

**COVER SHEET**

Principal applicant

**Kristof Stasiewicz**

Research programme

**Analysis and Visualization of Space Measurements**

**Progress Report for 2003  
for projects previously funded by SNSB**

**The progress report must include:**

Achieved scientific and technical goals;

A tabulation of all relevant publications that have been published during the year (if you enclose reprints; 3 copies are sufficient);

Specification of all space based experiments that have been performed during the year;

Specification of attendance to scientific conferences

**This report covers progress concerning programmes financed through the following contracts:**

<b>Dnr</b>	<b>Amount granted the reported year</b>	<b>Title of research programme</b>	<b>Programme leader</b>
96/01	0 kkr for 2004 580 kkr in 2003	Analysis and Visualization	Kristof Stasiewicz
94/02	0 kkr for 2004 390 kkr in 2003	ISS-Radio	Kristof Stasiewicz

Note: All contracts for which funding from SNSB was received or utilised during the year in question should be included in the table (the progress report can be omitted if it has previously been submitted independently to SNSB).

**IRF** Uppsala

Analysis and Visualization /ISS

Progress report for 2003

## 1. Overview of the results

### OVT

Within this project we have developed computer software Orbit Visualisation Tool for Cluster, which is highly appraised by international community with over 500 registered users worldwide. The software is available free of charge at <http://ovt.irfu.se>.

Thirty eight users wrote letters to SNSB urging for support of this project. Several citations are shown in Appendix on page 17

### New PhDs

PhD student (Yuri Khotyaintsev) working within this programme and supported previously by SNSB, has completed his doctoral degree by defending the thesis: Alfvén Waves and Energy Transformation in Space Plasmas, 28 January 2003.

### New Discoveries

Within this project we made an important discovery of magnetosonic solitons in Cluster data. Solitons and nonlinear shock waves have been studied theoretically and experimentally in fluids for more than a century. However, no convincing evidence has so far been provided from measurements in space. In a paper published recently by Stasiewicz et al., in Physical Review Letters, February 28, 2003, we demonstrated for the first time the existence of large scale, large amplitude solitons at the magnetospheric boundary layers. Another paper on large amplitude shocklets has been published in Geophysical Research Letters. Several other papers that exploit this discovery are under preparation.

### Invited Presentations

Five invited presentations to international meetings and conferences may be regarded as an indication of the level of our research.

### Development of ISS-Radio

In collaboration with Space Research Centre in Warsaw we are developing the flight model of digital Radio Spectrometer to be flown on International Space Station. Because of lack of dedicated funding in Sweden, the project progresses slower than initially planned. The launch is scheduled now for 2006.

### European Research Training Network

High international standard of our research has been recently appreciated by the European Commission, which entrusted us with co-ordination of European Research Training Network involving six expert groups from 6 countries. The network is investigating turbulent boundary layers in geospace plasma using measurements from Cluster and other satellites. The project ends in March 2005. Information about network is available at <http://cluster.irfu.se/rtn/>.

### Highlights on magnetosonic shocklets.

In an article published by GRL we present detailed properties of fast magnetosonic shocklets (1000 km in size and amplitude of 10 times the background B-field and density values) observed in natural unbounded collisionless plasma by a fleet of four Cluster spacecraft at the quasi-parallel bow shock. We provide for the first time details of the internal structure of shocklets which have magnetic pulses shifted in time from the plasma density pulses, have localized regions with ion acoustic turbulence, and are shown to slow down and thermalize the solar wind ions. The shocklets emit weak electron plasma waves which are used to verify the plasma density profiles within the structure and are for the first time reported in this paper. We provide an explanation for the observed relationship between the magnetic field and plasma density profiles within the structure. The results have been published in *Geophysical Research Letters*, 30(24), 2241, doi:10.1029/2003GL017971, 2003

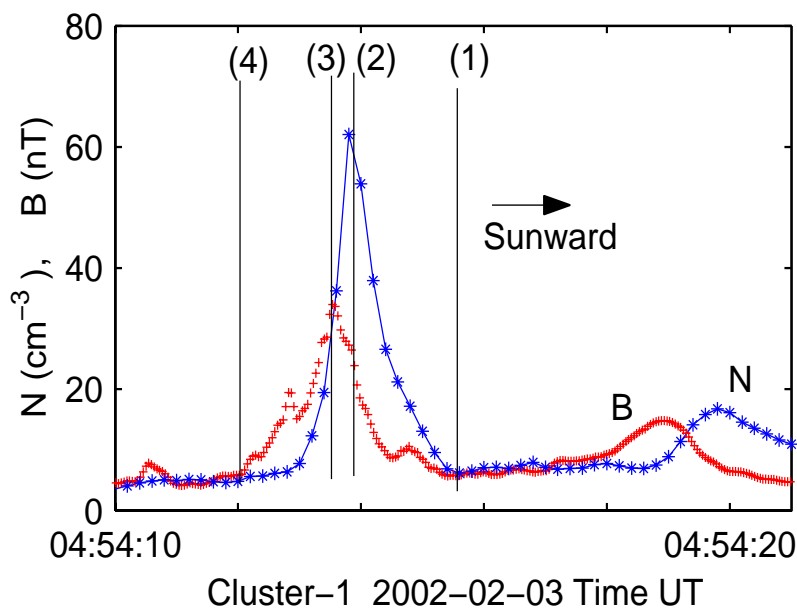


Figure shows magnetic field and density variations within large amplitude shocklets at the bow shock (Stasiewicz et al., 2003).

## 2. List of publications in 2003

J. Blecki, S. Savin, H. Rothkaehl, R. Wronowski, **K. Stasiewicz**, Z. Nemecek, J. Safrankowa and K. Kudela

The role of the wave particle interactions in the dynamics of the plasma in the polar cusp, *Cosmic Research*, vol 41, no 4, 332-339, 2003.

J. Błęcki, S. Savin, N. Cornilleau-Wehrin, K. Kossacki, M. Parrot, H. Rothkaehl, **K. Stasiewicz**, R. Wronowski, O. Santolik and J.-A. Sauvaud

Fine structure of the polar cusp as deduced from the plasma wave and plasma measurements, *Adv Space Res.*, vol 32, No 3, pp315-321, 2003.

**Y. Khotyaintsev, S. Buchert, K. Stasiewicz, A. Vaivads**, S. Savin, V. O. Papitashvili, C. J.

Farrugia, B. Popielawska, Y.-K. Tung, Transient reconnection in the cusp during strongly negative IMF B<sub>y</sub>, *J. Geophys. Res.* Vol. 109, No. A4, A04204, 03 April 2004

**Y. Khotyaintsev, A. Vaivads**, Y. Ogawa, B. Popielawska, M. Andre, S. Buchert, P. Decreau, B. Lavraud and H. Reme  
Magnetic reconnection in high-beta plasma: Cluster observations in cusp. Submitted to Ann. Geophys., 2003.

V. Krasnoselskikh, V. Lobzin, S. Schwartz, P. Décreau, B. Lefebvre, J.-L. Pinçon, M. Dunlop, J.-M. Bosqued, S. Bale, A. Balogh, N. Cornilleau-Wehrin, A. Fazakerley and **G. Gustafsson**  
Interpretation of Downshifted Electron Plasma Oscillations observed by Cluster. Submitted to J. Geophys. Res., 2003.

B. Popielawska and **G. Gustafsson**

The distant cusp and the surrounding magnetopause: A view in snapshots from POLAR, Adv. Space Research, Vol 31, No.5, pp 1353-1362, 2003.

S. Savin, L. Zelenyi, S. Romanov, I. Sandahl, J. Pickett, E. Amata, L. Avanov, J. Blecki, E. A. Sauvaud, A. Skalsky, V. Smirnov, **K. Stasiewicz**, J. G. Trotignon and Y. Yermolaev  
Magnetosheath - Cusp Interface, Ann. Geophys., in press, 2003.

S. Savin, A. Skalsky, L. Zelenyi, P. Song, T.A. Fritz, E. Amata, J. Buechner, J. Blecki, L. Avanov, **K. Stasiewicz**, J. G. Trotignon and Y. Yermolaev  
Magnetosheath interaction with high-latitude magnetopause, Surveys in Geophys., 2003.

**K. Stasiewicz**, P. K. Shukla, **G. Gustafsson**, **S. Buchert**, B. Lavraud, **B. Thidé**, and Z. Klos,  
Magnetosonic Solitons Detected by the Cluster Spacecraft, Pys. Rev. Lett., **90**, 085002, 2003

**K. Stasiewicz**, **Y. Khotyaintsev** and M. Grzesiak,  
Dispersive Alfvén Waves Observed by Cluster at the Magnetopause, Physica Scripta, T107, 171, 2004.

**K. Stasiewicz**, **M. Longmore**, **S. Buchert**, P. Shukla, B. Lavraud, J. Pickett  
Properties of Fast Magnetosonic Shocklets at the Bow Shock, Geophys. Res. Lett., 30(24), 2241, doi:10.1029/2003GL017971, 2003.

J. S. Pickett, J. D. Menietti, G. B. Hospodarsky, D. A. Gurnett and **K. Stasiewicz**, Analysis of the turbulence observed in the outer cusp boundary layer, Adv. Space Res., in press, 2003.

E. Yordanova, M. Grzesiak, A. W. Wernik, B. Popielawska and **K. Stasiewicz**  
Multifractal structure of turbulence in the magnetospheric cusp, submitted to Ann. Geophysicae, 2003.

### 3. Presentations on international conferences

Note:

**Titles of invited presentations** are shown in boldface.

European Geophysical Union, meeting in Nice, 6-11 April, 2003

K. Stasiewicz, **Invited: Magnetosonic solitons detected by Cluster**

B. Popielawska, Y. Khotyaintsev, G. Gustafsson, B. Kellett, C. Farrugia, J. Pickett and K. Stasiewicz, Structure of high-latitude magnetopause near the merging site  
STAMMS, Orleans, May 2003.

Y. Khotyaintsev, et al, "Cluster observations of a reconnection site at high-latitude magnetopause"

International Topical Conference on Plasma Physics, 6-13 September, 2003, Thira, Greece.

K. Stasiewicz, **Invited: Dispersive Alfvén waves observed by Cluster at the magnetopause.**

Prague Conference, Magnetospheric Response to Solar Activity, Prague, September, 2003.

Popielawska, Y. Khotyaintsev, J. Pickett, C. Farrugia, B. Kellett, G. Gustafsson and K. Stasiewicz, **Langmuir and Electron Solitary Waves at High-latitude Magnetopause Near the Merging Site, solicited**

6th Cluster workshop, ESTEC, Oct 2003.

Y. Khotyaintsev, et al. "Reconnection in high-beta plasma: Cluster observations in the exterior cusp"

Conference on Sun-Earth Connections, Kona, USA, 7-15 February, 2004.

K. Stasiewicz, **Invited: Magnetosonic solitons and shocklets at the magnetospheric boundaries.**

ISSI workshop on nonlinear structures and solitons, Bern, 22-23 March, 2004.

K. Stasiewicz, **Invited: Nonlinear structures and solitons in space**

Alfvén 2004 Conference on space environment turbulence organized by WISER (World Institute for Space Environment Research), Beaulieu, France, 19-23 April 2004.

K. Stasiewicz, **Invited: Alfvén solitons and shocklets in the magnetosheath region.**

## Appendix. Letters of support for OVT.

Below we show text of 7 (out of 38 ) letters that were sent to Swedish National Space Board in support for Orbit Visualization Tool project in Uppsala . This project received no funding for year 2004.

----- Original Message -----

From: "Jurgen Watermann" <[jfw@dmi.dk](mailto:jfw@dmi.dk)>  
To: "Kristof Stasiewicz" <[ks@nest.irfu.se](mailto:ks@nest.irfu.se)>  
Sent: Wednesday, January 14, 2004 12:56 PM  
Subject: Re: OVT News

The Swedish National Space Board  
Solna  
Sweden

Dear Sirs,

it is with great concern that I learned that the Swedish National Space Board has chosen to discontinue financial support to the OVT (Orbit Visualization Tool) project which is managed by Dr. Stasiewicz. Our group regrets this very much and urges you to reconsider the decision and re-establish support to the OVT team.

Our group is involved in various space research projects, among others with the Greenland ground-based magnetometer chain and the Ørsted satellite, both of which are carried out under the scientific leadership of our group. We participate in the data analysis and interpretation from other space research projects, e.g., the Cluster, CHAMP and SAC-C satellites. Analysis and interpretation of joint data sets from ground and space have always been a major topic in our group, and we rely consequently on tools to visualize satellite orbits and specifically satellite-satellite and satellite-ground constellations.

We have learned to value and highly appreciate the great possibilities provided by the OVT to support our research. I am not aware of any other tool which is comparable in quality and functionality to the Swedish OVT. And it is specifically encouraging to see that this widely used tool is made available through the intense effort of a relatively small team.

We expect to be involved in the analysis of data from near-future multi-satellite projects, specifically the ESA missions ACE+ and SWARM which currently undergo Phase-A studies. It will greatly facilitate research building on these new missions if the OVT will continue to be available and will be further developed to accommodate future missions and specifically those very interesting multi-satellite missions.

Yours sincerely

Jurgen Watermann, Project Scientist Greenland Magnetometer Chain  
Danish Meteorological Institute  
Solar-terrestrial Physics Division  
Copenhagen, Denmark

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Solar-Terrestrial Physics Division <http://www.dmi.dk/solar-terrestrial/>  
Greenland magnetometer array <http://www.dmi.dk/projects/chain/>  
Personal URL <http://www.dmi.dk/solar-terrestrial/staff/watermann/homepage.shtml>

9 ----- Original Message -----

From: "Pontus C:son Brandt" <[brandpc1@jhuapl.edu](mailto:brandpc1@jhuapl.edu)>

To: <[spaceboard@snsb.se](mailto:spaceboard@snsb.se)>

Cc: <[k.stasiewicz@irfu.se](mailto:k.stasiewicz@irfu.se)>

Sent: Wednesday, January 14, 2004 2:24 PM

Subject: OVT support

Dear Space Board,

It has come to my attention that the OVT software development has been cut from further funding. I hereby would like to express my support for further funding. I work with the physics and coupling of the inner magnetosphere by mainly using global ENA-images from the IMAGE satellite, but also in-situ data from both ground and space. Our prime in-situ data is the data from the Cluster mission and we're highly dependent of having accurate orbit parameter visualization. We have the OVT package installed here at The Johns Hopkins University Applied Physics Laboratory and it is one of the best visualization tools I've come across.

If funding is cut it will not only hamper our ongoing investigations, but will affect the essential cross-comparisons between Cluster and the IMAGE extended mission, launch of TWINS (two ENA imagers) this year, and launch of the Double Star Program (polar ENA imager).

With the recent upswing in global imaging missions, a new window to global large-scale MI-coupling has been opened. Comparison with in-situ Cluster data is not only used for validation purposes but, more importantly, for data assimilation of ring current and plasma sheet ion pitch-angle distributions into the global data. Also, global ring current distributions can be used to derive the large-scale pressure driven current systems. Recently, the Cluster magnetometer team has performed a curlometer technique to derive the current system in the inner magnetosphere. The one-year old results still stands and strongly indicate that what we took for granted about the large-scale pressure-driven current systems, has to be modified. This can only be done with a combination of global data and in-situ Cluster data. Accurate and versatile position displays are essential for this type of global study.

These kind of software developments never receive sufficient attention. They do not produce any scientific papers, but nevertheless they are important to keep running. I know more teams (Dr. Dandouras, CESR, France), that would agree with me on all of the above.

Hoping for continued support, and development, of OVT.

Best regards...

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| Pontus C:son Brandt |  
| Applied Physics Lab |  
| 11100 Johns Hopkins Rd. |  
| Laurel |  
| MD 20723-6099 |  
| USA |  
| tel:+1-240-228-3837 |  
| fax:+1-240-228-0386 |  
email:pontus.brandt@jhuapl.edu

17 ----- Original Message -----

From: "Slava Pilipenko" <[pilipenk@augzburg.edu](mailto:pilipenk@augzburg.edu)>

To: <[Per.Tegner@snsb.se](mailto:Per.Tegner@snsb.se)>

Cc: <[ks@nest.irfu.se](mailto:ks@nest.irfu.se)>

Sent: Tuesday, January 20, 2004 9:52 AM

Subject: Problems with OVT project

Dear Dr. Per Tegner,

I was rather upset and concerned to know that the OVT (Orbit Visualisation Tool) project has been cancelled by the Swedish National Space Board. Up to now the world space community used to use for the satellite position calculations mainly the facilities provided by the NASA Satellite Situational Center (SSC). However, this software has been developed about 30 years ago and became rather obsolete. Thus, the OVT project provided a good alternative to SSC and was a noteworthy contribution of Swedish space physicists to the world satellite operations. Additional advantage of OVT was that this software was primary oriented on the analysis of multi-satellite missions, which are becoming more and more widespread (Cluster, Double Star, Resonance, etc.). I think that OVT would require some improvement (such as more options for ground-satellite conjunctions query, augmentation with more satellite orbit elements, etc.) and it is a great pity that this project - very perspective for the world space science, will not be developed anymore.

Sincerely,

Prof. Viacheslav A. Pilipenko  
Space Research Institute, Russian Academy of Sciences  
Profsojuznaja 84/32  
117810  
Moscow

tel.: 7-095-2544290 (office)  
7-095-4383985 (home)  
Fax: 7-095-2556040

11 ----- Original Message -----

**From:** [Ivan Galkin](#)

**To:** [Per.Tegner@snsb.se](mailto:Per.Tegner@snsb.se)

**Cc:** [K. Stasiewicz](#)

**Sent:** Thursday, January 15, 2004 3:27 PM

**Subject:** Future of the OVT project at IRFU

Dear Dr. Tegner:

I am writing this letter in support of the software development team at IRFU responsible for the OVT (Orbit Visualization Tool). My name is Ivan Galkin, I am the Section Head at the UMASS Lowell Center for Atmospheric Research. As a member of the IMAGE Radio Plasma Imager team, I use the OVT quite often to visualize the geometry of our joint campaigns with the ground instruments, where it is important for us to trace the Earth's magnetic field lines from the IMAGE spacecraft to the ground. The OVT is a truly remarkable software, easy to use, configurable to work with other missions and ground instruments. A lot of good thinking went into this project, and I was extremely pleased to see that the authors of this tool were able to continue its development by adding new features.

It is my understanding that financial support the OVT team has been discontinued. If this decision was made on the grounds of lack of interest to the OVT project from the space science community, I would like to voice my opinion on the contrary. The OVT has provided us with the solution we could not find elsewhere, and in this respect it is unique and irreplaceable.

Thank you for your time and consideration of this important matter. I do hope that the OVT project will be able to continue its operations.

Respectfully,  
Ivan Galkin

**Ivan A. Galkin**

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Lowell, MA 01854, USA

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Fax: (978)459-7915

20 ----- Original Message -----

From: "Daly Dr., Patrick" <[daly@linmpi.mpg.de](mailto:daly@linmpi.mpg.de)>

To: <[Per.Tegner@snsb.se](mailto:Per.Tegner@snsb.se)>

Cc: <[k.stasiewicz@irfu.se](mailto:k.stasiewicz@irfu.se)>; "Escoubet, Philippe" <[Philippe.Escoubet@esa.int](mailto:Philippe.Escoubet@esa.int)>; <[spaceboard@snsb.se](mailto:spaceboard@snsb.se)>

Sent: Friday, January 23, 2004 10:20 AM

Subject: The OVT Project at Uppsala

Dear Dr. Tegner,

As Principal Investigator for the RAPID experiment on board the Cluster Mission, I am particularly distressed to hear that support for the OVT (Orbit Visualizing Tool) Team at the Swedish Institute of Space Physics, Uppsala, is to be discontinued.

This software is extremely useful for understanding and visualizing the complicated geometry of the four Cluster spacecraft. It is not just a question of determining where the spacecraft are located at any time, for other orbit determination programs do this too, but more importantly to see how they are positioned relative to one another. The interactive features are most important, allowing one to zoom, rotate, and otherwise to view the situation from any desired perspective. This is valuable to understand the relative timings of events observed in the data. The ease with which OVT can assist the data analysis cannot be understated.

Further development on OVT would be very desirable, especially to be able to generate easily a sequence of pictures (ie a movie) along the orbit, or to add event markers that the user has determined from his or her own data set. Such additions would make OVT very advantageous for data presentation, something that is very tricky with 4 spacecraft. It is a shame that this development is not to be realized.

I would hope that you could find some way to continue to support this worthwhile and indispensable project.

Sincerely yours,

Patrick Daly,  
RAPID PI

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Dr. Patrick W. Daly                      Tel. [+49] 5556-979-279  
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31 ----- Original Message -----

From: [finn](mailto:finn)

To: [Per.Tegner@snsb.se](mailto:Per.Tegner@snsb.se)

Cc: [k.stasiewicz@irfu.se](mailto:k.stasiewicz@irfu.se)

Sent: Wednesday, February 04, 2004 3:06 PM

Subject: Støtte for OVT

**Generaldirektør Per Tegner**  
**Swedish National Space Board**

Romfysikkseksjonen ved Universitetet i Bergen er med i forskergruppen som har utviklet og bygget RAPID instrumentet på CLUSTER satellittene. Vi deltar aktivt i analysen av data fra satellittene. I vårt analysearbeide har vi stor nytte av OVT (Orbit Visualisation Tool) verktøyet. Et slikt verktøy er essensielt for

forståelse og tolkning av tredimensjonale data. Vi ser derfor med stor uro på at OVT ikke får midler slik at verktøyet kan vedlikeholdes. Over tid vil OVT kunne miste sin funksjonalitet og ikke lengere være et tjenlig verktøy for forskningen. Vi håper at Rymdstyrelsen vil klare å finne midler, slik at OVT fortsatt kan være et nyttig verktøy for romforskning.

På vegne av Seksjon for romfysikk  
Institutt for fysikk og teknologi  
Universitetet i Bergen  
Med hilsen  
Finn Søråas  
Professor

36 ----- Original Message -----

From: "Liu Qiang" <[yeeder@hotmail.com](mailto:yeeder@hotmail.com)>

To: <[Per.Tegner@snsb.se](mailto:Per.Tegner@snsb.se)>

Cc: <[k.stasiewicz@irfu.se](mailto:k.stasiewicz@irfu.se)>

Sent: Wednesday, February 18, 2004 4:28 AM

Subject: Thanks OVT team. Thanks Swedish National Space Board!

Dear Mr. Per Tegner,

I'm from the Double Star Project (DSP) team in Center for Space Science and Applied Research (CSSAR), Chinese Academy of Sciences (CAS), Beijing, China. I'm in charge of the mission analysis and the orbit design. DSP( [http://www.esa.int/export/esaSC/120381\\_index\\_0\\_m.html](http://www.esa.int/export/esaSC/120381_index_0_m.html) ) is a joint ESA/Chinese project to study the effects of the Sun on the Earth's environment, and in particular the 'magnetotail', where storms of high-energy particles are generated. It consists of two satellites, TC-1, the near equatorial satellite, which has been successively launched in Dec.30, 2003, and TC-2, the polar satellite, which is scheduled to be launched in July this year.

Thanks OVT team! OVT is really a great tool. It's used in my job for DSP, both the mission analysis and the orbit design. The first time I knew OVT was at the end of 1998 when I worked at ESOC for DSP. from that time on, It has been a necessary in my daily toolkit. It is intensively used in my daily work, to verify the mission analysis and the orbit design, to produce presentation, to explain my idea to the colleagues. And I also recommend OVT to my colleagues, it now appears in the screen of the operations team of TC-1 almost every day. It's also used in European PIs' whose instruments are installed in DSP satellites.

At the present, some new projects in geospace exploration are being discussed in CSSAR, like SWISE, which is proposed to join the IWLS, includes three satellites, orbiting in different altitudes. OVT will also keep playing an important role in my job for that and other space environment related projects.

The attached image is created by OVT. It clearly shows the collaboration status of DSP and CLUSTER-II. I do not know any other software could do better than OVT in this area.

Thanks OVT team. And Thanks Swedish National Space Board! If OVT does not get your generous help, we can not have this continuously updated powerful tool.

To make our work more effective, we need OVT, OVT needs your great help for hosting the web site, so we also need your great help!

Best regards  
Liu Qiang