Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-01 会場:202 時間:5 月 23 日 09:00-09:30

Sprint-B/ERG 衛星計画
Sprint-B/ERG satellite project

高島 健 [1*], 小野 高幸 [3], 三好 由純 [2], 浅村 和史 [1]
TAKASHIMA, Takeshi[1*], ONO, Takayuki[3], MIYOSHI, Yoshizumi[2], ASAMURA, Kazushi[1]

[1]ISAS/JAXA, [2] 名古屋大学太陽地球環境研究所, [3] 東北大学大学院理学研究科
[1]ISAS/JAXA, [2]STEL, Nagoya University, [3]Tohoku University

The ERG (Energization and Radiation in Geospace) is a geospace exploration mission in Japan for the solar maximum and subsequent declining phase of solar cycle 24. The mission is especially focusing on the relativistic electron acceleration mechanism in the context of the cross-energy coupling via wave-particle interactions as well as the dynamics of space storms. The interplay among different plasma/particle populations of the inner magnetosphere; plasmasphere, ring current/plasma sheet, and radiation belts is a key to understand the energetic particle accelerations. The cross-regional coupling such as magnetosphere-ionosphere via FAC and the potential electric fields causes the spontaneous variations of the ambient fields.

The ERG project consists of the satellite observation team, the ground-based observation team, and integrated-data analysis/simulation team, as well as the science working team and the project science team. The SPRINT-B/ERG satellite of ISAS/JAXA will be launched into inner magnetosphere in FY2014-2015. The comprehensive instruments for plasma/particles, field and waves are installed in the SPRING-B/ERG satellite to elucidate the electron acceleration processes. The newly developed system will directly measure the flow of the Poynting flux between particles and waves in the wave-particle interactions. In this talk, we will present the current status of the ERG project and possible collaborations with other geospace satellite missions.

キーワード: 小型科学衛星, ジオスペース探査
Keywords: Small Science Satellite, Geospace Exploration

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-02 会場:202 時間:5 月 23 日 09:30-10:00

Development of a Low-Energy Electron Instrument LEP-e for the ERG Mission
Development of a Low-Energy Electron Instrument LEP-e for the ERG Mission

Chio Z. Cheng[1*], Yoichi Kazama[1], Chian-hsiao Ho[1]
CHENG, Chio Z.[1*], Yoichi Kazama[1], Chian-hsiao Ho[1]

[1]Plasma and Space Science Center, National Cheng Kung University
[1]Plasma and Space Science Center, National Cheng Kung University

Plasma and Space Science Center (PSSC) at National Cheng Kung University in Taiwan is now developing a low-energy electron instrument for Japan's radiation belts observation mission ERG (Energization and Radiation in Geospace). The instrument consists of an electrostatic energy analyzer with multi-channel plates (MCP) and electronics. The energy analyzer is of the top-hat type, and measures radiation belt electrons from approximately 10 eV to 20 keV. The analyzer's design was studied by numerical particle tracing simulations to achieve good electron measurement performance. The challenge in this development is how to suppress effects due to harsh background radiations in the inner magnetosphere. As a measure against radiation, the analyzer employs 6-mm aluminum shields to reduce radiation penetration to the MCP. Based on GEANT4 radiation simulations with the AE-8/AP-8 radiation model, ˜1000 counts/sec of the radiation noise can be received by the MCP. To reduce the radiation effects, a channel is placed for measuring the background noise counts. In the presentation, the electron observation performance and the radiation effects will be discussed.

キーワード: Top-Hat Analyzer, Electron Energy Spectrum, Electron Pitch Angle Distribution, radiation belt
Keywords: Top-Hat Analyzer, Electron Energy Spectrum, Electron Pitch Angle Distribution, radiation belt

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-03 会場:202 時間:5 月 23 日 10:00-10:15

SPRINT-B(ERG) 衛星に搭載する中間エネルギーイオン質量分析器の性能試験
Performance tests of medium-energy ion mass spectrometer developed for SPRINT-B (ERG)

笠原 慧 [1*], 浅村 和史 [1], 高島 健 [1], 平原 聖文 [2]
KASAHARA, Satoshi[1*], ASAMURA, Kazushi[1], TAKASHIMA, Takeshi[1], HIRAHARA, Masafumi[2]

[1] 宇宙科学研究所, [2] 名古屋大学
[1]ISAS, [2]Nagoya University

We have been developing a medium-energy ion analyser for the radiation belt mission SPRINT-B (ERG). This instrument is comprised of an electrostatic analyser, time-of-flight (TOF) mass spectrometer, and solid state detectors, hence it can measure energy, mass and charge state of 10-180 keV/q ions. It provides the significant information of flux and pitch angle distribution of ring current core components, which is essential for the understanding of the radiation belt dynamics. One of the important issues for particle measurements in the inner magnetosphere is the mitigation of the background noise caused by the radiation belt particles. When the penetrating high-energy electrons (greater than MeV) and protons (greater than 10 MeV) hit detectors in the TOF unit, they produce spurious signals. Secondary particles (electrons and gamma rays) also cause a significant background. Therefore we have designed a TOF unit that is especially suitable for the radiation belt observations in terms of the small detection areas (note that the background count rate is less for the smaller detector areas). Through experiments in a laboratory we have confirmed expected performance on TOF profiles expected from numerical simulations.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-04 会場:202 時間:5 月 23 日 10:15-10:30

内部磁気圏での直接探査を目的とした 0.01-25keV/q イオン質量分析器の開発
Development of 0.01-25keV/q ion mass spectrometer for inner magnetospheric reserach

浅村 和史[1*], 風間 洋一[2], 笠原 慧[1]
ASAMURA, Kazushi[1*], KAZAMA, Yoichi[2], KASAHARA, Satoshi[1]

[1] 宇宙研, [2] 台湾国立成功大学
[1]ISAS/JAXA, [2]NCKU, Taiwan

Measurements of plasma partciles with energies lower than 100keV is not easy in the terrestrial magnetosphere, since fluxes of high-energy particles are large. High-energy particles can penetrate through, or kick out the secondary particles when they hit materials. This means they can be detected by a detector inside an instrument without any analysis, namely, noise. We are developping an ion energy-mass spectrometer with energy range of 0.01-25keV/q for terrestrical inner magnetosphere. In order to reduce the noise generated by the high-energy particles, we apply a time-of-flight (TOF) technique. In addition, we try to minimize size of the detector.

We will discuss how an instrument in the current design can survive under severe environment like terrestrial inner magnetosphere.

キーワード: プラズマ粒子計測器, 内部磁気圏, ERG
Keywords: plasma particle instrument, terrestrial inner magnetosphere, ERG

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-05 会場:202 時間:5 月 23 日 10:45-11:15

The ESA-led JUpiter ICy moon Explorer mission: a sophisticated instrumentation in an intense radiation environment

The ESA-led JUpiter ICy moon Explorer mission: a sophisticated instrumentation in an intense radiation environment

Nicolas Andre[1*]
ANDRE, Nicolas[1*]

[1]IRAP, CNRS/Universite Paul Sabatier, Toulouse, France
[1]IRAP, CNRS/Universite Paul Sabatier, Toulouse, France

The JUICE (Jupiter ICy moon Explorer) mission is one of the three candidates for the first ESA Cosmic Vision 2015/2025 L-class mission slot, with a foreseen launch in 2022. The final selection will be known in April 2012. JUICE will carry out an in-depth study of the Jovian system and its four largest satellites, with particular emphasis on Ganymede and Europa. It will conduct unprecedented detailed studies of Jupiter and its magnetosphere, the diversity of the Galilean satellites, the physical characteristics, composition and geology of their surfaces. A model payload of 11 instruments addressing most of JUICE science goals has been studied for the spacecraft. The studied model payload consists of a remote sensing package, a geophysical package, and an in situ package. We will first review the mission science objectives and enabling instrumentation. We will then make use of the charged particle package in order to illustrate some of the main mission challenges related to the intense radiation environment of Jupiter.

キーワード: Jupiter, instrumentation, mission, radiation, particle package
Keywords: Jupiter, instrumentation, mission, radiation, particle package

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-06 会場:202 時間:5 月 23 日 11:15-11:30

BepiColombo 日欧共同水星探査ミッション：MMO プロジェクト最新状況報告
BepiColombo Euro-Japan Joint mission to Mercury: MMO Project Status update

早川 基 [1*]
HAYAKAWA, Hajime[1*]

[1] 宇宙航空研究開発機構・宇宙科学研究所
[1]ISAS/JAXA

紀元前から知られる水星は、「太陽に近い灼熱環境」と「軌道投入に要する多大な燃料」から周回探査は困難であり、昨年 3 月からの米国 MESSENGER による観測が初めてのものである。過去の探査から、この小さな惑星にはあり得ないと考えられていた磁場と磁気圏活動の予想外の発見をもたらしたが、その究明は未だこれからの課題となっている。「ベピ・コロンボ（BepiColombo）」は、欧州宇宙機関（以下、ESA）との国際分担・協力によりこの惑星の磁場、磁気圏、内部、表層を初めて多角的・総合的に観測しようとするプロジェクトである。固有磁場と磁気圏を持つ地球型惑星は地球と水星だけで、初の水星の詳細探査＝「初の惑星磁場・磁気圏の詳細比較」は、「惑星の磁場・磁気圏の普遍性と特異性」 の知見に大きな飛躍をもたらす。また、磁場の存在と関係すると見られる巨大な中心核など水星の特異な内部・表層の全球観測は、太陽系形成、特に「地球型惑星の起源と進化」の解明に貢献する。

本計画は、観測目標に最適化された 2 つの周回探査機、すなわち表面・内部の観測に最適化された「水星表面探査機 (MPO)」（３軸制御、低高度極軌道)、磁場・磁気圏の観測に最適化された「水星磁気圏探査機 (MMO)」（スピン制御、楕円極軌道）から構成される。ISAS ／ JAXA は、日本の得意分野である磁場・磁気圏の観測を主目標とする MMO 探査機の開発と水星周回軌道における運用を担当し、ESA が残りの全て、すなわち、打ち上げから惑星間空間の巡航、水星周回軌道への投入、MPO の開発と運用を担当する。

両探査機に搭載する数々の科学観測装置は、2004 年の搭載機器選定以降開発は着々と進行し、日本側の詳細設計審査は平成 23 年 11 月に終了し、ESA 側の詳細設計審査は平成 24 年 7 月に予定されている。JAXA の開発する MMO は本年 1 月に電気・機械インターフェース試験が終了し、本年 6 月末から開始される総合試験までの間に搭載各機器の環境試験並びに最終のキャリブレーションが行われる。また、MMO 構造モデルは昨年 11 月に ESA/ESTEC へ輸送され、今年行われる全体構造モデル試験に備えている。

水星到着後の観測は、選ばれた装置開発チームに留まらず、広く日欧研究者で構成する「BepiColombo 科学ワーキングチーム」(年 1 回程度開催) で立案・実施される。本講演では、これら科学観測に関連した状況及び、日本側が製作を担当する MMO について最新状況を報告する。

キーワード: 水星, 惑星探査, 国際協力
Keywords: Mercury, Planetary Exploration, International Collaboration

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-07 会場:202 時間:5 月 23 日 11:30-11:45

太陽発電衛星における大電力マイクロ波と電離層プラズマとの相互作用に関する宇宙実験の基礎検討
Space Experiment on Interaction between High Power Microwave and Ionospheric Plasma for Solar Power Satellite

田中 孝治 [1*], 阿部琢己 [1], 牧 謙一郎 [1], 佐々木進 [1]
TANAKA, Koji[1*], Takumi Abe[1], Kenichiro Maki[1], Susumu Sasaki[1]

[1] 宇宙航空研究開発機構
[1]Japan Aerospace Exploration Agency

The Space Solar Power System (SSPS) which converts solar energy into electricity in space, and transmits energy using microwave from space to the ground is a promising candidate for a clean and sustainable energy system. The first solar power satellite (SPS) concept was proposed by Dr. P.E.Glaser in 1968. R & D activities on the SPS have been carried out in US, Japan and Europe. Some key technologies require space experiments in order to realize the SPS. Especially, Wireless power transmission (WPT) is inherent technology of the SPS, and WPT demonstrations on the ground and in space have been performed in Japan. Two rocket experiments, MINIX in 1983 and ISY-METS in 1993 were performed by Kyoto University and ISAS in order to study nonlinear interactions of the high power microwave in the space plasma environment and to demonstrate microwave power transmission. However higher-accuracy evaluation of the effect of the microwave against the ionospheric region is required because the experiments of the sounding rocket are limited in time and mass resources. Microwaves interact with ionospheric plasma. Plasma density gradient and its variation will results the phase shift of the microwave and degradation of the accuracy of the microwave beam pointing. Also, injection of the high power microwave into plasma will cause a change in plasma distribution of ionospheric region or a plasma hole that will affect on communications. There are some interaction mechanism between ionospheric plasma and high power microwave. Plasma heating by the microwave will cause a decreasing of the plasma density and thermal self focusing of the microwave beam. Several potential non-linear interactions between ionosphere and microwave have been identified. These include parametric instability excitation, electron thermal runaway in the lower ionosphere and thermal self-focusing of the microwave beam by the ponderomotive force. Microwave power density around ionospheric region is designed around several hundred W/m2 for the future commercial base SPS. These effects should be confirmed by the space experiments. We are considering a space experiment on the WPT from space to the ground and on the interaction between high power microwave and ionospheric plasma using a small scientific satellite. The total microwave power radiated from the power transmission panel is 0.95 kW for a single antenna panel configuration. This level of microwave power injection will generate a power density above 1000 W/m2 within 50 m, and 100 W/m2 within 100 m in the ionosphere. Effects of interaction between high power microwaves and plasma in ionosphere can be measured. We plan to measure the electron temperature, the electron density and excited waves under the microwave irradiated conditions using plasma probes, wave receiver or some observation equipments. We would like to discuss the on-board instrumentations for the plasma and waves measurement in ionosphere.

キーワード: 太陽発電衛星, マイクロ波, 無線送電, 電離層, プラズマ
Keywords: Solar Power Satellite, Microwave, WPT, plasma, ionosphere

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-08 会場:202 時間:5 月 23 日 11:45-12:00

Development of High Resolution Magnetometers for Space Plasma Study at SPDL

Development of High Resolution Magnetometers for Space Plasma Study at SPDL

Lin-Ni Hau[1], Bo Jhou Wang[1*], Yu-Chieh Chou[1], Yen-Ting Lai[1], Chi-Chun Lin[1], Chun-Sung Jao[1]
Lin-Ni Hau[1], Bo Jhou Wang[1*], Yu-Chieh Chou[1], Yen-Ting Lai[1], Chi-Chun Lin[1], Chun-Sung Jao[1]

[1]Institute of Space Science, National Central University, Jhongli, Taiwan R.O.C.
[1]Institute of Space Science, National Central University, Jhongli, Taiwan R.O.C.

Space plasma has the unique property of being highly collisionless and thus conducting. As a result, the magnetic field is highly perturbed due to the complex motion of charged particles. Measurement of high resolution magnetic field is very important for providing information on the physics of small spatial and temporal scales of collective plasma which cannot be achieved by particle instruments. Satellite Payload Development Laboratory (SPDL) at National Central University was founded in 2002 with the goal of developing high resolution space instruments for in-situ exploration and study of magnetspheric and collisionless space plasma by space science major students. In this talk we present the achievement and recent progress on the development of high resolution magnetometers by the efforts of SPDL members.

キーワード: Magnetometer, Space Plasma
Keywords: Magnetometer, Space Plasma

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-09 会場:202 時間:5 月 23 日 13:45-14:15

Tiny magnetic field measurement system onboard satellites by using an ASIC chip

Tiny magnetic field measurement system onboard satellites by using an ASIC chip

Werner Magnes[1*], Hans Hauer[2], Aris Valavanoglou[1], Matthias Oberst[2], Harald Neubauer[2], Irmgard Jernej[1], Christian Hagen[1], Wolfgang Baumjohann[1]
MAGNES, Werner[1*], Hans Hauer[2], Aris Valavanoglou[1], Matthias Oberst[2], Harald Neubauer[2], Irmgard Jernej[1], Christian Hagen[1], Wolfgang Baumjohann[1]

[1]Space Research Institute, Austrian Academy of Sciences, [2]Fraunhofer Institute for Integrated Circuits
[1]Space Research Institute, Austrian Academy of Sciences, [2]Fraunhofer Institute for Integrated Circuits

Scientific instruments for space applications are required to reduce their resource requirements, such as volume, mass and power while at the same time achieving at least the same performance as conventional instruments. So it is important that especially the instrument front ends and readout units undergo miniaturization.

A front-end ASIC (Application Specific Integrated Circuit) for magnetic field sensors based on the fluxgate principle (Magnetometer Front-end ASIC, MFA) has been developed that reduces the required power for the active readout electronics by a factor of 10 as well as the area needed on a printed circuit board by a factor of 3-4 compared to magnetic field instruments e.g. aboard Venus Express (ESA).

The concept of the MFA is based on a combination of the readout electronics of a conventional fluxgate magnetometer with the control loop of a delta-sigma modulator in order to get an optimized signal-to-noise ratio with a reasonable oversampling factor. The analog part of the MFA contains altogether four 2-2 cascaded sigma-delta modulators. Three of those modulators are having the fluxgate sensor in their control loops for a direct analog-to-digital conversion of the sensor output. The fourth modulator is unmodified and connected to the output of an eight-to-one multiplexer for housekeeping measurements (e.g. temperatures of MFA and fluxgate sensor). The single-bit outputs of the cascaded modulators are processed by a digital tuning logic for generating a fourth-order noise shaped and digitized output signal. The digital part includes primary (128Hz output) and secondary decimation filter stages (2, 4, 8, to 128Hz output) as well as a serial synchronous interface (data are transmitted with 24 bit resolution). The chip area (0.35um CMOS from austriamicrosystems) is about 20mmˆ2 and the total power consumption is 60mW (drive power for the fluxgate sensor is not included).

The achieved performance and radiation robustness can be summarized with THD $>$ 95dB, SNDR in field mode $>$ 85dB, offset stability $<$ 10pT/degC and $<$ 0.2nT/100h and TID $>$ 300krad. A first space magnetometer equipped with the MFA will fly aboard a 4-satellite NASA mission called Magnetospheric Multiscale (launch in 2014).

キーワード: Magnetometer, Miniaturization, Fluxgate, Magnetic Field
Keywords: Magnetometer, Miniaturization, Fluxgate, Magnetic Field

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-10 会場:202 時間:5 月 23 日 14:15-14:30

アナログ専用集積回路による小型プラズマ波動受信器の開発
Development of Miniaturized Plasma Wave Receiver using analog ASIC

福原 始[1*], 岡田 聡[1], 石井　宏宗[1], 小嶋 浩嗣[1], 山川　宏[1]
FUKUHARA, Hajime[1*], OKADA, Satoshi[1], Hiromune Ishii[1], KOJIMA, Hirotsugu[1], Hiroshi Yamakawa[1]

[1] 京都大学　生存圏研究所
[1]Research Institute for Sustainable for Humanosphere

Since space is filled with collisionless plasmas, kinetic energies of plasma particles are exchanged via electric and magnetic fields, so-called plasma waves. The plasma waves have been observed a number of scientific spacecraft with plasma wave receivers. The plasma wave receivers are classified into two types, spectrum receivers, and waveform receivers. The spectrum receivers provide an overview of physical processes in which the plasma waves are excited, grown, and dissipated. The waveform receivers give not only amplitude but also phase of the plasma waves. Phase information between the plasma waves and plasma particle is essential in wave-particle interactions. It is important for understanding physical processes to combine both kinds of data of spectra and waveforms. Since the plasma waves have various intensities in wide-band frequency range, from DC to tens of MHz, the onboard instruments for the plasma wave observation are required to have low noise, high sensitivity, and wide dynamic range in wide-band. The required performances lead to increase the weight budget of the analog part of the instrument since discrete electronics devices and integrated circuits are usually used to implement the instruments. We have developed dedicated chip which can drastically decrease weight budget of the plasma wave instruments for multi-point observation and deep space exploration missions. It is also significant that manufacturing a number of instruments with the same performance becomes easy. In this paper, we demonstrate the miniaturized plasma wave receiver using ASIC (Application Specific Integrated Circuit) technology. The ASIC is a LSI (Large Scale Integrated circuit) for a particular purpose, is commonly developed for a consumer electronics products. For the spectrum receiver, we develop a double super heterodyne receiver, so-called ”Sweep Frequency Analyzer (SFA).” This SFA is improved in the time resolution with keeping good frequency resolution by combining the analog frequency conversion and FFT. The SFA consists of an amplifier, a frequency synthesizer, mixers and band-pass filters. These component circuits are fabricated in chips and their performances are tested. The waveform receiver generally consists of the band-limiting filter, the amplifier, the anti-aliasing filter, and the A/D converter. The developed chip contains these circuits except for the A/D converter, and has six-channel to observe full components of the electric and magnetic fields waves. The chip is connected to A/D converters, a clock generator, and power circuits on the PCB. The sampling frequency is 400 kHz, and the dynamic range of the A/D conversion is 14 bits. The total dimension of the PCB containing waveform receiver chip is 50 mm by 90 mm, similar size of a business-card. By the development of the dedicated chip, the weight per channel of the waveform receiver declines to a tenth of the NOZOMI LFA, which was the onboard instrument of the pas Japanese scientific spacecraft.

キーワード: プラズマ波動, 小型化, 集積回路, ASIC, 周波数掃引受信器, 波形捕捉受信器
Keywords: Plasma Wave, Downsizing, Integrated Circuit, ASIC, Sweep Frequency Analyzer, Waveform Capture

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-11 会場:202 時間:5 月 23 日 14:30-14:45

惑星探査用小型LED ライダーの開発
LED mini lidar for Planetary Exploration

小林 正規 [1*], 椎名達雄 [2], 小山護哲 [2]
KOBAYASHI, Masanori[1*], Tatsuo Shiina[2], Moriaki Koyama[2]

[1] 千葉工業大学惑星探査研究センター, [2] 千葉大学大学院融合科学研究科
[1]Planetary Exploration Research Center, Chiba Institute of Technology, [2]Graduate School of Advanced Integration Science, Chiba University

宇宙にはダストが普遍的に存在している。特に固体惑星の進化を議論する上では重要な役割を果たす。
例えば小惑星の表面や周辺に存在していて、その存在は表面の進化を反映していると考えられる。小惑星表面のダストは、太陽光による帯電で形成される電場によって水平方向に輸送されるとも考えられ、同様の輸送機構は月面上でも起きていると考えられているが、詳細は不明である。
高速宇宙ダストであれば、衝突電離のような衝撃によって発生する現象を利用して従来の宇宙ダスト観測装置で検出・観測できるが、浮遊しているダストをその場観測することはこれまでほとんどなされていない。我々は、ほとんど相対速度を持たないダストを観測するために、地上ではエアロゾルを観測するために使われるライダーについて検討している。通常ライダーは光源にパルスレーザーを利用するが、我々は発光ダイオード（LED）を使うことを検討している。LED を利用することのメリットとして、サージに強くドライバの構成も簡易であることなど、扱いが非常に容易であることが挙げられる。LED の使用によって、装置全体を小型化することができる。
このような LED ライダーは、ライダーが火星着陸ミッション Phoenix に搭載された気象観測ステーションで気象観測装置の一部となったように、気象観測にも利用できるだろう。
また、LED は発光の波長の多様性に富んでいるので、例えば差分吸収法を使ってある特定の大気成分を調べるようなことも比較的容易である。
本講演では、惑星探査用 LED ライダーの開発状況について報告する。

キーワード: 発光ダイオード, ライダー, 惑星探査, 小型, ダスト観測
Keywords: LED, LIDAR, Planetary Exploration, compact, dust observation

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-12 会場:202 時間:5 月 23 日 14:45-15:00

アナログ ASIC を用いた小型プラズマ波動観測器のアンテナインピーダンス計測システム
The Development of the Miniaturized Antenna Impedance Measurement System using ASIC

石井 宏宗 [1*], 福原　始 [1], 小嶋　浩嗣 [1], 山川　宏 [1]
ISHII, Hiromune[1*], Hajime Fukuhara[1], Hirotsugu Kojima[1], Hiroshi Yamakawa[1]

[1] 京都大学生存圏研究所
[1]Research Institute for Sustainable Humanosphere, Kyoto University, Japan

Space is filled with plasmas. Since space plasmas are essentially collisionless, plasma wave is one of the most essential physical quantities in the solar terrestrial physics. There are two kinds of plasma wave receivers, the sweep frequency analyzer and the waveform capture. While the sweep frequency analyzer provides plasma wave spectra, the waveform capture provides waveforms of plasma waves with wave phase information. Electric field sensors in plasmas show different features from in vacuum. Since plasma is a dispersive medium, the antenna impedances are various complex numbers in the frequency domain. Consequently, in order to calibrate the observed plasma wave data we have to measure not only the antenna impedances but also the transfer functions of plasma wave receiver's circuits precisely. The impedances of the electric field antennas are affected by surrounding plasma density and temperature. However, these states of plasmas change from moment to moment. Thus, we precisely should measure the antenna impedances onboard spacecraft and convert the observed waveform data into the calibrated data. On the contrary, we can obtain the plasma density and temperature from the antenna impedances.

Various systems for measuring the antenna impedance were proposed. A synchronous detection method is used on the Bepi-Colombo Mercury Magnetospheric Orbiter (MMO), which will be launched in 2014. MMO has the onboard digital synthesizer, as a signal source. The synthesized waveforms are fed to the preamplifiers of electric field sensors through a fixed resistor after the D/A conversion.

We can obtain a transfer function of the circuit by applying the synchronous detection method using output waveform, and digitalized signal source. This system is also useful to check the behavior of the waveform capture receiver. The size of this system is same as an A5 board. In recent years, Application Specific Integrated Circuit (ASIC) is in attention which is a technique to integrate large scale and complicated circuits. Lots of ASICs have been applied to high energy astrophysics, though there are few applications in the solar terrestrial physics.

In this paper, we present our attempt to miniaturize the antennas impedances measurement system and Waveform Capture. We design 8bits segment D/A converter synchronized with waveform captures. We improve input logic of the D/A converter to generate a very weak signal accurately.

キーワード: 小型衛星, プラズマ波動観測器, アナログ ASIC
Keywords: Miniaturized satellite, Plasma wave reciever, Analogue ASIC

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-13 会場:202 時間:5 月 23 日 15:00-15:15

ASIC 搭載型 MCP アノードの性能と飛翔実証試験
Flight verification and performance of a discrete MCP anode with ASIC

斎藤 義文 [1*], 横田 勝一郎 [1]
SAITO, Yoshifumi[1*], YOKOTA, Shoichiro[1]

[1] 宇宙科学研究所
[1]Institute of Space and Astronautical Science

近年観測ロケットや人工衛星搭載観測装置による荷電粒子の計測時間分解能は急速に高くなって来ている。計測時間分解能を上げるためにはいくつかの開発項目が存在するが、荷電粒子の検出器開発もその一つである。観測ロケットや人工衛星搭載観測装置による数 eV/q から数十 keV/q の荷電粒子の計測は静電分析器、特に TOP HAT 型の球型静電分析器 [Carlson et al., 1983, Young et al., 1988] を用いることが主流となっており、荷電粒子の検出器としては、円型１次元の位置検出機能を持つものが要求される。静電分析器に入射した電子、イオンの個数をエネルギー毎に計数するパルスカウントを行うために、電子、イオンを増幅する MCP (Micro Channel Plate) と、増幅された電子を収集するアノードを組み合わせたものが広く用いられている。この円型１次元の位置検出機能を持つアノードにもいくつかの異なるタイプの物が存在する。その中で、最も高時間分解能化に適したアノードは、検出する位置毎に電子を収集するための電極を用意し、それぞれの電極にアンプを接続するディスクリートアノードと呼ばれるものである。高時間分解能計測を実現するためには、短いサンプリング時間の間に十分な統計精度を持つだけのカウントを計測できる必要がある。このことは、高いカウントレートに対応したアノードが必要であることを意味している。ディスクリートアノード自体は従来から広く用いられていたが、問題は位置検出の分解能（荷電粒子計測の入射角度分解能に相当する）を上げようとすればするほど多数のアンプを必要としてその結果回路規模や消費電力が観測ロケットや人工衛星に搭載困難なほど大きくなる事であった。そこで、この問題を解決するために開発を開始したのが、多数のアンプとカウンタを含んだ数ミリ角の ASIC (Application Specific Integrated Circuit) を搭載したディスクリートアノードである [Saito M. et al., AIP Conf. Proc. 1144, 48 (2009), DOI:10.1063/1.3169303]。このアノードの開発を開始してから８年が経過したがようやく２回のロケット実験で飛翔実証試験に成功した他、２０１４年打ち上げ予定の水星磁気圏探査衛星 BepiColombo/MMO 搭載イオンエネルギー分析器 MIA のイオンの検出器として搭載するための準備が整った。観測ロケットや、人工衛星に搭載するためには、小型軽量、低消費電力で、打ち上げ時の振動／衝撃に耐え、特に水星ミッションでは宇宙空間における高範囲の温度変化や放射線に対して耐性を有してかつ打ち上げ前の試験環境で性能劣化をおこしにくい物である事が望ましい。そこで、ディスクリートアノードを 1mm 厚のセラミック上の金属パターンで構成し、背面に ASIC をベアチップのままで搭載する構造を採用することにした。電荷を受けるアノードと、信号処理を行うアンプがすぐそばにある事から S ／ N 性能は非常に良いことが明らかになった。ASIC を BARE CHIP のままで使用することから、微細なボンディングを短絡から保護する等の目的で電荷を収集する部分を除くアノード全体をパリレンでコーティングする方法を採用し良好な結果を得ている。これまでに、Total Dose, Single Event Latch Up を含む放射線照射試験、マイナス４０度から８５度までの熱サイクル試験などを実施し、良好な結果を得ている。また性能的には周期的なパルスであれば１ CH 当たり 25MHz までの計測を行う事ができることを確認した。

これまでにこの ASIC 搭載型 MCP アノードは、ノルウェーの観測ロケット実験 ICI-2, ICI-3 (Investigation of Cusp Irregularity-2, 3: それぞれ２００８年１２月と２０１１年１２月にノルウェーのスバルバード島から打ち上げ) に搭載した低エネルギー電子計測装置 LEP-ESA の電子検出器として使用し、２回の飛翔ともにカスプ周辺のプラズマ擾乱現象の存在する領域での高時間分解能電子計測に成功した。今後、水星磁気圏探査衛星 BepiColombo/MMO 搭載イオンエネルギー分析器 MIA のイオンの検出器として使用する他、小型低消費電力、高時間分解能が要求される将来のミッションに本 ASIC とその搭載技術は広く応用する事ができるものと期待している。

キーワード: 荷電粒子, 検出器, ASIC, MCP アノード
Keywords: charged particle, detector, ASIC, MCP anode

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-14 会場:202 時間:5 月 23 日 15:30-15:45

将来惑星探査へ展開する小型電波受信センサーシステムの開発
Development of small-sized radio sensor for future Jovian mission

笠羽 康正 [1*], 三澤 浩昭 [2], 土屋 史紀 [2], 三好 由純 [3], 木村 智樹 [4], 小嶋 浩嗣 [5], 石坂 圭吾 [6], 高島 健 [4]
KASABA, Yasumasa[1*], MISAWA, Hiroaki[2], TSUCHIYA, Fuminori[2], MIYOSHI, Yoshizumi[3], KIMURA, Tomoki[4], KOJIMA, Hirotsugu[5], ISHISAKA, Keigo[6], TAKASHIMA, Takeshi[4]

[1] 東北大・理・地球物理, [2] 東北大・惑星プラズマ大気研究センター, [3] 名大・STEL, [4]ISAS/JAXA, [5] 京大・生存圏研, [6] 富山県大・工
[1]Dep. Geophysics, Tohoku Univ., [2]PPARC, Tohoku Univ., [3]STEL, Nagoya Univ., [4]ISAS/JAXA, [5]RISH, Kyoto Univ., [6]Toyama Pref. Univ.

Future Jovian mission is now planned for 2020s. One of its major objectives is the investigation of electromagnetic system connected and drived by Jupiter. Under the international collaborations, we have started the development for the small-sized radio sensor for this mission from 2011. We succeeded to establish the base technical elements for (1) light-weight rigid antenna with simple and reliable extension capability and (2) small-sized radiation-hard preamp with the highest sensitivity.

In any missions related to plasmas, electric field from DC to several 10s MHz has contributed to the remote-sensing and in-situ studies of dynamics and energetic interactions in the electromagnetic system, associated with remote optical measurements and in-situ particle and magnetic field sensors.

For the Jovian project, Euro-USA-Japan joint team is formed for the plasma and radio wave studies. Especially in Jupiter, it is important as a remote sensing tool for the direct measurement of Jovian radio source regions distributing around the Jovian system, i.e., polar region, radiation belts, Io torus system, and several satellites with thin atmospheres like Io, Europa, Ganymede, and Calisto. We are involved for this topic, based on the Plasma Wave Investigation (PWI) aboard the BepiColombo/MMO, and started the small-sized radio sensor package with antenna and preamp within the tightest resource limitations.

In 2011, we investigated base technologies for (1) a 3-axial antenna with 2m length, extracting at the Earth orbit and can be kept along the long travel to the orbit around Galilean satellites, and (2) a 3-axial preamp covering 10 kHz - 50 MHz with highest sensitivity, enough radiation tolerance in Jovian environment (the hardest in the solar system), within the mass limit less than 200g, and

For the former, we established the simple extension mechanism based on the self-extracting thin metal element, which is based on the combination of the SCOPE Z-axis antenna (STEM-type extension mechanism but with a complex motor system) and the sounding rocket antenna (self-extraction antenna but limited within 1m extension length). For the latter, under the collaboration with the IRF Uppsala (Sweden) team, we established the key parts of the radiation-hard analogue custom IC technologies, in which the most difficult part was a relay in the package with high-impedance, small-sized, and high-reliability enough. In parallel, we also tested the high-sensitivity preamp BBM under the radiation hard condition, and proved that even in 200 krad the degradation of the noise level is only the twice, without critical linearity and sensitivity damages. In 2012, we will proceed to the next phase.

These small but reliable extension mechanism and electronics are not so much expensive. Therefore, we consider to apply them to sounding rocket experiments. It can be also adopted to any space and planetary missions in which the resource is very tight.

キーワード: 電場, プラズマ波動, 電波, アンテナ, センサー, 木星
Keywords: electric field, plasma wave, radio wave, antenna, sensor, Jupiter

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PCG14-15 会場:202 時間:5 月 23 日 15:45-16:15

Means to avoid the contamination effect of Langmuir probe measurement for ionosphere studies

Means to avoid the contamination effect of Langmuir probe measurement for ionosphere studies

Koichiro Oyama[1*], C.H Lee[1], Hui-Kuan Fang[1], C.Z.Cheng[1]
OYAMA, Koichiro[1*], C.H Lee[1], Hui-Kuan Fang[1], C.Z.Cheng[1]

[1]Plasma and Space Science Center, NCKU, Taiwan
[1]Plasma and Space Science Center, NCKU, Taiwan

Some scientists are still not aware of the serious effect of electrode contamination in Langmuir probe experiments in space, or they do not take any action for that even though they are aware of the seriousness. We stress here that one should pay extra small attention to the electrode contamination to get accurate and reliable parameters, by which the long time effort for sounding rocket/satellite mission does not end in vain. In this paper we describe two main features of voltage-current characteristic curves associated with contaminated Langmuir probe, which are predicted from equivalent circuit model which we proposed in 1970's. We then show that that fast sweep DC Langmuir probe can give reliable result in steady state regime. The first sweep probe can also give a reliable result in transient situation such as the passing through plasma bubble in the ionosphere where electron density suddenly changes, after the several sweep cycle of the probe voltage. This fact is first confirmed through Laboratory experiment.

キーワード: Ionosphere, Surface contamination, Langmuir Probe
Keywords: Ionosphere, Surface contamination, Langmuir Probe