~~TOP SECRET~~/C/SPECIAL HANDLING

~~TOP SECRET~~ CORONA

BOS-COR-9232-68-470

17

J-3 PROGRAM

APRIL P.I.M. MEETING

10 APRIL 1968

Itek OPTICAL SYSTEMS DIVISION
ITEK CORPORATION • 10 MAGUIRE ROAD • LEXINGTON, MASSACHUSETTS 02173

SPP-68-008

~~TOP SECRET~~/C/SPECIAL HANDLING

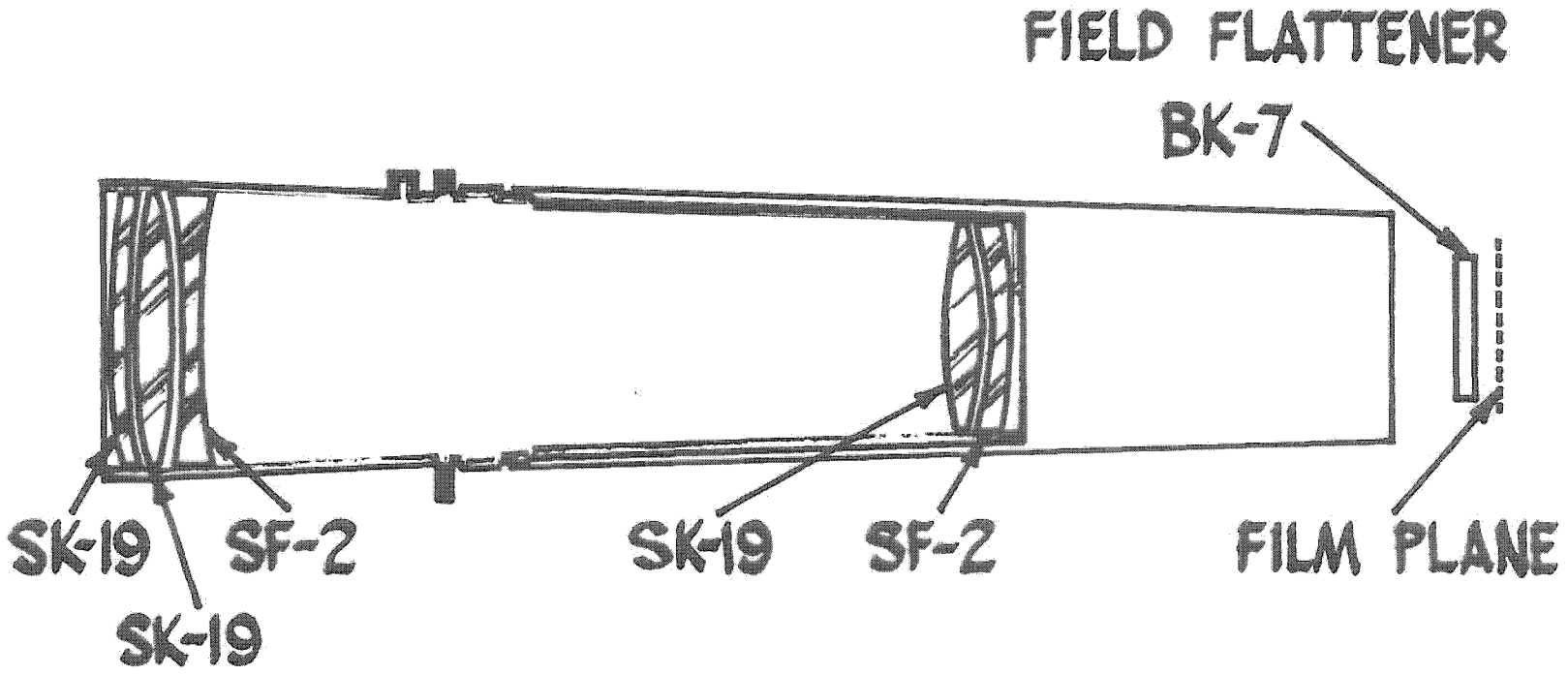
~~TOP SECRET~~ CORONA

HANDLE VIA BYEMAN CONTROL SYSTEM ONLY

J-3 PROGRAM

J-3 LENS CONFIGURATION

J-3 f/3.5 PETZVAL LENS



FIRST GENERATION LENS DESIGN

24 inch FOCAL LENGTH, f/3.5 6° FIELD

SPECTRAL RANGE 0.5461 - 0.6900 μ

GLASS WEIGHT ≈ 15 LBS

- RELATIVELY THIN ELEMENTS
- DIFFERENT DIA. ELEMENTS IN FRONT GROUP
- "RQ" QUALITY GLASS
- FIRST 12 LENS MADE TO THIS DESIGN
- LENSES 1 THRU 12 MADE TO THIS DESIGN
  (QR-1, QR-2, CR-1, 1/2 CR-2, 1/2 CR-3, 1/2 CR-5 & 1/2 CR-9)

SECOND GENERATION LENS DESIGN

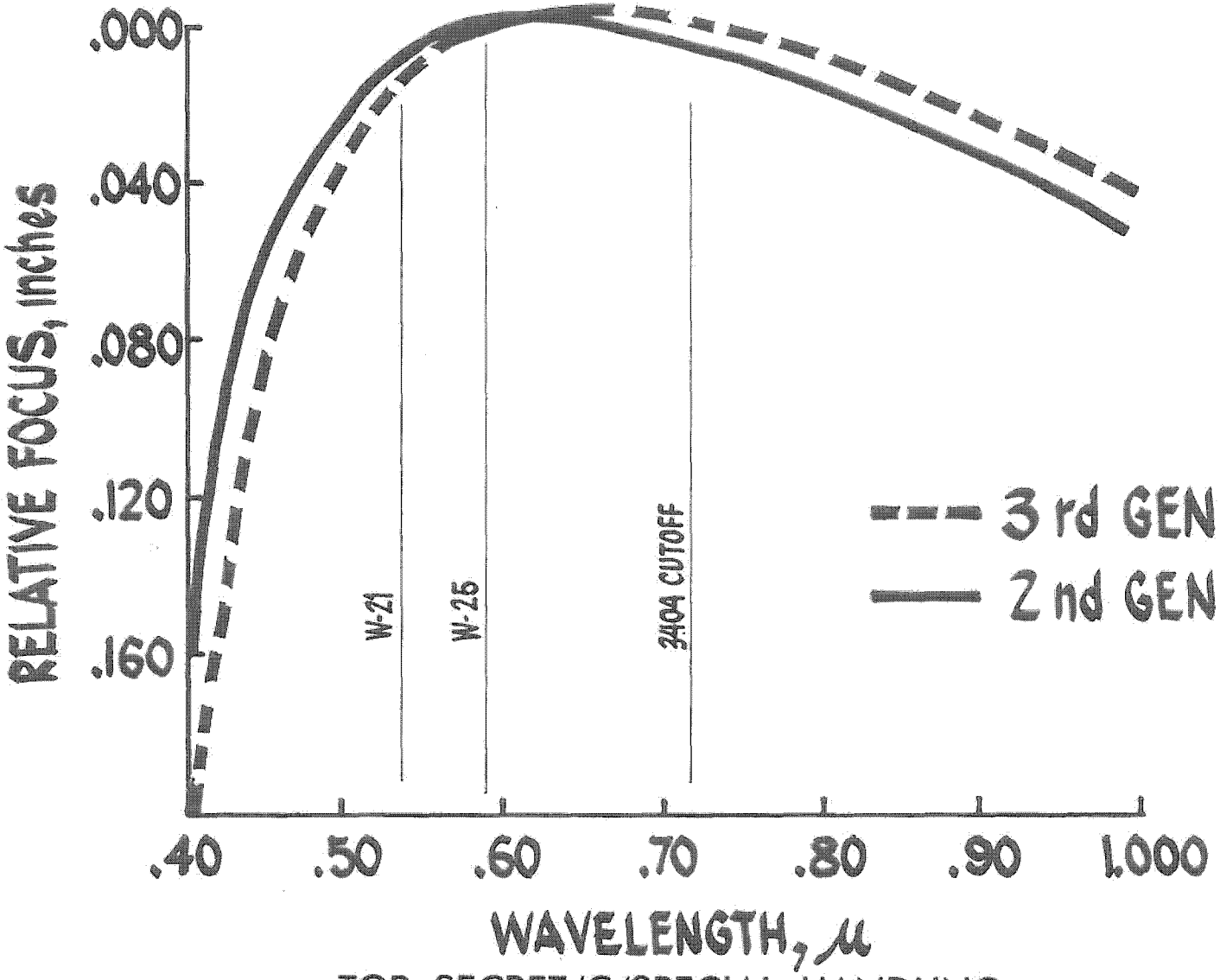
24 inch FOCAL LENGTH, f/3.5 6° FIELD

SPECTRAL RANGE 0.5461 - 0.6900 μ

GLASS WEIGHT ≈ 17 LBS

- ELEMENTS 1, 3 AND 4 THICKENED TO FACILITATE MFG.
- SAME DIA. ELEMENTS IN FRONT GROUP
- SF-12 GLASS REPLACED WITH SF-2 BECAUSE OF SUPERIOR WORKING PROPERTIES
- C.G. OF COMPOSITE GLASS AND CELL MAINTAINED CLOSE TO NODAL POINT
- "AO" QUALITY GLASS
- LENSES 13 THRU 22 MADE TO THIS DESIGN (1/2 CR-2, 1/2 CR-3 1/2 CR-4, 1/2 CR-6, 1/2 CR-7, 1/2 CR-8)
- GENERATION I & II LENSES ≈95% OF THE DIFF. LIMIT ON FILM

FOCUS VS WAVELENGTH FOR 24 in. PETZVAL



THIRD GENERATION LENS DESIGN

24 inch FOCAL LENGTH, f/3.5 6° FIELD

SPECTRAL RANGE 0.6000 – 0.7100 μ

- INCLUDES ALL GENERATION II IMPROVEMENTS
- TAILORED TO W-25 FILTER GIVING ≈25% IMPROVEMENT FROM 156 TO 192 ℓ/mm
- ≈7% IMPROVED RESOLUTION WITH W-21 FILTER
- LENSES 23 THRU 34 MADE TO THIS DESIGN (1/2 CR-4, 1/2 CR-5, 1/2 CR-6, 1/2 CR-7, 1/2 CR-8 1/2 CR-9, 1/2 CR-10, 1/2 CR-11, & 1/2 CR-12)
- GENERATION III HAS GIVEN 94% OF DIFF. LIMIT OF LENS ON FILM (W-25)

FOURTH GENERATION LENS DESIGN

24 inch FOCAL LENGTH, f/3.5 6° FIELD
SPECTRAL RANGE 0.6000 - 0.7100 μ

- INCLUDES ALL GENERATION II & III IMPROVEMENTS
- GLASS SURFACE IRREGULARITY IMPROVED FROM $\frac{1}{10}\lambda$ TO $\frac{1}{15}\lambda$
- ELEMENT 4 TO BE UNDERCUT TO REDUCE TILT
- TIGHTER MECHANICAL TOLERANCES ON LENS CELL & SPACERS
- PH-3 GLASS FOR IMPROVED HOMOGENEITY

LENS PERFORMANCE

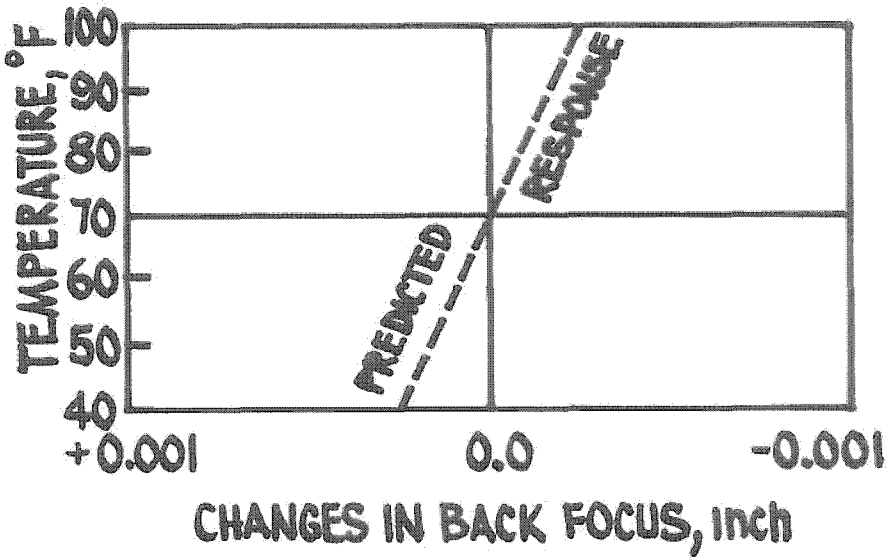
LENS GENERATION	OPTICAL FILTER EK WRATTEN OR EQUIV	MTF PREDICTIONS ℓ/mm	STATIC SPECIFICATIONS ℓ/mm	STATIC ACTUAL (TYPICAL) ℓ/mm
I	W-21	156	140	140-145
	W-25	152	N/A	N/A
II	W-21	156	140	145-150
	W-25	152	N/A	N/A
III	W-21	167	150	155-160
	W-25	193	175	180
IV	W-21	167	155	N/A
	W-25	193	185	N/A

NOTE
MTF PREDICTIONS BASED ON
EK 3404 FILM AT 2:1 CONTRAST

THERMAL SENSITIVITY UNIFORM EXCURSIONS

MAGNESIUM CELL WITH TITANIUM FIELD FLATTENER CONE, MOUNTED AT TRUNNION AXIS

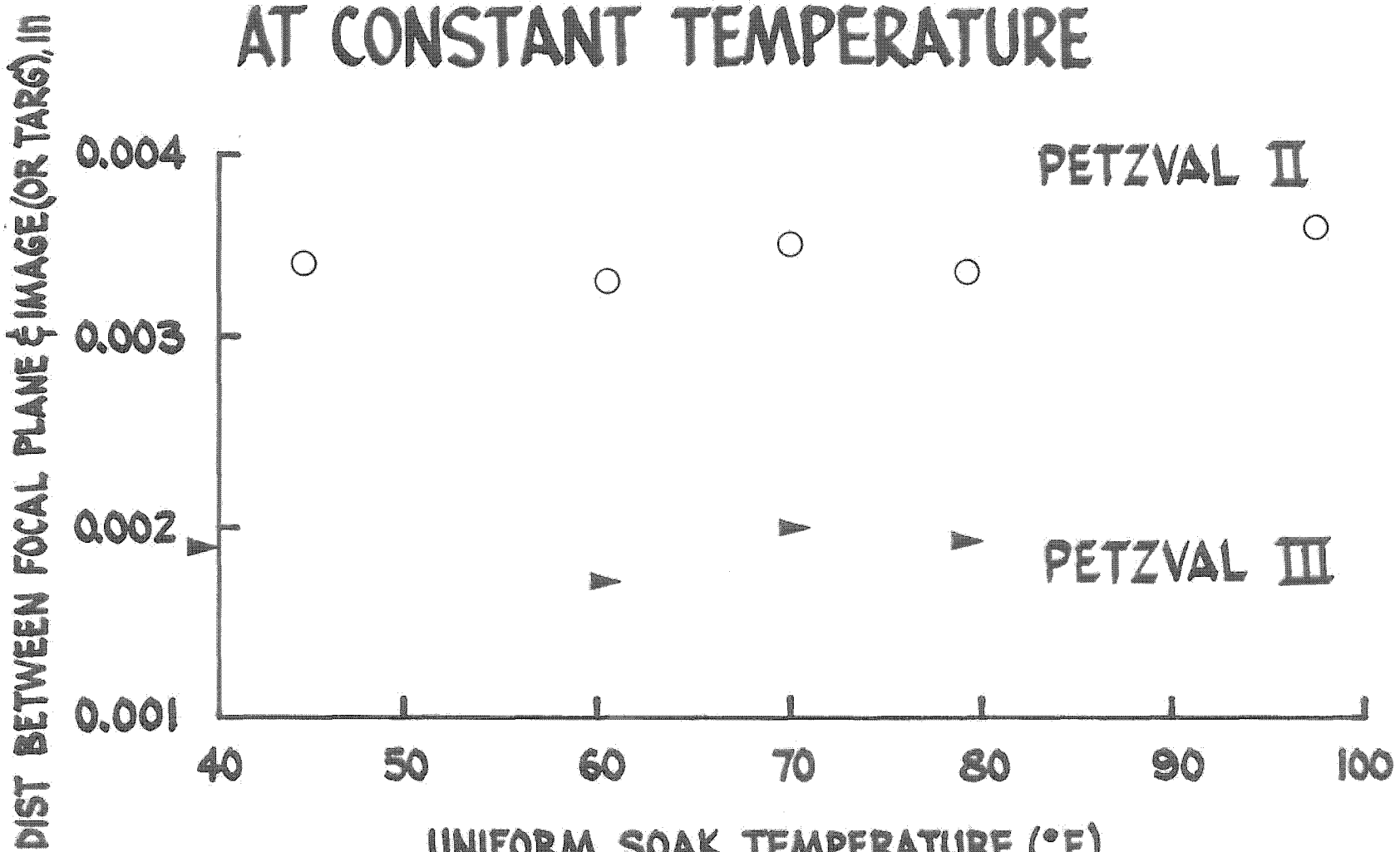
EACH DESIGN IS TUNED SUCH THAT IDEAL CORRECTION IS OBTAINED OVER OPERATIONAL TEMP.



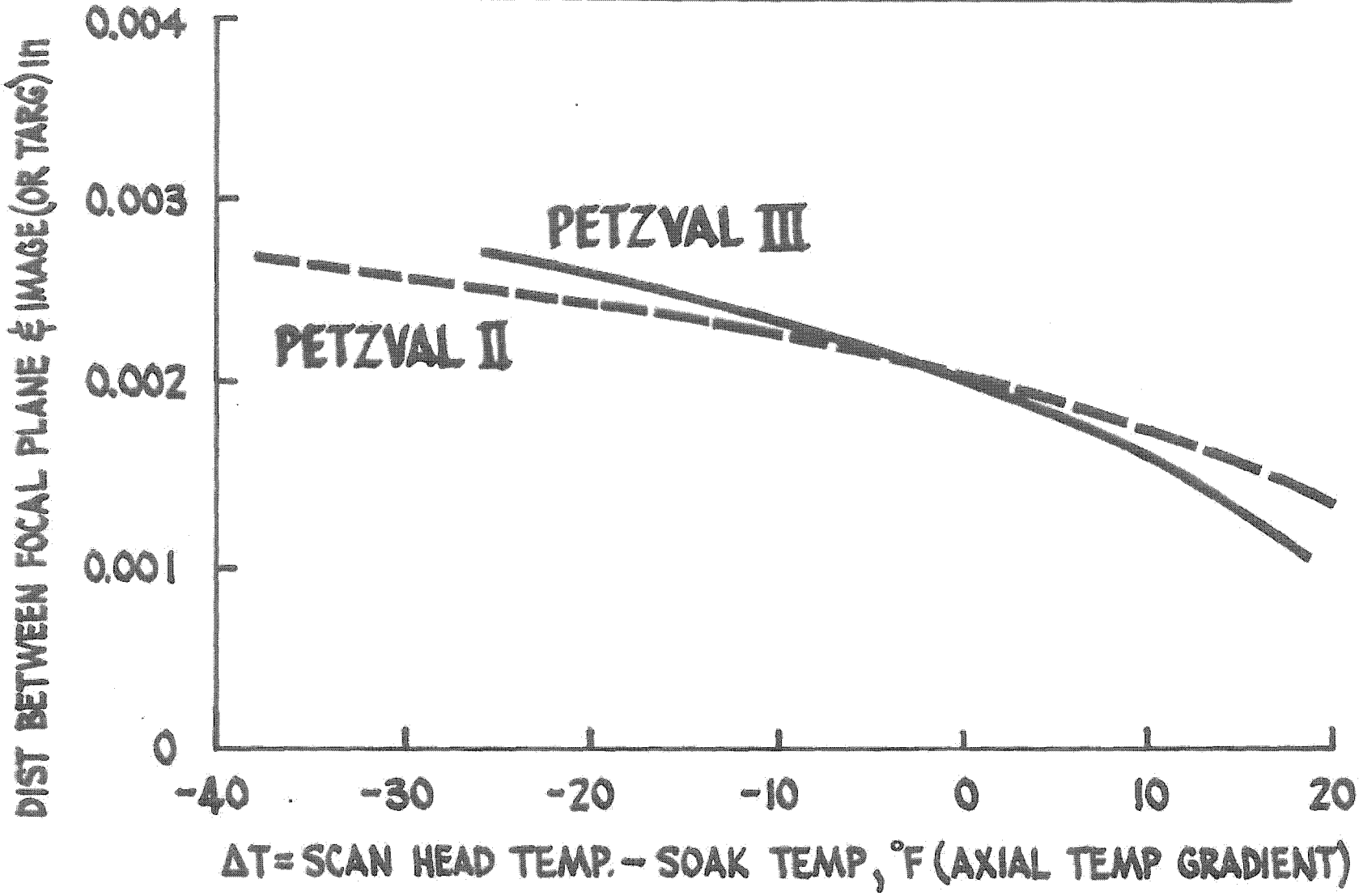
FACTORS CONSIDERED

- ELEMENT THICKNESS CHANGE
- AIRSPACE CHANGES DUE TO CELL EXPANSION
- CURVATURE CHANGES
- INDEX OF REFRACTION CHANGES

FOCAL PLANE VARIATION
AT CONSTANT TEMPERATURE



NORMALIZED FOCAL PLANE VARIATION



CR-1 SYSTEM ANALYSIS

PERFORMANCE ESTIMATE

- GOOD CORRELATION BETWEEN PREDICTED AND ACTUAL CORN TARGET RESOLUTIONS
- AVERAGE PREDICTED CORN TARGET RESOLUTIONS (2:1 CONTRAST, 8 TARGETS)

	ALONG TRACK	CROSS TRACK
UNIT 302 AFT	16.4 ft	16.9 ft
UNIT 303 FWD	12.4 ft	11.6 ft

- AVERAGE PREDICTED HPL TARGET RESOLUTIONS (2:1 CONTRAST)

	ALONG TRACK	CROSS TRACK
UNIT 302 AFT	18.7 ft	19.5 ft 12 TARGETS
UNIT 303 FWD	13.8 ft	13.9 ft 13 TARGETS

CONCLUSIONS

- GOOD CORRELATION FOUND BETWEEN AVERAGE PREDICTED GROUND RESOLUTIONS AND P.I. RATINGS
- DUE TO AIR-TO-VACUUM FOCUS SHIFT OF 0.014 inch BOTH INSTRUMENTS WERE OUT OF FOCUS

UNIT 302 AFT	0.002 inch
UNIT 303 FWD	0.001 inch

- DYNAMIC AND STATIC RESOLUTIONS RELATED BY

$$R_d = \frac{R_o}{\left[1+(b\,R_o)^{E_1}\right]^{E_2}}$$ WHERE

R_d = DYNAMIC RESOLUTION
R_o = STATIC RESOLUTION
b = IMAGE SMEAR
E_1, E_2 = EXPERIMENTALLY DETERMINED EXPONENTS

- EDGE-TRACE ANALYSIS OF CORN TARGETS DOES NOT CORRELATE WITH ACTUAL CORN TARGETS G R D
- HPL TARGETS WERE PROPERLY EXPOSED
- FILM CHARACTERISTICS NOT AFFECTED BY MISSION ENVIRONMENT

RECOMMENDATIONS

- CORN TARGET DISPLAYS SHOULD BE IMPROVED IF POSSIBLE
- FOCUSING OF THE INSTRUMENTS SHOULD BE DONE BY RUNNING DYNAMIC RESOLUTION VERSUS SMEAR TESTS
- FAILURE OF EDGE-TRACE ANALYSIS SHOULD BE INVESTIGATED
- THE PREDICTED GROUND RESOLVED DISTANCES FOR HPL TARGETS SHOULD BE CORRELATED TO SIZES AND TYPES OF OBJECTS RECOGNIZED BY PHOTOINTERPRETERS
- THE CAPABILITY TO DISCONNECT INSTRUMENT FROM 24 VOLTS SHOULD BE DEVELOPED

CR-2 SYSTEM ANALYSIS

PURPOSE

- INVESTIGATE THE CAPABILITY OF THE J-3 SYSTEM TO HANDLE NEW PHOTOGRAPHIC TECHNIQUES

HISTORY

CONTINUATION TO EKIT PROJECT WHICH INVESTIGATED BASIC TECHNIQUE FEASIBILITY ON HIGH ALTITUDE AIRCRAFT

COLOR	B&W	FILTERS	MISC
SO-121	SO-362	POLARIZER	INDEX
BI-SPECTRAL	SO-166		METRIC
COLOR FILMS	SO-230		IR S-O-A
SO-180	NIGHT		
	LOW γ		
	EXPOSURE		

J-3 SYSTEM CAPABILITY PLAN

1101 EXPOSURE CHANGE
FILTER CHANGE

1102 BI-SPECTRAL
POLARIZER
SO-230

1103 BI-SPECTRAL
WIDE BAND FILTER
SO-380

1104 SO-180
NIGHT

1105 SO-121

TENTATIVE
KODACHROME II
THROUGH FOCUS
POLARIZER

EXPOSURE

- TERRAIN AND TARGET DENSITY READINGS ARE STATISTICALLY DIFFERENT
- INTERRUPTED PROCESS CANNOT CORRECT IMPROPER EXPOSURE FOR TARGETS
- TARGETS FROM PAST MISSIONS HAVE NOT BEEN UNDEREXPOSED - THEY HAVE BEEN OVEREXPOSED
- 1/3 STOP DECREASE IN EXPOSURE WOULD HAVE PROPERLY EXPOSED TWO TARGETS FOR EACH ONE UNDEREXPOSED

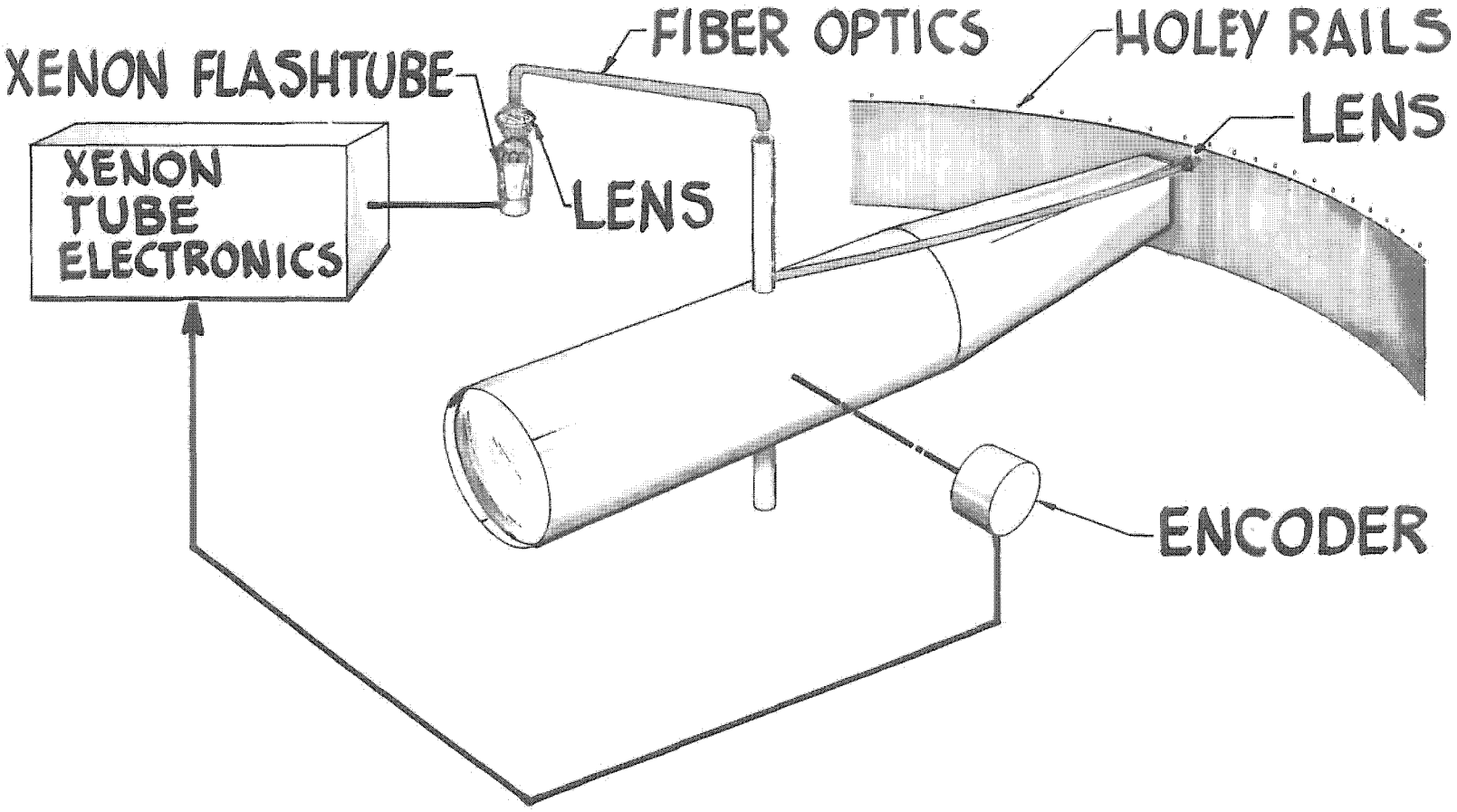
BI-COLOR

- NORMAL PHOTOINTERPRETER USES NOT AFFECTED
- COLOR PRINTS CAN BE MADE OF SELECTED AREAS WITH SOME RESOLUTION LOSS
- POTENTIAL USE FOR SPECTRAL ASSESSMENT
- IMAGE QUALITY OF GREEN FILTER RECORD SLIGHTLY LESS THAN THAT OF RED FILTER, COMPARABLE WITH AVERAGE J-1 MISSION
- CONTRAST LOWERED WITH GREEN RECORD

P.G. CALIBRATION CR-4 & UP

NOD TO SCAN CALIBRATION

PRIMARY TECHNIQUE (RAIL)



IN-FLIGHT NOD TO SCAN CALIBRATION

- CR-4 ONLY SYSTEM SCHEDULED. ALL HARDWARE INSTALLED AND FUNCTIONING

- HARDWARE AVAILABLE FOR TWO ADDITIONAL IN-FLIGHT CALIBRATIONS

  SPECIAL H.O. FIDUCIAL LAMPS, POWER SUPPLY REQUIRED

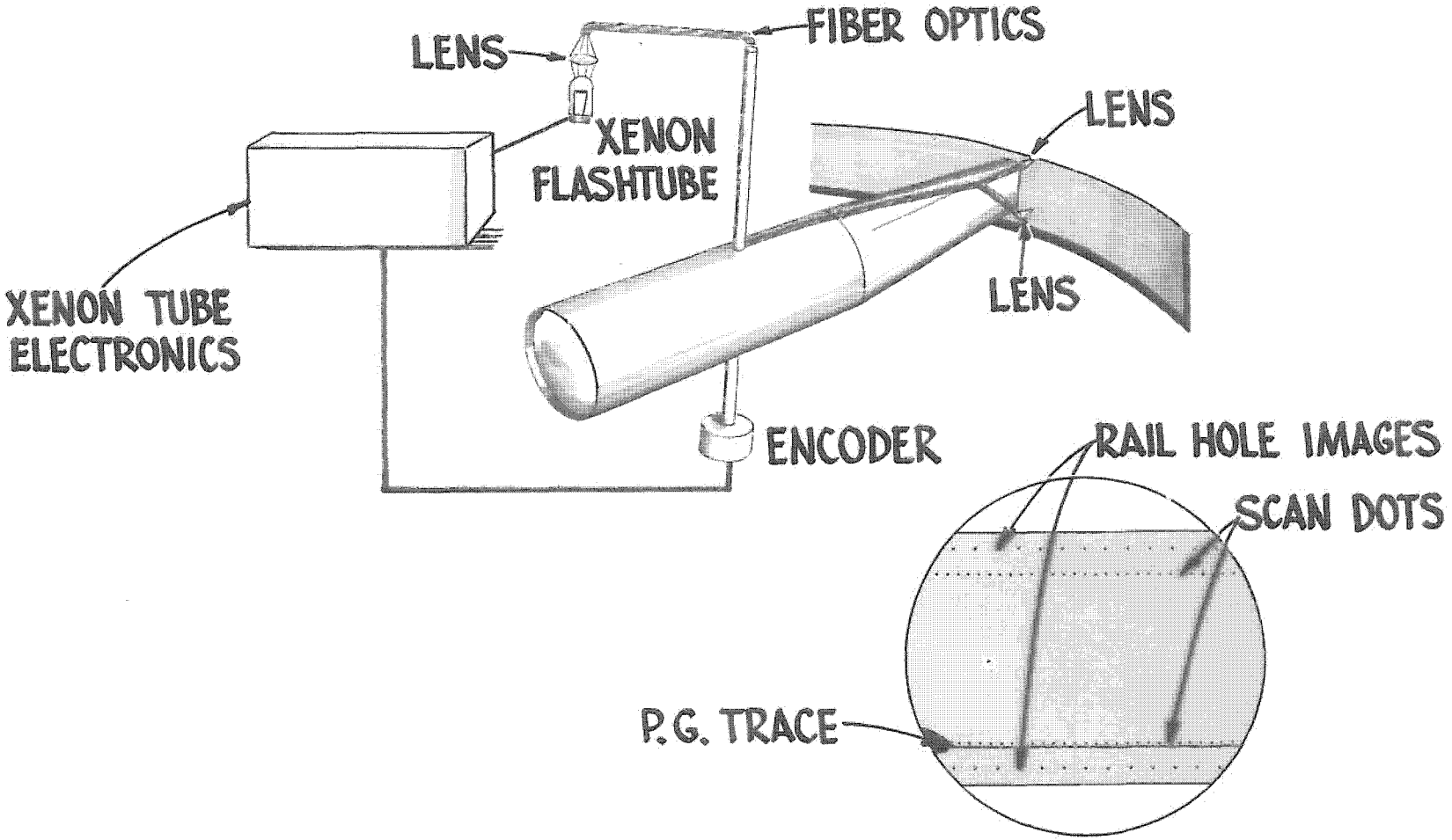
  2 MONTHS MIN LEAD TIME REQUIRED FOR FAB AND SYSTEM TEST AND DEBUG

- CR-4 IS SPLIT-LOAD FLIGHT

  FIRST USE OF MATERIAL CHANGE DETECTOR

  NOD DOT XENON PACKAGE WILL OPERATE IN BOTH INTENSITY MODES

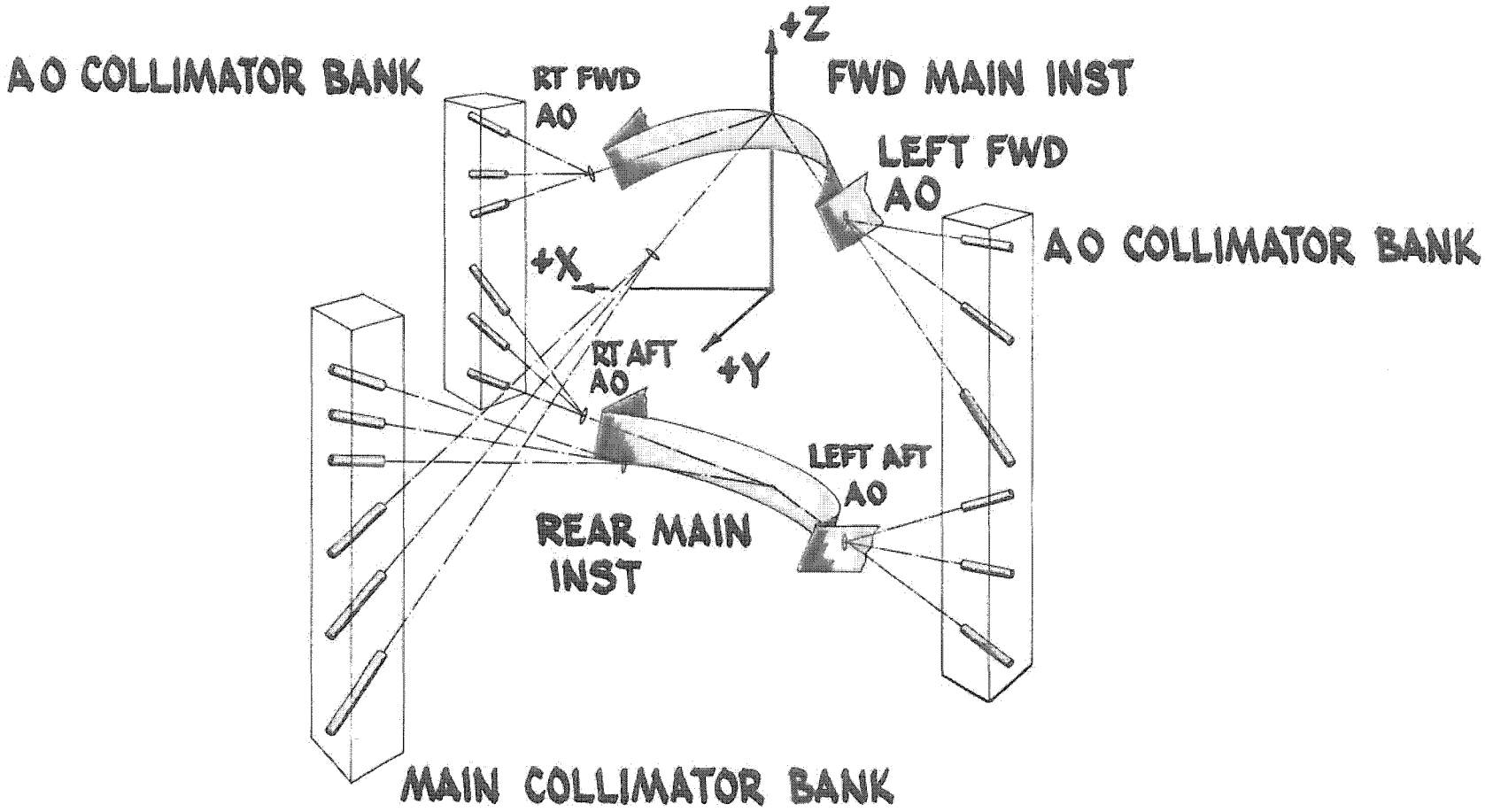
RAIL HOLE CALIBRATION



CR-4 P.G. CALIBRATION

- CALIBRATION OF OPTISYN ENCODER BY THEODOSYN ENCODER (ACCURATE TO 1 ARC-SEC)
- PRINCIPAL POINT CALIBRATION OF ALL P.G. DATA POINTS EXCEPT RAIL HOLES ON OPTICAL BENCH
- DATA ACQUISITION OF 10 PANORAMIC FRAMES CONTAINING RAIL HOLE IMAGES AND SCAN DOTS (CALIBRATED OPTISYN ENCODER ATTACHED TO SCANNING SHAFT)
- MENSURATION OF DATA ACQUIRED BY B AND C (PERFORMED BY DATA ANALYSIS CENTER)
- CALIBRATION OF P.G. TRACES, NOD DOTS, AND TIME MARKS WITH RESPECT TO PRINCIPAL POINT (FROM DATA OF B)
- CALIBRATION OF RAIL HOLES FROM SCAN DOTS UTILIZING DATA FROM A, B, AND C
- CALIBRATION REPORTS (CR-1, CR-2, CR-4 FROM DAC)

RO TEST FACILITY



RO CALIBRATION

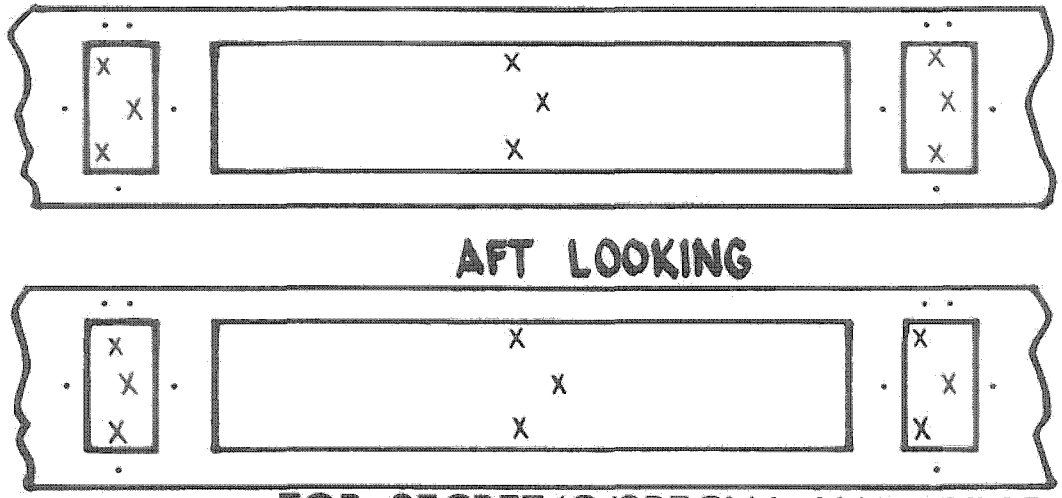
OBJECTIVE

TO RELATE AO AND PAN CAMERA SYSTEMS IN COMMON OBJECT SPACE COORDINATE SYSTEM

METHOD

TEST IMAGERY OF COLLIMATOR FACILITY REDUCED USING PG & AO CALIBRATION DATA. RESULTING ORIENTATION MATRICES ROTATES AO VECTOR INTO PAN VECTOR, AND ONE PAN VECTOR TO ANOTHER AT TIME OF AO EXPOSURE

TEST FORMAT

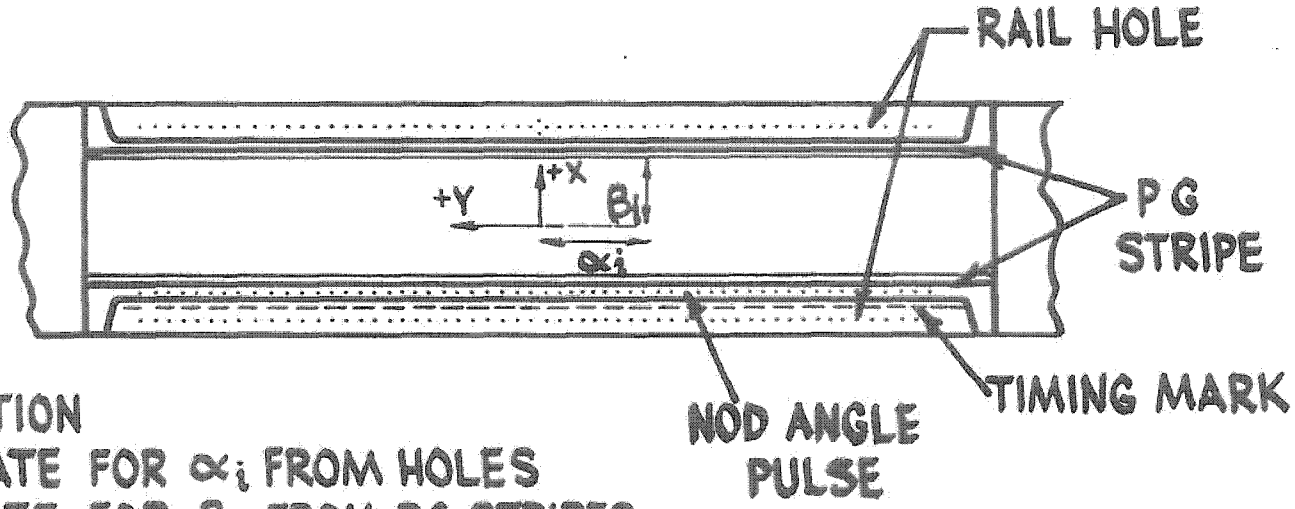


PG CALIBRATION

OBJECTIVE TO DETERMINE INTERIOR ORIENTATION PARAMETERS IN A RECOVERABLE SYSTEM

CALIBRATION DATA FOCAL LENGTH & RADIUS OF ROTATION
SCAN ANGLE COORDINATES α, OF RAIL HOLES
CROSS WEB COORDINATES β, OF PG STRIPES
FMC CONSTANT & NOD ANGLE PULSE VALUES

CALIBRATION FORMAT DIAPOSITIVE EMULSIVE UP IN OBJECT SPACE



DATA UTILIZATION
INTERPOLATE FOR α_i FROM HOLES
INTERPOLATE FOR β_i FROM PG STRIPES

METHODS

PAST (CR1- CR3)

PREEXPOSED RESEAU ON PG IMAGERY

PRINCIPAL POINT RECORDS
- MEASURE RESEAU HOLES
- ELIMINATE FILM SHRINKAGE
- DETERMINE SCAN COORDINATES

ADVANTAGES
- ALL HOLES CALIBRATED

DISADVANTAGES
- LESS ACCURATE (~±5 μ in)
- GREATER MEASURING EFFECT

PRESENT (CR4 & SUBSEQUENT)

PG IMAGERY WITHOUT RESEAU BUT WITH CALIBRATED ENCODER PULSES

PRINCIPAL POINT RECORDS
- MEASURE ENCODER PULSE HOLES
- INTERPOLATE FOR SCAN COORDINATES

ADVANTAGES
- DECREASED MEASURING EFFORT
- IMPROVED ACCURACY

DISADVANTAGES
- TERMINAL HOLES IN SCAN DIRECTION NOT CALIBRATED

U.T.B.

REDESIGN REQUIRED TO TRANSPORT UTB(mech)

- ADDED TWO ROLLERS TO THE APERTURE COVER
- ADDED 8 DRUM ROLLERS
- REDESIGNED THE CONSTANT TENSION ASSEMBLY
- STIFFENED NOD ROLLER PIVOT, ADDED STOP SCREWS
- ADDED A SECONDARY ROLLER
- REDUCED WIDTH OF ENTRANCE ROLLER
- EXTENDED SUPPORTING DIAMETERS OF STEERING ROLLERS
- MODIFIED A.O. CLAMP CONFIGURATION
- DECREASED T/U TENSION

PROBLEMS IN TRANSPORTING UTB(SO-380)

- TRACKING TESTS PERFORMED ON INST. 299

- TEST RESULTS SHOWED THE FOLLOWING PROBLEMS:

  TRACKING CONSTANT TENSION OSCILLATION, WRINKLING, CREEP OVER FLANGES, FILM PULL-OUT FROM RAILS, ERRATIC TRACKING, RUBBING ON T/U SPOOL FLANGE

  MARKING MINUTE SCRATCHES, STRAIN SENSITIVITY OF FILM

  PHOTOGRAPHIC LOWER SCAN RESOLUTION FOCAL PLANE DISTORTION (DR "A" TEST)

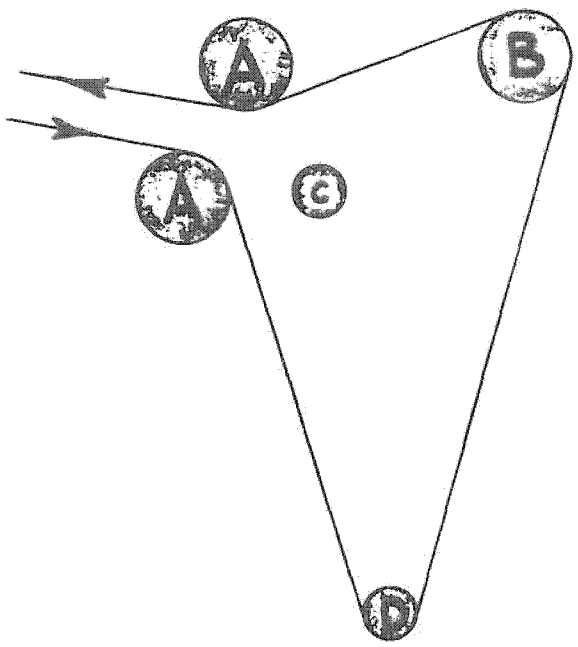
SUPPLY MODIFICATIONS

- STATIC TENSION REMAINS AT 13 oz
- STATIC TENSION INCREASED TO 21 oz FOR FIRST SEC AT SHUT DOWN
- REMAINDER OF CREEP CYCLE IS AT NORMAL 13 oz

TAKE UP MODIFICATIONS

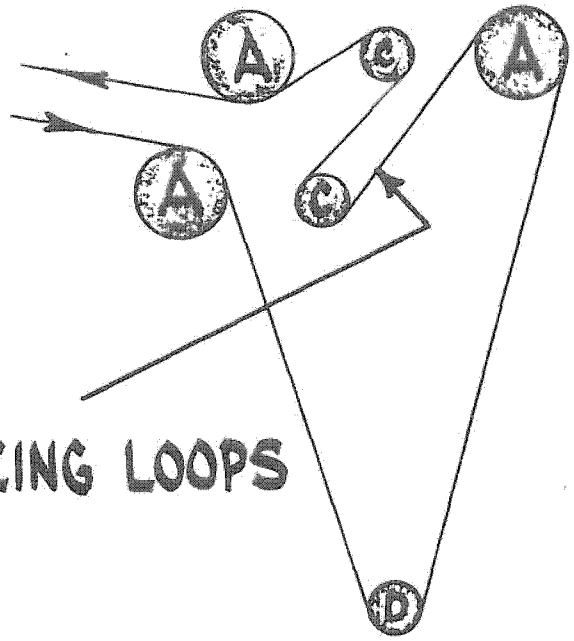
- STATIC TENSION REDUCED TO 30 oz IN "A" AND 25 oz IN "B"
- RUNNING TENSION IS 17 TO 18 oz @ 21 in/sec WITH U.T.B.
- CIRCUIT MODIFIED TO PROVIDE NORMAL ACCELERATION TORQUE FOR 3.5 sec AT START-UP
- ROLLER CARRIER MOD - "B" TAKEUP

FILM PATH VARIATION "B" TAKE-UPS



PRESENT METHOD

DRAG PRODUCING LOOPS



IMPROVED METHOD

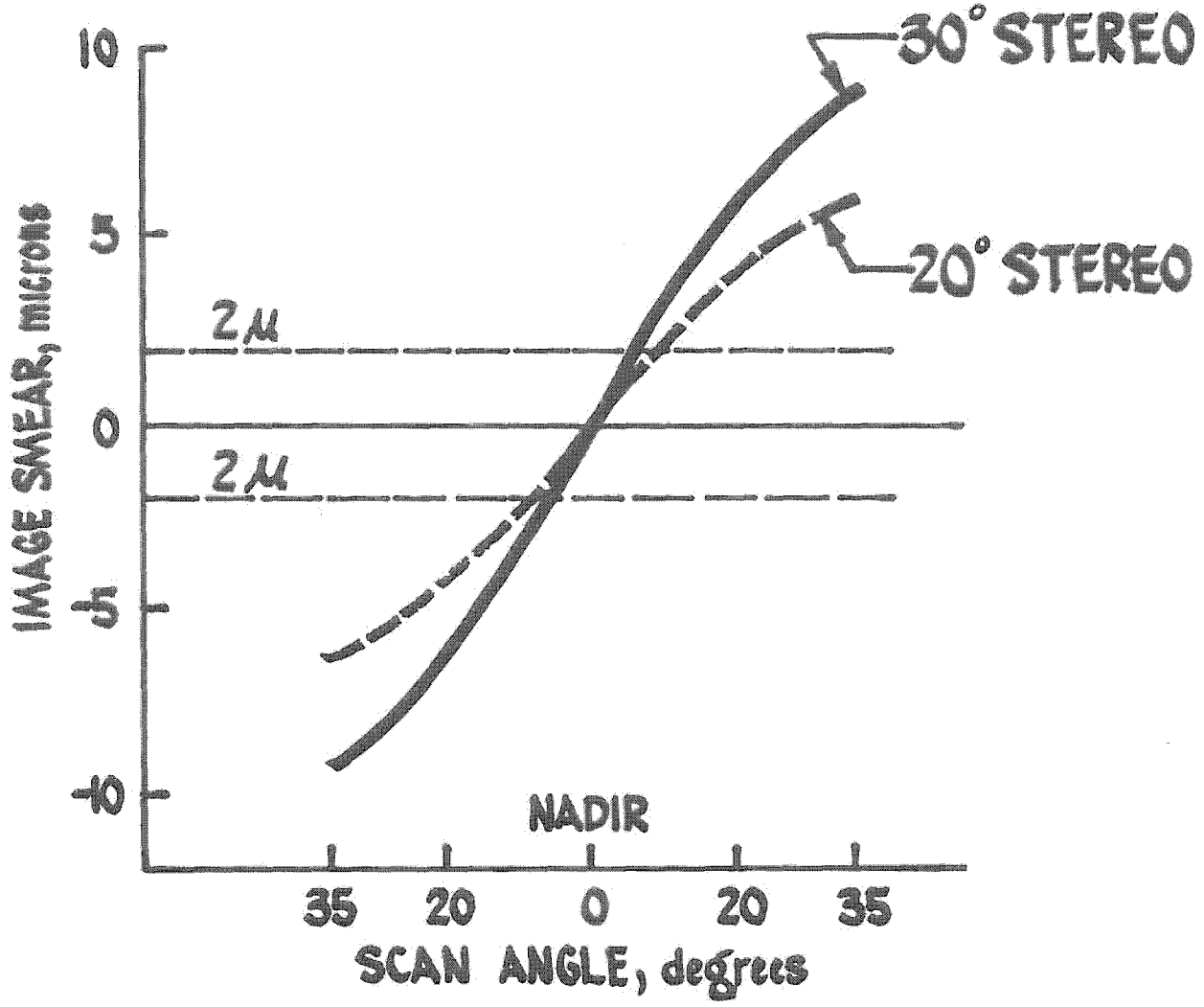
DRAG LOOPS IMPROVE C&W OPERATION (UTB)

CONCLUSION

ALL KNOWN PROBLEMS REGARDING USE OF SO-380 SOLVED

CROSSTRACK ERROR DUE TO STEREO ANGLE

UNCOMPENSATED CROSS-TRACK SMEAR



ADDITIONAL REQUIREMENTS
(CAMERA)

- REDESIGN FMC MECHANISM, FLEX BOOT, ROLLER BRACKETS, GROUND SUPPORT EQUIPMENT
- REMOUNT MCD AMP
- MODIFY J-3 SIMULATOR - A/P
- MODIFY OR REPLACE AUX. STRUCTURE