ESA Pilot Project
Real-Time Forecast Service for Geomagnetically Induced Currents

The Team

- **Swedish Institute of Space Physics**

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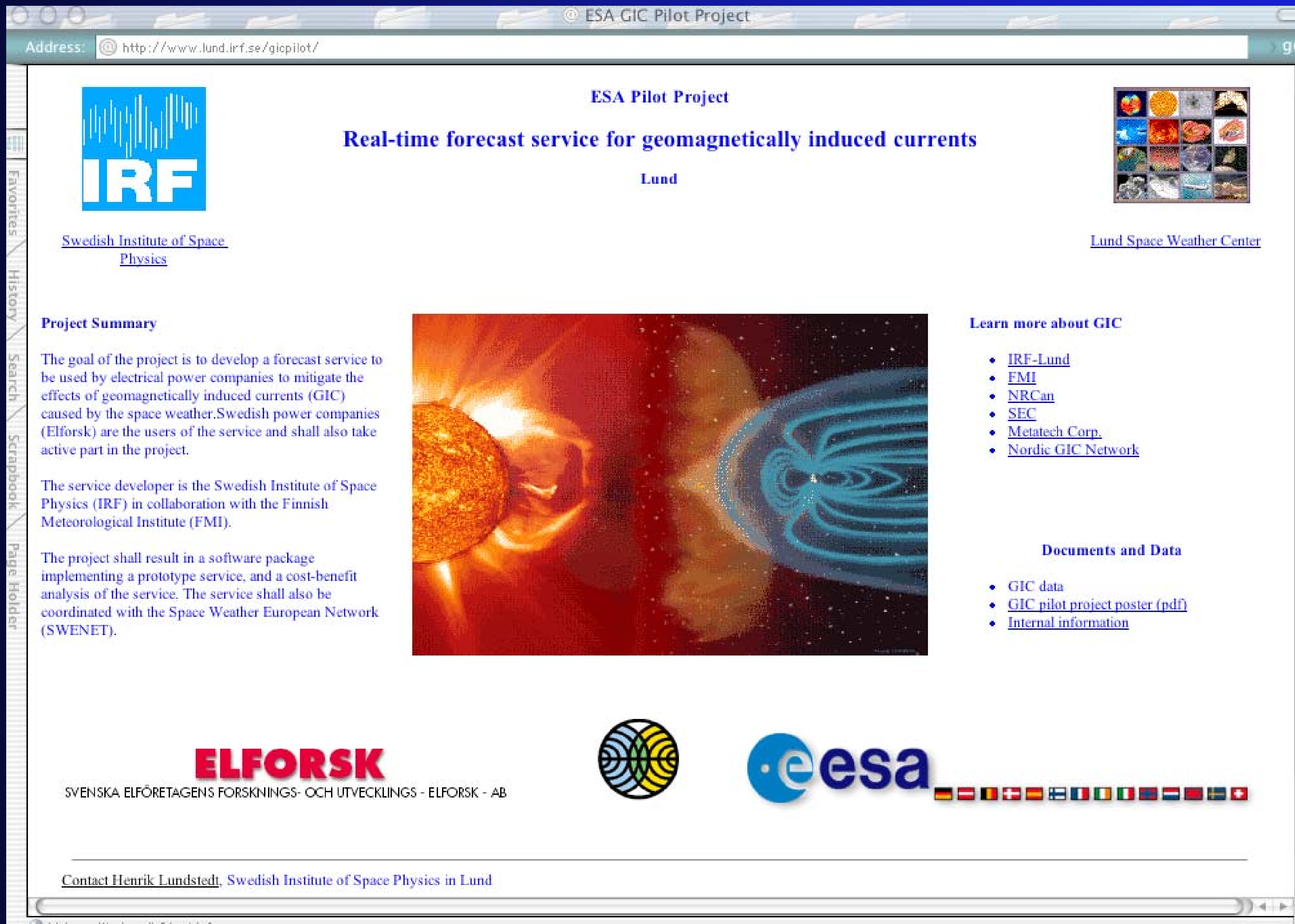
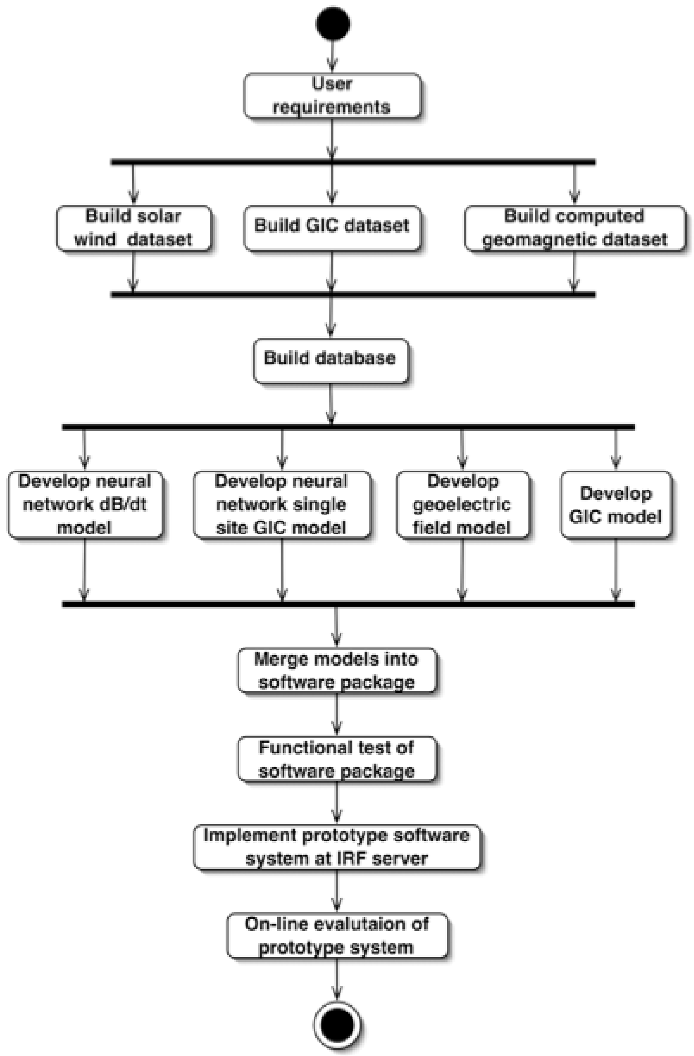
  (Å.Sjödin & H. Swahn)

Our GIC Pilot Project website
(www.lund.irf.se/gicpilot)



Work plan



WP 100

WP 200

WP 300

WP 400

WP 100 - URD (IRF)

URD draft submitted

A space weather forecast system for geomagnetically induced currents

User Requirements Document

ESTEC Contract Number 16953/02/NL/LvH

Issue 1

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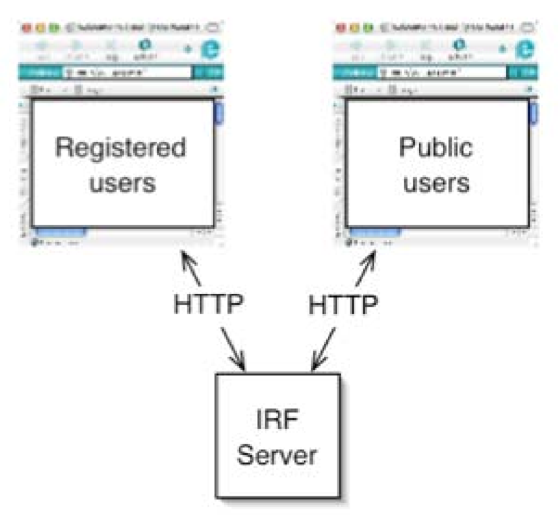
URD

Fig. 1. The power transmission network in northwestern Europe. The line just north of Oskarshamn marks the modelled area.

- One hour forecasts
- For a zone, GIC index
- For a station, GIC
- For a transformer GIC
- Graphical interface (map)



URD

3.2 Constraint requirements

CON.1.	One hour prediction horizon. (Mandatory)
Source	1.2, 2.5
CON.2.	95% accuracy of zonal average absolute GIC. (Goal)
Source	1.2, 2.5
CON.3.	95% accuracy of zonal maximum absolute GIC. (Goal)
Source	1.2, 2.5
CON.4.	The power grid data is confidential and shall be accessible only to the project team.
Source	2.4.8.4
CON.5.	The measured GIC data from the Swedish power grid may not be published. However, plots and other summary information may be published.
Source	2.4.8.3

WP 200 - Data base

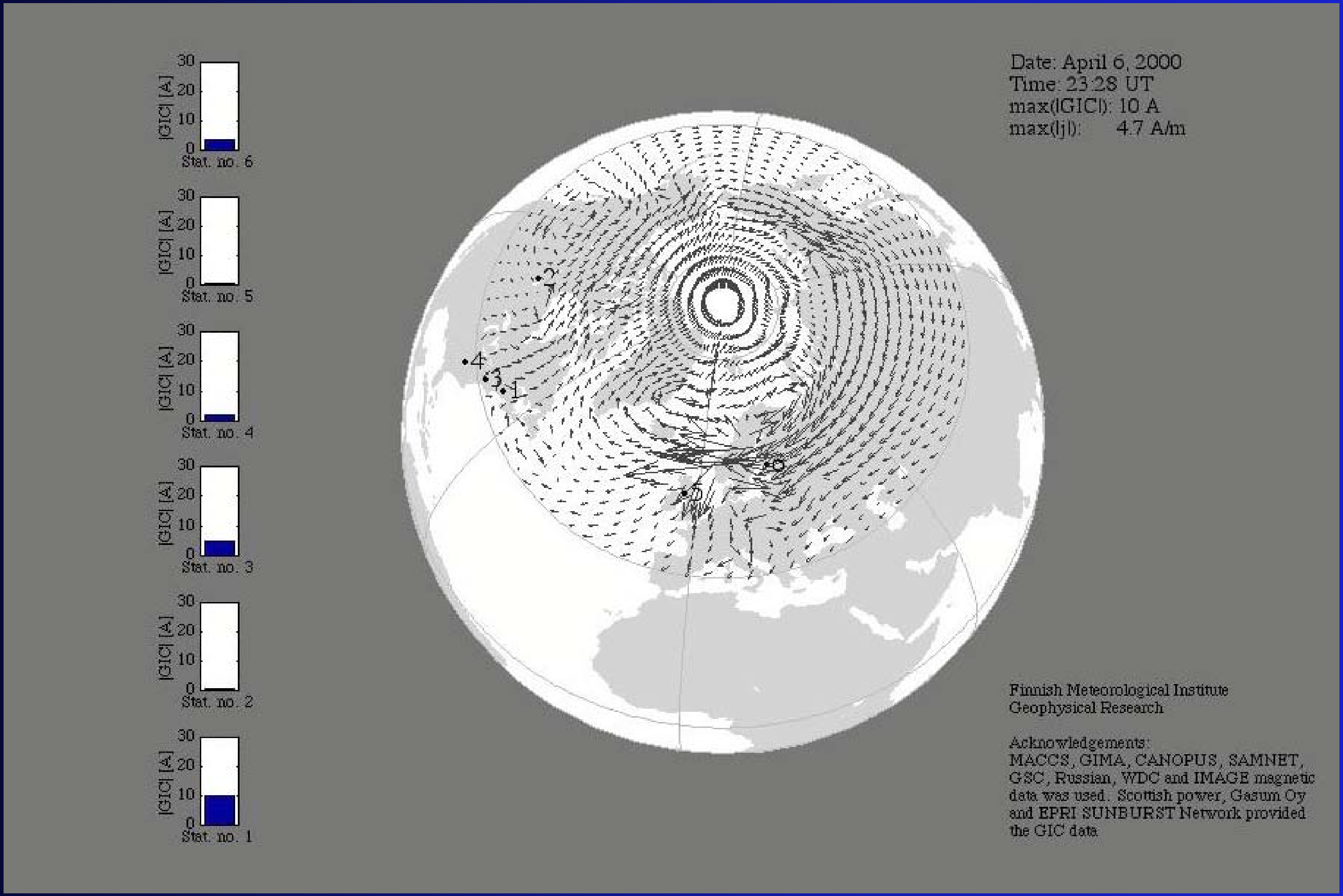
The data base contains

- solar wind data
- geomagnetic field data (IMAGE, Brofelde, Wingst)
- GIC data
- power grid data (Southern Sweden).

The data is transferred into a MySQL data base.

Our earlier developed interface in Java will be rewritten to work with MySQL data base (PW).

WP 300 - Geoelectric field and GIC Models (FMI)



WP 400 Forecasts (IRF)

- **Local dB/dt from solar wind** (IRF)

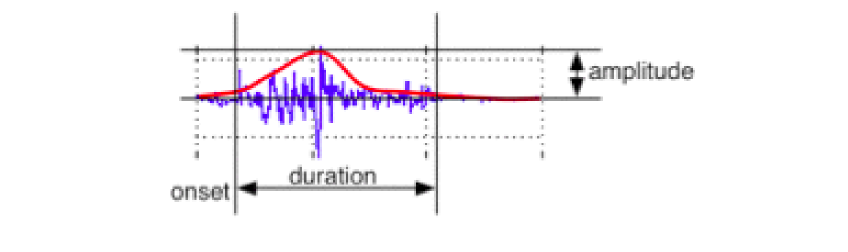
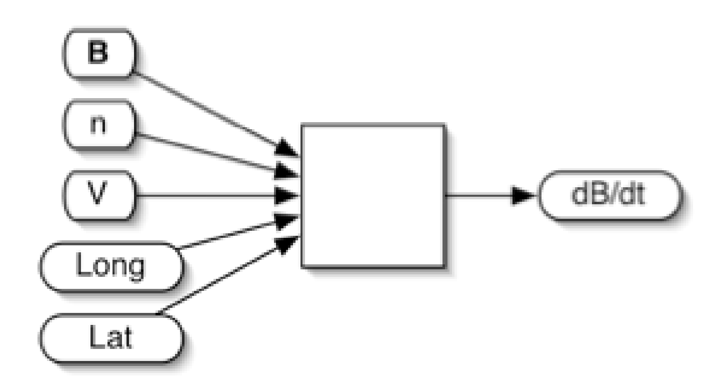


Fig. 3. The figure shows an illustration of how the GIC can be parameterized into a GIC index.



- **Geoelectric field from the magnetic field** (FMI)

The electric field can be calculated from E(ω) = Z(ω) B(ω)

- **GIC from geoelectric field** (FMI)

After the geolelectric field is known, GIC in the network can be determined by using dc circuit theory. It requires that the geometrical and geographical configuration of the system and its resistances are known.

WP 500 - Service Implementation (new magnetometer in Southern Sweden from DMI giving new magnetic field data) (IRF)

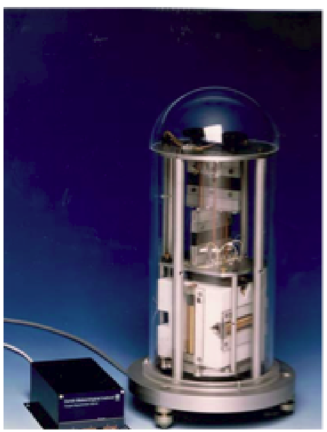
Fluxgate Magnetometer FGE

Since the 1920th DMI has been involved in the development and production of instruments for use at magnetic observatories and the La Cour instruments such as the QHM and the BMZ well as the La Cour variometers have been used and are still being used world wide in more than 60 different countries.

In recent years DMI has developed and started to produce highly stable fluxgate magnetometer type FGE, which is suitable for digital recording of the magnetic field at observatories and in the field.

The main idea behind this effort has been to construct a reliable and very stable instrument, which does not suffer from annoying drift with time and temperature.

The FGE magnetometer has analog outputs enabling use to adapt the instrument to their own data logging systems. An optional build-in AD-converter is also available.



In order to avoid drift due to tilt of the instrument pier, which is often the main cause of baseline drift, a special version of the magnetometer is available in which the sensors are suspended by two crossed bronze bands to compensate the tilt.

Features

3 linear core sensors mounted on a marble cube for good mechanical stability.
Compensation coils on quartz base for highest temperature stability.
Highly stable digitally controlled compensation of main field.
Very good long time stability.
Nonmagnetic electronics which may be placed close to the sensor head in a thermostatically controlled room to avoid any temperature drift.
2 built-in temperature sensors.

Optional features

Suspended sensors for optimal baseline stability.
Battery operation.
Build-in 16 bit AD-converter (Adam module)

Specifications

Analog output:	±10V
Dynamic range:	User specified
Resolution:	0.1 nT
Compensation field range:	+-64 000 nT
Compensation field steps:	150 nT
Misalignment of sensor axis:	< 2 mrad
Long time drift:	< 3 nT/year
Temp. coeff. of sensor:	< 0.2 nT/°C
Temp. coeff. of electronics:	< 0.1 nT/°C
Resolution of temperature:	0.1 °C
Band pass:	DC to 1 Hz

Spec. of optional suspension

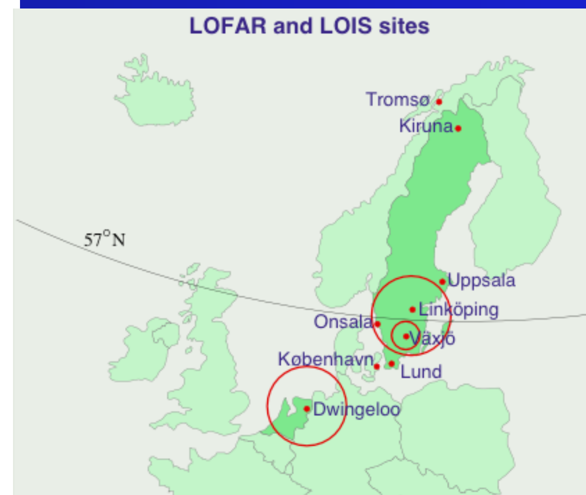
Range of compensation: ± 0.5°
Factor of compensation: > 200

General information

Size of sensor:	190 x 190 x 190 mm, 9.5 kg
Size of suspended sensor:	250 x 250 x 550 mm, 20 kg
Size of electronics:	160x90x360 mm, 3.0 kg
Power requirements:	230 VAC, 3W
Operating temperature:	0 to 60°C Optional
Optional power supply:	10-18 VDC, 3 W

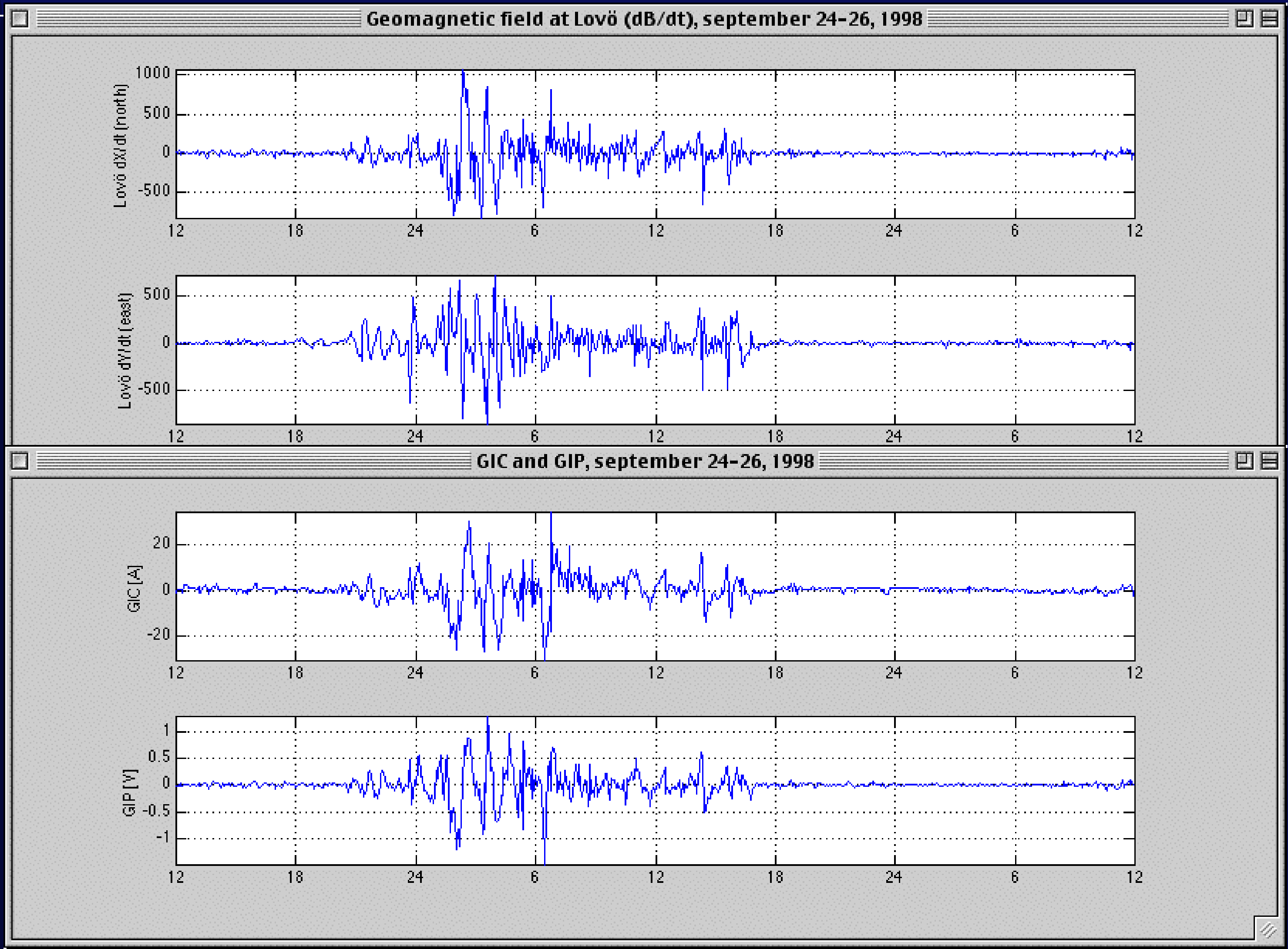
Optional digital output:

8 ch / 16 bit ADAM AD-converter

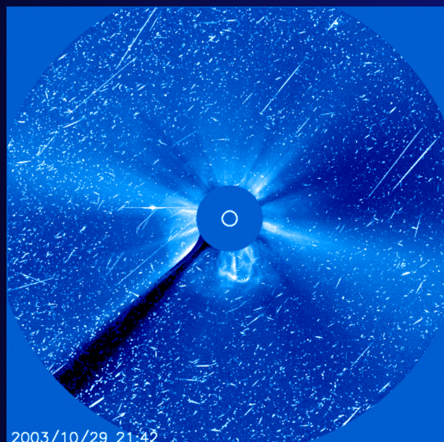


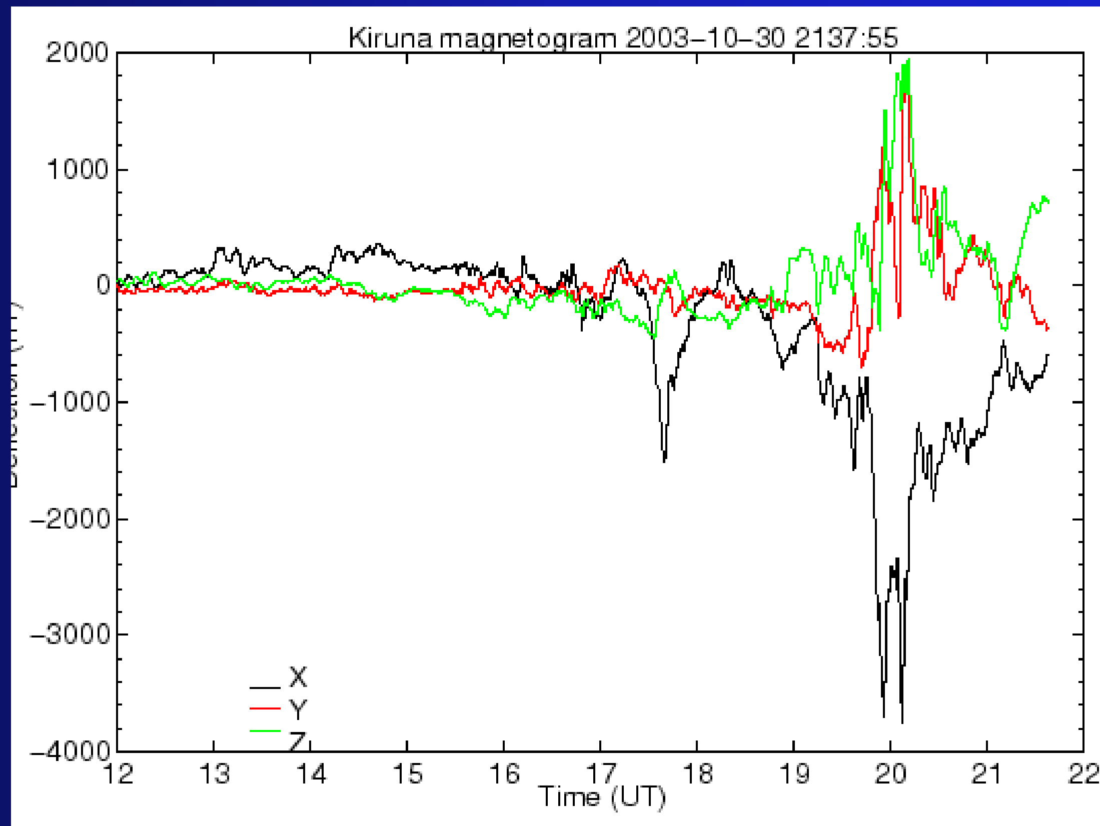
Meeting on December 1
In Lund about the
Financing (~12k€).
The infrastructure
ready.

WP 600 - Testing , Cost-benefit analysis (GIC Events) September 24-26, 1998



Then halo CME of October 29 arrived at 17 UT on October 30





Discussions with operators during the storm. They made adjustments but not enough

Power systems effected, power outage 20:07 in Malmö

GICs > 200 A were measured.