AT/01.13/004
Systems Definitions
Also AT/10.1/037

Date: 10/4/84
Previous Update: 28/3/84
Version No.: 3

AT SYSTEMS DEFINITION

A. CONFIGURATION

1. Compact Array (AT/10.1/036)

(a) Six antennas, each 22 m in diameter, alt/az mounted Cassegrain optics.

(b) East-west grating array, maximum baselines 1.5, 3, 6 km.

(c) Antennas relocatable on rail track between stations as follows:

(i) A 3 km section from 0 to 3 km containing 35 stations and 5 antennas.

(ii) 100 m section at 6 km containing 2 stations and 1 antenna.

(d) Grating increment 15 m, shortest spacing 30 m.

****(e) Spur track provided for possible future north-south extension of array.

(f) Minimum redundancy solutions optimised for pseudo-regular coverage of the uv plane after 2, 4, 8, 12, 16, 24 observing periods of 12 hours.

(g) All 4-period subsets of the 24-period solution optimised for pseudo-regular coverage of the uv plane.

(h) All baselines with the 15 m increment in the 3 km array available after 27 observing periods.

(i) Pseudo-zoom arrays available after 1, 2, 4, 8 observing periods.

(j) Approximately scaled arrays available for 1.5/3 km and 3/6 km.

2. Long Baseline Array.

(a) The long baseline array includes:

(i) One or more compact array antennas in tied mode.

(ii) A 22 m diameter antenna on Siding Spring Mountain near Coonabarabran, N.S.W

(iii) The Parkes 64 m telescope.

(b) Real time radio links providing 140 Mbits/s between the three sites.

**** Possible doubling of link capacity between Siding Spring and Culgoora to handle the extra load required for this path.

(c) Provision for inclusion into the array of an antenna at the NASA Deep Space Station, Tidbinbilla, with up to two 140 Mbits/s channels to Parkes on a real time radio link.

(d) Provision for future extensions of the array with:

(i) One or two additional antennas in the Culgoora/ Siding Spring area.

(ii) An antenna at or near Epping.

B. ANTENNA ELEMENTS

1. New Antennas (6 x 22 m dishes at Culgoora, 1 x 22 m dish at Siding Spring).

(a) Alt. - Az mounted.

(b) At Culgoora the antennas will be self-propelled on rail track at a maximum speed of 2 km/hr; Siding Spring antenna fixed.

(c) Subreflector to be provided with 20-30 mm axial motorised adjustments.

(d) Access and space (a cube of side 0.3 metre approximately) at Prime Focus provided for possible future use (maximum additional weight approximately 15 kg).

(e) Full dish operable at 44 GHz with aperture efficiency approximately 0.5. Central 11 metres operational to 115 GHz with aperture efficiency approximately 0.3.

(f) Optics: Cassegrain at frequencies higher than 1 GHz, lower frequency optics yet to be decided.

2. Existing Parkes 64 metre radiotelescope (AT/15.7/013)

Optics: Prime focus all frequencies.

C. FEEDS

1. Feeds for New Antennas

1.1 Feeds above 1.25 GHz are wideband (> octave) corrugated feeds to cover:

(i)	L/S	1.25	-	2.50 GHz
(ii)	C/X	4.5	-	10.2
(iii)	K/Q	21.0	-	50.0
(iv)	W/F	84.0	-	116

1.2 Dichroic system for simultaneous observation at S & X bands to be provided.

1.3 All Feeds to operate on-axis, except X-band when simultaneous with S-band.

1.4 Wideband feeds and receivers to be mounted near vertex on rotating-turret (remotely controlled).

1.5 Low frequency feed parameters yet to be finalized.

1.6 Linearly polarized feeds (AT/16.2/008).

2. Feeds for Parkes 64 metre radiotelescope.

Not yet designed.

D. RECEIVERS

1. Receivers for New Antennas.

1.1(a). High Frequency Systems (greater than 1 GHz)

Optics: Cassegrain.

Frequency: Each dual frequency, dual polarization receiver system will be housed in a common cryogenic package and operate from a single wide-band feed. The following bands will be covered:

L - 1.25 - 1.75 GHz) S - 2.2 - 2.5 GHz)	Common cryogenic package
C - 4.5 - 6.1 GHz) X - 8.3 - 10.8 GHz)	Common cryogenic package
K - 21.0 - 25.5 GHz) Q - 42.0 - 50.0 GHz)	Common cryogenic package
W - 84.0 - 98.5 GHz) F - 105.0 - 116.0 GHz)	Common cryogenic package

NOTE: (1) These are design goals. Present technology would restrict us to approximately 15% bandwidth.

**** (2) Within the budget a minimum of four of these frequencies will be provided.

1.1(b) Low-frequency systems (less than 1 GHz)

Optics: Yet to be decided.

Frequency: Yet to be decided.

1.2 Environment -

(i) LNAs above 1 GHz will be cooled together with as much of the polarization, bandsplitting and feed waveguide as practicable.

(ii) Low frequency LNAs will operate at room temperature

1.3 The four receiver systems (8 frequency bands) in 1(a) will be operational at all times as far as practicable.

1.4 Space to be provided on turret for all 4 feeds mentioned in (c) (i) and the associated dual channel receivers.

2. Receivers for Parkes 64 Metre Radiotelescope

2.1(a) High frequency systems (greater than 1 GHz)

Optics: Prime focus.

Frequency: Each dual frequency, dual polarization receiver system will be housed in a common cryogenic package and operate from a single wide-band feed. The following bands will be covered:

L - 1.25 - 1.75 GHz) S - 2.2 - 2.5 GHz)	Common cryogenic package
C - 4.5 - 6.1 GHz) X - 8.3 - 10.8 GHz)	Common cryogenic package
K - 21.0 - 25.5 GHz) Q - 42.0 - 50.0 GHz)	Common cryogenic package
W - 84.0 - 98.5 GHz) F - 105.0 - 116.0 GHz)	Common cryogenic package

NOTE: (1) These are design goals. Present technology would restrict us to approximately 15% bandwidth.

**** (2) Within the budget a minimum of four of these frequencies will be provided.

2.1(b) Low frequency systems (less than 1 GHz)

Optics: Prime focus.

Frequency: Yet to be decided.

2.2 Environment

(i) LNAs above 1 GHz will be cooled together with as much of the polarization, bandsplitting and feed waveguide as practicable.

(ii) Low frequency LNAs will operate at room temperature.

E. SYSTEM

Compact Array (Max R.F. frequency 115 GHz)

1. IF digitized at antenna.

2. Four IF channels available from each antenna; selected from any of the operating (on-axis) frequency bands in either sense of polarization.

3. Each IF channel to have separately tunable LO.

4. Fringe stopping at antennas using a "unified clock" scheme.

5. Signal transmission via optical fibres.

6. Each IF data stream (320 MBaud capacity) shall be composed of one of the following:

   a) 1 bit sampled, 160 MHz bandwidth.

   b) 2 bit sampled, 80 MHz bandwidth.

   c) A time multiplexed, signal consisting of:

      (i) 2 bit sampled, 40 MHz bandwidth (continuum);

      (ii) 4 bit sampled, 10 MHz bandwidth (tied array and narrowband line);

      (iii) 2 bit sampled, 20 MHz bandwidth (wideband line).

7. Narrowband filtering of I.F. required in factors of 2 down to 625 KHz. This will probably have to be done with a combination of analogue and digital filters at each antenna.

8. "Tied" array capability for 1 to 6 antennas.

Long Baseline Array (Max RF Frequency 44 GHz, Culgoora-Parkes
22 GHz, Culgoora-Tidbinbilla

1. I.F. digitized at antenna.

2. 2 I.F. channels available from each antenna.

3. Each I.F. channel to have separately tunable LO.

4. Fringe stopping at antennas.

5. Signal transmission via microwave links.

6. I.F. data rate 20 Mbits per IF channel.

7. Narrowband filtering of I.F. will be available in factors of 2 down to 625 KHz.

F. CORRELATOR

1. Provision for simultaneous operation in the following four modes:

   a) Compact Array Line OR Wideband Continuum.

      15 Baselines, with up to 8 products per baseline, providing a minimum of 16 frequency channels per product for 1 bit correlation at 160 MHz bandwidth or for 2 bit correlation at 80 MHz bandwidth. Recirculation up to a factor of 64.

      Minimum bandwidth 625 KHz. For fewer products per baseline, proportionally more channels per product.

   b) Compact Array Narrowband Continuum.

      Operating at 40 MHz bandwidth, providing up to 8 products for each of the 15 baselines; with at least 8 frequency channels per product.

   c) LBA Line.

      Similar to a) above, but for only 6 baselines with 4 products per baseline. Provision for expansion to 15 baselines.

   d) LBA Continuum.

      Similar to b) but with 4 products for each of the 6 baselines. Expandable to 15 baselines.

2. Compatible with future addition of FFT pre-processors at each antenna - to obtain more frequency channels.

3. Includes delay tracking systems for both arrays, and the system for providing "tied" array signal.

4. Includes FFT processing, Van Vleck correction, Hanning and output selection.

G. SIGNAL DISTRIBUTION

1. Compact Array via Fibre Optics (probably monomode fibres). Not defined as yet.

2. Long Baseline Array via Microwave Link. Other possibilities being studied. Not defined as yet.

H. COMPUTING

The ON-LINE computing system will be located at Culgoora and consist of:

a) At the control site:

1. 2 x VAX 11/750 (one synchronous and one asynchronous possibly with an interconnect system to permit functional interchange).

2. Control console.

3. Tape drives and disk units.

b) At each antenna element:

1. Coordinate conversion and control/monitor functions performed by antenna microcomputers with communication links to the synchronous computer.

The OFF-LINE computing system will be located at Epping and will provide a minimum processing capability equal to:

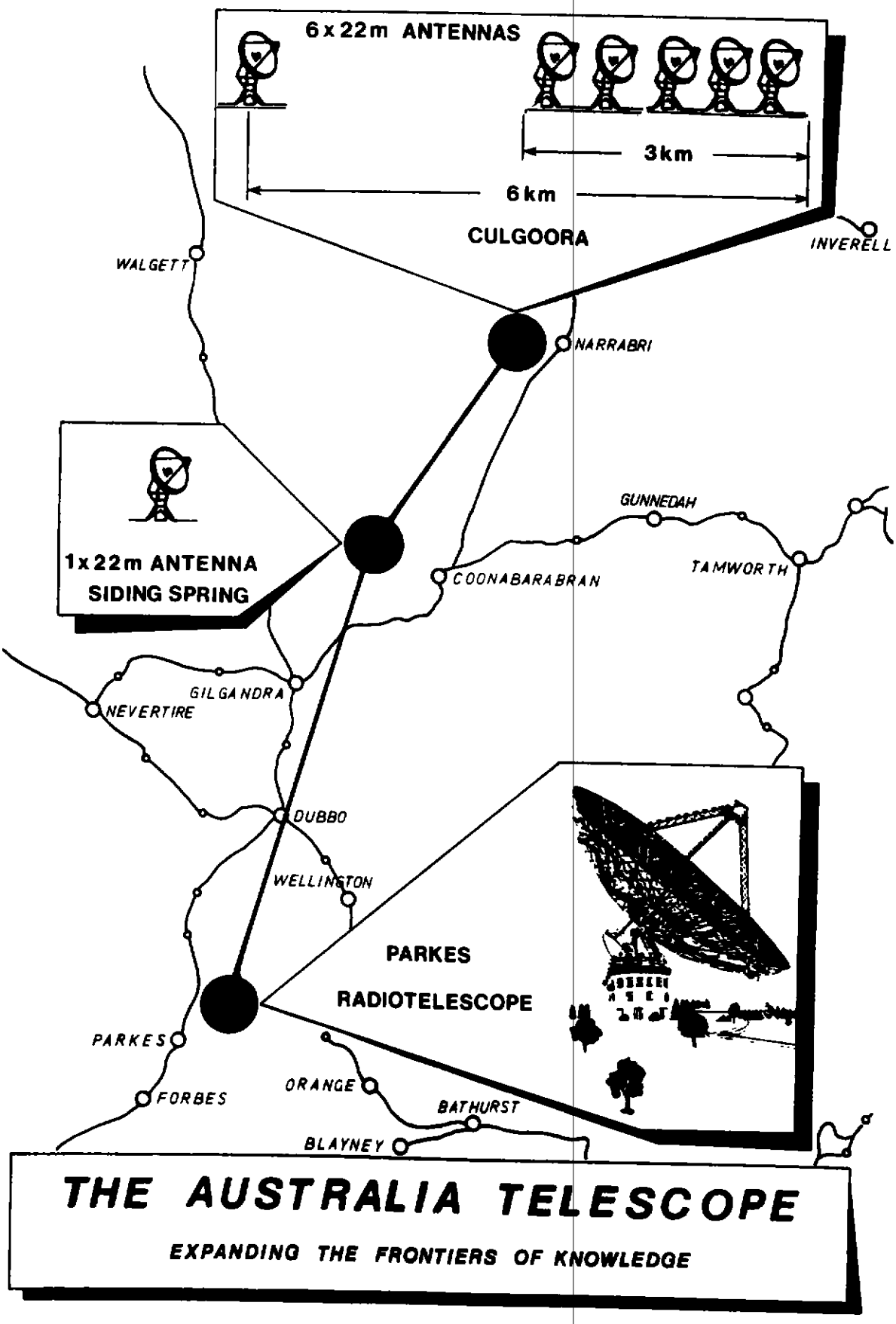
1. 1 x VAX 11/780 (with interconnect to present RP VAX 11/750).

2. 2 x Array Processors.

3. Tape drive and disk units.

4. Image Processor.

**** Items marked thus are on a best effort basis. Manpower and/or financial constraints will determine their eventual incorporation into the Australia Telescope.


6 x 22m ANTENNAS
3km
6km
CULGOORA
INVERELL
WALGETT
NARRABRI
1x22m ANTENNA
SIDING SPRING
GUNNEDAH
TAMWORTH
COONABARABRAN
GILGANDRA
NEVERTIRE
DUBBO
WELLINGTON
PARKES
RADIOTELESCOPE
PARKES
FORBES
ORANGE
BATHURST
BLAYNEY
THE AUSTRALIA TELESCOPE
EXPANDING THE FRONTIERS OF KNOWLEDGE

Date: 1/11/85
Previous Update: 10/4/85
Version No.: 6

AT SYSTEMS DEFINITION

A. CONFIGURATION

1. Compact Array

(a) Six antennas, each 22 m in diameter, alt/az mounted Cassegrain optics.

(b) East-west grating array, maximum baselines 1.5, 3, 6 km.

(c) Antennas relocatable on rail track between stations as follows:

(i) A 3 km section from 0 to 3 km containing 35 stations and 5 antennas.

(ii) 75 m section at 6 km containing 2 stations and 1 antenna. Provision for future third station.

(d) Grating increment 15 m, shortest spacing 30 m.

(e) Provision for a future spur track for a north-south extension of array.

(f) Minimum redundancy solutions optimised for pseudo-regular coverage of the uv plane after 2, 4, 8, 12, 16, 24 observing periods of 12 hours.

(g) All 4-period subsets of the 24-period solution optimised for pseudo-regular coverage of the uv plane.

(h) All baselines with the 15 m increment in the 3 km array available after 27 observing periods.

(i) Pseudo-zoom arrays available after 1, 2, 4, 8 observing periods.

(j) Approximately scaled arrays available for 1.5/3 km and 3/6 km.

2. Long Baseline Array.

(a) The long baseline array includes:

(i) One or more compact array antennas in "tied" mode.

(ii) A 22 m diameter antenna on or near Siding Spring Mountain in Coonabarabran Shire, N.S.W

(iii) The Parkes 64 m telescope.

(b) Tape recording capability at the three sites to enable data correlation.

(c) Provision for inclusion into the array of an antenna at the NASA Deep Space Station, Tidbinbilla [with up to two 140 Mbits/s channels to Parkes on a real time radio link] and an antenna at Hobart.

(d) Provision for future extensions of the array with:

(i) One or two additional antennas in the Culgoora/ Siding Spring area.

(ii) An antenna at or near Epping.

B. ANTENNA ELEMENTS

1. New Antennas (6 x 22 m dishes at Culgoora, 1 x 22 m dish at Siding Spring).

(a) Alt. - Az mounted.

* (b) At Culgoora the antennas will be self-propelled on rail track at a maximum speed of 3 km/hr; Siding Spring antenna fixed.

(c) Subreflector to be provided with 50 mm axial motorised adjustments.

(d) Access and space (a cube of side 0.3 metre approximately) at Prime Focus provided for possible future use (maximum additional weight approximately 15 kg).

* (e) Full dish operable at 50 GHz with aperture
* efficiency approximately 0.5. Central 15.3 metres operational to 115 GHz with aperture efficiency approximately 0.3.

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* Denote changes since last version.

(f) Optics: Cassegrain. Prime focus operation at frequencies below 1 GHz not designed out.

2. Existing Parkes 64 metre radiotelescope (AT/15.7/013)

Optics: Prime focus all frequencies.

C. FEEDS

1. Feeds for New 22m Antennas

1.1 All feeds designed for Cassegrain focus.

1.2 Feeds above 1.25 GHz are wideband (> octave) corrugated feeds to cover:

(i) L/S 1.25 - 2.50 GHz
(ii) C/X 4.4 - 10.8
(iii) K/Q 20.0 - 50.0
(iv) W/F 84.0 - 116

1.3 Dichroic system for simultaneous observation at S & X bands to be provided.

1.4 All Feeds to operate on-axis, except X-band when simultaneous with S-band.

1.5 Wideband feeds and receivers to be mounted near vertex on rotating-turret (remotely controlled).

1.6 Low frequency feed parameters yet to be finalized.

1.7 Dual linearly polarized feeds oriented at 45 and 135 degrees.

2. Feeds for Parkes 64 metre radiotelescope.

2.1 All feeds to be for prime focus operation.

* 2.2 Feeds currently under development: single frequency feeds covering receiver bands as defined in D1.1(a) and dual frequency feeds covering parts of pairs of bands will probably be provided.

* 2.3 Dual linearly polarized feeds oriented at 45 and 135 degrees.

3. Feed Priorities

3.1 First priority - design and construction of L/S and C/X feeds for 22 m antennas.

3.2 Second priority - feeds for Parkes and provision for beam switching.

3.3 Third priority - low-frequency feeds and S/X optics.

* 3.4 Fourth priority - provision for beam switching on Siding Spring 22 m antenna.

D. RECEIVERS

1. Receivers for New Antennas.

1.1(a). High Frequency Systems (greater than 1 GHz)

Optics: Cassegrain.

Frequency: Each dual frequency, dual polarization receiver system will be housed in a common cryogenic package and operate from a single wide-band feed. The following bands will be covered:

*

L - 1.25 - 1.78 GHz)	Common cryogenic
S - 2.2 - 2.5 GHz)	package
C - 4.4 - 6.1 GHz)	Common cryogenic
X - 8.0 - 9.2 GHz)	package
xxxx K - 20.0 - 25.5 GHz)	Common cryogenic
xxxx Q - 42.0 - 50.0 GHz)	package
xxxx W - 84.0 - 98.5 GHz)	Common cryogenic
xxxx F - 105.0 - 116.0 GHz)	package

NOTE: (a) These are design goals. Present technology would restrict us to approximately 15% bandwidth.

(b) These frequency bands are "clear" bandwidths, * i.e. system performances should not deteriorate significantly up to the band edges, particularly where spectral lines are involved.

1.1(b) Low-frequency systems (less than 1 GHz)

Optics: Cassegrain.

Frequency: Yet to be decided.

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xxxx Within the budget a minimum of L/S, C/X systems will be provided.

1.2 Environment -

(i) LNAs above 1 GHz will be cooled together with as much of the polarization, bandsplitting and feed waveguide as practicable.

(ii) Low frequency LNAs will operate at room temperature

1.3 The four receiver systems (8 frequency bands) in 1(a) will be operational at all times as far as practicable.

1.4 Space to be provided on turret for all 4 feeds mentioned in (c) (i) and the associated dual channel receivers.

2. Receivers for Parkes 64 Metre Radiotelescope

2.1(a) High frequency systems (greater than 1 GHz)

Optics: Prime focus.

Frequency: The feasibility of dual frequency systems is still under investigation.
The following bands will be covered:

L - 1.25 - 1.78 GHz)
S - 2.2 - 2.5 GHz)

C - 4.4 - 6.1 GHz)
X - 8.0 - 9.2 GHz)

xxxx K - 20.0 - 25.5 GHz)
xxxx Q - 42.0 - 50.0 GHz)

NOTE: These are design goals. Present technology would restrict us to approximately 15% bandwidth.

2.1(b) Low frequency systems (less than 1 GHz)

Optics: Prime focus.

Frequencies: Yet to be decided.

2.2 Environment

(i) LNAs above 1 GHz will be cooled together with as much of the polarization, bandsplitting and feed waveguide as practicable.

(ii) Low frequency LNAs will operate at room temperature.

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xxxx - Within the budget a minimum of L/S, C/X systems will be provided.

3.0 Receiver Priorities

3.1 First priority - provision of C/X, L/S receivers for the 22 m antennas.

3.2 Second priority - provision of C/X, L/S receivers at Parkes (including stand-alone operation).

* 3.3 Third priority - provision for stand-alone operation with the Siding Spring antenna.

E. SYSTEM

1. Compact Array (Max R.F. frequency 115 GHz)

1.1 IF digitized at antenna.

1.2 Four IF channels available from each antenna; selected from any of the operating (on-axis) frequency bands in either sense of polarization.

* 1.3 For each antenna ony two independent simultaneous LO's will be provided. (This is based on the premise that the array can be 'tied' using two LO's).

* 1.4 Fringe stopping at antennas.

1.5 Signal transmission via optical fibres.

* 1.6 Each IF data stream (512 MBaud capacity) shall be composed of one of the following:

* a) 1 bit sampled, 256 MHz bandwidth.

* b) 2 bit sampled, 128 MHz bandwidth.

* c) 4 bit sampled 64 MHz bandwidth.

* 1.7 The 4 bit sampled 64 MHz bandwidth signal will be processed at the centre as follows:-

(1) 4 bit to 2 bit digital conversion to provide 64 MHz bandwidth inputs to the continium correlator and/or to the line correlator.

(2) 4 bit to analogue conversion to provide:-

(a) an analogue signal for filtering in factors of 2 from 32 MHz down to 0.5 MHz. The filtered signal will be redigitized (2 bit) for input to the line correlator.

(b) analogue signals corrected in gain and phase that can be combined to give tied array signals in 2 linear or 2 circular polarizations with a maximum bandwidth of 64 MHz. Narrower filtering will be done (down to 62.5 kHz) in the VLBA tape recorders.

* 1.8 "Tied" array capability for 1 to 6 antennas. Providing up to 4 I.F. channels either linearly or circularly polarised.

2. Long Baseline Array

* (Max RF Frequency 116 GHz where possible

2.1 I.F. digitized at antenna.

* 2.2 4 I.F. channels available from each antenna.

* 2.3 Provision of 2 independent, simultaneous LO's per antenna.

2.4 Fringe stopping at antennas.

2.5 Signal data collection using tape recording.

* 2.6 Maximum I.F. data rate (to suit VLBA tape recorders) 256 Mbits/sec., i.e. for 2 bit sampling, one channel 64 MHz wide, 2 channels 32 MHz wide or 4 channels 16 MHz wide).

* 2.7 Narrowband filtering of I.F. will be available in factors of 2 down to 62.5 kHz in VLBA tape recorders.

3. LO Switching:

* All LO frequencies must be capable of being switched at rates of up to (1 Hz).

4. Priorities

4.1 First priority - Compact Array operation.

4.2 Second priority - Long Baseline Array.

* 4.3 Third priority - Siding Spring Stand-Alone operation.

F. CORRELATOR:

1. Culgoora

1.1 Provision for simultaneous operation in the following four modes:

a) Compact Array Line OR Wideband Continuum.

15 Baselines, with up to 8 products per baseline, providing a minimum of 16 frequency channels per product for 1 bit correlation at 256 MHz bandwidth or for 2 bit correlation at 128 MHz bandwidth. Recirculation up to a factor of 64 if possible.

Minimum bandwidth 0.5 MHz. For fewer products per baseline, proportionally more channels per product.

b) Compact Array Narrowband Continuum.

Operating at 64 MHz bandwidth, providing up to 8 products for each of the 15 baselines; with at least 8 frequency channels per product.

c) LBA Line.

Similar to a) above, but for only 10 baselines with 4 products per baseline. Provision for expansion is under discussion.

d) LBA Continuum.

Similar to b) but with 4 products for each of the 10 baselines. Provision for expansion is under discussion.

1.2 Compatible with future addition of FFT pre-processors at each antenna - to obtain more frequency channels.

1.3 Includes delay tracking systems for both arrays, and the system for providing "tied" array signal.

1.4 Includes FFT processing, Van Vleck correction, Hanning and output selection.

1.5 Tape playback system and interface to correlator for LBA correlations.

2. Parkes and Siding Spring

2.1 Provision of auto-correlators. Eight modules (1 Block) for Line and two Modules for continuum. This is identical to one baseline of the CA correlator.

3. Priorities

3.1 First priority - Compact Array correlator.

3.2 Second priority - Parkes stand-alone correlator.

3.3 Third priority - Long Baseline Array correlator.

3.4 Fourth priority - provision of a stand-alone correlator for the Siding Spring antenna.

G. DATA DISTRIBUTION

1. Compact Array: via Fibre Optics (probably monomode fibres).. Not defined as yet.

2. Long Baseline Array: Using tape recording.

H. LOCAL OSCILLATOR AND MONITOR DISTRIBUTION

1. Compact Array: via fibre optics or coaxial cable.

2. Long Baseline Array: to be chosen from AUSSAT, Telecom links (monitor only) or local clocks (L.O. only).

I. COMPUTING

1. ON-LINE Computing

1.1 The ON-LINE computing system will be located at Culgoora and consist of:

a) At the control site:

(i) 2 x VAX 11/750 (one synchronous and one asynchronous possibly with an interconnect system to permit functional interchange).

(ii) Control console.

(iii) Tape drives and disk units.

b) At each antenna element:

(i) Coordinate conversion and control/monitor functions performed by antenna microcomputers with communication links to the synchronous computer.

1.2 Functions yet to be defined.

2. OFF-LINE Computer

2.1 The OFF-LINE computing system will be located at Epping and will provide a minimum processing capability equal to:

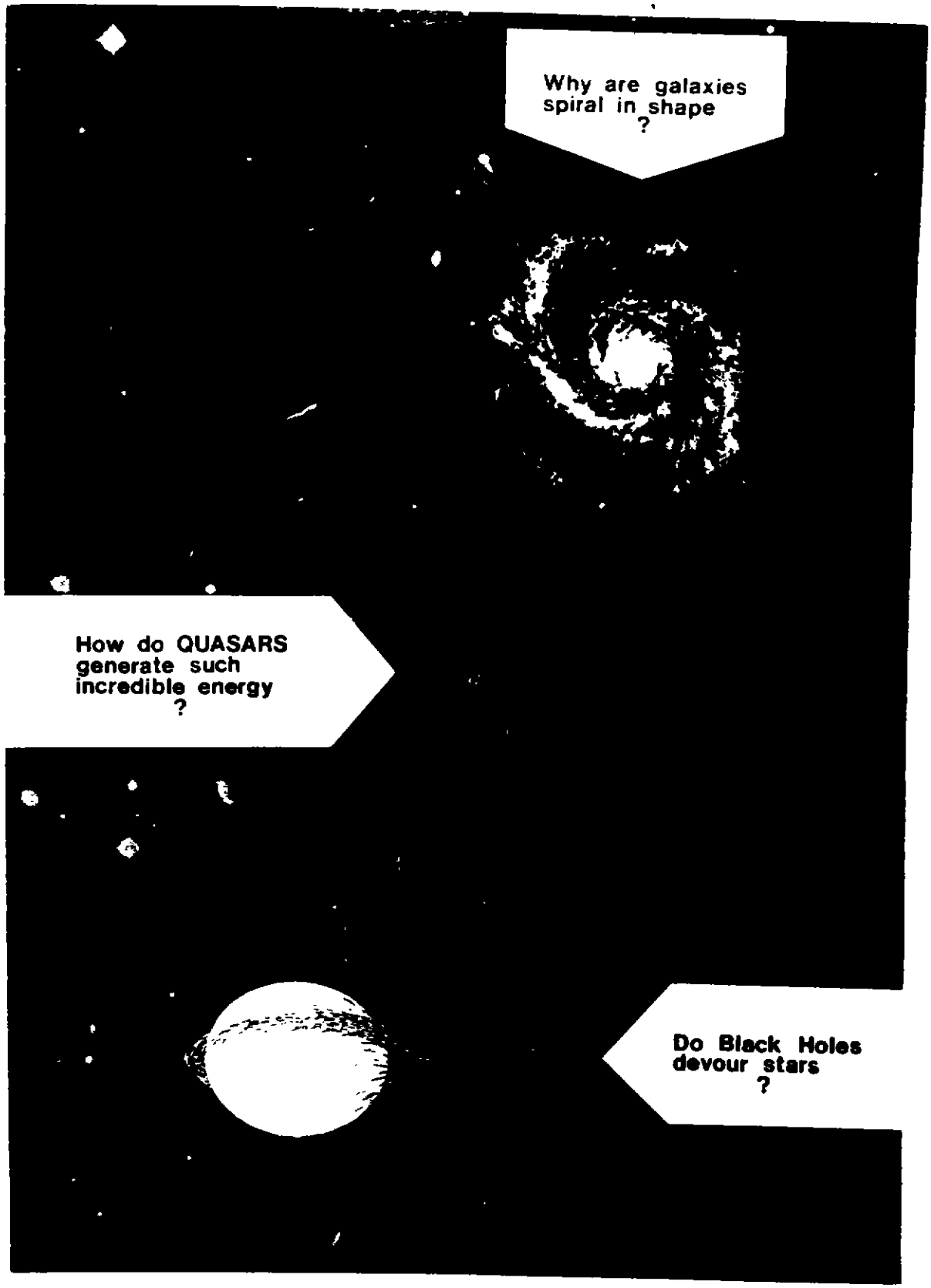
* a) 1 x VAX 8600 (with interconnect to present RP VAX 11/750).

b) 2 x Array Processors.

c) Tape drive and disk units.

d) Image Processor.

2.2 Functions yet to be defined.



QUESTIONS THE AUSTRALIA TELESCOPE CAN ANSWER