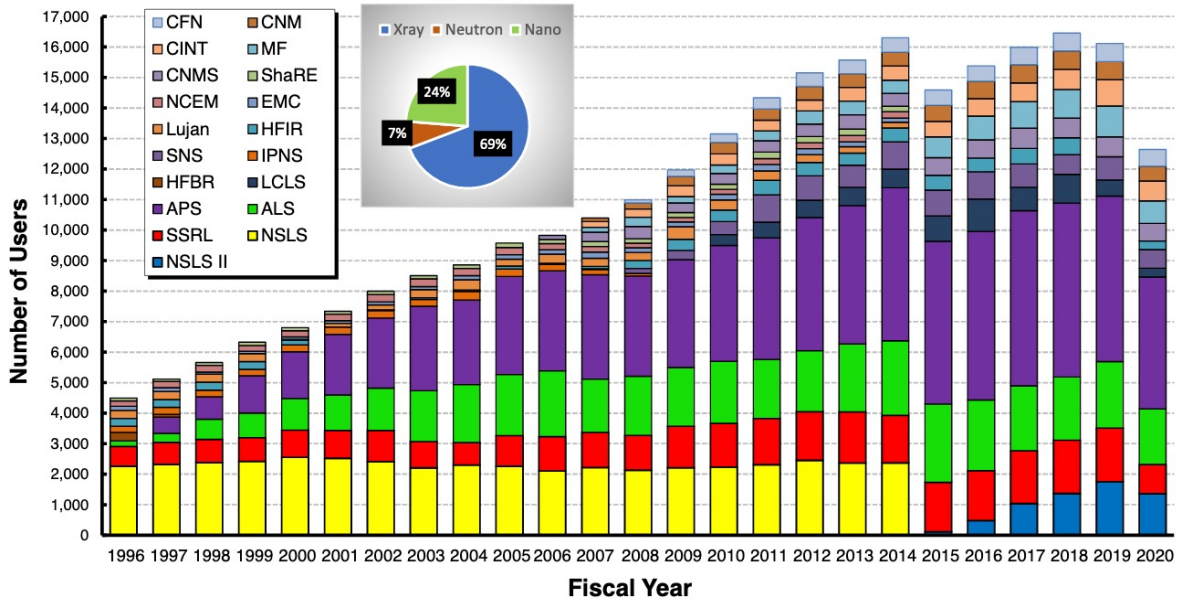
Linda Horton, (Dec. 2020 BESAC meeting)

BES Construction/MIE Funding Profiles: 2000 – 2020



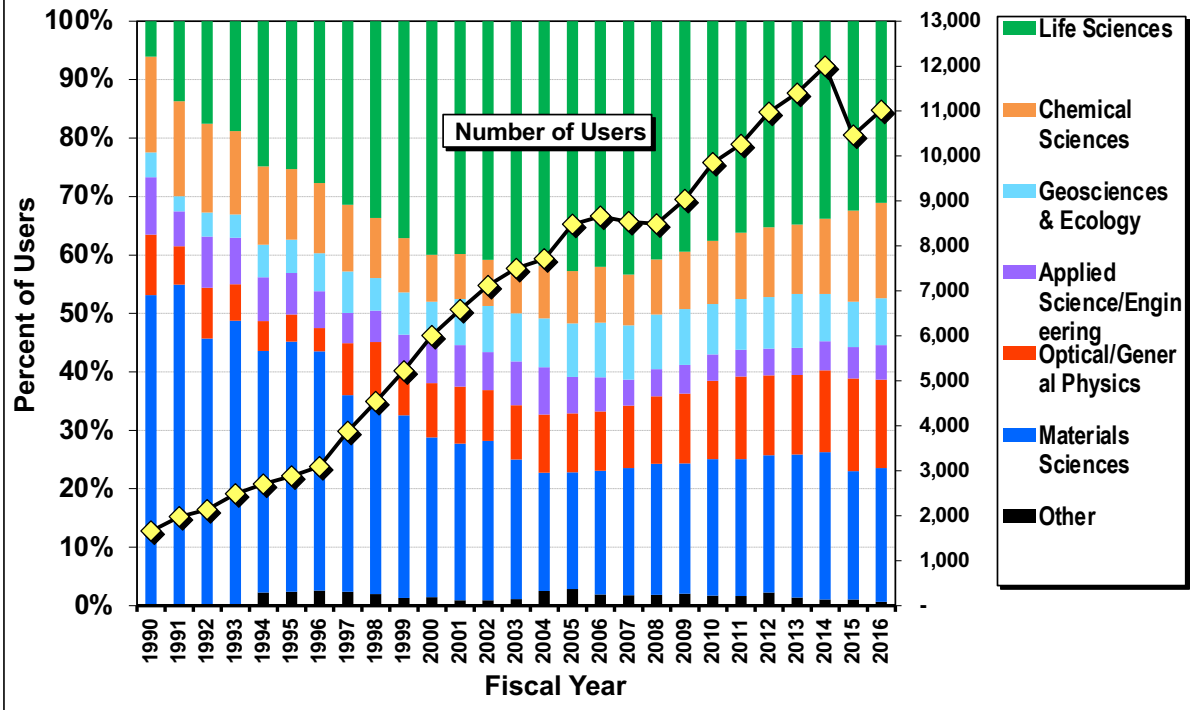
Linda Horton, (Dec. 2020 BESAC meeting)

BES User Facilities Hosted Over 12,500 Users in FY 2020 Impacted by COVID-19



Linda Horton, Associate Director, Office of Basic Energy Sciences (Dec. 2020 BESAC meeting)
https://science.osti.gov/-/media/bes/besac/pdf/202012/1115_Horton_BESAC_202012.pdf

Users by Discipline at the DOE Light Sources



John Budai: 2018 NX School presentation

WHERE CAN I GET TIME?

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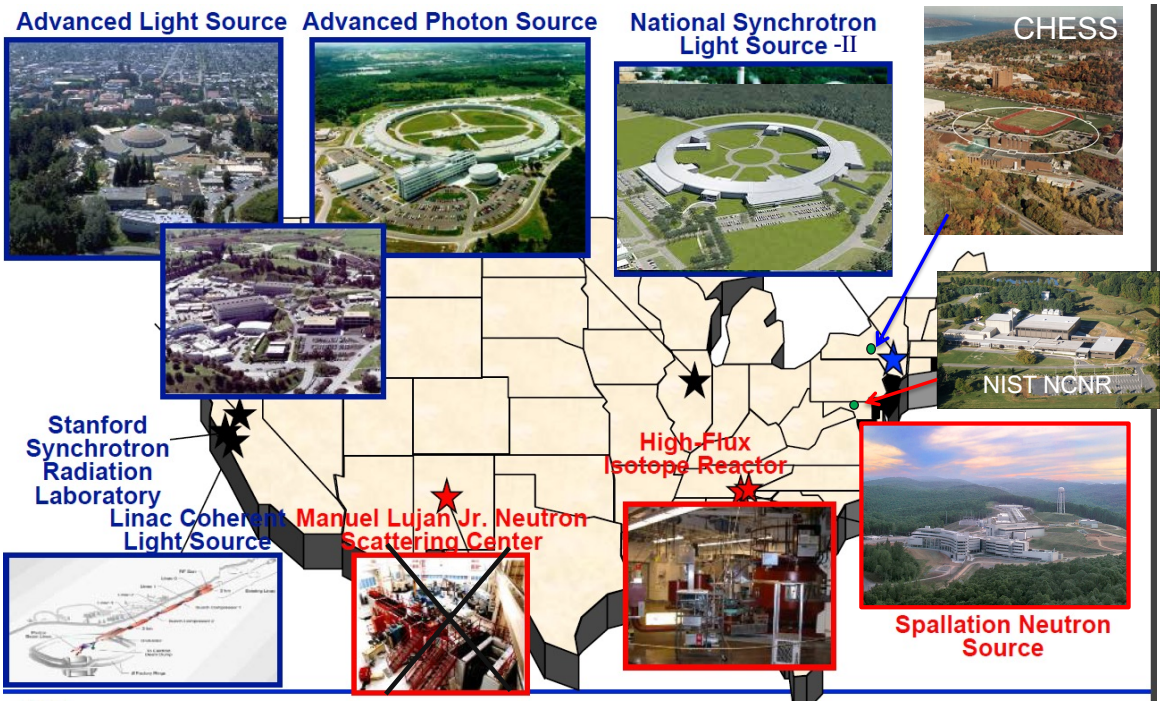
X-ray and Neutron Sources (most DOE-Basic Energy Sciences)



Also 5 DOE Nanoscience Centers (BNL, SNL/LANL, ORNL, ANL, LBNL)
DOE Electron Microscopy Centers (ANL, LBNL, ORNL)

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CONSIDER FACILITIES WORLDWIDE

For some measurements, the leading instruments are outside the US

◆ **Light Sources (see www.lightsources.org),** >50 synchrotrons + FELs

- European Synchrotron Radiation Facility (ESRF), Grenoble, France
- Swiss Light Source (SLS, Paul Scherrer Institute)
- LNLS - Laboratório Nacional de Luz Síncrotron (Brazil)
- Canadian Light Source / Centre Canadien de Rayonnement Synchrotron
- SPRING-8, Japan
- PETRA III, Germany
- Diamond Light Source, Oxfordshire, UK

◆ **Neutron Sources (see www.neutronsources.org),** ~50 centers

- Institut Laue-Langevin (ILL), Grenoble, France
- ISIS UK
- JSNS at J-PARC, Japan
- China Spallation Neutron Source, Dongguan
- European Spallation Source (ESS), Lund, Sweden (user program ~2023)

Several universities run small reactors, but they are seldom appropriate for cutting edge research

WHAT BEAMLINES OFFER GU TIME?

GU = General User

APS/NSLS/SSRL/ALS

- **Beamlines run by facilities offer most (80-100%) of beamtime to users.**
  - **Externally-run (e.g. CATs, etc.) may offer a smaller fraction (typically 25% at APS), but all beamlines must offer GU beam time**

SNS/HFIR

- **Amount varies by instrument, but typically ~75% GU time**

NIST

- **Cold neutron instruments are typically run by NSF and are ~75% GU**
- **Thermal neutron instruments are typically internally and are ~25% GU**

HOW DO I GET BEAM TIME AT A USER FACILITY?

- All DOE, NIST, and NSF neutron and x-ray sources offer access to beam time through an experimental proposal system. “General User (GU) time”
  - Other specialized programs may be possible for other types of access (technique/instrumentation development; long-term experiments,…)
  - Beamlines do get a bit of discretionary time; sometimes a beamline scientist may be able to get in a short “proof of concept” measurement, or may be willing to collaborate
- Proposal submission is done through a web-based application. When and how often proposals are submitted varies by facility
  - APS, NSLS-II three times (“cycles”) per year
  - SNS/HFIR, ALS, LCLS two times per year
  - Deadlines are “hard”; *a submission 1 minute late may not be accepted*
- All proposals are peer-reviewed and rated, and beam time is allocated based on the scores of these reviews
- The highest ranked proposals are usually allocated time; the beamline staff schedule those proposals
  - At APS: if a proposal is not given time, and the request is renewed each cycle, the review score is improved each cycle (proposals “age up”)

NON-GU PROPOSALS

Each facility handles this different

APS

GUP - General User Proposal are valid for two years or until recommended shifts are fully used. A beam time request has to be submitted for each cycle for which the proposal is to be considered.

PUP – Partner User Proposal - Groups whose work involves a greater degree of collaboration with the APS. (e.g. major new instrumentation or technique).

Rapid Access Mail in Powder Diffraction for 11-BM, 11-ID, 17-BM. Very easy , they send you capillary tubes.

Rapid Access General User Proposal is valid for a single cycle, single Beam Time Request

CHESS – Cornell

Standard Proposal is good for two years from the date of review and acceptance. After a proposal has been reviewed and accepted, it generates its first beam time request. A Beam Time Request (BTR) must be submitted for every following cycle for which a user requests beam time.

Feasibility study proposals are only granted for one-time access to test something never done before.

NIST Center for Neutron Research

New Proposal Regular proposal (including continuation) for one beam time access, reviews by Committee (BTAC)

Quick Access Proposal for experiments that cannot be delayed. Reviewed by BTAC but held to higher standard

Beam Time Request is a request for part of the instrument time reserved for NIST internal research programs. Such requests may be made by external users through collaborative research projects with a NIST Staff member.

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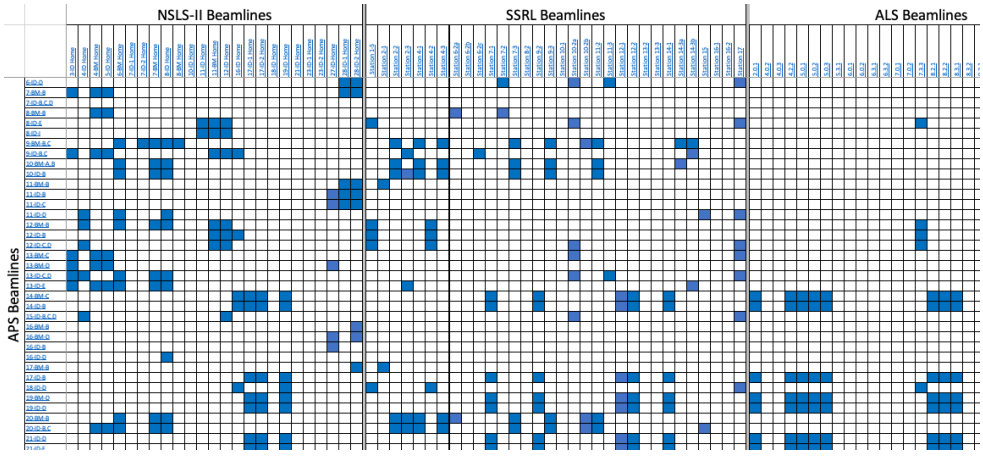
ALSO CONSIDER: APS WILL BE “DARK” FROM APRIL 2023 TO APRIL 2024

Other beamlines with similar capabilities to APS beamlines will likely be more busy during this period

- See https://aps.anl.gov/APS-Upgrade/Comparable-Beamline-Options-For-Users
- Understand that every beamline in the U.S. has different strengths and may not be able to perform equivalent measurements



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HOW DO I SUBMIT A PROPOSAL

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FIRST: LEARN ABOUT WHAT YOU WANT TO DO

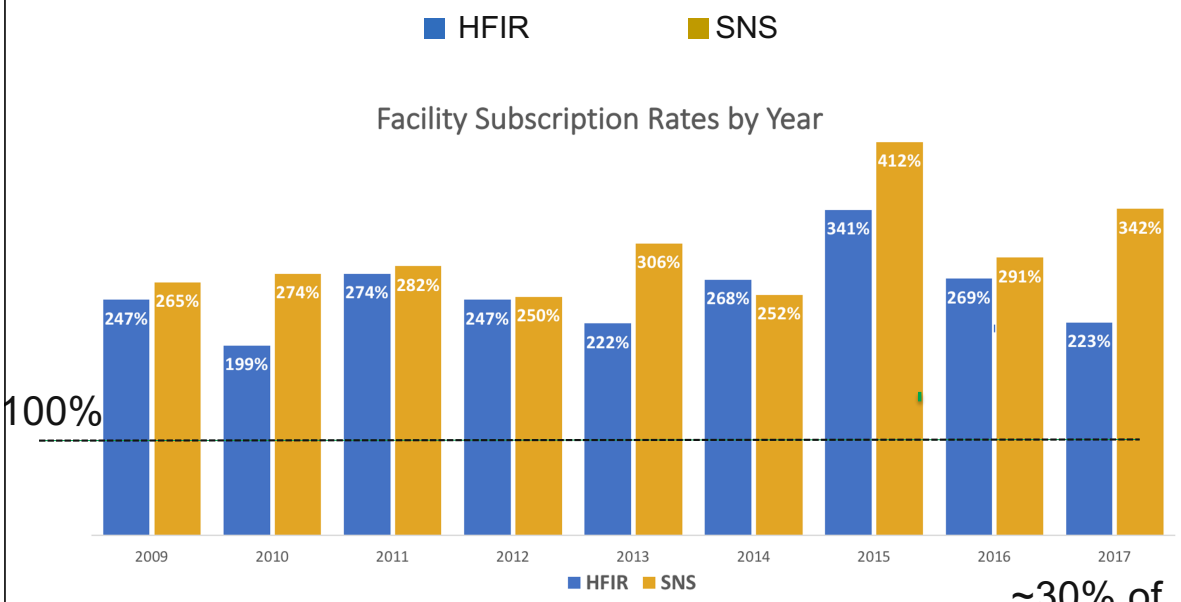
Study facilities and instrument web pages

Questions to consider:

- What is the research problem? What do you hope to learn?
- Which instrument(s) are appropriate? (what level of review scores are needed?)
- How mature is the research project (risk, size)?
- What is the material – sample composition, form, size, availability? Consider safety restrictions
- 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? Pay attention to proposal deadlines!

Unless you have access to an expert, contact an Instrument Scientist to discuss your research

Overall subscription rates at HFIR/SNS remain high



~30% of requested time is granted

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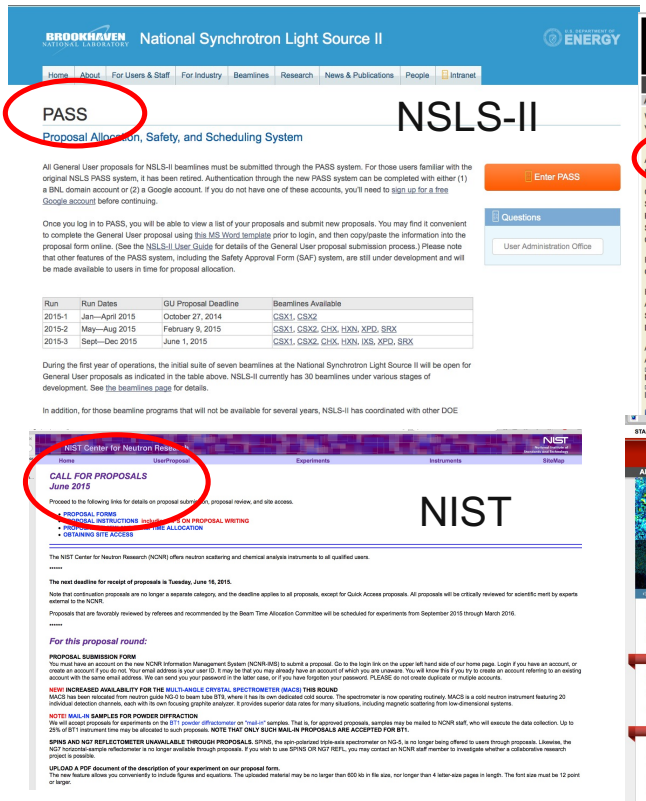
Submitting a proposal

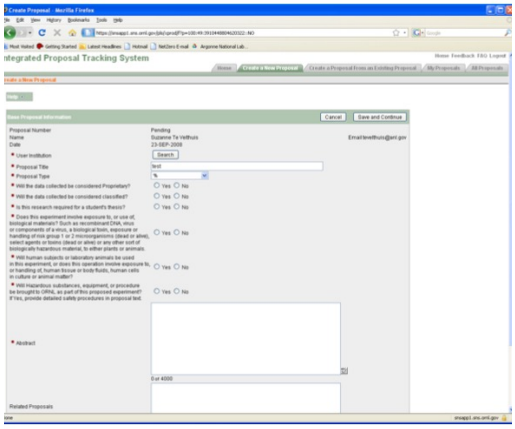
Facilities have link on home page



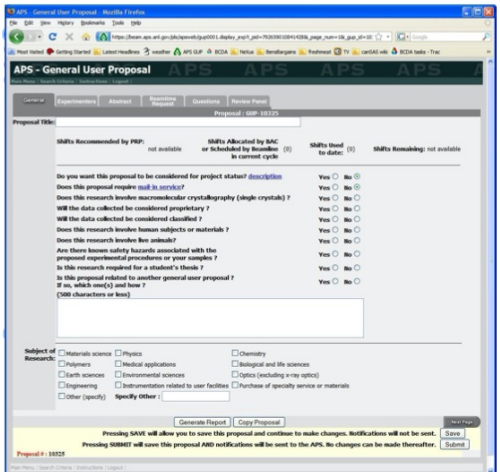
John Budai: 2018 NX School presentation

TYPICAL PROPOSAL FORMS

SNS/HFIR



APS



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TYPICAL QUESTIONS IN A PROPOSAL

- 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) or (Neutrons + X-rays)?
  - Need for a particular facility (instrument, insertion device vs bending magnet?)
  - Spallation vs. reactor source
  - Hard X-rays vs. soft
  - Particular technique or sample environment
- Previous experience with technique/materials;
- Previous sample characterization
- Previous results; related publications
  - If similar work has been done by others, how will yours be different?
- Describe the proposed experiment(s), including samples and measurement process. *Show that you are prepared!*
- Time needed for measurement; justify that number

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WHAT DOES A REVIEWER WANT TO KNOW?

Things to think about when writing a proposal

- Does the proposer have what they need to do the measurement?
  - A well-characterized pure material
  - Do they have the expertise to analyze the data?
- Does the proposer know what they want to learn?
- Is the measurement likely to provide a useful result?
  - Is this the right measurement?
  - Is the instrument sensitive enough to show what is needed?
- Can the desired goal be reached with a lab-based measurement?
- Is anyone going to care?
  - Important scientific questions are more likely to get time with an “unlikely to succeed proposal”

AN OUTLINE FOR A PROPOSAL (I-A)

Provide some background

- **Pick a good title.** Specific and to the point is better than spectacular and vague. Spectacular and specific is fine if credible.
  - Good: “XAS study of Fe valence in CaFe2As2 under pressure ”
  - Bad: “Understanding superconductivity in superconductors”
- Is it thesis related? Is there a deadline?
  - DOE likes to see thesis research at beamlines
  - May push your proposal up if scores are close
- Write a good abstract - this is where the reviewer develops first impression
  - Do not just upload a PDF document! Creates more work for reviewer
  - Scientific merit in abstract is most important criteria for the score
- Do include a figure from previous work
  - Shows how you made use of previous beamtime
  - Do NOT upload 20 pages of supplemental materials. Only a few figures to help your scientific case

AN OUTLINE FOR A PROPOSAL (I-B)

Provide some background

- Who is involved? Include your advisor (& have he/she read your initial proposals)
  - If you have expert collaborators, list them
  - (include your supervisor!)
  - Collaborator who supplied sample.
  - Theorists
  - Don't include a beamline scientist unless you have discussed collaboration with them

- Why is this research being done?
  - Big picture: 1-2 sentences, max. (Don't assume that the reader will know that your family of materials is of interest for catalysis, thermoelectrics, solar…). Reviewer is probably familiar with instrument, but possibly in a very different field. Try to capture imagination of reviewer with basic idea.
  - Curiosity-based research is fine, but relate the research to bigger questions (planetary science, cosmology…)

AN OUTLINE FOR A PROPOSAL (II-A)

Describe the measurement

- What exactly do you want to measure (how many samples, how are the samples different, what environmental conditions)
  - Say if you have the samples on hand. If not (not good!) how do you know you can make/get them?
  - How are samples characterized? (Do you really have a good sample?)
  - Measurement conditions may be impossible for a particular beamline

- Be clear about experimental limitations that you plan to work around
  - For neutrons, be aware of "impossible" isotopes/elements (be clear about deuteration, etc.);
  - For x-rays consider fluorescence & absorption edges, penetration depths…

- If you have any preliminary facility measurements, mention them.
  - Explain why what has been done is not sufficient; what will be different in the proposed measurement.
- Likewise, discussing theoretical work can show that you are well prepared

AN OUTLINE FOR A PROPOSAL (II-B)

Measurement time estimates

- Beamtime estimates are looked at critically
  - Asking for way too little time marks you as unknowledgeable
  - If you ask for a large fraction of the available time, even if estimate is reasonable, your experiment will be seen as impossible
    - Consider breaking the project up into manageable segments with separate proposals

Discuss the expected measurement with someone who has experience with the technique or intended instrument (usually a beamline scientist), they have the best idea what is needed.

If your experiment requires extra time than usual (for example, with a dilute sample) explain why this is the case

AN OUTLINE FOR A PROPOSAL (III)

Analysis

- Discuss how will you go from a measurement to a result?
  - Have you (or your group or even cite someone else) done something related?
- Why do you think the measurement will give you the result you want?
  - *"If we see… this will demonstrate that…"*
  - *"This measurement will resolve the debate in the literature between…, because…"*
  - Can you model the experiment to show expected differences if your hypothesis is or is not true?

You do not need to be certain your measurement is going to work – this is experimental science after all – but if the reviewer is sure that the experiment will not work, they are not going to give you time. If you convince them that you have examined the issues they are thinking about and still have reasons to consider the odds as worthwhile, they are more likely to give your idea a chance.

KEEP IT SHORT AND SWEET

A proposal is not a paper

- Some of the best rapid access proposals I have reviewed have been 3 or 4 paragraphs!
  - Long proposals make for grumpy reviewers

- You do not need to cite all the literature or prove your claims.
  - It is enough to say “Skutterudites are a very promising class of thermoelectrics” or “A goal in our work is to find lead-free piezoelectrics”

  - “The Smith-Jones group has applied XYZ analysis to <their problem>; this approach can be applied to <our problem>.”

- An experiment need not be “fancy” to require a synchrotron/neutron source.
  - I have approved of experiments on known-structure materials for 11-BM when the goal was low level crystalline impurity quantification or size/microstrain
    - Crucial: explain why the experiment is not possible on lab instrument

ONE REVIEWER’S PET PEEVES

- When the proposal is inconsistent: Tables list different numbers or composition samples than text; are inconsistent on measurement conditions (e.g. numbers of temperature points)
  - Without knowing what measurements will be done, one cannot decide how much time is needed
  - If the proposer can’t get this right, can you trust anything else in the proposal?

- Proposals that tell me what will be determined (e.g. a crystal structure) without explaining why that is needed for the project

- When the proposal requires environmental control that is not available or ignores the difficulty that it adds to the measurement

I will be trying to decide if your measurement will have enough sensitivity to learn what you want. If you have already demonstrated this (calculation or prior measurement), please tell me.

SAMPLES ARE KEY

When reviewing a proposal, I look very carefully at what samples will be used

- I have seen too many proposals that underestimate the task of creating appropriate samples (for example, amount scale-up for neutrons)
  - Showing up and saying ”we could only make these…” is not a good thing
- Experiments fail because samples are not worthy of beamtime (phase pure, well characterized, in sufficient quantities…)
  - Sometimes this is unavoidable, but if you waste beamtime for lack of characterization that could have been done with more preparation, you may not be so welcome for your next measurement
- If you have well characterized samples ready, say so.
  - If you don’t, I probably will assume you are writing a proposal for samples that you hope to have by the time you get beamtime

As a reviewer, one goal is to separate the people who are prepared from the ones who are not.

GETTING HELP

INSTRUMENT SCIENTISTS ASSIST FIRST-TIME AND RETURNING USERS

- **Beamline scientists provide technical advice, guidance, and assistance**
  - Instrument options
  - Sample and experiment preparation
  - Will estimate amount of beamtime needed
  - Logistics (scheduling, transporting and storing samples)
  - Proposal preparation tips and assistance
  - Will usually not provide data analysis, but can help get you started
- **Publication considerations**
  - Beamline scientists should not automatically be considered a collaborator, but often should be offered co-authorship
  - You must acknowledge the beamline and facility; consider thanking non-collaborator beamline scientists by name
  - Chocolate never hurts…

Depending on the level of involvement, consider if beamline staff should be seen as collaborators. Include them as co-author if she/he put in a significant amount of time, provides scientific insight or helps significantly with data analysis.

IF YOU ARE A NEWBIE, GET SOME HELP

Consult with a Beamline Scientist

- Beamline scientists are really busy (particularly, just before proposal deadlines), but they are the ultimate resource. Most really like working with students and see bringing in new users as an important part of their job.

When all else fails:

- If you are having trouble getting time, you can see if you can enlist a beamline scientist as a collaborator
  - She/he may be able to make a preliminary measurement as a proof of concept
  - Beamlines do not get much internal time: proposals are still usually needed
  - They may be able to help improve your proposal
  - **Note**: simply adding the name of a beamline scientist as a participant will not make a weak proposal any stronger.

Feedback

Lecture – 3:30 – 4:30
Proposal writing - Brian Toby
https://forms.office.com/g/gye2UKB3Sf