SEPAC as the first large scale international collaboration in space program between Japan and US

1. Background
2. Scientific objectives of SEPAC
3. Major scientific results
4. Contribution to space science and development

March 2006

What' SEPAC?

Space Experiments with Particle Accelerators

using
electron beam/plasma accelerators and diagnostic instruments on Space Shuttle orbiter,

to study
(1)Vehicle charge build-up and its neutralization
(2)Beam plasma physics
(3)Beam atmosphere interaction

was conducted
as a joint program between ISAS/Japan and US investigators, starting in 1978 (-1992)

Background and History

In the early 1970', NASA began soliciting international collaboration for space science using the new reusable manned launch vehicle "space shuttle".

SEPAC proposal for AMPS(Atmosphere, Magnetosphere, Plasma in Space) payload by the late Tatsu Obayashi, ISAS professor

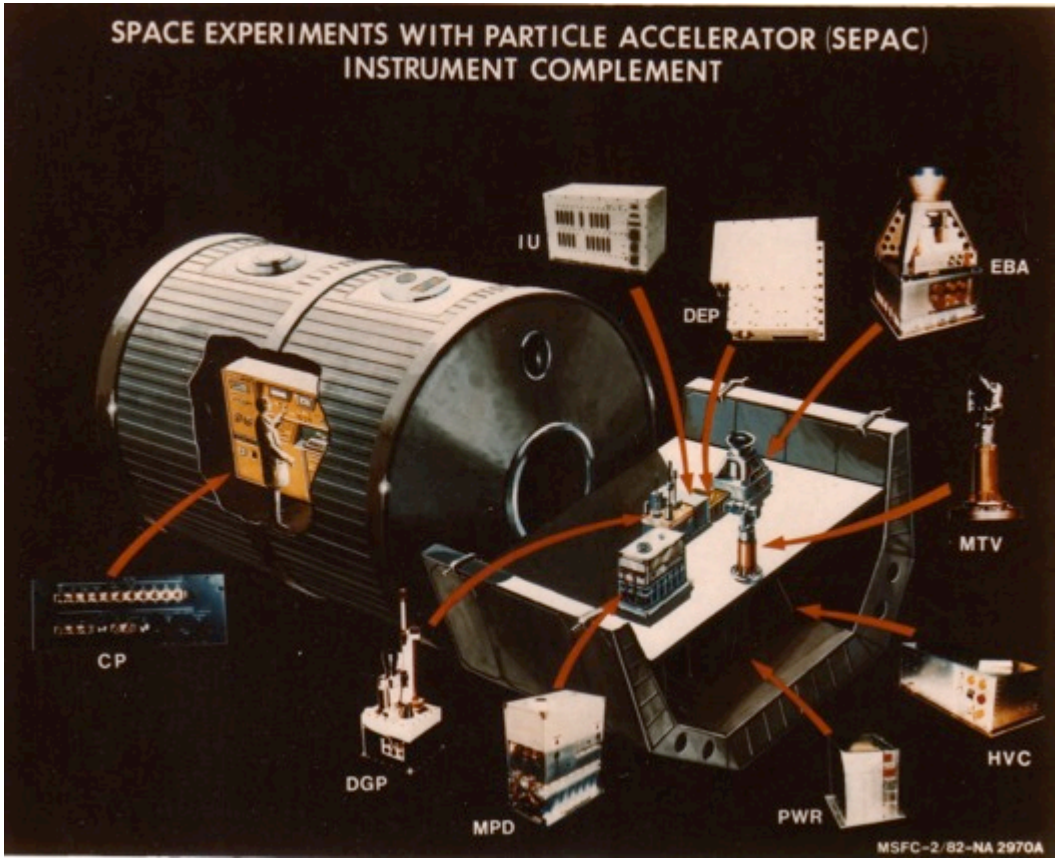
1976 Selected as an experiment for Spacelab-1 mission
1983 First experiment
1985 Selected as an experiment for EOM-1 mission
1986 Reconfigured for ATLAS-1 mission after "Challenger disaster"
1992 Second experiment

SEPAC Instruments

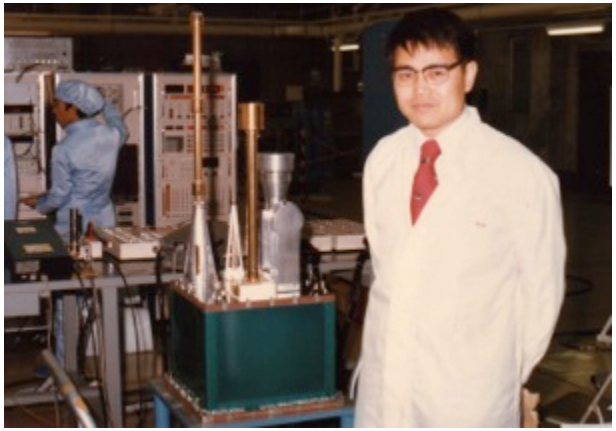
Japanese Development
(1)Electron Beam Accelerator: 7.5kV, 1.6 A, 10ms~1sec
(2)Magneto-Plasma-Dynamic Arcjet: 2kJ/pulse, 1ms, Ar
(3)Neutral Gas Plume Generator: Nitrogen
(4)Monitor and Diagnostic Equipment: Beam monitor TV camera, Photometer, Energetic particle analyzer, Plasma probe, Wave and field probes

US Development
(1)Control and Data Management Equipment: Control Panel, Dedicated Experiment Processor, Interface Unit

Configuration of SEPAC Instruments



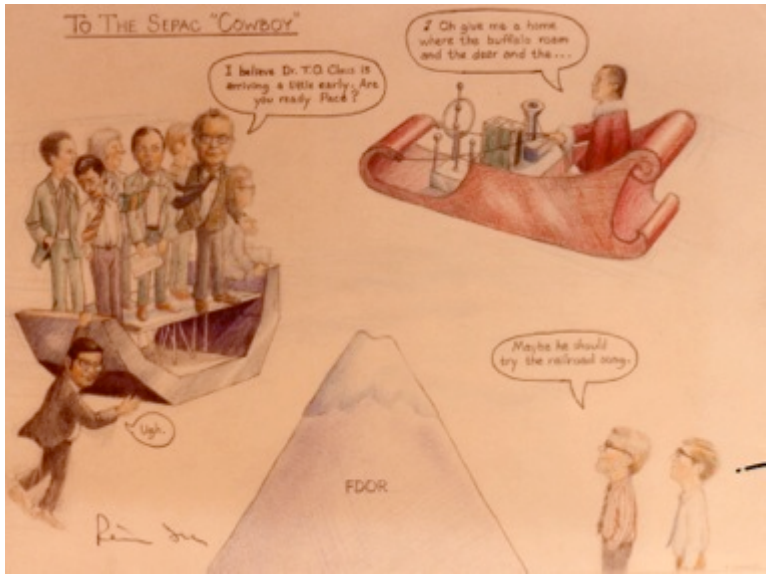
Prof.Ejiri lead SEPAC science team, developing onboard diagnostic instruments and on-line data analysis system on ground.



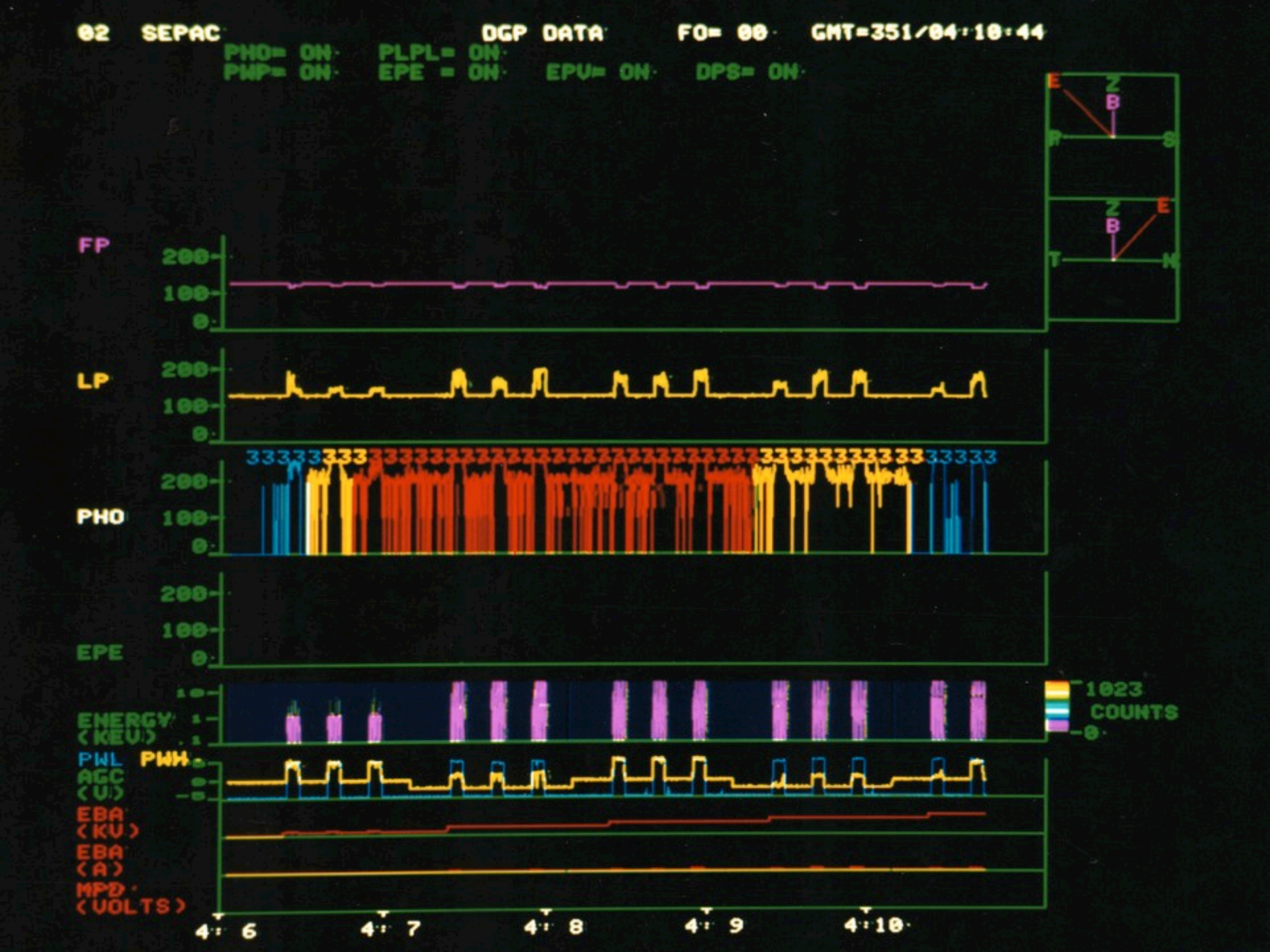
SEPAC Team

PI: T.Obayashi (ISAS)

US Team:
W.T.Roberts (MSFC)
C.R.Chappell (MSFC)
D.L.Resoner(MSFC)
J.Burch(SWRI)
W.L.Taylor(TRW)
P.M.Banks (Stanford Univ.)
P.R.Williamson (Stanford Univ.)
O.K.Garriott(JSC)



Japanese Team:
N.Kawashima, (ISAS)
K.Kuriki (ISAS)
M.Nagatomo (ISAS)
K.Ninomiya (ISAS)
M.Ejiri (ISAS)
S.Sasaki (ISAS)
M.Yanagisawa (ISAS)
I.Kudo(ETL)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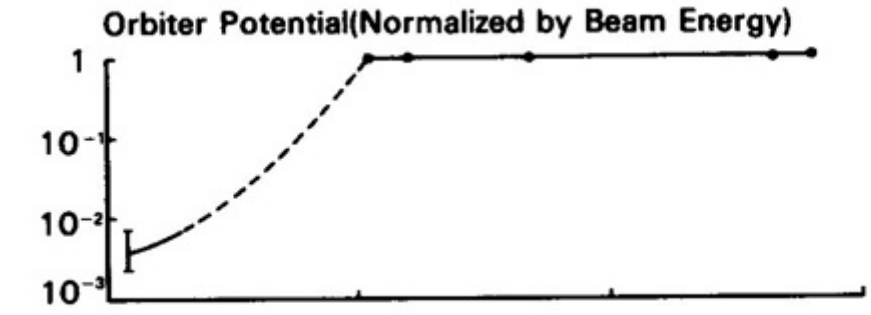
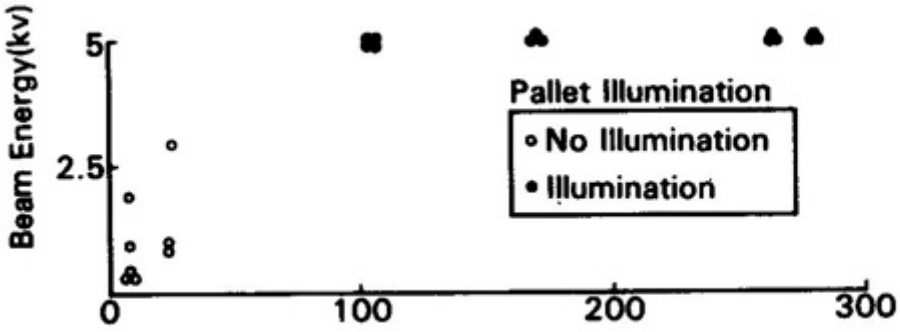
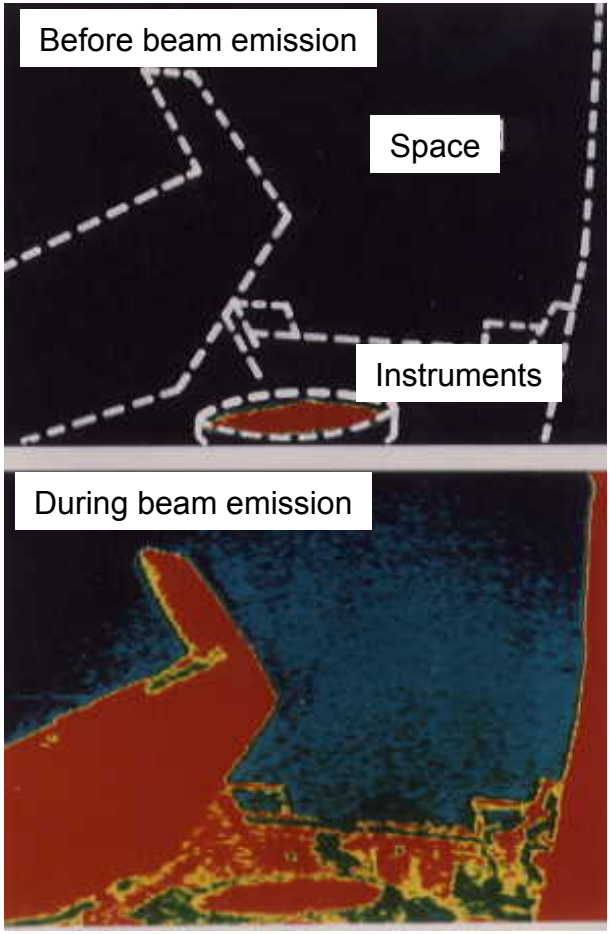
Major Results- (1) Charging

Charge-up theory was verified and full charge-up in space was first demonstrated.

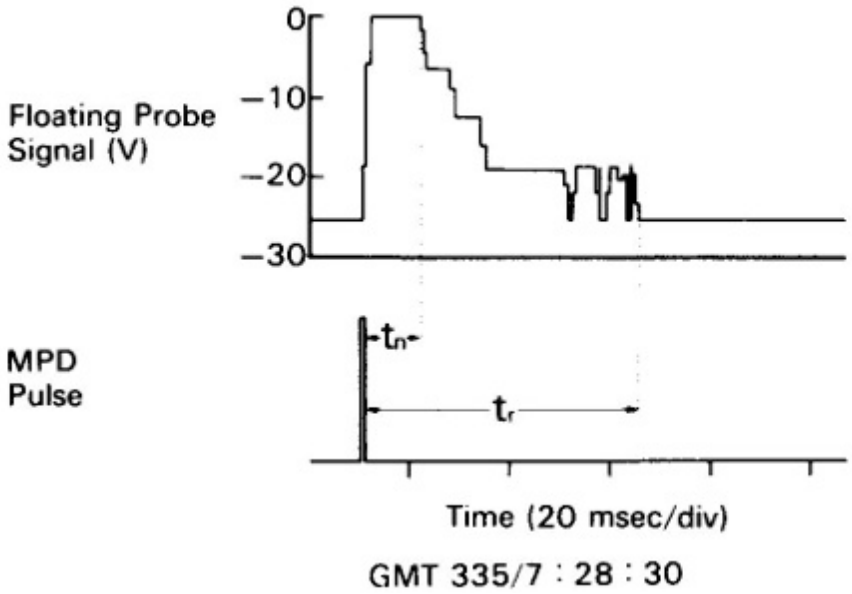


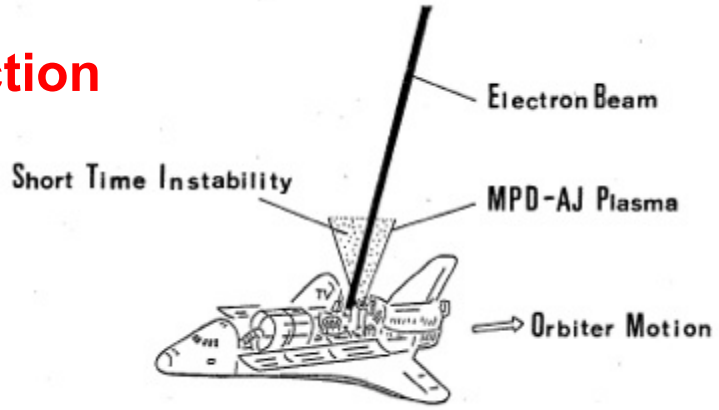


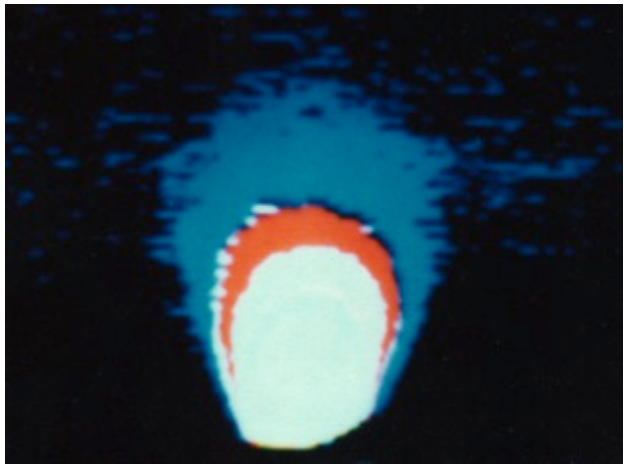


Major Results- (2) Charge Neutralization

Charge-neutralization by plasma injection was first demonstrated and analyzed.



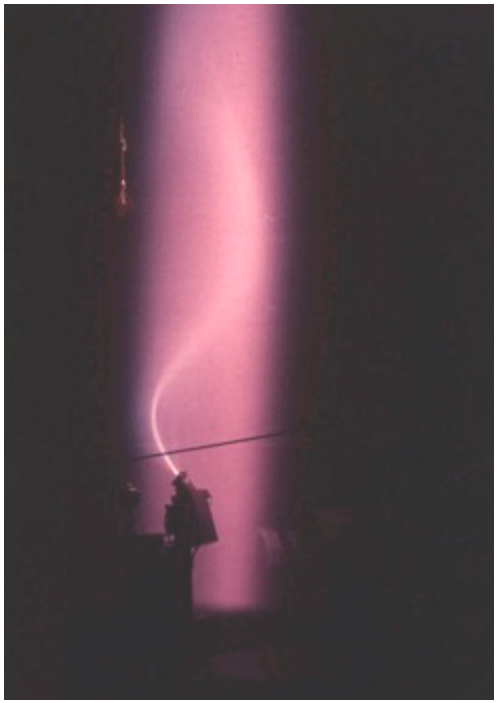




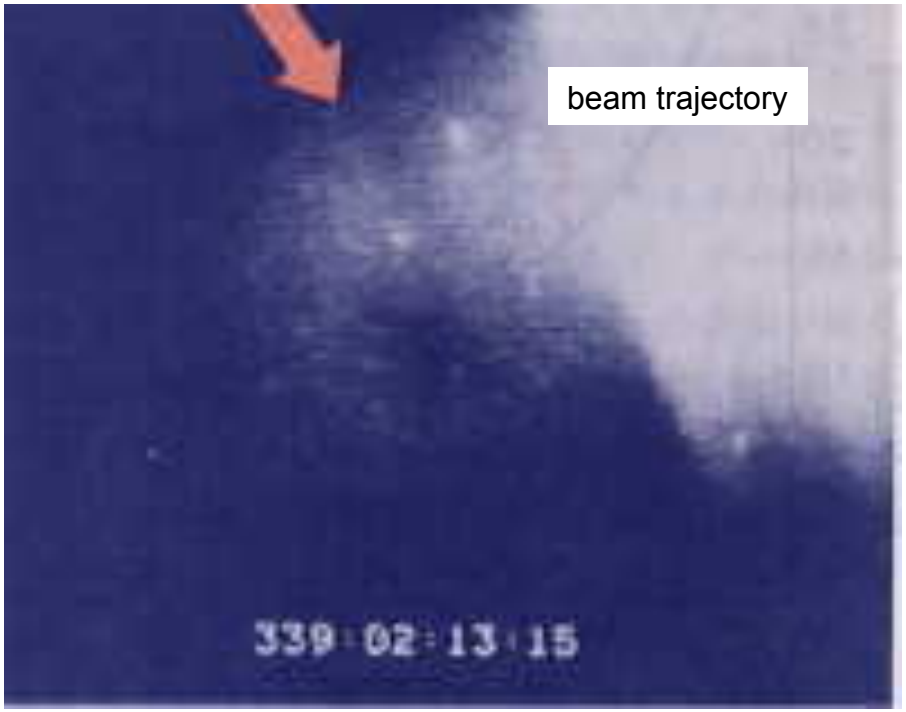
Major Results- (3) Beam Plasma Discharge

Beam Plasma Discharge is an ionization by energetic electrons generated by beam plasma interactions in a gas-beam system, which was clearly demonstrated in space.

BPD in Laboratory

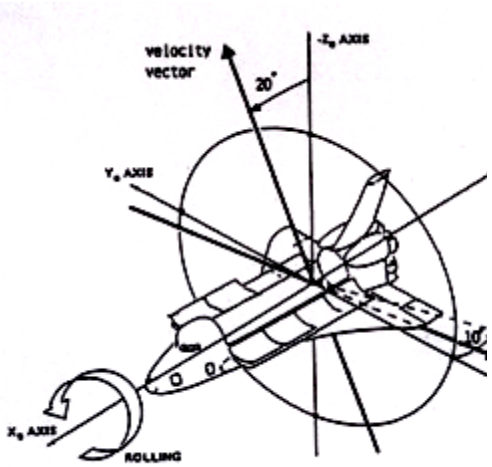


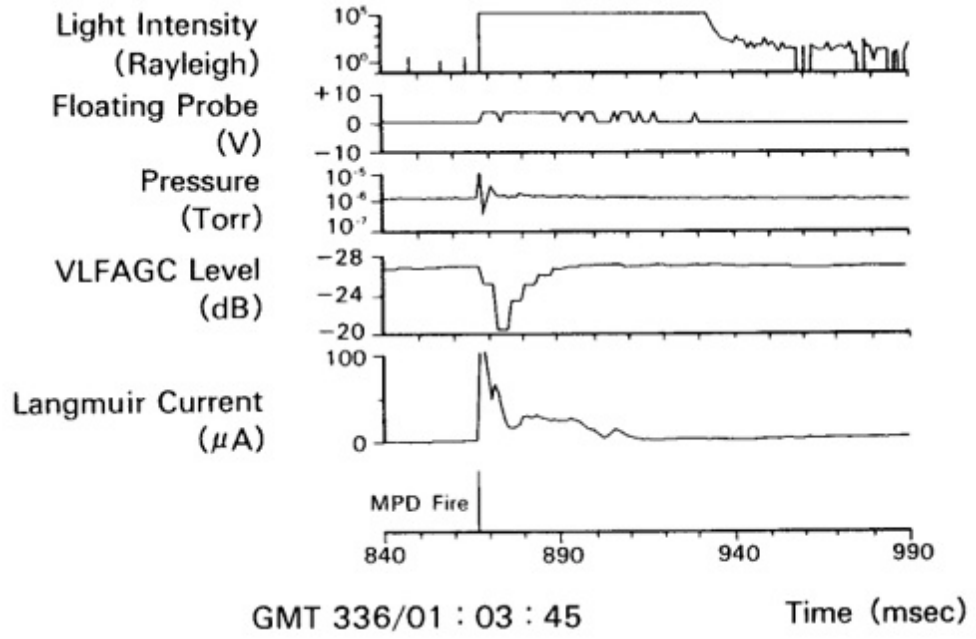
BPD in space



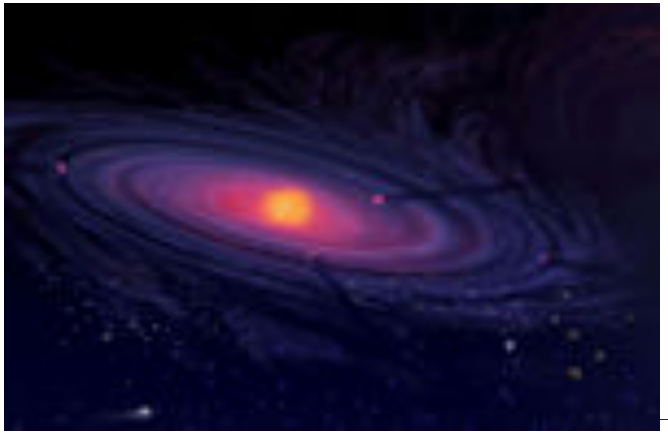
Major Results-(4) Critical Velocity Ionization

CVI is an ionization process in which the gas velocity perpendicular to the magnetic field exceeds a critical value ($1/2mVc^2=e\varphi$).





CVI in space first reported in SEPAC

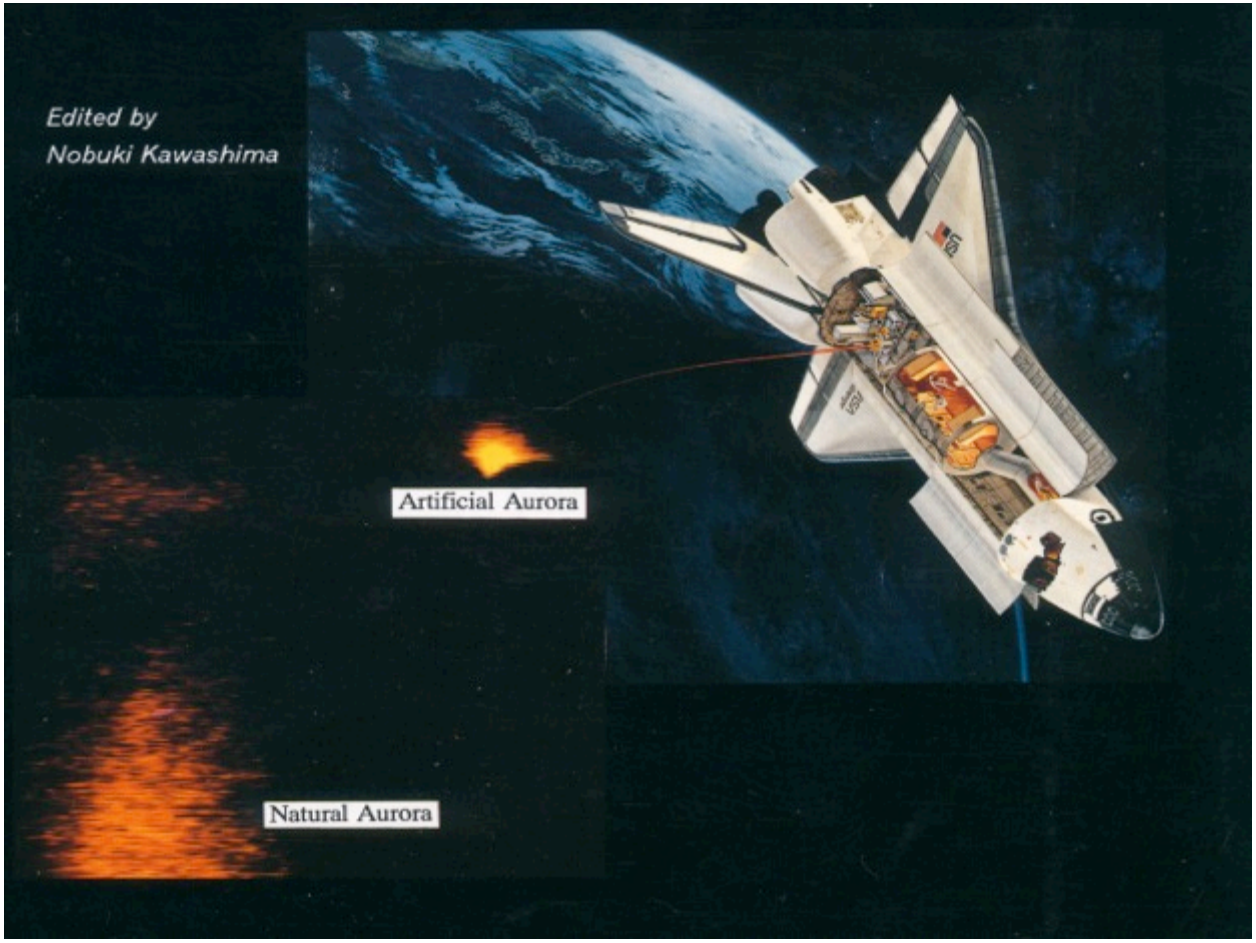


suggested by Alfvén in 1954 as part of a larger cosmological theory accounting for the formation of the solar system,

Experiment	*Year*	*Increase Ionization*
SEPAC	1983	yes
XANI	1989	yes
STS 39	1991	no
ATLAS 1	1992	yes
APEX	1993	yes
North Star	2000	yes
ARGOS	2000 and 2001	no

Major Results-(5) Artificial Aurora

A trail in the wake direction unexpectedly observed, indicating after-glow phenomena, possibly excited by hot electrons generated by beam-plasma interactions.



6.25keV, 1.2 A injection, 427.8 nm(N_2^+) emission 110-130 km

SEPAC Contribution to Space Science and Space Development

1. a lot of new findings and surprises in space plasma physics in particle-particle and particle-wave interactions,

2. demonstrated the controlled space experiment as a powerful tool to study space physics,
3. first large scale international collaboration in space program between Japan and US, educating many scientists and engineers who have lead projects in space science and even wider fields in Japan and US.