VLB ARRAY MEMO No. 632

The VLBA Options List

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The VLBA Options List was originally intended to facilitate selection among numerous possible cost-saving or performance-enhancing variations on Array specifications. As the VLBA project has developed from design to construction, most original options have either been incorporated into the Array, or rejected (implicitly or explicitly) and omitted from further planning. The Options List has thus evolved into a "wish list" of desirable upgrades to the basic VLBA currently foreseen in the construction plan.

In general, the nominal specifications from which the options depart are those presented in the current chapters of the "VLBA Project Book". I have attempted to include all options seriously considered at at the date of compilation, although this necessarily involves an exercise of judgement. Not included in the List are choices of a strictly technical nature which have a negligible impact on *both* cost and performance.

The options are grouped into major areas generally paralleling the group structure of the VLBA project with some exceptions to allow a more unified presentation. Each option is given a mnemonic name, briefly described, and its effect on Array performance outlined. The cost is estimated as precisely as possible, generally for the entire 10-station VLBA unless indicated as cost per station. Development costs are mentioned (but not estimated) *only* for those options where they may be substantial.

ANTENNAS

86-GHz Operation (see also 86-GHz Receiver)

Description: Improve pointing performance by grinding azimuth track and/or implementing circulating-coolant system.

Effect: Satisfactory pointing for 86-GHz operation.

Cost: To be determined from operating experience; probably less than 120 k$.

Receivers & Feeds

6-GHz Receivers

Description: Add 6-GHz receivers (sharing 4.8-GHz feeds) at some stations.
Effect: Observations of 6.035-GHz OH line possible.
Cost: 19 k$ *per station*, plus development cost.

10.7-GHz Receivers

Description: Add 10.7-GHz receivers *and feeds* at some stations. (One such system already installed at Pie Town site.)
Effect: Additional X-band capability beyond planned 8.4 GHz (for continuity of ongoing observing programs, and compatibility with global array).
Cost: 20 k$ *per station.*

12.2-GHz Receivers (Uncooled)

Description: Add uncooled 12.2-GHz receivers *and feeds* at some stations. (Would have to replace 10.7-GHz.)
Effect: Observations of 12.2-GHz methanol maser line possible.
Cost: 13 k$ *per station*, plus development cost.

12.2-GHz Receivers (Cooled)

Description: Add cooled 12.2-GHz receivers *and feeds* at some stations. (Would have to replace 10.7-GHz.)
Effect: High-sensitivity observations of 12.2-GHz methanol line.
Cost: 20 k$ *per station*, plus development cost.

86-GHz Receivers (see also 86-GHz Operation)

Description: Add 86-GHz receivers *and feeds* at some stations.
Effect: Observations at 86 GHz possible.
Cost: 50 k$ *per station*, plus development cost.

Additional Dual-Frequency Pair(s)

Description: Implement additional dichroic reflector systems for, *e.g.*, 4.8/22, 10.7/43, or 15/43-GHz pairs.
Effect: Improved atmospheric/ionospheric calibration, and extended coherence times at high frequencies.
Cost: $\sim$80 k$ *per pair.*

Remote Dual-Frequency Operation

Description: Equip dichroic reflectors for remotely commanded operation.
Effect: Improved sensitivity for single-band observations, and unimpeded observation using neighboring feeds.
Cost: $\sim$100 k$ *per pair* equipment cost, plus development cost.

Auxiliary Station Electronics

Fewer Water-Vapor Radiometers

Description: Delete 22/31-GHz radiometers for measuring atmospheric water vapor content at some stations.

Effect: Restricted calibration of atmospheric phase fluctuations for astrometric/geodetic observations, and mapping at high frequencies.

Saving: 50 k$ *per station.*

Dual-Frequency GPS Systems

Description: Replace standard satellite timing receivers with advanced, dual-frequency systems at some stations.

Effect: Enhanced calibration of ionospheric propagation effects.

Cost: 40 k$ *additional, per station.*

Baseband Electronics, Record & Playback Systems

32 Channels

Description: Double station complement of baseband converters (to 16) and sampler modules (to 4).

Effect: More channels (32) and tunable LO's (16) available for specialized observations; bandwidth per channel limited by standard peak recordable data rate (512 Mbit/s — 4 times sustainable rate).

Cost: 420 k$.

128 Tracks

Description: Double station complement of formatter data-path modules (to 4) and recorder headstacks (to 4 — 2 per recorder).

Effect: Higher peak recordable data rate (1024 Mb/s — 8 times sustainable rate) for high-sensitivity, short-coherence-time observations; matches capacity of standard baseband converter complement.

Cost: 320 k$.

Extended Array

These options represent extensions of the 10-station VLBA project to VLBA project to cover more uniformly the range of baselines available on the surface of the Earth and approach a "matched u-v filter" appropriate to any angular scale. The extensions provide facilities to integrate the VLA and VLBA apertures into a fully-capable joint instrument, and to broaden the aperture coverage more generally using additional stations.

Additional Acq./Rec. System(s)

Description: Provide complete or partial acquisition/recording systems for fixed sites (*e.g.*, the VLA, Green Bank, ...) or as portable units.

Effect: Enhancement of the Array (in particular to include elements with large collecting areas or high-frequency performance).

Cost: 164 k$ *per station* for *single* DAR/REC system, plus control computer.

Pie Town VLA Station

Description: Implement wideband digital data link from Pie Town site to the VLA; provide VLA electronics at Pie Town, and upgrade VLA correlator delay *etc.*

Effect: Pie Town usable as VLA "outrigger".

Cost: $\sim$1 M$.

Additional Southwest VLBA Stations

Description: Build additional fully-equipped stations at three sites close to the VLA: Dusty, Bernardo, and Roswell, NM.

Effect: VLBA aperture extended inwards from 200 km towards 35 km outer envelope of VLA aperture.

Cost: $\sim$5.6 M$ *per station.*

South American VLBA Station

Description: Build an additional fully-equipped station in northern South America, probably in Ecuador.

Effect: Improved north-south aperture at equatorial and southern declinations.

Cost: $\sim$5.6 M$.