Planning (VLA) observations

14th Synthesis Imaging Workshop (May 2014)

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National Radio Astronomy Observatory (Socorro, NM)

Atacama Large Millimeter/submillimeter Array

Karl G. Jansky Very Large Array

Robert C. Byrd Green Bank Telescope

Very Long Baseline Array

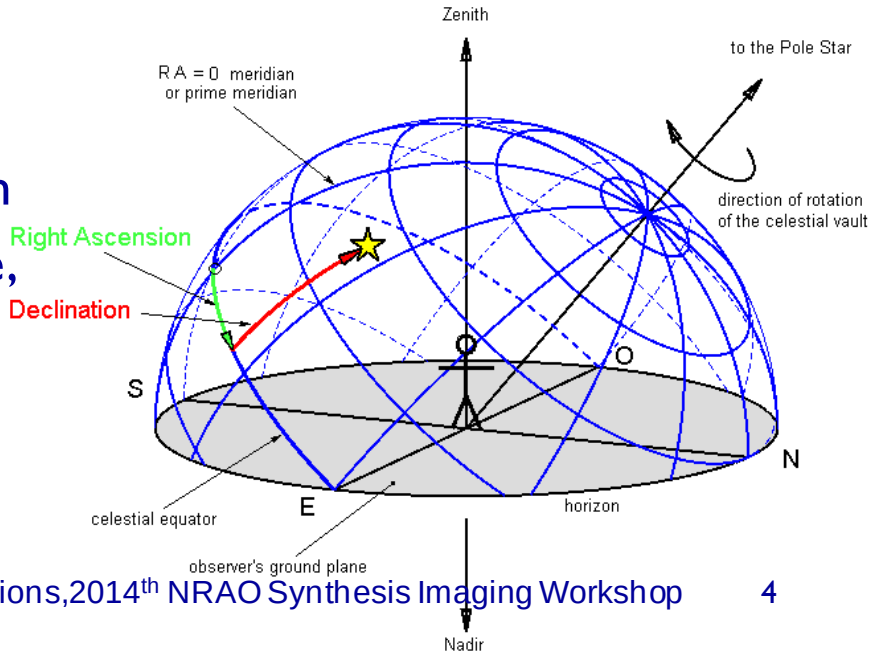
Outline

- General advice on planning any (ground based) observation
- NRAO telescopes: the GBT, ALMA, VLBA, and in particular the VLA
  - VLA, VLBA and ALMA are radio frequency interferometers, GBT is a single radio dish
  - ALMA is a joint endeavor (i.e. somewhat special with its own rules)
- Specific advice for planning VLA observations (I): Proposing
  - Planning starts before proposing/applying for time
- Introduction to the web-based tool to apply for NRAO telescope time
  - Proposal Submission Tool (PST) found at https://my.nrao.edu
- Specific advice for planning VLA observations (II): Scheduling
  - Operations and logistics: dynamic scheduling and scheduling priorities
  - Creating observing schedules is about determining the optimum trade-offs (for **YOUR** science case)
- Introduction to the web-based tool to schedule VLA observations
  - Observation Preparation Tool (OPT) through PST or via https://obs.vla.nrao.edu/opt

Planning observations

Planning any (ground based) observation

- Location of the telescope
  - Determines what part of the sky is visible
    - Declination range, e.g., for the VLA: -44° to +90°
  - Determines the dry/wet seasons and other weather and atmospheric related issues (e.g., troposphere and ionosphere)
  - Determines the level of interfering human activities (light pollution, radio frequency interference)
- Particular telescope may have closures (e.g., maintenance) or instrumentation may be unavailable for periods of time, usually well announced



Planning any (ground based) observation

- Scientific and technical justification
  - Operating telescopes costs money; observing time is precious!
  - Time is available for well justified (scientific) projects on a competitive basis
  - Scientific justification (next slide) should clearly outline the broader scientific relevance and define goals that outline why only (new) telescope time using this particular instrument on a specific target will achieve that goal and contribute to the general knowledge of the research topic
  - Technical justification is to demonstrate that the choice of instrumentation, the observing time and the proposed methodology will yield the result using the requested resources in the most optimal way (i.e., within reason)
  - Projects are ranked by committees based on scientific and technical merit but even a top-notch scientific case may end up without observing time if the justification is poorly argued or technically not feasible
  - Conditional to constraints known to the TAC (time/resources available, day/night and other operational conditions, competition)

Scientific and technical justification

- **Why?**
  - Science context and motivation: what makes this subject scientifically interesting for the field?
  - Outline the broader impact of the science topic and the importance for astrophysics
- **What?**
  - Specific science questions: what missing but obtainable knowledge is furthering the field?
- **How?**
  - Specific science goals: how are these observations, resulting observables, going to answer the questions above and how will the science goals be achieved by this program?

Scientific and technical justification

- **Must appeal to non-expert astrophysicist reviewer** (try to avoid all jargon!)
- Who?
  - Target selection criteria: why are these object chosen for the observations, can the sample be smaller, can it instead be done with similar sources at less popular LST ranges?
- When and where?
  - Should this wait for a better opportunity, hosted by another telescope, that is, why now and why this telescope?
- What is needed?
  - Resources such as instrumental setups, observing time, operational conditions, data reduction requirements
  - *Show it can be done!*

NRAO telescopes

NRAO telescope gallery

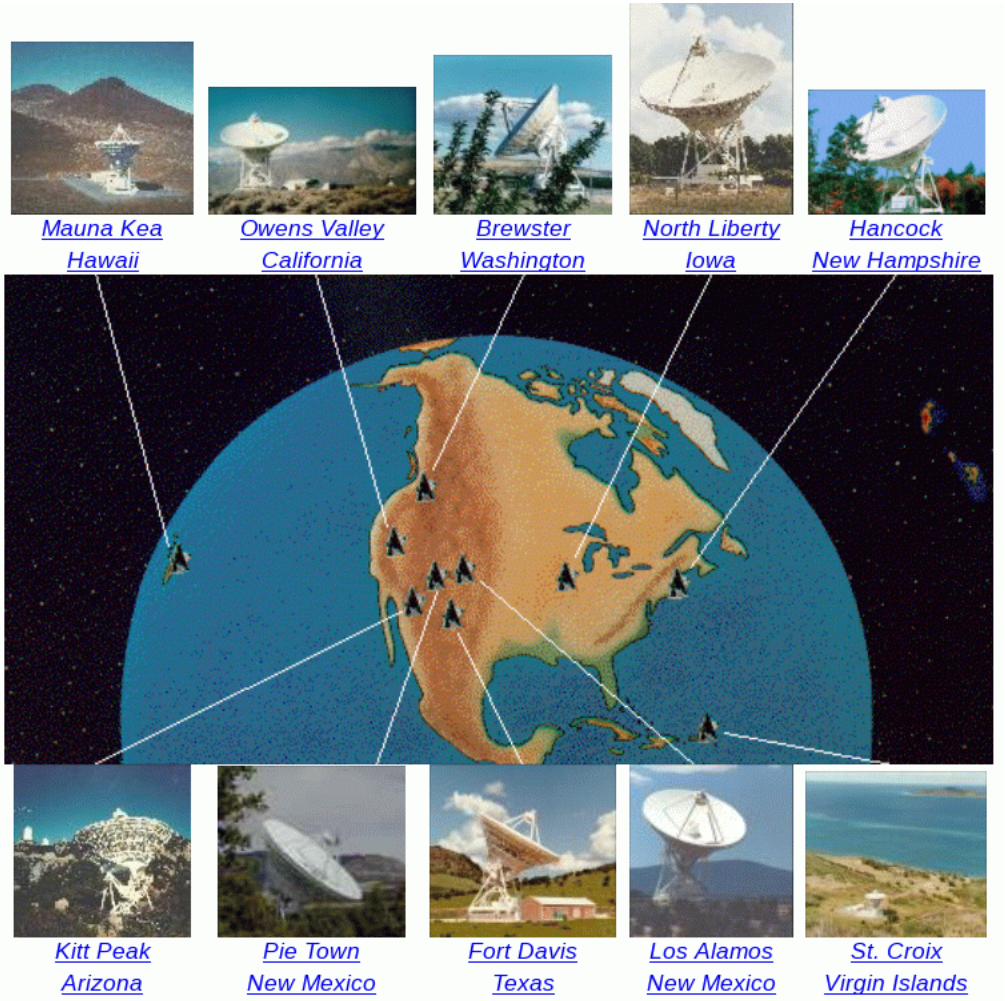
- *Robert C. Byrd* **Green Bank Telescope (GBT)**
  - Fully steerable single dish antenna in WV
  - 100 meter diameter
  - Unblocked view
  - About 100 MHz to 100 GHz
- Not an interferometer (often used as an array element)
- Single dish school next year…

NRAO telescope gallery

- **Atacama Large Millimeter Array (ALMA)**
  - 66 (50 movable and 4+12 stationary) antennas in Chile
  - 12 & 7 meter diameter
  - Baselines up to 16 km
  - About 50 GHz to 1 THz (1000 GHz, 300 μm)
- Almost end of construction…
- Shared instrument (East-Asia, Europe, North America)
- Separate talk here

NRAO telescope gallery

- **Very Long Baseline Array (VLBA)**
  - 10 stationary antennas spread across the US
  - 25 meter diameter
  - Baselines up to 8500 km
  - About 300 MHz to 90 GHz
- Frequently combined with others (US, Europe, Asia, etc)



NRAO telescope gallery

- *Karl G. Jansky* **Very Large Array (VLA)**
  - 27 (+1) movable antennas near Socorro NM!
  - 25 meter diameter
  - Baselines up to 36 km
  - About 70 MHz to 50 GHz
  - New instrument!
- Site tour on Sunday…
  (in A array configuration ☹)

Karl G. Jansky Very Large Array (VLA)

- Movable antennas: compact ("D" configuration) through spread out ("A")
  - Baseline coverage 35 m to ~1 km (D), 3 km (C), 11 km (B), 36 km (A)
    Highest angular resolution in A, best surface brightness sensitivity in D – for a given frequency
  - "Hybrid" configurations: extended north arm for southern sources
  - Configuration change every 4 months: 3 months regular, 1 month hybrid
    "Any" array configuration includes regular, hybrid and "move" time configurations
- Every antenna currently has 8 permanent receiver feeds
  - Continuous frequency coverage from 1 to 50 GHz (working on < 1 GHz)
  - Continuum bandwidth of 2 or up to 8 GHz dual polarization (L: 1 GHz)
  - Switching between feeds takes 10-20 seconds, setups 10-40 seconds
- Extremely flexible WIDAR correlator
  - Up to 64 independent "spectral windows", 31 kHz to 128 MHz (< 8 GHz)
  - Frequency channels of 2 MHz down to 122 Hz (single pol, without recirculation)

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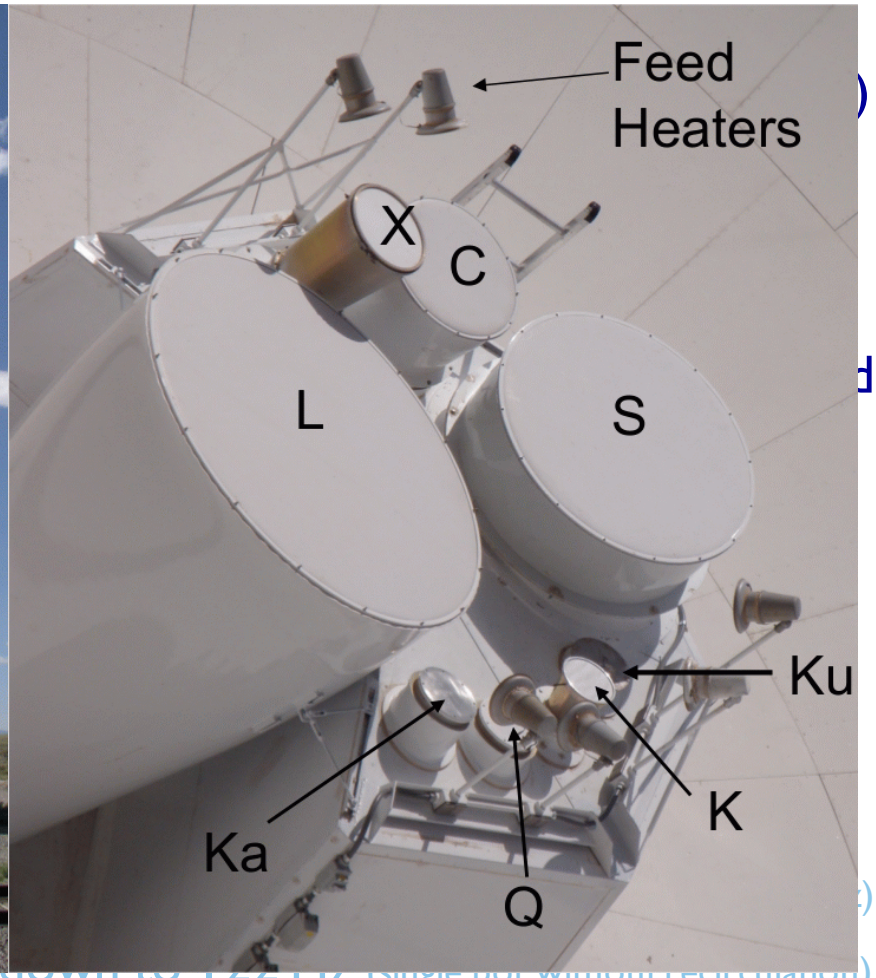

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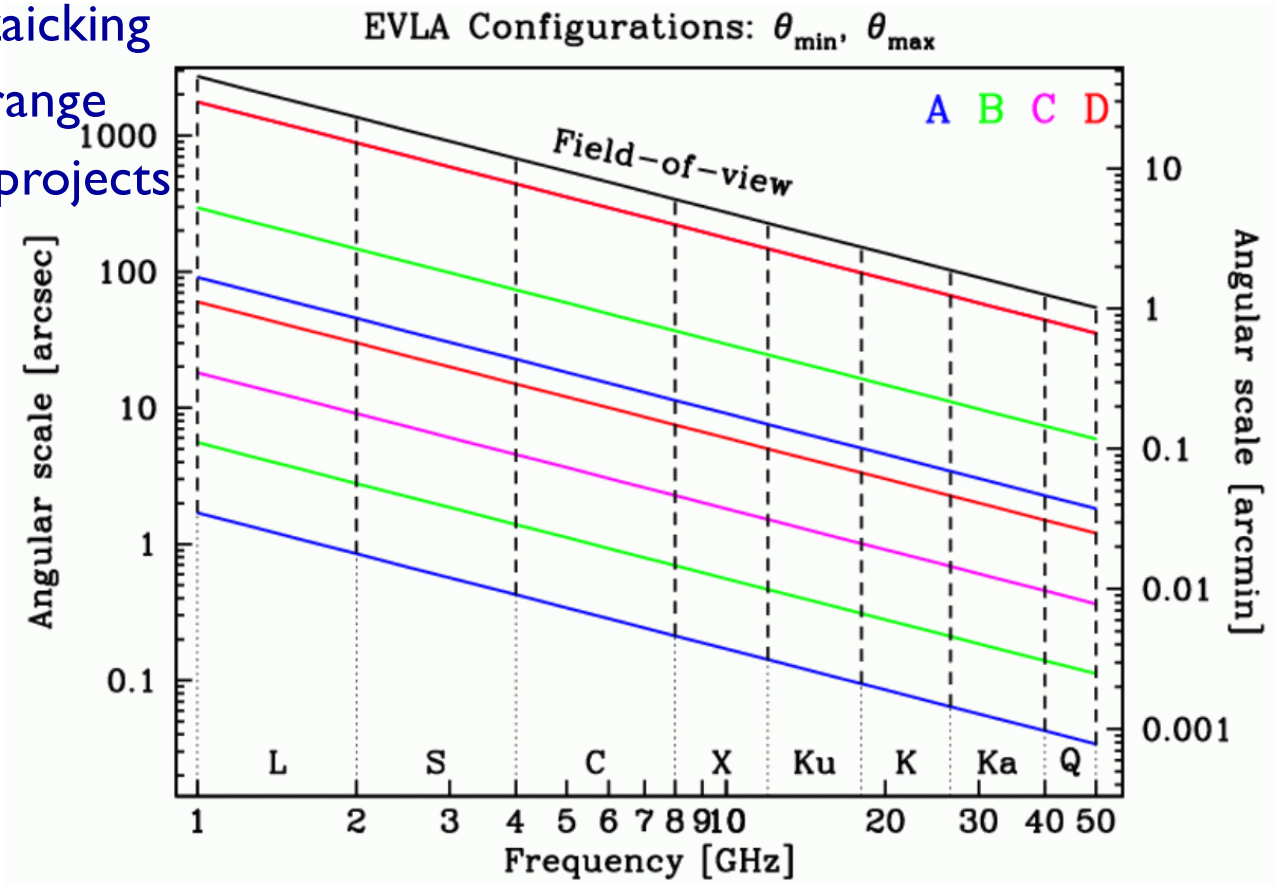
Karl G. Jansky Very Large Array (VLA)

- Frequency bands
- Field-of-view & mozaicking
- Angular resolution range
- Multi-configuration projects



Proposing for VLA observations

Planning VLA observations: Proposing

- Two proposal rounds per year
  - Deadlines near February 1st and August 1st
  - Both for Regular and Large proposals
- DDT: exploratory/target of opportunity
  - Small amount of time (typically couple of hours)
  - Must argue why the normal deadline could not be met
- Scientific justification should be clear and to the point
  - See a previous slide
- Technical justification should address and solve all potential issues
  - Includes setup, sources, data size and reduction, analysis, logistics, etc.

Planning VLA observations: Proposing

- **Read the Call for Proposals** (CfP)
  - Changes, new opportunities
- **Read the on-line documentation!**
  - Instructions and restrictions change
  - Suggestions and hints for higher success rate
- Helpdesk (https://help.nrao.edu) is available
  - Do not wait until just before the deadline, response may be delayed!
  - Best to start asking for help about 2-3 weeks before the deadline
    - i.e., just after the CfP is issued

Planning VLA observations: Proposing

- VLA frequency band
  - Specify the frequency to observe and why
  - Field-of-view at this frequency
    - Need mozaicking?
- VLA configuration (A-D):
  - What angular resolution for the smallest details?
  - What angular scale for the largest structure?
    - Need multi-configuration?
  - B and C configurations less oversubscribed, can those be used instead?
- Need for subarrays? Use less antennas in "move" time?

Planning VLA observations: Proposing

- VLA frequency setup
  - Standard continuum observations?
    - In C, X, Ku bands, use 8-bit or 3-bit?
    - Multi-frequency synthesis?
  - Spectral line, with continuum or complex correlator configuration?
    - Bandwidth per spectral window
      - up to 64 independently configurable
    - Channel separation within each spectral window
    - Polarization within each spectral window
    - Other details like rest frequencies, velocities/redshifts
- Data rate for the setup within the limits?

Planning VLA observations: Proposing

- Observing time request
  - Use **exposure calculator** to estimate sensitivity, image RMS
    - https://obs.vla.nrao.edu/ect
    - Signal-to-noise needed for science, self-calibration?
    - Dynamic range limited or detection experiment?
  - Include overhead for calibration, special processing needs
  - (u,v) coverage considerations (snapshot, full polarization tracks)
  - Specific LST ranges that the sources are above the elevation limit (8°)
    - How many blocks of observing time versus available?
- Is the total project data volume realistic?
  - Data reduction resources (cpu, disks, people, clock time) available?

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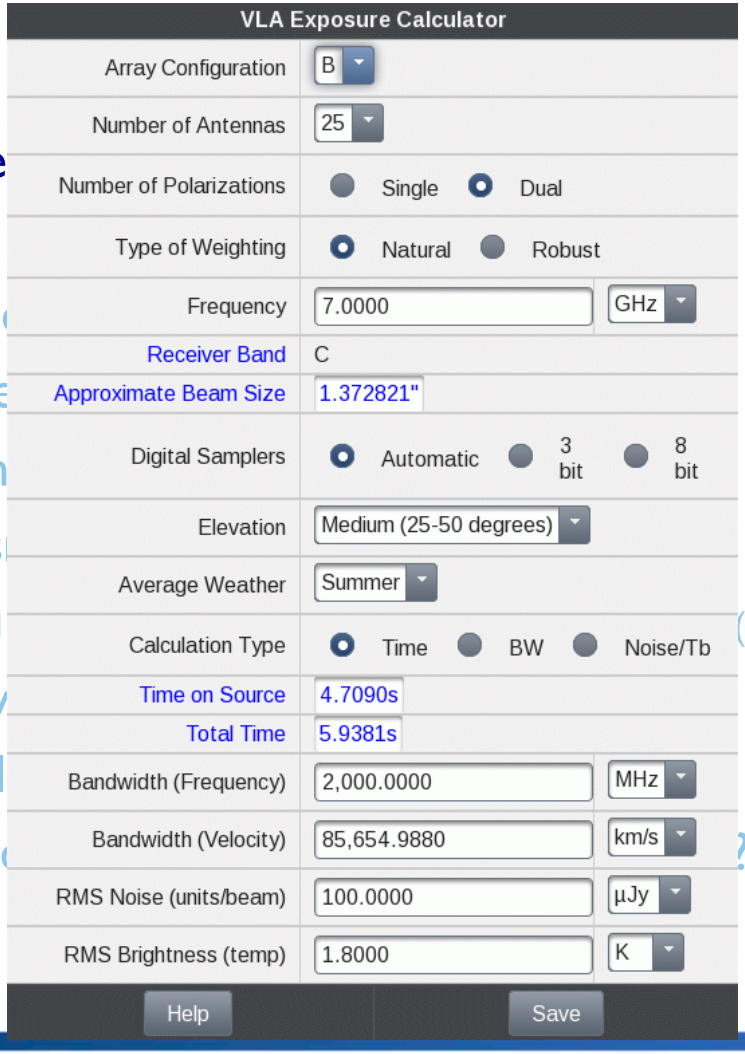

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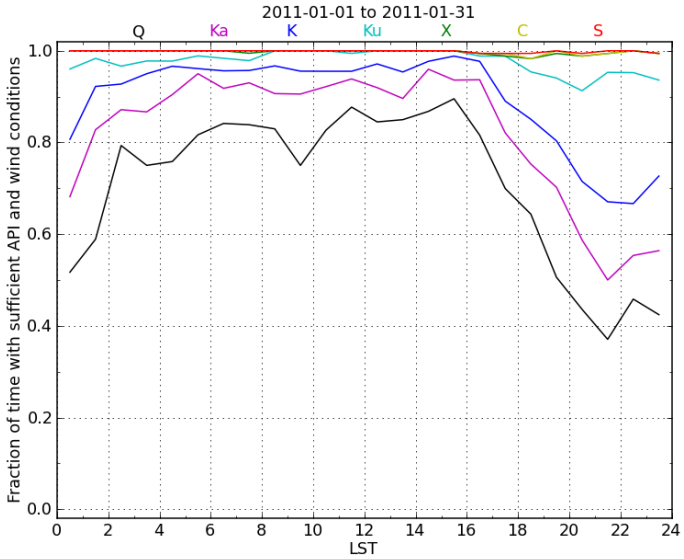
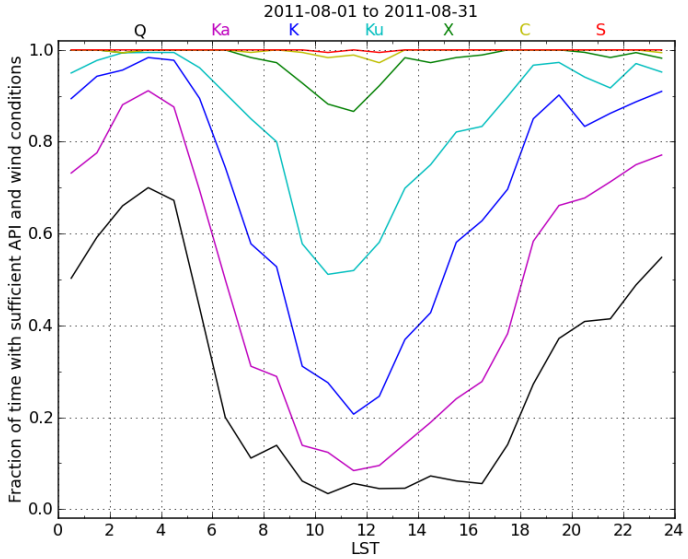
Planning VLA observations: Proposing

- Is source logistically observable?
  - Weather, e.g., decreased time for high frequencies in late summer



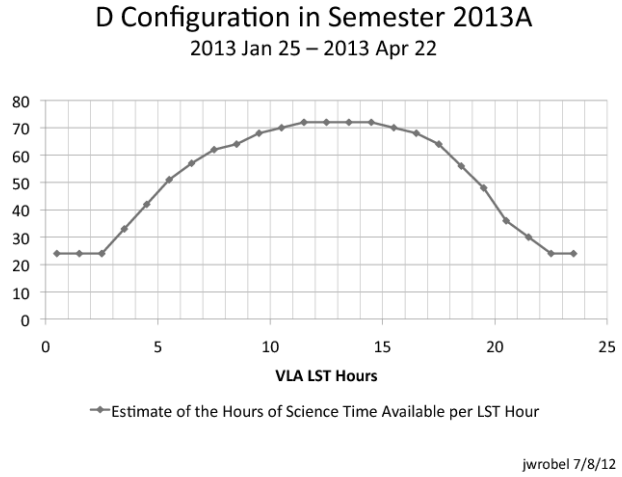


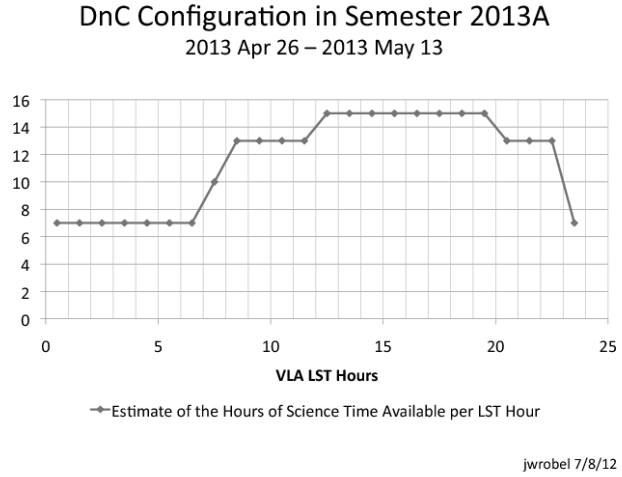
High-frequency observing in January mostly okay, even at LST 22-24h

Mostly poor high-frequency observing conditions in August LST 6-22h

Planning VLA observations: Proposing

- Is source logistically observable?
  - Weather, e.g., decreased time for high frequencies in late summer
  - Time of day, e.g., maintenance during working hours, less RFI at night
  - Available time function of LST, e.g., Galactic LST at 18h in high demand
  - Solar activity, twilight observing, proximity to the Sun





- Available time as function of LST: daytime used for maintenance and tests!

Proposal Submission Tool

NRAO Proposal Submission Tool (PST)

- NRAO portal at https://my.nrao.edu (ALMA portal depends on region)
  - Things change, please read the CfP and on-line documentation!
  - Helpdesk (https://help.nrao.edu) is available, allow for response time
- Create new proposal and select instrument: VLA, VLBA, GBT (& GMVA)
- Follow the tree on the left to construct the proposal
- Submit (and wait)
- Disposition letters 3-4 months later

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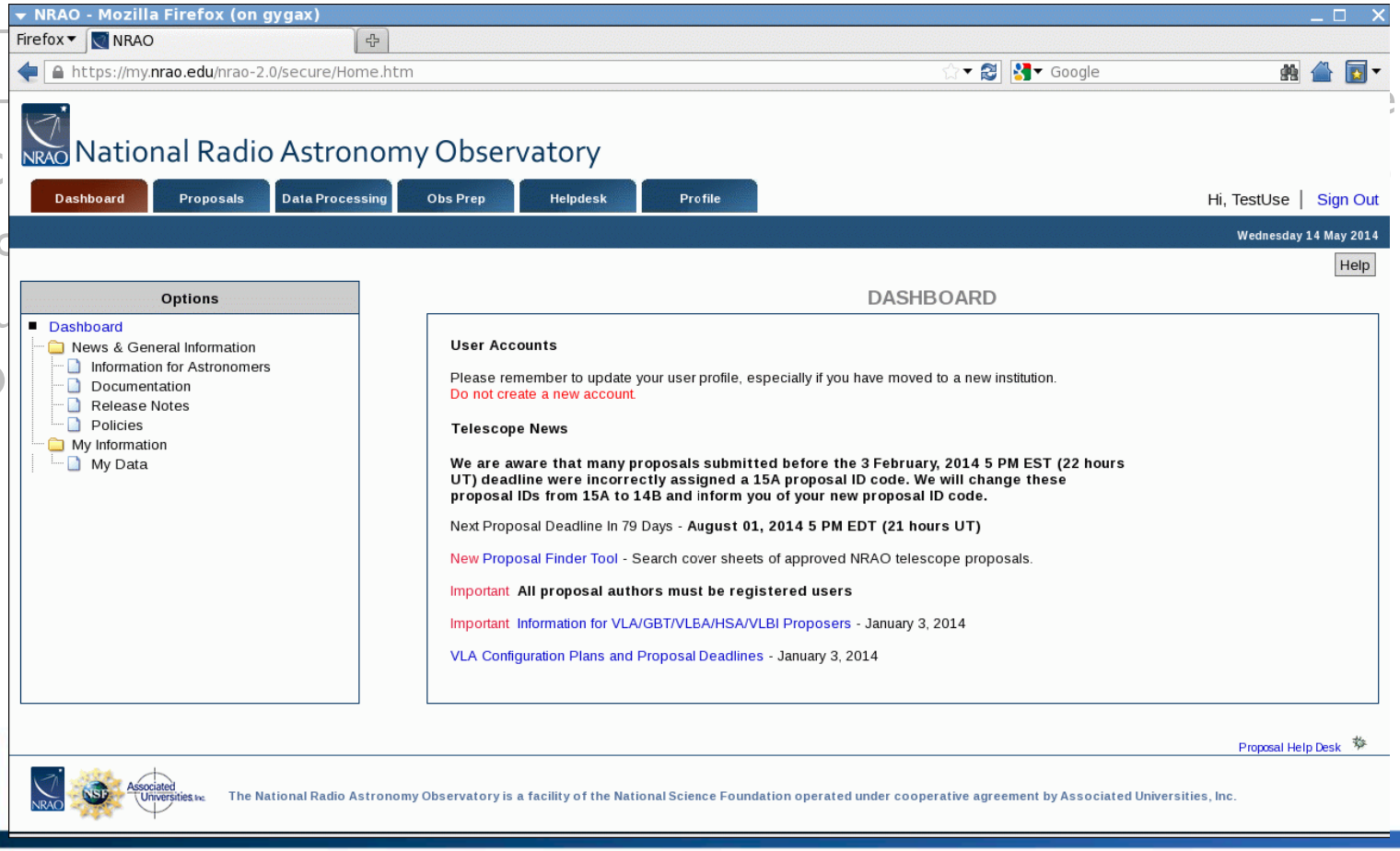

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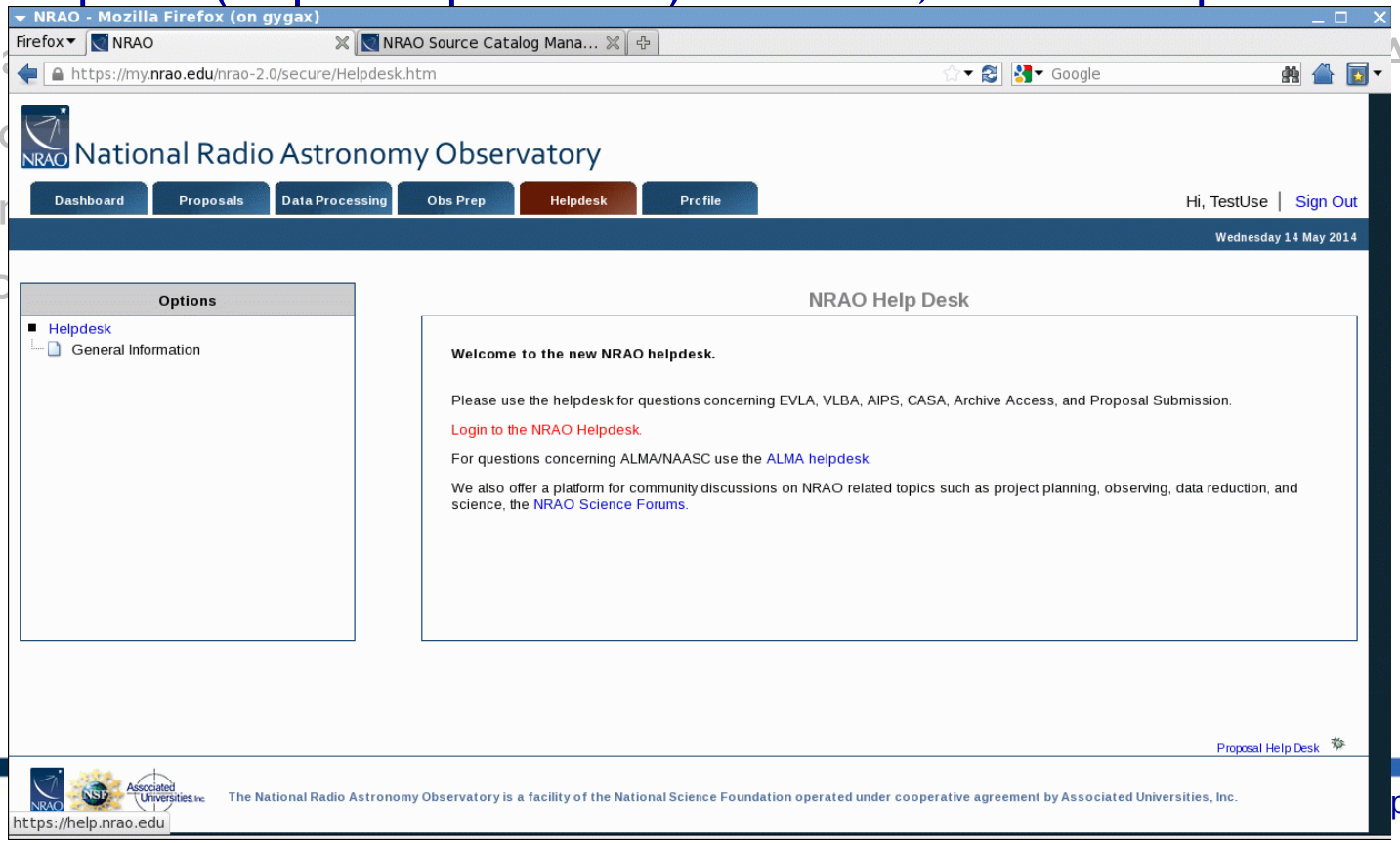

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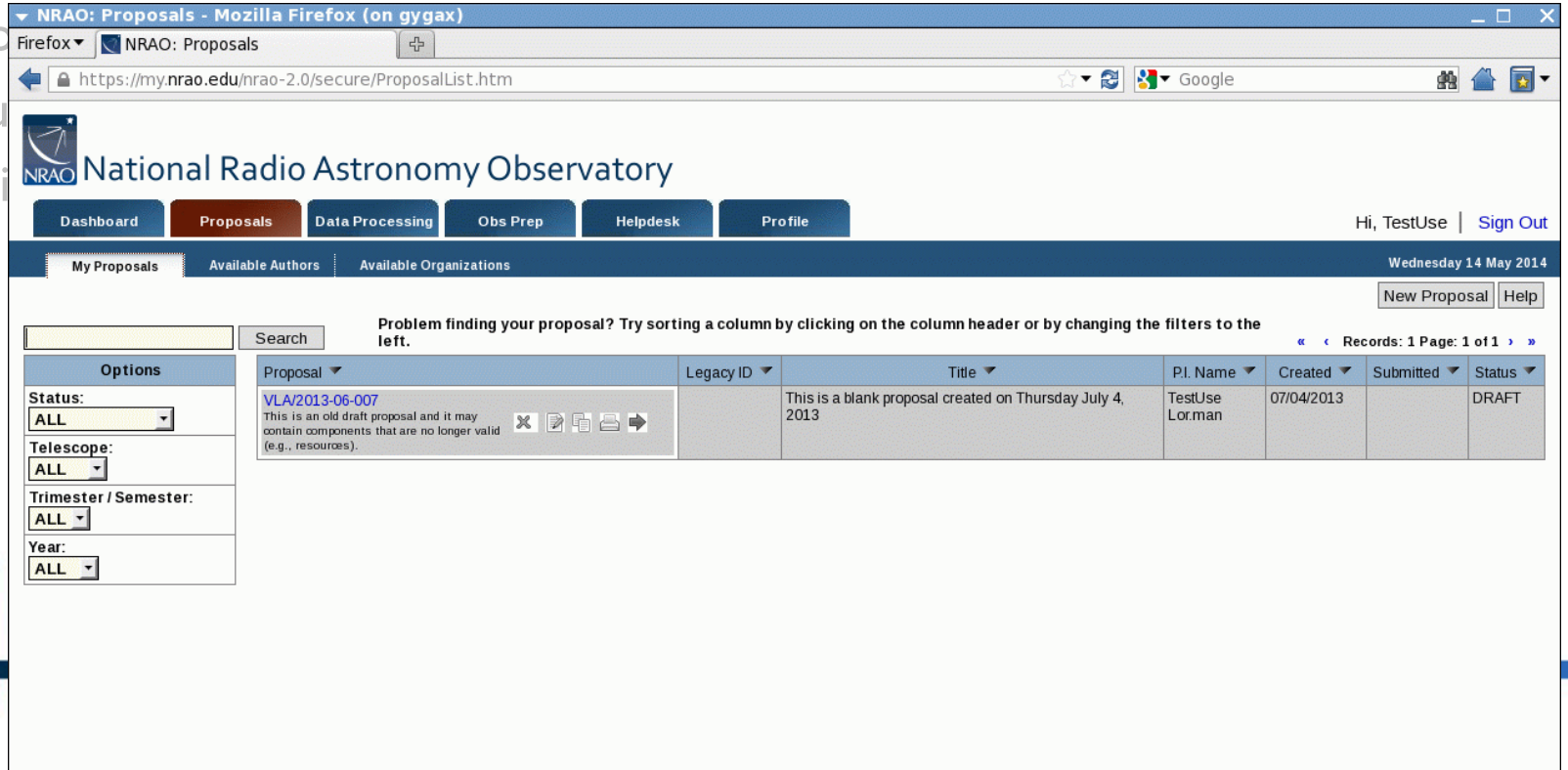

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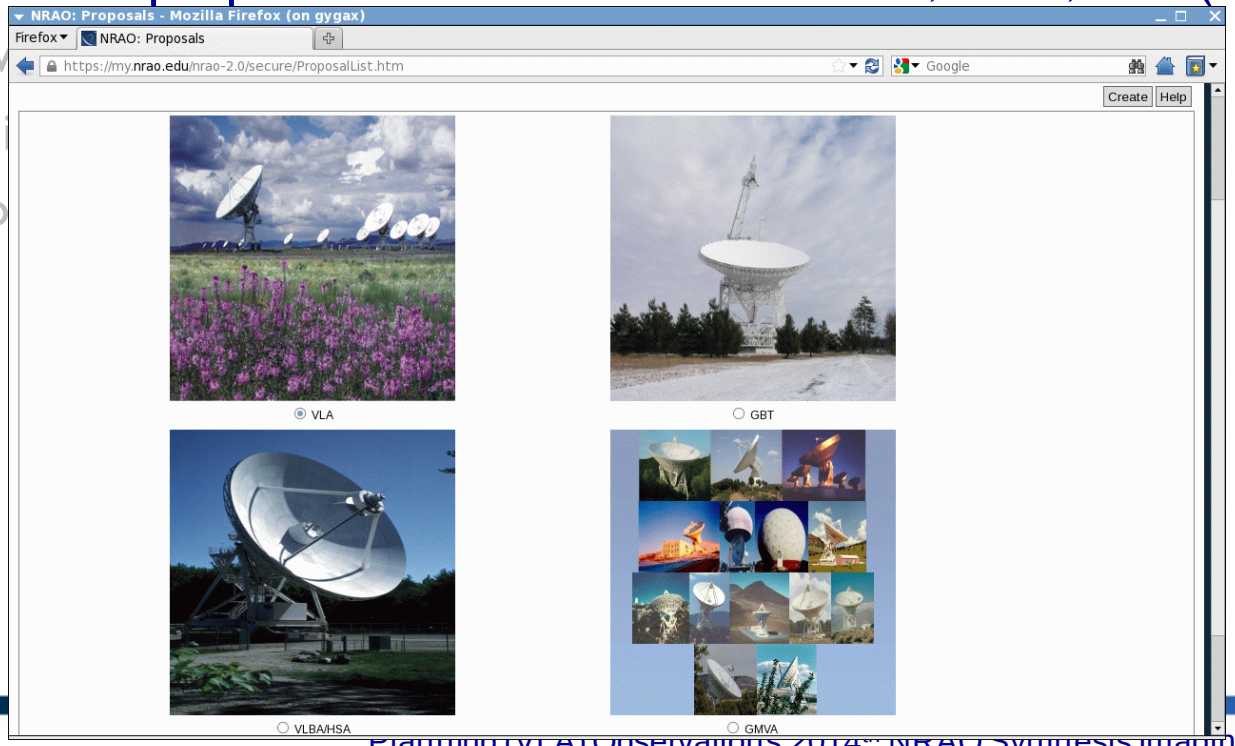

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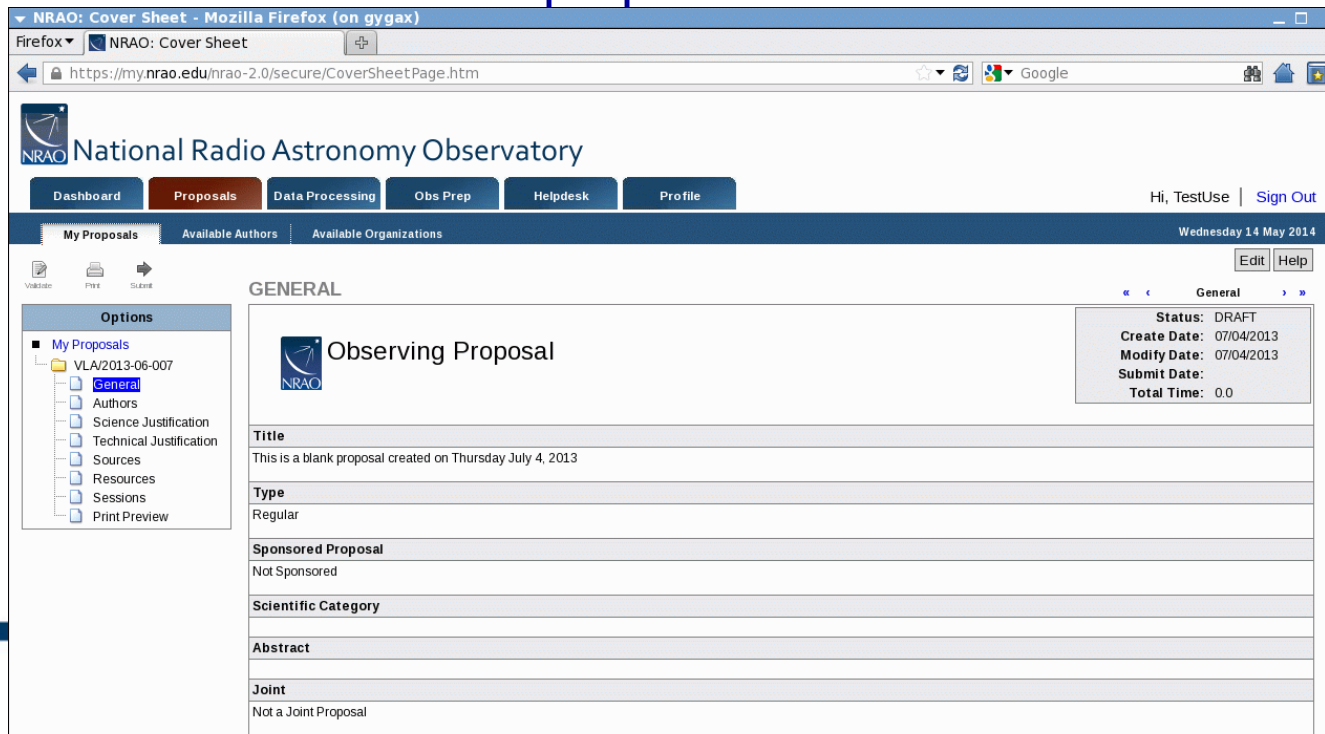

Scheduling of VLA observations

Planning VLA observations: Scheduling

- VLA is dynamically scheduled and uses scheduling priorities
  - A: most likely to be completed
  - C: filler, i.e., when time available and schedule appropriate
- Typically not known when a particular observation takes place
  - For a given array configuration and LST, select from the list of available observing schedules:
    - Highest priority at the top of the list
      - Scheduling priority
      - Science priority (i.e., competition from other PIs)
    - Deselected if science conditions (weather) unfavorable
    - Deselected if operational constraints unfavorable

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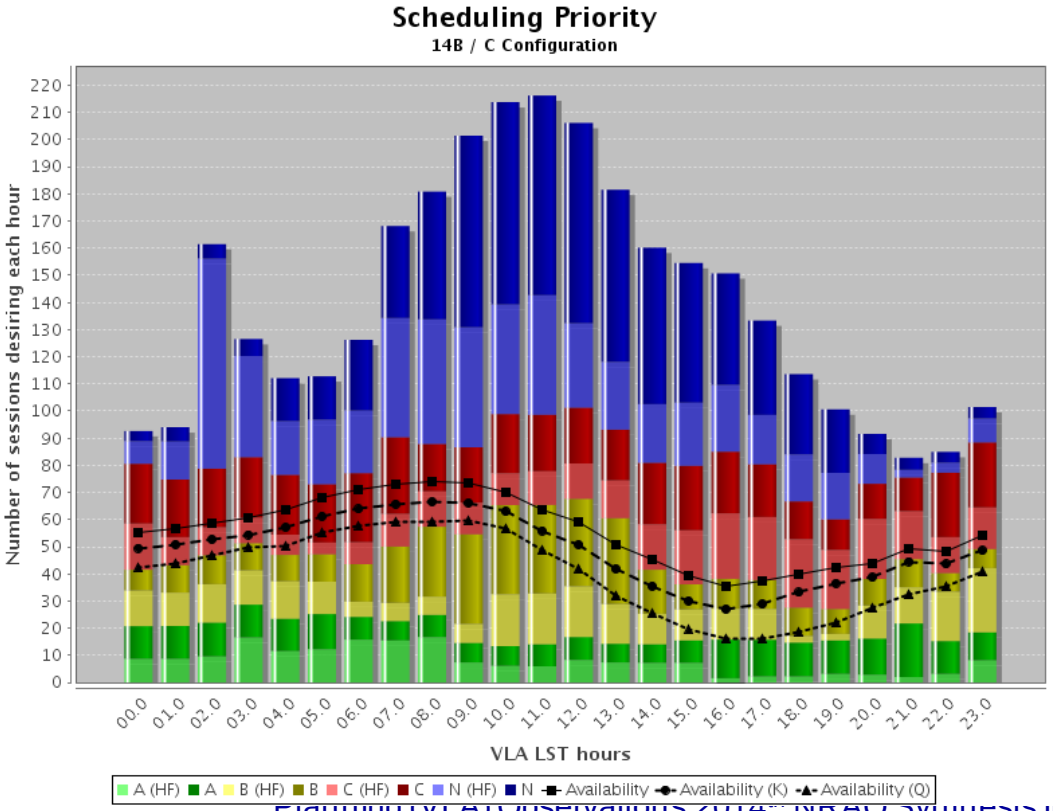

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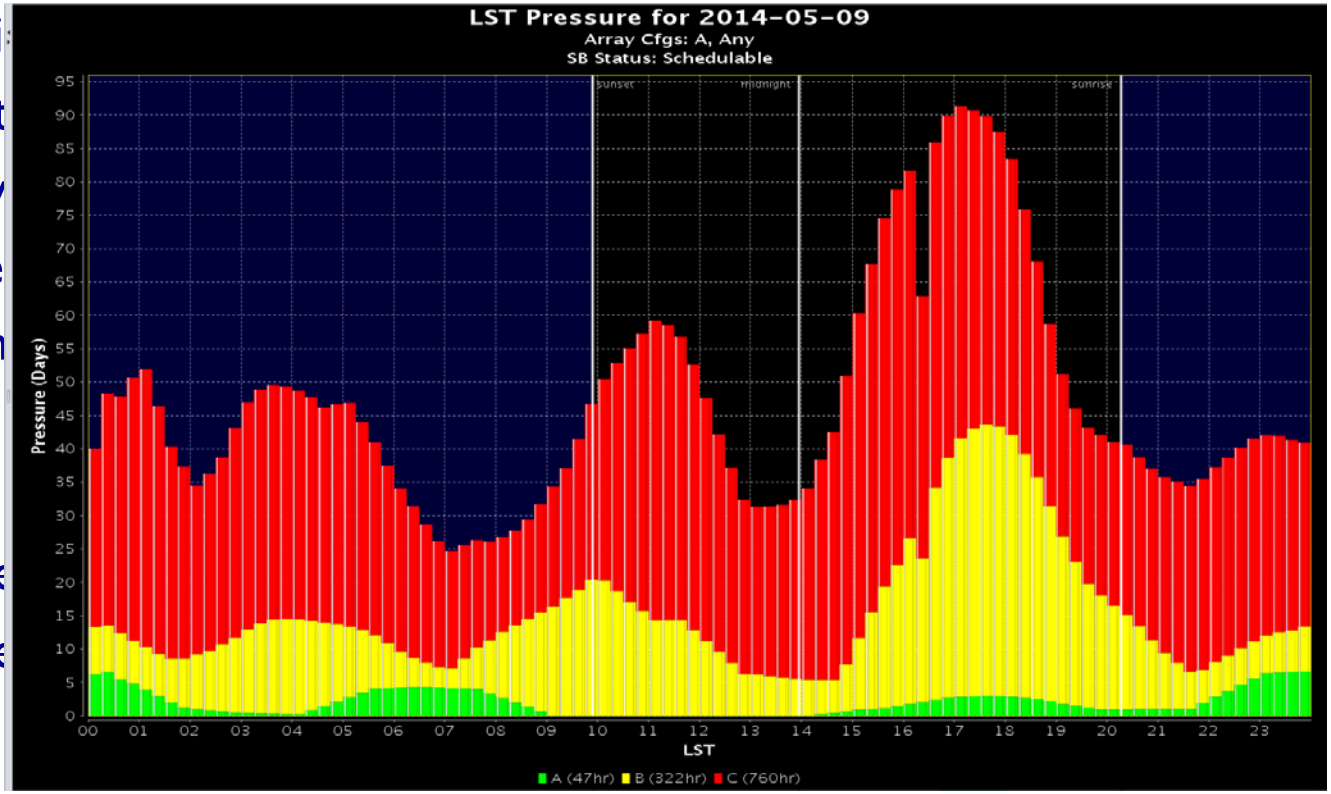

Planning VLA observations: Scheduling

- Some PI control on trade-offs in the scheduling constraints for higher success rate, especially for scheduling priority B and C
- **Read the documentation:**
  - https://science.nrao.edu/facilities/vla/
    - Observational Status Summary
    - Guide to VLA observing
    - OPT manual
- Ask for help!
  - https://help.nrao.edu/

Observation Preparation Tool

Observation Preparation Tool (OPT)

- Use to create VLA observing schedules, a.k.a. "scheduling blocks (SBs)"
- NRAO portal at https://my.nrao.edu or via https://obs.vla.nrao.edu/opt
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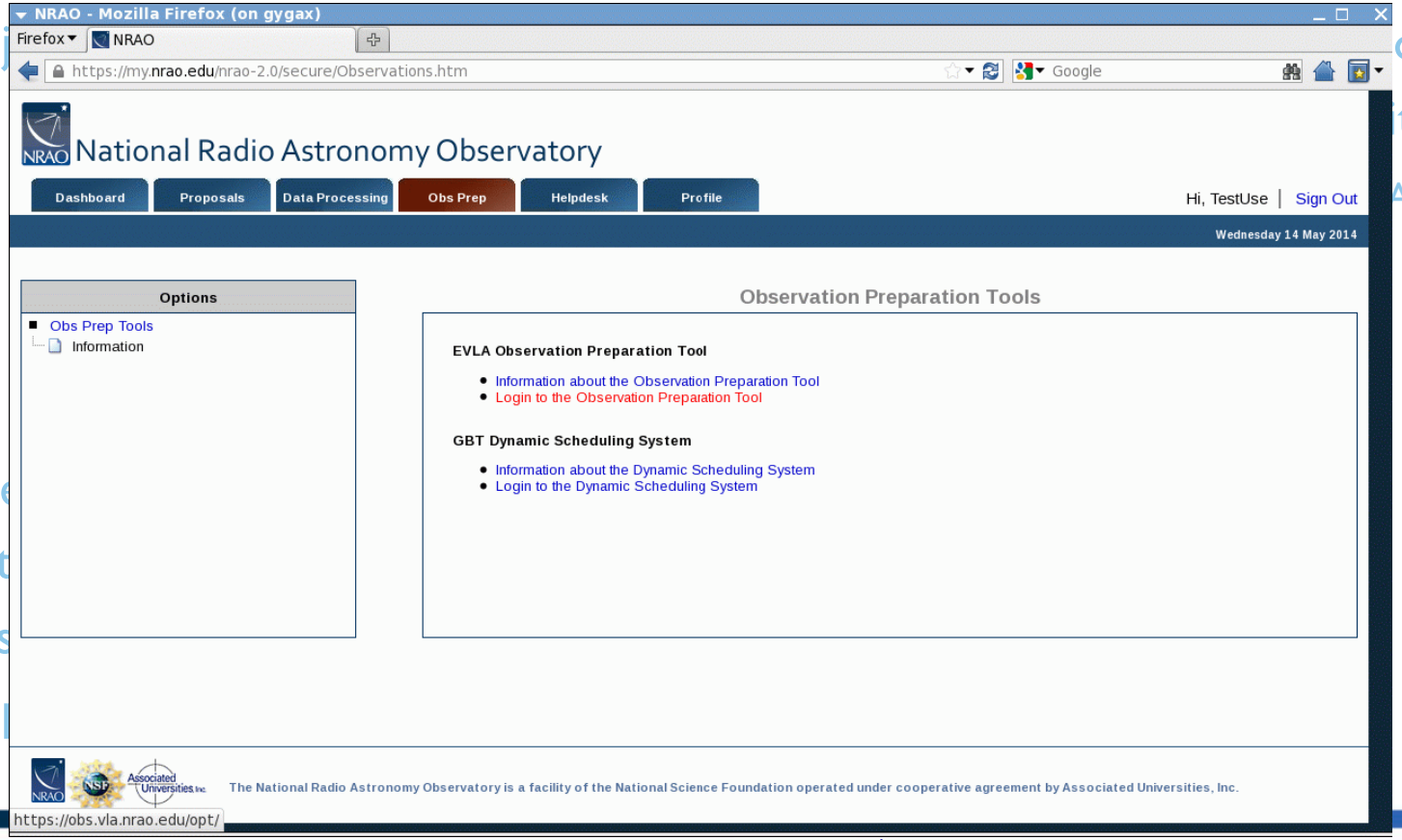

Observation Preparation Tool (OPT)

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- NRAO portal at https://my.nrao.edu or via https://obs.vla.nrao.edu/opt
- Project is created in the OPT a few weeks before the array configuration
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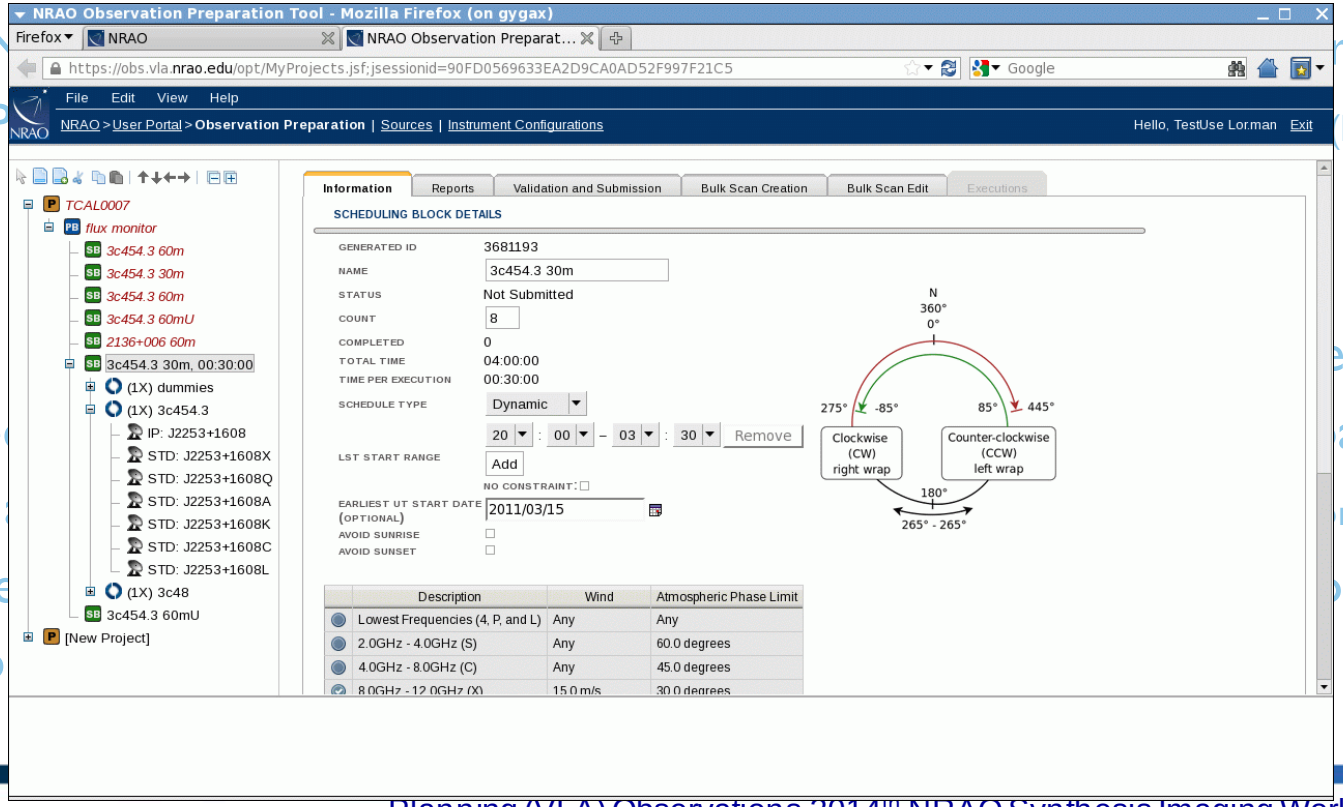

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- NRAO portal at https://my.nrao.edu or via https://obs.vla.nrao.edu/opt
- Project is created in the OPT a few weeks before the array configuration
  - NRAO fills in read-only details, e.g., PI, time, array, scheduling priority(!)
  - Proposers responsible for schedule and observing constraints (LST, API, ..)
    - Things change, please read the on-line documentation!
    - Helpdesk (https://help.nrao.edu) is available, please use it
    - Schedule is checked for logistical issues, but not for science!
- Scheduling may require making trade-offs, depending on science goals
- Not all SBs will be completed (priority/competition, weather, constraints, operations)
- Observations are directly archived and pipelined, proprietary period
- Proposers may be contacted about the pipelined data products

OPT "hands-on" tutorial

- Using the OPT, login and navigate, "look and feel"
- Existing project SB (scheduling block) available
- Examine SB
  - Conditions, reports and validation
- Modify SB
  - SCT, source catalog tool
    - Search for calibrators, create a new source
  - RCT, resource (instrument setup) catalog tool
    - Default continuum setups, create a line setup
  - OPT, observation preparation (scan sequence) tool
    - Change (re)source, scan sequence, play with conditions
- Validate and "submit"

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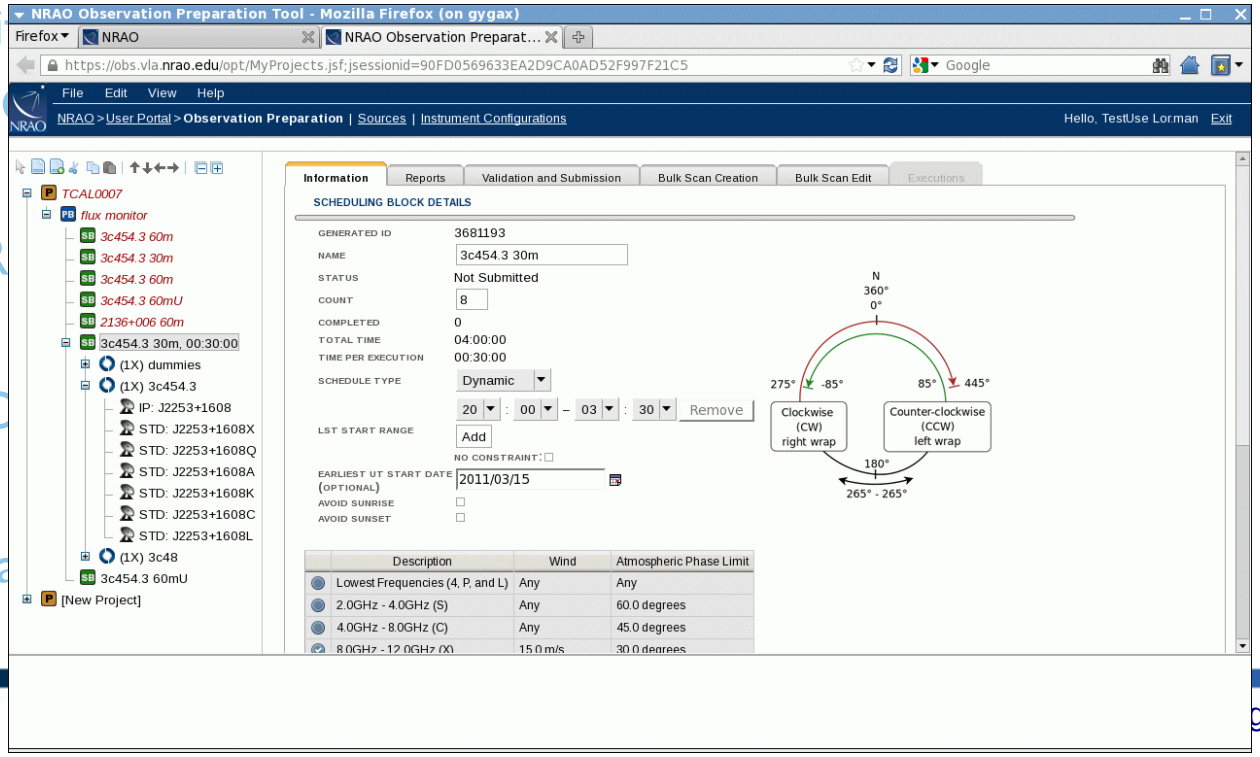

OPT "hands-on" tutorial

- Using the OPT, login and navigate, "look and feel"
- Existing project SB (scheduling block) available
- Examine SB
  - Conditions, reports and validation
- Modify SB
  - SCT, source catalog tool
    - Search for calibrators, create a new source
  - RCT, resource (instrument setup) catalog tool
    - Default continuum setups, create a line setup
  - OPT, observation preparation (scan sequence) tool
    - Change (re)source, scan sequence, play with conditions
- Validate and "submit"

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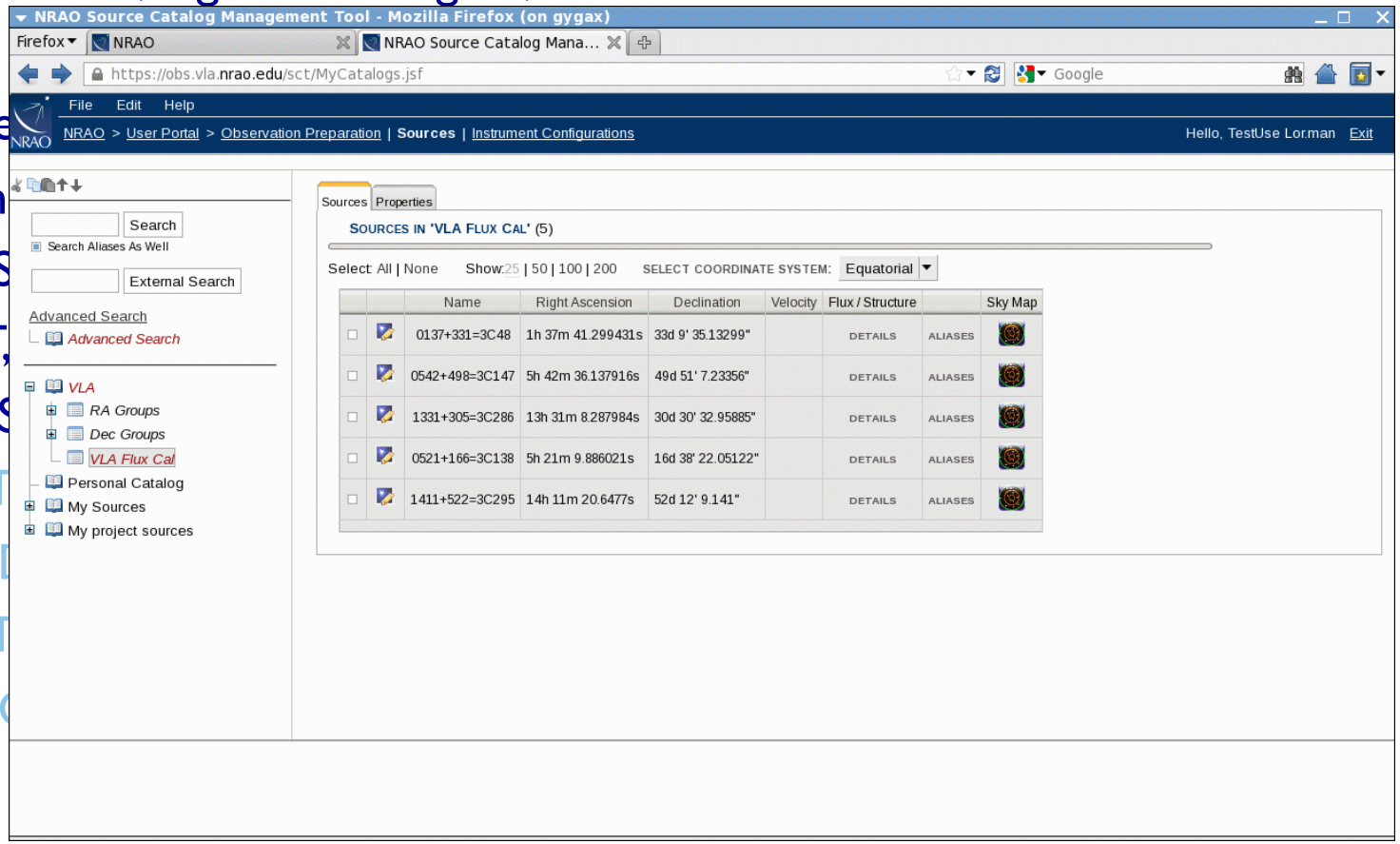

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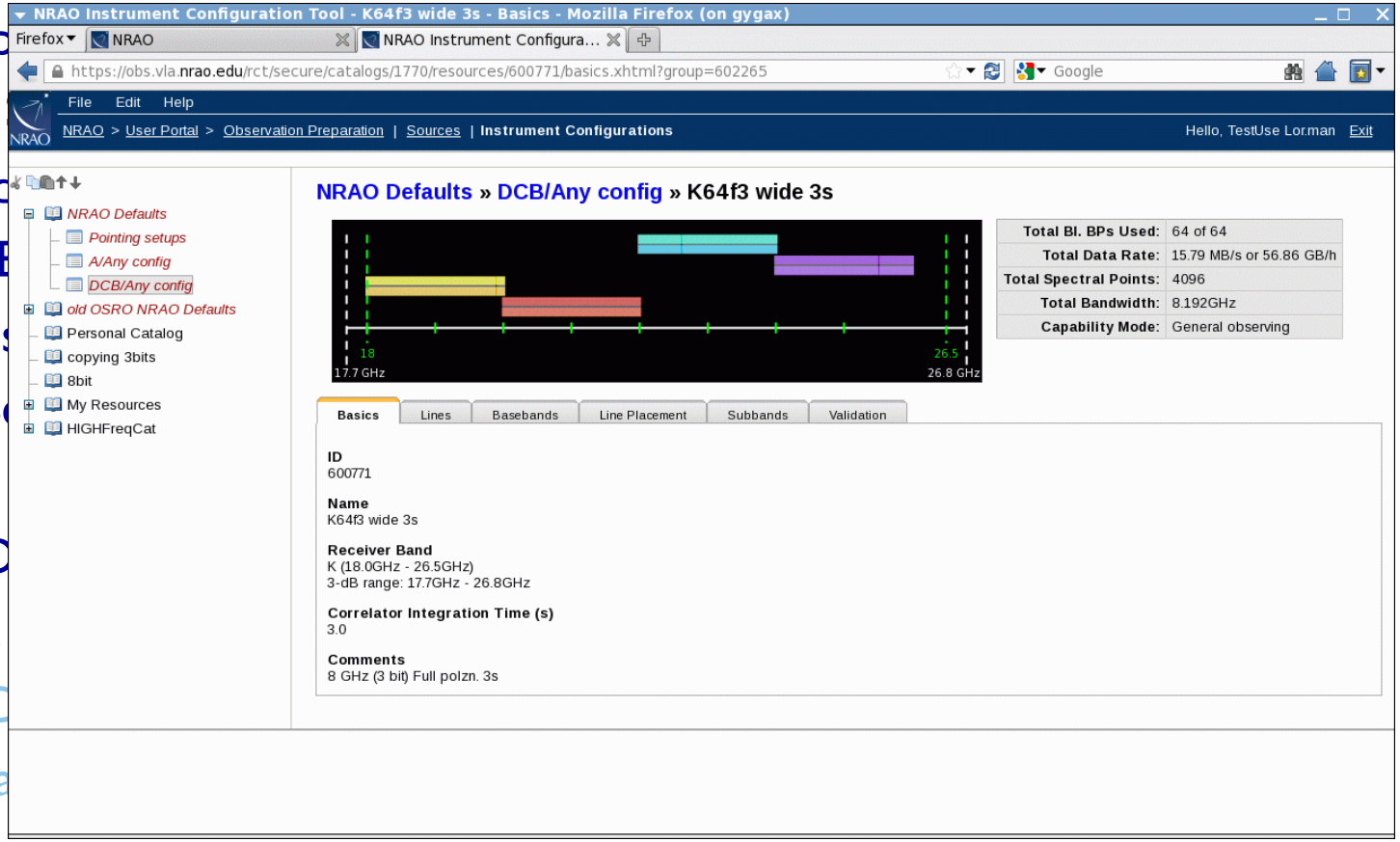

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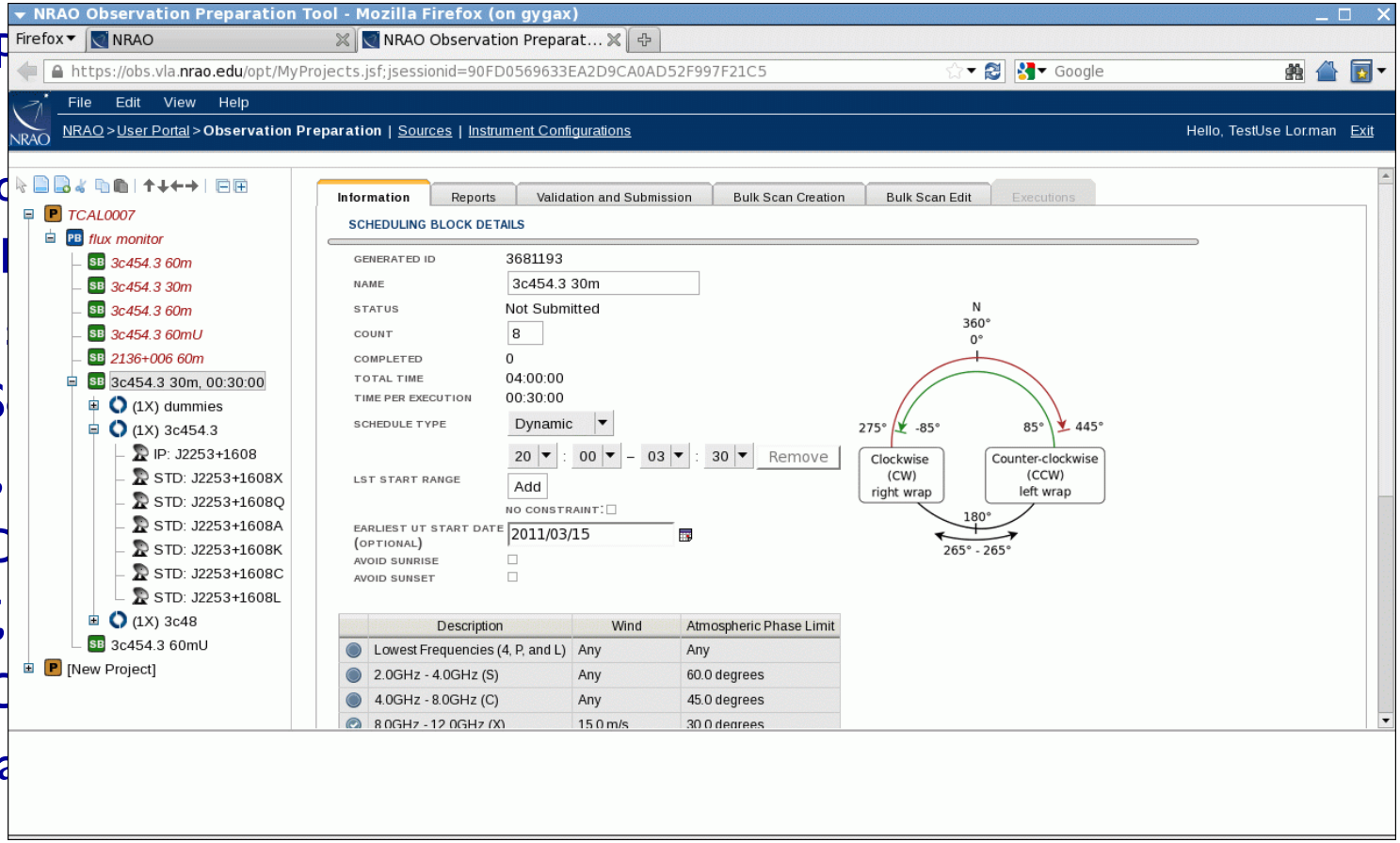

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Questions ?