Proposing for the GBT

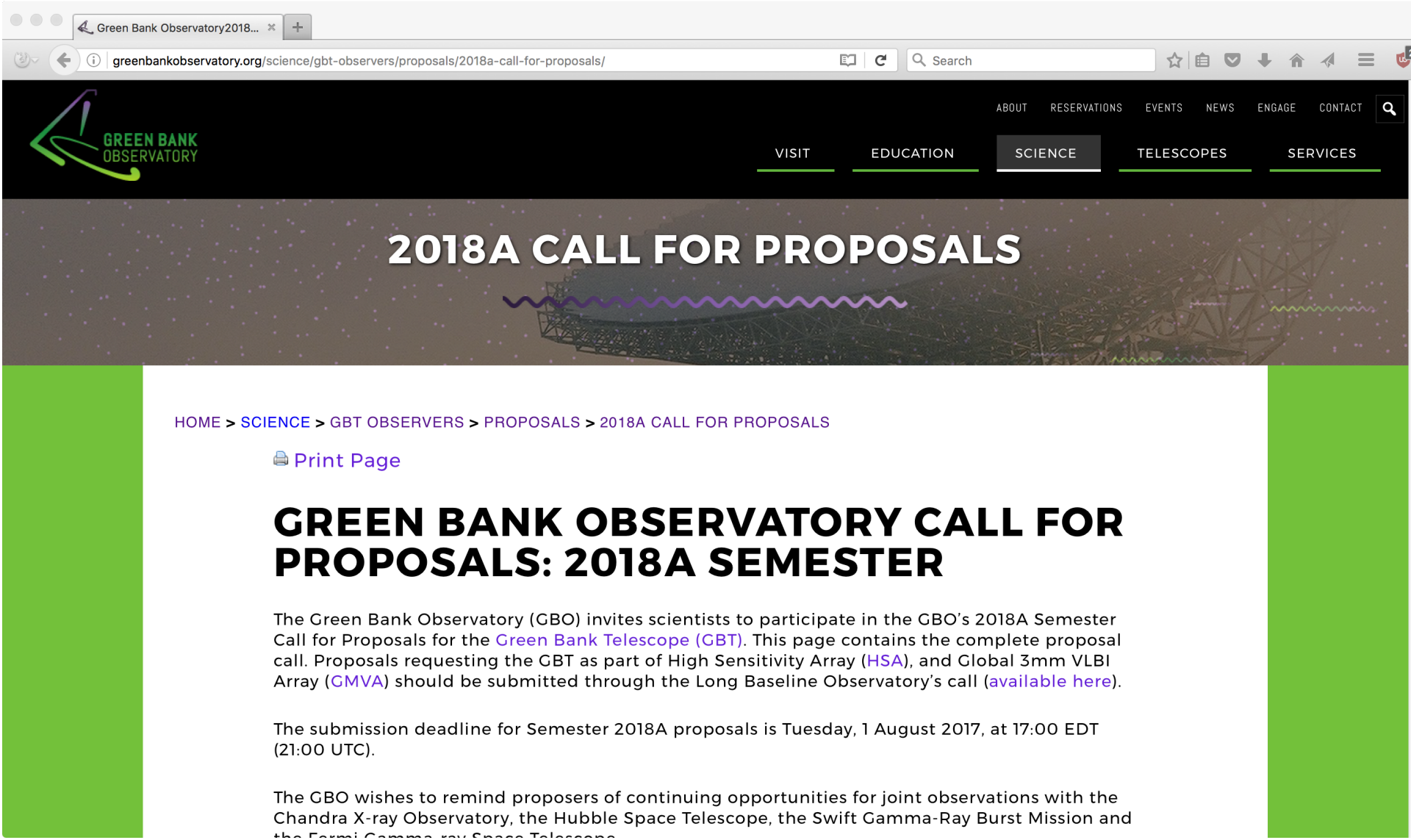
David Frayer (Green Bank Observatory)

GREEN BANK OBSERVATORY

GBT 18A Proposal Call

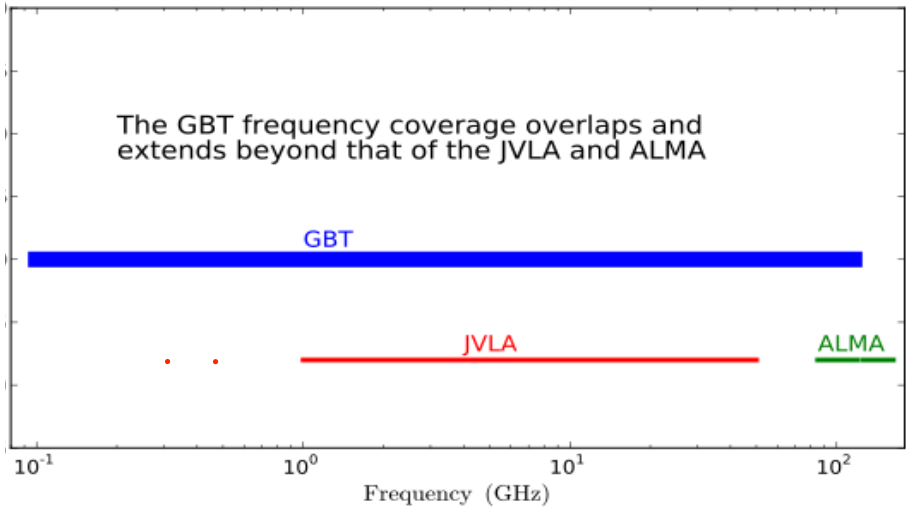
- Next GBT proposal deadline is **Aug. 1, 2017at 5pm EDT (2100 UT)** which is for semester "18A" (Feb—July 2018) observations {same time frame as VLA and VLBA proposal call}
- Users must propose using the Proposal Submission Tool (PST) and register with mynrao.edu
- Scientific Justification (pdf file) limited to 4 pages (11pt font), including all figures, tables, and references
- Technical Justification details are filled into text boxes within the PST
- Large proposals (>200hr) [10 page limit] and must include a data management plan
- Proposals requesting GBT with HSA, VLBA, GMVA should consult VLBA/HSA and GMVA proposal call
- Opportunities for Joint Observations of GBT with HST, Chandra, Swift, Fermi (as well as joint with VLA and VLBA)
- Open-skies reduction – limited VLBI observations, limited time for "fixed" and "windowed" observations, sessions <6hrs, and some instruments will have limited availability

greenbankobservatory.org/science/gbt-observers



Key Capabilities of the GBT

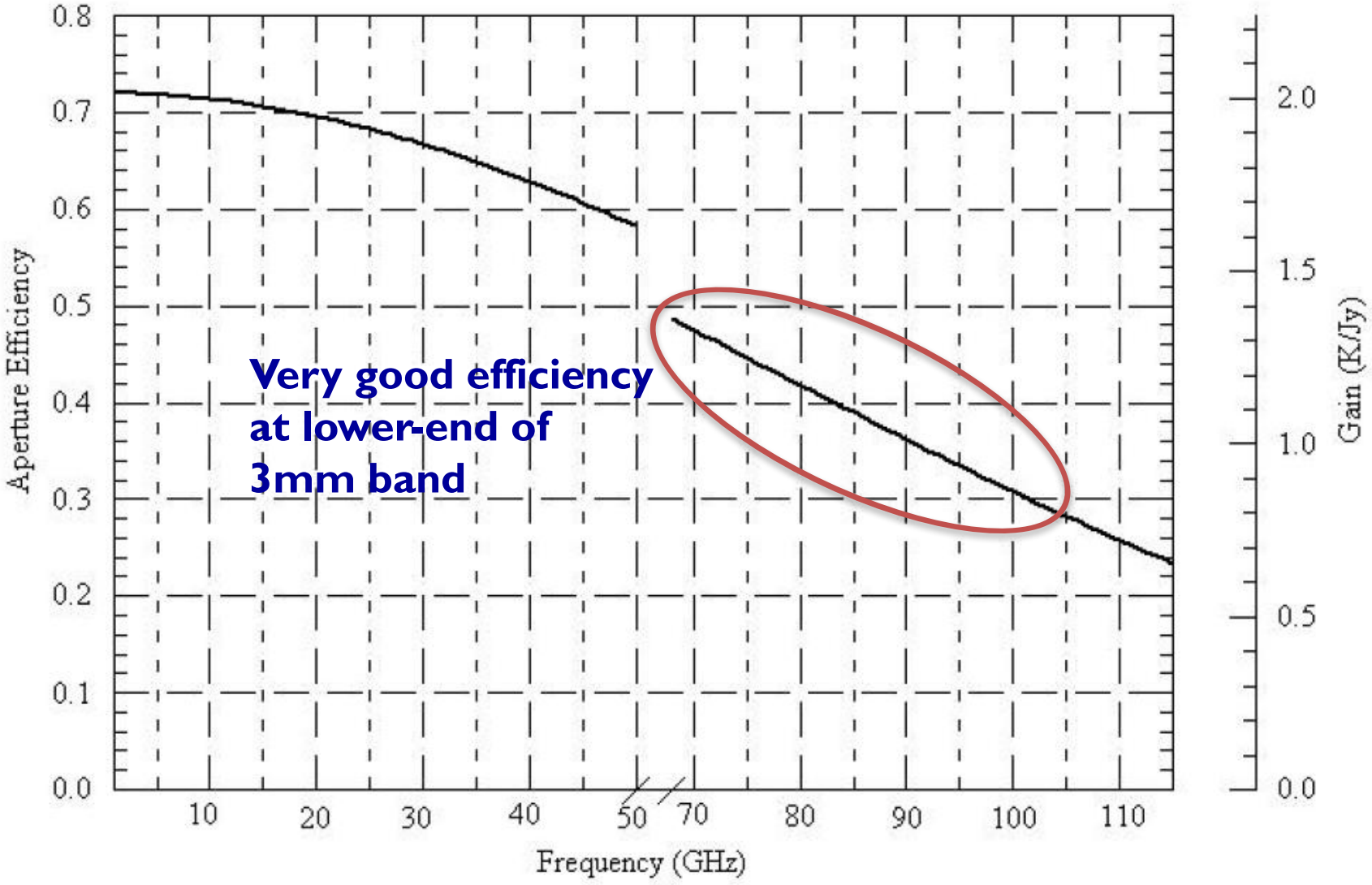
- 100 meter diameter unblocked
- Receivers cover 0.1 to 116 GHz
- Excellent point-source sensitivity
- Unsurpassed sensitivity for extendec objects
- >85% of total sky covered (δ≥-46°)
- Location in the National Radio Quiet Zone



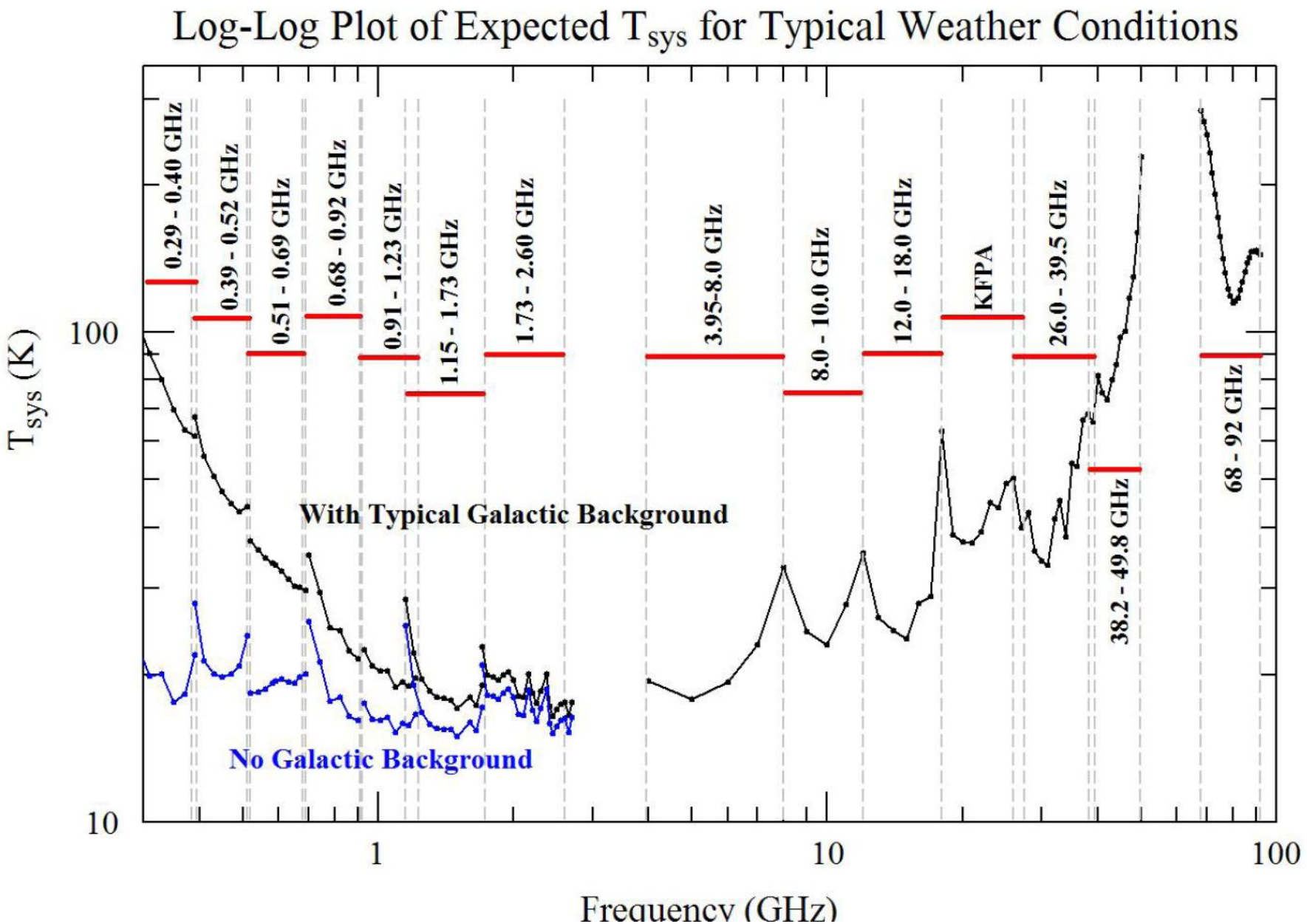
GBT Specs:

Location	Green Bank, West Virginia, USA
Coordinates	Longitude: 79°50′23.406″ West (NAD83) Latitude: 38°25′59.236″ North (NAD83) Track Elevation: 807.43 m (NAVD88)
Optics	110 m x 100 m unblocked section of a 208 m parent paraboloid Offaxis feed arm
Telescope Diameter	100 m (effective)
Available Foci	Prime and Gregorian f/D (prime) = 0.29 (referred to 208 m parent parabola) f/D (prime) = 0.6 (referred to 100 m effective parabola) f/D (Gregorian) = 1.9 (referred to 100 m effective aperture)
Receiver mounts	Prime: Retractable boom with Focus-Rotation Mount Gregorian: Rotating turret with 8 receiver bays
Subreflector	8-m reflector with Stewart Platform (6 degrees of freedom)
Main reflector	2004 actuated panels (2209 actuators) Average intra-panel RMS 68 μm
FWHM Beamwidth	Gregorian Feed: $\sim 12.60/f_{GHz}$ arcmin Prime Focus: $\sim 13.01/f_{GHz}$ arcmin (see Section 3.1.1)
Elevation Limits	Lower limit: 5 degrees Upper limit: $\sim$ 90 degrees
Declination Range	Lower limit: ~ -46 degrees Upper limit: 90 degrees
Slew Rates	Azimuth: 35.2 degrees/min Elevation: 17.6 degrees/min
Surface RMS	Passive surface: 450 μm at 45° elevation, worse elsewhere Active surface: $\sim$ 250 μm, under benign night-time conditions
Pointing accuracy	1σ values from 2-D data 5″ blind 2.7″ offset

GBT Aperture Efficiency and Gain (K/Jv)



Noise Levels (Tsys) for Typical Weather

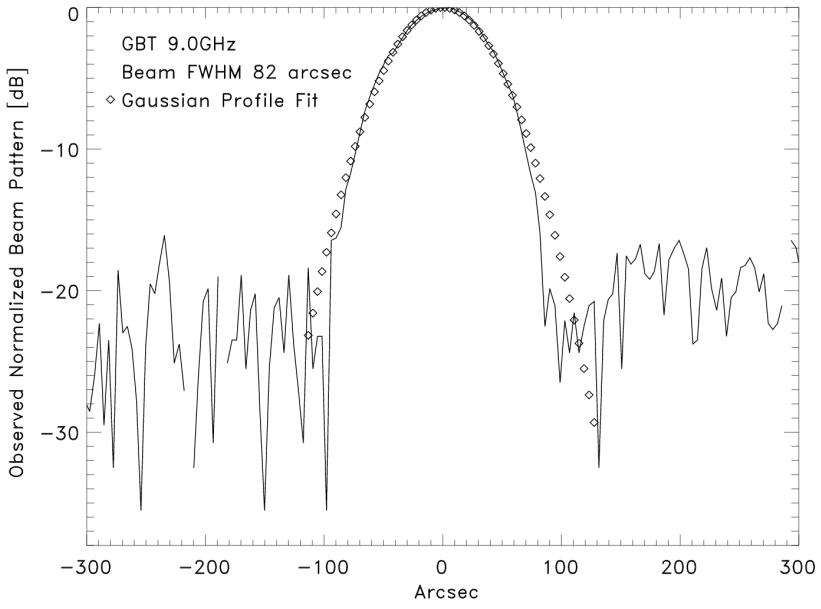


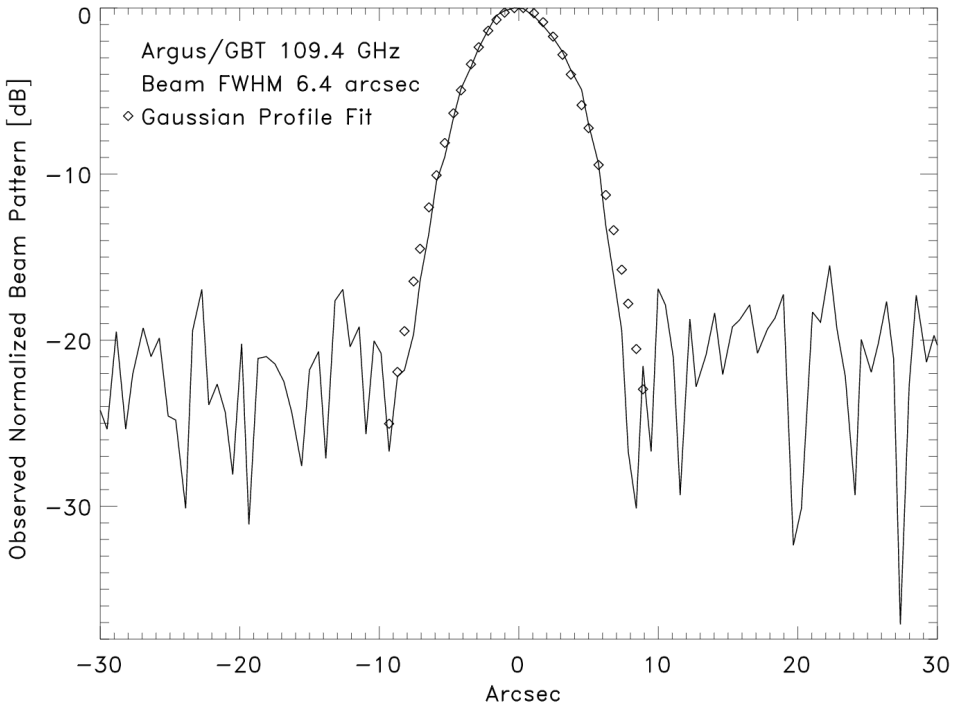
GBT Pointing and Surface Performance

- ~5-10 arcscec blind pointing
- ~1.5 arcsec offset pointing
- ~<1 arcsec tracking accuracy
- Rms (surface) ~ 0.35mm – no corrections during day
- Rms (surface) ~ 0.3mm – no corrections during night
- Rms(surface) ~0.23mm with corrections at night
- Long-term Goal: Rms(surface)~0.20mm

GBT Achieves Theoretical Beam

(even at 110 GHz! – GBT memo #296)





Available GBT receivers

Table 1: GBT Receivers

Receiver	Frequency Range
Prime Focus 1	290-920 MHz
Prime Focus 2	910-1230 MHz
L-band	1.15-1.73 GHz
S-band	1.73-2.60 GHz
C-band (shared risk)	3.8-8.0 GHz
X-band	8.0-11.6 GHz
Ku-band	12.0-15.4 GHz
K-band Focal Plane Array (7 pixels)	18.0-26.0 GHz
Ka-band	26.0-39.5 GHz
Q-band	38.2-49.8 GHz
W-band	67-93.3 GHz
MUSTANG 2 bolometer array (shared risk)	80-100 GHz
ARGUS (shared risk)	75-115.3 GHz, Private PI instrument

Available GBT Backends

Table 2: GBT Backends and Observing Modes

Backend	Observing Modes
Versatile Green Bank Astronomical Spectrometer (VEGAS)	Continuum, pulsar, spectral line
Digital Continuum Receiver (DCR)	Continuum
Green Bank Ultimate Pulsar Processing Instrument (GUPPI)	Pulsar
Mark V Very Long Baseline Array Disk Recorder	Very Long Baseline Interferometry
Caltech Continuum Backend (CCB) (Ka-band)	Continuum
Zpectrometer (Ka-band)	Private PI instrument
Radar	Private PI instrument

Starting to move away from GUPPI in 18A

Open for public use

Breakthrough Listen Backend available in 18A , shared risk

Observing Mode vs Backend Capabilities

What are you doing?:	Continuum	Continuum full-stokes	Line	Pulsar	VLB	Radar
	DCR	Mode-1 VEGAS	VEGAS	GUPPI	Mark5 VLBA recorder	Radar backend
	CCB (Ka)	Mueller matrix calibration (function of parallactic angle)	{29 modes}	VEGAS-Pulsar		
	Mustang (3mm)			{Search mode, timing mode}		
	Reduction uses specialized scripts					

VEGAS Modes:

16 separate spectrometer channels (8 dual polarization channels) that can be divided between beams and different frequencies as needed and can support up to 8 spectral sub-windows per spectrometer.

Maximum data rate ~160GB/s, but most projects at <1MB/s

Table 4: VEGAS modes.

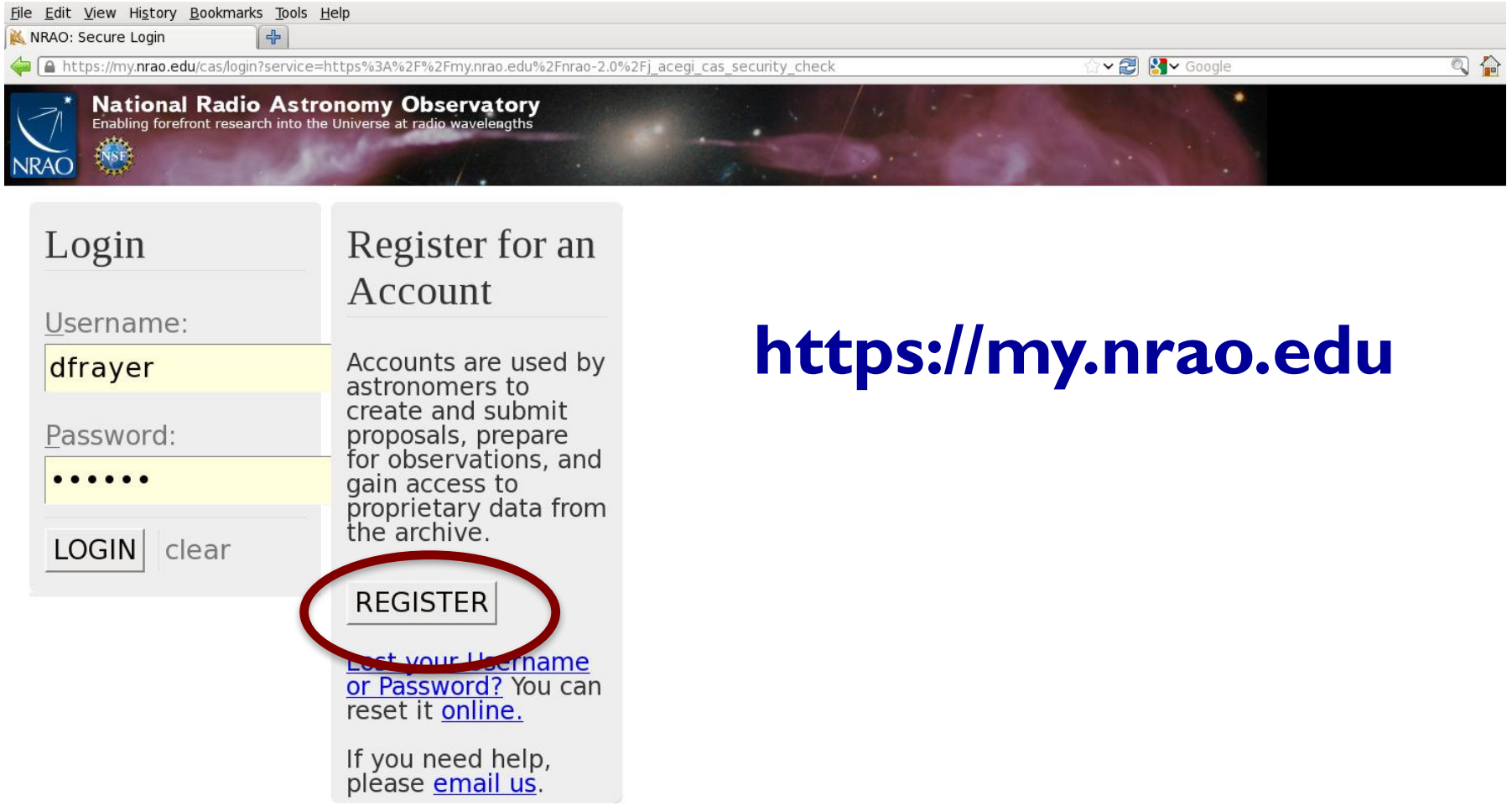
Mode	Spectral Windows per Spectrometer	Bandwidth per Spectrometer (MHz)	Number of Channels per Spectrometer	Approximate Spectral Resolution (kHz)
1	1	1500[a]	1024	1465
2	1	1500[a]	16384	92
3	1	1080[b]	16384	66
4	1	187.5	32768	5.7
5	1	187.5	65536	2.9
6	1	187.5	131072	1.4
7	1	100	32768	3.1
8	1	100	65536	1.5
9	1	100	131072	0.8
10	1	23.44	32768	0.7
11	1	23.44	65536	0.4
12	1	23.44	131072	0.2
13	1	23.44	262144	0.1
14	1	23.44	524288	0.05
15	1	11.72	32768	0.4
16	1	11.72	65536	0.2
17	1	11.72	131072	0.1
18	1	11.72	262144	0.05
19	1	11.72	524288	0.02
20	8 [c]	23.44	4096	5.7
21	8 [c]	23.44	8192	2.9
22	8 [c]	23.44	16384	1.4
23	8 [c]	23.44	32768	0.7
24	8 [c]	23.44	65536	0.4
25	8 [c]	16.875	4096	4.1
26	8 [c]	16.875	8192	2.0
27	8 [c]	16.875	16384	1.0
28	8 [c]	16.875	32768	0.5
29	8 [c]	16.875	65536	0.26

[a] The useable bandwidth for this mode is 1250 MHz.
[b] The useable bandwidth for this mode is 850 MHz.
[c] For modes 20-24, the spectral windows must be placed within 1500 MHz with a useable frequency range of 150 to 1400 MHz. For modes 25-29, the spectral windows must be placed within 1000 MHz with a useable frequency range of 150 to 950 MHz.

GBT Bandwidth Limitations

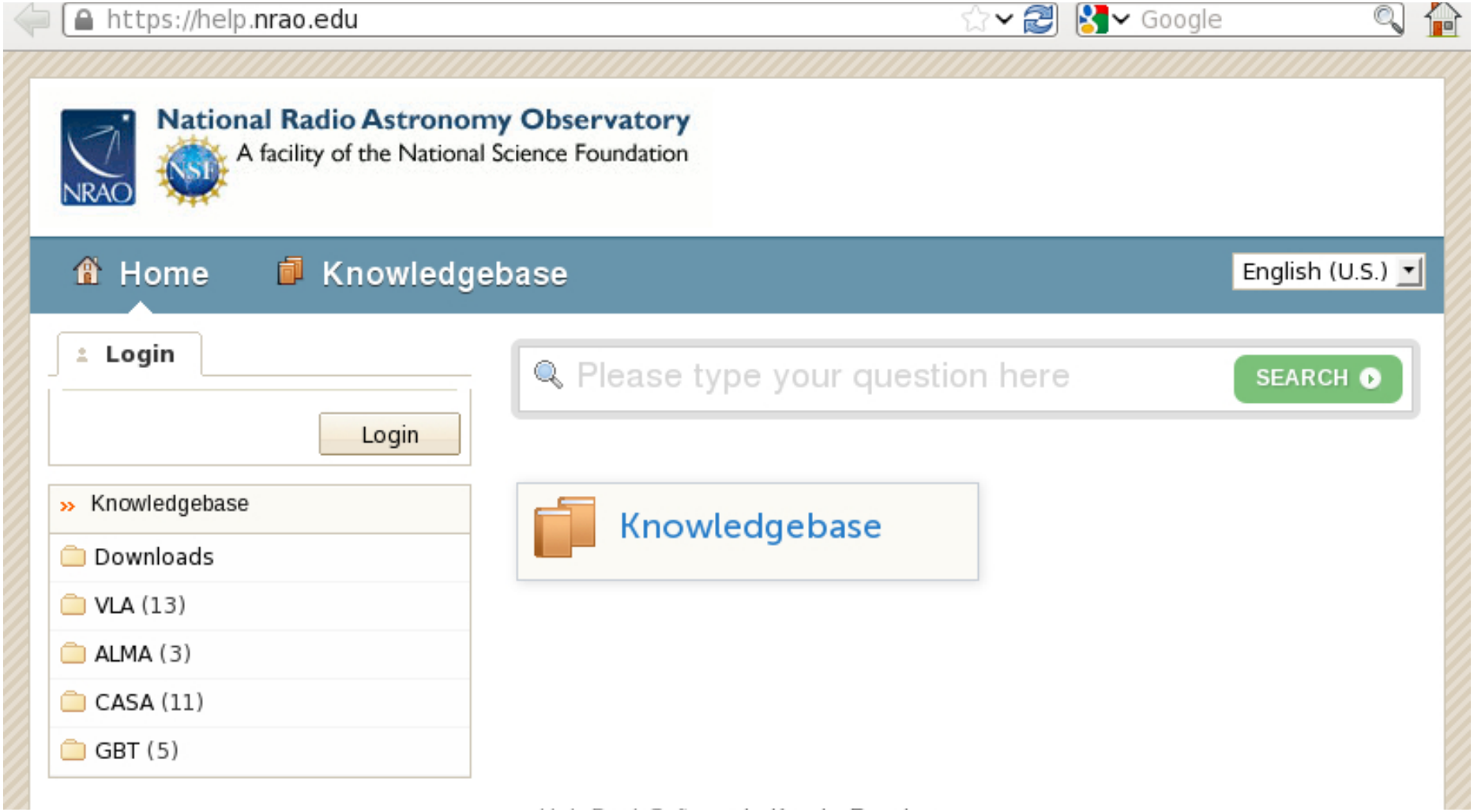
- IF system limit is 4 GHz of instantaneous bandwidth for most current high-frequency receivers
- CCB and Zpectrometer covers full Ka-band but with low spectral resolution
- Low end of W-band and Ka-band enables 6 GHz of bandwidth
- Argus limited to 1.5 GHz of bandwidth
- Current optical fiber system limited to 8 GHz of bandwidth
- Studies on-going for a wide-bandwidth pulsar instrument (e.g., 0.5-4 GHz).
- Bandwidth limitations are not fundamental, just $$.

“MyNRAO” Account needed for using the Proposal Submission Tool (PST)

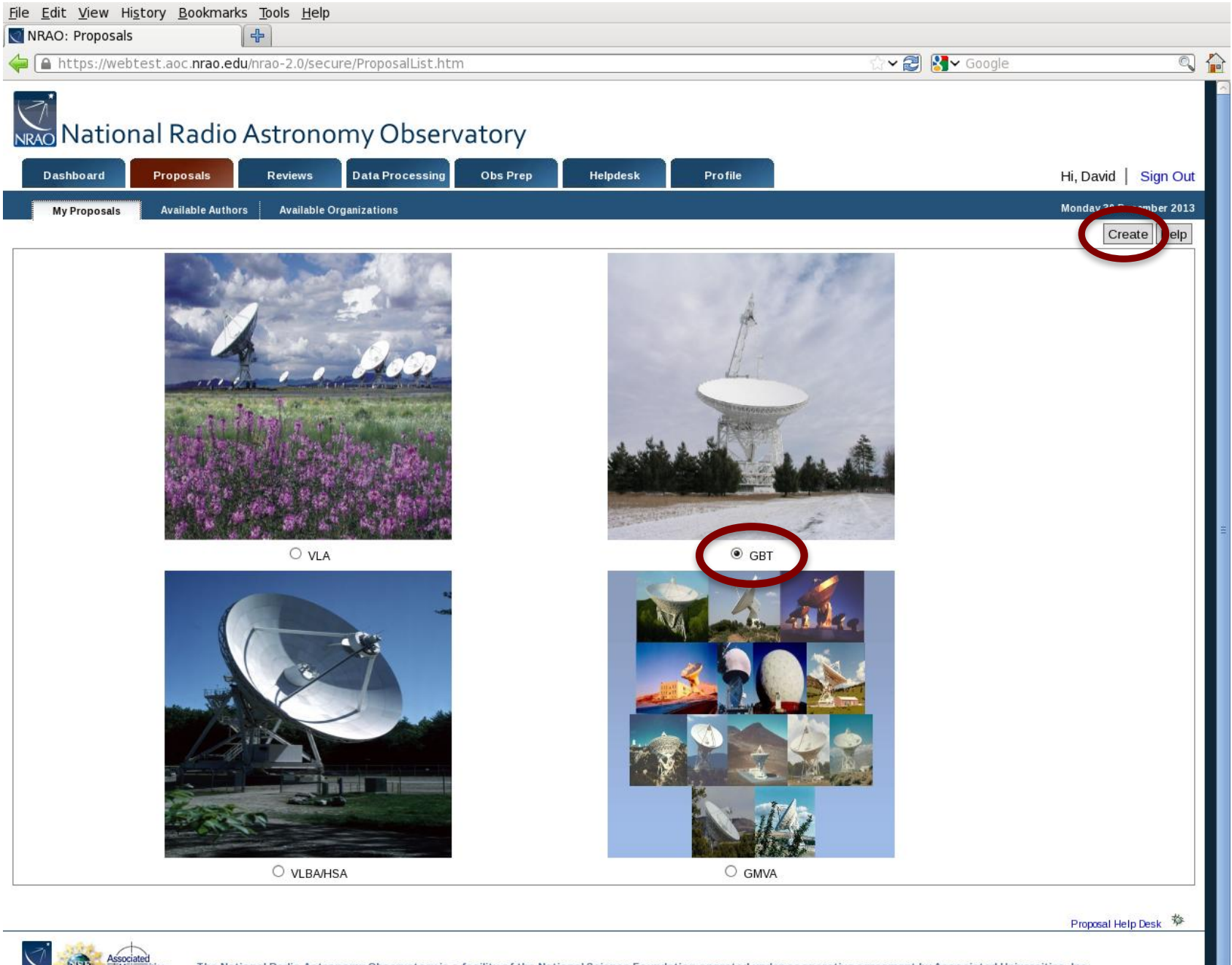


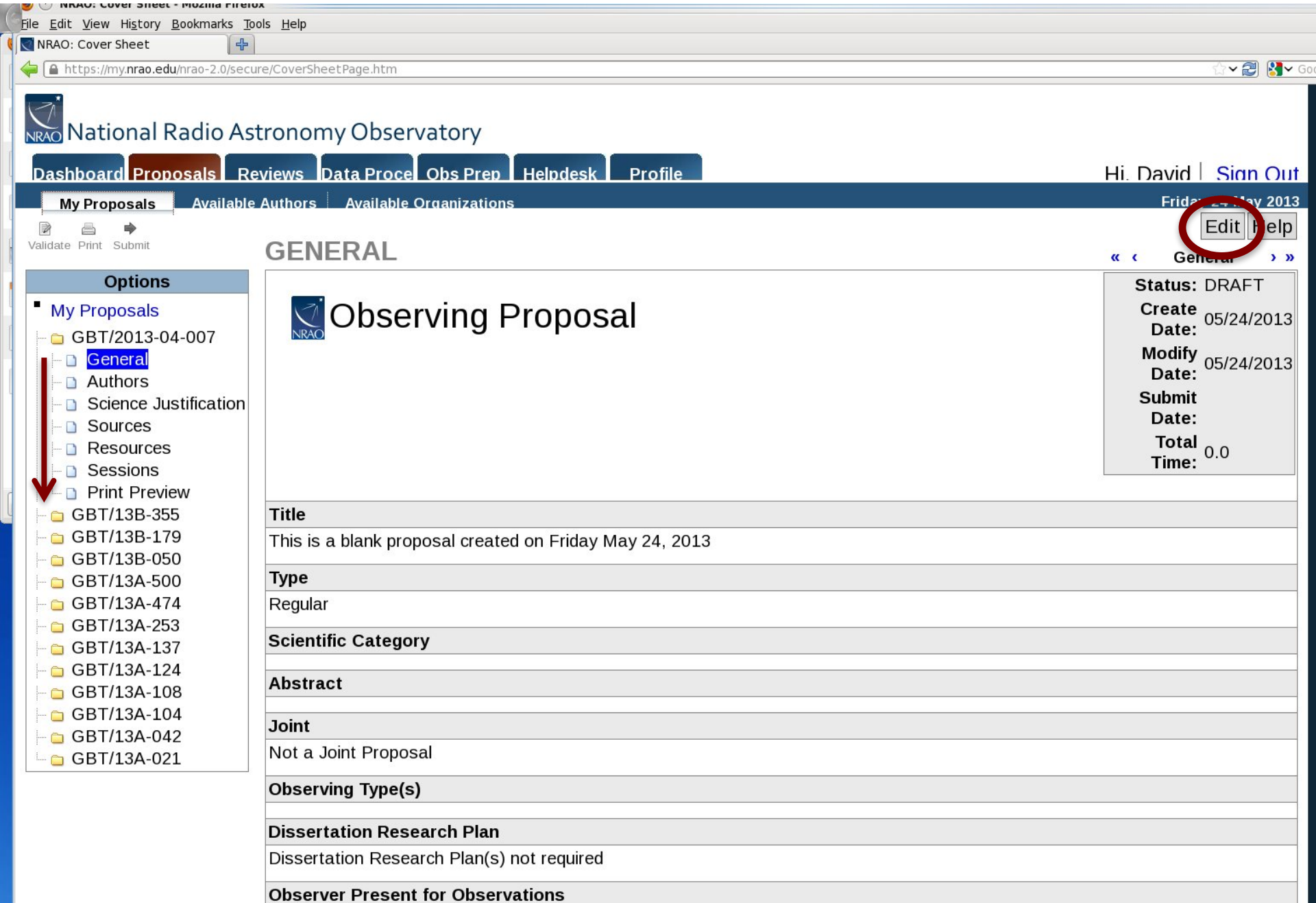
https://my.nrao.edu

Use NRAO Helpdesk for any Questions (https://help.nrao.edu: VLA/GBT/VLBA Proposal Submission “Department”)



Create New Proposal

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GBT/13A-042
GBT/13A-021
Observing Proposal
Status: DRAFT
Create Date: 05/24/2013
Modify Date: 05/24/2013
Submit Date:
Total Time: 0.0
Title
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Type
Regular
Scientific Category
Abstract
Joint
Not a Joint Proposal
Observing Type(s)
Dissertation Research Plan
Dissertation Research Plan(s) not required
Observer Present for Observations

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NRAO: Cover Sheet

https://my.nrao.edu/nrao-2.0/secure/CoverSheetPage.htm

General Information

National Radio Astronomy Observatory

Dashboard | Proposals | Reviews | Data Process | Obs Prep | Helpdesk | Profile

Hi, David | Sign Ou

My Proposals | Available Authors | Available Organizations

Friday 24 May 201

Validate Print Submit

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GENERAL *(changes will auto-save in 9 minutes)*

« ‹ General › »

Options

- My Proposals
  - GBT/2013-04-007
    - General
    - Authors
    - Science Justification
    - Sources
    - Resources
    - Sessions
    - Print Preview
  - GBT/13B-355
  - GBT/13B-179
  - GBT/13B-050
  - GBT/13A-500
  - GBT/13A-474
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  - GBT/13A-021

Observing Proposal

Status: DRAFT
Create Date: 05/24/2013
Modify Date: 05/24/2013
Submit Date:
Total Time: 0.0

Title *(80 characters max)*

The GBT is best radio telescope on planet Earth

Proposal Type

(•) Regular ( ) Large ( ) Triggered ( ) Director's Discretionary Time

Scientific Category (Click here for additional information about Proposal Science Categories)

( ) Active Galactic Nuclei	(Active galactic nuclei: Seyferts; low-luminosity AGN; H2O megamasers; radio galaxies; blazars; quasars/QSOs; environmental interactions)
( ) Energetic Transients and Pulsars	(X-ray binaries, cataclysmic variables, supernovae, gamma-ray bursts, pulsars)
( ) Extragalactic Structure	(Galaxies (line): galaxy structure; galaxy kinematics and dynamics; galaxy chemistry; gas in galaxies)
( ) High Redshift and Source Surveys	(High-Z objects; extragalactic source surveys; galaxy formation; gravitational lenses; CMB; early universe)
( ) Interstellar Medium	(galactic HI & OH; ISM magnetic field; SNRs; HII regions; astrochemistry)
(•) Normal Galaxies, Groups, and Clusters	(Galaxies (continuum), groups, clusters: disk emission; star formation; magnetic fields; galactic winds; starbursts; intracluster emission)
( ) Solar System, Stars, Planetary Systems	(Sun, planets, comets, IPM; exoplanets; main sequence stars; active stars; stellar winds; AGB & post-AGB stars; PNe; novae)
( ) Star Formation	(young stellar objects; protostars; jets, outflows; T Tauri stars; circumstellar disks; protoplanetary systems; astrochemistry)

Abstract *(200 words max, 10 min)* **[Word Count : 30]**

We proposed GBT W-band observations of HCN and HCO+ to combine GBT short-space data with our ALMA images to study the dense gas properties in our favorite galaxy.

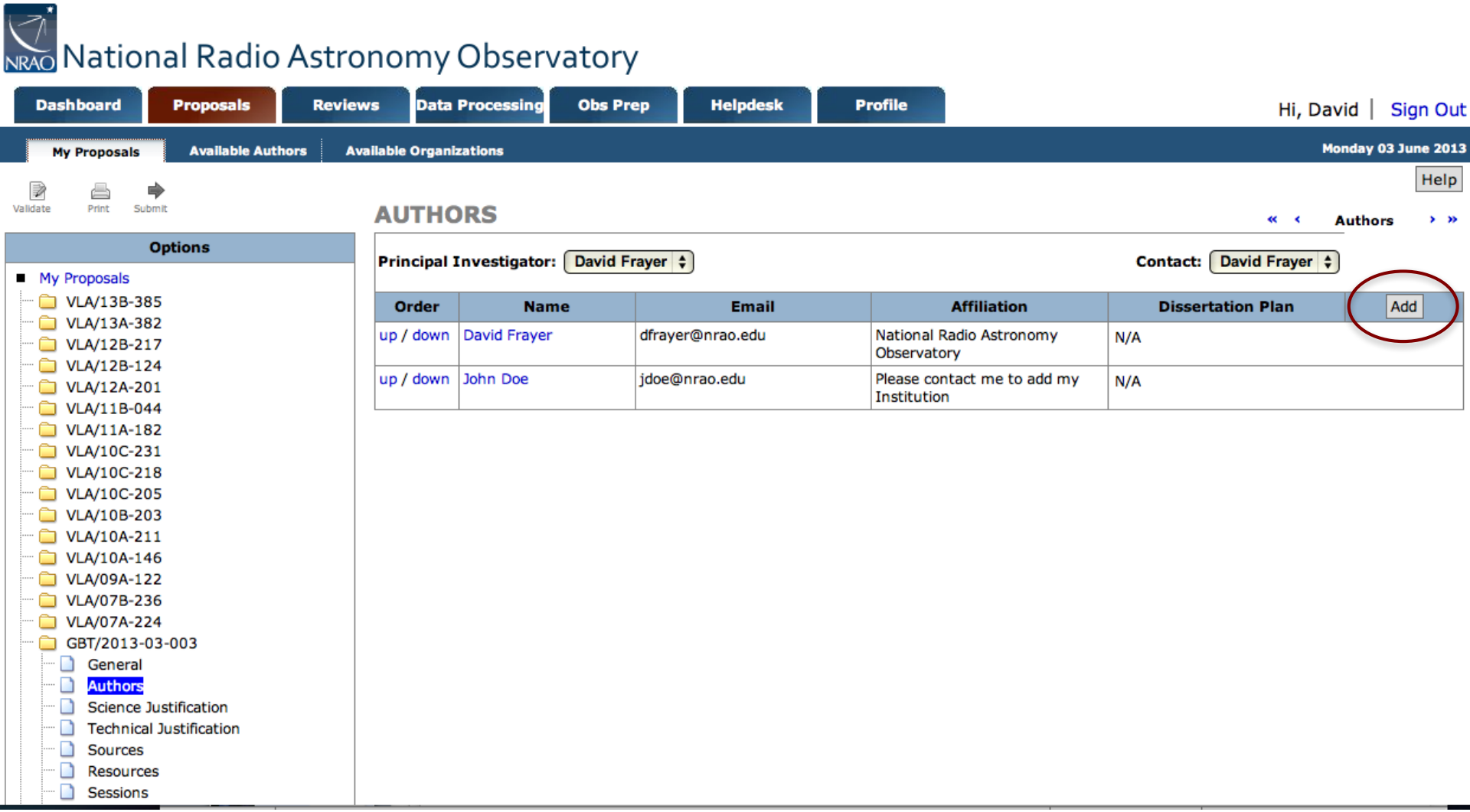
Joint

(•) Not a Joint Proposal ( ) Joint with VLA ( ) Joint with VLBA ( ) Joint with VLA and VLBA

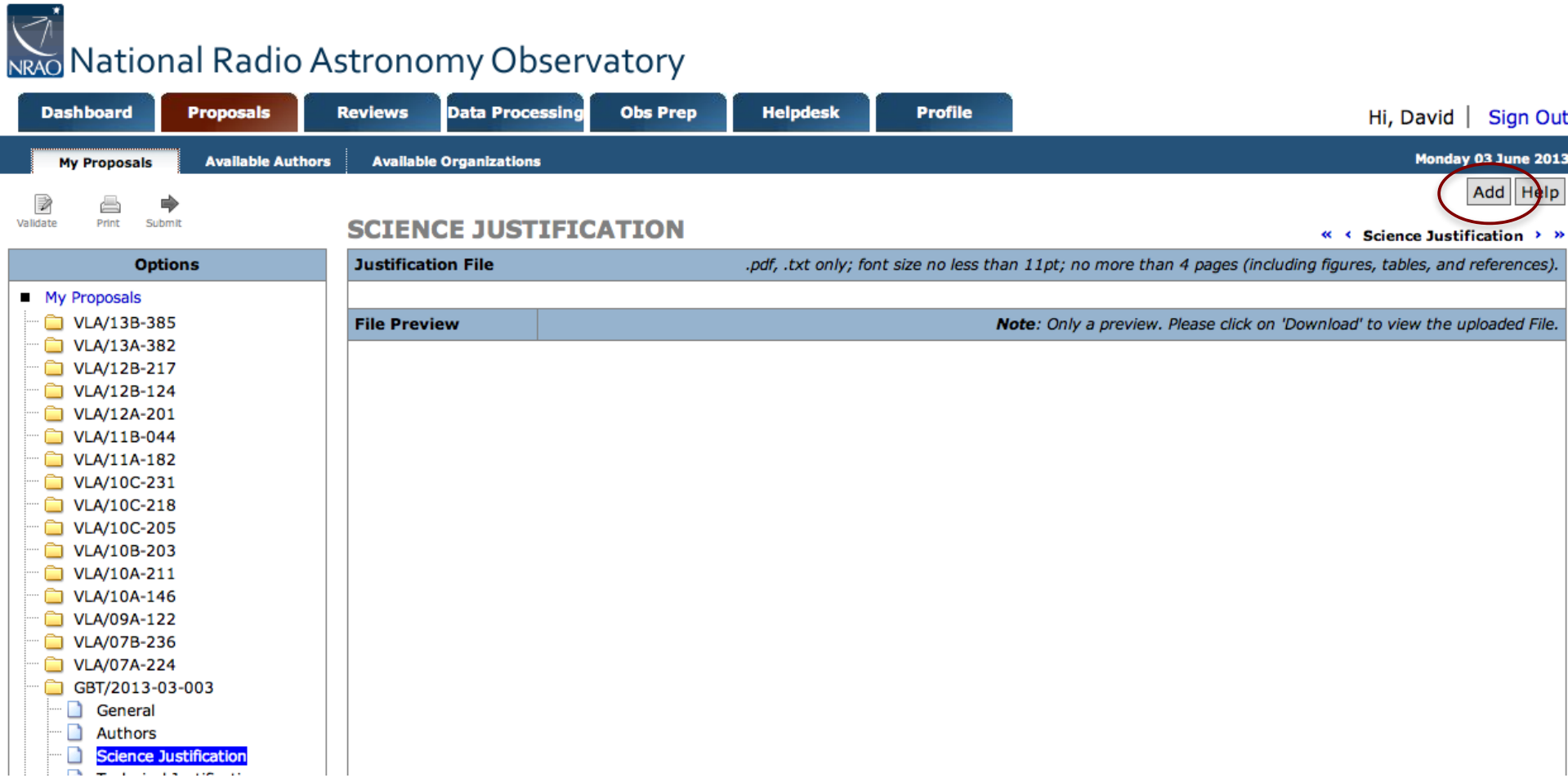
Observing Type(s)

☐ Continuum ☑ Spectroscopy ☐ Polarimetry

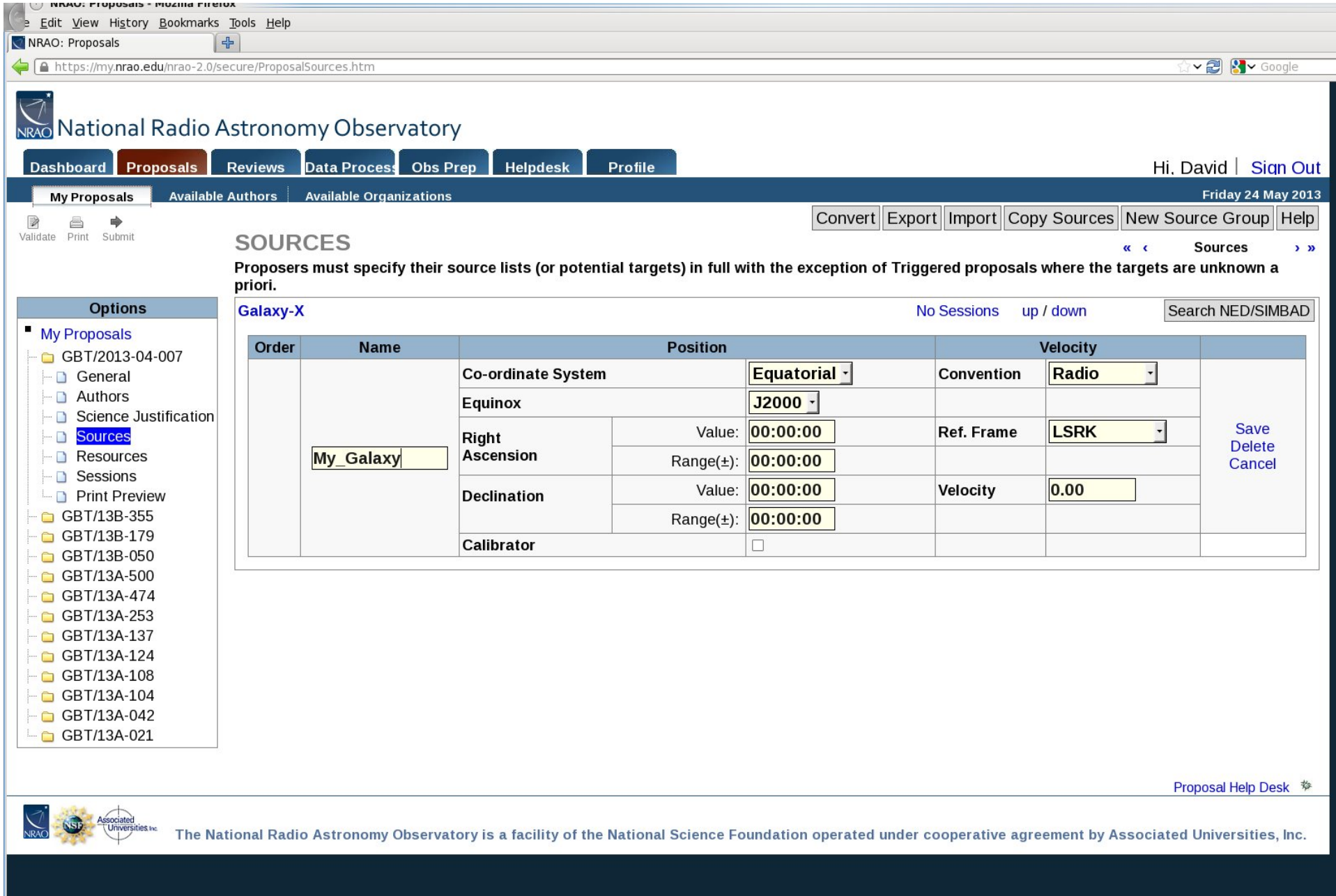
Adding in Authors



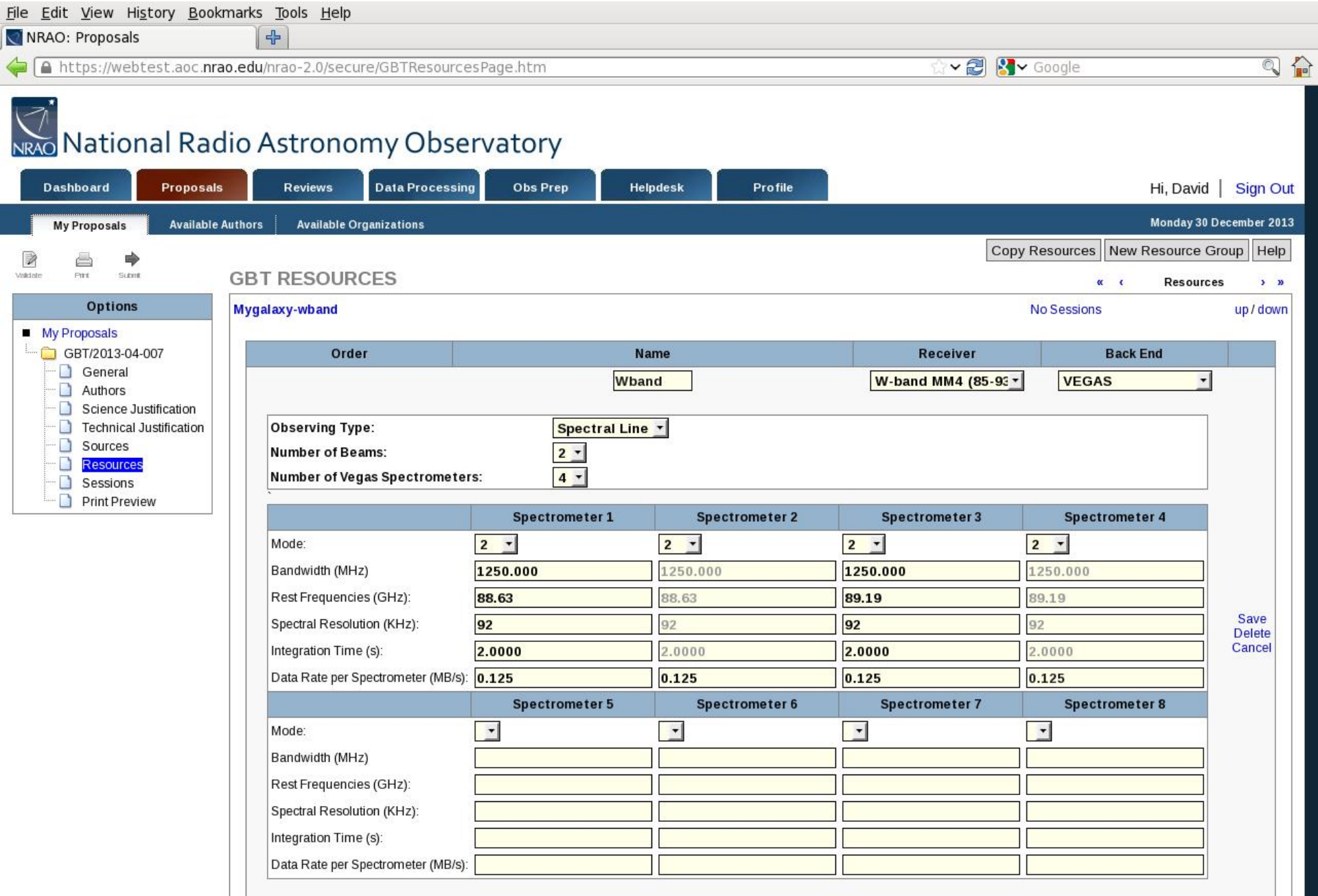
Add in Science Justification (4pages)



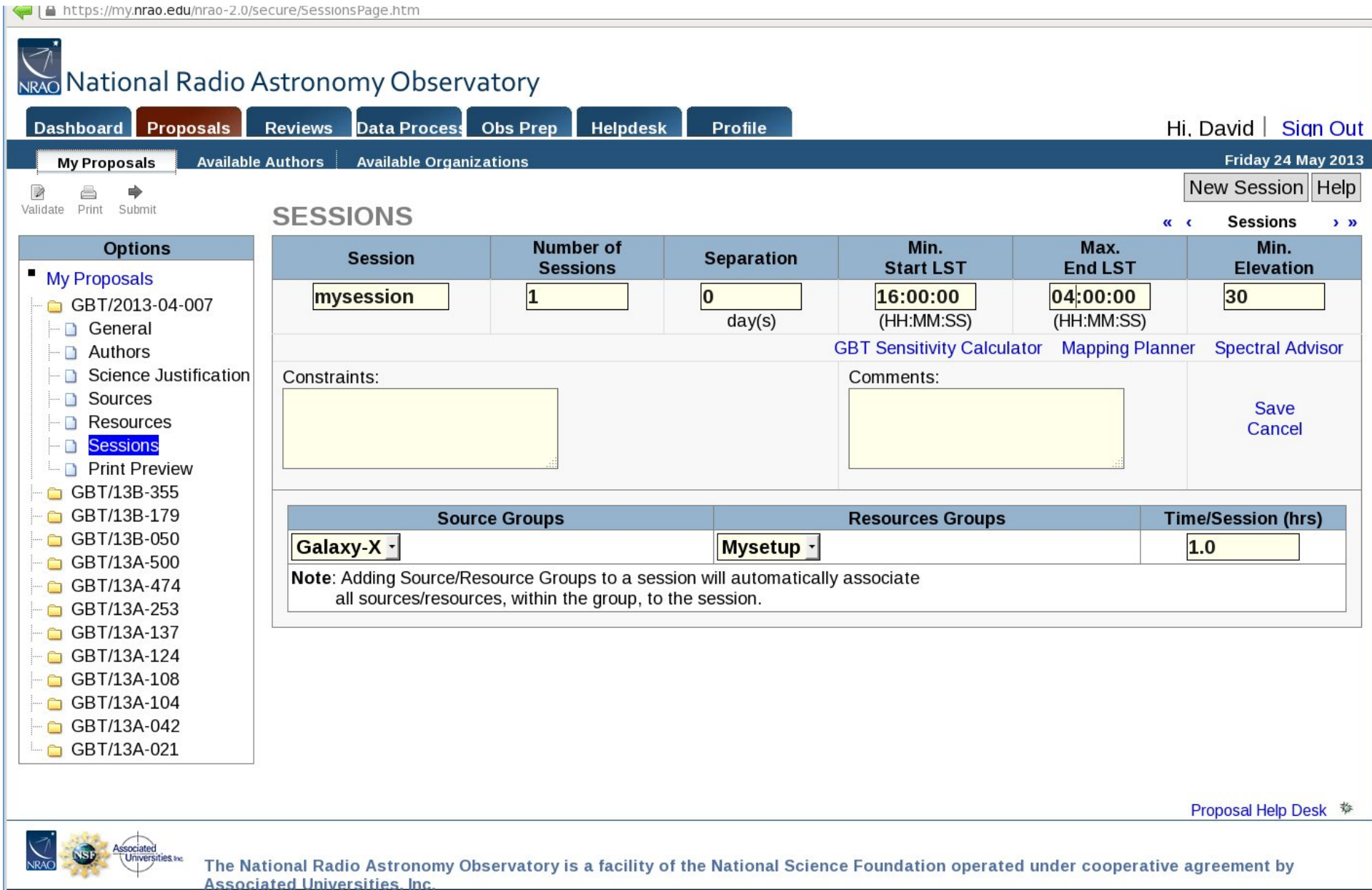
Enter Source Information



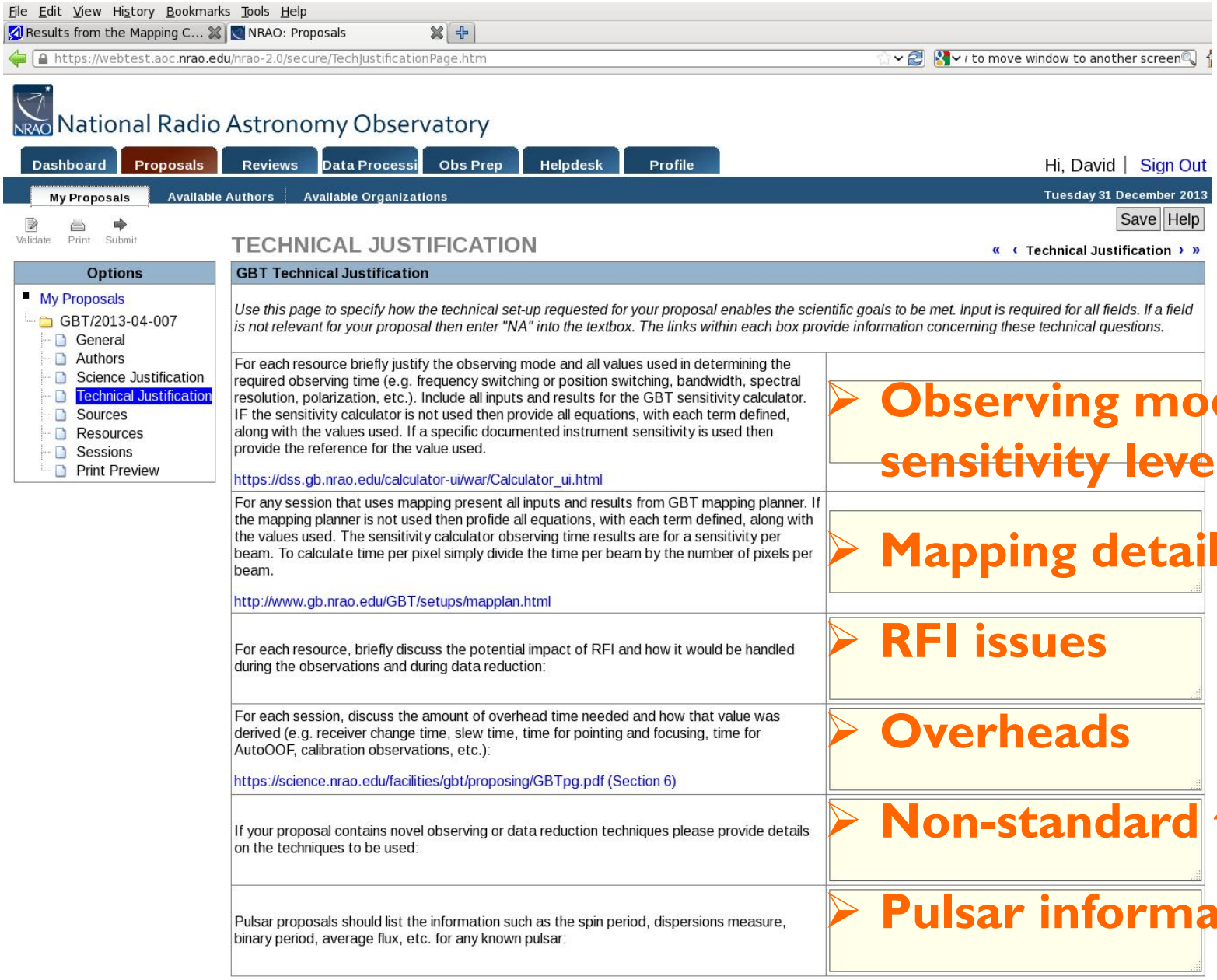
Enter “Resources” (Receiver and Backend configuration)



Enter Observing "Sessions" (defined by source LST ranges and resources/receiver)



Fill in Technical Justification Boxes

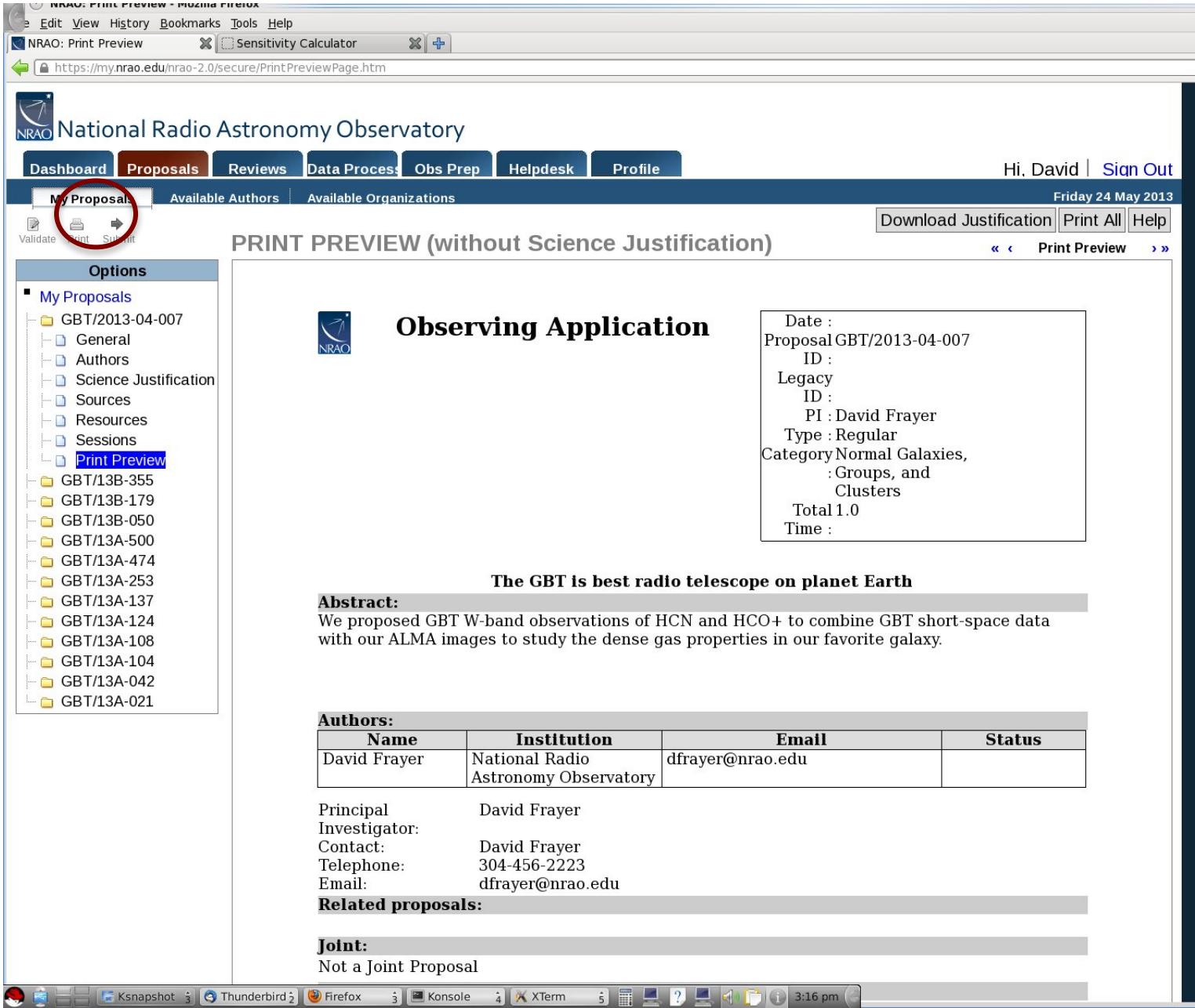


- **Observing modes and sensitivity level**
- **Mapping details**
- **RFI issues**
- **Overheads**
- **Non-standard techniques**
- **Pulsar information**

No page limits for technical boxes.

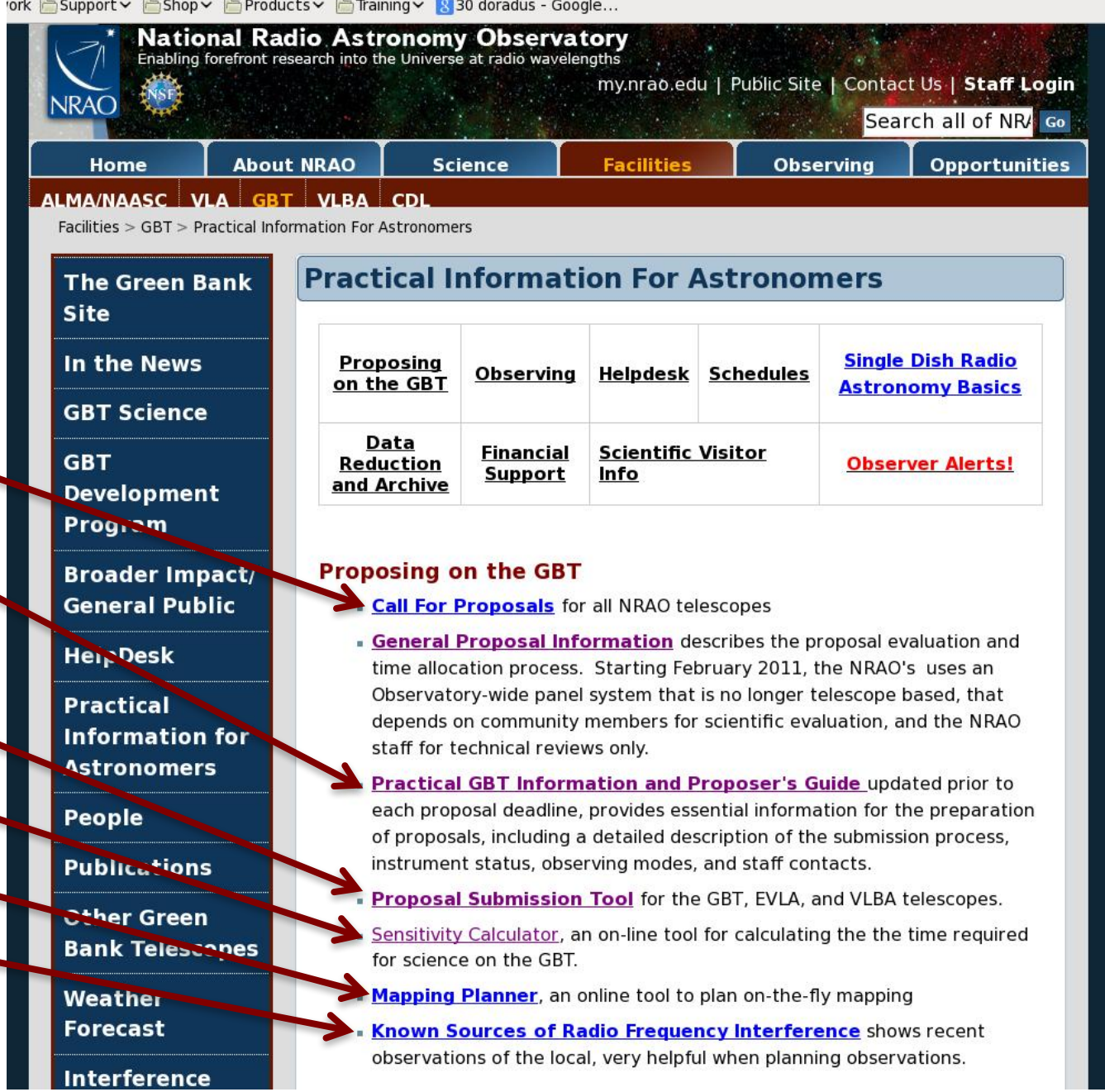
Review Proposal, “Validate”, and Submit

If you need to update the proposal after hitting submit, withdraw proposal and copy information into a new proposal an resubmit (unlike ALMA, Spitzer,….)



GBT Astronomer's Web-page ("Practical Information for Astronomers")

- Call for Proposals
- GBT proposal Guide
- Proposal Submission Tool (PST)
- Sensitivity calculator
- Mapping Planner
- Known RFI



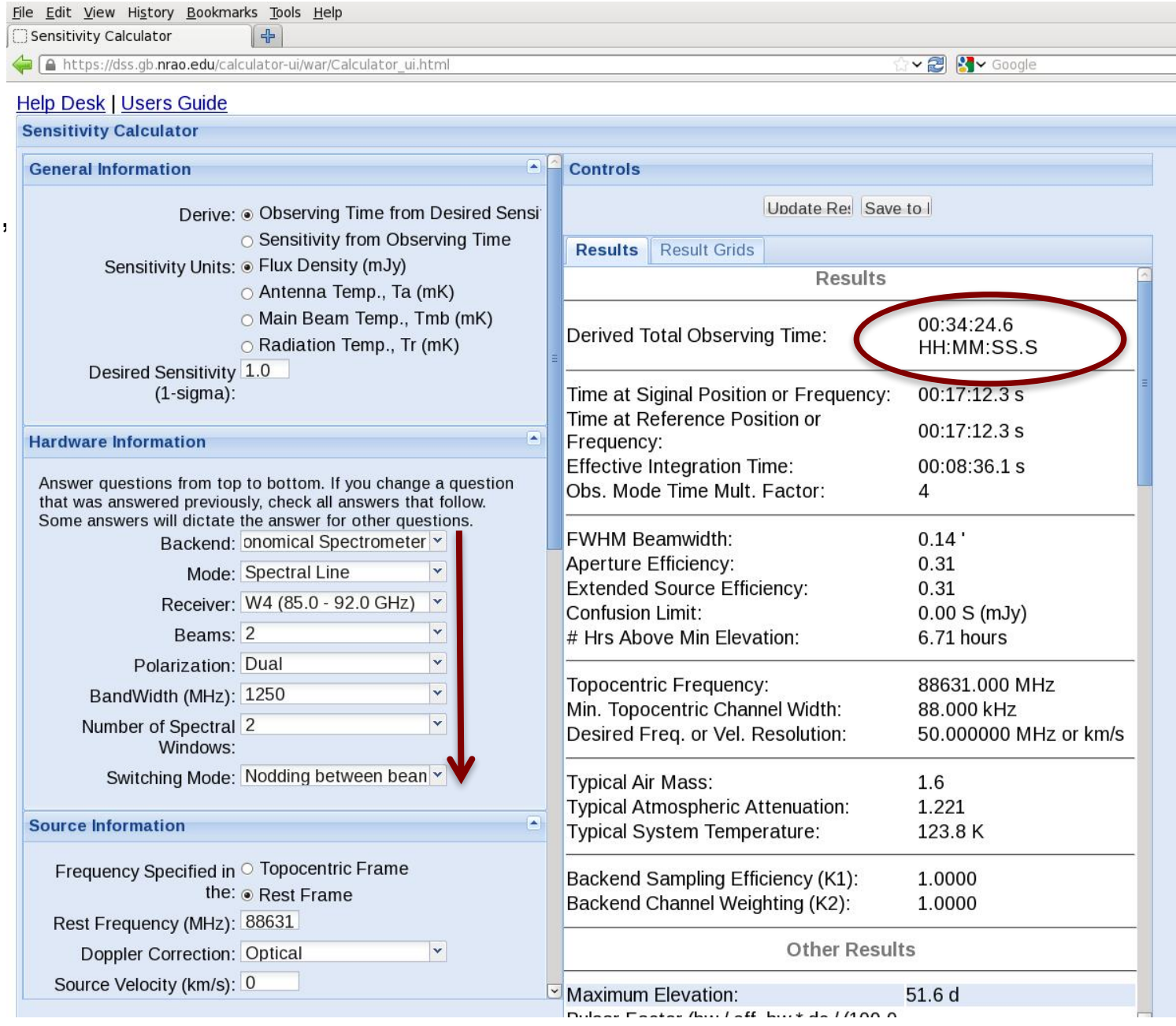
Where to find information needed for "Technical Justification Boxes":

1) **Observing modes and sensitivity level: inputs and results of sensitivity calculator**
2) **Mapping details: Mapping Calculator web page**
3) **RFI issues: RFI web pages, if needed**
4) **Overheads: GBT proposers guide and instrument web pages**
5) **Non-standard techniques: staff/experts, if needed**
6) **Pulsar information: pulsar experts, if needed**

GBT Sensitivity Calculator/Time Estimator

GBT Sensitivity Calculator also useful for verifying available modes (number of beams, polarization, spectral windows)

Input sensitivity needed, results of observing time required, setup and observing mode(s) in the Technical Justification boxes of the PST



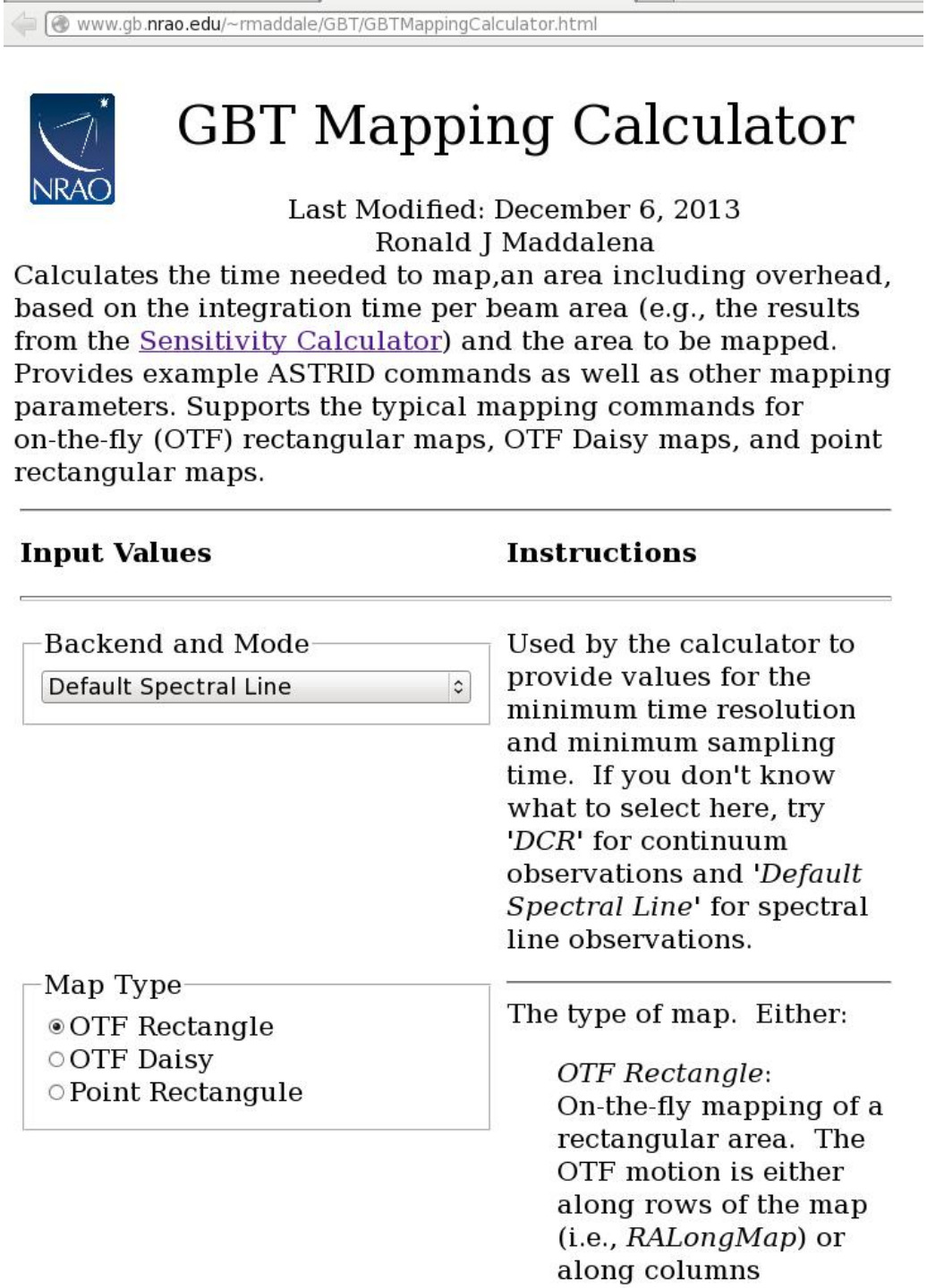
GBT Mapping Calculator

Input:

- Backend
- Map Type (OTF, point)
- Frequency
- Integration time per beam
- Map Size (or radius)
- Sampling (with respect to Nyquist)

Output:

- Observing time (including overheads)
- Astrid command to carry out observation
- Any warnings (e.g., too many accelerations per minute)



www.gb.nrao.edu/~rmaddale/GBT/GBTMappingCalculator.html

GBT Mapping Calculator

Last Modified: December 6, 2013
Ronald J Maddalena

Calculates the time needed to map,an area including overhead, based on the integration time per beam area (e.g., the results from the Sensitivity Calculator) and the area to be mapped. Provides example ASTRID commands as well as other mapping parameters. Supports the typical mapping commands for on-the-fly (OTF) rectangular maps, OTF Daisy maps, and point rectangular maps.

Input Values | **Instructions**

Backend and Mode: Default Spectral Line

Used by the calculator to provide values for the minimum time resolution and minimum sampling time. If you don't know what to select here, try '*DCR*' for continuum observations and '*Default Spectral Line*' for spectral line observations.

Map Type
- (•) OTF Rectangle
- ( ) OTF Daisy
- ( ) Point Rectangule

The type of map. Either:

OTF Rectangle:
On-the-fly mapping of a rectangular area. The OTF motion is either along rows of the map (i.e., *RALongMap*) or along columns

Radio Frequency Interference (RFI)

National Radio Astronomy Observatory

NRAO Green Bank > RFI Protection Group > GBT RFI Archives

GBT Radio Frequency Interference

- Introduction
- GBT Receiver Plots by Band
- GBT RFI Monitoring Station Plots by Band
- Older Surveys and Band Summaries
- Known Sources Database

Introduction

The Green Bank Radio Frequency Interference (RFI) Protection Group would like to offer two primary tools to observers for the purposes of RFI avoidance and mitigation. One of these tools is an archive of RFI scans which will give the observer an idea of spectral occ seen by the GBT receivers themselves, and (eventually) from the GBT RFI Monitc (pictured right).

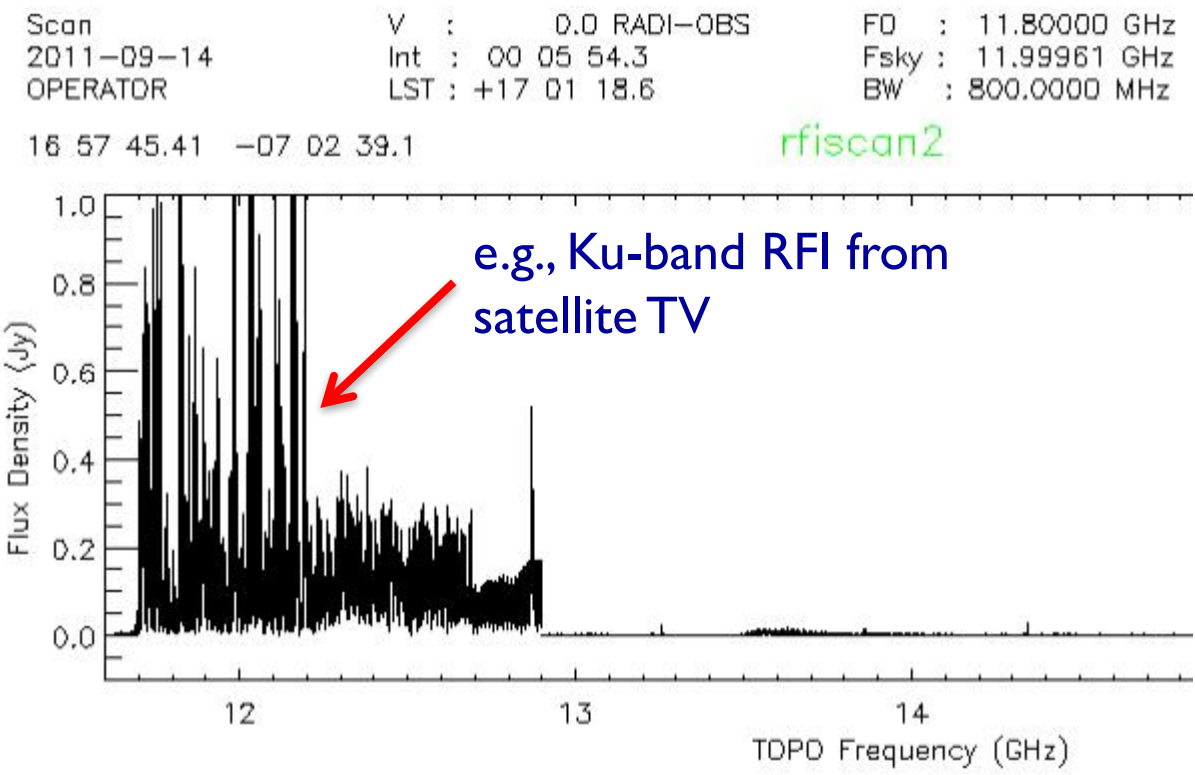
The second, still under construction, will be a RFI Database which provides details persistent, identified RFI sources including coordination information where applica now, we have a Table of Known RFI Sources and a number of Older Surveys and Summaries linked below.

To maximize your chances of RFI avoidance, we advise the following:
1) Consult the latest GBT RFI plots to determine whether the spectrum you wish t typically clear, or occupied by RFI.
2) Consult the Table of Known RFI Sources and/or the Surveys and Band Summa determine whether the source of the RFI is well known and/or likely to be somethi coordinate with (broadcast television, for instance, isn't going to coordinate with us
3) Contact a member of the Green Bank RFI Group to determine whether coordin possible. If it is, you will need to obtain a fixed window from the dynamic schedulir your observation, and the RFI group can then arrange coordination.

Usually, by the time RFI is experienced during observation, it is too late to do anyt it, but it is still worth reporting, in case it can be mitigated in advance of future obse

For additional information email interference@nrao.edu.

Check for possible RFI issues from RFI group's web pages and posted RFI scans from the GBT



e.g., Ku-band RFI from satellite TV

New Instruments

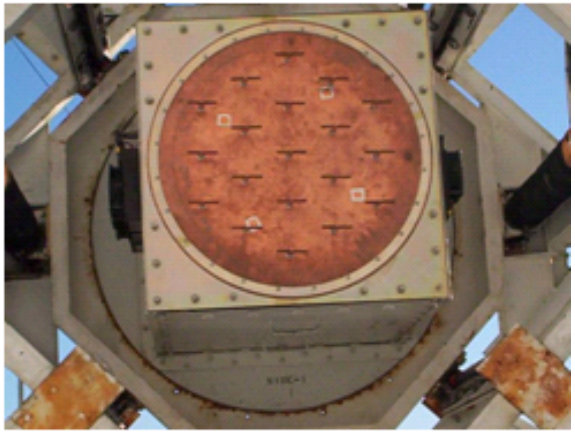
Mustang-2 [Upenn/NRAO]
3mm bolometer camera

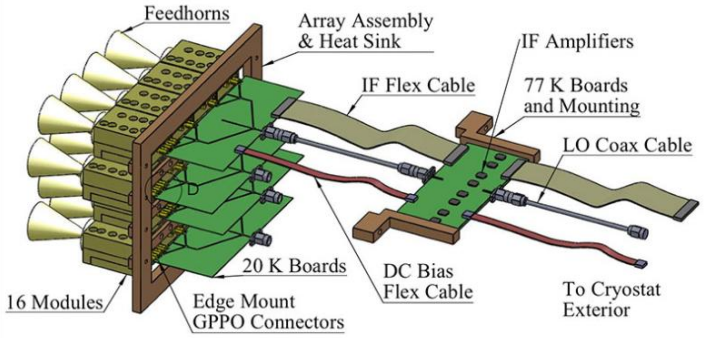
FLAG

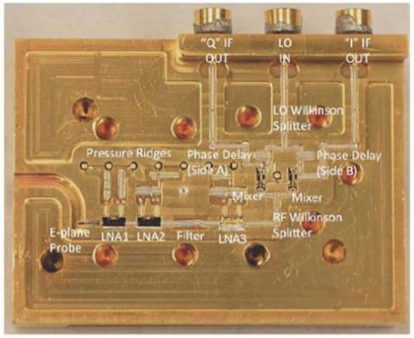
19-element phased-array feed [PAF] (7beams) at 21cm BYU/NRAO. Planned future 37element PAF (20beams).

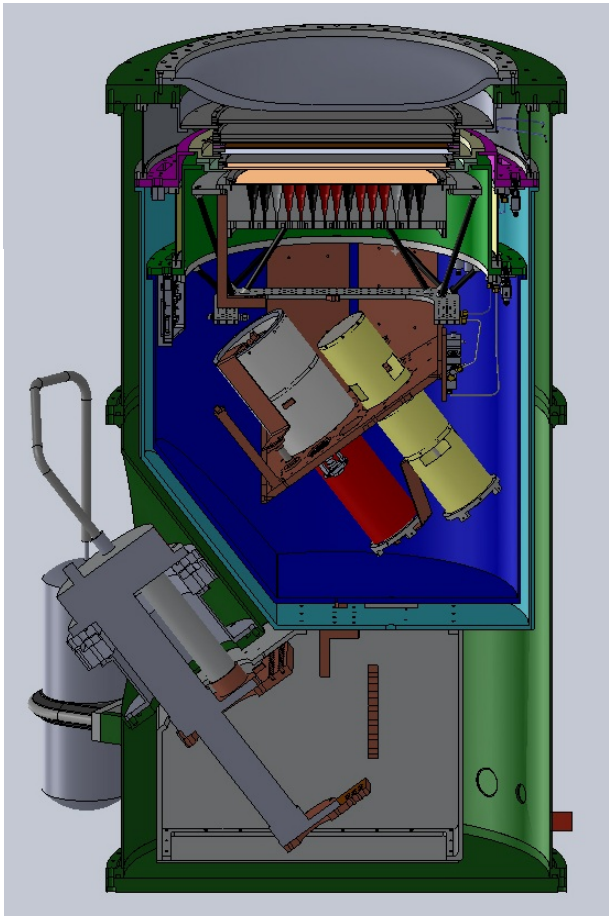
Argus

16 element scalable 75-115 GHz FPA [Stanford/CIT-JPL/UMd/Miami/NRAO]

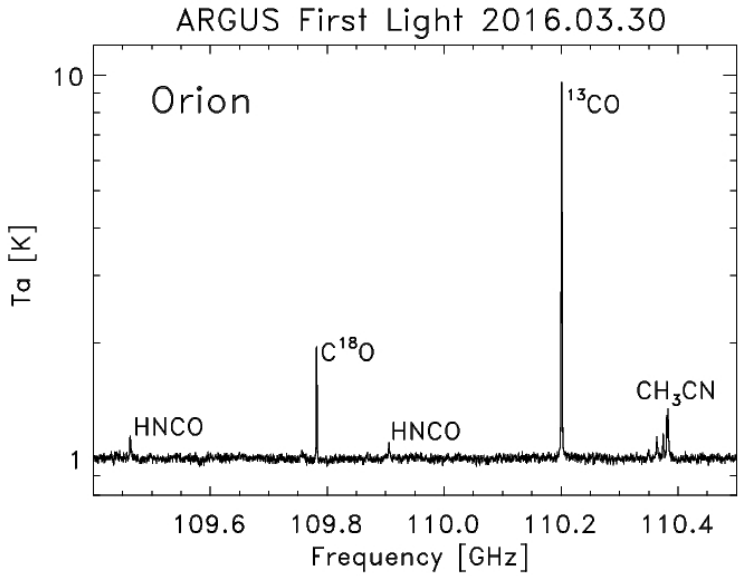


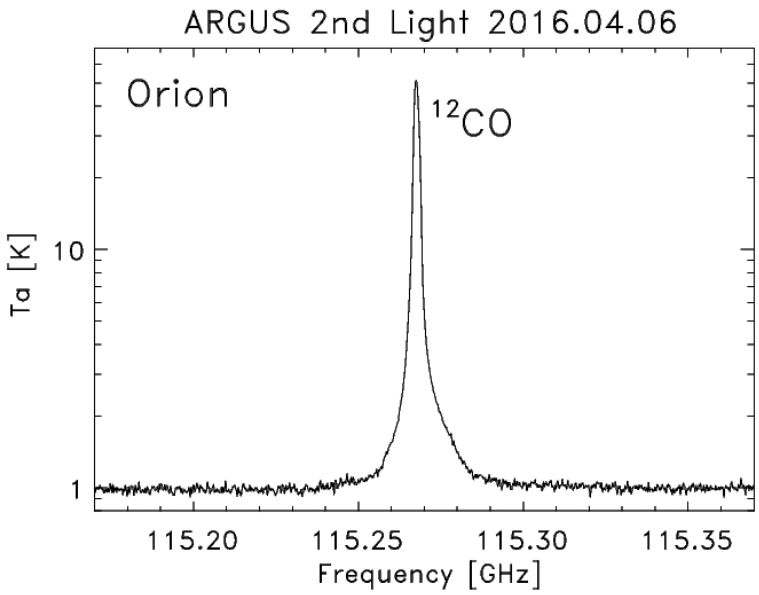




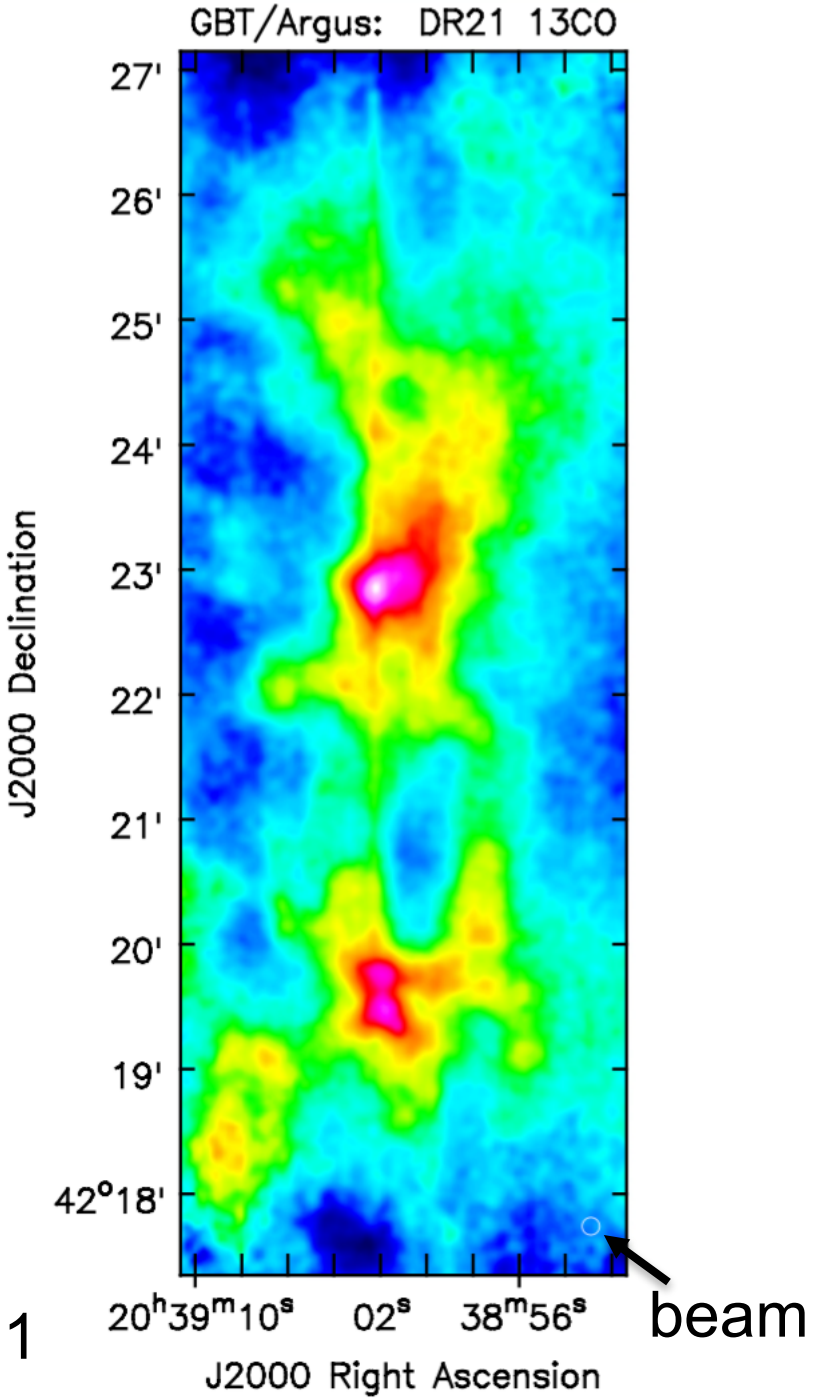


Argus First Light & Map





40min map of DR21



Some Key Points for GBT Observing

- All awarded projects are assigned a GBT scientific staff member as the friend of the project who will help you set up observing scripts and with your data reduction.
- After setting up your observing scripts, enable your project within the DSS and specify observers and have observers fill out their blackout dates.
- The DSS will schedule your project based on weather, observer availability, and receiver/backend availability.
- **GBT users carry out their own observations** (either by visiting the site or remotely {but need training for remote observing} – on-site observers are given priority for observations.

Demo of GBT proposal tools

- Demos of sensitivity and mapping calculator as time permits:

➢ **http://www.gb.nrao.edu/CDE2017**

GBT CDE Material

Cornell 2017 July 10-11

Key Links

- Remote GBO Login
- GBO Observers Web Page
- NRAO-GBT Practical Information for Astronomers Web Page

Presentations

GBT Spectral-line Data Reduction Demos

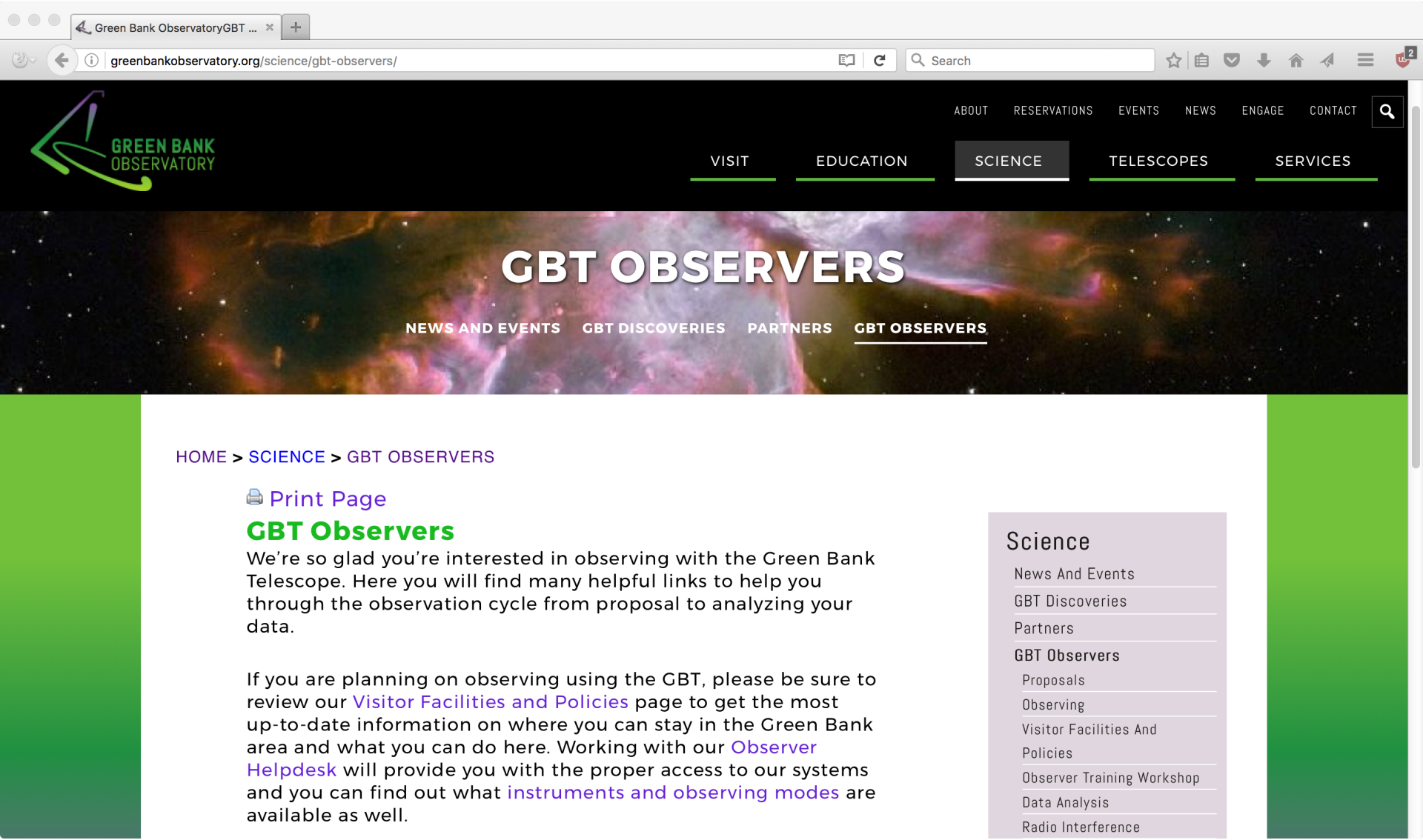
All demo's, data, and scripts are located at: /home/scratch/dfrayer/DATAdemo

- DEMO_basics (Basics of GBTIDL)
- DEMO_frequency_switching (Frequency switching example)
- DEMO_sdfits_HIsigref (sdfits example, basic gbtidl scripting, and reducing HI data)
- DEMO_argus_mapping (Argus Mapping)
- DEMO_NGC6946_HI_pipeline (Example of the GBT pipeline)
- DEMO_argus_frequency_switching_deep_coadd (Argus coadd of FSW HCN(1-0) data)

Observing Related Documentation and Links

- Observer Information
  - GBT Proposer's Guide

GBO GBT Observers Web Page
(under construction)



Next GBT Observer Training Workshop
18-22 Sep 2017