J. L. BURCH

23 SEPTEMBER 1980

MAGNETOSPHERIC MULTIPROBES

INVESTIGATIONS AND INSTRUMENTATION

SPACELAB ACTIVE EXPERIMENTS WORKING GROUP MEETING
NASA - MARSHALL SPACE FLIGHT CENTER
23 SEPTEMBER 1980

	MULTIPROBE INVESTIGATOR TEAM	J. L. BURCH NOVEMBER 5, 1979

PRINCIPAL INVESTIGATOR:	J. L. BURCH	S W R I
CO-INVESTIGATORS:	C. R. CHAPPELL	M S F C
	S. A. FIELDS	
	C.-G. FÄLTHAMMER	SWEDISH ROYAL INSTITUTE OF TECHNOLOGY
	J. D. WINNINGHAM	S W R I
	W. B. HANSON R. A. HEELIS W. J. HEIKKILA	U T - DALLAS
	M. SUGIURA	G S F C
	W. H. FARTHING	
	S. D. SHAWHAN	S U I
	H. R. ANDERSON	R I C E

	MULTIPROBE SCIENTIFIC OBJECTIVES	J. L. BURCH NOVEMBER 5, 1979

- DETERMINE THE SPATIAL STRUCTURE OF PLASMA PHENOMENA SUCH AS THE AURORA, CONVECTION REVERSALS, AND ION TROUGHS

- SEPARATE SPATIAL AND TEMPORAL VARIATIONS IN THESE PHENOMENA

- DETERMINE FIELD-ALIGNED CURRENT DENSITIES BY MEASURING CURL $\overline{B}$ AND APPLYING THE MAXWELL EQUATION CURL $\overline{B} = \mu_o \overline{J}$

- PERFORM MULTIPLE-POINT ANALYSES OF PARTICLE BEAMS, WAVE FIELDS AND PLASMA CLOUDS THAT ARE INJECTED INTO THE IONOSPHERE AND MAGNETOSPHERE BY SPACELAB ACTIVE EXPERIMENT FACILITIES

- MISSION A

  INITIAL: A CLUSTER COVERING A VOLUME WITH DIMENSIONS IN THE RANGE OF 1 km TO 20 km.

  FINAL: LINEAR TRAIL WITH INTERPROBE SPACINGS OF 1 km TO 100 km.

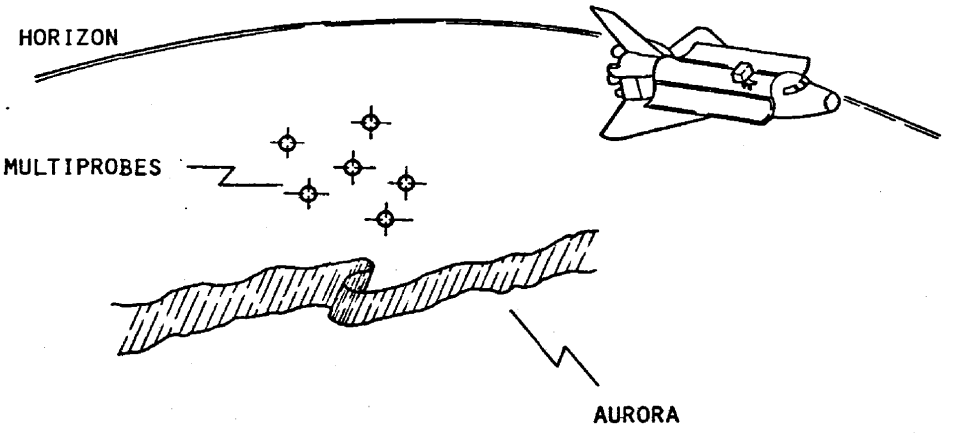
- MISSION B

  LINEAR TRAIL WITH INTERPROBE SPACINGS OF 600 km TO 6000 km.

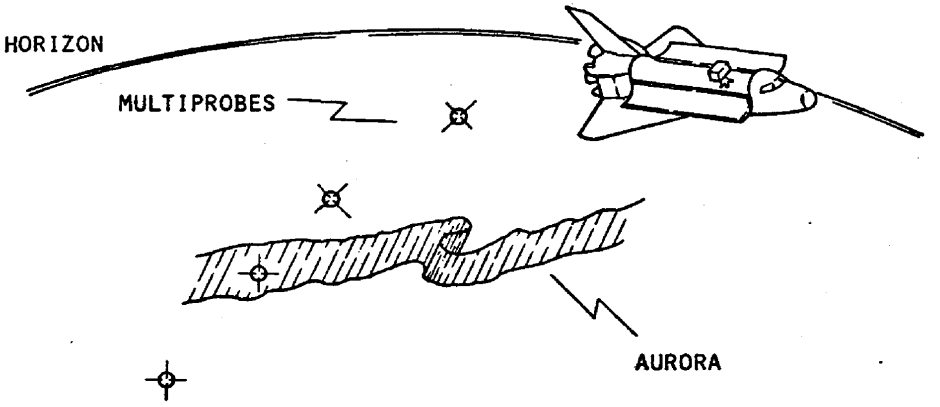
- POSITION DETERMINATION

  200 METERS (MISSION A)

  1 KILOMETER (MISSION B)



MISSION A (CONFIGURATION 1)



MISSION A (CONFIGURATION 2)

ELECTRON BEAM INJECTION EXPERIMENT
WITH MULTIPROBES

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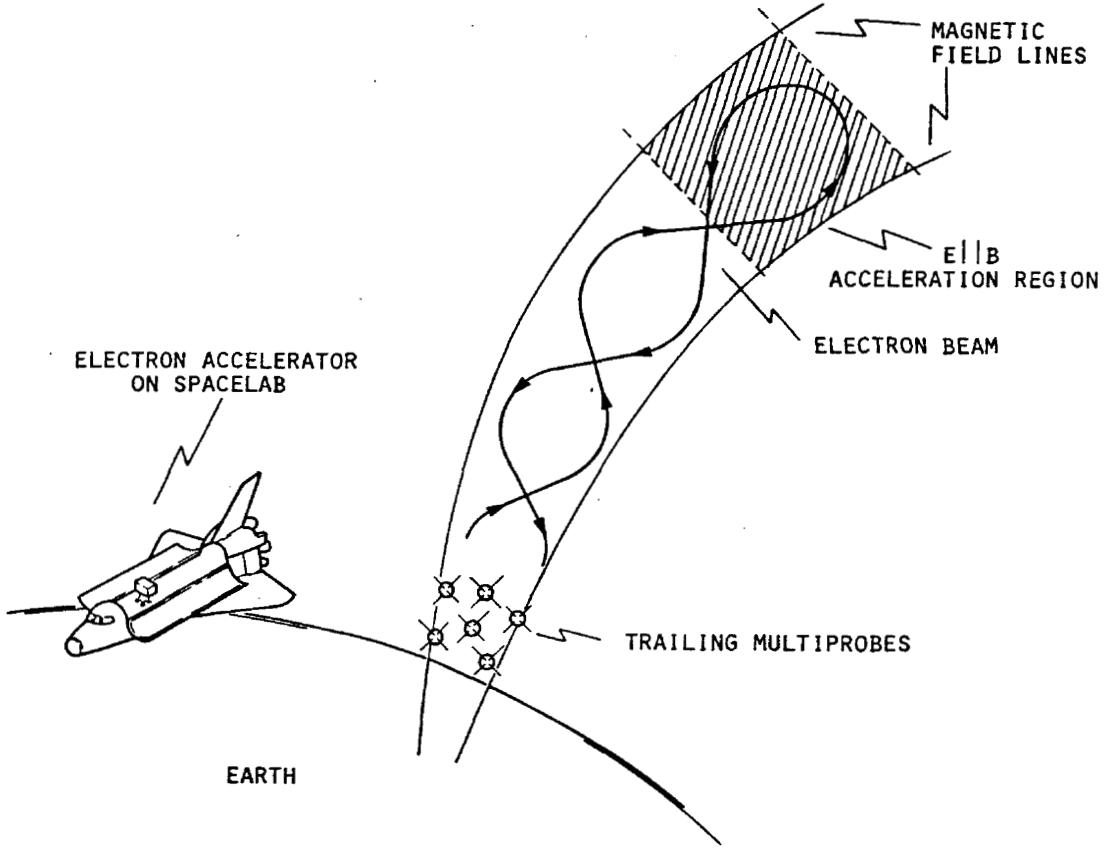

	MULTIPROBE SCIENTIFIC MEASUREMENTS	J. L. BURCH
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BASIC COMPLEMENT

- VECTOR MAGNETIC FIELD WITH ACCURACY OF 50 nT AND SPATIAL RESOLUTION OF 200 METERS.
- VECTOR ELECTRIC FIELD WITH ACCURACY OF 5 mV/m AND SPATIAL RESOLUTION OF 200 METERS.
- ELECTRON DENSITY AND TEMPERATURE WITH SPATIAL RESOLUTION OF LESS THAN 1 km.
- ENERGY SPECTRA AND PITCH-ANGLE DISTRIBUTIONS OF SUPRATHERMAL ELECTRONS FOR ENERGIES OF 5 eV TO 30 keV WITH AT LEAST TEN COMPLETE ENERGY SCANS PER SPIN PERIOD.

OPTIONS

- VECTOR ION DRIFT WITH ACCURACY OF 100 m/s, AND SPATIAL RESOLUTION OF LESS THAN 10 km.
- THERMAL ION TEMPERATURE AND COMPOSITION OVER MASS RANGE OF 1 TO 56 AMU.

MULTIPROBE WITH DEPLOYED BOOMS AND ANTENNAS

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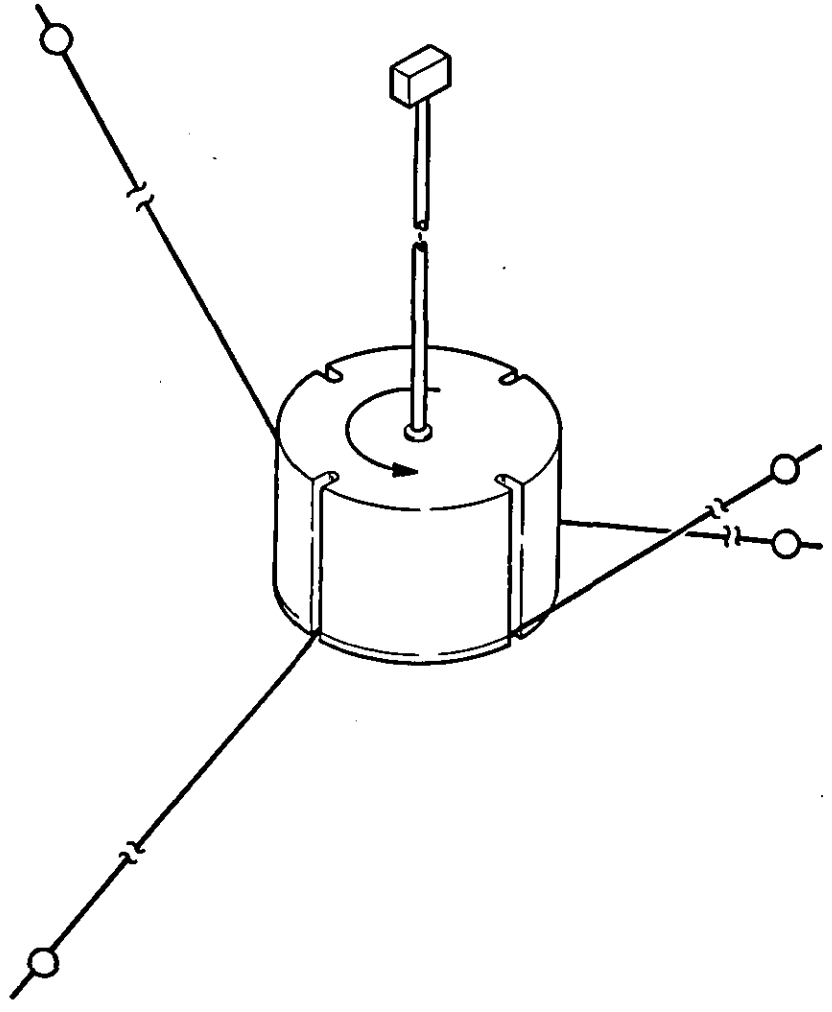

MULTIPROBE CLUSTER FOR CURRENT MEASUREMENTS

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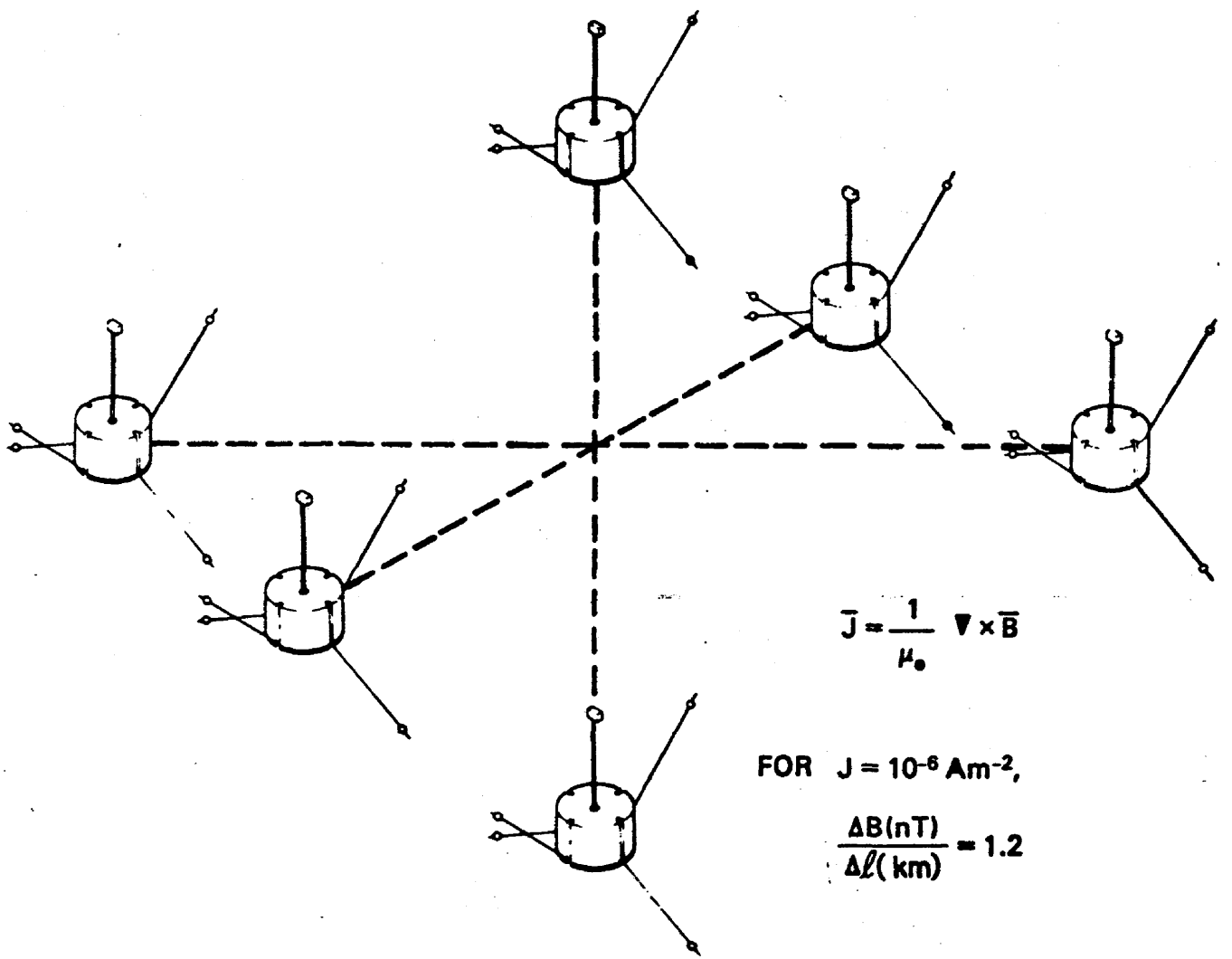

$$\bar{J} = \frac{1}{\mu_o} \nabla \times \bar{B}$$

FOR $J = 10^{-6}\ Am^{-2}$,

$$\frac{\Delta B(nT)}{\Delta \ell(km)} = 1.2$$

MULTIPROBE INVESTIGATION OF STRUCTURE AND DYNAMICS OF ION TROUGH

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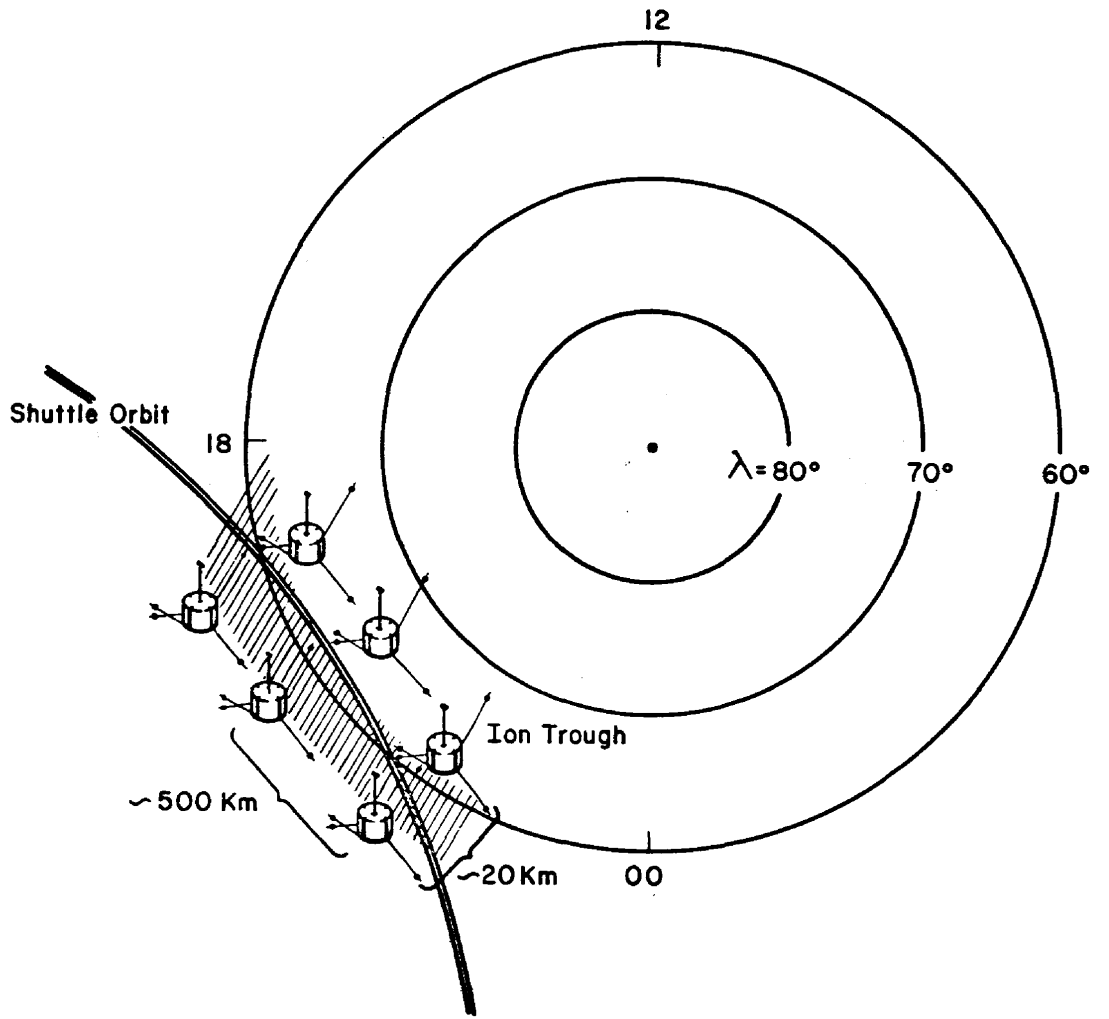

MMP INVESTIGATION OF FLOW REVERSALS (CLEFT AND HARANG DISCONTINUITY)

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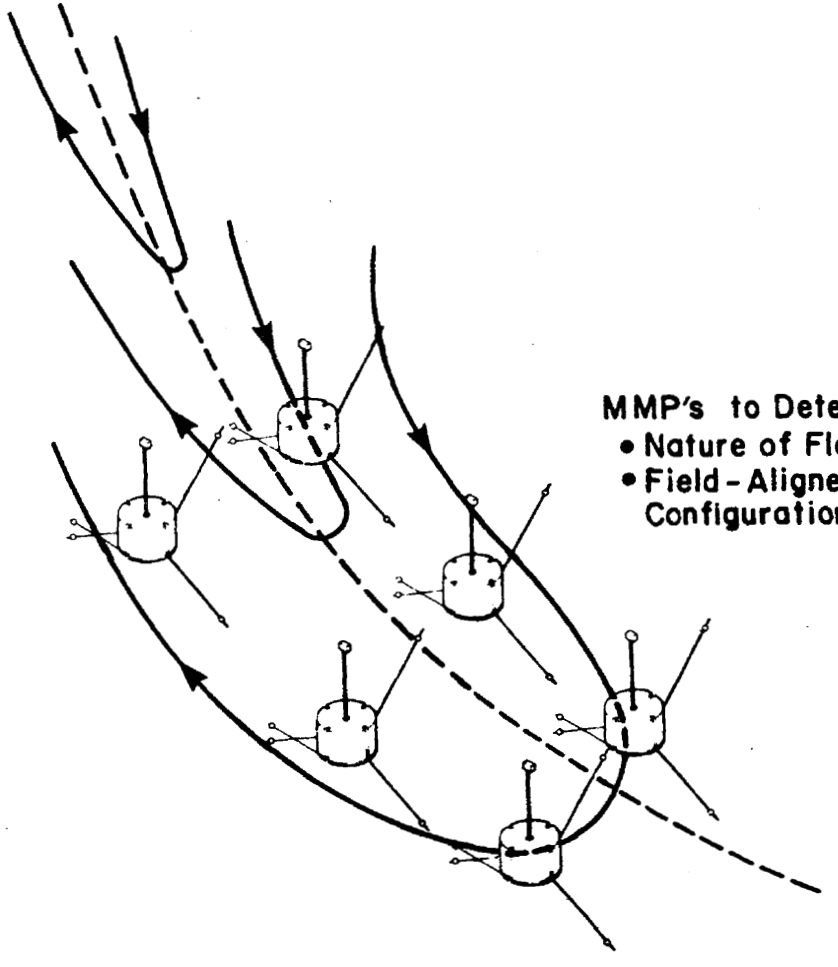

MMP's to Determine
- Nature of Flow Reversal
- Field-Aligned Current Configuration

USE OF MULTIPROBES IN WISP WAVE INJECTION EXPERIMENTS

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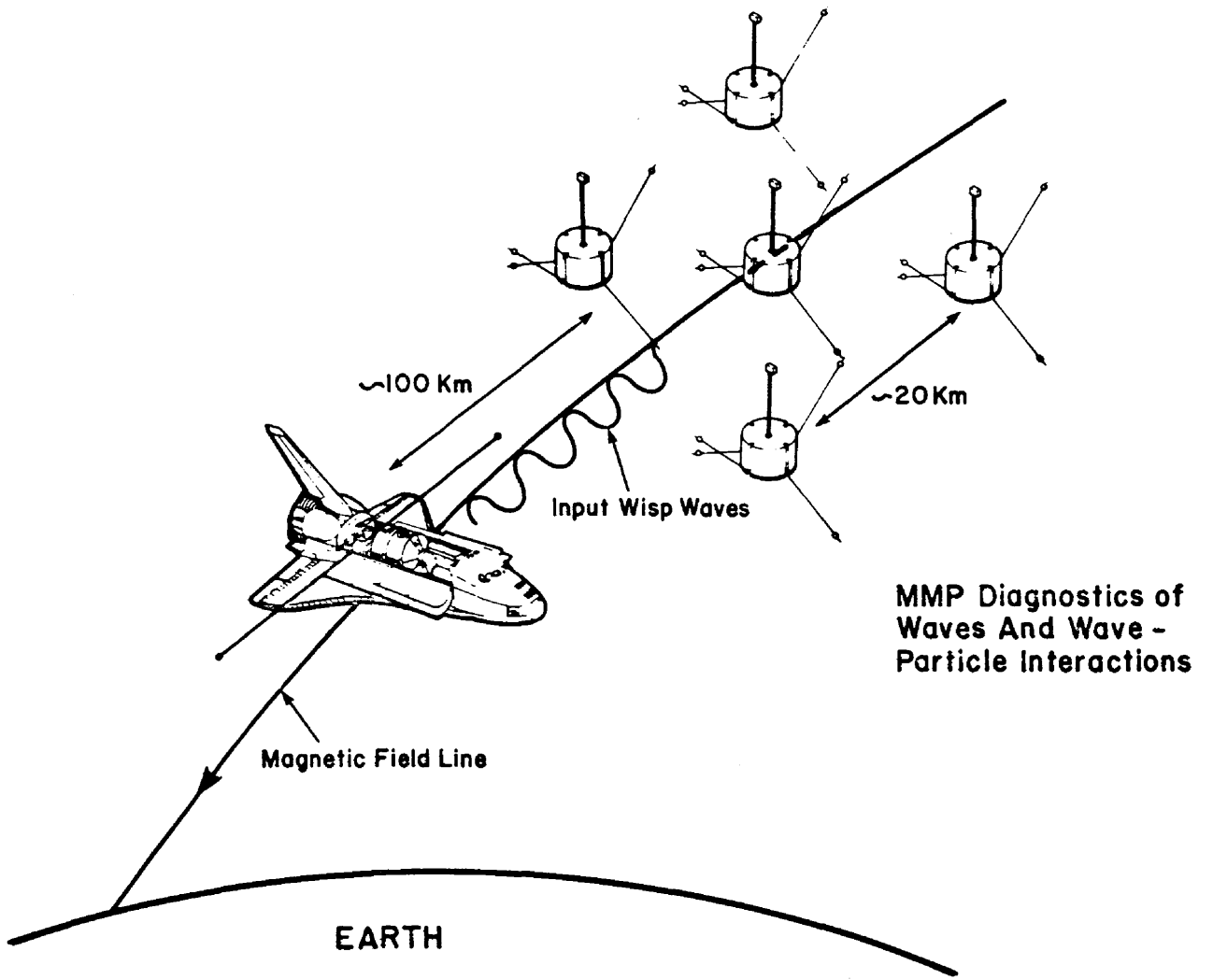

MMP Diagnostics of Waves And Wave - Particle Interactions

USE OF MULTIPROBES IN SEPAC BEAM-PLASMA EXPERIMENTS

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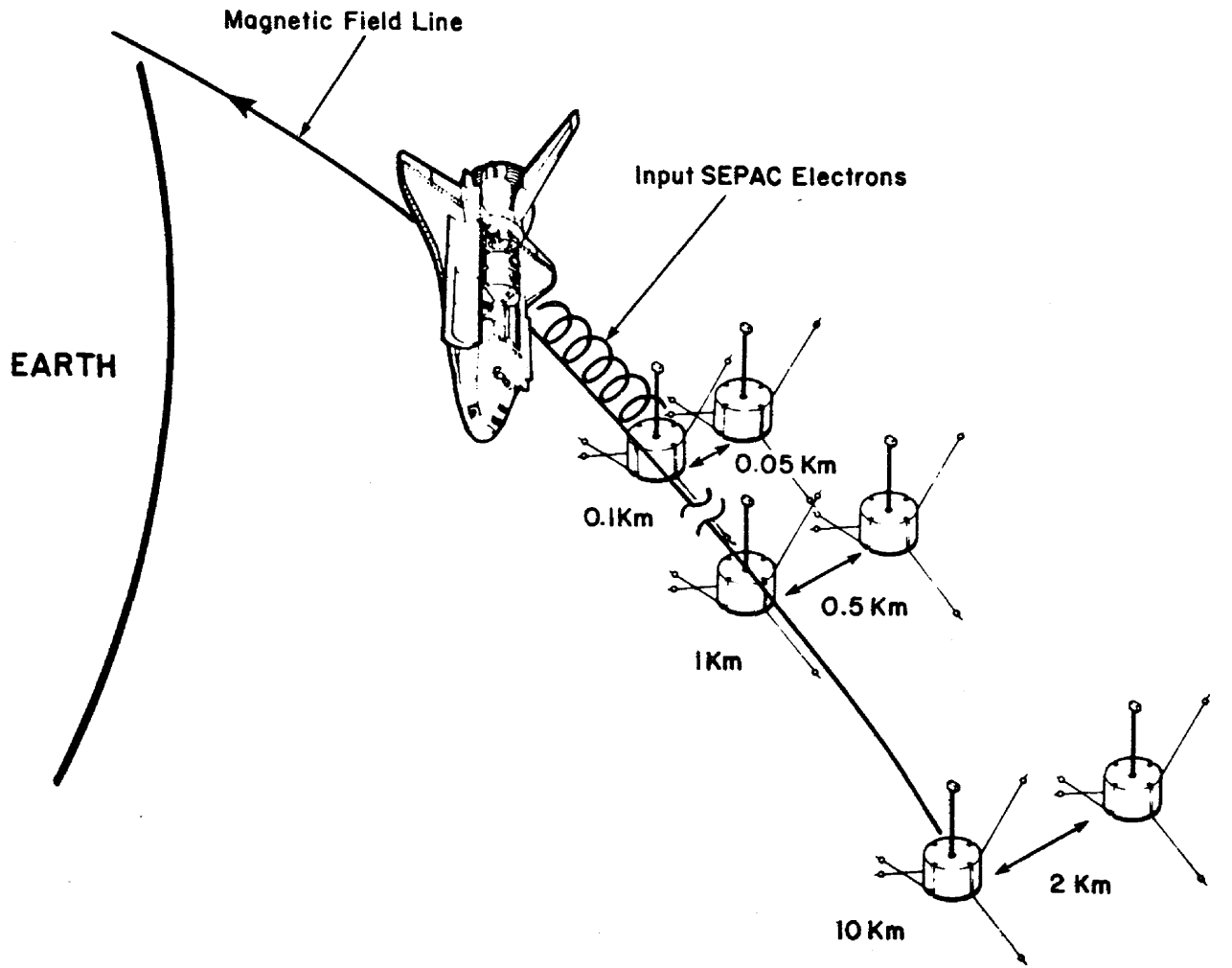

USE OF MULTIPROBES WITH ELECTRODYNAMIC TETHER

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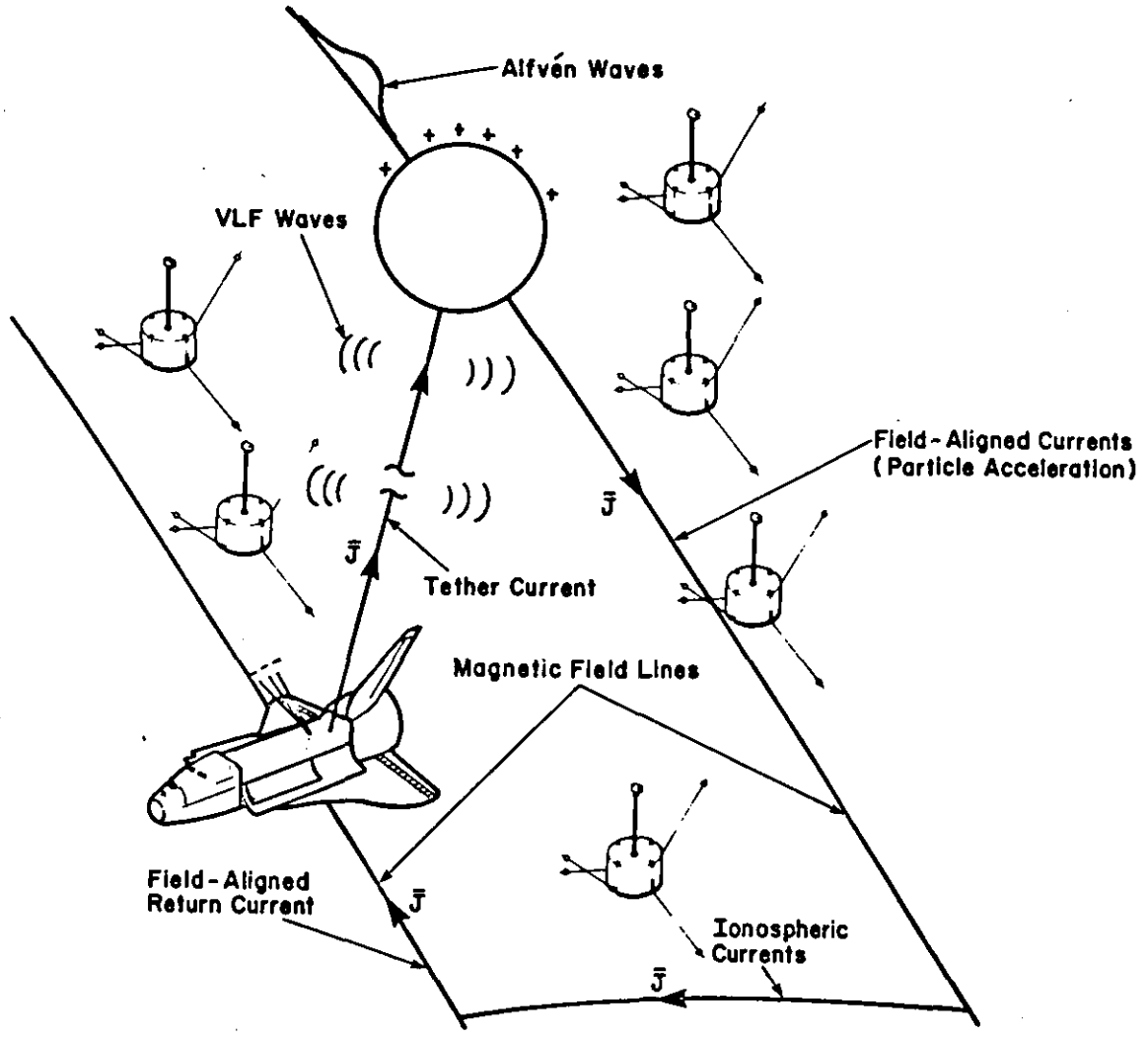

MULTIPROBE INVESTIGATION OF TRANSVERSE ION ACCELERATION

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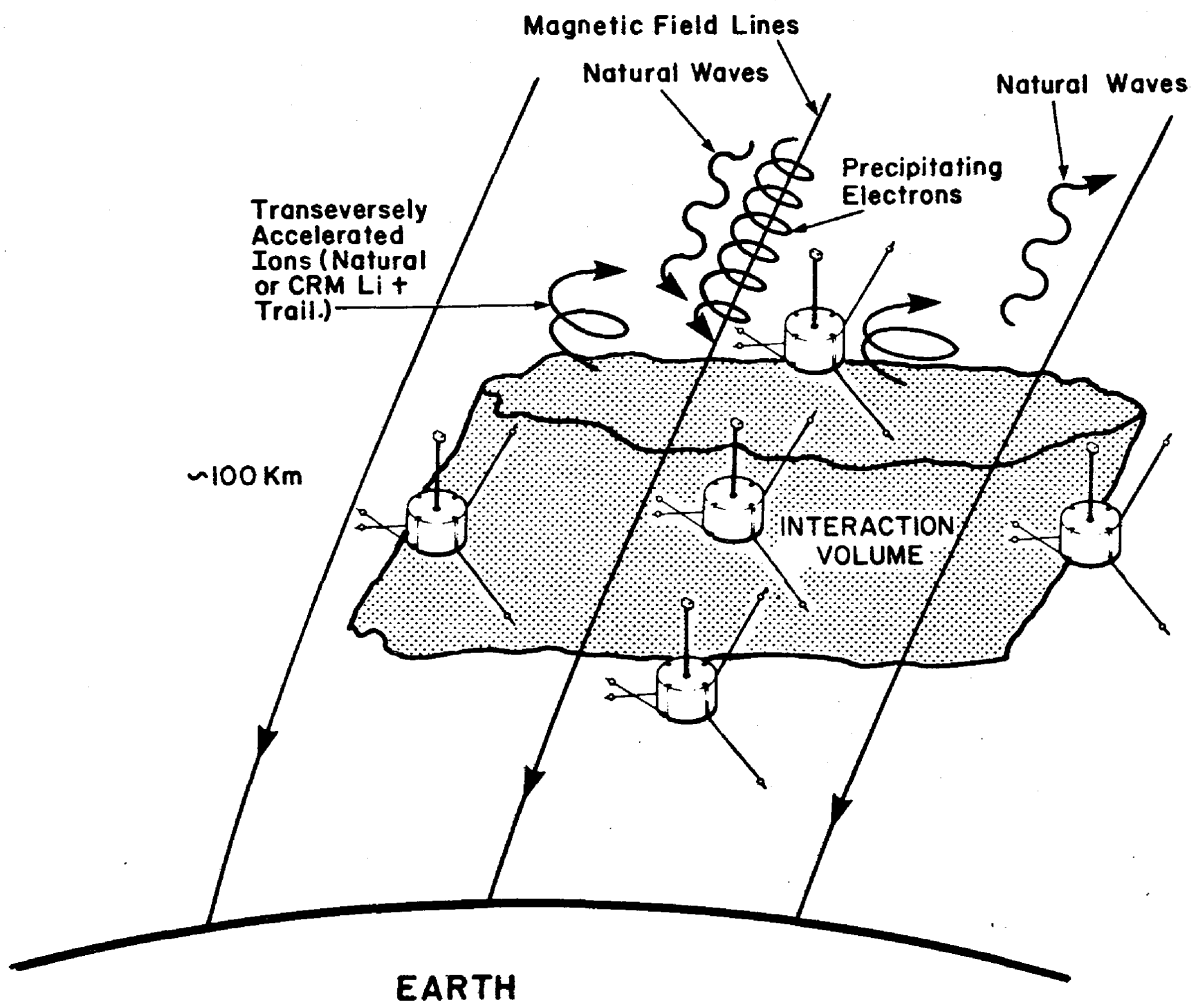

USE OF MULTIPROBES IN CRM CONDUCTIVITY MODIFICATION EXPERIMENTS

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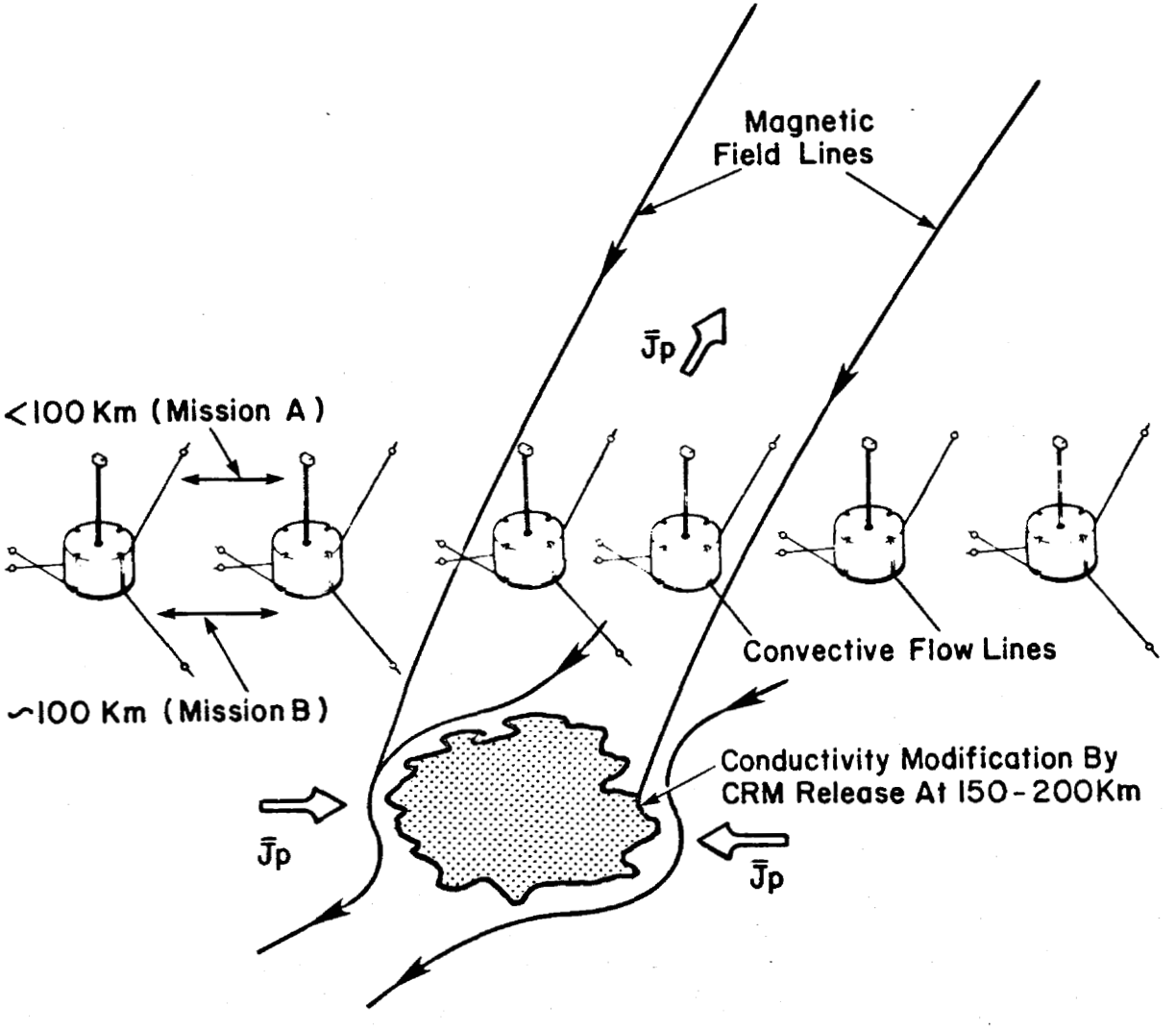

MULTIPROBE STOWAGE AND EJECTION SYSTEM

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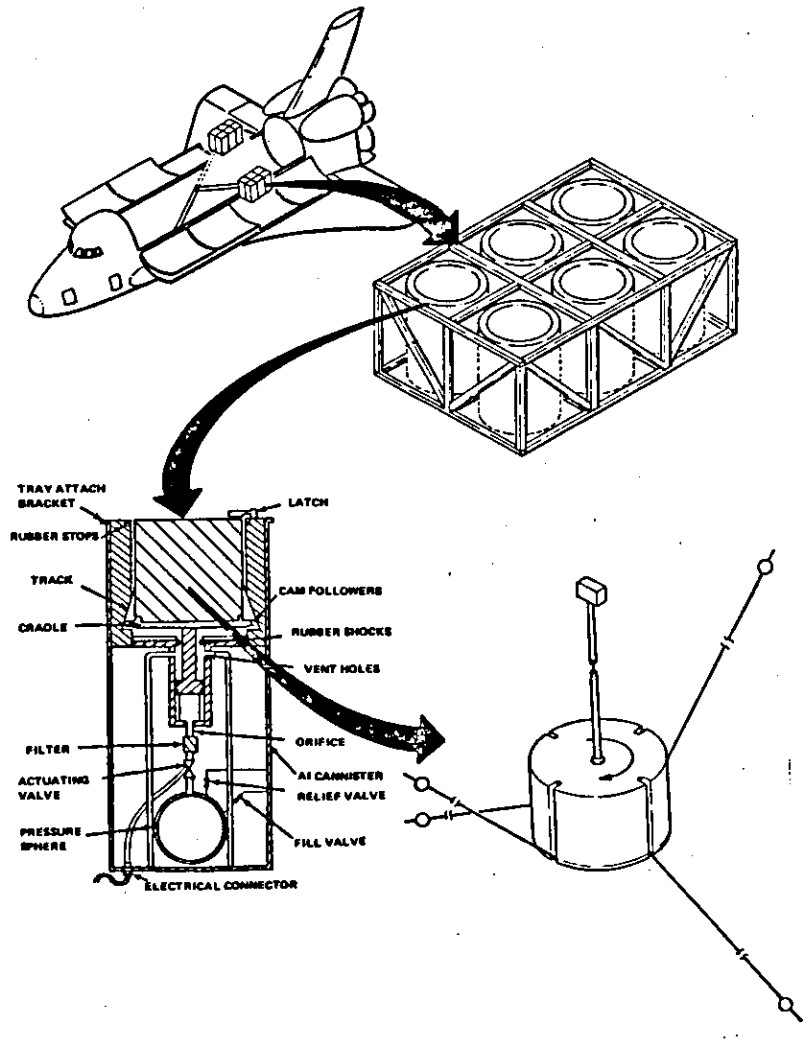

PLAN VIEW OF ASSEMBLED MULTIPROBE SUBSYSTEMS

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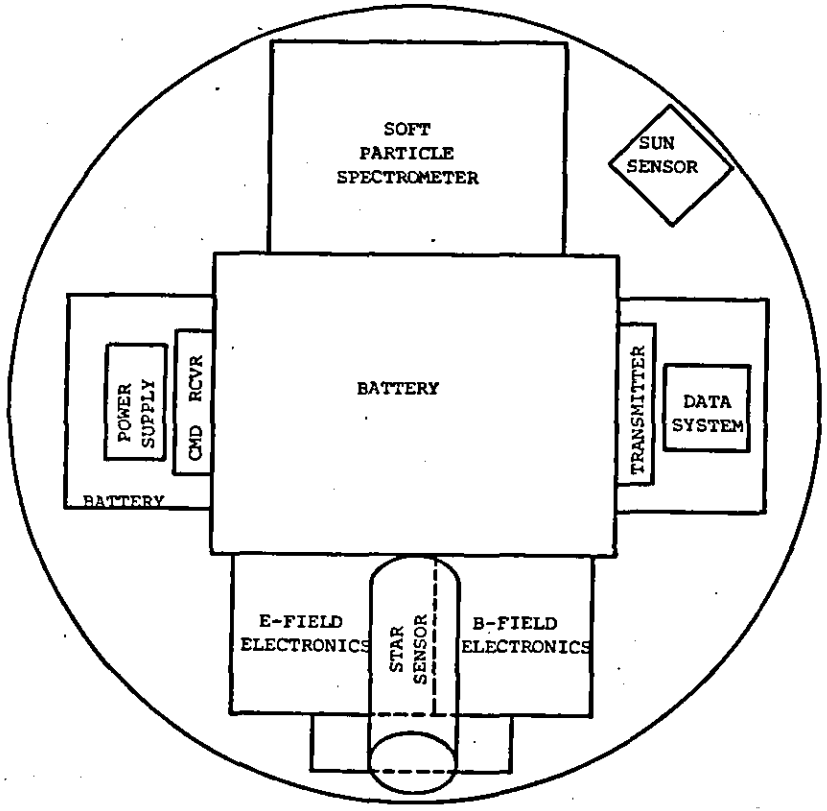

CUTAWAY VIEW OF ASSEMBLED MULTIPROBE

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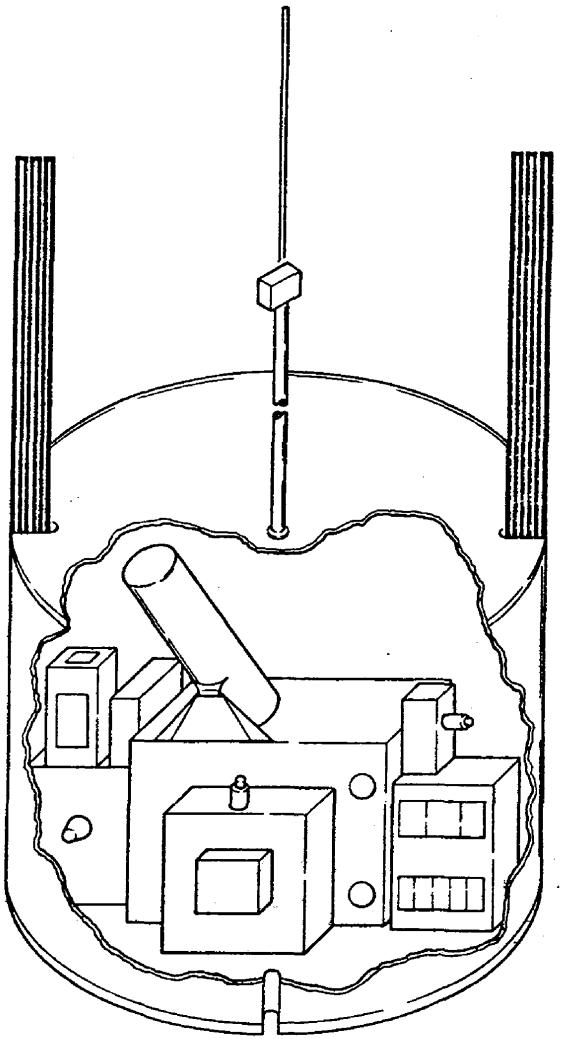

DIAM: 60 cm

HEIGHT: 38 cm

MASS: 50 kg

MULTIPROBE SYSTEM BLOCK DIAGRAM

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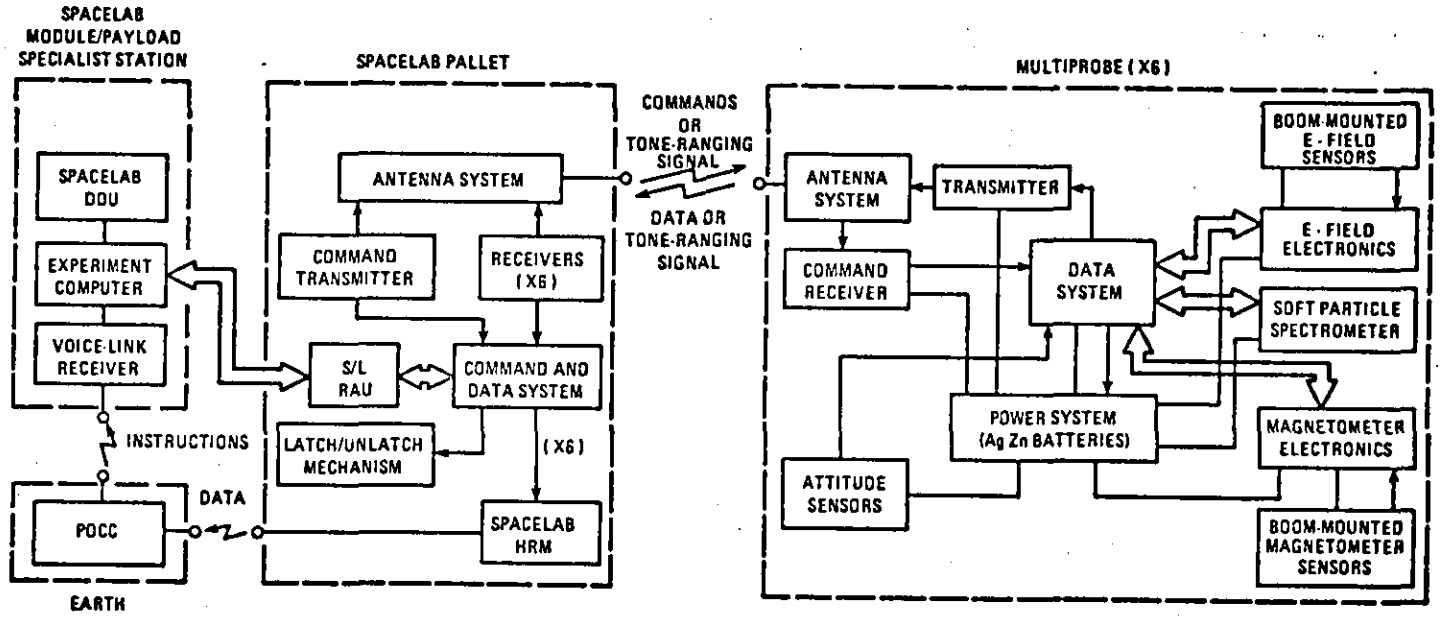

MULTIPROBE SYSTEM MOUNTED ON SPACELAB PALLET

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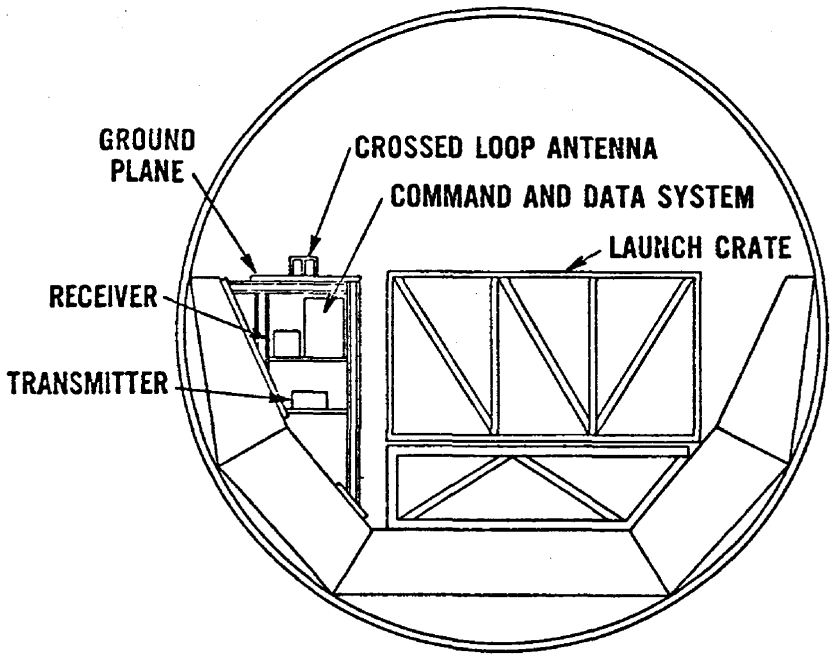

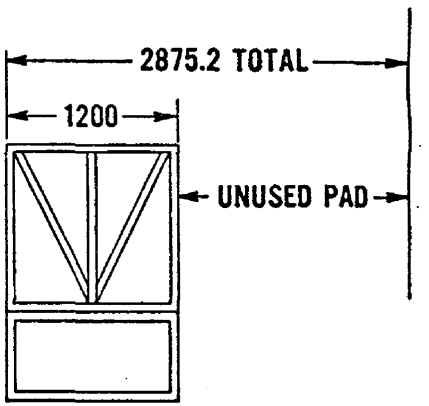

	MULTIPROBE TRADE STUDIES	J. L. BURCH
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INSTRUMENT ACCOMMODATIONS

- EVALUATE MEANS OF PROVIDING MECHANICAL MOUNTING FIXTURES FOR EACH INSTRUMENT WITH SERVICEABILITY AS A CONSIDERATION
- EVALUATE ELECTRICAL INTERFACE CIRCUITS NECESSARY TO PROVIDE COMMAND AND DATA SUPPORT TO EACH INSTRUMENT
- EVALUATE POWER CIRCUIT INTERFACE REQUIREMENTS FOR FUSING AND CONTROL CONSIDERATIONS
- EVALUATE EMI ENVIRONMENT FOR INSTRUMENT CONTAMINATION CONSIDERATIONS

POWER

- EVALUATE THE SUITABILITY OF VARIOUS BATTERY TECHNOLOGIES (INCLUDING LITHIUM, AgZn, AND NiCd BATTERIES) FOR THE MULTIPROBE POWER SUBSYSTEM

ATTITUDE DETERMINATION

- EVALUATE THE USE OF SUN SENSORS, HORIZON SENSORS, AND STAR SENSORS FOR DETERMINING 3-AXIS ATTITUDE TO THE REQUIRED 0.1^{o}

ELECTRIC FIELD ANTENNAS

- EVALUATE THE SUITABILITY OF VARIOUS TYPES OF ANTENNAS, INCLUDING HINGED, TAPE AND WIRE

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STOWAGE AND EJECTION

- EVALUATE THE FOLLOWING ALTERNATIVE MEANS OF STOWING AND EJECTING MULTIPROBES AT SPACELAB:

  (1) COLD-GAS DRIVEN PISTON EJECTION FROM A MODIFIED IECM FRAME

  (2) SPIN-UP AND EJECTION BY A SPECIAL PURPOSE END EFFECTOR ON THE RMS, AS IN THE PDP

  (3) SPIN-UP AND EJECTION FROM THE RMS BY A COLD-GAS SYSTEM INTERNAL TO EACH MULTIPROBE

THERMAL CONTROL

- EVALUATE VARIOUS PASSIVE AND ACTIVE MEANS OF CONTROLLING THE THERMAL ENVIRONMENT OF THE ENTIRE PALLET-MOUNTED MULTIPROBE SYSTEM AND OF EACH INDIVIDUAL DEPLOYED MULTIPROBE.

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TRACKING

- EVALUATE THE FOLLOWING ALTERNATIVE METHODS FOR OBTAINING POSITION DETERMINATION TO AN ACCURACY OF 200 m:

  (1) TONE-RANGING WITH DIRECTIONAL ANTENNAS

  (2) TONE-RANGING WITH OPTICAL FIXES AND ORBITAL MECHANICS CALCULATIONS

  (3) GLOBAL POSITIONING SYSTEM

  (4) ORBITER RENDEZVOUS RADAR WITH TRANSPONDERS

COMMUNICATIONS

- EVALUATE USE OF THE 401 TO 402 MHz BAND WITH DEDICATED MULTIPROBE TRANSMITTER AND RECEIVERS ON SPACELAB AND, ALTERNATIVELY, S-BAND COMMUNICATIONS WITH THE ORBITER PAYLOAD INTERROGATOR.

COMMAND AND DATA MANAGEMENT

- EVALUATE OPTIONS FOR THE PROCESSING OF COMMANDS AND DATA ON BOARD SPACELAB AND AT EACH MULTIPROBE. IDENTIFY THE NEED FOR AND THE UTILIZATION OF THE SPACELAB DDU AND EXPERIMENT COMPUTER, A SPACELAB-BASED DEP, COMMAND ENCODER, AND DATA ACQUISITION SYSTEM, AND A MULTIPROBE-BASED COMMAND DECODER AND DATA ACQUISITION SYSTEM.

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PAYLOAD AND MISSION SPECIALIST SUPPORT

- DEFINE THE ROLE OF CREW MEMBERS IN EJECTING AND TRACKING MULTIPROBES
- DEFINE THE ROLE OF CREW MEMBERS IN CONTROLLING THE MULTIPROBES IN ORBIT IN COORDINATION WITH OTHER SPACELAB FACILITIES SUCH AS WISP AND SEPAC

FUNCTIONAL OBJECTIVES

- DEFINE SCIENTIFIC EXPERIMENTS TO BE CARRIED OUT WITH THE MULTIPROBES AND IDENTIFY OTHER REQUIRED SPACELAB FACILITIES
- DEVELOP A STRAWMAN MISSION TIMELINE TO INCLUDE EFFECTS OF MULTIPROBE ORBITAL MECHANICS AND SEPAC AND WISP BEAM AND WAVE INJECTION CHARACTERISTICS

ORBITAL ANALYSIS

- EVALUATE FEASIBILITY OF ACHIEVING THE REQUIRED RELATIVE POSITIONS AMONG THE MULTIPROBES AND SPACELAB.
- DETERMINE OPTIMUM DRAG COEFFICIENTS FOR MULTIPROBES
- DETERMINE OPTIMUM LAUNCH CONDITIONS AND ORBITAL PARAMETERS TO MEET THE MULTIPROBE FUNCTIONAL OBJECTIVES