AT Files.

AT 39.3/029

AUSTRALIA TELESCOPE NATIONAL FACILITY

HI MULTIBEAM RECEIVER

Record of Planning Session held on 16 September 1993 09.30-12.30 in CSIRO Lecture Theatre, Epping

Present: L.Staveley-Smith, R.D.Ekers, R.P.Norris, R.Webster (Melbourne), R.Haynes, E.Troup, J.W.Brooks, N.E.B.Killeen, R.Ferris, W.Wilson, K.Wellington, T.Oosterloo, M.Sinclair, M.Bailes, B.Koribalski, A.Young, G.Graves, G.McCulloch, R.A.Vaile (UWS), J.Caswell, M. Filipovic, Takahashi, A.K.Tzioumis, A.E.Wright (Parkes).

Attached Documents:
A. Agenda
B. Astronomical requirements (viewgraphs of L.Staveley-Smith)
C. Projected use of Parkes telescope (viewgraph, R.D. Ekers)
D. Feed design (viewgraphs,T.Bird)
E. Receiver (viewgraph, M.Sinclair)
F. Filter options (R.Ferris)
G. Data transfer (A.Young, G.McCulloch)

Summary:

The meeting was opened with Lister Staveley-Smith describing the broad astronomical aims of the project (Appendix B1). These are:- (1) a deep 21 cm HI survey of the local Universe to 14,000 km/s; (2) deeper HI studies of selected regions (behind Galactic Plane; blank fields etc.). At a later stage, Magellanic Stream and Galactic HI studies will be considered (these is not part of the ARC/SERC proposal). The Parkes Telescope will cover the southern hemisphere and, possibly, the Lovell Telescope will be used to cover the Northern Hemisphere. Approximately 6 months of observing time ($5x10^5$ pointings with a 9-beam system) will be required for the survey, and ~3 months for the selected regions. A comparison with other single-dish and synthesis telescopes (Appendix B2) shows that a multi-beam system on Parkes is competitive with the VLA in coherent mode for small (unresolved) sources, when the limited bandwidth of the VLA is considered (6.25 MHz versus 64 MHz). However, the large source performance of the Parkes antenna is orders of magnitude better. Technical requirements were also discussed (Appendix B3). The optimal beam separation on the sky is the total emission sampling interval (λ/D) rather than the Nyquist interval for the all-sky survey. With the present design, an interleave factor of 2 in each dimension is therefore required. Ron Ekers pointed out this will change if the feed geometry is not rectangular.

Ron Ekers addressed collaborative, management and financial aspects. NFRA is not suitable for providing receivers because of their ongoing upgrades. The GBT is optimised for single-beams, so they are not looking at multi-beam receivers yet. Arecibo are very interested - we should maintain links with them as they will be looking for new developments after their upgrade. The new NAIC Director (Paul Goldsmith) was involved in the UMass multibeam CO receiver development. Jodrell Bank is presently the most hopeful source of high quality LNA's. They have an application before the SERC for £132k. The AT budget for the multi-beam receiver is $90k and 2 manyears for 1993/94, and $110k and 7 manyears for 1994/95. However we are dependent on external funding. As a model for the survey, the success of the PMN survey was mentioned. The timescale of the project and other committments for the Parkes Telescope were discussed (Appendix C).

Rachel Webster indicated smaller funds might be available from University of Melbourne, and suggested a new ARC application next year if the current one fails.

Alan Wright discussed the management of the observing and data reduction in light of the PMN experience. A need for a large effort from non-ATNF staff was emphasised (user-pays), and that sending a Ph.D. student to help observe for a few nights was not enough. The need for good scientific management was emphasised.

Ron Ekers elaborated on the latest CSIRO management schemes which have more emphasis on objectives and less on group structure. The National Facility approach was preferred, whereby the data would be widely available after a suitable period (cf ATCA Magellanic Cloud mosaicing project).

There was a general feeling that large blocks of time were required to run the project efficiently, but that 2 months at a time was ok. However, Ray Haynes pointed out that such an approach doesn't fit in with the gaps in the current long-term Parkes schedule (Appendix C). The best observing time is 1995, following the SETI observing period.

John Brooks took over the chair from Lister Staveley-Smith for the Technical Planning discussion. Trevor Bird gave a presentation on technical specification and a preliminary study of feed design.. His viewgraphs are attached (Appendix D). Square horns were used instead of circular horns because they were thought to be easier to manufacture. However, Mal Sinclair's receiver design has a circular OMT and a square-to-circular waveguide transition. This was agreed to be unnecessary complexity. The next feed design will consider circular horns. The requirement for feeding the Lovell Telescope with its much smaller f/D was discussed. Dielectric loaded feeds would be one possibility.

Mal Sinclair presented the existing receiver design (Appendix E). Total weight would be 300 kg. The estimated noise budget was: LNA 3K (20K physical); 0.141 cable 3K (40K physical); OMT 3.6K (0.2dB loss at 70K physical); window 1K; horn 1K; spillover 7K; sky 6K. Total estimated T(sys) is 25K per channel. A simple uncooled OMT design would add 14K. This was regarded as unacceptable. In light of Trevor Bird's calculations, the spillover contribution for the simpler feed design may have been underestimated by 5K. This was viewed with concern.

Dick Ferris summarised filter design (Appendix F). The 64 MHz band would have to be obtained by analogue filters (too fast for current digital filters). Bandwidths 16MHz and below could be obtained digitally (Fig.F1).

Gerry McCulloch (w. Alan Young) discussed data transmission options: analog on coax .v. analog on fibre .v. digital on fibre. See Appendix G. Preliminary cost estimates per channel were given.

After the meeting, a cost estimate for a semi-custom 256 Mbps ECL link was sent by FIBERNET (also Appendix G)

Warwick Wilson and Euan Troup summarised correlator and telescope control matters. The LBA alpha computer would be capable of data collection and data reduction and possibly telescope control. Ray Norris and Rachel Webster discussed the feasibility of intelligent on-line data reduction and source detection.

Lister Staveley-Smith October 1993

APPENDIX A

THE HI MULTIBEAM RECEIVER
A PLANNING SESSION

A planning meeting for the HI multibeam receiver will take place on Thursday 16 September in the first floor Lecture Theatre in EPPING. All are welcome. Coffee will be available.

<u>Thursday 16 September 09.30-12.30</u>

09.30	Introduction	
09.35	Astronomical objectives - Lister Staveley-Smith	
09.50	Collaborative and management issues - Ron Ekers - Rachel Webster (ARC update)	
10.15	Lessons from previous surveys - Alan Wright	
10.30	TECHNICAL PLANNING - Feed Design (Trevor Bird) - Receiver design (Mal Sinclair) - Filter design (Dick Ferris, Warwick Wilson) - Data transfer (Kel Wellington?, Gerry McCulloch, Alan Young) - Sampler and correlator status (Warwick Wilson) - Computer Hardware (Warwick Wilson, Andrew Hunt) - Telescope control and software (Warwick Wilson, Euan Troup)	Chairman: John Brooks

12.15 Conclusions
12.30 LUNCH

A short discussion of the relevance for multibeam CO astronomy at Mopra may take place, time permitting.

The Lecture Theatre is available from 1.30 to 3.00 if specific issues need further discussion.

Lister Staveley-Smith 24/8/93

BROAD AIMS OF PROJECT

1. A deep λ21cm HI survey of the whole of the local Universe to *cz*=14000 km s^{-1}.

   (~10^6 independent beams, ~6 months Parkes observing time)

2. Deeper HI surveys of "selected" regions

   (Galactic Plane, blank fields, ~3 months)

3. Possibly also Magellanic Stream and Galactic HI studies.

   (~1 month)

1. A HEMISPHERIC SURVEY WITH PARKES

- ~ 7 min. per pointing with 9 beams

  (≡ 25 min. CONVENTIONAL SINGLE BEAM OBSVN)

  ⇒ ~ 6 MONTHS for whole southern sky

- Estimated number of galaxies detectable

  $\simeq 10^4$ galaxies

Why a large survey ?

- Look at the Universe in another domain. The HI universe is dominated by YOUNG, GAS-RICH galaxies and PROTOGALAXIES. Therefore important for studying FORMATION of GALAXIES.

For example, HOFFMAN, SILK & WYSE (ApJ 388 L13 1992) predict that the INITIAL STRUCTURE of galaxies is strongly dependent on LARGE-SCALE ENVIRONMENT. Giant, unevolved CROUCHING GIANTS should occur in VOIDS.

Also, Disney et al.

- <u>COSMOLOGY</u>: Every large-scale extragalactic survey is useful cosmologically.

An <u>HI survey</u> may be exceptionally so, as it is free from the effects of Galactic extinction and confusion (some problems near centre with high T_{sys} and free-free abs^{n})

Gives galaxy properties: Recession velocity, Rotation velocity, neutral hydrogen mass.

Useful for studying LARGE SCALE STRUCTURE (3D), PECULIAR VELOCITY FIELD

- **Galaxy Interactions**

Gaseous tidal tails are the best indication of large-scale interactio between galaxies.
Such systems tell us much about Galaxy formation, dynamic and dark matter.

$\Rightarrow$ Excellent follow-up work possibl on CA

c

eg. INTERGALACTIC RING in M96 group (Schneider et al.)

2. Deeper surveys

- Higher redshifts in Galactic Plane
- Low column density 'failed' galaxies (low-z damped Ly-α?) ~~fa...~~
- Gas-rich dwarf galaxies
  - → better LF
  - → better group dynamics

Comparison of Telescope Performance in Spectral-Line Survey Mode

(a) SMALL SOURCE PERFORMANCE $\tau \propto (N_b A_{tot} N_a)^{-1}$ (Identical $\Delta S, T_{sys}$)

Telescope	Beams	Antennas	Pointings sr^{-1}	Time sr^{-1} (τ)
Parkes	9	1	1×10^4	1 month
Parkes	1	1	9×10^4	9 months
Dwingeloo	1	1	1×10^4	5 years
GBT/Efflesberg	1	1	2×10^5	4 months
Arecibo (upgraded)	1	1	9×10^5	1 month
Compact Array	1	5	1×10^4	3 months
VLA	1	27	1×10^4	3 days
VLA (incoherent)	1	27	1×10^4	2 months

(b) MAXIMUM BANDWIDTH FOR <30 km s^{-1} VELOCITY RESOLUTION

Telescope	**Bandwidth (MHz)**
Parkes (9)	64
Other single-dishes	10-100
Compact Array	32
VLA (coherent)	6.25

APPENDIX B2

Comparison of Telescope Performance in Spectral-Line Survey Mode

(b) LARGE SOURCE PERFORMANCE (15 arcmin)

Telescope	Beams	Antennas	Pointings sr^{-1}	Time sr^{-1} (τ)
Parkes	9	1	1×10^4	1 month
Parkes	1	1	9×10^4	9 months
Dwingeloo	1	1	1×10^4	5 years
GBT/Efflesberg	1	1	2×10^5	22 months
Arecibo (upgraded)	1	1	9×10^5	7 years
Compact Array 375-m	1	5	1×10^4	10^4 years
VLA D array	1	27	1×10^4	1000 years
VLA (incoherent)	1	27	1×10^4	2 months

ASTRONOMICAL REQUIREMENTS

- Large no. of beams
  (7 ~ 18 consistent with likely processing power)
- Large bandwidth with good frequency resolution to give good REDSHIFT coverage and sufficient velocity resolution (64 MHz, 512 × 18 ch: just ok). Front end b/w ~ 200 MH
- At cost of aperture efficiency of central beam being lowered, beams may be brought close together to maximise efficiency of outer beams.
- Maximise G/T (as long as sidelobe levels not too high)

- Need accurate **theoretical beam**, if Galactic HI to be attempted.
- Prefer beam spacing on sky = $n\frac{\lambda}{D}$ which ($n=1$) is the <u>TOTAL EMISSION sampling interval</u> (RECTANGULAR GRID). Present 26 arcmin spacing is OK ($n=2$). FULL SAMPLING INTERVAL (Nyquist) is $\frac{\lambda}{2D}$, and only relevant for Galactic HI.
- <u>$T_{sys} \sim 20K$</u> desired

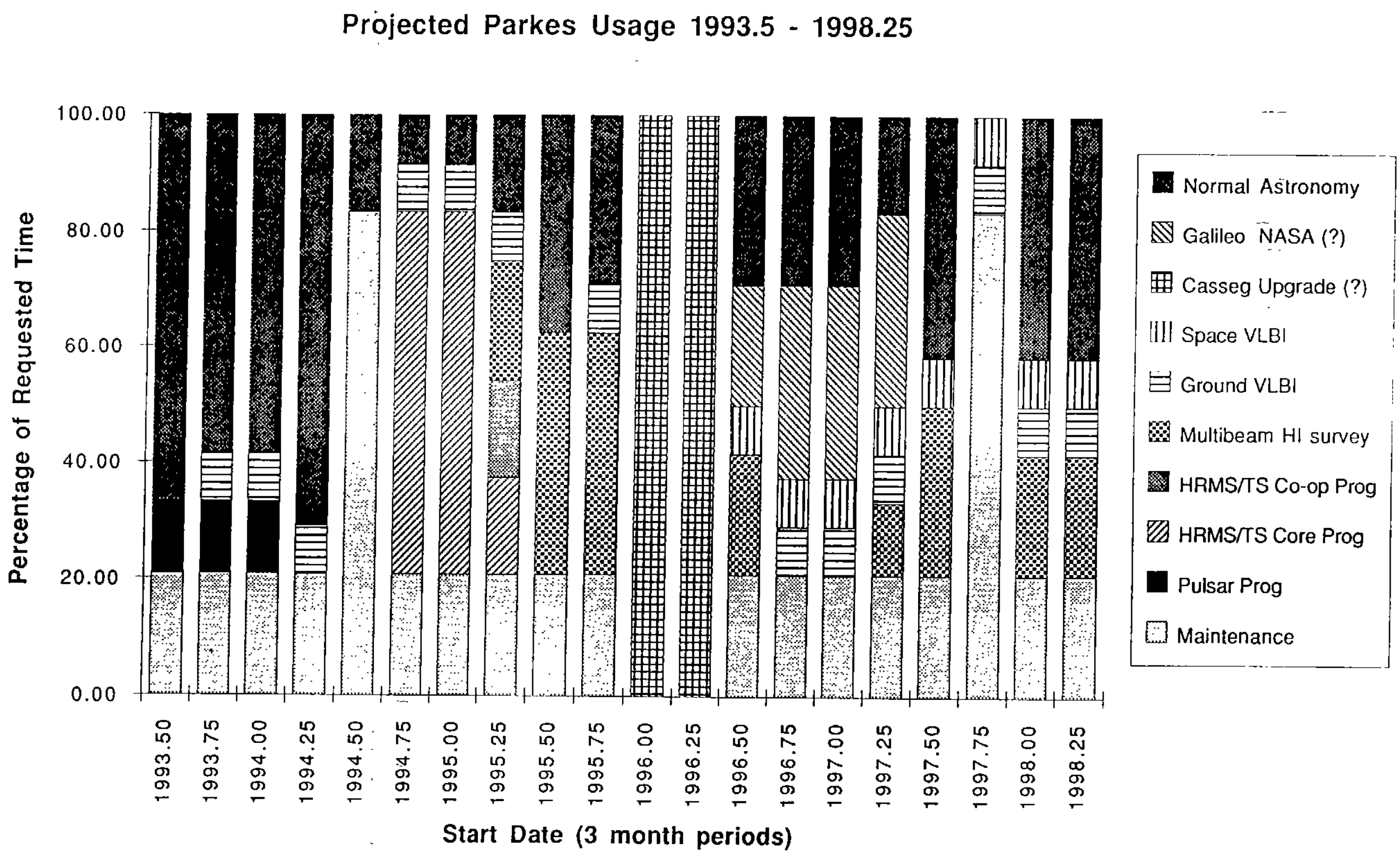
  $T_{amp} < 3K$ 1320 — 1420 MHz

  $< 5K$ 1270 — 1470 MHz
- <u>Polarization or phase performance</u> not an issue (YET)

contd. 3

- IF bandwidth 64 MHZ is ok
- Need excellent filter stability
- An alternative BANDWIDTH of 16 or 32 MHZ would ensure that LOWER REDSHIFT RANGE observations can still be made after the LBA and MOPRA correlators are returned to their rightful purpose
- Similarly, a 4 MHZ BANDWIDTH would be ideal for follow-up Galactic & Magellanic work (~4 correlator blocks)
- GRIDDED observations preferable to SCANNING (?) But need v. small dead-time, and a rotating feed (Alt-az mount)

APPENDIX C



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APPENDIX D

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Initial Study of the Parkes Radiotelescope with Multiple Beams

Trevor Bird

16 September 1993

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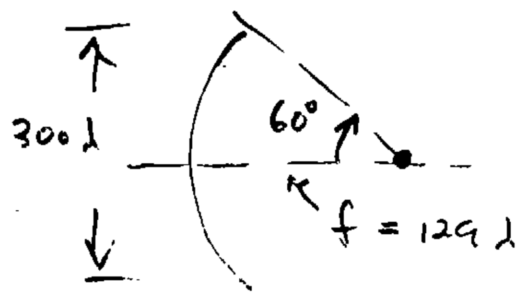
Target Specifications

• Beam efficiency	>55%
• Sidelobe level	>14dB
• Cross-polarization	>20dB
• Feed horn return loss	>20dB
• Spillover efficiency	<-0.5dB

Parkes at 21 cm

HPBW ~ 0.21°



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Feed Element Options

- Conventional flared rectangular horns
- Stepped rectangular horns
- Conventional flared conical horns
- Stepped conical horns
- Dielectric-loading to reduce horn size.

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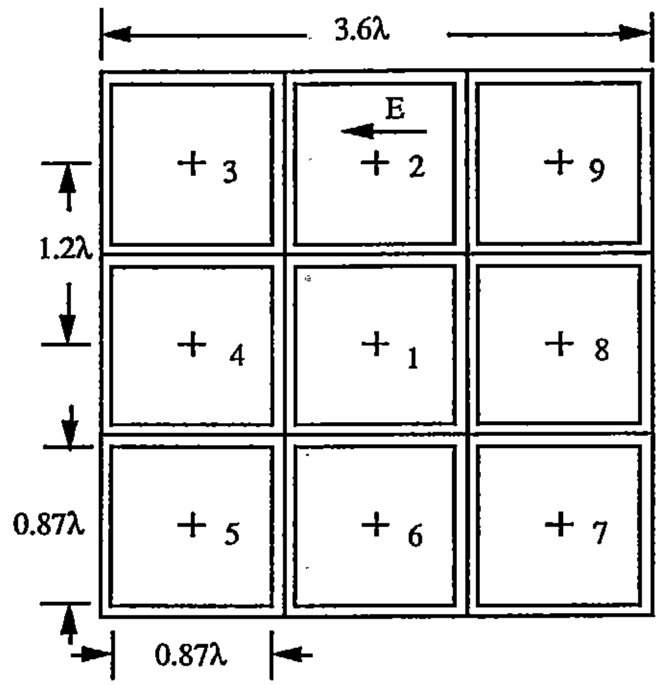
Nine-element array option



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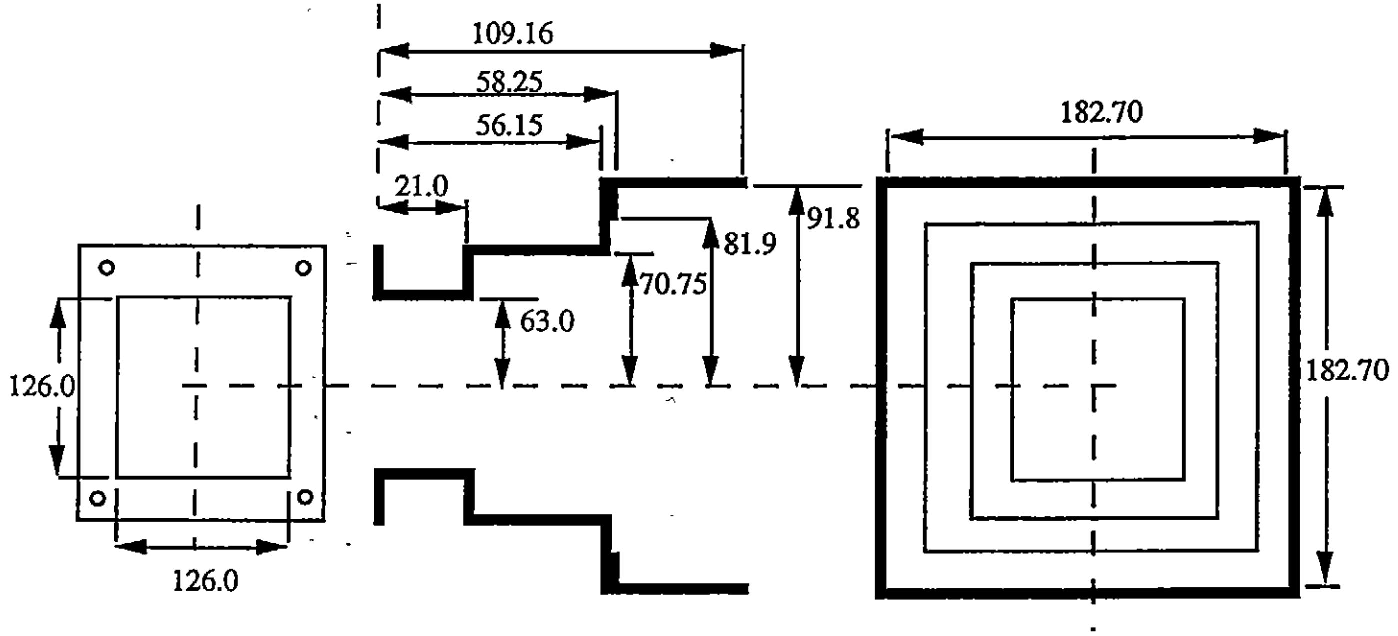
Stepped Rectangular Horn



All dimensions in mm

Materials: Welded aluminium sheet

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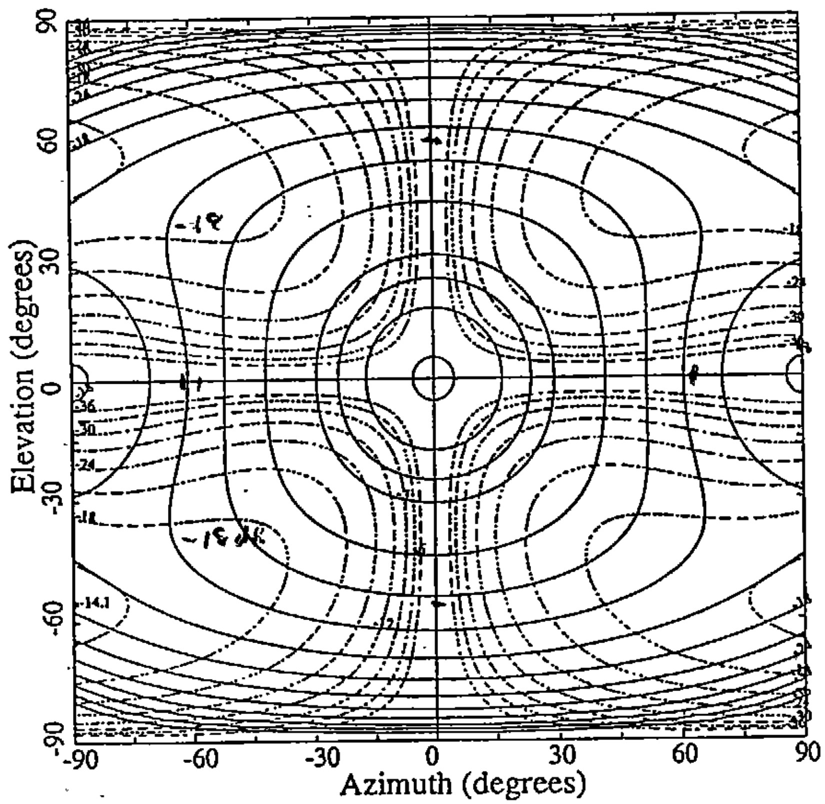
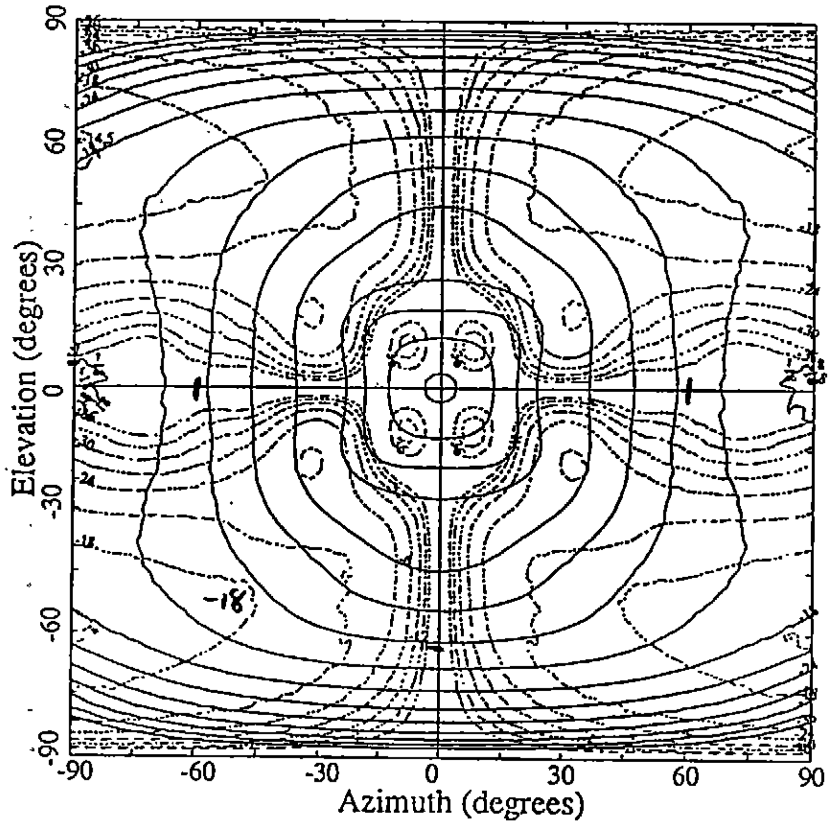
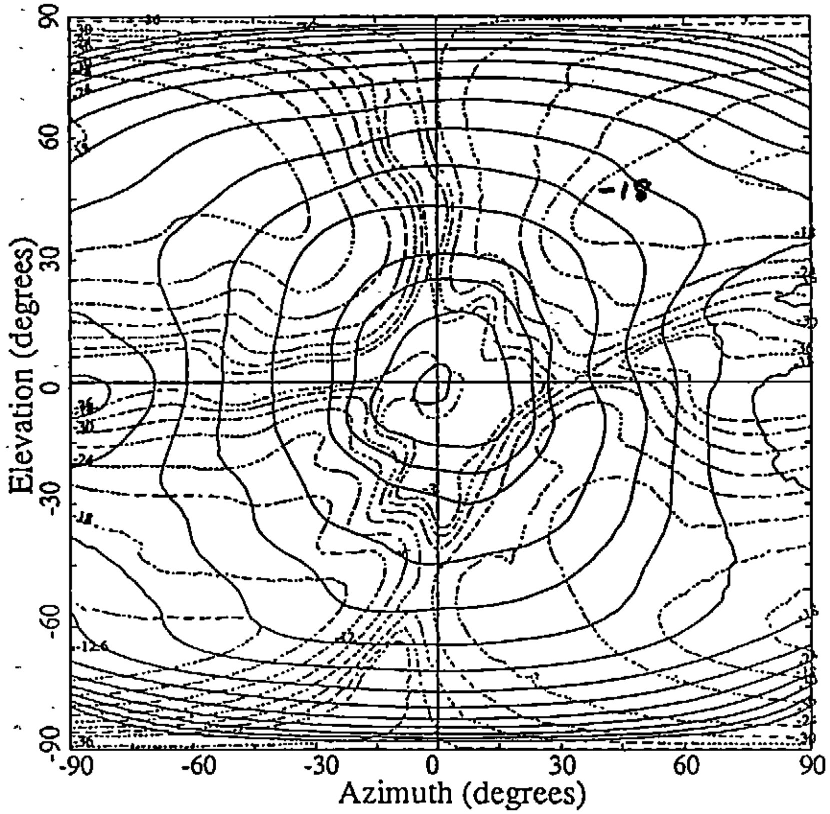
Radiation patterns of isolated square horn



Radiation patterns of 9-element array with horn 1 excited



Radiation patterns of 9-element array with horn 3 excited



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Level of co-polarized mode excited

Reflection coefficient

Element Excited	Coupling dB $TE_{10} \leftrightarrow TE_{10}$								
	1	2	3	4	5	6	7	8	9
1	-26.1	-36.3	-39.2	-31.4	-39.2	-36.3	-39.2	-31.4	-39.2
2	-36.3	-25.9	-31.8	-39.1	-45.1	-41.9	-74.7	-39.2	-31.8
3	-39.2	-31.8	-26.2	-35.2	-42.2	-45.1	-44.7	-44.1	-51.6
4	-31.4	-39.2	-35.2	-26.3	-35.1	-39.1	-44.2	-51.6	-44.1

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Level of cross-polarized mode

Element Excited	Coupling dB $TE_{10} \leftrightarrow TE_{01}$								
	1	2	3	4	5	6	7	8	9
1	<-60	<-60	-39.6	<-60	-39.7	<-60	-39.7	<-60	-39.7
2	<-60	<-60	-56.7	-39.2	-46.7	<-60	<-60	-39.3	-57.1
3	-39.6	-56.3	<-60	-56.9	<-60	-44.6	-44.0	-46.8	<-60
4	<-60	-40.3	-56.4	<-60	-56.4	-40.2	-44.9	<-60	-44.9

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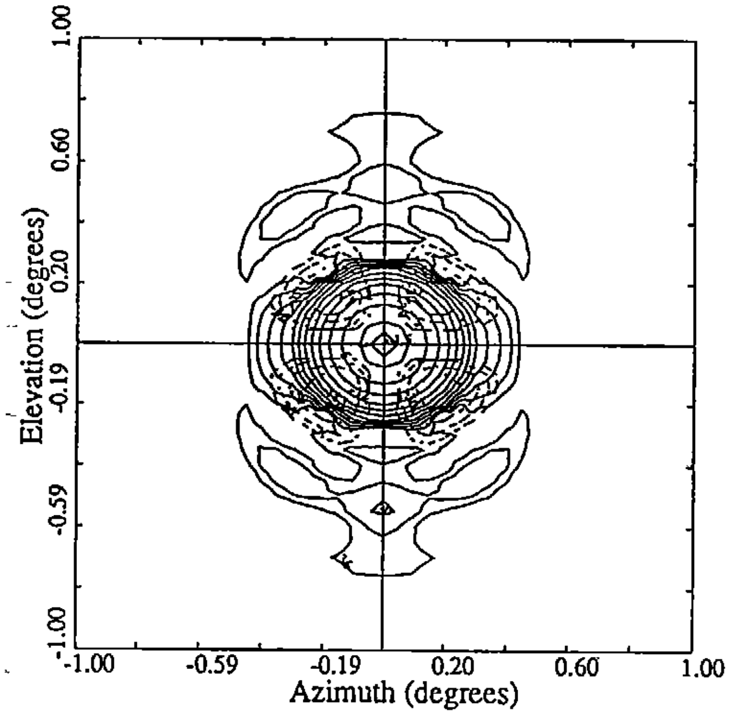
Secondary pattern of Parkes with 9-element array - horn 1 excited



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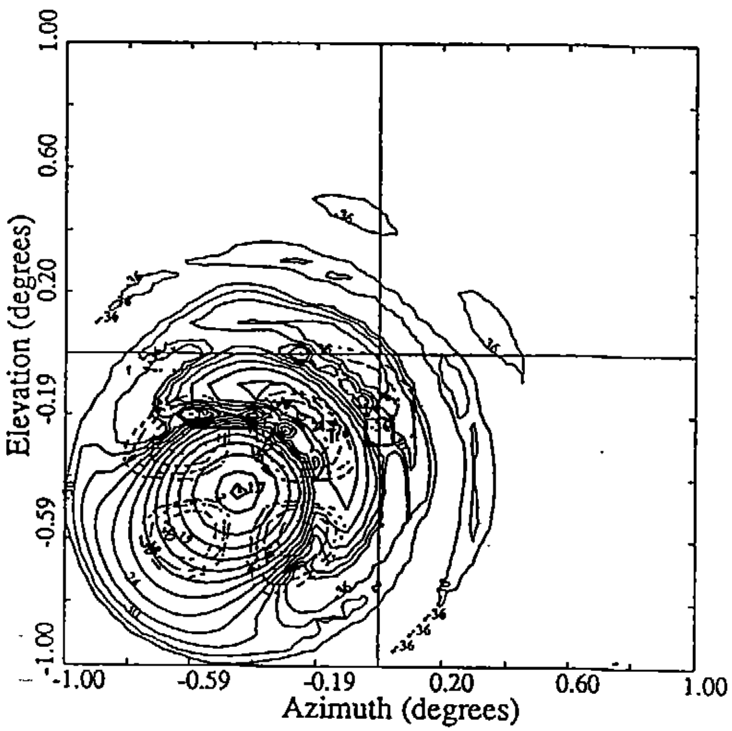
Secondary pattern of Parkes with 9-element array - horn 3 excited



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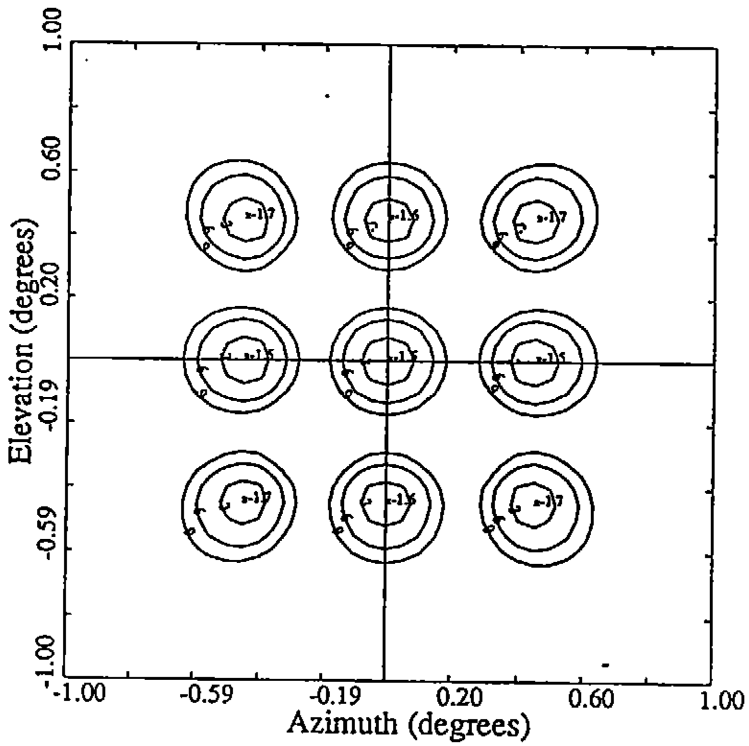
Beams produced by Parkes with 9-element array



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Performance of Parkes with 9-element array

Element No. Excited	Beam θ_b	Direction ϕ_b	Aperture Efficiency dB	Spillover Efficiency dB	Feed Return Loss dB
1	0°	0°	-1.54 (70.1%)	-0.50	-26.1
2	0.432°	180°	-1.67 (68.1%)	-0.50	-25.9
3	0.612°	135°	-1.70 (67.6%)	-0.53	-26.2
4	0.432°	90°	-1.58 (69.5%)	-0.53	-26.3

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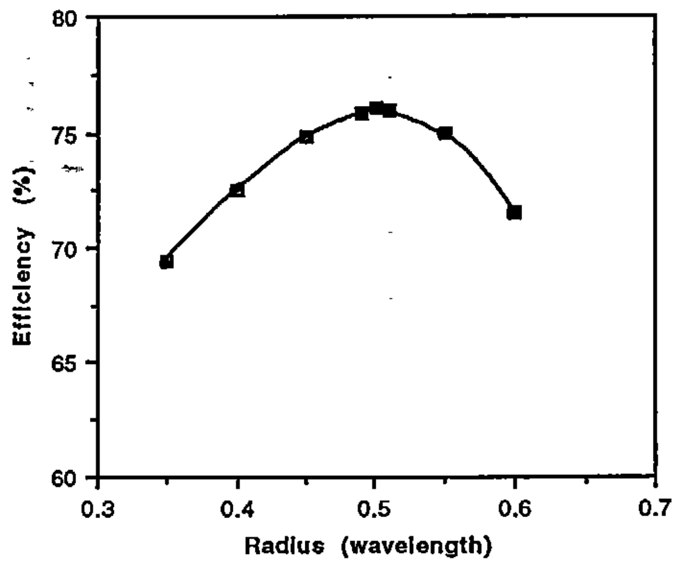
Circular Horns

With Parkes.



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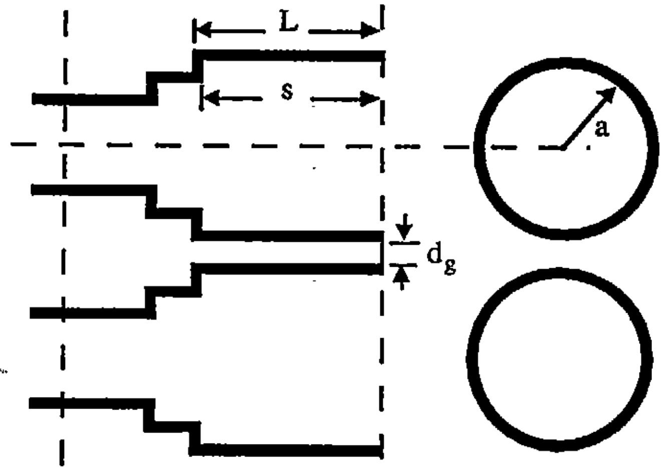
Stepped Circular Horns



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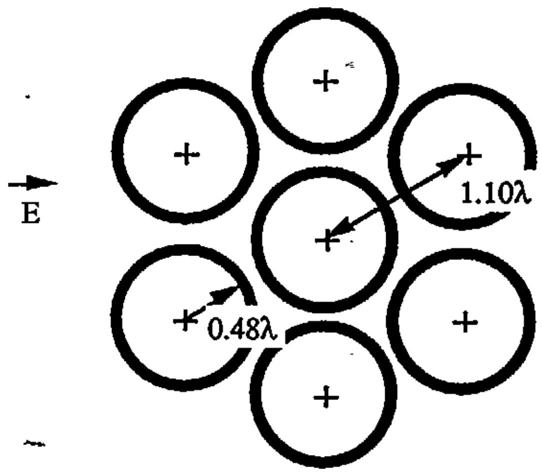
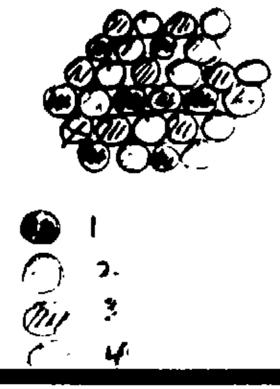
Seven-element array option





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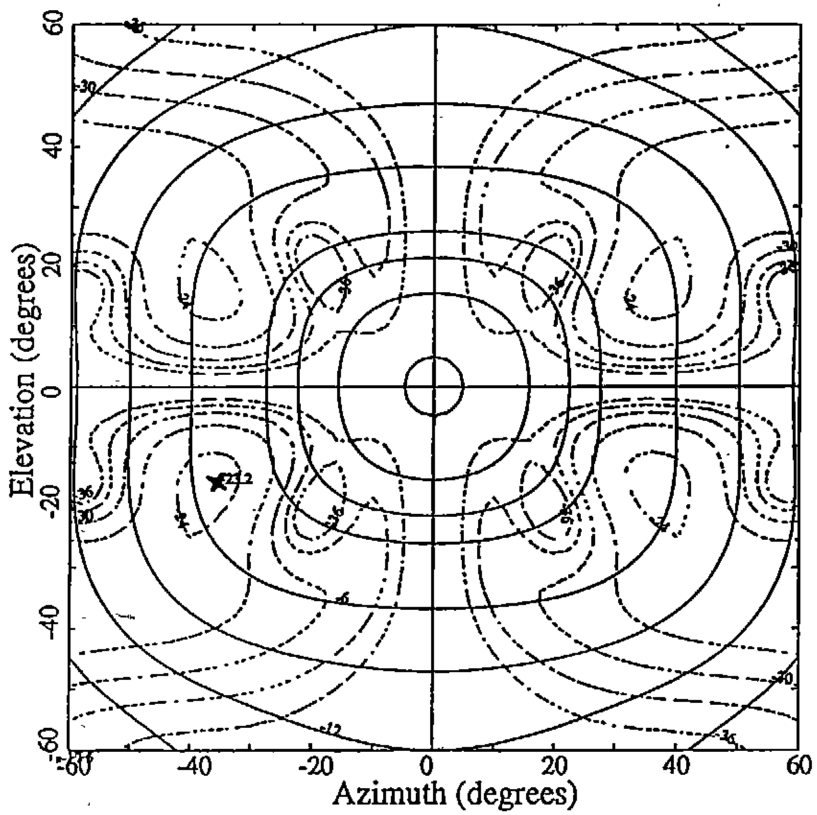
Radiation patterns of 7-element array with horn 1 excited



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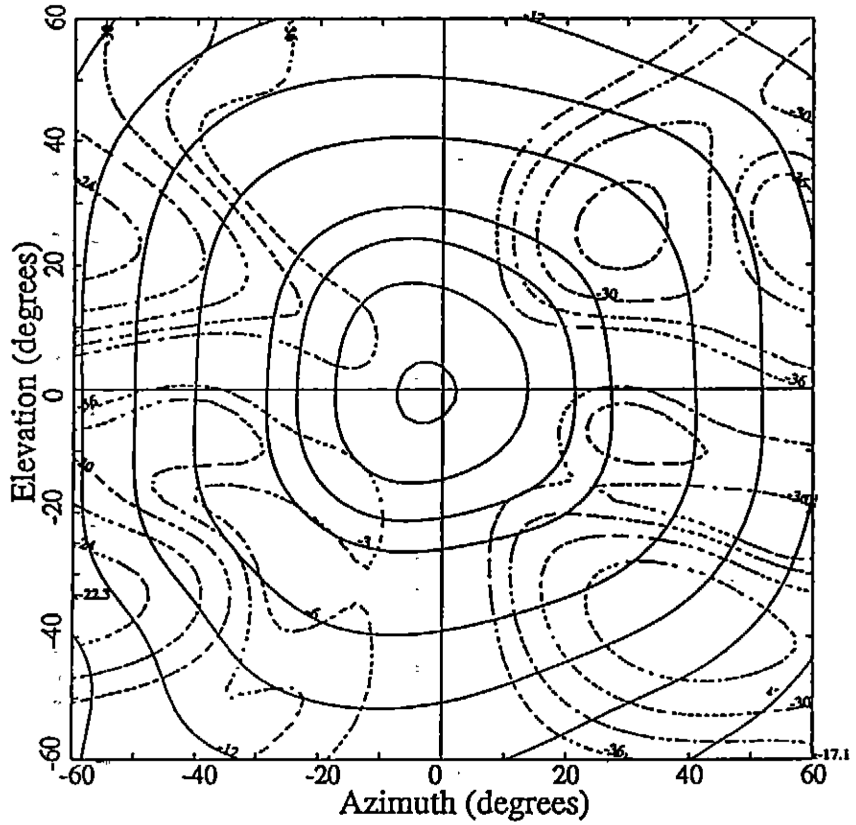
Radiation patterns of 7-element array with horn 3 excited



21Cm Multibeam FRONT-End:

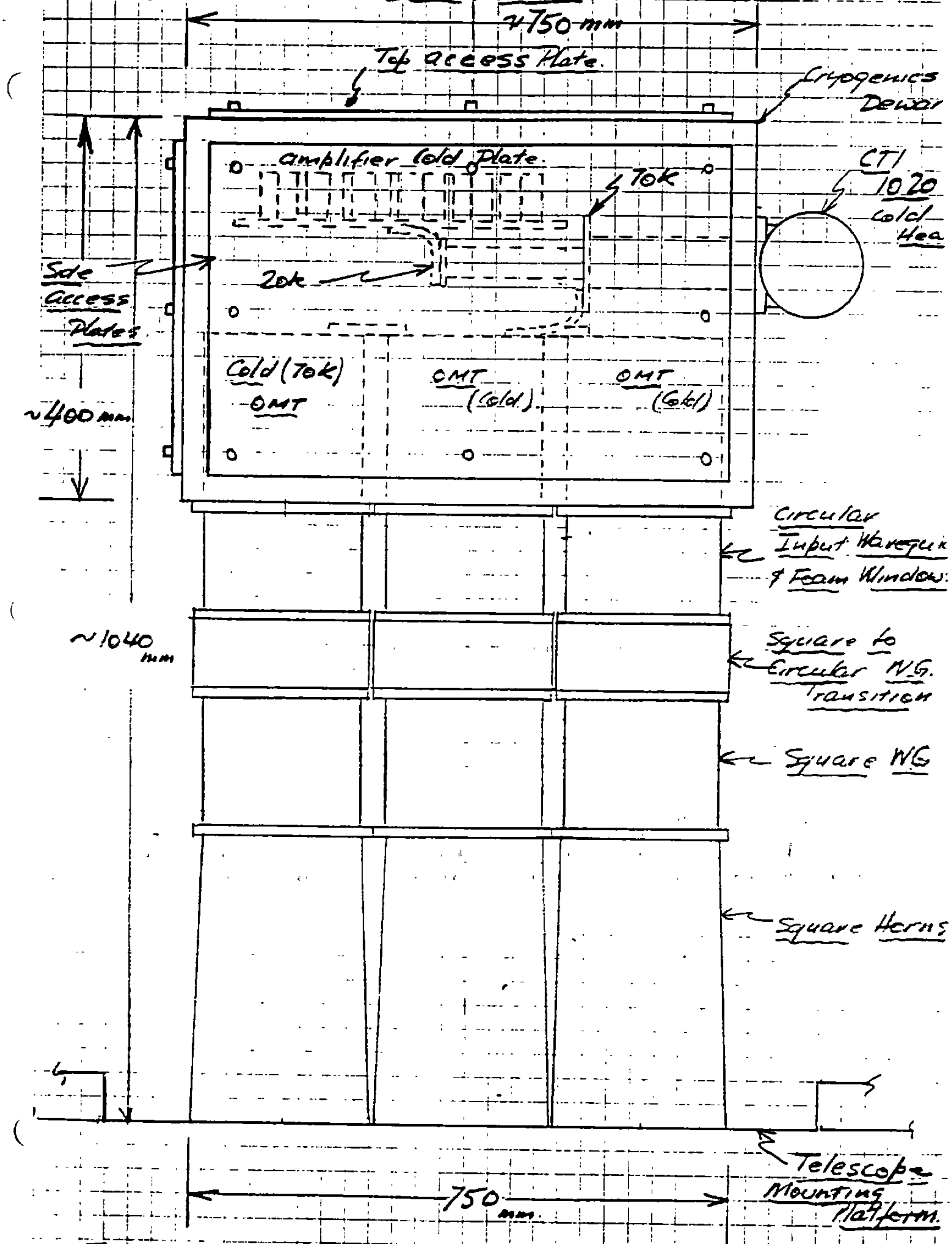


Fig 1

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APPENDIX F

HI Multibeam Receiver - Filter Options

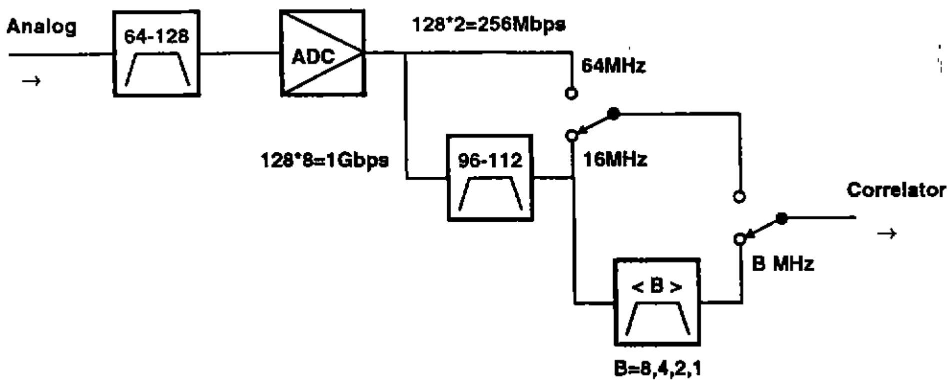


Fig. 1. Analog 64MHz, Digital 16, 8, 4, 2 & 1MHz Filters

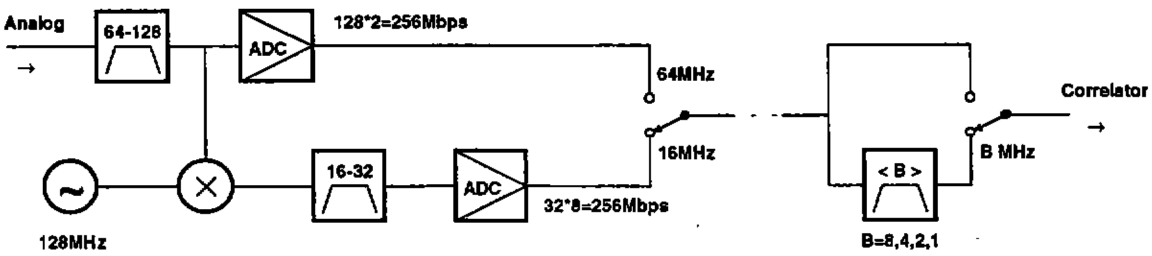


Fig. 2. Analog 64 & 16MHz, Digital 8, 4, 2& 1MHz Filters.

Dick Ferris 16-Sep-93

APPENDIX G

THE HI MULTIBEAM RECEIVER

DATA TRANSFER

Alan Young
Gerry McCulloch
15 September 1993.

This is a summary of alternatives for transferring the receiver IF data from the aerial cabin to the correlator. All prices are "back of the envelope" budgetry prices only, obtained from one potential supplier.

Requirements:

The front end produces 2 x 9 x 64MHz channels of IF output. (The IF frequency is 64MHz to128MHz.)

For 2-bit sampling, this is 256Mbit/sec/channel of data.

Phase stability between orthagonal channels from one feed is not a requirement.

It is assumed that 200metres of cable is required between the aerial cabin and the correlator.

Alternatives:

There are three alternative ways of transferring this IF data from the cabin to the correlator, whch should be considered:

1) Send analog IF from the cabin using coax cable, and sample at the correlator.
2) Send analog IF from the cabin using fibre optic cable, and sample at the correlator.
3) Sample in the aerial cabin and send the digitized data to the correlator over optical fibre.

For fibre, multimode fibre (62.5micron diameter) would be sufficient for the bandwidths and data rates being considered here. Because the cable has to bend continually with the telescope motion, multicored tight buffered cable would be required. This is not much more expensive than the more common, loose cored cable.

Considerations for each proposal:

1) Coaxial cable.

The use of coaxial cable has the advantages that there are no samplers in the cabin to cause interference to the front end, and that no additional electronics would be required to put the signals on and off the cable. A bundle of 18 would be bulky, and we would have to check that there is room on the rotators for this bundle.

Suggest 0.25inch Superflex Heliax cable, which cost A$4.50/metre in 1985- so assume $10/metre now. This cable is known to have good temperature stability. At 100MHz, this cable has 12dB loss over 200metres, and would have a slope of about 3dB between 64MHz and 128MHz. This is not excessive, and could be easily equalised or calibrated out.

A coax cable installation would have good signal/noise and linearity.

Would expect good phase tracking between pairs of cables.

Cost: Say, $2,200 per transmission channel (which includes cable and connectors).

Fibre-optic cable:

For the short cable run required, we would use "off-the-shelf" cable, which commonly comes in 6 core and 12 core cables. An estimate of cost is $8/metre for 6 core cable, and $14/metre for 12 core cable. We would probably put in two 12 core cables, so the fibre price would be $5,600, or $310/channel.

There are two ways of terminating the fibre cable and connecting it into the end equipment. For our quantities of connectors, the costs for either way are about $80/connector.

In total, fibre plus connectors is about $500/channel.

2) Analog transmission over fibre:

I have obtained prices for one analog video unit which has 3 by 75MHz bandwidth video channels, plus some additional data channels. (A copy of the datasheet is attached.) A transmitter and receiver pair (for 3 channels) costs

$8,800, or $3,000/channel. It may be possible to get the electronics repackaged without the data channels, for less cost. The input is probably baseband video. There would be <3dB slope across the channel. Signal/noise and linearity are not specified for this unit, but these are normally considerably worse than coax (40dB dynamic range is hard to achieve). The end-to-end phase tracking and stability between pairs of channels is unknown, but would be worse than coax cable, but probably still quite good.

3) Digital transmission over fibre.

A fibre optic company has found some transmitter/receiver units rated to 220Mbit/sec. The manufacturer would expect no problems to push them a little higher to our 256Mbit/sec. These transmitter-receiver pairs take ECL in directly, which would make them easy for us to interface to.
These units cost $2,000/channel, but may be cheaper in quantities of 20 or so. (This particular pair of transmitter and receiver requires the data to be present at all times. If Manchester encoding was required to satisfy this requirement, then the data rate would become 512Mbit/sec, and there would be some increase in the cost of suitable units.)

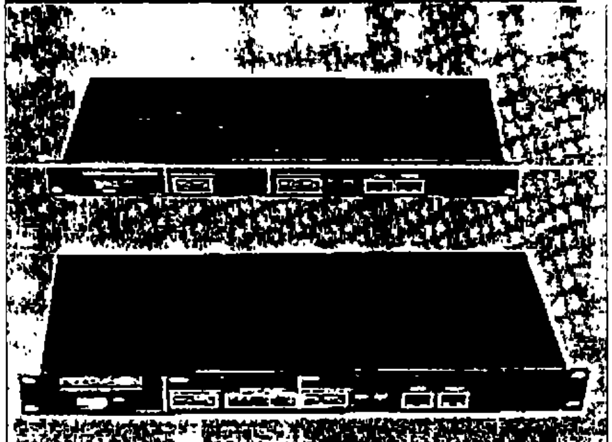
Attached is summary sheet showing the alternatives, and the factors which have to be considered for each of them.

Summary

Analog on Coax	Analog on Fibre	Digital on Fibre
50ohm input	Baseband Video in (?) 75ohm input	ECL Compatable
12dB loss	No loss (overall)	No loss
3dB slope across band (requires compensation?)	3dB slope across band (requires compensation and baseband converter?)	Flat response
Good S/N	Poor S/N	N/A
Good linearity	Poor linearity	N/A
Good dynamic range	Poor dynamic range	N/A
Cable very bulky and heavy	Cable relatively small and light	Cable relatively small and light
Cable not very flexible - cable wraps OK?	Cable flexible	Cable flexible
No end electronics	Relatively large electronics at each end- power, weight and reliability concern	Small electronics at each end- more reliable than analog on fibre
No chance of interference to front end	No chance of interference to front end	Possibility of interference to front end from 18 off samplers
Remote possibility of leakage from cable	No cable leakage	No cable leakage
	Requires possible baseband converter and maybe 50/75 ohm conversion.	May require Manchester encoding to keep data present at all times (for these units only?)
say $2,200/channel	say $3,500/channel plus baseband converters	say $2,500/channel

VIDEO

FIBERVISION FX/FR-5700



FOR HIGH RESOLUTION RGB CAD WORKSTATIONS

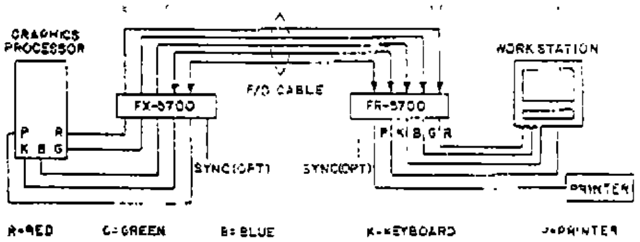
The FIBERVISION FX/FR-5700 consists of the FX-5700 graphics transmitter and FR-5700 workstation receiver. Both units are designed to transmit ultra-high resolution full color video signals from a graphics processor to a high resolution workstation, as well as bi-directional keyboard and serial printer data. The FX/FR-5700 will interface with most conventional computer graphics systems and will allow operation over distances of 1 to 3 kilometers. Both units are supplied in standard EIA 1 3/4" x 19" rack mounted enclosures and an optional desk-top workstation cabinet is available for the FR-5700 for further convenience. All connections from the FX/FR-5700 and the graphics system are by means of conventional BNC and DB-25 connectors.

Technical Specifications

NUMBER OF CHANNELS	6 (3 Video, 1 Sync. 2 RS-232)
VIDEO BANDWIDTH (R, G, or B)	75 MHz (+0, -3 dB)
VIDEO BANDWIDTH (Composite)	225 MHz (+0, -3 dB)
VIDEO INPUT/OUTPUT VOLTAGE	1 V pp
VIDEO INPUT/OUTPUT IMPEDANCE	75 ohms
VIDEO CONNECTORS	BNC
SYNC INPUT *	1 to 5 V pp
SYNC.OUTPUT *	TTL
MINIMUM SYNC PULSE WIDTH	500 nsec
KEYBOARD/PRINTER FORMAT	RS-232C, Serial
KEYBOARD/PRINTER DATA RATE	0 to 64 Kb/sec
ALLOWABLE TRANSMISSION LOSS	50u Fiber, 0 - 6 dB 62.5u Fiber, 0 - 9 dB 100u Fiber, 0 - 12 dB
OPERATING WAVELENGTH	850 nm
OPTICAL CONNECTORS	ST
POWER REQUIREMENTS	115/230 VAC, 50/60 Hz
PHYSICAL SIZE	1.75 x 7.75 x 19 in (4,4 x 19,7 x 48,3 cm)
OPERATING TEMPERATURE RANGE	-20 to +60 degrees C

* Sync signals may be sent separately or via the R, G or B channels.

Typical High Resolution CAD System Using FX/FR-5700



Features

- RGB Color Transmission
- Ultra-High Resolution
- Convenient Rack Mounting
- Bi-Directional Keyboard Port
- Bi-Directional Printer Port

Ordering Information

Graphics Transmitter	FX-5700-1
Workstation Receiver	FR-5700-1
Desk-top Workstation Cabinet	CAB-5700

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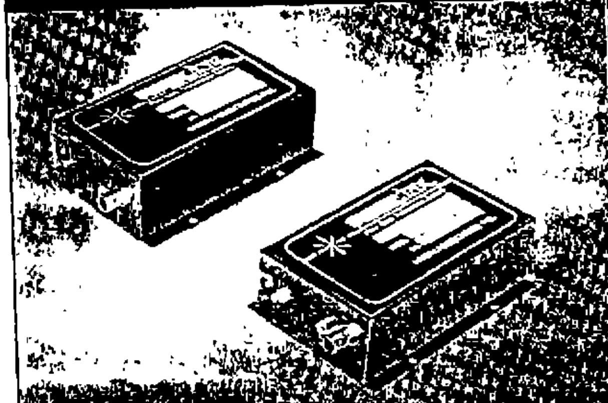
FIBERLINK XD/RD-7450

ECL



FOR VERY HIGH SPEED SIMPLEX TRANSMISSIONS

Features

- Data Rates To 220 Mb/sec
- Positive or Negative ECL
- Operates With 50 To 100u Fiber
- Adjustment Free

Ordering Information

220 Mb/sec Digital Transmitter XD-7450

220 Mb/sec Digital Receiver RD-7450

This system may be mounted in an MCR-1000S rack with an AP-2000 adaptor plate for each module to be mounted.

The XD/RD-7450 system consists of the XD-7450 transmitter and RD-7450 receiver. Both units are fully compatible with standard positive or negative ECL logic (user selectable) and will operate at data rates of 1 Mb/sec to 220 Mb/sec. Due to the high data rate of this system, the units are not DC coupled and must always have a data stream present for proper operation. The XD/RD-7450 is designed to operate from batteries or unregulated AC or DC sources thereby providing unparalleled versatility in a fiber optic transmission system.

Technical Specifications

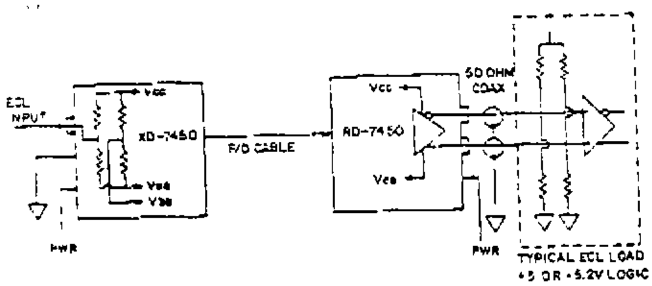
COMPLETE SYSTEM BANDWIDTH ***	1 Mb/sec to 220 Mb/sec
SYSTEM RISE OR FALL TIME	2.5 nsec typical
LOGIC INTERFACE	+5V ECL or -5.2V ECL
ALLOWABLE TRANSMISSION LOSS	50u Fiber, 0 - 12 dB 62.5u Fiber, 0 - 15 dB 100u Fiber, 0 - 18 dB
BIT ERROR RATE (worst case)	1×10^{-9} (@ 220 Mb/sec)
OPERATING WAVELENGTH	1300 nm
OPTICAL CONNECTORS	ST
SIGNAL CONNECTOR	Electrical SMA
POWER REQUIREMENTS * (Transmitter or Receiver)	+12 to +18 VDC @ 150 mA or 12 to 18 VAC rms @ 150 mA
PHYSICAL SIZE **	2.5 x 4.75 x 1.5 in (6.4 x 12.1 x 3.8 cm)
OPERATING TEMPERATURE RANGE	0 to +50 degrees C

* For operation from 115 VAC, 50/60 Hz, a PS-2500 plug-in adaptor is required for each module. For operation from 230 VAC, 50/60 Hz, a PS-2501 is required.

** The outline drawing of this system is OD22 in the OUTLINE DRAWINGS section of this catalog.

*** Due to the high data rate of this system, fiber optic cable bandwidth must be considered. Standard 500 MHz/KM fiber will only allow 3 to 4 KM of transmission distance.

Typical Interface For XD/RD-7450 Units



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Fax from Sydney Office	
Attn	**- Mr. Gerry McCulloch**
Company	**- CSIRO**
FAX	**- 02 3724490**
Phone	**- 02 3724467**
From	**- Scott Robertson**
Date	**- 16 September, 1993**
Subject	**- Quotation**
Your ref.	**-**
Our ref.	**- SR30916G.DOC**
No. pages (Incl. this page) -	~~1~~ 3

FIBERNET
ADVANCED OPTICAL FIBER TECHNOLOGY

Level 3 Unit 1 14 Aquatic Drive
Frenchs Forest N.S.W 2086
Australia
Phone 61 2 975 3737
Fax 61 2 975 3736

Dear Gerry,

I have received the following pricing information from Math Associates on your semi-custom ECL links. How did your meeting go? Do you still want to pursue an analogue solution?

Item	Description	Unit Cost	Qty.	Total Cost
1	Math Associates XD-7450/EN-3 ECL transmitter. 256Mbps - 1300nm ST.	$1,274.00	18	$22,932.00
2	Math Associates RD-7450/EN-3 ECL receiver. 256Mbps - 1300nm ST.	$1,318.00	18	$23,724.00
3	Math Associates AP-2000 rack mount adaptor for items 1 & 2.	$67.00	36	$2,412.00
4	Math Associates MCR-1000A rack mounting shelf with built in power supply.	$692.00	4	$2,768.00
	TOTAL			**$51,836.00**

Commercial Conditions

1. Prices quoted are in Australian dollars based on the following exchange rate of Aus $1.00 = U S $0.65
2. The Westpac selling rate for the appropriate currency on the date of invoice shall be used to calculate the actual price.
3. Prices quoted do not include sales tax or customs duty which will be charged at cost where applicable. Any sales tax exemptions must be supplied in the correct format at the time of order placement. We are unable to legally amend sales tax charges after invoice date
4. Terms of payment are strictly nett within 28 days of the date of invoice for Account Customers
5. This quotation is valid for 30 days from the date hereon.
6. Other applicable conditions are detailed in "Fibernet Pty. Ltd - Terms and Conditions of Sale - 1 January 1991".
7. Prices quoted are FIS.
8. Delivery lead time is 6 weeks from receipt of order
9. Credit card or pre-payment by cheque may be requested for small value orders
10. A minimum order value of $250 is requested in order to cover administrative overheads.

If you have any queries concerning this quotation please contact me.

Best regards,

Scott Robertson
Account Manager

ENCLOSURES

FIBERLINK
MCR-1000A

The MCR-1000A is a 19 inch wide by 5 1/4 inch high rack mounted enclosure which will accept any combination of ten FIBERLINK or FIBERVISION transmitters or receivers with a total load of 3.3 amperes. The unit contains a 115/230 VAC, 50/60 Hz power supply, detachable line cord, power switch, and fuse. Modules mount on plug-in adaptor plates available separately), or are supplied in "/MCR" housings, both of which simply slide into the rack. Electrical and optical signal connectors are provided on the rear of the enclosure and a removable front plate is provided for protection and overall appearance. An optional wall mounting bracket is

MULTI-CHANNEL RACK ENCLOSURE

Technical Specifications

NUMBER OF POSITIONS	10
POWER REQUIRED	115 or 230 VAC, 50/60 Hz 3.5 VA typical
MAXIMUM TOTAL LOAD CURRENT	3.3 A
FINISH	Clear Anodized Aluminum
PHYSICAL SIZE	19 x 5 1/4 x 10 in (48.3 x 13.3 x 25.4 cm)
OPERATING TEMPERATURE RANGE	-30 to +65 degrees C

Features

- Accommodates Up To Ten FIBERLINK or FIBERVISION Transmitters or Receivers
- 115/230 VAC, 50/60 Hz
- Standard 19 inch Rack Mounting
- Wall Mount Available

Adaptor Plates for MCR 1000A

The proper adaptor plates for the various FIBERLINK and FIBERVISION modules are listed below. One adaptor plate is required for each transmitter or receiver.

SYSTEM	PLATE NO.	SYSTEM	PLATE NO.
DB-1000A	AP-1100	XA/RA-1000A	AP-1000
DB-1001	AP-1100	XA/RA-1050	AP-1000
DB-1002	AP-1100	XA/RA-1100	AP-1000
FX/FR-1000A	AP-1000	XA/RA-1120	AP-1000
		XA/RA-1300A	AP-1000
FX/FR-1001V	AP-1000	XA/RA-1800A	AP-1200
FX/FR-1450	AP-1000	XA/RA-1805	AP-1150
FX/FR-1500A	AP-1000	XA/RA-1900	AP-1000
FX/FR-1501	AP-1000	XC/RC-8130	AP-2000
FX/FR-1560	AP-1000	XD/RD-7000	AP-2000
FX/FR-1600	AP-1000	XD/RD-7200	AP-2000
XD/RD-7220	AP-2000	XD/RD-7400	AP-2000
FMX/FMR-1300	AP-1150	XD/RD-7420	AP-2000
FMX/FMR-1330	AP-1150	XD/RD-7430	AP-2000
FMX/FMR-1360	AP-1150	XD/RD-7450	AP-2000
FMX/FMR-1390	AP-1150	XD/RD-7500	AP-7500
XR-1100A	AP-1100	OC-3800	AP-2000
XR-2000A	AP-1100	XRD-7300	AP-1150

Ordering Information

Multi-channel Rack Enclosure	MCR-1000A
Wall Mount Bracket	WB-1000

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