[redacted]

GENERAL STUDY OF CAMERA SYSTEMS FOR PHOTOGRAPHIC AERIAL RECONNAISSANCE

PURPOSE

INVESTIGATE TRADE-OFFS AMONG THE MANY PARAMETERS.
OPTIMIZE THE PHOTOGRAPHIC OUTPUT
DETERMINE THE REQUIRED CONDITIONS TO ATTAIN A SPECIFIED PERFORMANCE LEVEL.

PARAMETERS & CONDITIONS

CONTROLLED BY NATURAL LAWS

- SOLAR RADIATION
- ATMOSPHERIC TRANSMISSION & SCATTERING
- SCENE REFLECTANCE & CONTRAST
- DIFFRACTION OF LIGHT

SPECIFIED

- ALTITUDE
- GROUND RESOLUTION

} ANGULAR RESOLUTION

- COVERAGE & MISSION LIFE
- VELOCITY
- WEIGHT LIMIT

VARIABLES [LIMITED BY STATE-OF-THE-ART]

SPECTRAL REGION

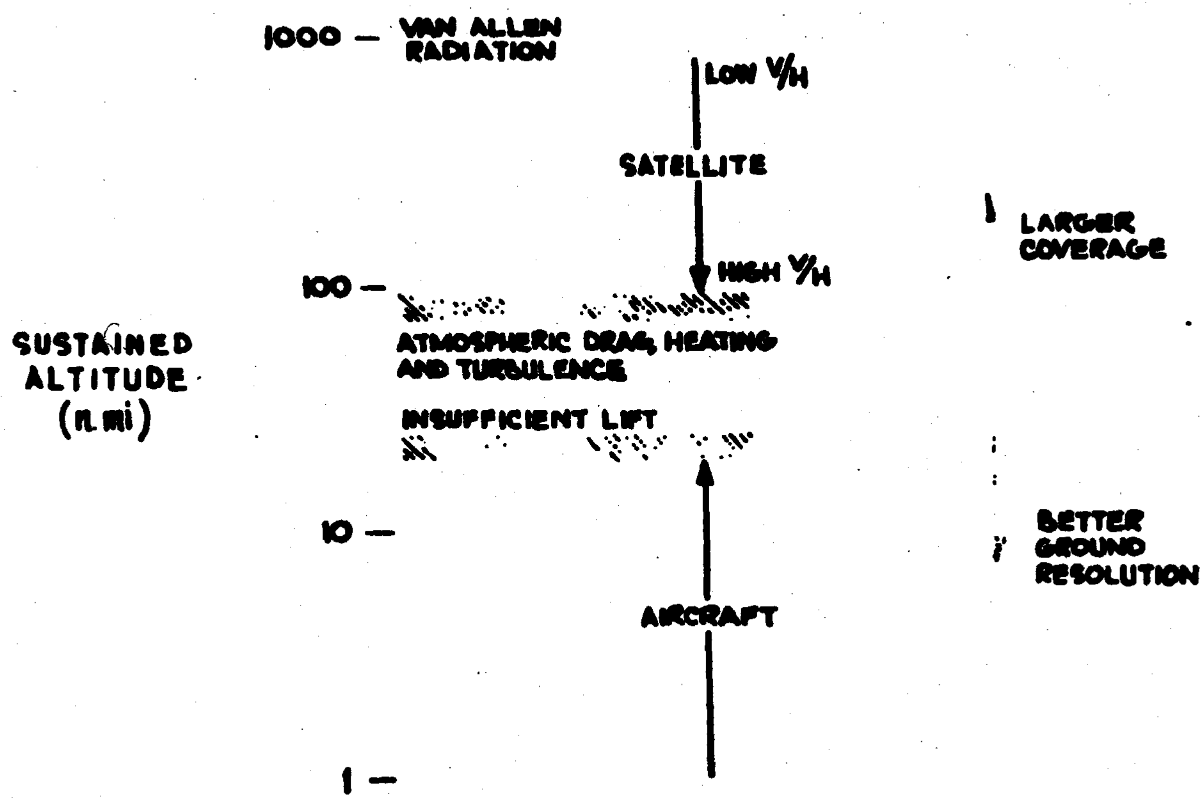
IMAGE SMEAR
- CAMERA SYSTEM
- VEHICLE ANGULAR MOTION & POSITION

LENS
- DIAMETER
- FIELD
- f/NO. AND FOCAL LENGTH
- IMAGE QUALITY

FILM
- SENSITIVITY
- IMAGE QUALITY

CAMERA TYPE

ALTITUDE

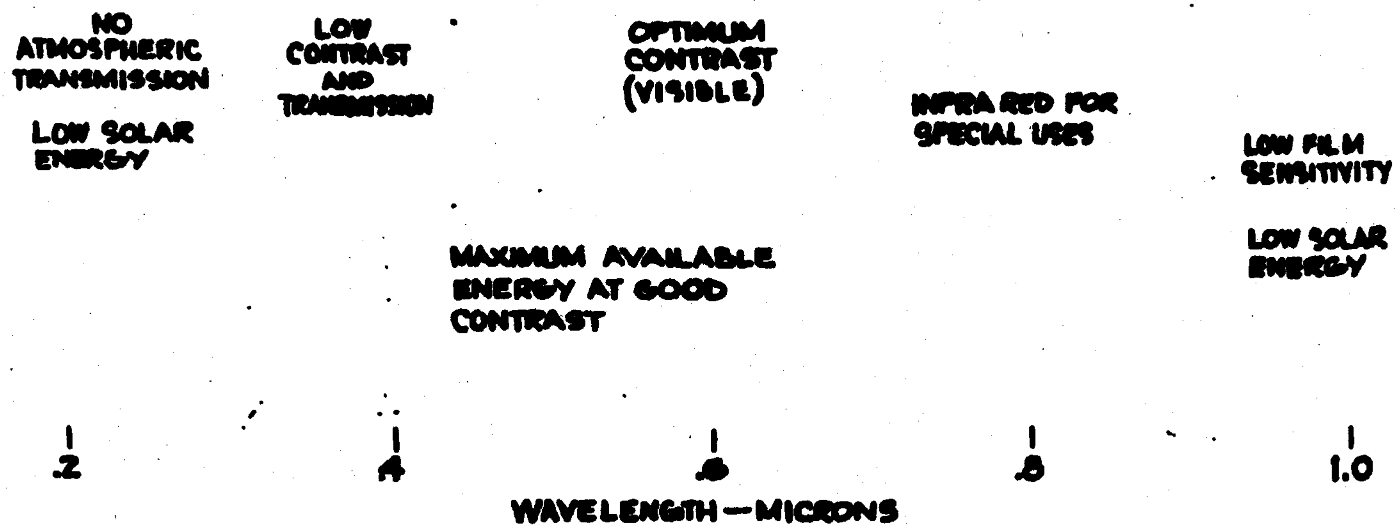


SUSTAINED ALTITUDE (n mi)
1000
100
10
1
VAN ALLEN RADIATION
LOW V/H
SATELLITE
HIGH V/H
ATMOSPHERIC DRAG, HEATING AND TURBULENCE
INSUFFICIENT LIFT
AIRCRAFT
LARGER COVERAGE
BETTER GROUND RESOLUTION

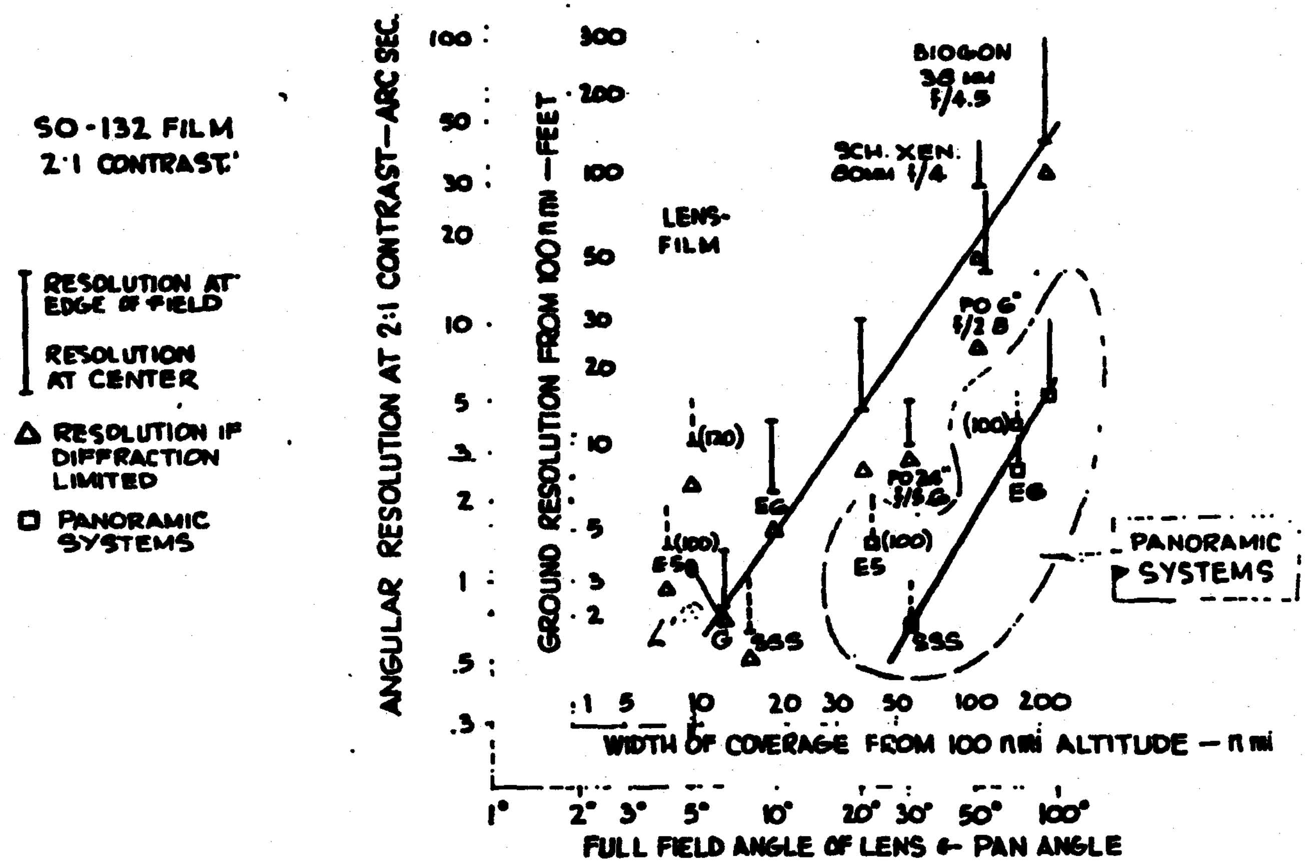
OPTIMUM SPECTRAL REGION FOR AERIAL PHOTOGRAPHY

CHOICE BASED ON

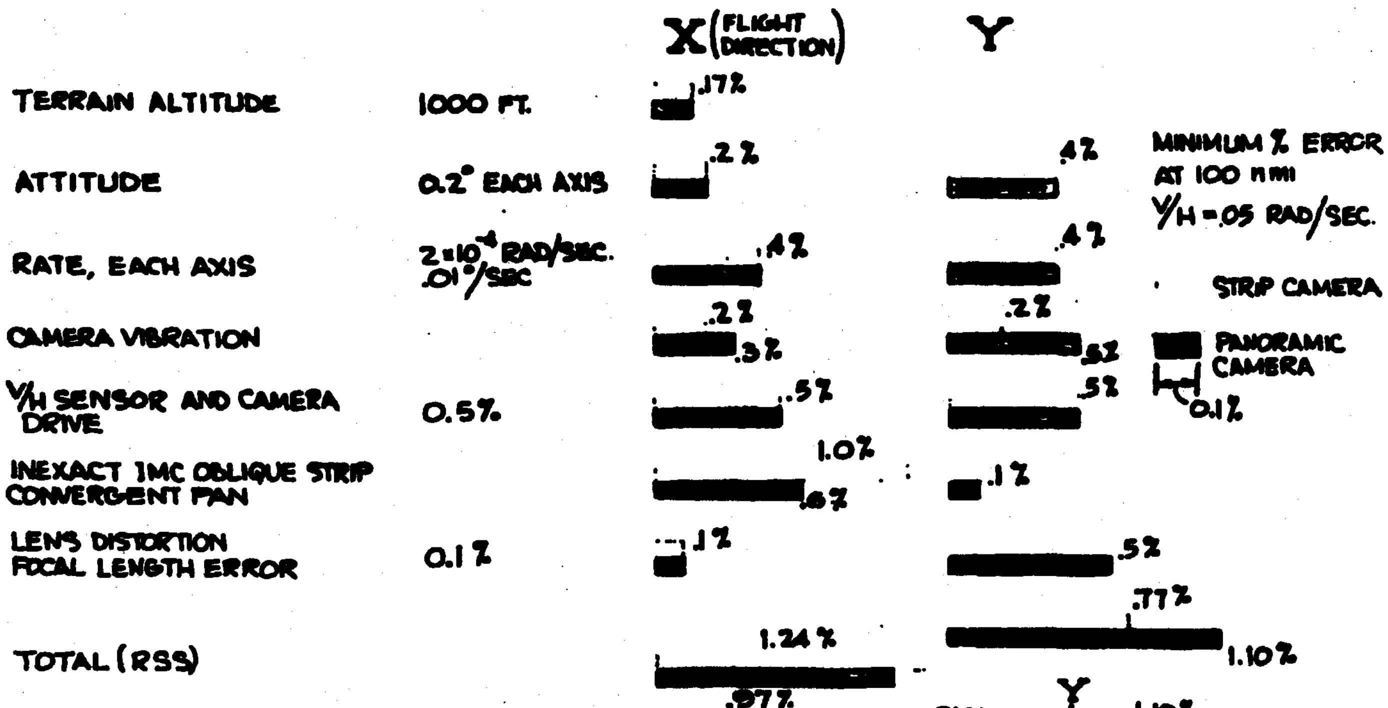
- SOLAR IRRADIANCE
- ATMOSPHERIC TRANSMISSION
- SCENE REFLECTANCE
- SCENE CONTRAST
- DIFFRACTION
- LENS TRANSMITTANCE AND COLOR CORRECTION
- FILM SPECTRAL SENSITIVITY



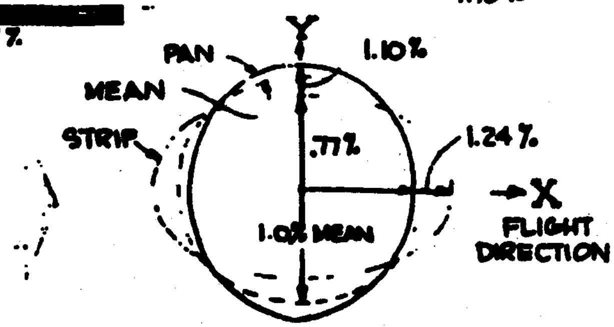
RESOLUTION vs. FIELD ANGLE



IDEAL CORRECTION OF IMAGE SMEAR

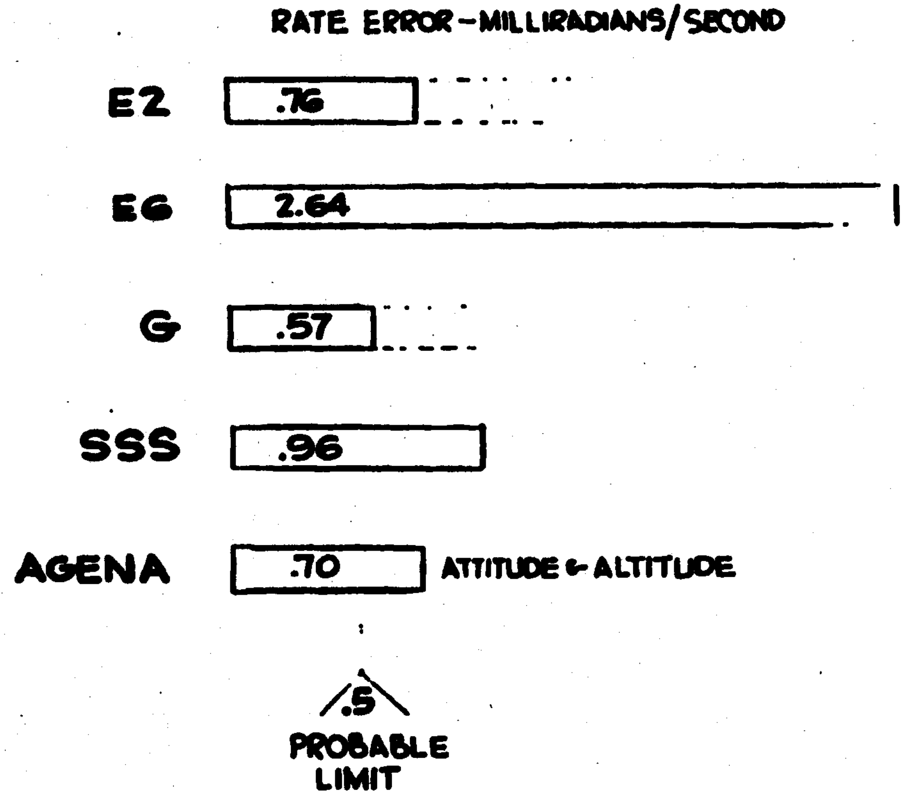


MEAN SMEAR
FOR THIS IDEAL CASE
1% OF V/H = ½ mr/sec.



EXAMPLES OF

RESIDUAL SMEAR RATE



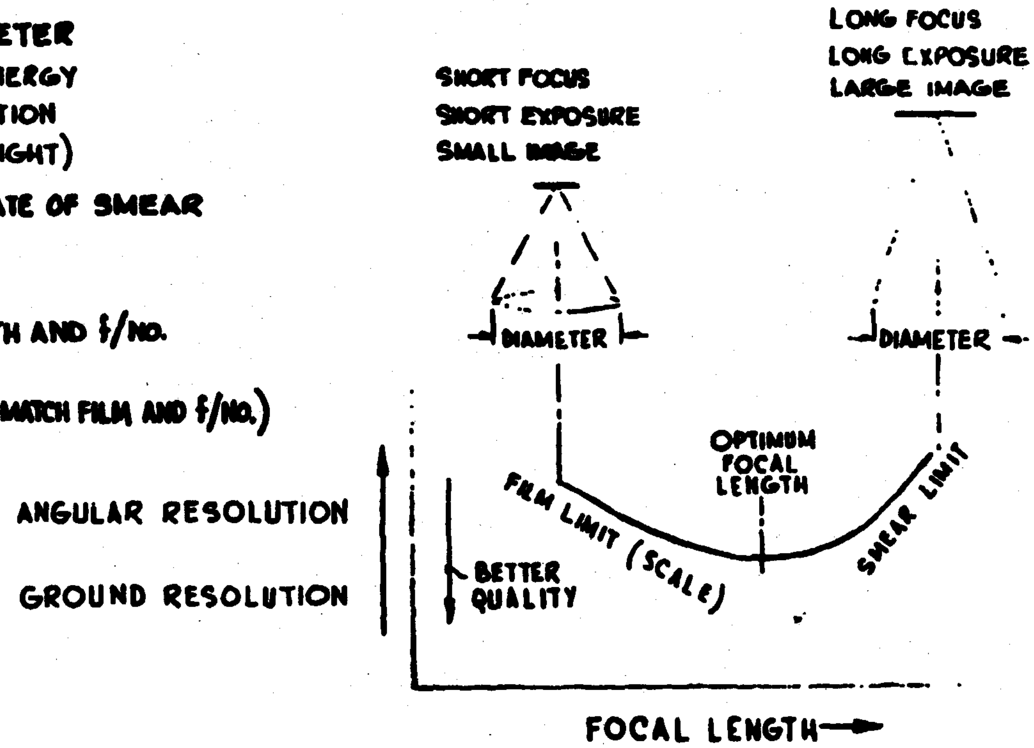
ANGULAR AND GROUND RESOLUTION
FOR FIXED INPUT TO CAMERA LENS

FIX

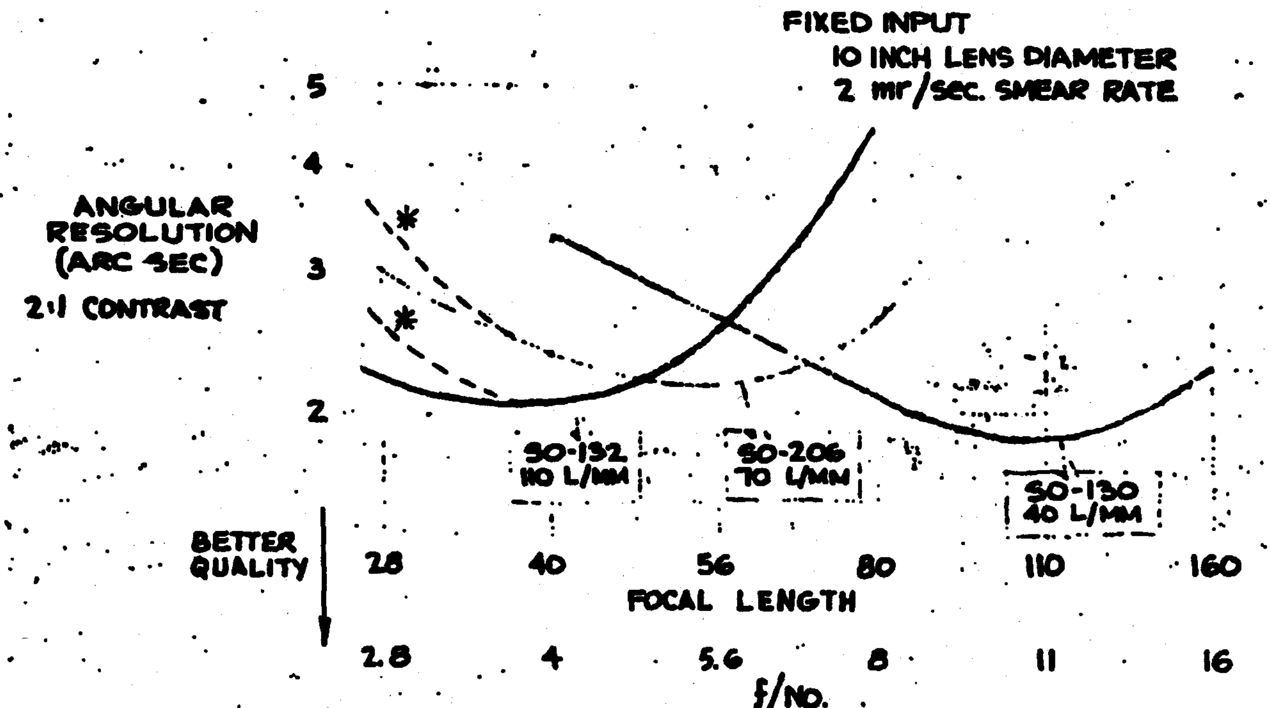
- LENS DIAMETER
  - LIGHT ENERGY
  - DIFFRACTION
  - (LENS WEIGHT)
- ANGULAR RATE OF SMEAR

VARY

- FOCAL LENGTH AND f/NO.
- FILM
- EXPOSURE (TO MATCH FILM AND f/NO.)



ANGULAR RESOLUTION vs. FOCAL LENGTH
FOR VARIOUS FILMS

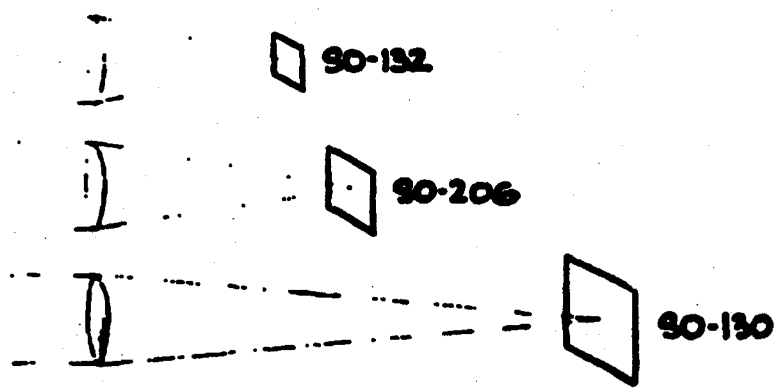


* LOSS DUE TO ABERRATIONS OF VERY FAST LENSES.

COMPARISON OF SYSTEMS USING DIFFERENT FILMS

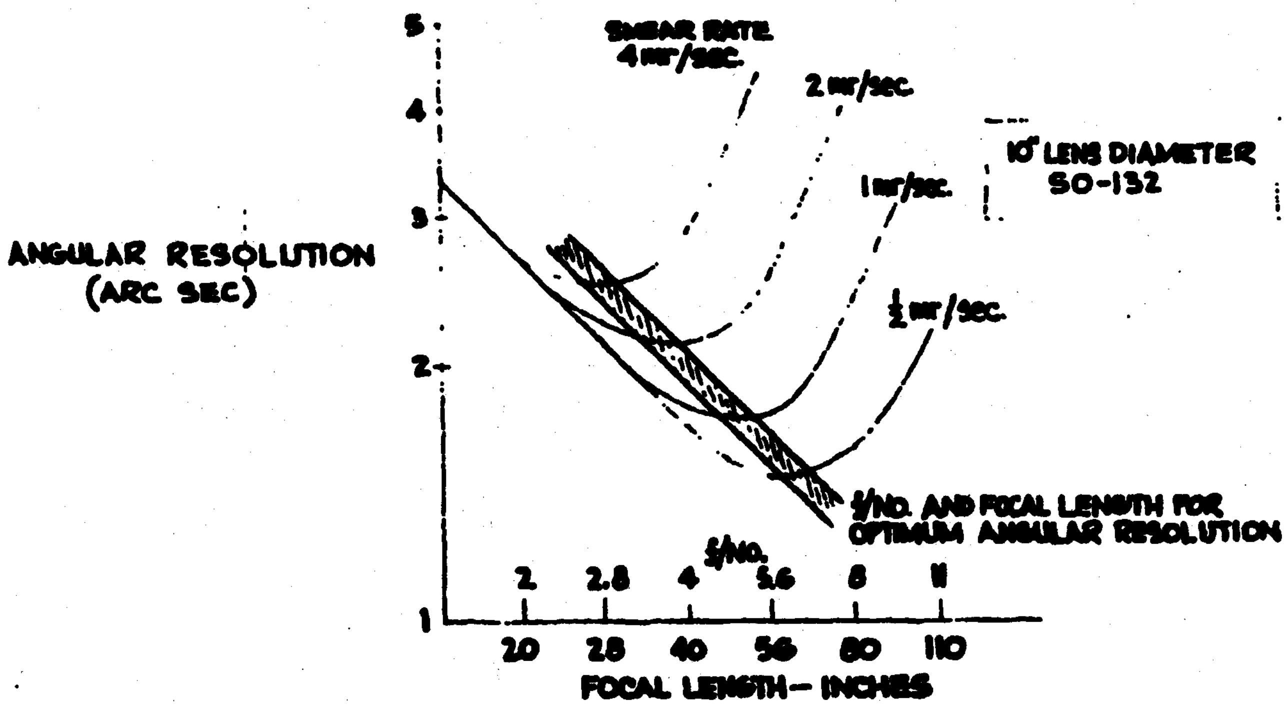
FIXED LENS DIAMETER & SMEAR RATE

	SO-132	SO-206	SO-130
RELATIVE GROUND AND ANGULAR RESOLUTION	1.0	1.07	.92
IMAGE RESOLUTION	110	70	40
OPTIMUM FOCAL LENGTH	40	56	110
OPTIMUM f/No.	4	5.6	11
RELATIVE FILM WEIGHT	1	2	8
RADIATION SUSCEPTIBILITY	~1	~2	~8



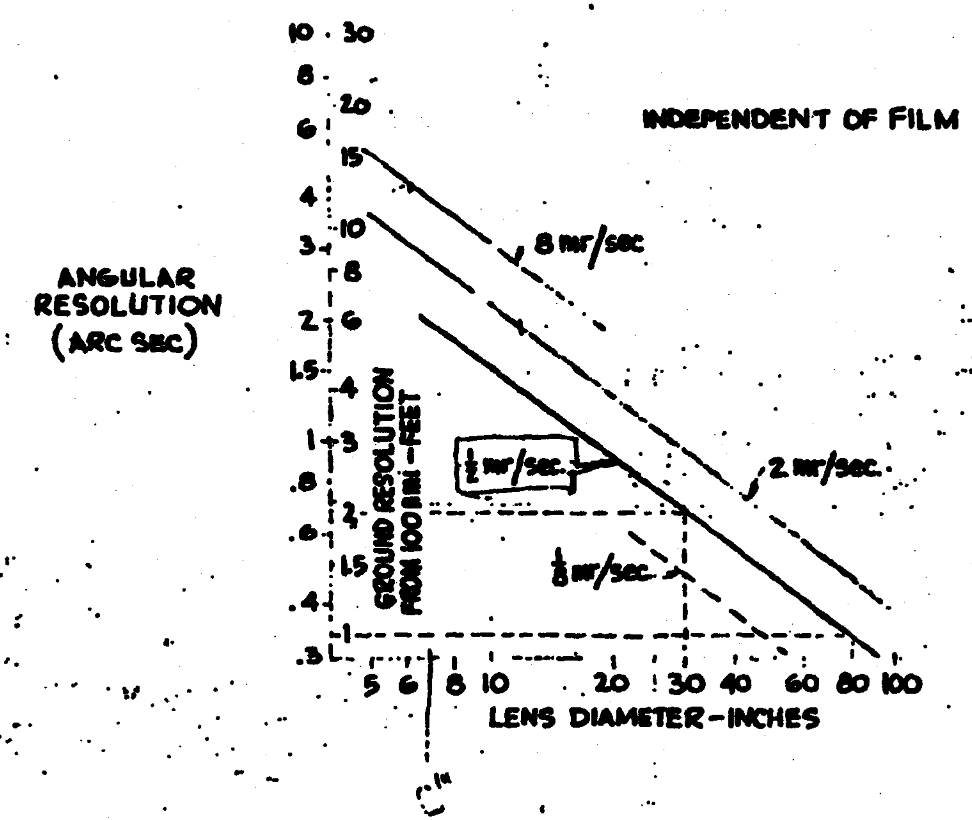
EFFECT OF IMAGE SMEAR

ANGULAR RESOLUTION vs. f/NO. AND FOCAL LENGTH

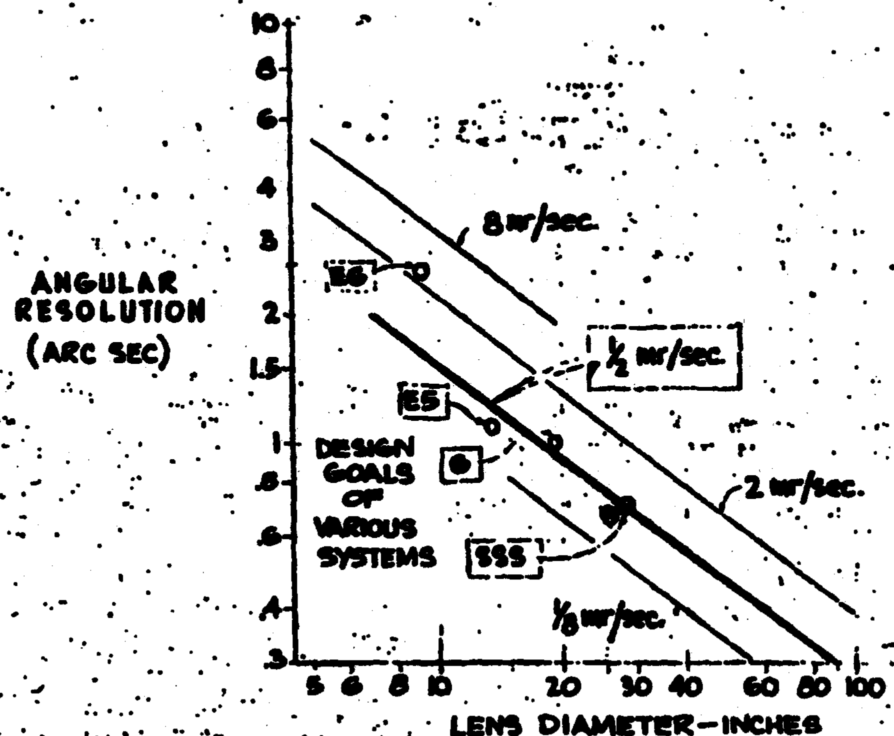


GROUND RESOLUTION vs. APERTURE

FOR A GIVEN SMEAR RATE

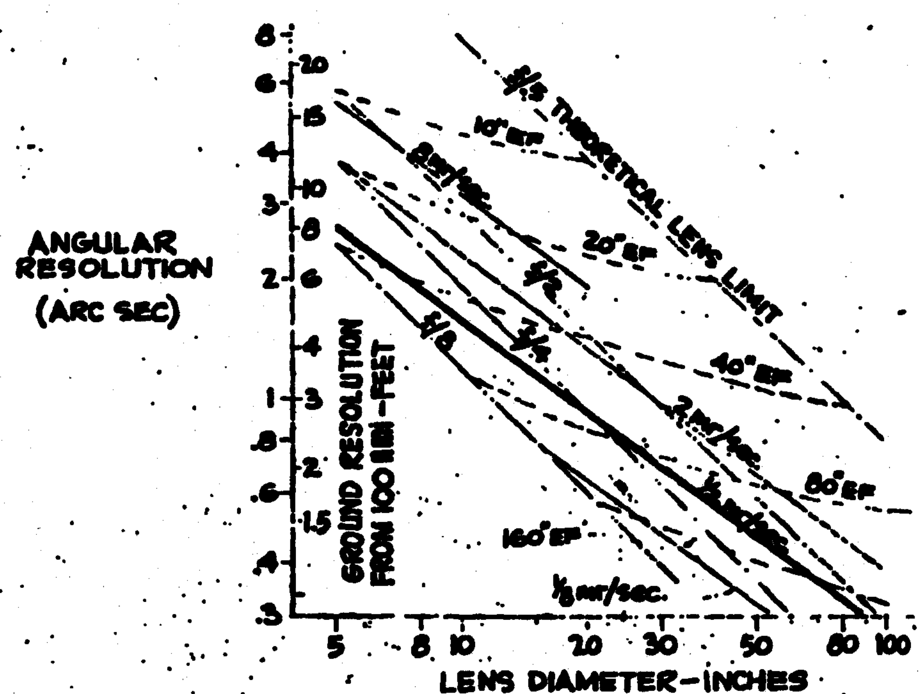


REQUIRED CORRECTION OF IMAGE MOTION



OPTIMUM DIAMETER, f/NO., FOCAL LENGTH

FOR A GIVEN RESOLUTION AND SMEAR RATE   SO-132 FILM



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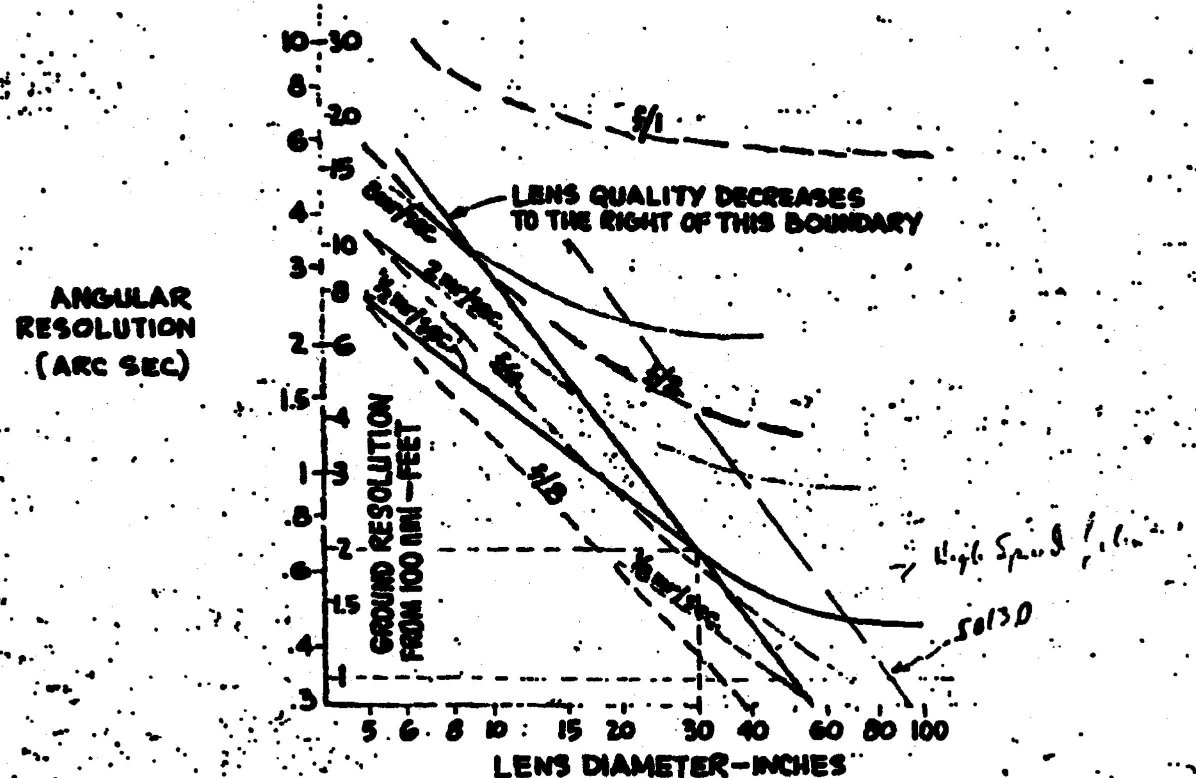
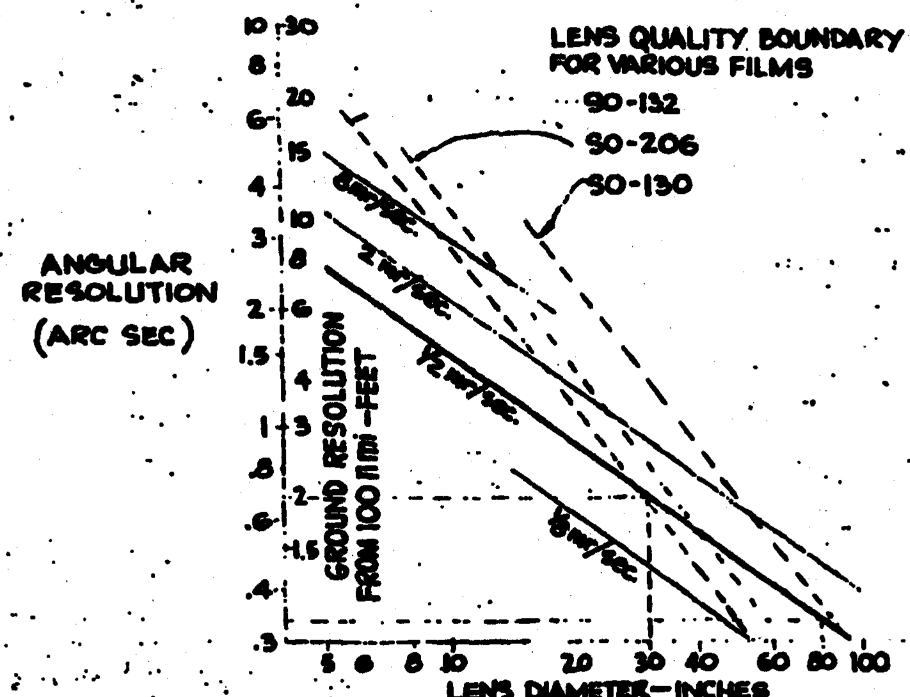
OPTIMUM DIAMETER AND f/NO.

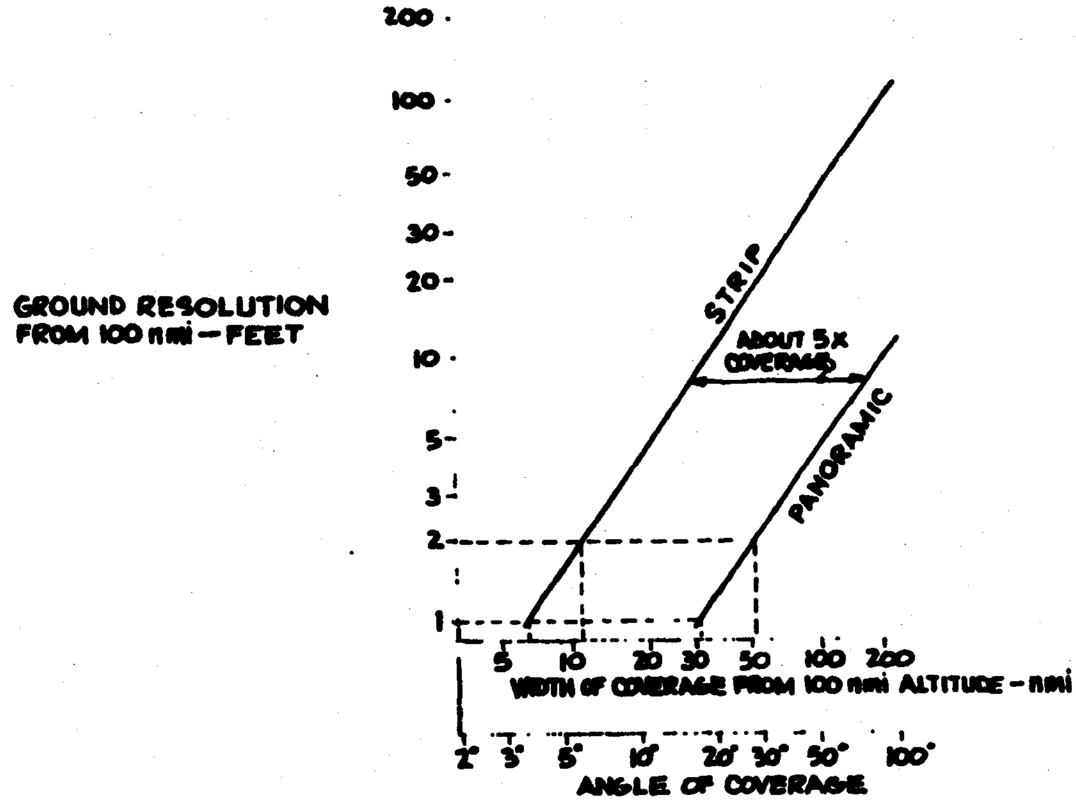
FOR LENSES WITH EXPECTED ABERRATIONS SO-132 FILM



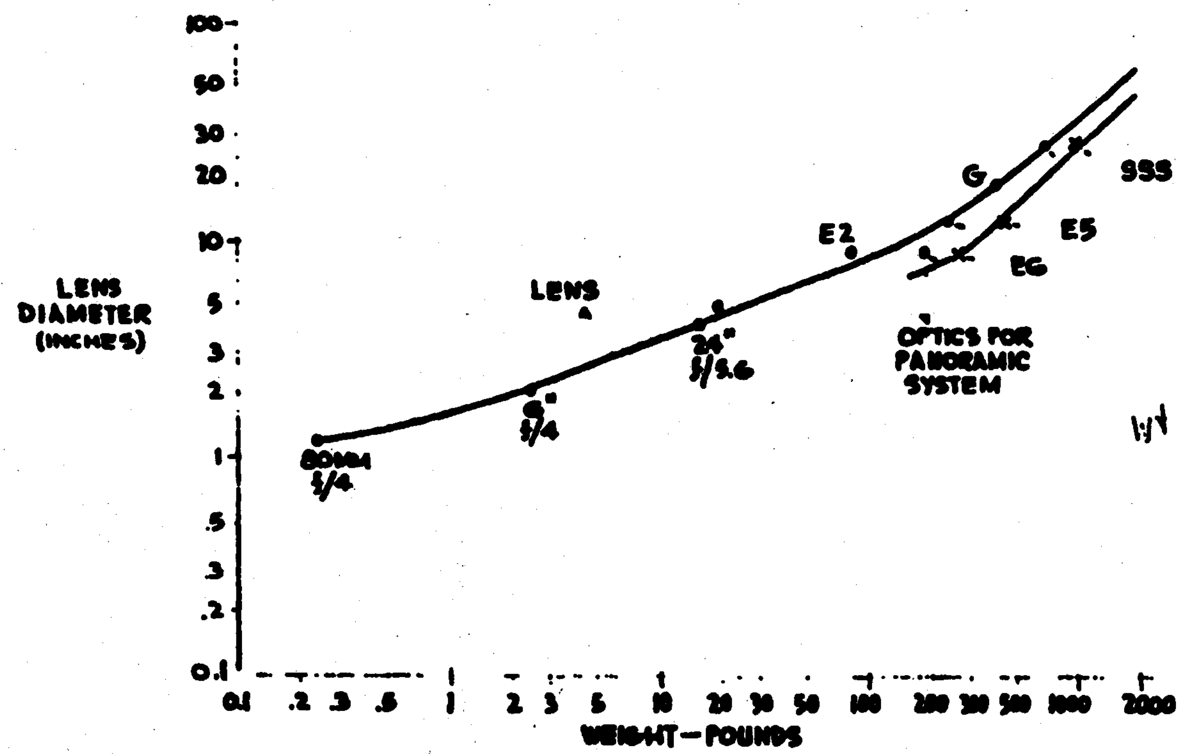
LIMITATION OF LENS QUALITY ON OPTIMUM DIAMETER



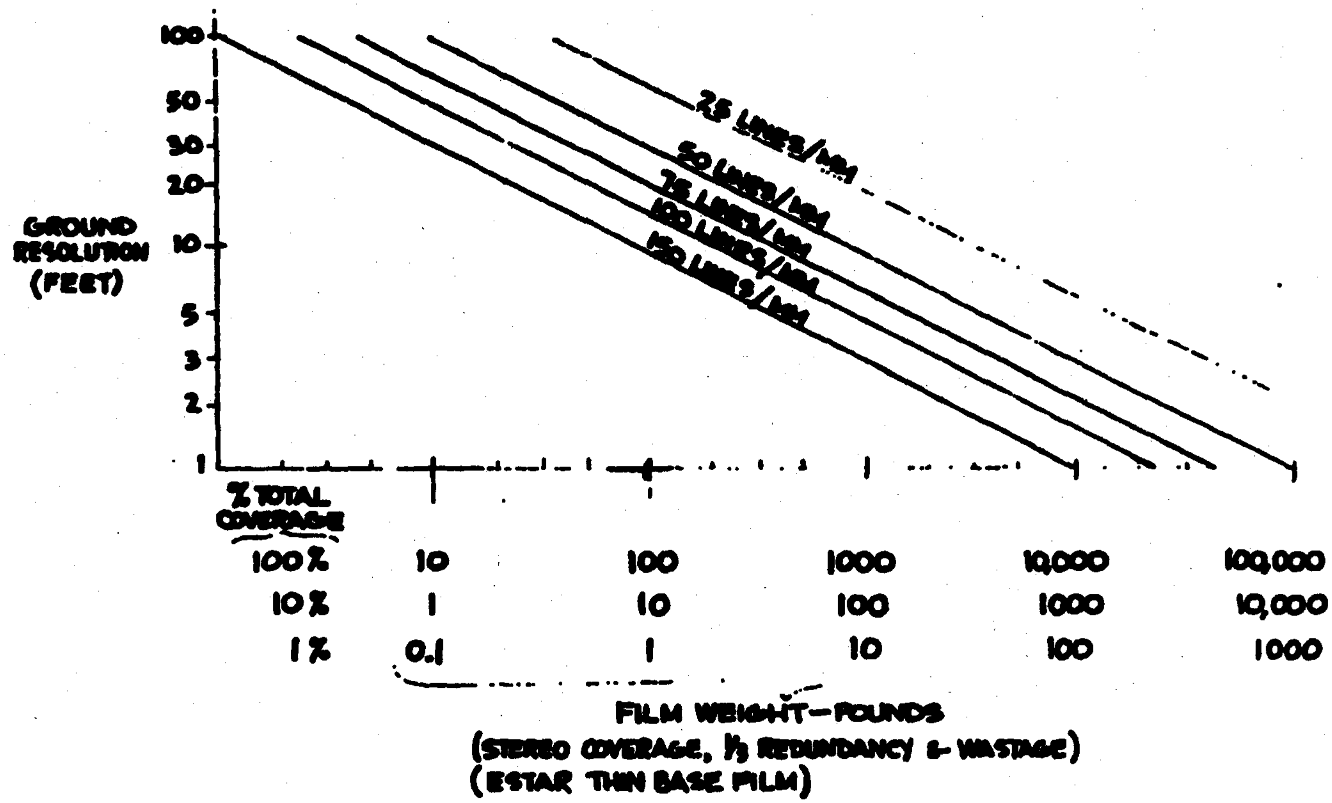
WIDTH OF GROUND COVERAGE vs. GROUND RESOLUTION



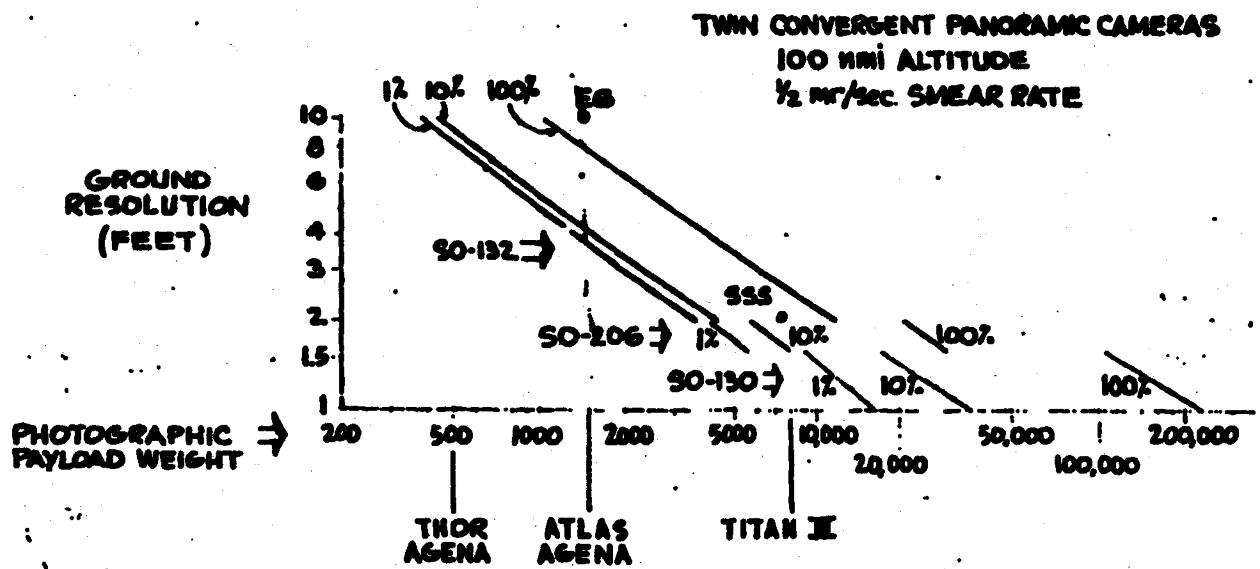
WEIGHT OF OPTICS vs. LENS APERTURE



FILM WEIGHT vs. GROUND RESOLUTION



PHOTOGRAPHIC PAYLOAD WEIGHT VS. GROUND RESOLUTION



ITEMS CONSIDERED

FILM

- RESOLUTION
- SPEED
- MASS
- TYPE

LENS

- APERTURE
- f/NO.
- T-STOP
- SPECTRAL TRANSMISSION
- FOCAL LENGTH
- ANGULAR FIELD
- MASS, CONFIGURATION

EXPOSURE TIME

SMEAR RATE

- ATTITUDE
- ALTITUDE
- VIBRATION
- IMPERFECT IMC

CAMERA TYPE

SYSTEM

- MASS, SIZE
- TARGET ACQUISITION
- INFORMATION PACKING DENSITY

REPRODUCTION

GENERAL CONCLUSIONS

1) SPECTRAL REGIONS

   VISIBLE, LIMITED BY LENS CORRECTION.

   IR FOR SPECIAL USES ONLY.

2. SMEAR RATE

   DIFFICULT TO IMPROVE UPON $1/2$ μr/sec ERROR.

3. FILM

   GROUND RESOLUTION INDEPENDENT OF CURRENT FILM FOR FIXED LENS DIAMETER AND SMEAR RATE.

   FINE GRAIN FOR MINIMUM WEIGHT AND RADIATION SUSCEPTIBILITY.

4. LENS DIAMETER

   DEPENDS ONLY ON SMEAR RATE AND ANGULAR RESOLUTION.

5. FOCAL LENGTH

   OPTIMUM EXISTS FOR A RANGE OF SMEAR RATE AND ILLUMINATION.

6. GROUND RESOLUTION OF 1 TO 2 FEET REQUIRES FASTER FILMS & MORE WEIGHT.

7. RESOLUTION LIMIT OF ABOUT 2 FEET WITH TITAN III.