International Collaboration in Sounding Rocket Research

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- A “Case Study”: one person’s participatory experience
- Observations: “Lessons learned”
- International Collaboration in CSA Context 2010

Participation in Sounding Rocket International Collaboration
A "Case Study"

	Launch	Project – Science Objective	Lead / F. Partners	New Results; Publications	Instr Dvpt
1980's	C. Perry	CENTAUR: Dayside cusp	**CAN** / UTD+	m-sheath aurora structure; >5	
	S. End	PAC - Pulsating Aurora	**CAN** / U Tokyo+	Pulsation dispersion; >10	
	CRR	Waterhole: Auroral dynamics	**CAN** / LANL	Auroral currents; 5	⇒ SMS
	CRR	Beam Plasma Discharge	USA / U Minnesota	⇒ BPD on Shuttle; 2(+)	
	CRR	MARIE: Auroral acceleration	**CAN** / Cornell	TAI, ⇒ LHSS; >5	⇒ SMS
	PFRR	ERRRIS: E-region e-dynamics	USA / GSFC	Auroral E-region; 1(+)	
2000's	Svalbard	SS520-2: Ion outflow microphys.	JPN / JAXA/ISAS	Cleft O+ imaging; 1(+)	⇒ IRM
	KSC	S520-23: Ion-neutral coupling	JPN / JAXA/ISAS	(Analysis in progress)	
	PFRR	ACES: Auroral current/dynamics.	USA / U Iowa	(CSA funding too late)	
	KSC	@520-26: Ion=neutral coupling	JPN / JAXA/ISAS	(2010/12 launch scheduled)	

Project Waterhole 1981-1984

Project team in front of Operations Building at Churchill Research Range. CASSIOPE/e-POP team members in photo: P.A. Bernardt (CER PI), D. Beattie (Bus Systems Eng), A.W. Yau (Mission Scientist)

Project Waterhole 1981-1984: The Science …

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 86, NO. A7, PAGES 5601–5613, JULY 1, 1981

Observations of Particle Precipitation, Electric Field, and Optical Morphology of an Artificially Perturbed Auroral Arc: Project Waterhole

A. W. YAU, B. A. WHALEN, AND F. CREUTZBERG

Herzberg Institute of Astrophysics, National Research Council of Canada

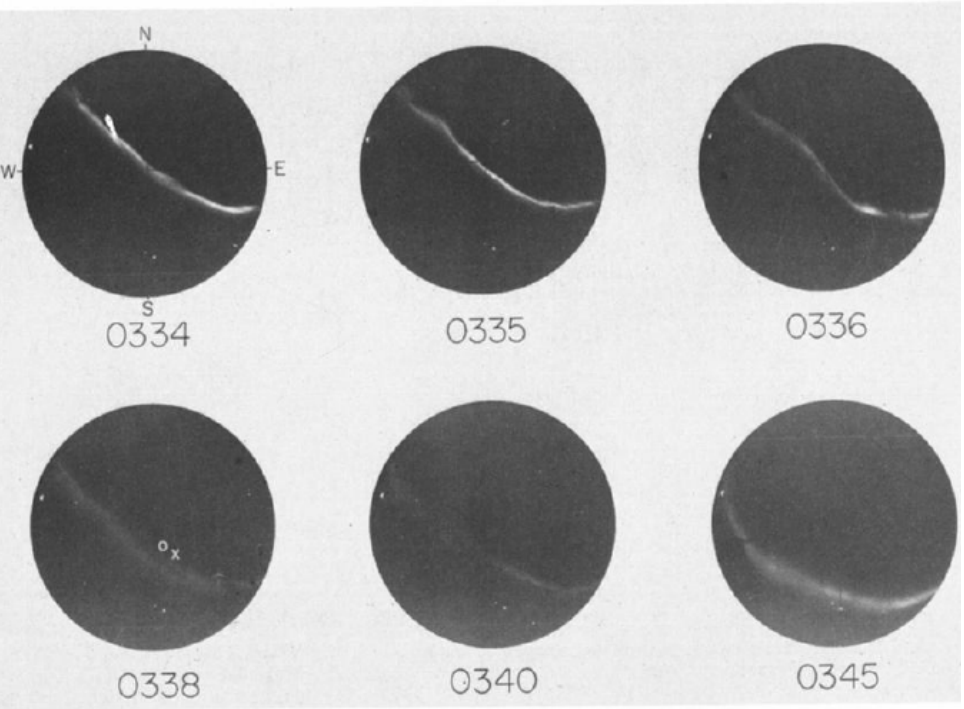


Fig. 11. ASC images of the auroral arc from 0334 to 0345. All frames were taken with 3-s exposure. Visibility thre
d of images is about 15 kR. The cross and the circle in the frame at 0338 denote the release point and its projection dc
100 km, respectively.

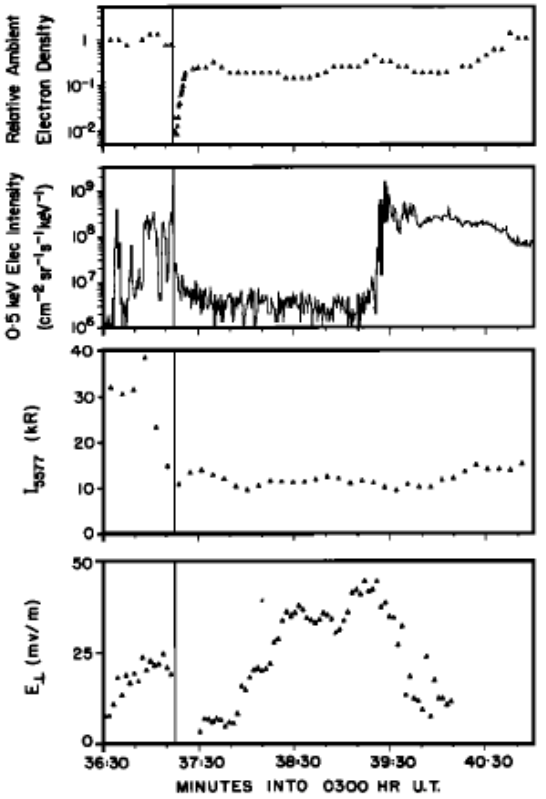


Fig. 13. Summary plot of in situ particle and field, and ground-based photometric measurements. (From top to bottom) Relative

Ionospheric depletion ⇒ auroral current disruption ⇒ auroral dimming

Project MARIE 1985 – The Science …

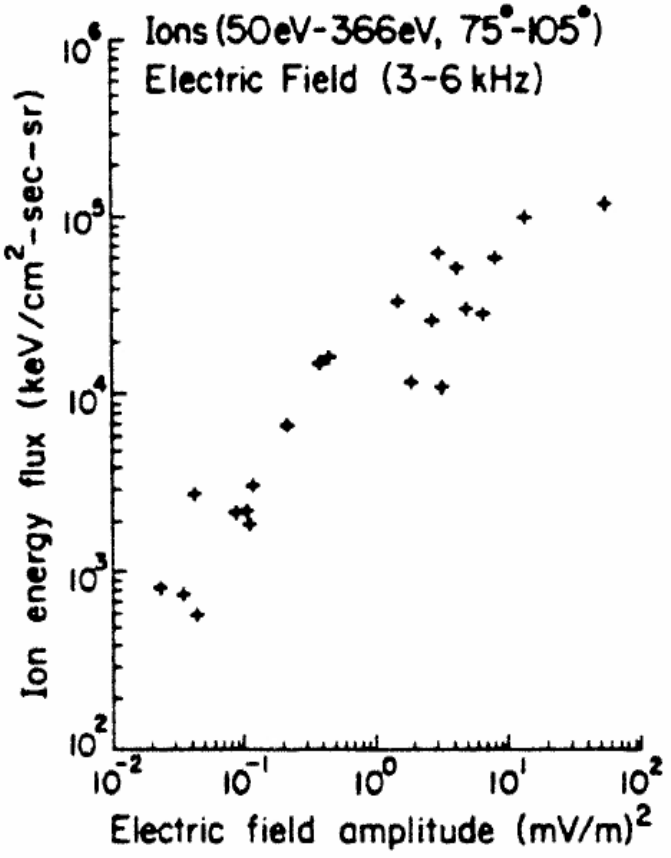


Fig. 6. Scatter plot of transversely accelerated ion energy flux and lower hybrid (3-6 kHz) electric field amplitude observed inside a region of transverse ion energization in the MARIE

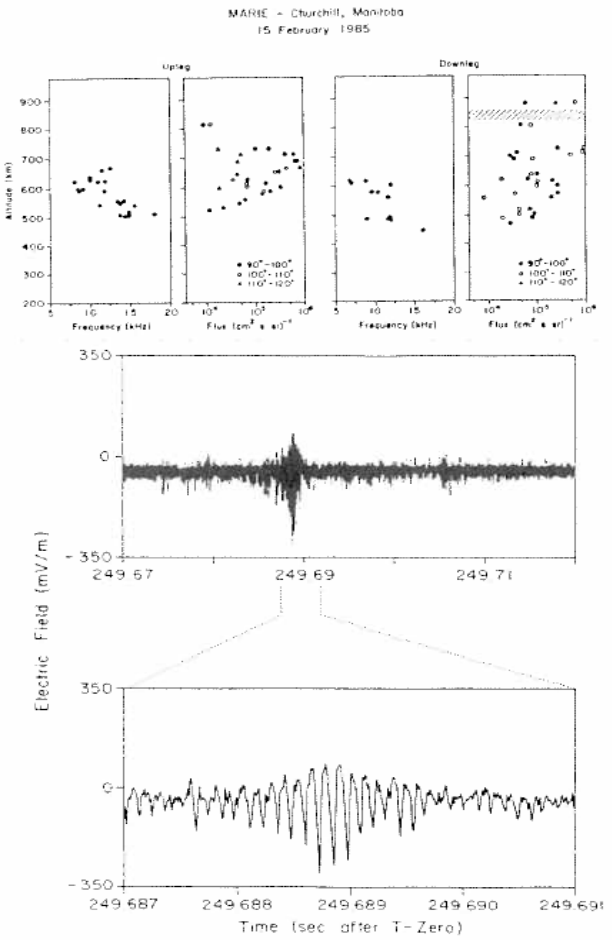


Fig. 7. Top panels: a comparison between the spikelet occurrence and the transversely accelerated ion fluxes in the MARIE rocket. Bottom panels: an example of one of the 30-40 spikelet events

Transverse ion acceleration and wave-particle interaction in auroral ionosphere

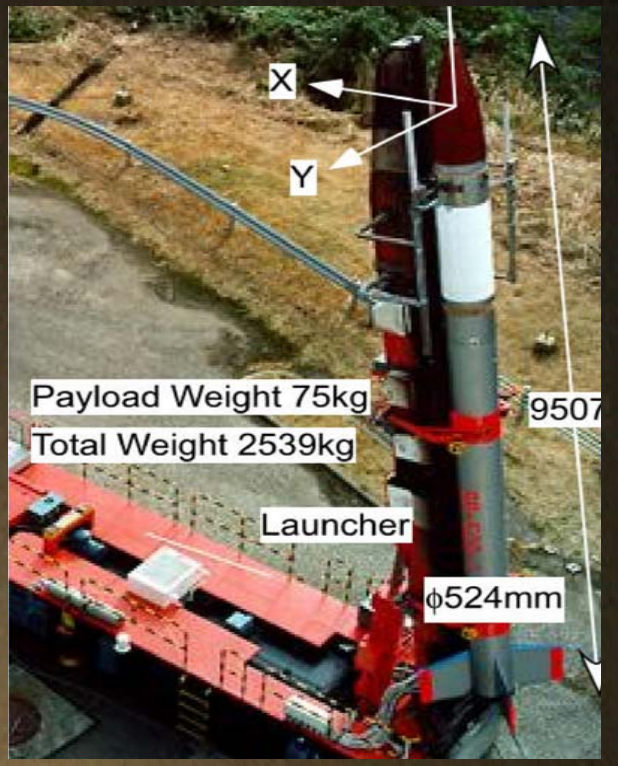
Lower hybrid waves and solitary structures (LHSS)

SS520-2 and TSA

SS520-2 Science Objective:
Ion acceleration/outflow microphysics in cleft

Launch: Svalbard, Dec. 4, 2000 Apogee: 980 km

Thermal Suprathermal Analyzer (TSA) Objective:
Suprathermal ions in cleft ion outflow using modified (from Nozomi TPA) boom, TOF gate, detector anode



International Collaboration – Benefits (at least in the past…)

- Quality opportunity for cutting edge science
  - Cutting-edge science not always possible to anticipate
- Quality opportunity for new instrument flight opportunities
  - But not only from time to time, particularly as a "guest"
- Valuable partnership experience
  - And potentially valuable long-term connection
- Leverage complementary scientific strengths and needs
- Potential stepping stones to future scientific opportunities
  - But difficult to predict which piece of stone will turn into a gem

International Collaboration – Challenges (at least in the past…)

- Opportunity often inconsistent with CSA schedule
- No NSERC International Opportunity Funds (IOF), NASA Stand Alone Mission of Opportunity (SALMON) type AO or Unsolicited Proposal
- Agency A won't commit until Agency B does, and vice versa
- No mechanism to work opportunity into CSA Work Plan

International Collaboration on Sounding Rockets…

- Provides quality opportunity for cutting-edge science, new instrument flights, HQP training – but not every time, and seldom simultaneously
- Works best in “two-way street”
- Works best when pursued strategically – and cultivated over long term
- Can be key element of (but not replacement for) indigenous program
- Is a means to enhance (but not in itself) an end

Suggestions made in 2007 Workshop Presentation…

Optimization and Creation of Opportunities

- "Opt in" or "opt out"
  - Both CSA and community must decide
- Be strategic
  - Develop small payload international collaboration strategy
  - Target at specific international partner
  - Establish community-based "Canadian" and bilateral SWG
  - Negotiate long-term collaboration programs with "like-minded" (and like-size) agencies

Feb 1, 2007 Community Workshop on Science from Suborbital Vehicles 8

Recommendations from Sounding Rocket Breakout Session in 2007 Workshop

Extracted from Sounding Rocket Breakout Session Report:

Maintain & enhance Canada's ability to participate in int'l collaboration

i. Ensuring sufficiently frequent and regular AO's

ii. Forming/supporting working groups with agency- and scientist-level participation…

iii. Weighing carefully the decision no longer to accept unsolicited proposals…

Fund Canadian-led rocket every 3-5 years, in collaboration with other agencies…

Fund participation in foreign-led collaborations at a rate of one every 1-2 years…

Suggested Update to Recommendations in 2007 Workshop

Suggested updates highlighted in red:

Maintain & enhance Canada's ability to participate in int'l collaboration

i. Ensuring sufficiently frequent and regular AO's

ii. Forming/supporting working groups with agency- and scientist-level participation…

iii. Weighing carefully the decision no longer to accept unsolicited proposals…

iv. Developing bilateral collaboration programs targeted at specific program objectives

Fund Canadian-led rocket every 1 to 2 years, in collaboration with other agencies*

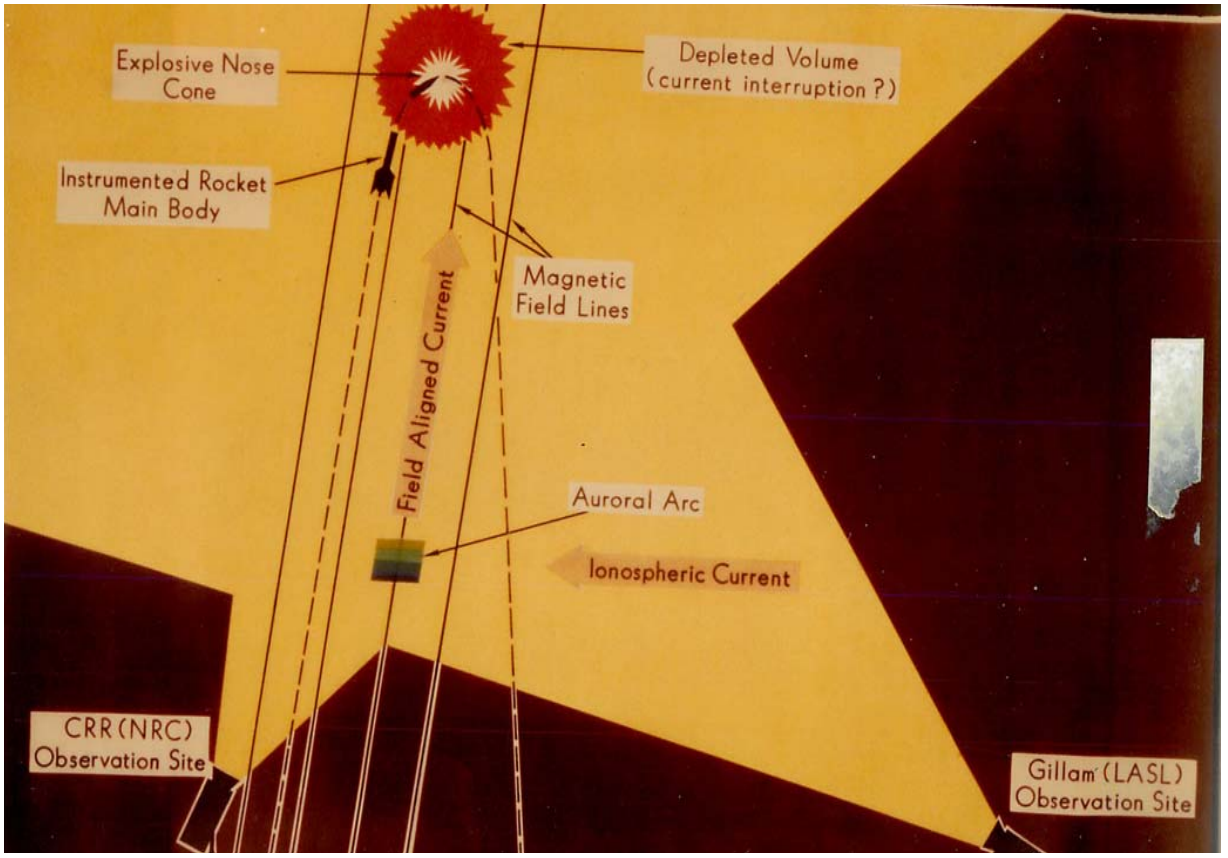
Fund participation in foreign-led collaborations at a rate of one every 1-2 years…

*** A steady stream of sufficient # of affordable missions is key to provide "end-to-end" training opportunity**

Thank You

For Your Attention!

Project Waterhole 1981-1984: The Concept …



Release water vapor into F-region above aurora

H_2O^+ and CO_2^+ ions dissociatively recombine to produce ion hole: “Waterhole”

Reduce ionospheric conductivity and disrupt auroral current system and …

Project Waterhole 1981-1984: The Team …

Bristol Aerospace (Launch Rocket and Payload Eng.), ADGA (Range)

NRC Space Research Facility Branch (SRFB; now CSA)

NRC Herzberg Institute of Astrophysics, Los Alamos Scientific Lab (now LANL)

TSA

Thermal Suprathermal Analyzer

- **Hemispheric electrostatic analyzer; time-of-flight**
- **2-D ion velocity distribution**
  - **Fast, mass-resolved**
  - **20-ms resolution**
  - **1-100 AMU/q; H^+, He^+, O^+**
  - **0.5-20 eV/q (12 energies)**
  - **8 angles**

The TSA Experience