VLBA Call for Proposals 2023A

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VLBA Call for Proposals include:

1) VLBA (Very Long Baseline Array)

2) HSA (High Sensitivity Array)

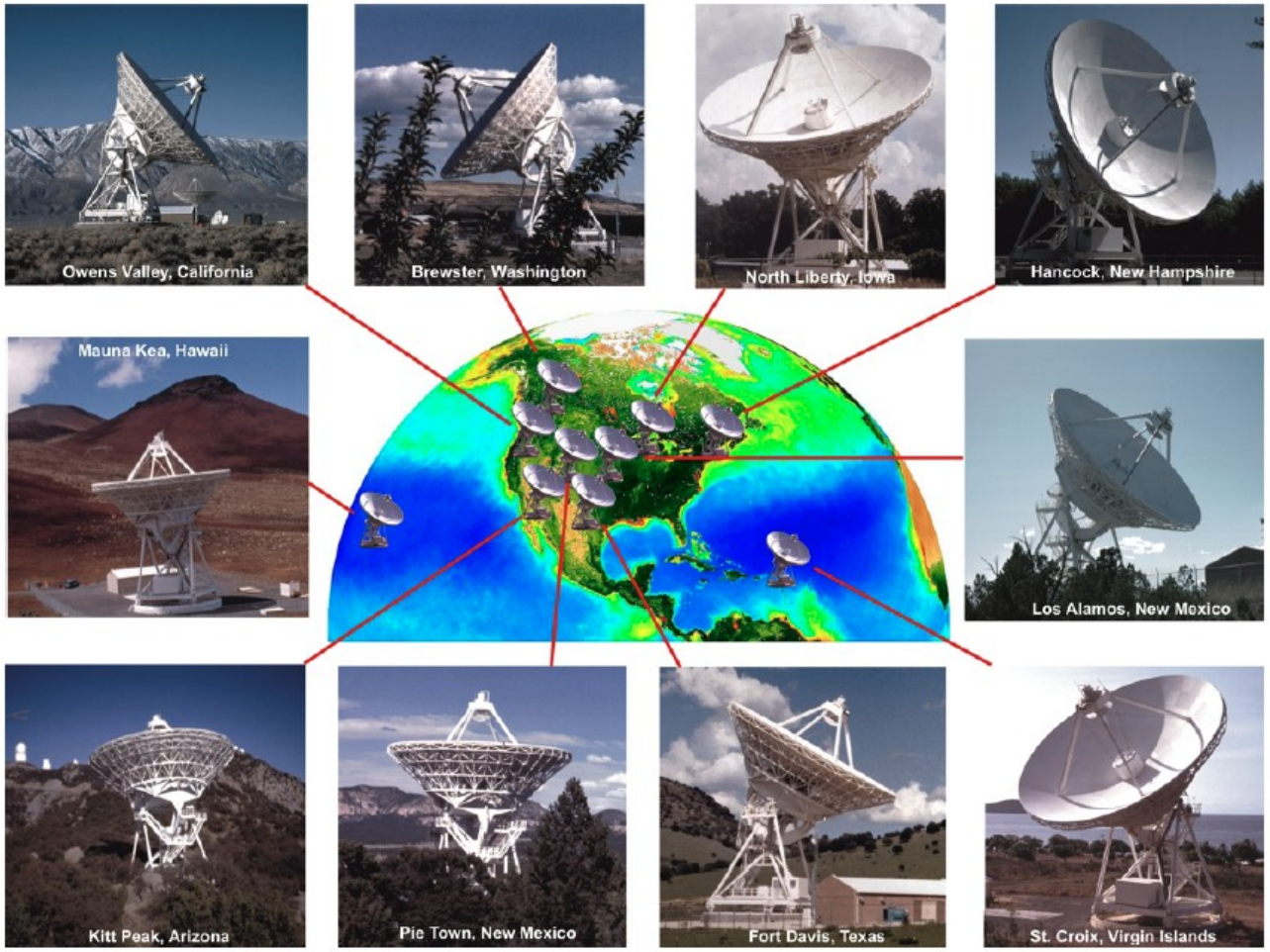
3) GMVA (Global 3mm VLBI Array)

VLBA: Very Long Baseline Array

10 stations, with:

- 236km shortest baseline
- 8611km longest baseline

Receivers:
90cm, 50cm,
21cm, 13cm, 6cm,
4cm, 2cm, 1cm,
7mm, 3mm



VLBA: Very Long Baseline Array

Semester 2023A: 1 Feb 2023 – 31 Jul 2023 (*differs from VLA)

Standard observing:

- Must use PST tool for submission (NRAO Proposal Submission Tool)
- Available: 1,000 hrs for Open Skies
- In recent times less demand for GST 6:00-18:00 hrs

In addition, we welcome:

- Large programs (200hrs or more)
- Fillers (2-6 hrs observing blocks, minimal observing constraints)

VLBA Observing “personalities”

- **Polyphase Filterbank (PFB) System:**
  - 16 data channels
  - 32 MHz bandwidth per channel
  - Up to 2048 Mbps data rate

- **Digital Downconverter (DDC) System:**
  - 1, 2, 4, or 8 data channels
  - 1 – 128 MHz bandwidth per channel
  - Up to 4096 Mbps (4Gbps) data rate for all bands except:
    - 90cm: maximum data rate of 256 Mbps
    - 50cm: maximum data rate of 32 Mbps
    - 21cm, 13cm: maximum of 2048 Mbps

VLBA Capabilities for 2023A

General Observing (GO):

- 4Gbps (4096 Mbps) data rate
  - DDC system only
  - receivers/bands: 6cm, 4cm, 2cm, 1cm, 7mm, 3mm
  - results in 1024 Mbps for polarization summed bandwidth
- S/X band (13/4 cm) simultaneous observing
  - up to 4Gbps data rate, but sensitivity slightly reduced
- VLBA + Y1
  - addition of single VLA antenna for short baseline (44km VLA – VLBA_PT)

VLBA Capabilities for 2023A

General Observing (GO), ***cont*****:**

- Multiple phase centers
  - – up to 300 phase centers with single polarization (4Gbps)
  - – up to 150 phase centers with dual polarization (4Gbps)

- Spectral Zooming
  - – selection of a narrow frequency window where higher spectral resolution can be set (*achieved during correlation)

- Flexible Spectral Resolution
  - – up to 4096 spectral channels per each data channel
  - – 2Hz minimum channel spacing

VLBA Capabilities for 2023A

General Observing (GO), *cont*:

- Flexible frequency setup (DDC)
  - 1, 2, 4, or 8 data channels available
  - 1 – 128 MHz bandwidth available
  - full flexibility of placing the channels within IF

- Pulsar modes
  - binary gating, matched-filter gating, and pulsar binning correlation

VLBA Capabilities for 2023A

Shared Risk Observing (SRO):

- Baseband data copy = availability of some fraction of raw data from VLBA stations

Requirements:

- Full justification for a need of raw data in the proposal
- No more than 5TB to be copied per station per month
- Channel and polarization selection not available
- Proposers must provide formatted, compliant hard drives

VLBA Capabilities for 2023A

Resident Shared Risk Observing (RSRO):

This program allows early access to new capabilities in exchange for a period of residency in Socorro to help commission those capabilities.

Note: these programs are never A-priority.

Examples:

- Multiple pulse cal tones per channel
  – currently 2 tones available, but DiFX can handle up to 128
- Tests of improved troposphere model

VLBA Capabilities for 2023A

Resident Shared Risk Observing (RSRO)

Examples, *cont.*:

- VLBA + Y3
  - need to enable interferometric pointing on the three VLA antennas, or enable recording data from 3 antennas Independently

- VLBA real time correlation
  - to enable transfer of the data over internet to be Correlated in Socorro in real time

For more suggestions see: VLBA RSRO

VLBA Current Known Issues

- **7mm sensitivity**: currently worse than nominal on some antennas due to focus and collimation issues. VLBA_SC especially affected at the moment. Problem actively worked on to be resolved soon.
- **VLBA_PT station**: currently undergoing a set of issues (hardware). Problems actively worked on to be resolved soon.
- **2cm flux density scale (DDC vs PFB)**: at 2cm (Ku band) LCP flux density is consistently ~10% lower than RCP, other bands show less severity. Post processing workaround is being worked on.
- **VLBA+Y1**: gain curves for VLA are not automatically recorded in the fits file. A memo on how to fix it is coming soon.

HSA: High Sensitivity Array

VLBA + phased VLA + GBT + Effelsberg

Up to 13 stations

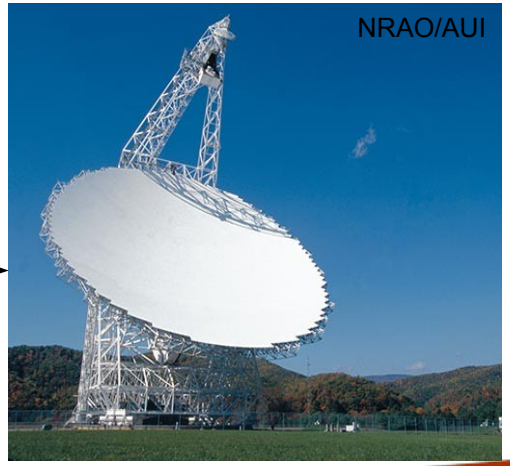
- 44km shortest baseline (PT-VLA)

Available receivers:

→ depend on included telescopes

Phased VLA (Y27; mainly B config in 2023A)

Effelsberg Radio Telescope



Green Bank Telescope (GBT)

HSA: High Sensitivity Array

Semester 2023A: 1 Feb 2023 – 31 Jul 2023 (same as VLBA only)

Standard observing:

- Must use PST tool for submission (NRAO Proposal Submission Tool)
- Separate proposals must be submitted for any *non-VLBI* use of any of the HSA stations (VLBA, VLA, GBT, Effelsberg)

- General observing as per VLBA, but:
  - Limitations: GBT operates under reduced open skies time, resulting in significant scheduling constraints; 6+hr observing block will be difficult to schedule

GMVA: Global 3mm VLBI Array

2023 Session I: 4 – 9 May 2023 or later sessions

Participating stations:

- Americas: VLBA (w/o HN, SC), GBT, ALMA, LMT (Mexico)
- East Asia: KVN network
- Europe: Effelsberg, Onsala, Pico Veleta, Noema, Metsahovi, Yebes, GLT

Proposals are accepted through the NRAO PST.

Note: phased ALMA can be requested only by proposals that were approved for GMVA 2022 Session I, but failed at ALMA, and were re-proposed for ALMA Cycle 9

UT1 – UTC Observations

The US Naval Observatory (USNO) uses VLBA for UT1 – UTC observations every other day

- **When:** between 17:15 and 19:45 UT, and last 1.5-2hours
- **Which stations:** MK and HN
- **Impact:** while our schedulers try to avoid significant impact of these observations on science programs, sometimes it is unavoidable; note that USNO takes priority over science operations

More information:
https://science.nrao.edu/facilities/vlba/observing/daily-ut1

Proposal writing tips: Technical justification

- **Requested stations:**
  - in sensitivity calculations always assume that 1 or 2 VLBA stations will not be available
  - if 10 stations are required, it may be harder to schedule
  - if Y1 is requested, a justification is needed

- **Scheduling and min/max GST:**
  - provide: anticipated length of observing blocks, acceptable weather, cadence (if applicable)
  - if you changed the min/max GST that PST calculated in the proposal, please provide brief explanation, e.g.

    "The entered GST range takes into account our need for scans on the fringe finder 3C84."

Proposal writing tips: Technical justification

- **Flux densities and calibration:**
  - if known, provide approximate flux densities of your targets at the requested bands
  - if flux densities are not known, provide best guess and explain how it is derived
  - flux density accuracy is typically ~10%, if you require better you have to explain how you will achieve it
  - if phase referencing, provide names of calibrators
  - indicate if self-calibration will be performed (or possible)

  Note: You can request extra time to find good calibrator!

New VLBA Calibrator Search Tool: https://obs.vlba.nrao.edu/cst/

Proposal writing tips: Technical justification

- **Sensitivity:**
  - Clearly state the sensitivity required to achieve the science goals of the proposal

- **Integration time (on-source):**
  - use EVN Sensitivity Calculator to estimate on-source Integration time to reach your sensitivity
  - use minimum acceptable number of antennas
  - if (u,v) coverage is more important than sensitivity, clearly state that and justify the increased time over calculated value

- **Imaging constraints:**
  - indicate if your image is likely to be sensitivity or dynamic range limited

Technical justification: ***three most common issues in VLBA proposals***

- Proposers state only 7 or 8 antennas are required but then calculate sensitivity for 10 antennas

  → Always do the sensitivity calculations using the *minimum* number of antennas you specified as required

- Proposers who request L or S bands (21cm, 13 cm) do not take RFI into account when estimating sensitivity

  → Assume the bandwidth is reduced by 30%

- Proposers state that flux density calibration is needed to be within 5%, but do not explain how to achieve this accuracy

  → The nominal VLBA flux density calibration is accurate to 10%

EVN Sensitivity Calculator

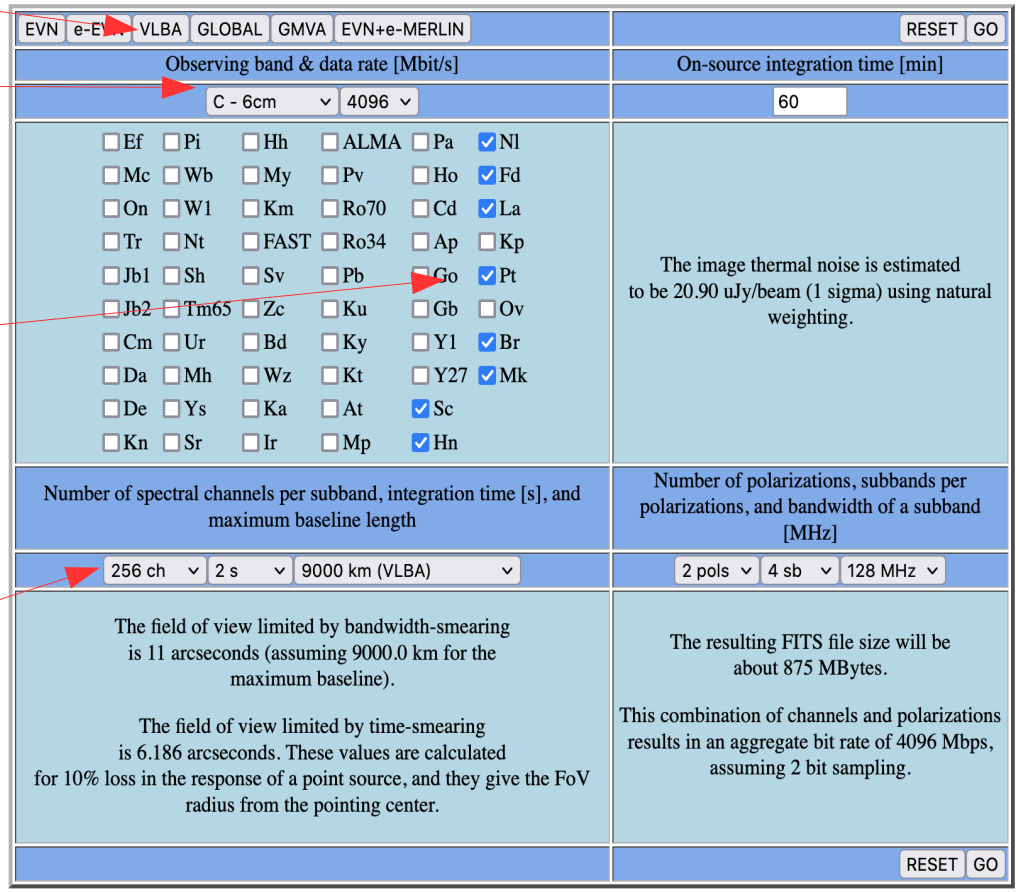
http://old.evlbi.org/cgi-bin/EVNcalc.pl

1) Select “VLBA”, desired frequency, and data rate

2) In this example, our minimum requested stations is 8 → adjust selection to reflect that

3) For correlation: choose number of channels (i.e. spectral channels) in each IF (i.e. data chan)

This will give you FOV



EVN Sensitivity Calculator

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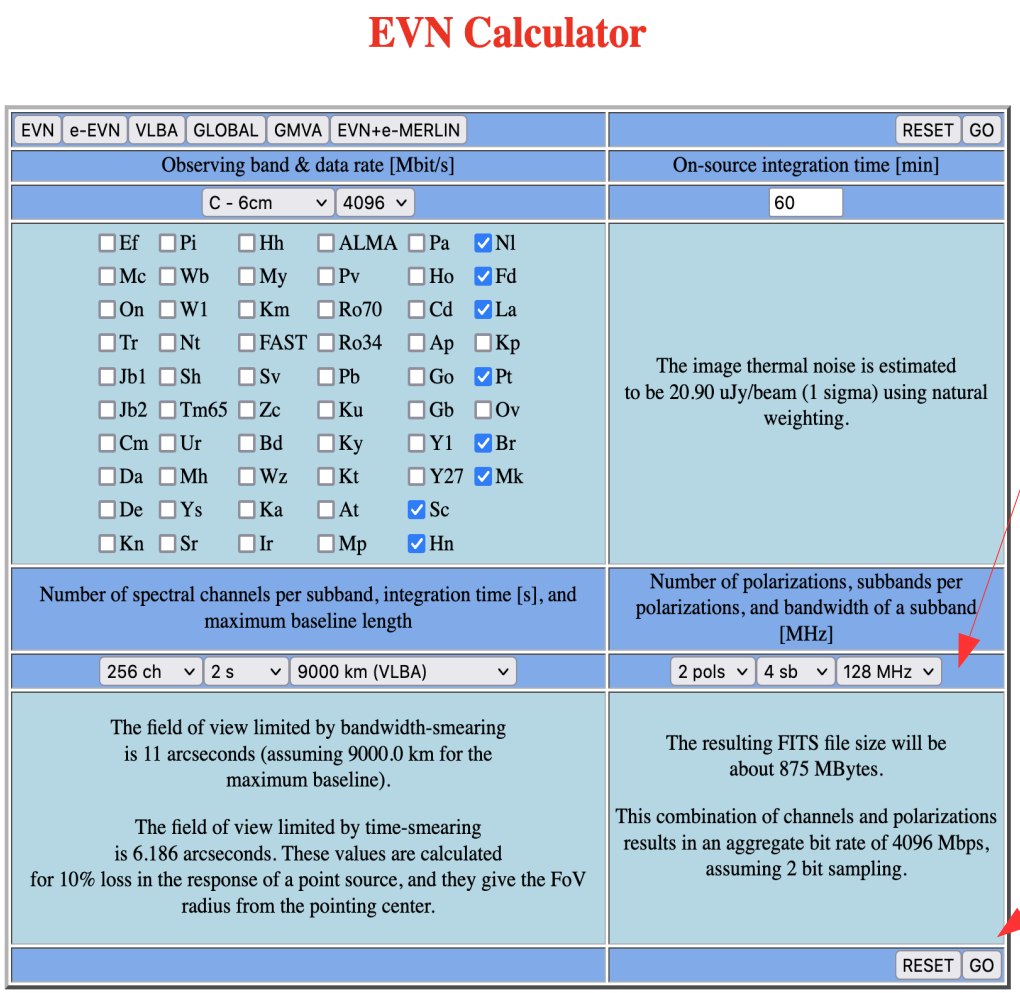

4) For observations:
– select number of polarization products,
– number of IFs in each polarization, and
– bandwidth per IF

(Note different nomenclature between EVN and VLBA!)

5) Hit GO

EVN Sensitivity Calculator

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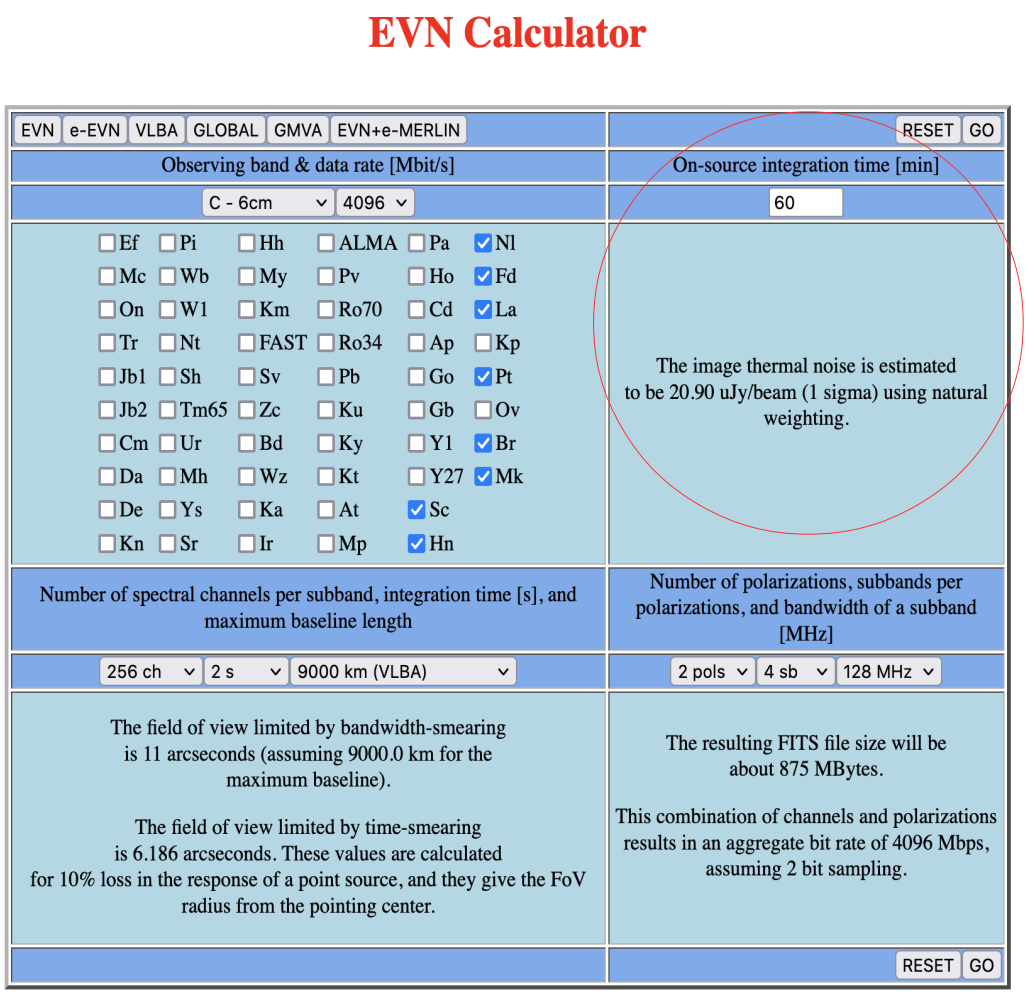


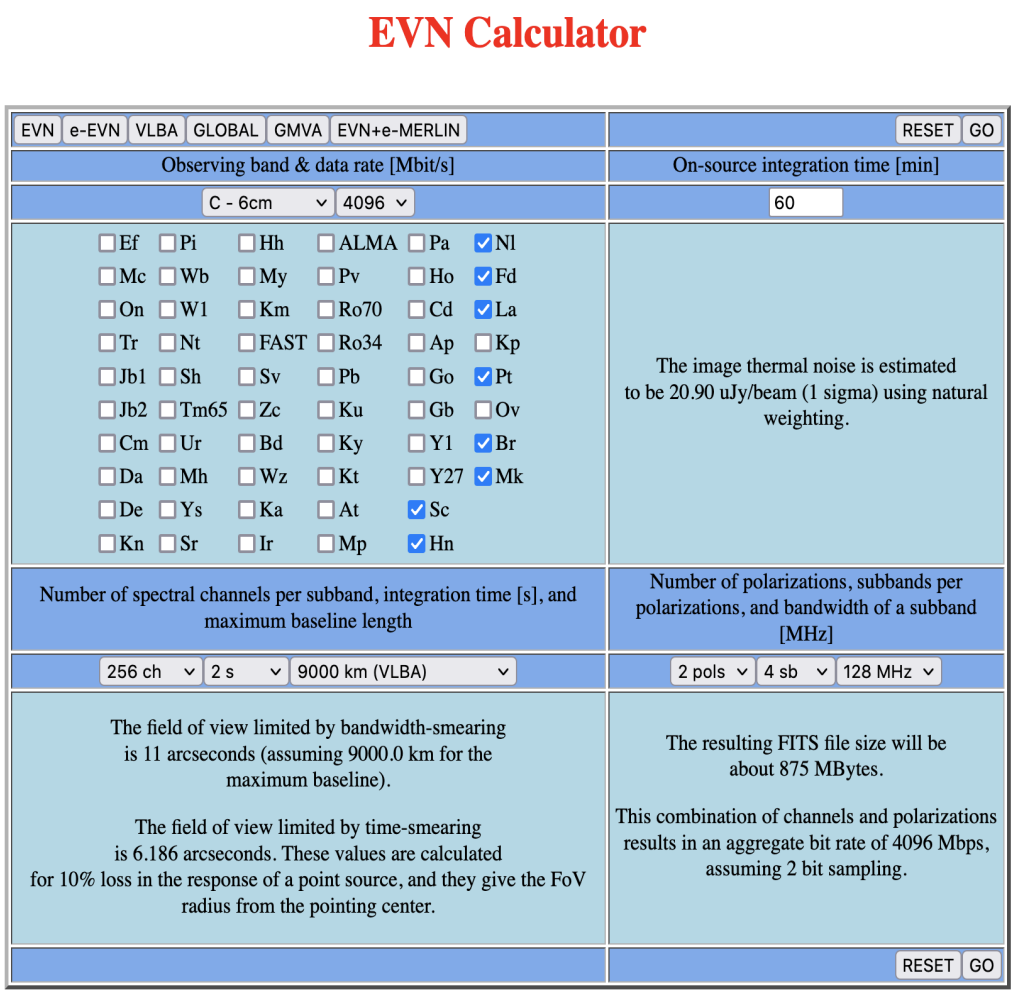
6) Your result – calculated rms for a given on-source integration time appears here

Repeat this for each requested setup and band.

Take screenshots of the final estimates and attach them to your proposal (technical justification)

EVN Sensitivity Calculator

http://old.evlbi.org/cgi-bin/EVNcalc.pl



Special case: **spectral lines**

EVN calculator gives estimates for full bandwidth. To covert this to spectral line observations do the following

→ multiply the full bandwidth sensitivity by SQRT of number of channels

e.g. 20.90 μJy/bm for 512MHz in dual polarization, divided into 125 kHz spectral channels (so 4096 of them) gives:

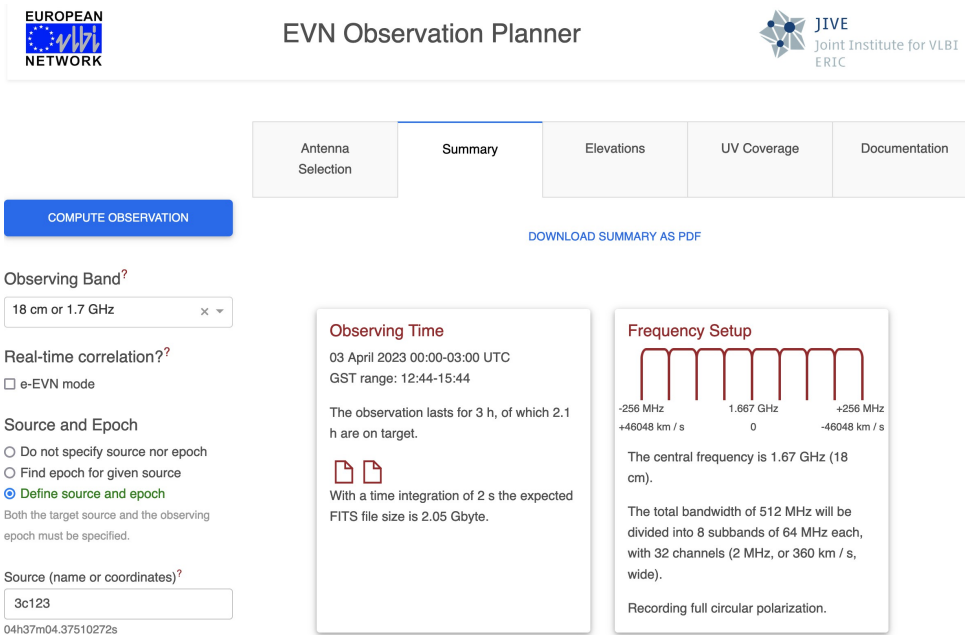
$$20.90\ \mu\text{Jy/bm} \times \sqrt{4096} = 1.34\ \text{mJy/bm}$$

EVN Observations Planner

NRAO still requires to include screenshot of the old EVN Sensitivity Calculator estimates as a part of the proposal.

However.. there is a new, more sophisticated tool on the block: https://planobs.jive.eu/

- More types of sensitivties
- Estimates of resolution
- Estimates of (u,v) coverage
- Manual mode for experts
- Guided mode for newer users
- *...and many more*



Proposal writing tips: General

- Start working on your proposal early (earlier than day before the deadline!)
- Make sure technical justification is exhaustive; also, no need to repeat this in science justification part
- Check “Offered Capabilities” section of the OSS in the case there are changes for the semester
  → VLBA: go.nrao.edu/vlba-capabilities
- **Scientific justification (brief notes):**
  → explicitly state scientific question to be addressed
  – then explain:
    – Why is this interesting?
    – How does it relate to other areas of astrophysics?
    – How will the observations help answer the question?

VLBA Resources

- NRAO Science Helpdesk: https://help.nrao.edu
- Call for Proposals: https://go.nrao.edu/cfp
- VLBA Observational Status Summary (OSS): https://go.nrao.edu/vlba-oss
- VLBA Proposing Guide (including HSA, GMVA): https://go.nrao.edu/vlba-prop-doc

Proposal Deadline 2023A:

Monday, 1 Aug 2023, 21:00 UTC

www.nrao.edu
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