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Design & Flight Testing of a Mortar Deployed Video Imager

4/10/01, NDIA PRES.

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SAM PEREZ / DIANE WAGNER / EUGENE SCHLENK - PM MORTAR SYSTEMS, ARDEC - MORTAR PARTS, DWGS, & INFO.

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Abstract

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- ***OBJECTIVES:*** **DESIGN & DEMONSTRATE A GUN-HARDENED, "WIRELESS", DIGITALLY-ENCRYPTABLE, IMAGER SYSTEM (<$10k/imager)**
- ***SUPPORTS:*** **ARDEC QUICKLOOK STO.**
- ***PLAN:*** **APPLY COTS VIDEO AND XMTR TECHNOLOGIES & INTEGRATE INTO A MODIFIED XM930 120mm MORTAR SUBMUNITION.**
- ***CONCLUSIONS:*** **SUCCESSFULLY FLIGHT-TESTED IMAGER MORTAR TO ~2000 G'S, PCZ #1.**
- ***LESSONS LEARNED:*** **IMAGERY MUST BE ANALYZED TO DETERMINE USAGE, TLE, BDA, etc. & TO DETERMINE REQ'D. IMPROVEMENTS.**

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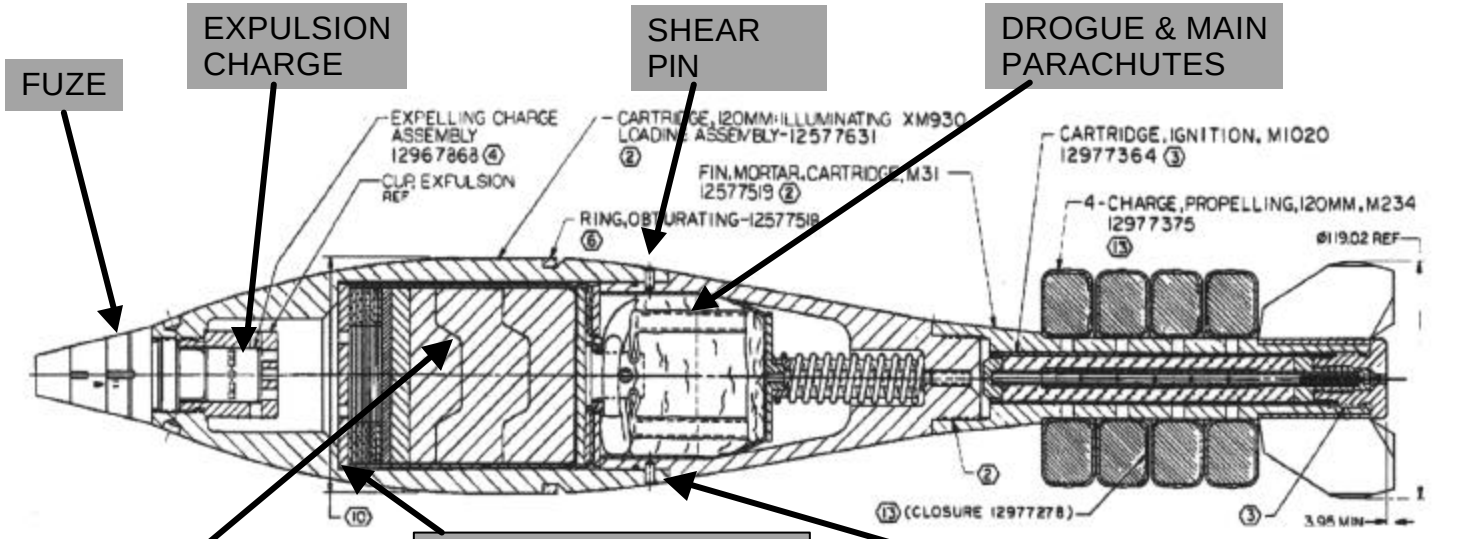
FLIGHT TEST PLATFORM – REQ.'D MODS.



1. REPLACED CANDLE LOADING ASSY. W/ IMAGER (3.68"dia.X 5.24"L)

2. REPLACED FIBERBOARD BAFFLE PLATE (.25"t) WITH STEEL PUSHER PLATE

3. TRIMMED REAR BODY JOINT EDGE (~ .160")

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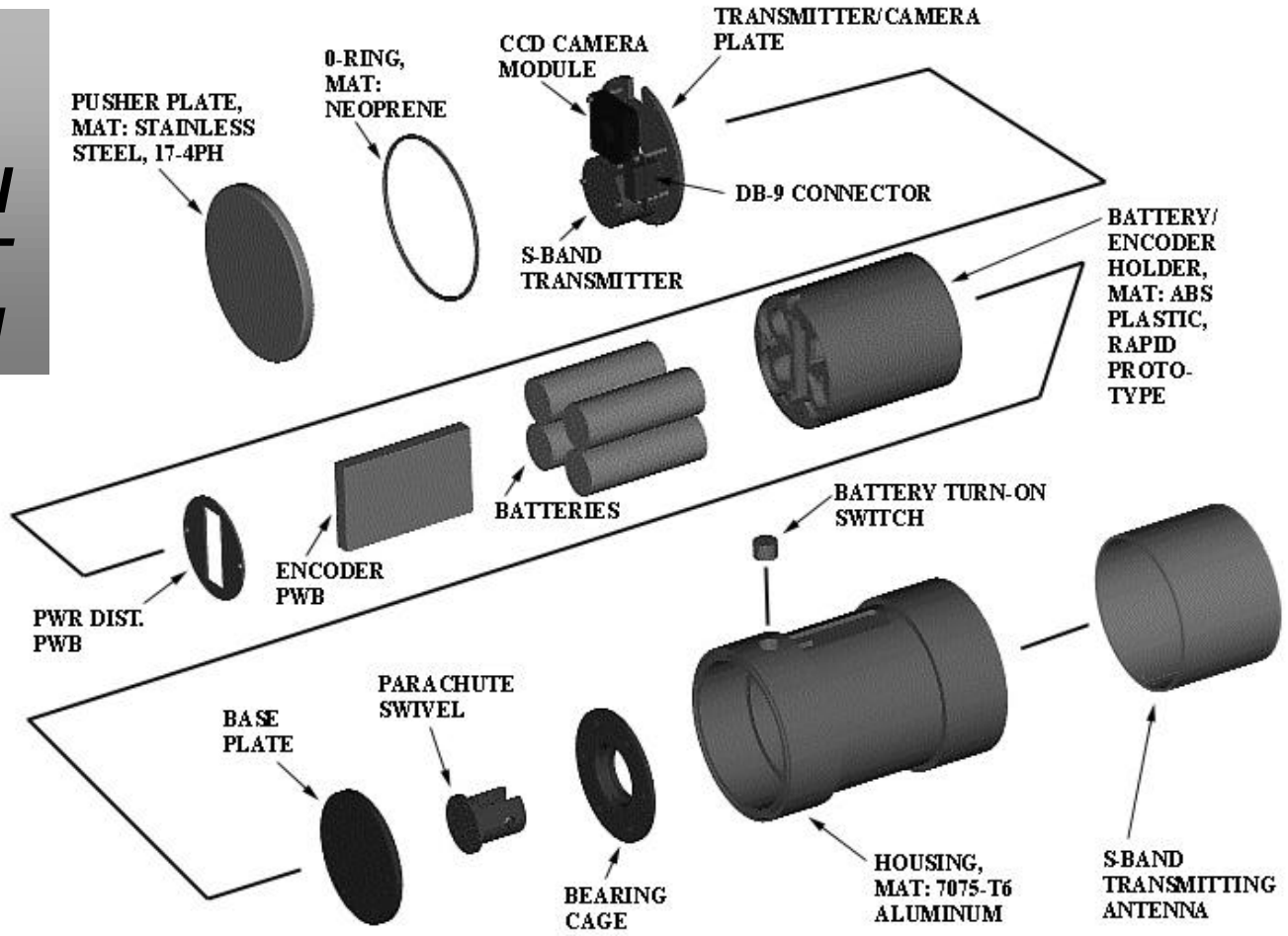
IMAGER SUB-MUNITION CONCEPT & DESIGN



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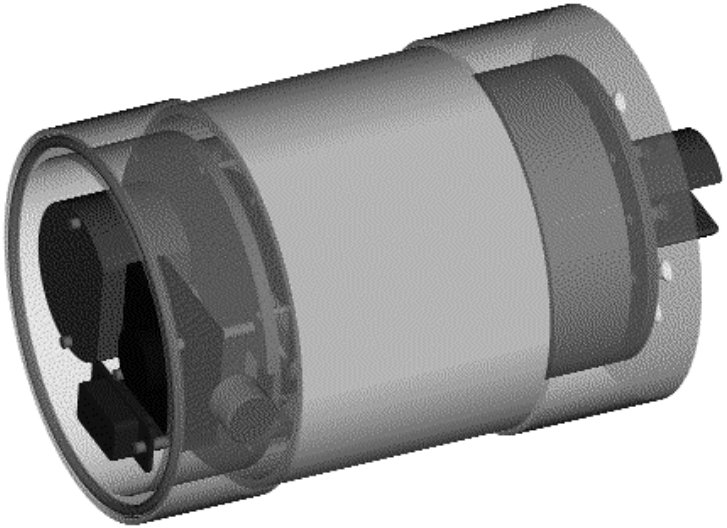
IMAGER BOM (NON-PROD. VERSION)	***$***
COTS CCD CAMERA	***120***
COTS VIDEO COMPRESSION ENCODER	***2880***
COTS XMTR, S-BAND, HI-G Q'D.	***4000***
COTS ANTENNA, S-BAND	***1525***
COTS BATTERIES, NICAD	***50***
PER UNIT COST (W/O NRE & LABOR COSTS)	***8575***



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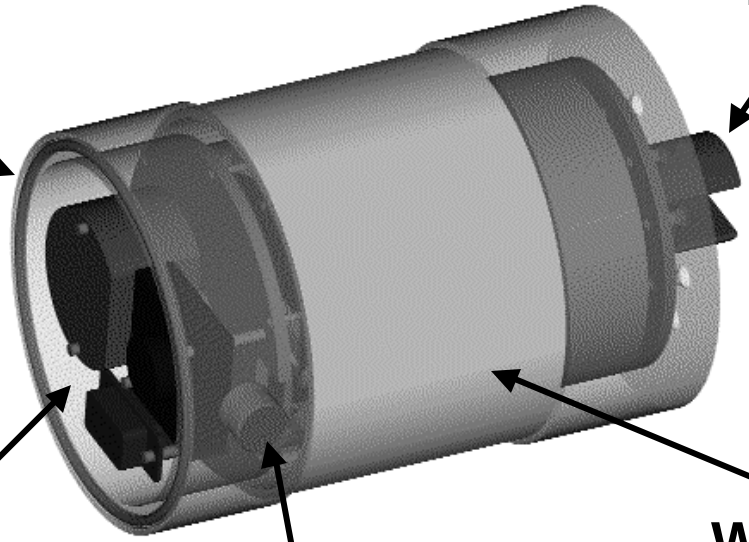
KEY DESIGN FEATURES….

O-RING SEAL FOR INTERNAL EXPULSION GAS RESISTANCE

INTERFACE TO EXISTING PARACHUTE



IMAGER FOV

ENCAPSULATE INTERIOR VOL. & COMPS. TO SHOCK-HARDEN

THRU-MORTAR-BODY MAN. TURN-ON SWITCH

INTEGRATE WRAP-AROUND ANTENNA

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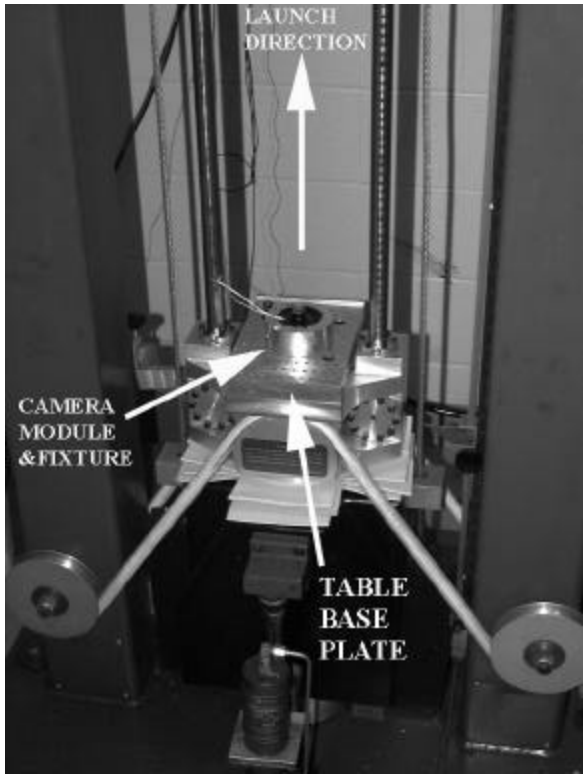
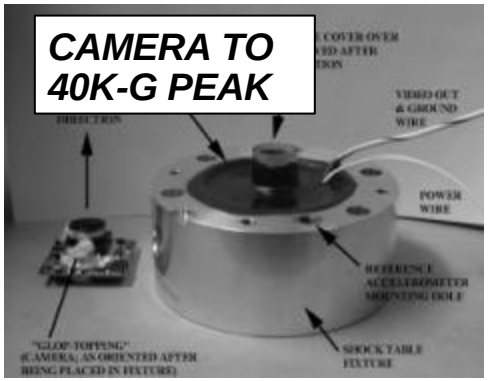
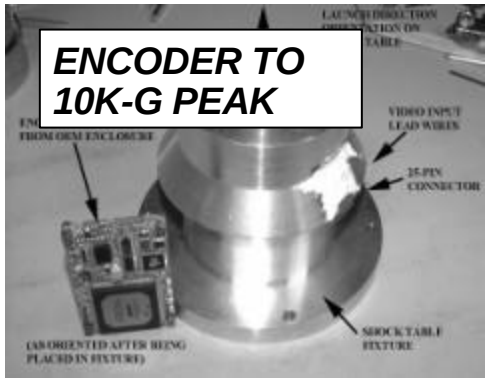
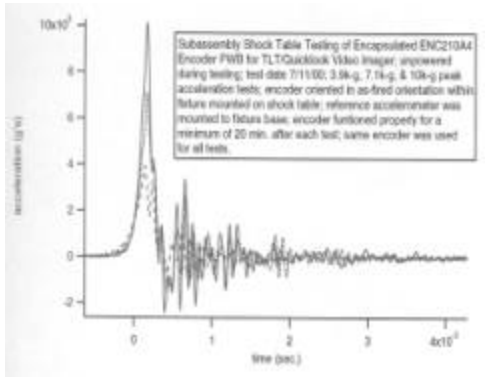
GROUND SHOCK TABLE TESTING OF IMAGER COMPONENTS…









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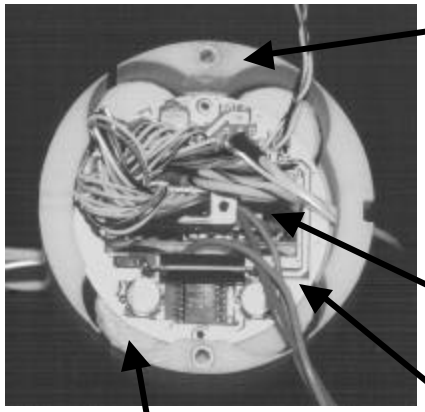
ASSEMBLE….

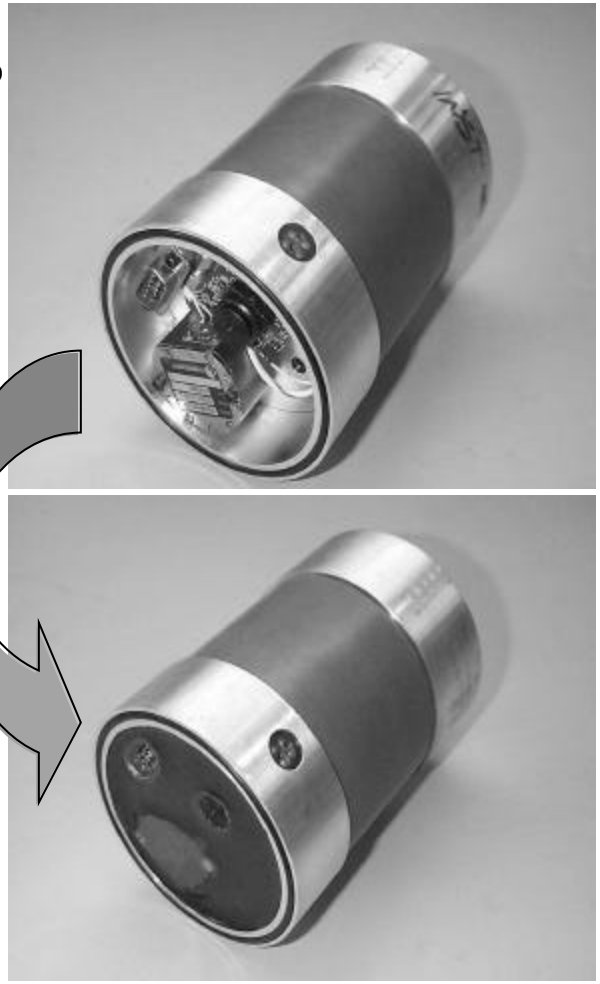


ABS PLASTIC RP BATT+ENCD'R+ PWR BOARD HOLDER (used CAE art-to-part technologies, FDM)

ENCD'R BRD (OEM as is)

PWR BRD

4X NICAD BATTS, (20min. total discharge time)



ENCAPSULATE….

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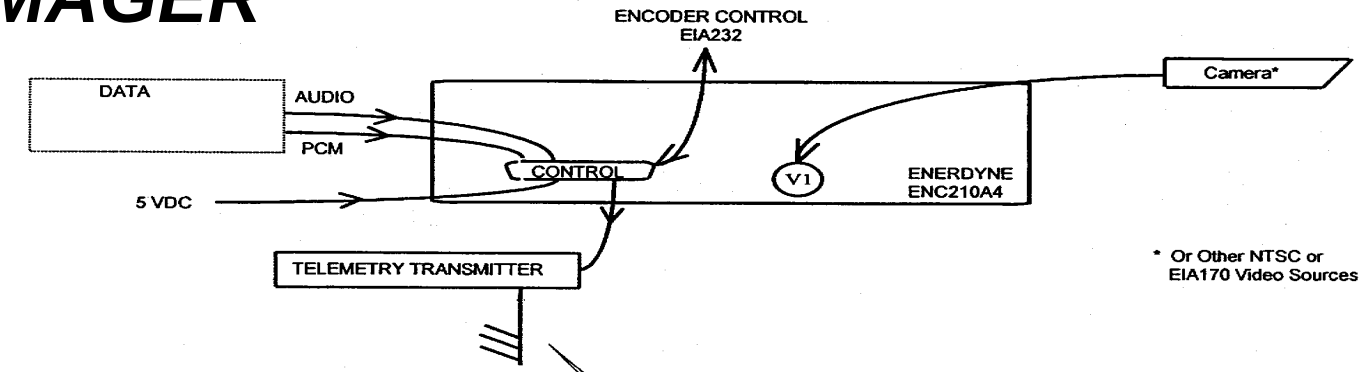
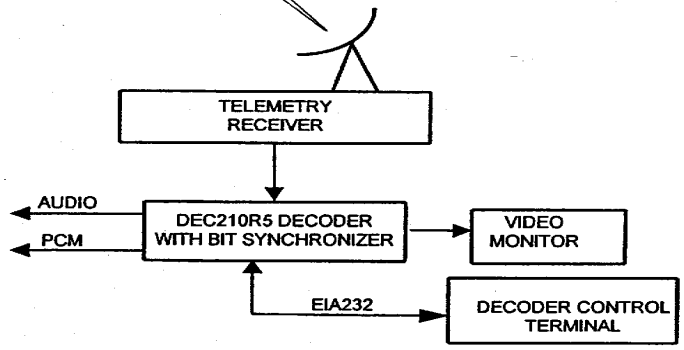
IMAGER SYSTEM

IMAGER



GROUND-STATION



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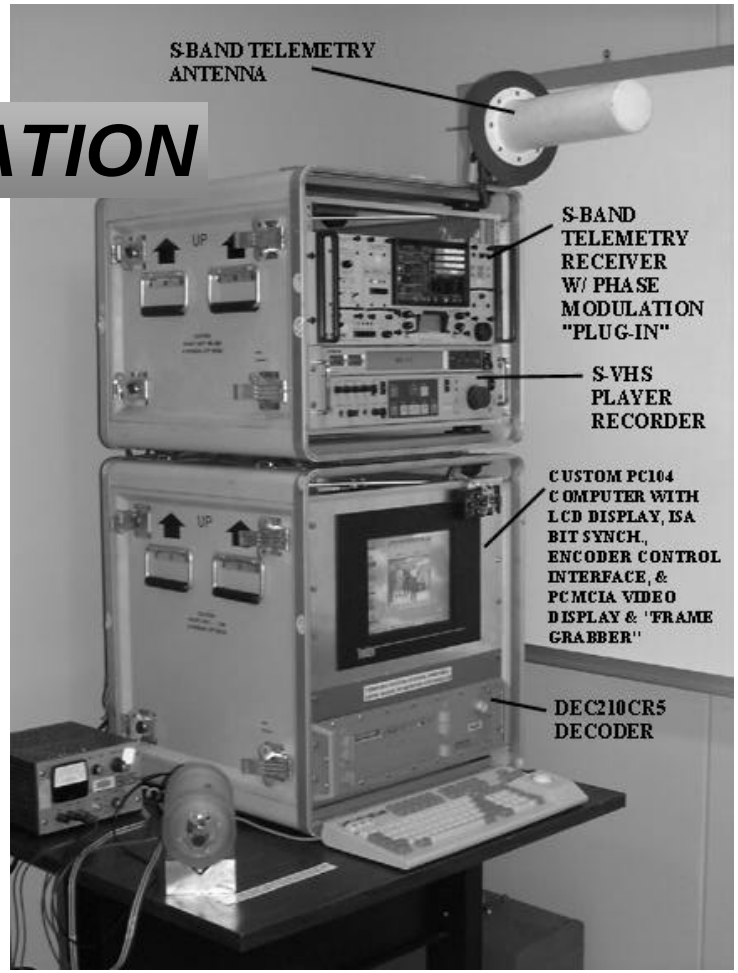
IMAGER GROUND STATION



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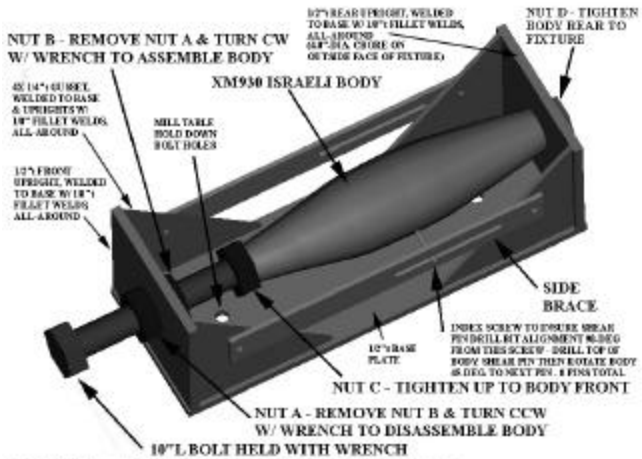
DESIGNED & BUILT A LOW-COST, IN-LAB MORTAR BODY ASSEMBLY FIXTURE

- **FOR BATTERY TURN-ON SW. PORT INSTALL.**
- **IMAGER INSTALLATION**
- **MORTAR BODY SHEAR PIN INSERTION**



XM930 ISRAELI BODY DRILL/DISASSY/ASSY FIXTURE (MASS= APPROX. 50 LBS)

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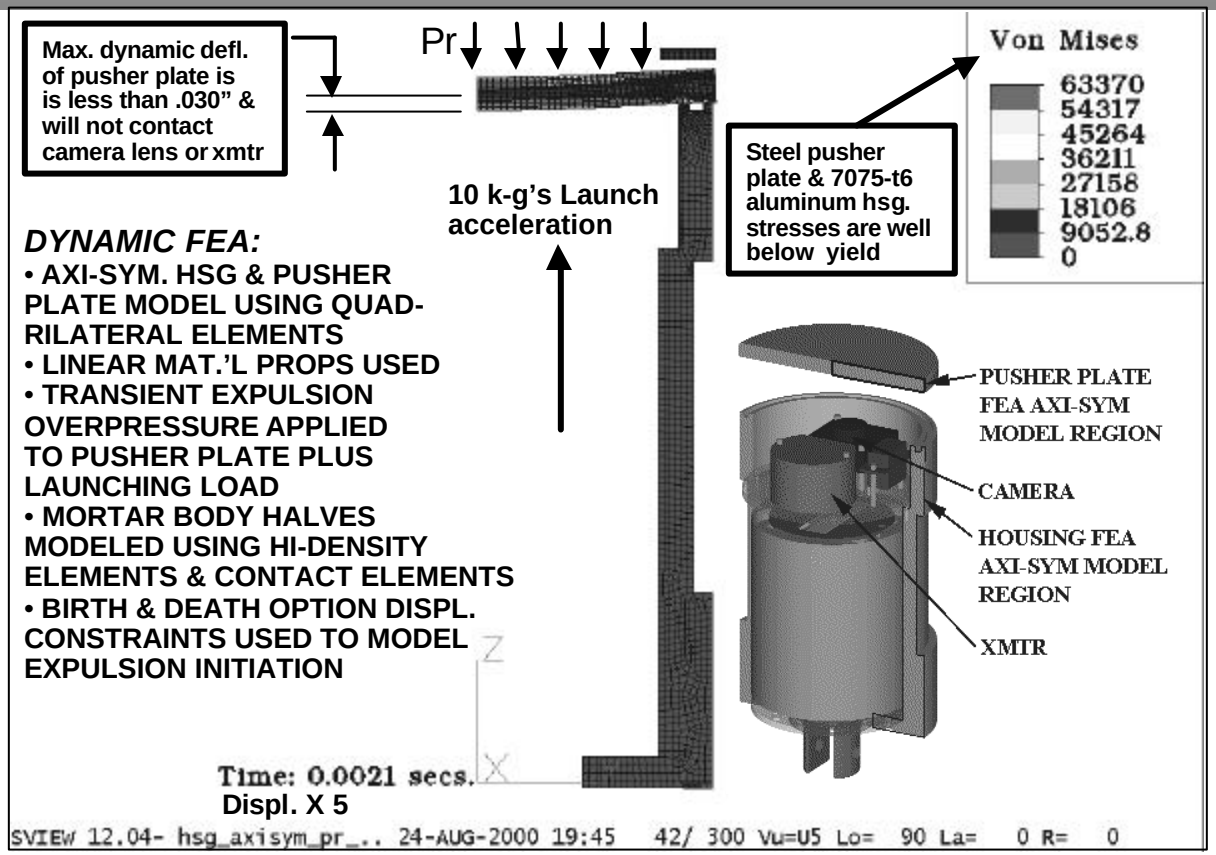
VERIFIED HSG. & PLATE STRUCTURAL INTEGRITY AND MORTAR EXPULSION DYNAMICS WITH FEA



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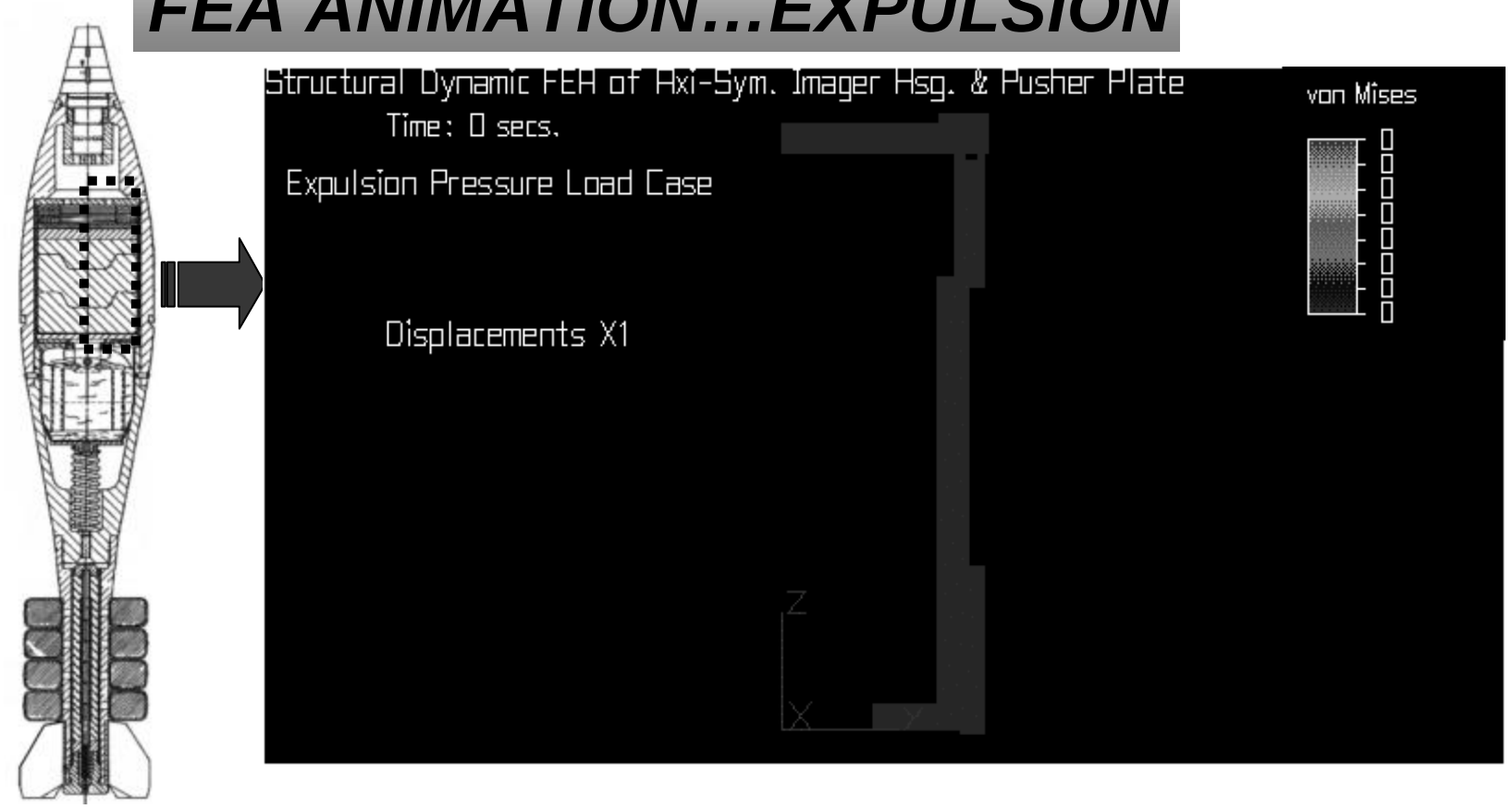
FEA ANIMATION…EXPULSION



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FLIGHT TESTED MOCKUP IMAGER ROUNDS

- **INSURED EXPULSION & CHUTE DEPLOYMENT**
- **VERIFIED INTEGRITY OF HOUSING & FEA PREDICTIONS**
- **VERIFIED INTEGRITY ANTENNA**
- **VERIFIED O-RING SEAL**
- **VERIFIED PUSHER PLATE DYNAMICS**

120mm MORTARS…WARMERS & MOCKUP IMAGER ROUND

RECOVERED MORTAR BODY HALVES AND MOCKUP IMAGER

RECOVERED MOCKUP IMAGER

MINIMAL RESIDUE DEPOSITED BY EXPUL. CHARGE GAS BLOW-BY... CAMERA LENS SHOULD BE O.K.

CONTACT PINS WERE NOT CONTACTED BY PUSHER PLATE DURING EXPULSION… CAMERA & XMTR SHOULD BE O.K.

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FLIGHT TESTING OF IMAGER MORTAR ROUND

- **PROVED IMAGER ROBUSTNESS TO TYPICAL MORTAR GUN-LAUNCHING LOADS (1500-3000 g's)…MINOR ANTENNA DAMAGE SUSTAINED IN SHOT**

- **IMAGER RECOVERED AND WAS REUSEABLE**

- **5 FR/SEC (@1.25MBITS/SEC.) ACQUIRED FOR 90 SEC. DECENT FROM EXPULSION @ 1400' ALTITUDE; INITIAL CAMERA FOV @ EXPULSION = 1616' x 1553', i.e. ~ 1m x 1m = 1 pixel**

20sec. of video from imager

20sec. of video of decending imager from camcorder on ground

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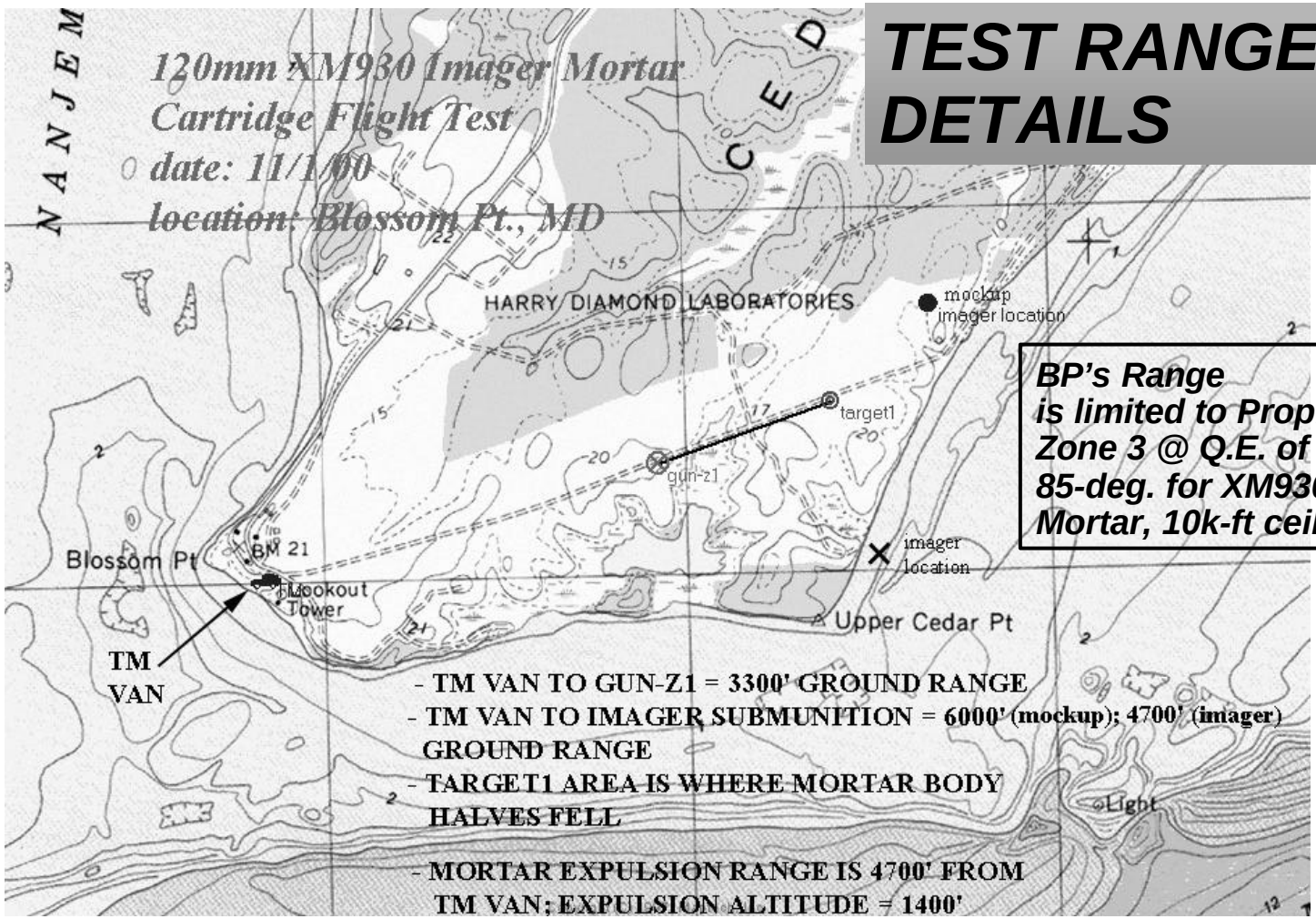
TEST RANGE DETAILS



BP's Range is limited to Prop. Zone 3 @ Q.E. of 85-deg. for XM930 Mortar, 10k-ft ceiling

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SUMMARY

- ***120mm MORTAR IMAGER CONCEPT PROVEN***
- ***IMAGER GUN-HARDENED TO ~2000 gs***
- ***IMAGER LESSONS LEARNED & FUTURE…***

• IMAGE QUALITY & USE MUST BE ADDRESSED
• ANTENNA RECEPTION ISSUES [VIDEO DROP-OUTS] MUST BE ADDRESSED
• INTEGRATE NEW HSTSS XMTR, INERTIAL SENSORS, SIG. COND., ADDITIONAL PCM ENCODER, NEW BATTERY, & GPS REC'R…SENSORS TELL WHERE IMAGER IS LOOKING
• ADDITION OF INTERNAL G-SWITCH TURN-ON FEATURE; REDUCES BATTERY VOL., ELIMINATES GUNNER TASK.