History of EISCAT- Part 6:
The participation of Japan in the EISCAT Scientific Association

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Abstract. This paper describes the details of the Japan's participation in the European Incoherent Scatter (EISCAT) Radar Scientific Association (hereinafter abbreviated as "the EISCAT Association") as an official associate country in 1996, emphasizing strong collaborations with Norwegian scientists and the EISCAT Association.

1 Original Planning of Svalbard Incoherent Scatter Radar (SIR) in Japan

In mid 80' the Ministry of Education, Science, Sports and Culture (hereinafter abbreviated as "MEXT"), Japan, appointed the Research Institute of Atmospherics, Nagoya University to be reorganized. The Research Institute of Atmospherics had been established in 1949 and it aimed to research atmospherics and related natural phenomena such as VLF electromagnetic waves. In 1987 soon after this appointment Professor Sachio Hayakawa, the President of Nagoya University, asked an academic community in Japan, the Society of Geomagnetism and Earth, Planetary and Space Sciences, to discuss and make a plan for the reorganization. The Society appointed Professor Takasi Oguti, a professor of Geophysics Research Laboratory at University of Tokyo, to chair the reorganization committee that then made a plan to reorganize the Research Institute of Atmospherics into the Solar-Terrestrial Environment Laboratory (STEL). The aim of the new laboratory was to study on the structure and dynamics of the solar-terrestrial system.

The committee represented by Oguti set up four scientific plans as its major projects of the forthcoming STEL, one of which was a project to construct a Svalbard Incoherent Scatter (IS) Radar (hereinafter abbreviated as 'SIR') on its own. The motivation behind this project came from the fact that Svalbard was located statistically beneath the cusp, where solar wind plasmas and energy directly entered the magnetosphere and hence it was one of the key regions for the solar wind-magnetosphere-ionosphere interactions. A great advantage of Svalbard was that it was the only place beneath the cusp on the globe to have dark sky time in the midday during winter, which made it possible to observe cusp auroras. In order to prepare the SIR project, Oguti asked Dr. Nobuo Matuura, the Communication Research Laboratory, the Ministry of Posts and Telecommunications, to join the STEL in 1988 and since then Professor Matuura was in charge of the SIR project together with Dr. Satonori Nozawa since 1989 and Dr. Ryoichi Fujii since 1992. The outline of the SIR was that the SIR would be a bistatic IS radar system with

a transmitter/receiver dish antenna in Longyearbyen and a phased array, multiple beams receiving antenna in Ny Ålesund as shown in Fig. 1 (Matuura and Nozawa, 1991). The phased array radar was designed also to have the capability to transmit radar beams and to work as a mono-static radar. The planned radar frequency was 400-500 MHz and the peak powers of the transmitters were 3MW for the dish antenna (MSDC klystrons, TV klystrons) and 3-5 MW for the phased array antenna with

35 3000-5000 cross dipoles (solid state module, 1kW each), respectively as shown in Fig. 2 (Matuura et al., 1990). It is noted that Kyoto University had successfully developed and installed a phased array radar system in Japan during the MAP period (Middle Atmosphere Project,1982-1985), and they had been running it with obtaining noble, important atmospheric data that could not have been obtained before.

2 Japan's Participation in the EISCAT Scientific Association with the Construction of the Second Svalbard IS Antenna

40 In September 1988, Oguti who later became the first director of the STEL had visited Professor Asgeir Brekke and his colleagues at the Auroral Observatory of the University of Tromsø and asked Norwegian scientists to get together with Japan for the SIR project that would be independent of the EISCAT Association. On the other hand, European scientists, particularly UK scientists had been deliberating a possibility to install IS radars in Svalbard, "Polar Cap Radar". STEL was contacted by the UK group in 1988 and asked for international collaboration with them. In September 1989, Dr. Anthony P. van Eyken with

45 the UK scientists published a report "The Polar Cap Radar" where three antennas were envisaged in Longyearbyen, which proposal was well received by the EISCAT Council (a private communication from A. Brekke). A detailed investigation of the scientific and technical case for a polar cap radar was made already by 1990 (Cowley et al., 1990). In September 1989, an EISCAT meeting at Hamburg, which Matuura attended, decided to examine the Polar Cap Radar under consideration of possible collaboration with the Japanese SIR research group. We learned later that the EISCAT community was then skeptical

50 to the Japanese SIR project, particularly to the development and capability of the proposed phased array system. It might be interesting to note that the USA research group represented by the Geophysical Institute of the University of Alaska, considered a plan to install phased array IS radar systems at Poker Flat in Alaska and Resolute Bay in Canada and asked the SIR group to join their project about the time. After the proposal of the Polar Cap Radar to the EISCAT, the SIR project got to be discussed as an international project between the STEL and the EISCAT association.

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In 1990 the Polar Cap Working Group formed in the EISCAT Association specified the EISCAT Svalbard Radar (ESR), which proposal was formally approved by the EISCAT Council in Uppsala, Sweden, in November 1992.

In June 1990 STEL was established and Oguti was appointed as the first director. The laboratory consisted of four research divisions: Atmospheric Environment, Ionospheric and Magnetospheric Environment, Heliospheric Environment and

60 Integrated Studies. The division of Ionospheric and Magnetospheric Environment was in charge of the SIR. A unique characteristic of the Laboratory was the function of 'inter-university collaboration' that promoted joint research projects for nationwide research institutions and researchers. (The Laboratory was again reorganized in 2015, named "Institute for Space-

Earth Environmental Research" that has further expanded its function to clarify the mechanisms and relationships between the Earth, the Sun, and cosmic space, treating them as a seamless system)

65   In December 1990, one of the four major projects of STEL, the SIR project was proposed (Matuura and Oguti, 1991). In April 1991 at the general assembly of the European Geophysical Society in Wiesbarden Germany, Matuura on behalf of STEL presented the SIR project (a phased array antenna system at Longyearbyen) by request of the EISCAT and the EISCAT presented their Polar Cap Radar project (a dish antenna system at Longyearbyen). The difference between the two systems with their comparison was reported on Nature News (Aldhous and Swinbanks, 1991). We later learned that there had been

70   some skepticism in the EISCAT community about expanding EISCAT membership outside Europe. Actually, there were various difficulties for the Japan's participation in the EISCAT Association.

We were very fortunate to have two key persons for helping us solve these difficulties during the period of the planning and negotiation with EISCAT, Brekke and Dr. Jurgen Röttger, the Director of the EISCAT Association of the time. Without the

75   two persons' devoted efforts/helps it would never have been possible at all for Japan to join the EISCAT Association.

One of the two persons, Brekke continuously acted central roles for the collaboration between Japan and the EISCAT before and during the vice-president and president of the EISCAT Council. Brekke often visited Japan and stayed at STEL three times as a visiting professor, and tried to persuade the MEXT and Nagoya University for the Japan's participation that would

80   inevitably require a rather large amount of budget at the beginning and stable annual membership fees later on. He invited Nozawa to the University of Tromsø for ten months in 1992 and gave him opportunities of training to operate the EISCAT radars and to process/analyze EISCAT data that were essentially important for the later development of the EISCAT user community in Japan. In August1992 Oguti and Fujii visited the place of the candidate site of SIR, Ny Ålesund, accompanied by Brekke and Dr. Truls Hansen. At that time STEL was still stick to the SIR project independent of EISCAT. After having

85   carefully observed the site, Oguti and Fujii realized various difficulties in the construction and run of SIR, e.g., rather severe regulation to the environment that would certainly make the construction of the active antenna difficult and costly. The intensive discussion with Brekke there was an epoch and we seriously started to consider to cooperate with EISCAT. On the very next day Oguti already stated to Brekke and the dean of the University of Tromsø to incorporate the Japan's project with the EISCAT proposal. Indeed, in November 1992 Matuura on behalf of STEL informed Brekke with an official letter that

90   STEL was thinking of changing its future proposal such that Japan would primarily participate in EISCAT Longyearbyen radar plan with Japanese in-kind contribution to the construction of the second dish.

In 1993 Brekke was elected chairperson of the EISCAT Council and he accelerated the process for the Japanese participation in the EISCAT Association. The EISCAT Council decided to send a delegation to Japan in September. The delegation

95   consisted of Brekke, Röttger and Professor Jorma Kangas, the University of Oulu Finland. The delegation visited Professor Nobuo Kato, the President of Nagoya University and did encourage him to apply for membership of the EISCAT Association

on behalf of Japan. They also visited Mr. Masayuki Inoue, the Director of the Division for International Research at the MEXT and again encouraged him to support the application of Japan becoming a member of EISCAT, with stating that EISCAT was considering Japan as the welcomed collaborator and the EISCAT was ready to invite Japan to participate in the EISCAT
100   Council.

In June 1994 STEL asked Mr. Masahiro Nishio, the Director General of Nagoya University to visit Svalbard for an inspection tour of EISCAT. It convinced him of the importance for Japan and Japanese researchers to participate in the EISCAT Association. After returning to Japan, he immediately started to negotiate with MEXT for the Japan's participation in the
105   EISCAT Svalbard IS Radar project, which we think triggered the merging of the two projects and Japan becoming an associate of the EISCAT Association. In late August to early September 1994, we held an EISCAT Workshop in Toba, Japan. It was very successful in terms of scientific values and personal ties between European and Japanese scientists, with attendees of 61 scientists including 17 scientists from foreign EISCAT related countries. Also participated were Mr. Furuya, a high governmental official from the Division for International Research at the MEXT and Mr. Ito, the Director General of Nagoya
110   University, by which we had a hunch that the STEL's proposal would be approved and funded. After the workshop, Brekke, Dr. Eivid Thrane, NDRE Norway, and Röttger together with Professor Susumu Kokubun, the director of STEL at that time and Matuura visited Inoue at MEXT again. Inoue informed them that the MEXT was going to fund the National Institute of Polar Research (NIPR) that was in charge of promoting scientific activities in both polar regions for the Japanese EISCAT project.

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In May 1995 funds for the Japan's participation with the in-kind contribution to the second dish antenna were released by MEXT. The EISCAT Council approved the Japan's participation in the EISCAT Association as the seventh associate country at Hamburg on May 23 (Plate 1) with concluding the Memorandum of Understanding between the National Institute of Polar Research (Director General Takeo Hirasawa, NIPR) and the EISCAT Scientific Association (Director Röttger). At the same
120   time the EISCAT Agreement among the original six Associate countries ended and the new Agreement was signed by the seven Associate countries including Japan. The second antenna was then constructed (Plate 2) and its inauguration was held at the antenna site in Longyearbyen on the summer solstice day 1996 (Plate 3).

This is a major outline of the Japan's participation in the EISCAT Association. There were, however, certain subjects between
125   Japan and the EISCAT Association that had to be carefully and comprehensively deliberated/treated and prepared, on which Röttger, Director of the EISCAT, did play essential and indispensable roles. The Deputy Director Anthony P. van Eyken also helped the process very much particularly from scientific aspects.

As mentioned earlier, the EISCAT Council was sometimes skeptical for the Japan's participation in the EISCAT Association
130   as an associate country, probably since this was the first case of a new member for the EISCAT and furthermore the

participation of a 'non-European' country. Röttger moved important issues forward with strong leadership, while always having respected the authority, opinions and orders of the EISCAT Council. The issues were for example, preparations for how to deal with a new associate, Japan, in the agreement, in-kind contribution for the joining EISCAT, the right of Japan (the allocation method of the observation time for Japan on the in-kind and annual contributions), etc. He made, with careful and

135 well-thought-out strategies, his best efforts to provide the both of the EISCAT Council and Japan with acceptable, possible proposals, with having observed and examined carefully both parties.

Röttger and his colleagues at the EISCAT Headquarter in Kiruna intensely supported us in technical and financial subjects for, e.g., the construction of the second antenna. Soon after the intension of the MEXT to fund the second antenna dispatched from

140 Inoue in September 1994 when the EISCAT delegation had visited him, STEL and NIPR started an investigation of the antenna and contacted Kvaener Kamfab AB that had constructed the first Svalbard IS antenna in order to collect necessary information. The category of the MEXT budget for the second antenna, however, had a difficult restriction that the budget had to be used in principle in one year, at most in two years, although construction works in Svalbard could be made only in a short period around summer and it was clear that two years were too short for completing the antenna construction. Before and after the

145 MEXT's release of the fund to the second dish antenna in May 1995, under such difficult circumstances Röttger and his headquarter colleagues helped us very intensively and finally the second antenna was installed in due time.

3 Concluding Remarks

Twenty-seven years have passed since the Japan's participation and thirty-four years since the first contact of Oguti with Brekke. It may be worthy to mention that the Japanese EISCAT activity has been placed as an important component among

150 the very long-term Japan and Europe, particularly with Norway, collaborations, as shown in Fig. 3. (Historically Professor Kristian Birkeland stayed in Tokyo and died there in 1917 and Japan was one of the 14 original signing countries of the Svalbard Treaty in 1920.) The collaboration started in the mainland of Norway in 70's between Oguti, the University of Tokyo, and Professor Alv Egeland, the University of Oslo for ground-based observations. Collaborations in Svalbard started in 1985 for ground-based observations. Observations/measurements with rockets and balloons had also been started well before the

155 Japan's participation in the EISCAT Association. We wonder that the experience and trust between Japan and Norway earned through these activities let the newly established STEL plan the Svalbard IS Radar project and later join the EISCAT Association.

The Japan's participation made the EISCAT more global, and Japan has established a trustworthy position in the EISCAT

160 Association in close collaborations with the EISCAT Associate countries. The activity of the EISCAT research community in Japan hosted by NIPR and STEL have been growing year by year. Nationwide researchers and graduate students have been enjoying the participation in radar experiments at Ramfjordmoen and in Longyearbyen (http://polaris.nipr.ac.jp/~eiscat/en/).

Furthermore, we have been conducting ground-based and space-borne projects in association with EISCAT, where in most cases the central sites of the projects have been located at Ramfjordmoen and Longyearbyen; for example, "Pulsating Aurora

165 Project" with three stations in northern Scandinavia since 2015 (http://www.psa-research.org/english/). The number of published refereed journal papers related to EISCAT is 240 (160 by Japanese first authors) as of 2021.

 Now the EISCAT_3D (its fast time sampling capability makes it actually 4D) (McCrea et al., 2015) being installed is expected to provide us with new astonishing nature and insights of the space around the earth that no one has ever seen before. The

170 Japanese EISCAT community has been making extensively preparations for the EISCAT_3D with great excitement.

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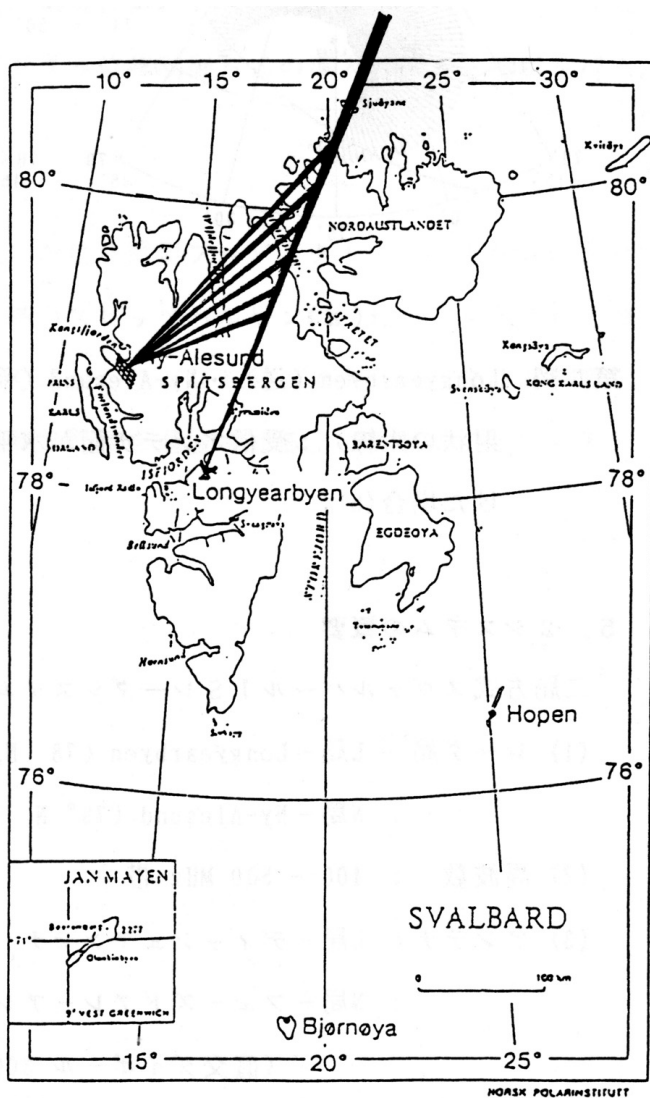
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Figure 1: Bi-static Svalbard IS Radar (SIR) system planned originally by STEL (Matuura and Nozawa, 1991)

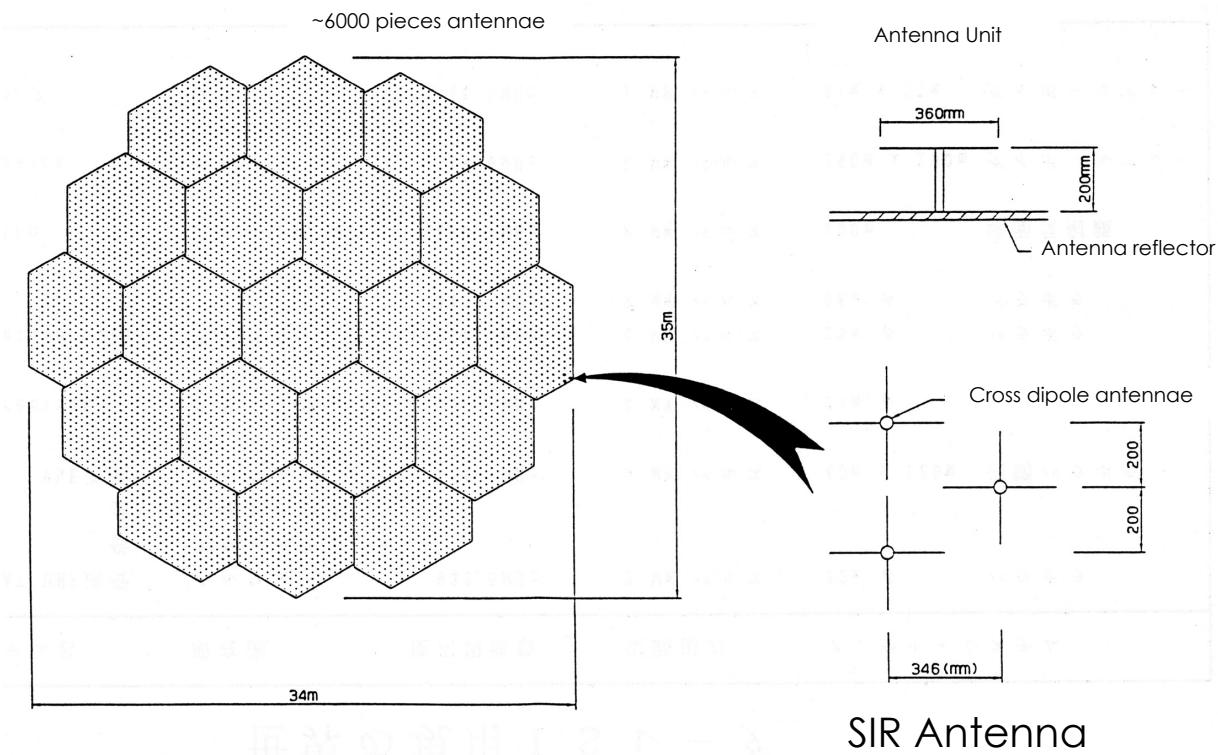



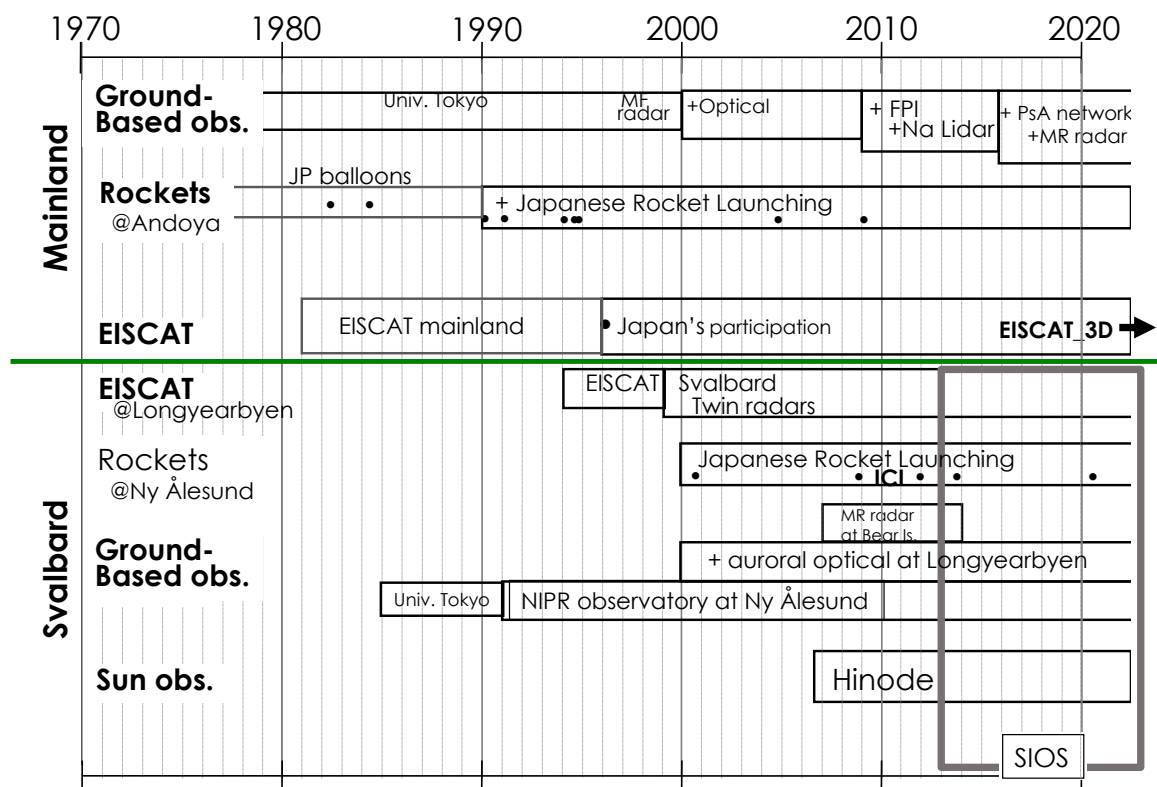
Figure 2: The structure of the SIR phased array antennae. (Matuura et al., 1990)

195 **Figure 3: History of the Japan-Norway collaborations in space science**

Plate 1: Japanese delegation, EISCAT Council delegates and Executives at the Council meeting on May 23, 1995 in Hamburg
(Taken from P. 13 of EISCAT ANNUAL REPORT 1994-1995, EUROPEAN INCOHERENT SCATTER SCIENTIFIC ASSOCIATION)

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Plate 2: The second dish antenna of the Svalbard IS radar system

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Plate 3: Japanese delegation at the Inauguration of the Svalbard IS radar on 21 June, 1996 in Longyearbyen (Professor Matuura on the
225   rightmost, Professor Hirasawa, Director General of NIPR on the second right and Professor Susumu Kokubun, Director of STEL on the
fourth right)