Planning (VLA) observations

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Sixteenth Synthesis Imaging Workshop

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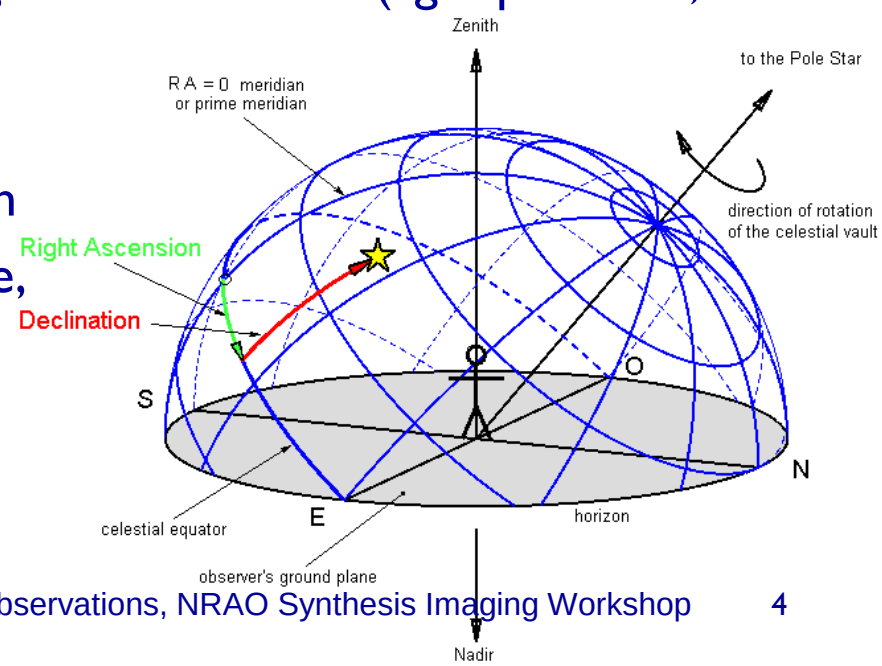
Outline

- General advice on planning any (ground based) observation
- AUI telescopes: the GBT, ALMA, VLBA, and in particular the VLA
  - VLA, VLBA and ALMA are radio frequency interferometers, GBT is a single radio dish
  - VLA is NRAO operated, VLBA is LBO operated (soon NRAO?) and GBT is GBO operated
  - ALMA is a joint endeavor (i.e. somewhat special with its own rules); for ALMA see next talk
- Specific advice for planning VLA observations (I): Proposing
  - Planning starts before proposing/applying for time
- Introduction to the web-based tool to apply for AUI 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 portal 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!*

AUI operated telescopes

AUI telescope gallery

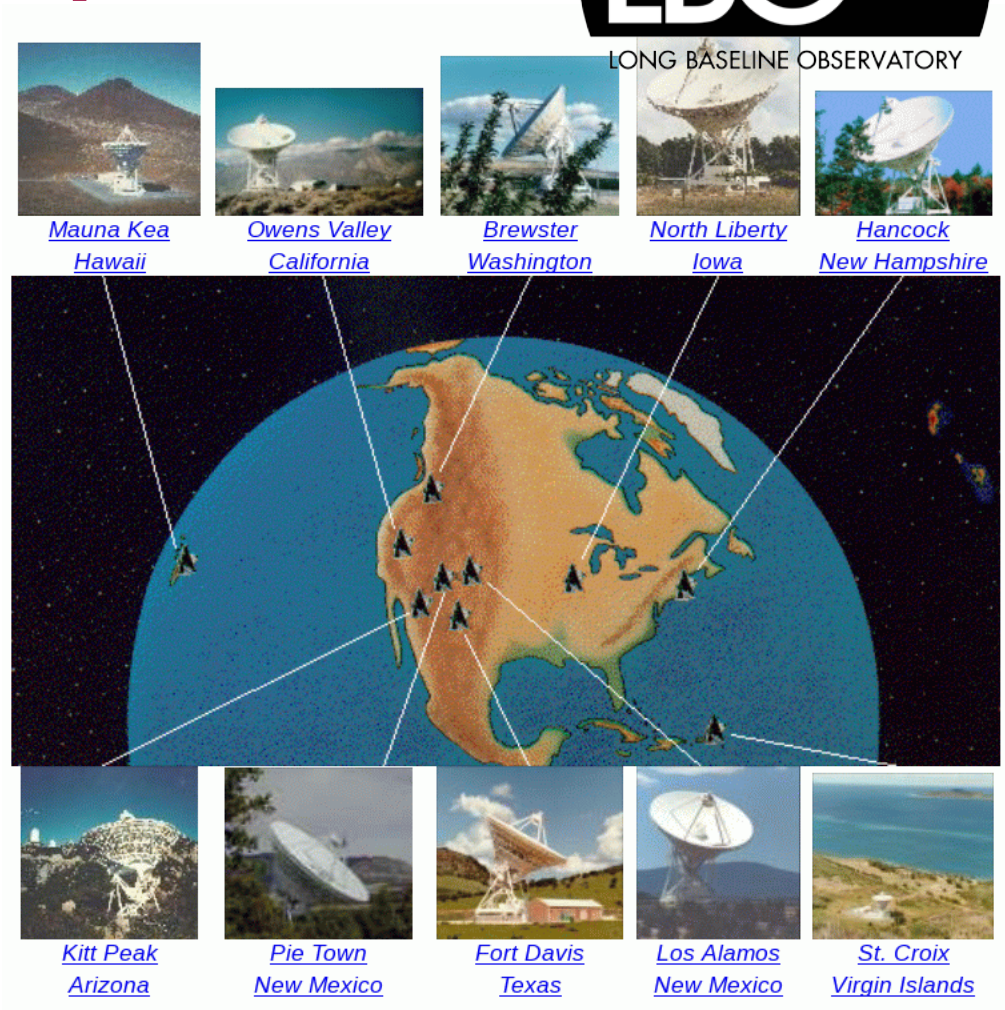
- *Robert C. Byrd* **Green Bank Telescope (GBT)** operated by GBO
  - Fully steerable single dish antenna in WV
  - 100 meter diameter
  - Unblocked view
  - About 100 MHz to 100 GHz
- Not an interferometer (often used as an array element)
- Separate single dish workshops elsewhere

AUI telescope gallery

- **Atacama Large Millimeter Array (ALMA)** operated by JAO
  - 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)
- Shared instrument (East-Asia, Europe, North America)
- Separate talk here

AUI telescope gallery

- **Very Long Baseline Array (VLBA)** operated by LBO
  - 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)



AUI telescope gallery

- *Karl G. Jansky* **Very Large Array (VLA)** operated by NRAO
  - 27 (+1) movable antennas near Socorro NM!
  - 25 meter diameter
  - Baselines up to 36 km
  - About 70 MHz to 50 GHz

- Site tour on Sunday…

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
  - Configuration change every ~4 months
    "Any" array configuration includes regular and "move" time configurations
- Every antenna currently has 8 permanent receiver feeds
  - Continuous frequency coverage from 1 to 50 GHz (working on < 1GHz)
  - Continuum bandwidth of 2 or up to 8 GHz dual polarization (L: 1GHz)
  - 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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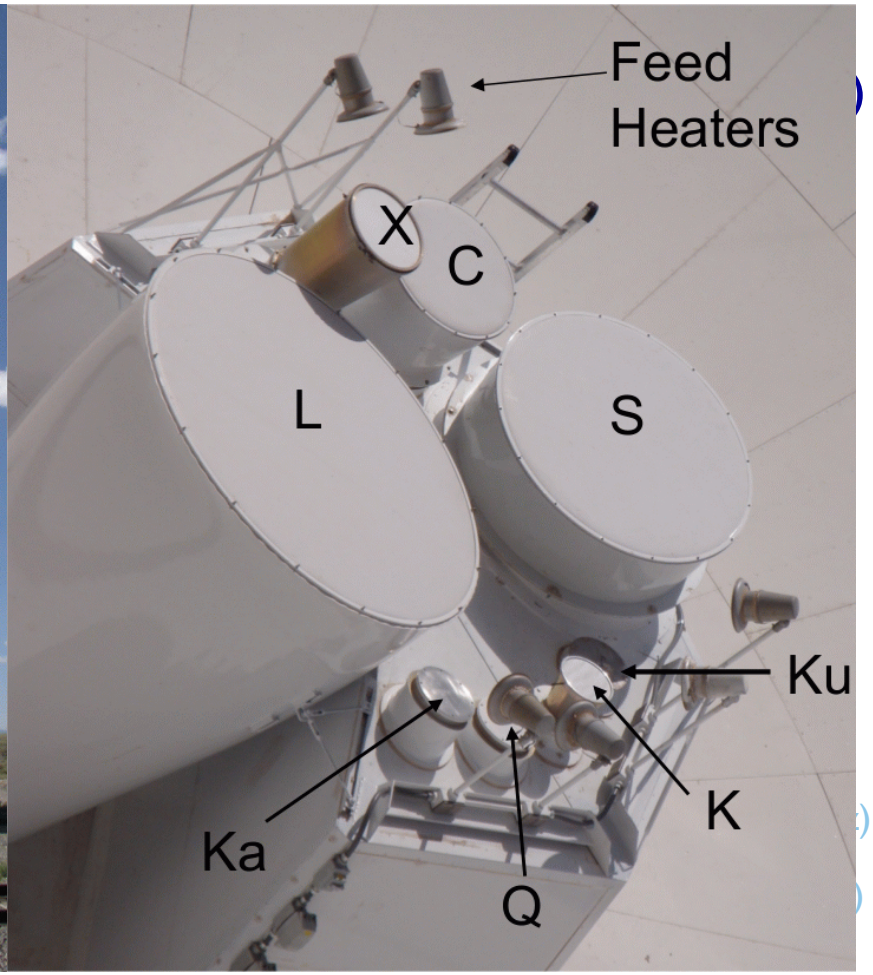

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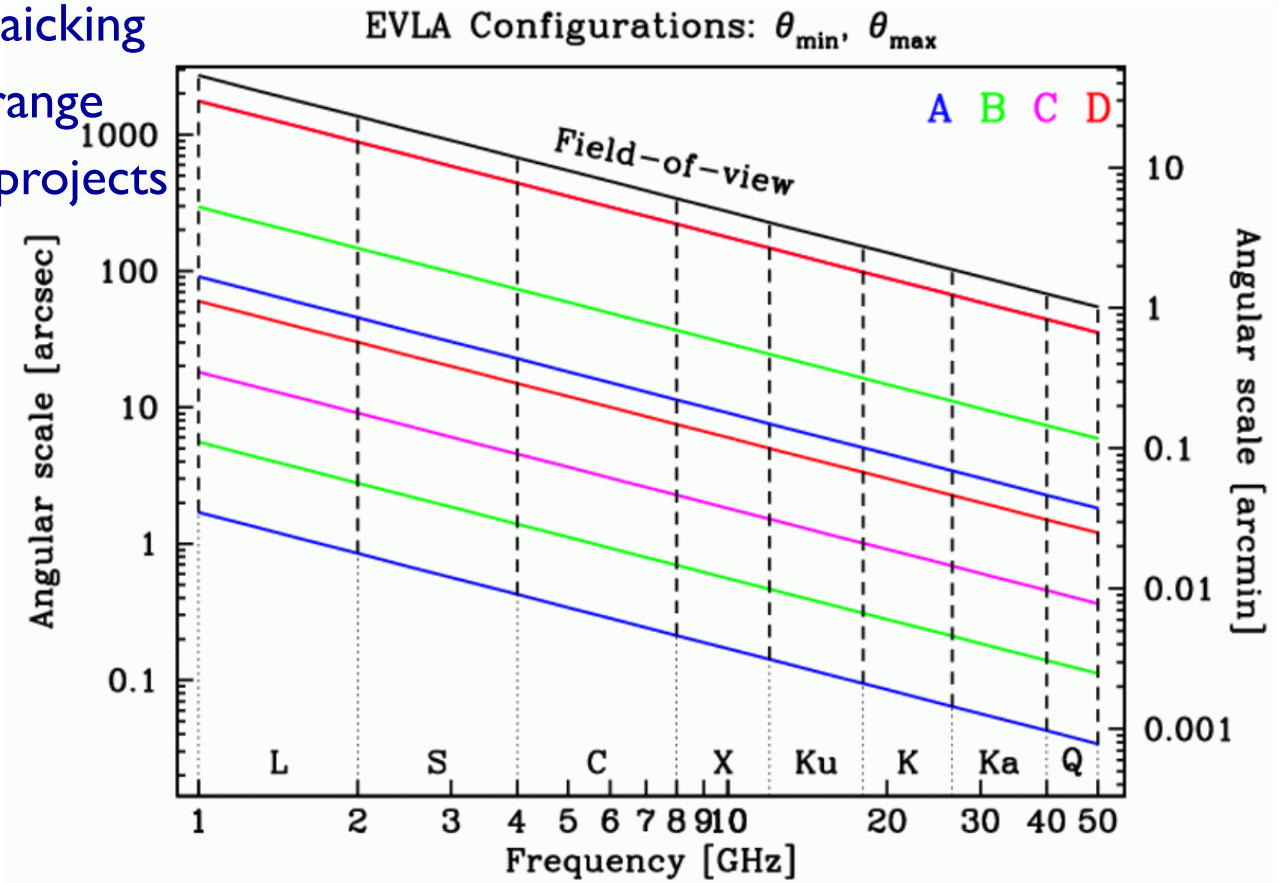
Karl G. Jansky Very Large Array (VLA)

- Frequency bands
- Field-of-view & mosaicking
- 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 resolve 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, special instructions
- **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 receiver band
  - Specify the frequency to observe and why
  - Field-of-view at this frequency
    - Need mosaicking?
- VLA array 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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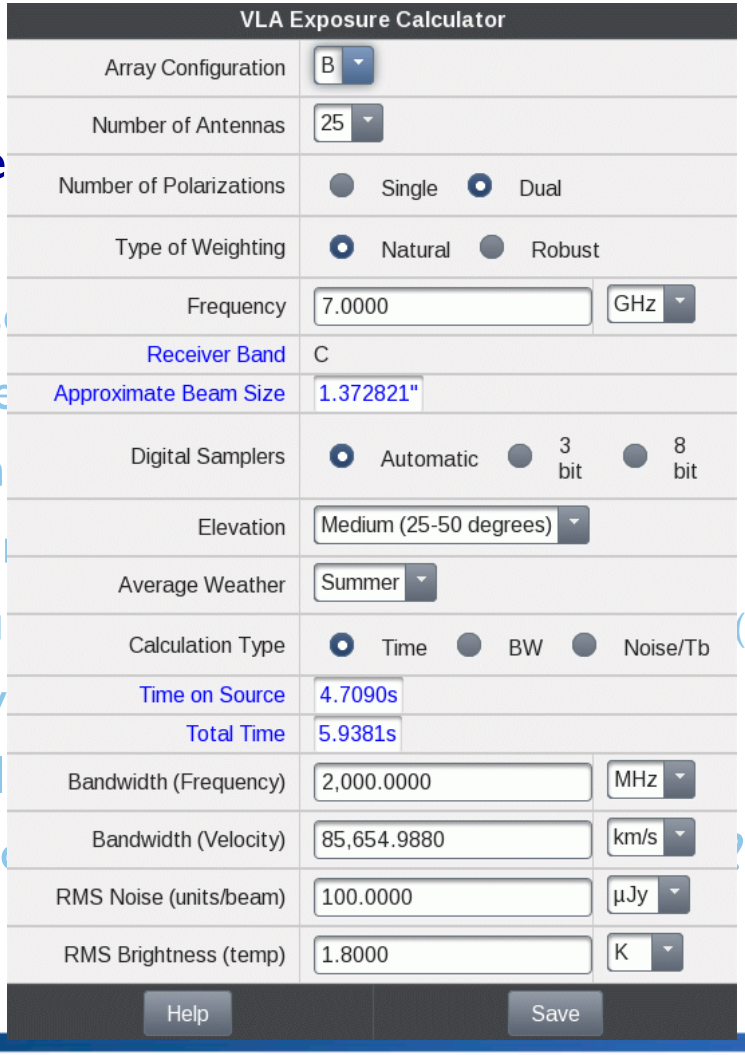

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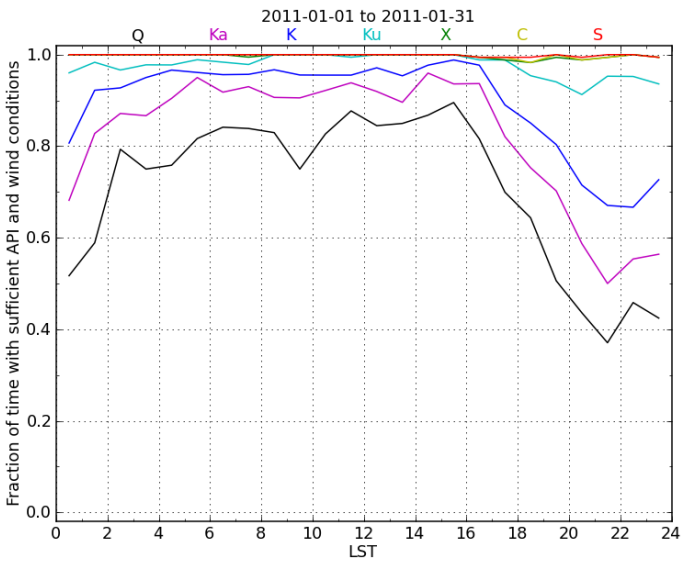
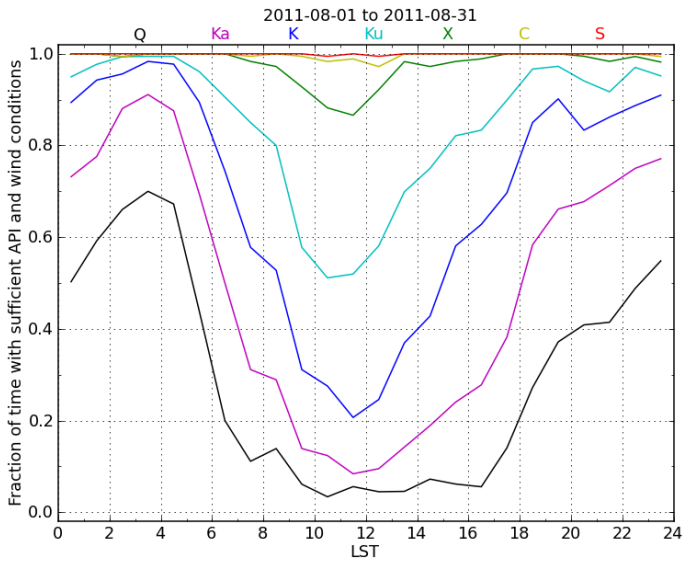
Planning VLA observations: Proposing

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



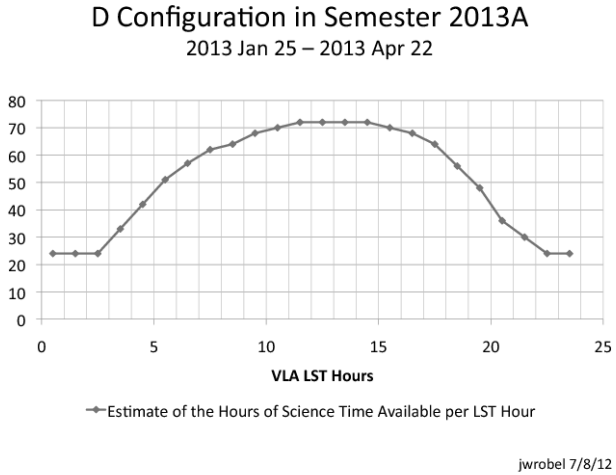


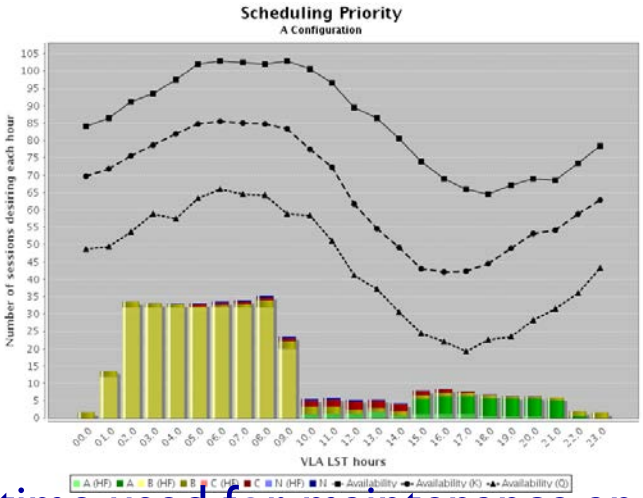
High-frequency observing in January mostly okay, even at LST 22-24h

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: almascience.org 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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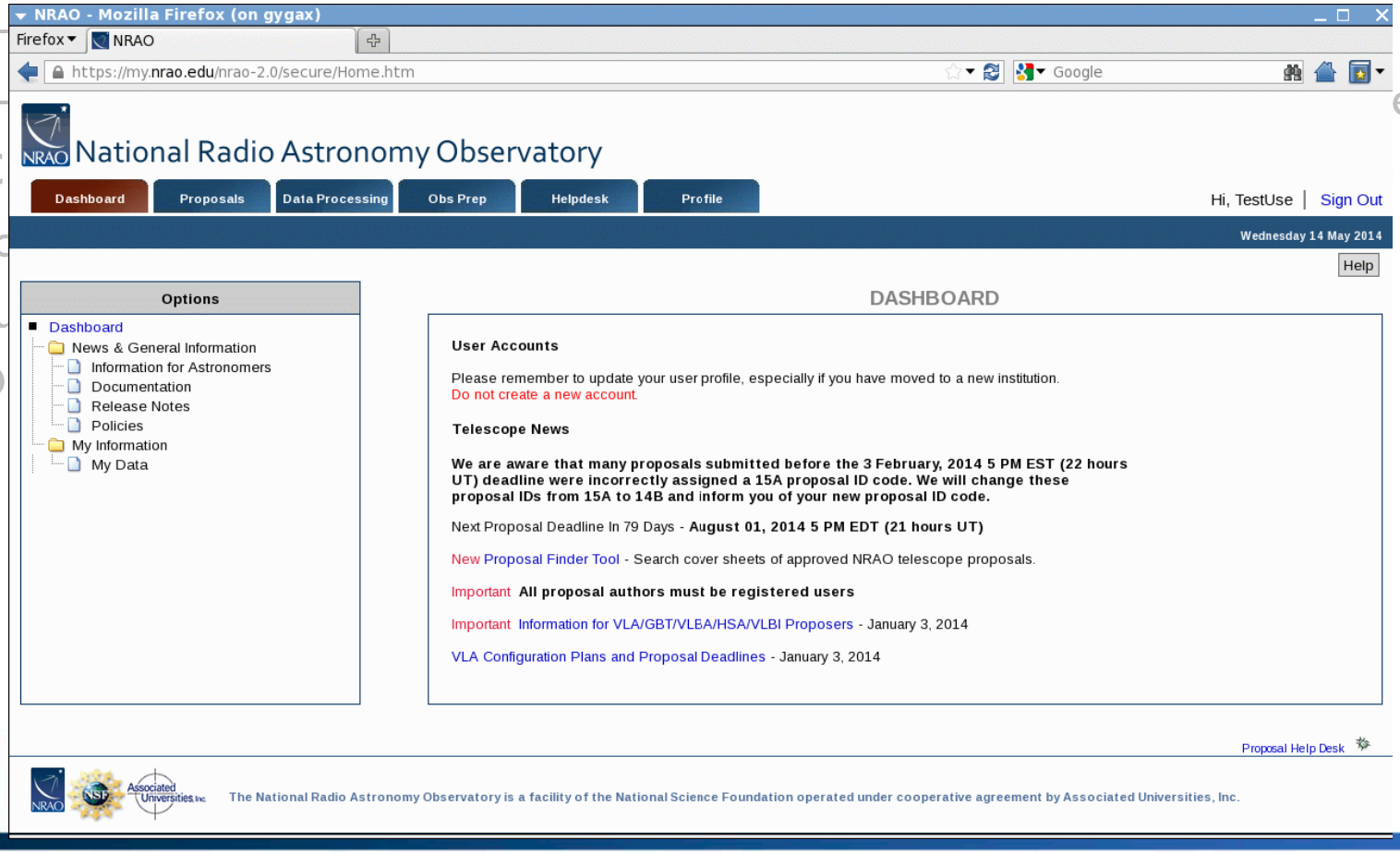

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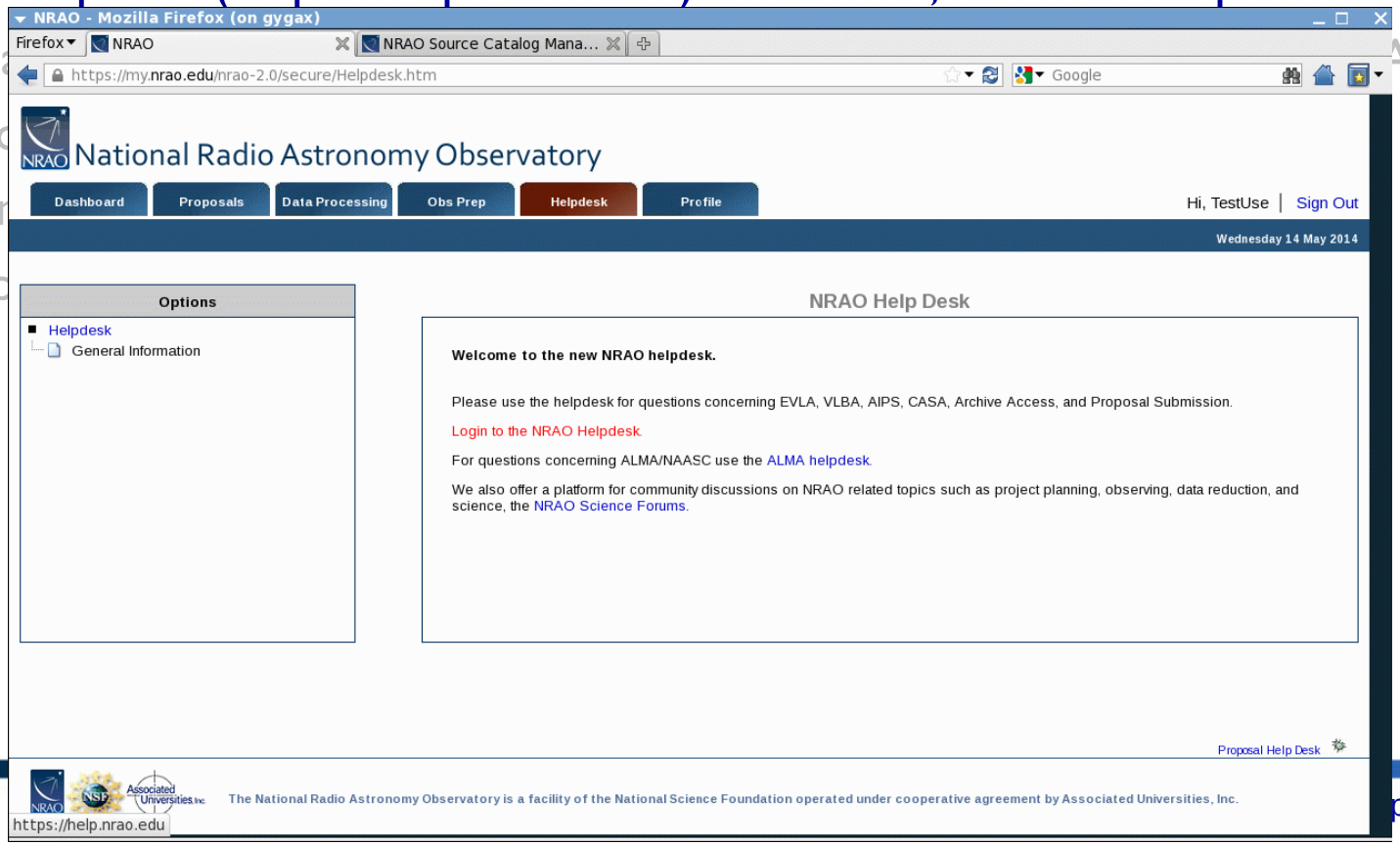

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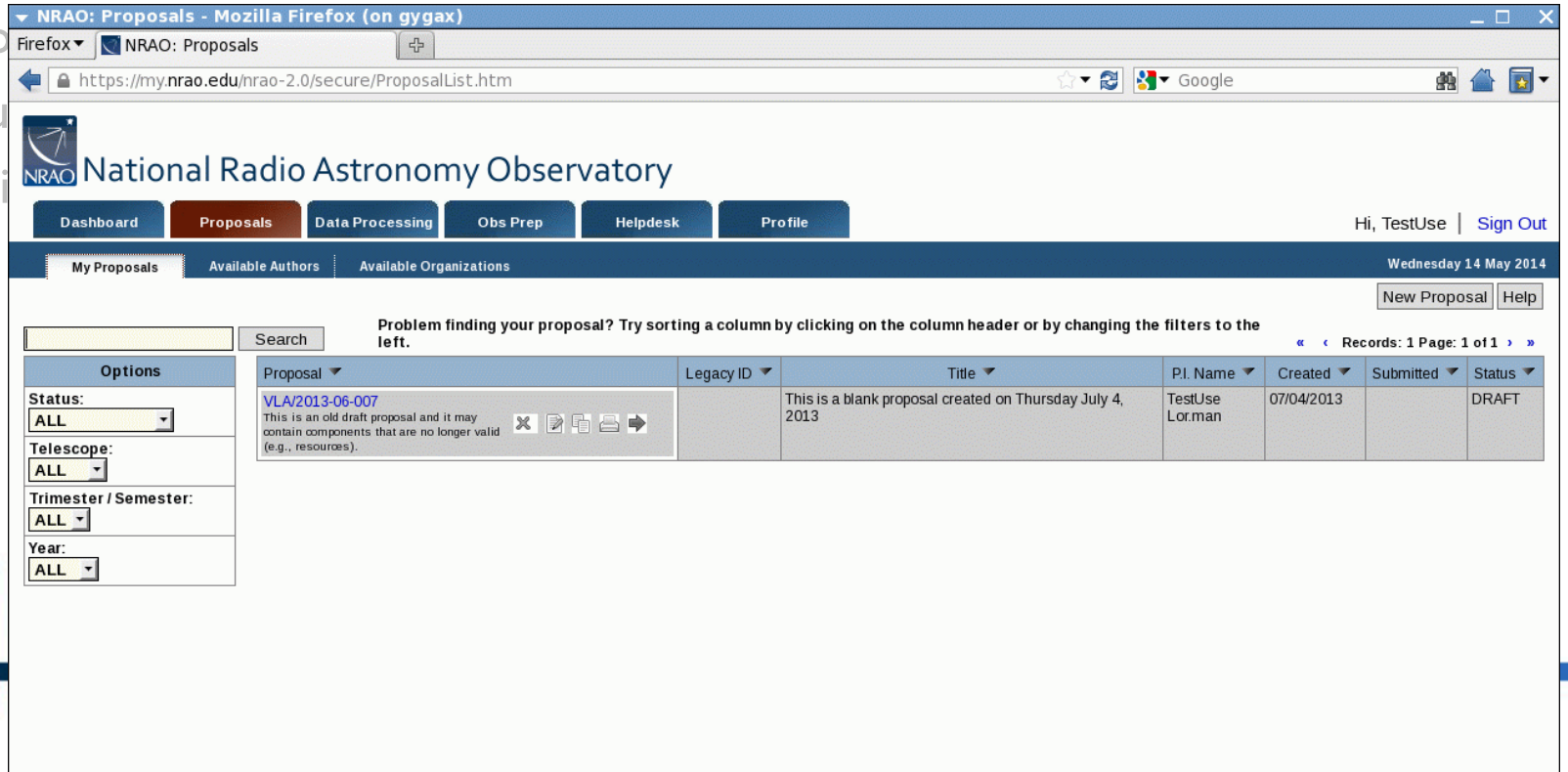

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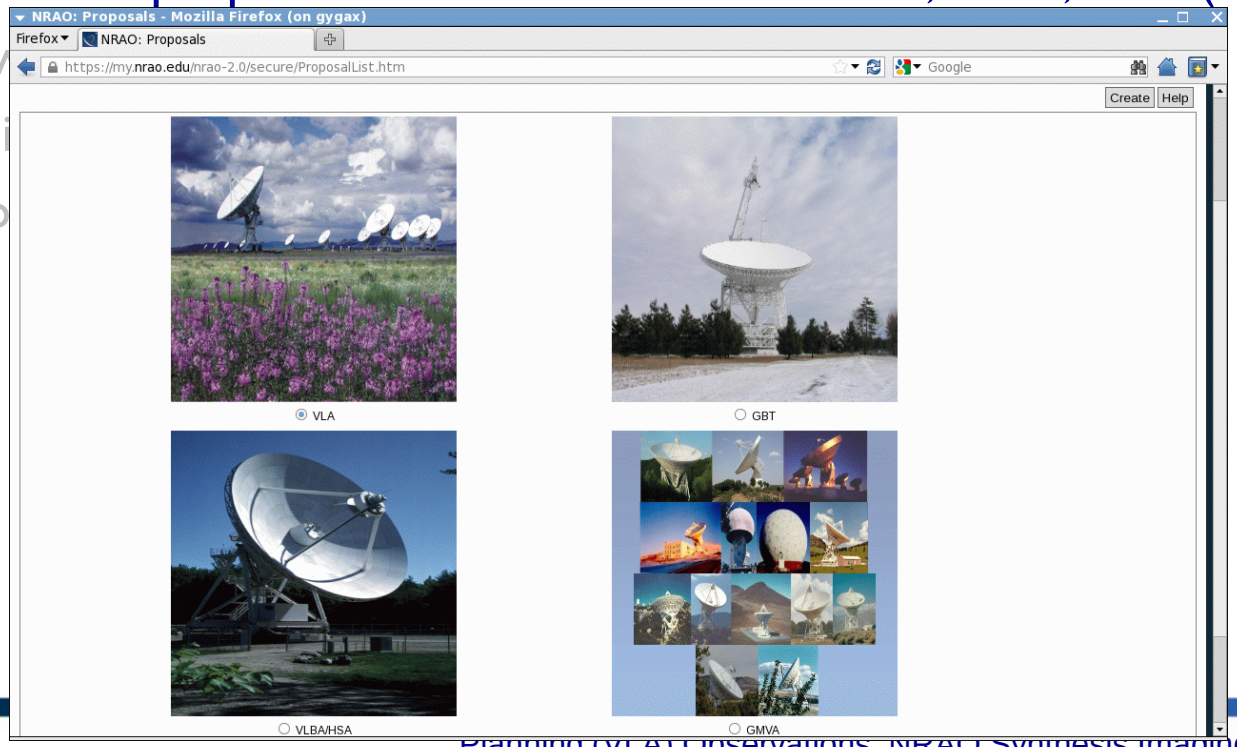

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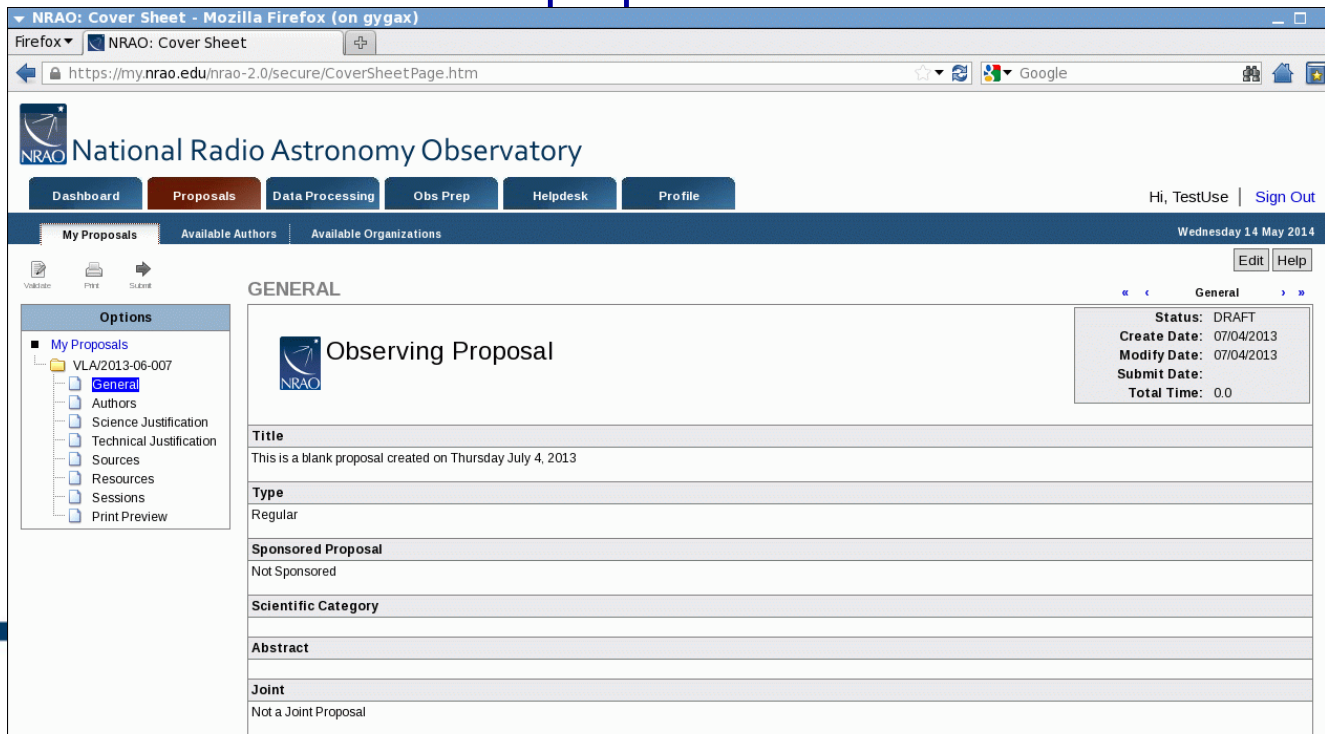

Scheduling of VLA observations

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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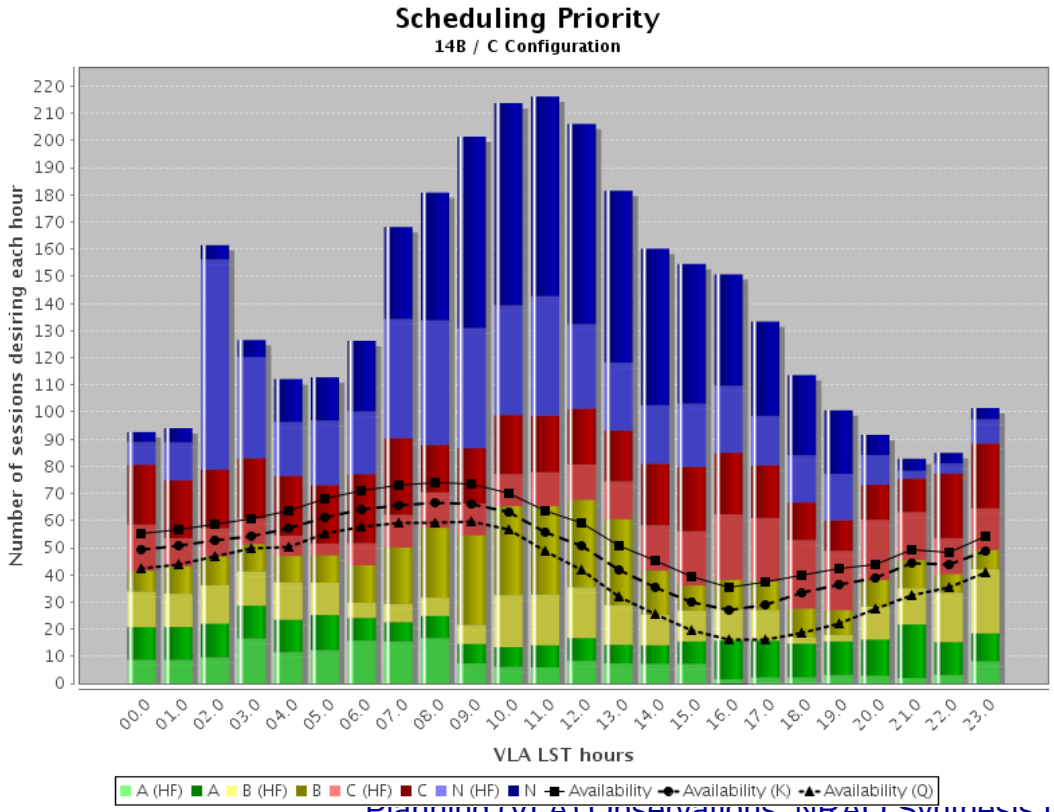

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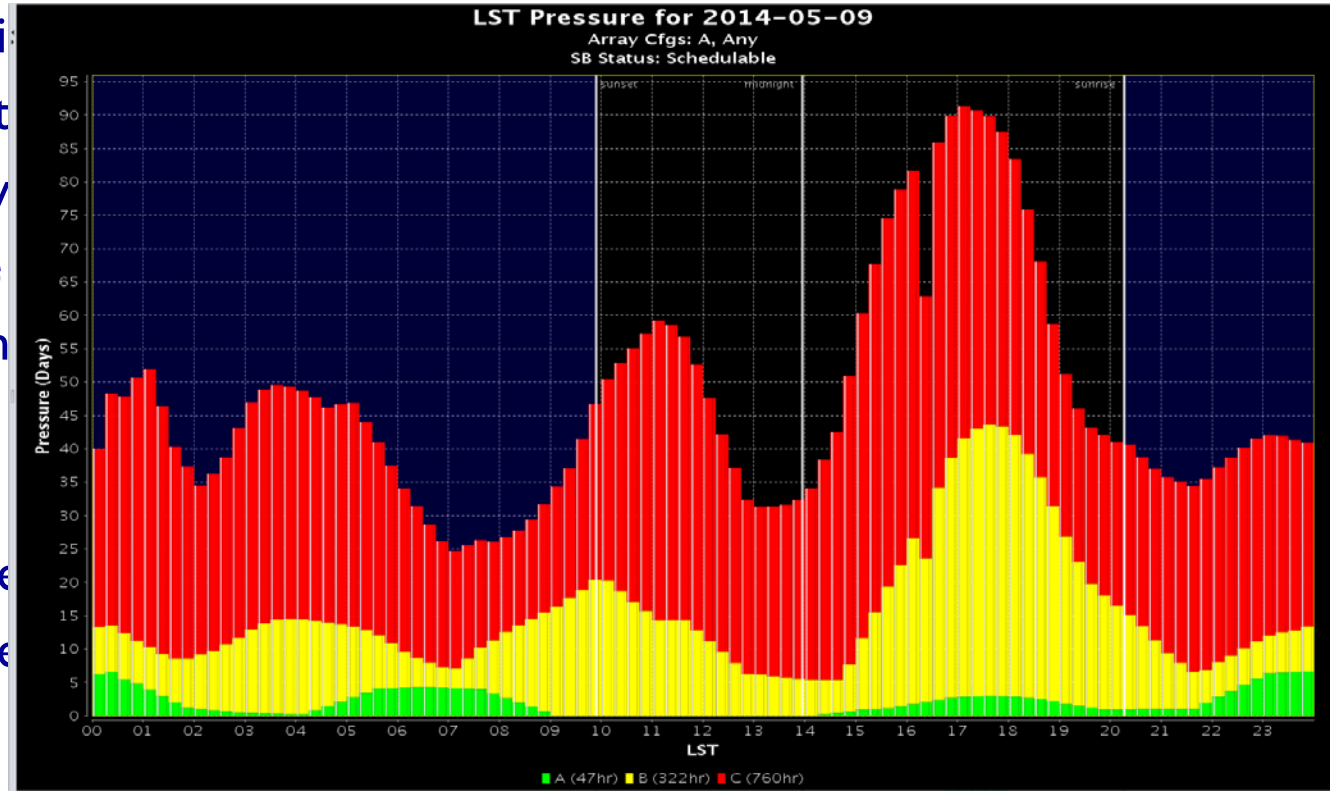

Planning VLA observations: Scheduling

- 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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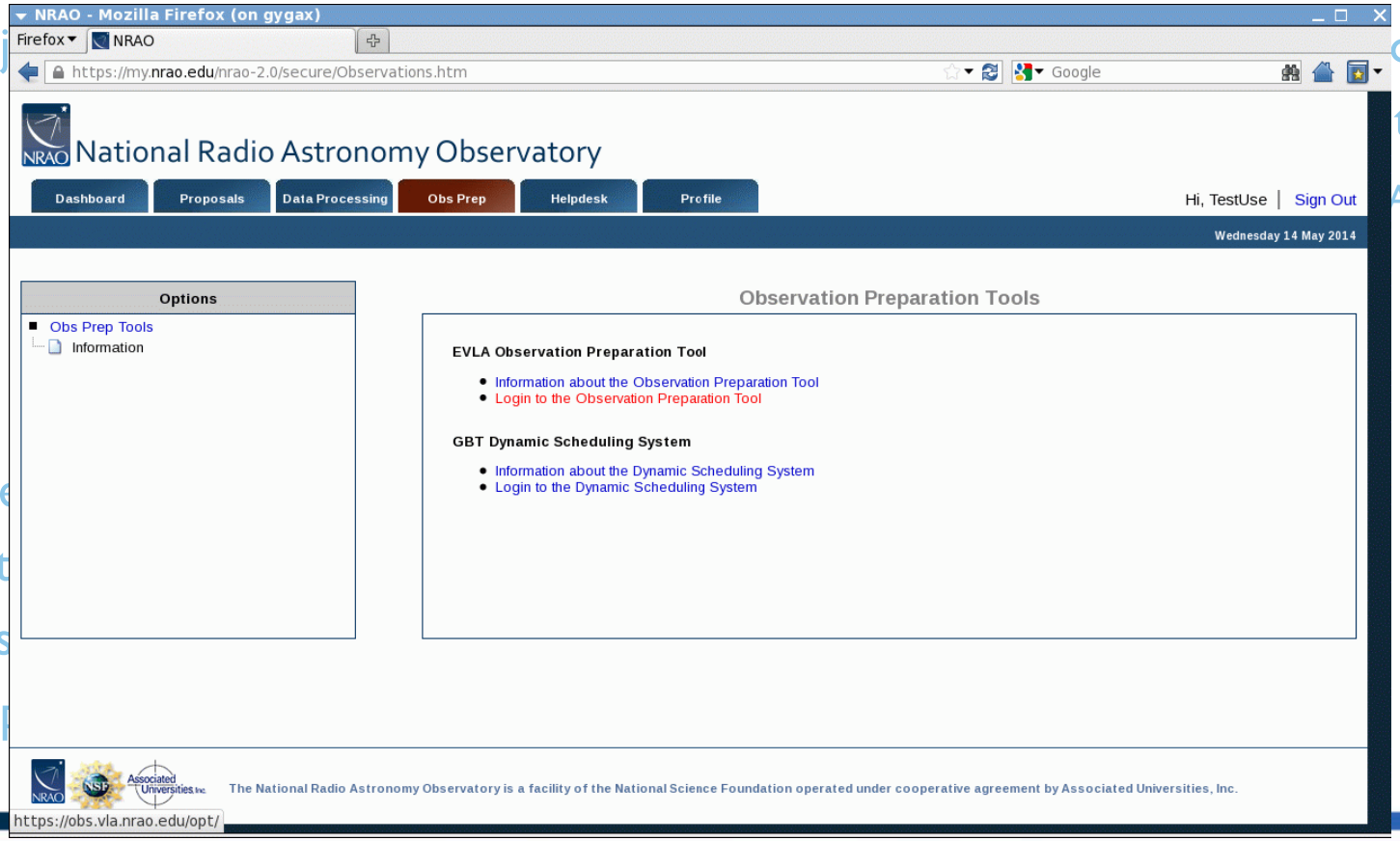

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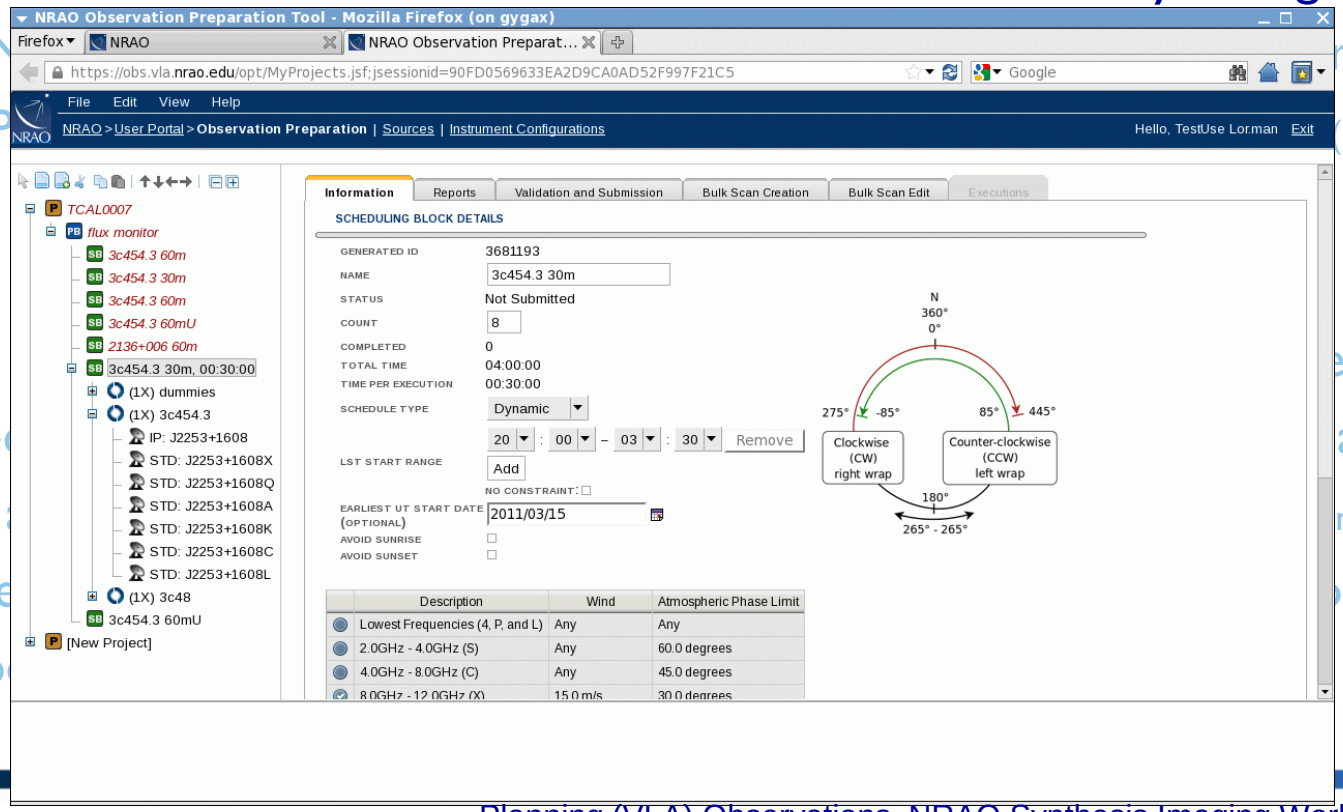

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Observation Preparation Tool (OPT)

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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
  - 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"
- Create project SB (scheduling block) from scratch
- Hypothetical project to observe PN
  - Lines and continuum
- Experiencing the use of
  - 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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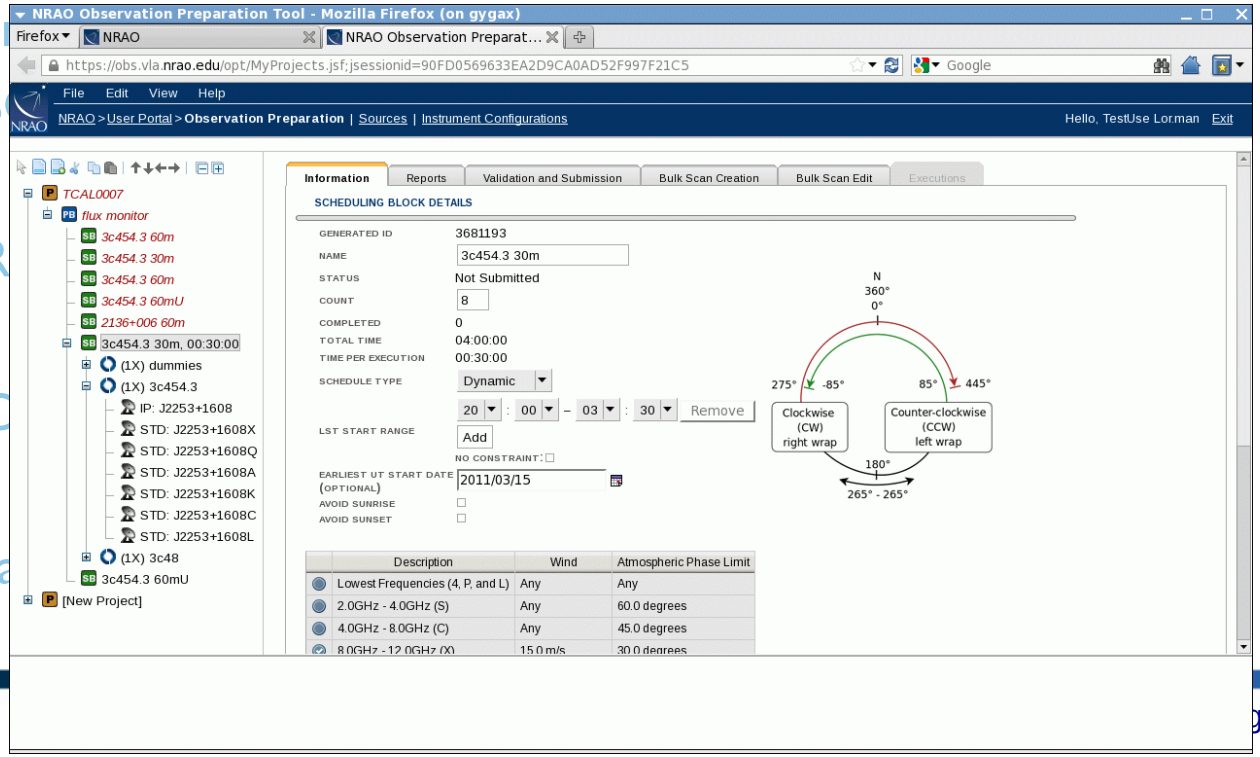

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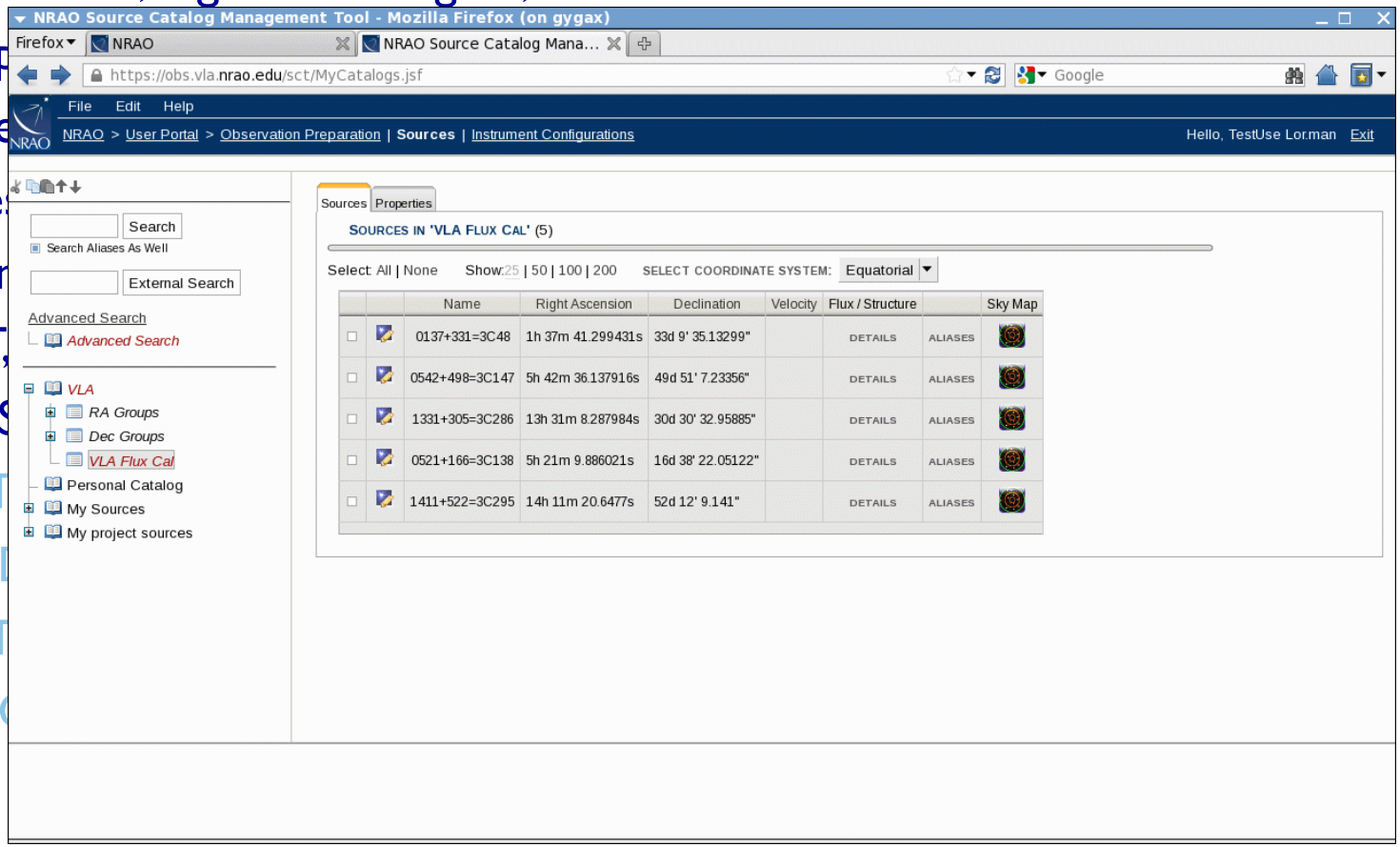
- Using the OPT, login and navigate, "look and feel"
- Create p
- Hypothe
  - Lines
- Experier
  - SCT,
    - S
  - RCT
    - I
  - OPT
    - C
- Validate



OPT "hands-on" tutorial

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- Create project SB (scheduling block) from scratch
- Hypothetical project to observe PN
  - Lines and continuum
- Experiencing the use of
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    - Search for calibrators, create a new source
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    - Default continuum setups, create a line setup
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    - Change (re)source, scan sequence, play with conditions
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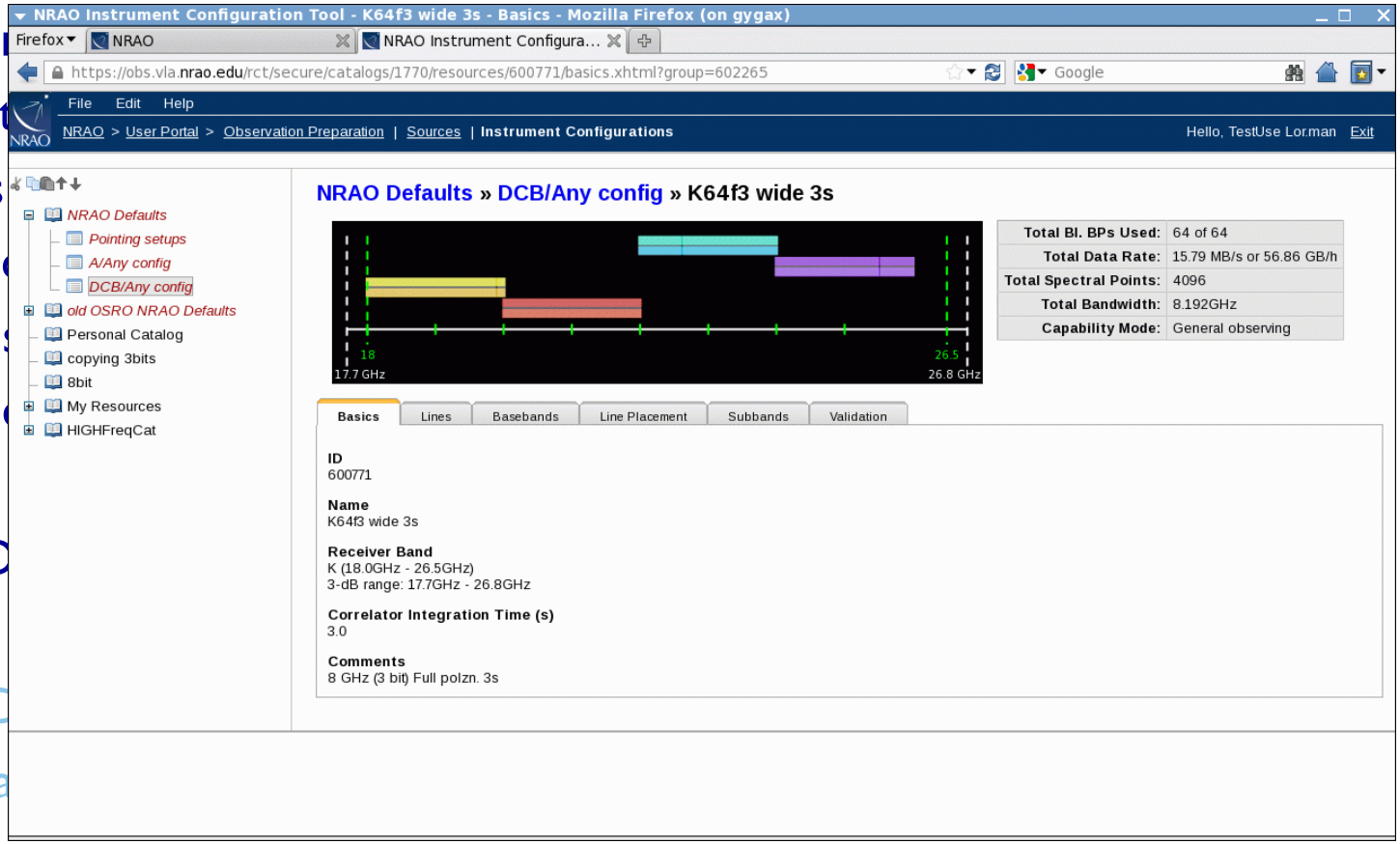

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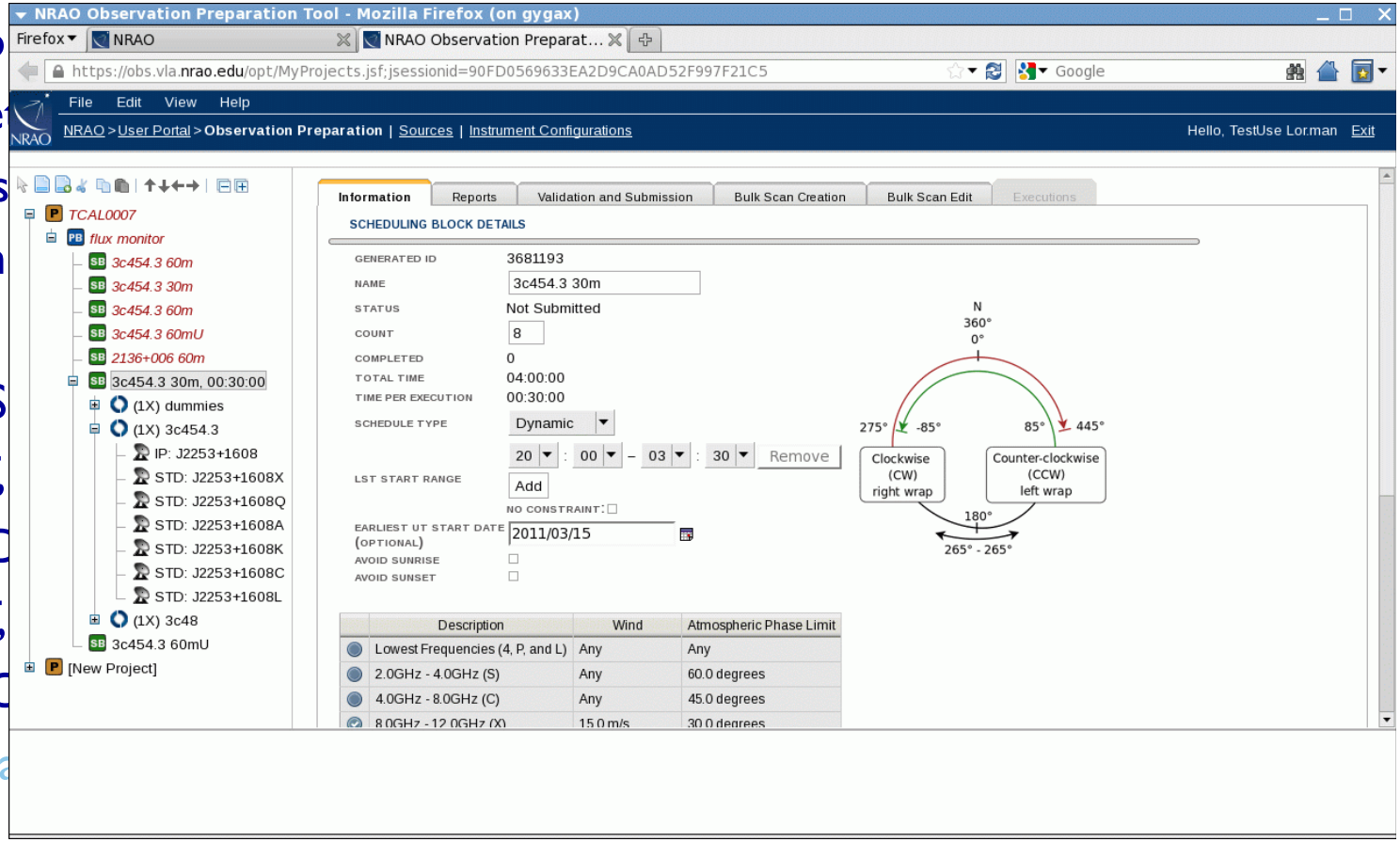

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Questions ?