**Tables of Contents: Jack Welch’s ATA Development and Lab Notebooks**

**Book #1**

Page # Topic

3 Useful optical formulas

4 SSWG Meeting

6 Some LP options – disk flexure formulas

7 Gain loss due to axial focus error

8 Gain change with frequency depending on F

10 Board meeting 12/21/98

11 Transmission line impedances and losses, including cold losses

13 dipole losses – loss estimates along the antenna

16 Simulation field for the plain wire zig-zag – pattern plot

22 Preliminary noise summary for plane zig-zag

23 More on reflector deflection – including RMS calculation

27 input z for plane zig-zag

28 Feed options: summary

29 AASC radio panel

30 Meeting with industry experts – ridged guide feed, for 5-6 dB gain

31 Two wire line losses revisited – accurate formulas

33 May 5, 1999 meeting of 1hT Board

34 Greg’s simulation with internal pyramid

35 new noise budget / first try at input circuit

36 pattern of feed : 5**°** sampling

38 focal ratios – pattern transform to aperture – illumination efficiency

41 defocus factor vs. F for phase center at 0.8λ plot

42 first new pattern plot

44 RFI measurements at Hat Creek

46 Possible double conversion baseband converter

47 1hT Board 7/28/99

48 Phase, frequency, and delay control for 1hT

52 Beam forming

55 more details on the baseband conversion and beam forming

58 forming a broadband null

60 1hT meeting

61 Primary pattern of one 5m dish

64 Zig-zag color image

65 First tip connector board

66 Apex circuit simulation

69 12//8/99 meeting with Sandy Weinreb and John Lugten: cooling options, Sandy’s amp

70 Gain loss vs. F and focus offset s/λ

72 Feed pattern with pyramid, 2**°** sampling

75 Angle vs. F – screen area for prime focus

76 Illumination efficiency by numerical integration of pattern

77 Check John Lugten’s phase center

78 Estimate of best choice of α

79-81 Plots of gain loss, spillover, ηeff vs. F

83 First estimate of overall efficiency vs. F 1/2/2000

85 Cassegrain options

90 Pattern of symmetric Cassegrain Dp = 5m Ds=1.5m λ=20cm

92 Circular diffraction papers

93 Diffraction corrections added to efficiency (Kildal)

94 Gain estimate from pattern

95 Overall efficiency vs F with diffraction – Tsys also

96 1hT Board meeting 2/14/00

98 Antenna diameter optimization wrt cost

99 Front end meeting 4/13/00

100 Effect of array size on RFI filtering and plot

104 1hT Boaard 5/12/00

106 Possibility of forming nulls on satellites

110 Tests of passive wideband balun

115 Tests of prototype Zig-zag feed

116 Gain calibration of 6 GHz coax/waveguide transitions

117 First rough gain measurement

118 Input copper losses revisited

121 Feed tip board figure

122 Dimensionand scaling for feed

123 Effect of phase center motion on spillover

124 Updated overall efficiency summary

126 Evaluation of X-band horns: match and gain

129 Antenna tests with circuit board on pg. 65

130 Modifications of circuit board – wire inductance formula

132 New gain summary

133 Greg’s new design with fins

135 Antenna input z, with and w/o gates

138 Transmission between 2 spiral antennas

139 Transmission between spiral and LP feed

140 8 GHz cross polarization

141 Comparison between symmetric Cassegrain and offset Gregorian

146 More details about the input circuit at the tip

**Book #2**

Page # Topic

1-3 Matt’s PDR Dec 1, 2000

4 Revision of offset Gregorian gain table

4-7 Spillover Calculations: Cassegrain, Gregorian, prime focus; skirt on 7

8 Ground screen

10 Spillover plot: Cassegrain, Gregorian, prime focus

11 Pattern comparisons

13 Shroud picture

14 Crude shroud/feed interaction

16 Careful shroud/feed interaction

19 Direct feed tip reflection

20 Direct backlobe reflection

21 Insulation properties of spherical foam ball

22 Jan 15, 2001 ATA Board

22 Heat conduction along pyramid

24 Skin depth for copper; successive thinning of pyramid walls

25 Thermal conductivity of copper – conductivity in sking

27 Run of temperature in foam

29 Inductance of straight wire in space

30 Matt’s design for antenna 3/6/01

31 Size of beam waists

32 Input connection schemes

34 Up/down converter meeting

35 Possible passive balun for the imbalanced LNA amps

36 LNA temp vs physical temperature

37 More on cooling Rev R of tip circuit

40 More measurements on passive balun ~ phase 7/23/01

41 Sensistivity of balun to nearby grounds

42 Tests of KRYTAR 3 dB coupler

42 Potential phase switch for 1st LO

46 Tests of double balun S11 and S22

49 Effect of phase sensitivity the first LO

52 MOU Board Sept. 17, 2001

53 Effect of metal bar on top of double balun

56 Feed tests at JPL

57 High Te superconductor

58 Tip circuit board design

60 Interior of feed design

61 11/12/01 Sandy’s JPL array, plans: first active balun design

62 Gain, stability of LNA; transmission line formulas

64 One dimensional heat flow for K(T) – Cu and Stainless Steel

68 First noise calculator for upper sections

70 Low temperature thermal conductivities

72 Equiangular spiral for input calibration

82 ATA-TAP meeting 2/8/02 – Rogers Dielectrics

83 Input match for spiral antenna

85 Pictures of prototype feed

90 Feed patterns

92 Noise summary @ 10 GHz

93 Feed patterns

96 Noise diodes

97 Equalizers for NITRO amps

104 AT what frequency will self-cal work?

105 Layout of calibration module

106 Design input region of the feed pyramid

111 Input line impedances and losses

115 RFI levels from the BIMA correlator

117 Thermal loads in the dewar

124 Review meeting

126 More on the calibration system

129 Jan 3, 2003 MOU meeting

129 Shielded room specs from Rick Fischer and Tom Landecker

130 Meeting with Sandy and Niklas 1/29/03 good active balun

134 Coupling between cal spiral and small spiral antenna

135 Thermal loads on heat shield

137 Test of 100-50 Ω matching box

138 Required gain stability for OTF (first try)

140 Thermal calculation for dewar interior

142 ATA sensitivity relative to Arecibo

143 Properties of crystalline quartz: thermal and electrical

144 Tests of double balun with various covers

151 Expected operation at 327 MHz

152 Thermal stability for OTF mapping

**Book #3**

Page # Topic

3-6 Cable losses for test feed

3-8 Cryogenic stainless cable: catalogue and properties

9 Effect of air flow hoes in pyramid

10 PAM Gain Stability measurements

12-21 Tests on new feed: S21 to simple antennas; S11 w and w/o gates

22 Niklas new LNA – expected Tsys

23 Possible feed gain @ 327 MHz, antenna gain also

24 radome cover “Sunbrella”

25 Optical pointing – computer control

26 Feed input transmission lines – loops; 2 wires next to wall

27 Slip connections for dewar

28-31 back-to-back Schottky’s for input protection

32 Plot of input LP filter

33 RF input from transponders and ham radios

34-35 input circuit with Schottky’s

36-37 Tsys measurements in cylinder; input from horizon

38-39 beam sampling for holography

40-41 TA from moon observations

42 review of input losses

43 tests on sliding needles at Matt’s

44 Copper, Gold, and Silver resistivity vs. temperature

45 Fitting gain pattern with Gaussian @ FWHM

46-48 ηB and ηap and expected Tsys

49 possible LO cross talk

50 Possible ATA close spacings

51 What size for the silo at Matt’s?

52-53 Single dish and Array overlap

54-55 200 MHz filter with 50 MHz BW for RPA

56-57 Tsys of feed in cylinder at Hat Creek

58 Footprint of RFP filter

59 HCRO air temp for Jan ‘03

60 HCRO air temp for July ‘04

61-63 temperature waves into soil w daily and annual periods

64 Tnoise with Tdewar = 50K

65 expected tracking errors

65-70 heat flow calculation for PVC in the ground

71-74 radial heat flow from pipes

75 alidade heat levels

76 pipe lengths to stations

77 dewar fixture to hold balanced LNAs

78-79 fixture mechanical resonances

80-83 observations for NSF proposal; 3 choices for 4-element arrays

84 equivalences for FX and XF correlators

85 skin depths; losses in WR90 waveguide

86 First M31 map for NSF proposal

87 heat flow with Hankel functions: radial temperature profile

88-89 Gain and Amplitude calibrations with interferometry

90-91 blank

92 a) losses in plastics b) X-band waveguide losses

93 RFCB filter; ATA oscillator settings

94 a possible waveguide LP filter

95-96 phase switching of second LO with Walsh functions

97 phase and delay tracking

98 3rd LO down mixer

99 atmospheric refraction

100 Switching with 8 Walsh Functiions

101-102 waveguide low pass filter

103-104 X-band horn gain vs. frequency

106-108 Earth’s atmosphere effect on refraction and νoff

109-110 cooling the bunker building with underground pipes

111 plastic losses – replace the delrin standoffs

112-113 Gains of standard horns

114 New reflection measurements with passive feed

115 New receiver temps with better tip circuit board

116-117 echoes from the tip circuit board and components in the dewar

118 extending feed to 25 GHz

119 dewar figures including colling model

120-122 radiative and conductive heat loads in dewar

123 matching thin plate glass

124 test for cooled feed

125 daily average temps at HCRO

126 attempt at solution with K(T)

127-131 positions of stations error effect on satellite radial velocity

128 plots of C and k vs. water content of soil

129 stations at Hat Creek

130 ATA properties

132-133 Tsys tests for final feed

134-135 Use moon observations for Tsys

136-137 LO #1 and #2 power levels

140 Hat Creek computing and control

142 air flow into rim box

143 Feed gain vs. frequency

144 Effects of feed variation on the gain

145 Temperature stability for TF

146 Temperature stability measurements on the PAX

147 gain and NF for FRCB

148 Tsys measurements on antenna 2K

**Book #4**

Page # Topic

3 Tsys for Ant 2K from Moon; PAM antenuators varied

4 LO2 leaks out of RFCB output; RFCB noise figure measured

5 RFCB noise figure and linearity tests

blank LO2 spectrum showing power supply noise; PAM diagram

6 PAM noise temperature

7 Linearity tests I/O on 2K and 2L

8 Candidate anti-aliasing filter: 800 MHz; 0.1 dB ripple

9 0.15 dB ripple filter: 800 MHz

10 Schedule to finish ATA-42

11 Observing the moon for Tsys cal

12-14 antenna construction costs

15-16 anti-aliasing filter for 1400 MHz

17 moving IF2 --> 600 MHz@ 200 MH BW; stability of FR4 board

18 losses in FR4 board

19 Temperature fluctuations in the correlator room

20 Attenuation characteristics for Chebycheff filters : 0.01 dB ripple

21 Group delay “ “ “ “: 0.01 dB ripple

22 Attenuation curves “ “ “ “: 0.1 dB ripple

23 Delay curves “ “ “: 0.1 dB ripple

24 Attenuation curves “ “ “ “: 0.5 dB ripple

25 Delay curves “ “ “: 0.5 dB ripple

26 Various filter options

27 Chip inductors from Coil Craft

28 600 MHz bandpass filter

29 LO2 sidebands from DC/DC converters; Liebert cooling capacity

30 Down sampling algebra

31 Down sampling spectra

32 Filter rejection and phase stability

33 Time-Frequency table for the back-end

34 Oren’s thoughts on digital back-end; PAM/PAX limit upper-frequency

35 RFCB finishing; node 4 antennas

36 Spectrum of ATA interference

37-38 final anti-aliasing filter

39 Rack space for RFCBs

40-42 Computer control commands

43 Moon observations for FX4B

44 Layout of beamformer room

45 Cable lengths

46 Semflex high performance cable

47 Correlator room issues; Jill’s PAM settings

48 RFCB rack layout

49 Node cooling problems

50-51 Cable power settings for LO cable losses

52 Receivers needing replacement

53-55 Distance to orbiting spacecraft

56-60 Radio source positions and fluxes

61 Rick’s command files

62 Problem with PAM bias circuits

63-65 The effects of being out of focus on both beam width and gain

66 Improved LNA bias current

66-69 New hot/cold loads for Minex

70 More out of focus conditions from page 65

71 Issues for completion 10/29/07

72 from page 69 more on hot/cold loads

73 Hat Creek FCB tests 11/11/07 of phase switching

74 Antenna S/N on W3OH (HI)

75 Notch filter for attemplifier

75-78 graphs gain and filter control unit

79-80 Review of the antenna air cooling 3/17/08

81 Current tasks 3/23/08

82 More on underground cooling

83 Grant proposals for ATA and CARMA

84 ATA confusion limits 4/20/08

85 Radome shading of antennas

85 More airflow measurements

86 New ideas on feed tip circuit board 5/15/08

87-88 More on new feed tip design

89 Standard semi-rigid cable table

90-91 Node temperature measurements

91-92 Thermal resistance calculations

94-101 Underground cooling of 5G

102 Discussion of effects of watering for 5G

104 Further expenses to completion

104-108 System linearity tests

109 Back-end power loads for a built-out ; 3-phase power

110 Total expected loads

111-113 Proposed processor building

114 Temperature measurements in the processor room

115-117 Correcting LO delays in the RFCB rack

118-120 Sensitivities for spectral line observing 12/17/08

121-124 Prospects for high-Z observing

125-126 Prospects for feed pattern measurements

127-129 The TANC power line proposal

130 Receiver noise temperature summaries

132 Antenna pattern, an axial average

133-135 System Gain stability measurements

136-141 Feed input circuit calculations

142 Possibility of cooling the entire feed

142 First look at reflection from flat rexolite plate instead of current standoffs

143 Tsys for observations toward the moon

144 Estimate of cross talk between ATA antennas

145 Effect of spherical glass bulb around feed tip

145-147 Effect of adding thin plastic layer to the glass bulb

150-151 Reflection from rexolite flat plate

**Book #5**

Page # Topic

2 Noise tests showing 9020A (Agilent) Spectrum Analyzer compared to E4408B

4-6 Noise tests with and without first tow cylindrical standoffs, showing improvement

7 Table of total emissivity of various materials

8-11 Noise tests with and without cylindrical standoffs I and II and with flat rexolite standoffs; results with flat standoffs the same as without any

12-19 **Memo** “Signal Transmission Through the LP Fee Glass Dewar”

20-21 Transmission along ray paths for different angles and frequencies

22 Experiments with layers of polyethelene instead of Teflon

23 Gary’s Hat Creek power measurements; transmission through 2 mm glass sphere

24-26 Effect of pointing errors on dynamic range of SKA map

27-30 Input filter for the new wideband feed: model and graphs

31 ATA feed repaired and with no short standoffs and the input low pass filter except for the input impedance

33 Transmission through repaired feed SB-044-B(2) with smallest cylindrical standoffs removed, the input LP filter in place except for L1

34 Repaired ATA feed, thin standoffs in place, cylindrical standoffs in place

35 Transmission through 1.5 mm glass sphere with and w/o plastic shell

36 Thermal transmission of fiberglass standoffs holding the new feed

36-39 Y-pole return loss on new feed for various offsets of the feed wrt the base plate. The best choise is offset of 0.134” wrt 1.0”

40 Match to connector on Rogers 3003 board

41 Comparison of transmission loss to feed wi and w/o the glass bolttle plus polylayer

42-43 New feed: return loss measured and corrected; return loss w and w/o input filter

44-47 Transmission through several different absorbers

48-53 Feed patterns take at SRI

54 Ray tracing for new LN load

55-58 **Memo** “Cooling the ATA PLP feed in its vacuum dewar”

59 Expected lowering of Tsys from cooling the feed

61 Using the new Agilent EXA N9010A for noise figure measurements

62-66 Using the Hitite amplifiers for post-amplification

67 Y-factor measurement of Hitite amplifiers w. spectrum analyzer

68-69 Y-factor measurement with an unstable LNA, intriguing results

70 Diagram of the LNA output connector with glass (hermetic) seal

71-72 Over simplified model of the effects of the glass

74 EVLA memos fot TSYS

75 Noise figure spectra show the 0.9 GHz dropouts

78-80 Show more noise figure spectra with 0.9 GHz dropouts

81-82 “” (discussion of cause for dropouts on pp 126-131)

89 Shows first good noise figure plot for new feed

90 New and old comparisons

91-92 VLA system temperatures

95-98 long baseline study

99 defocus calculation for gain

100-102 transmission through new EMI absorber

103 model temperature (noise) curve for new feed

104 transmission through anti-aliasing filter

105 good Y-factor curve of new feed compared to current ATA

108 possible noise cal scheme for new LNAs; not done

109 coaxial Zo for connectors

110-111 measuring cable losses as a function of frequency

112 reflection from Maury Cold Load

113-114 possible cold load; not used

115 conversation with Doug Dillon at Photonics Inc. re: their new system

116 RFCB diagram with levels

117 PSI-2600 Photonic link

118 ATA dynamic range levels currently

119 dynamic range for the PSI-2600

120 PSI speed

121 comparison of sensitivities of 4 photonic systems

122-125 correction layer for new plastic bottles (approximate)

126-131 dropout problem fixed

132 Calvin’s PAM

136 Noise temps for three LNAs vs. physical temperature

137 cryocooler, vacuum pump, thin layer to reduce plastic bottle diffusion

138 Fraunhofer mimic

139 Fraunhofer mimic S11 and S12

140 Chalmers mimic

141 Chalmers S11 and S12 plots vs. frequency

142 Fraunhofer Y-factor vs. frequency measurements

143 Chalmers Y-factor vs. frequency measurements

144 mimic block pictures

145 expected noise figures for Chalmers and Fraunhofer mimics

146 measured cool down temps and cooling power vs time

147 same plot for plain plastic bottle

148 power transmission through matching circuit with looped, not straight wires

149 Same but with first loop correct length and second loop length doubled

150 transmission through 6” bottle with .07” thickness vs. frequency

151 same but with pyrex bottle with dielectric constant = 5.1 and .06” thickness

152 Transmission through 6” bottle with .04” thickness and dielectric constant = 5.1 vs. frequency