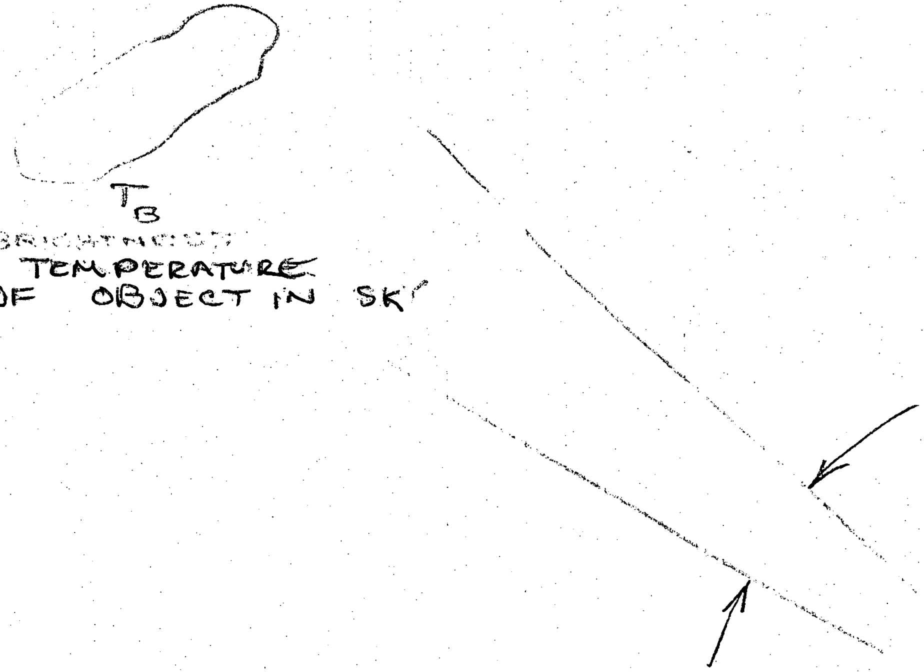
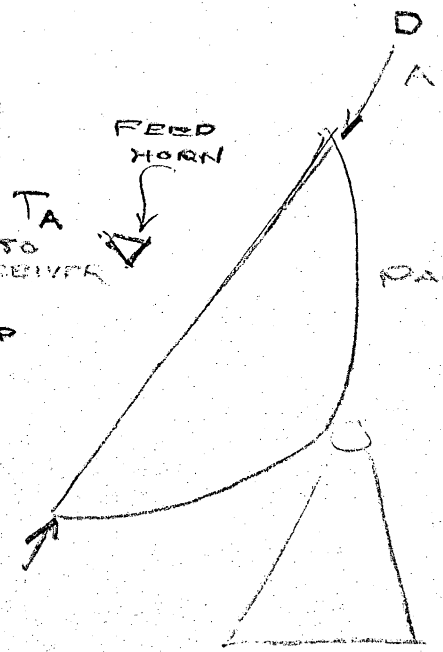
LECTURE NOTES
S. WEINREB
JUNE 17, 1975





ANTENNA NOISE TEMPERATURE; ANTENNA GAIN FUNCTION; SKY BRIGHTNESS TEMP

$$T_A = \frac{1}{4\pi} \int_{4\pi} G(\theta,\varphi)\, T_B(\theta,\varphi)\, d\Omega$$

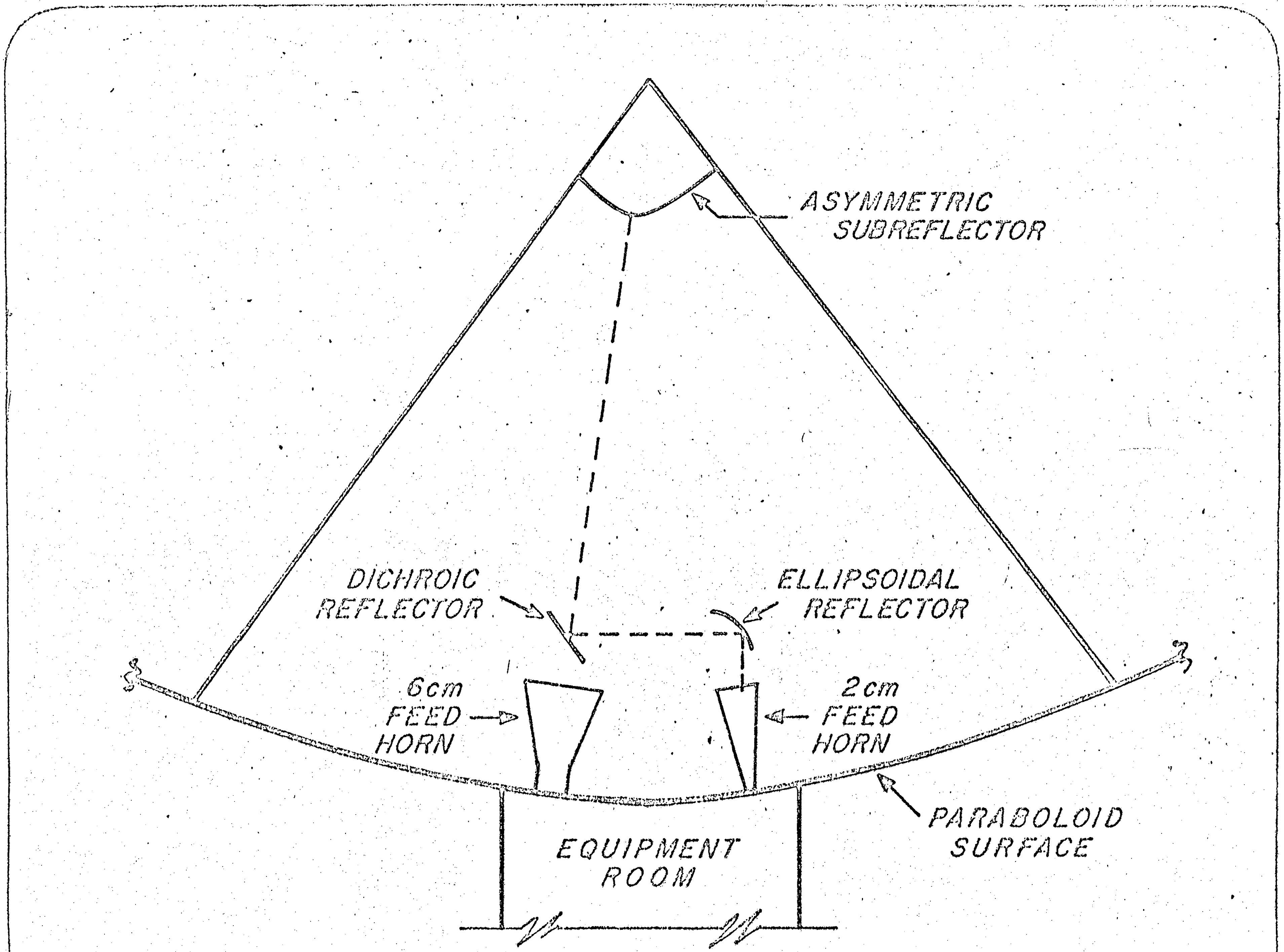
$$G(0,0) = \frac{4\pi A}{\lambda^2}$$

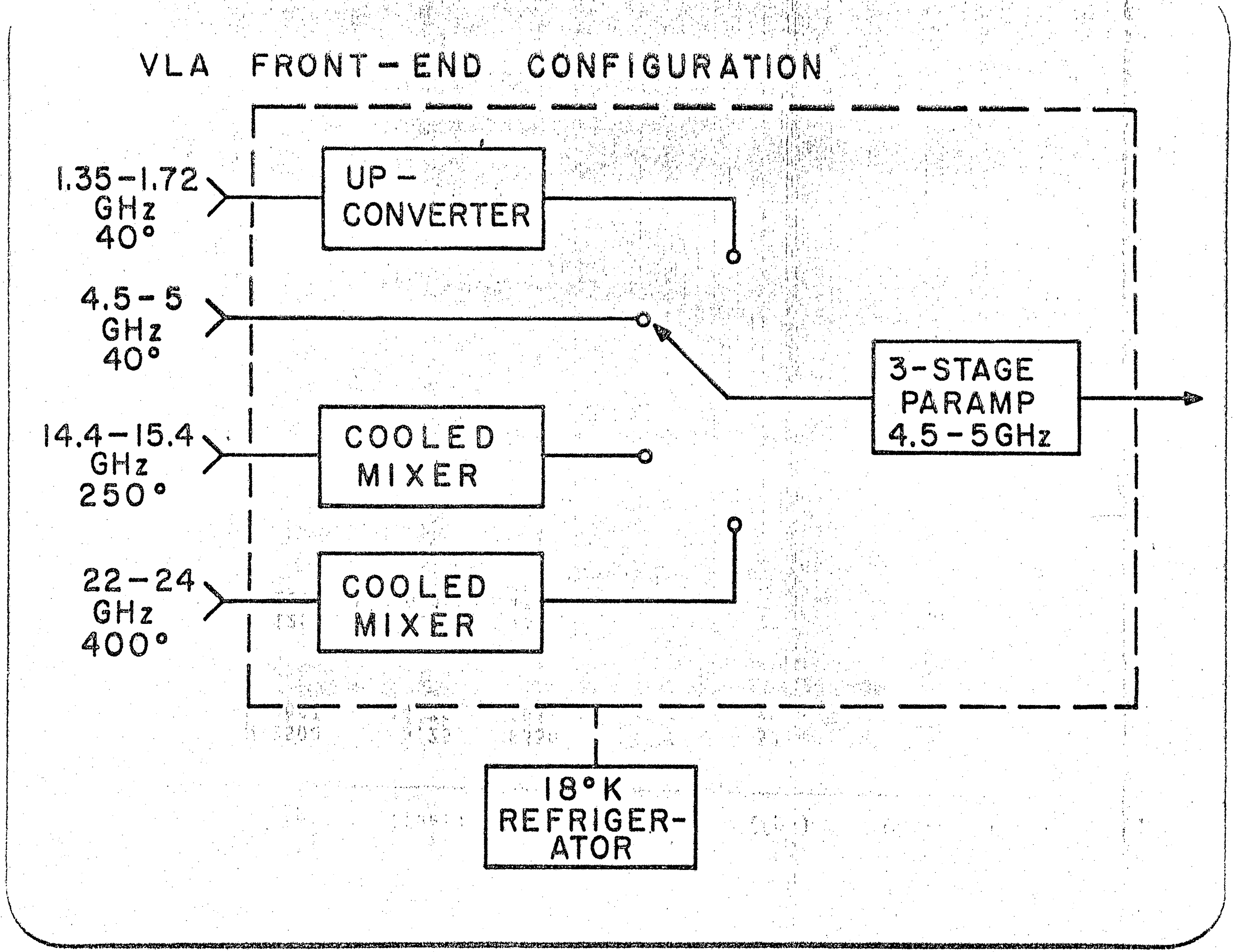
$$\frac{1}{4\pi} \int G(\theta,\varphi)\, d\Omega = 1$$

BASIC RADIO TELESCOPE

S. Weinreb

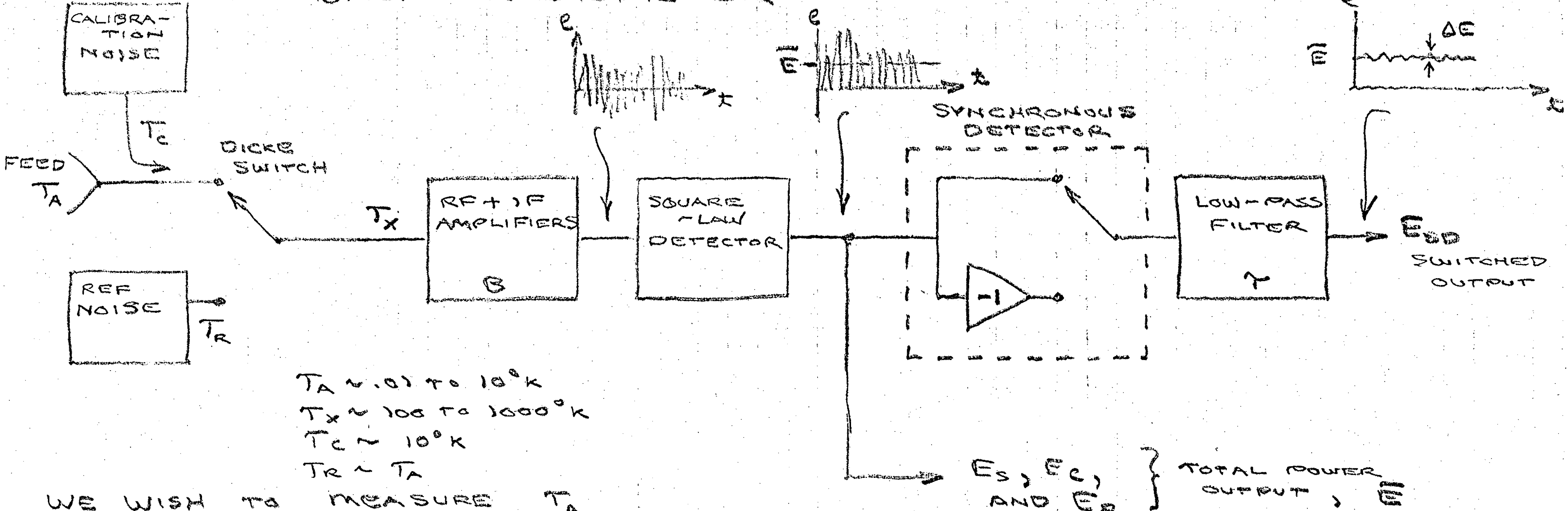
VLA FEED CONFIGURATION





NATIONAL SCIENCE FOUNDATION

BASIC RADIOMETER



WE WISH TO MEASURE T_A

BASIC INPUT-OUTPUT RELATION ⟶ (AVERAGE DETECTOR OUTPUT VOLTAGE, $\bar{E}$) = ($k \; B \; G'$) × (TOTAL INPUT NOISE TEMPERATURE), where $k B G' \equiv G$

- k = 1.38×10^{-23}
- B = NOISE BANDWIDTH
- G' = TOTAL POWER GAIN

SWITCH UP, CAL OFF ⟶ $\bar{E}_S = G(T_x + T_A)$ SIGNAL VOLTAGE

SWITCH UP CAL ON ⟶ $\bar{E}_C = G(T_x + T_A + T_c)$ CALIBRATION VOLTAGE

SWITCH DOWN CAL OFF OR ON ⟶ $\bar{E}_R = G(T_x + T_R)$ REFERENCE VOLTAGE

3 EQUATIONS, 3 UNKNOWNS (T_A, G, T_x)

LECTURE NOTES
S. WEINREB
JUNE 20, 1974

SENSITIVITY LIMITATIONS

(1)

$$\frac{RMS}{MEAN} = \frac{\Delta E}{\bar{E}} = \frac{\Delta T_A}{T_x + T_A} = \frac{1}{\sqrt{B\tau}}$$

LIMIT DUE TO STATISTICAL FLUCTUATIONS OF NOISE

B — NOISE BANDWIDTH; τ — INTEGRATION TIME

(2)

$$\frac{\Delta G}{G} \sim 1\%$$

LIMIT DUE TO RECEIVER GAIN STABILITY

MODIFICATIONS TO BASIC RECEIVER

(1) DICKE SWITCHING - SYNCHRONOUS DETECTION

$$\bar{E}_{SD} = E_S - E_R = G(T_A - T_R)$$

(2) COMPUTER SYNCHRONOUS DETECTION

$$T_A = \frac{\bar{E}_S - \bar{E}_R}{\bar{E}_C - \bar{E}_S} \cdot T_C + T_R$$

(3) MULTICHANNEL LINE RECEIVER

— COMB FILTERS AND MULTIPLE DETECTORS

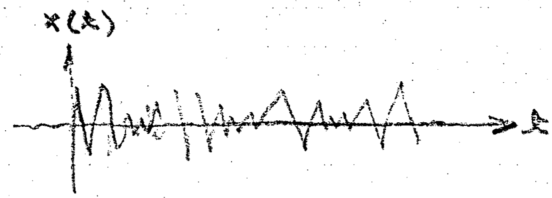
AUTOCORRELATION RECEIVERS

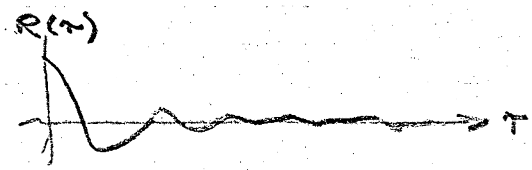
$$T(f) = \int_{-\infty}^{\infty} R(\tau)\cos 2\pi f\tau \, d\tau$$

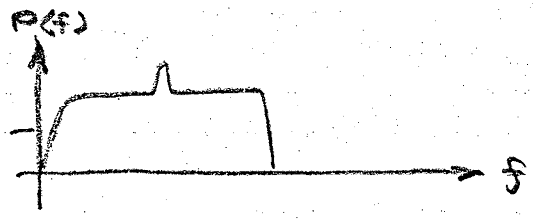
TEMPERATURE SPECTRUM $T(f)$ AS FOURIER TRANSFORM OF AUTOCORRELATION FCN, $R(\tau)$

$$R(\tau) = \lim_{T\to\infty} \frac{1}{2T}\int_{-T}^{T} x(t)\,x(t+\tau)\,dt$$

DEFINITION OF $R(\tau)$ IN TERMS OF SIGNAL TIME FUNCTION, $x(t)$.







MODIFICATIONS TO THEORY

MODIFICATION	EFFECT
τ CANNOT $\to \infty$	FREQUENCY RESOLUTION $B \sim \frac{1}{\tau_{MAX}}$
T CANNOT $\to \infty$	STATISTICAL FLUCTUATION $\frac{\Delta T}{T} = \frac{1}{\sqrt{BT}} \sim \sqrt{\frac{\tau_{MAX}}{T}}$
$R(\tau)$ IS SAMPLED IN STEPS OF $\Delta\tau$	$f_{MAX} = \frac{1}{2\Delta\tau}$
$x(t)$ IS SAMPLED IN STEPS OF Δt	NO EFFECT IF $f_{MAX} = \frac{1}{2\Delta t}$
$x(t)$ IS QUANTIZED IN N BITS	$\frac{\Delta T}{T}$ SLIGHTLY INCREASED