Monitoring the EGNOS SYSTEM TEST BED at the Radio Navigation Experimentation Unit (RNEU)

ESTEC/ESA

2nd ESTB Workshop, Nice, 12th November 2001

What is the RNEU ?

- **Specialised facilities located at ESTEC/TOS-ET** with simulation and test capabilities
- Used to **support ESA projects**: EGNOS, Galileo, ISS-ATV, METOP, GOCE
- Capabilities:
  - **Early development of navigation technologies**
  - **HW/SW Simulation** of Satellite Navigation Systems
  - **HW/SW Implementation and Test** of Navigation and Integrity Algorithms
  - **Assessment of navigation receivers** (commercial and prototypes)
  - **Monitoring of GPS/GLONASS/ESTB**
- Constantly expanded and upgraded to cover all aspects of satellite Navigation

esa

RNEU equipment to monitor ESTB

- **Novatel RIMS A receiver** (3 OEM L1/L2 cards)
- User prototype receivers:
  - **Novatel Millenium L1/L2**
  - **Aquarius Series 5000 (Thales)**
  - **Javad Legacy**
- **GPS/GLONASS Health Monitoring Unit**
- **Post-Processing Tools:**
  - Espada 3.1 (ESA)
  - Pegasus (EEC)
- **HW/SW Simulators** (to support system analysis and test receivers):
  - Espada 3.1 (ESA) - ESVS (ASPI)
  - EETES (GMV) - GSS HW Signal simulator for GPS/GLONASS/ESTB

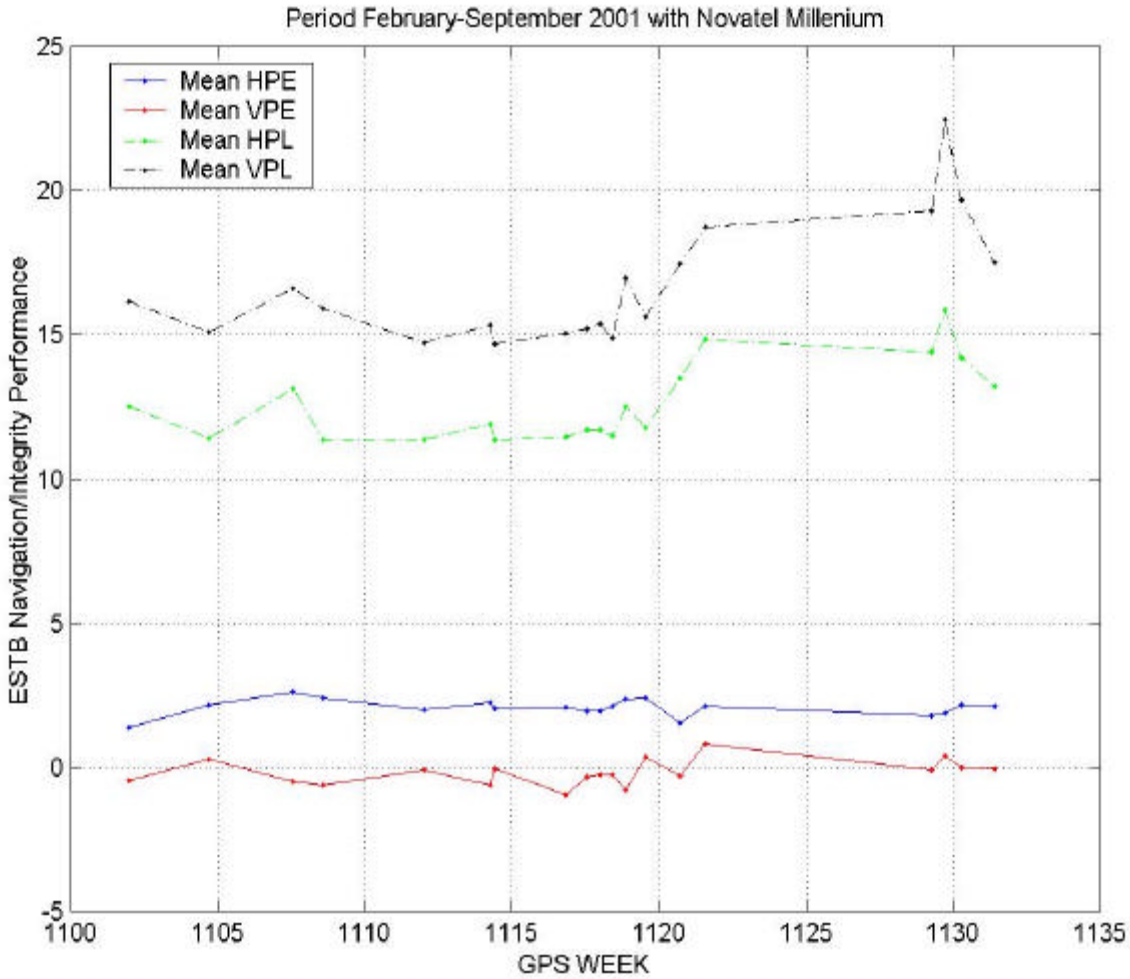
Support to ESTB activities

- **ESTB Performance Monitoring** (Monthly report)
- **Support to ESTB Helpdesk in receivers assessment** for EGNOS/WAAS Test Beds
- **Support to definition and monitoring of ESTB trials based on ESTB** covering multi-modal applications
- **Support to EGNOS AIV**
- **Support to Propagation aspects such as the assessment of the broadcast ESTB Ionospheric model**
- **Verification of bounding capabilities of broadcast UDRE/UIVE**
- **Calibration of simulation models** (EGNOS UERE Budget) for prediction of performances

Typical User Equipment

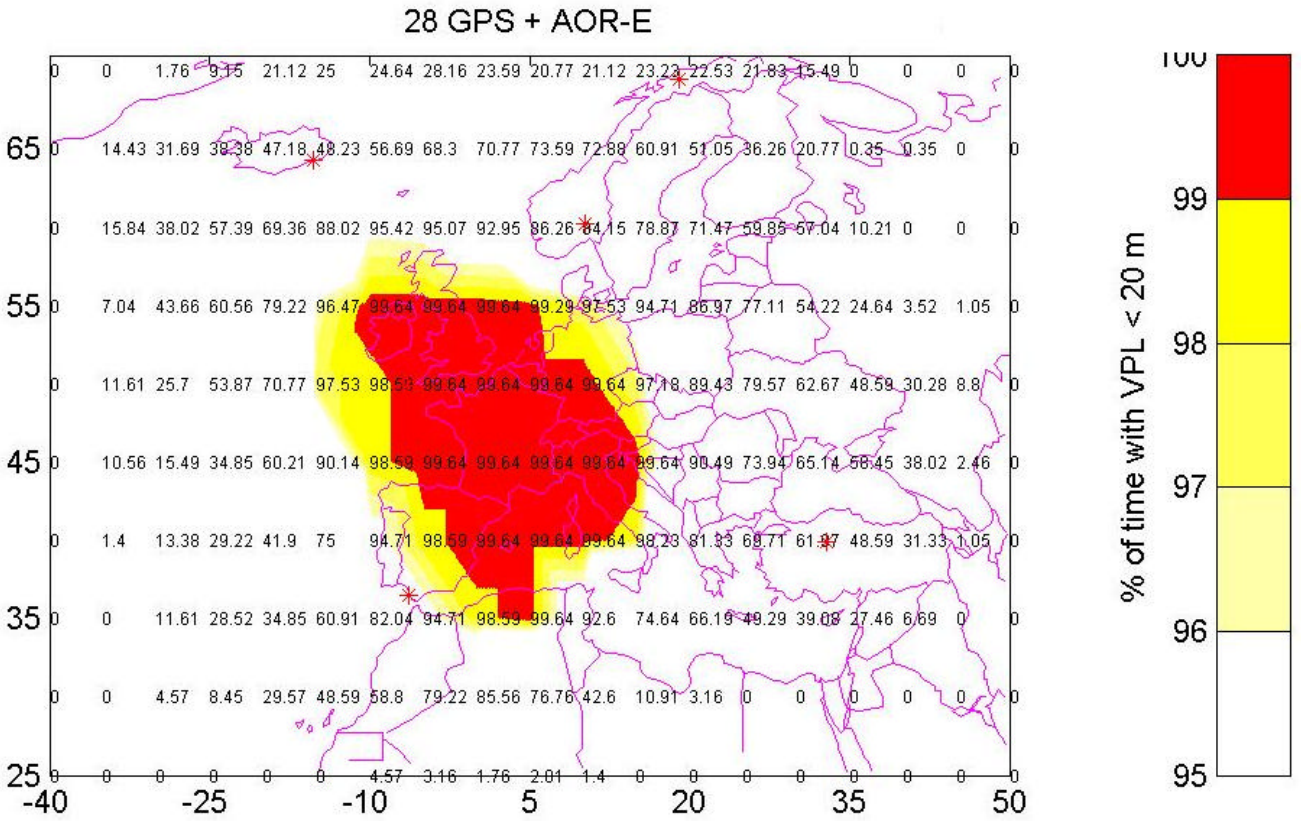
- ESTB receiver prototype
- L1 antenna
- Power supply at 10-36 V
- Serial COMs Cable
- Rx Monitoring Software
- Post-processing software tools to interface with equipment for
  - Performance monitoring
  - Analysis of ESTB Broadcast information
  - Prediction of integrity performance over Europe

Performance Summary at ESTEC



- Novatel Receiver
- Each point represents 24 h processing data at 1Hz
- ESTB Mode 0/2 are mixed
- Average Perfo. (Mean ±Std)
  - HPE: 2.07 ± 1.2 m
  - VPE:-0.18 ± 3.13 m
  - HPL: 12.61± 4.18 m
  - VPL: 16.67 ± 5.26 m

ESTB Integrity performance in Europe

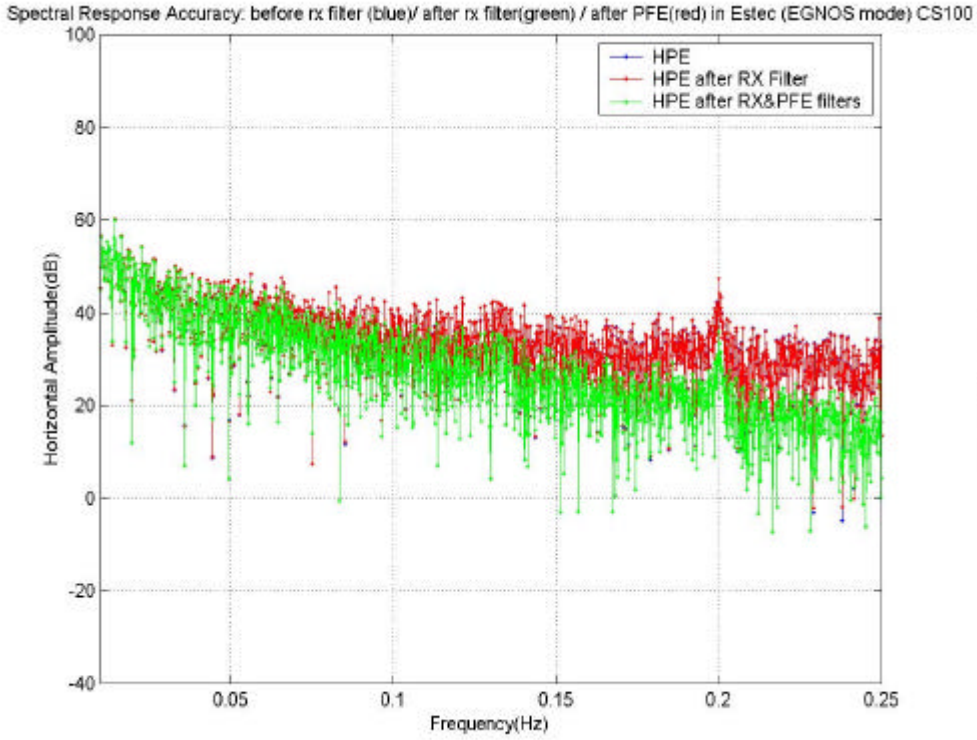


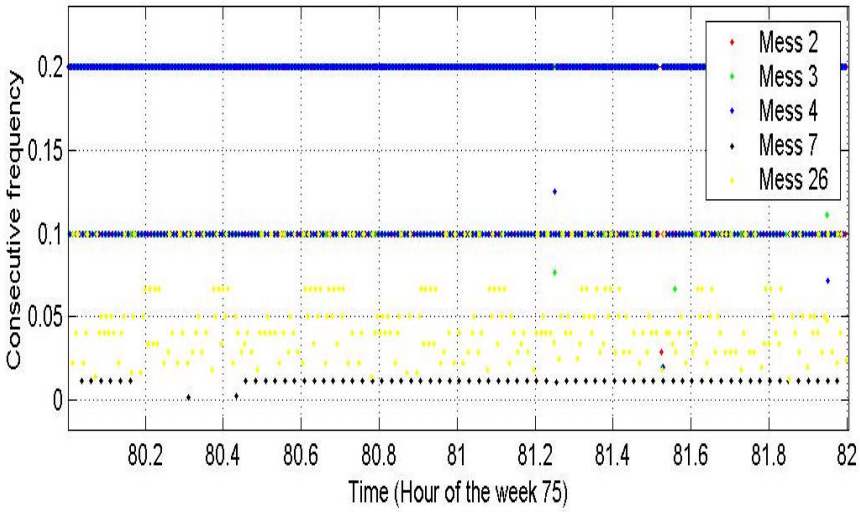
Mask Angle: 5 degrees

- ESTB Integrity Performance over Europe
- Today very sensitive to ESTB RIMS deployment

Static/Dynamic ESTB spectral analyses

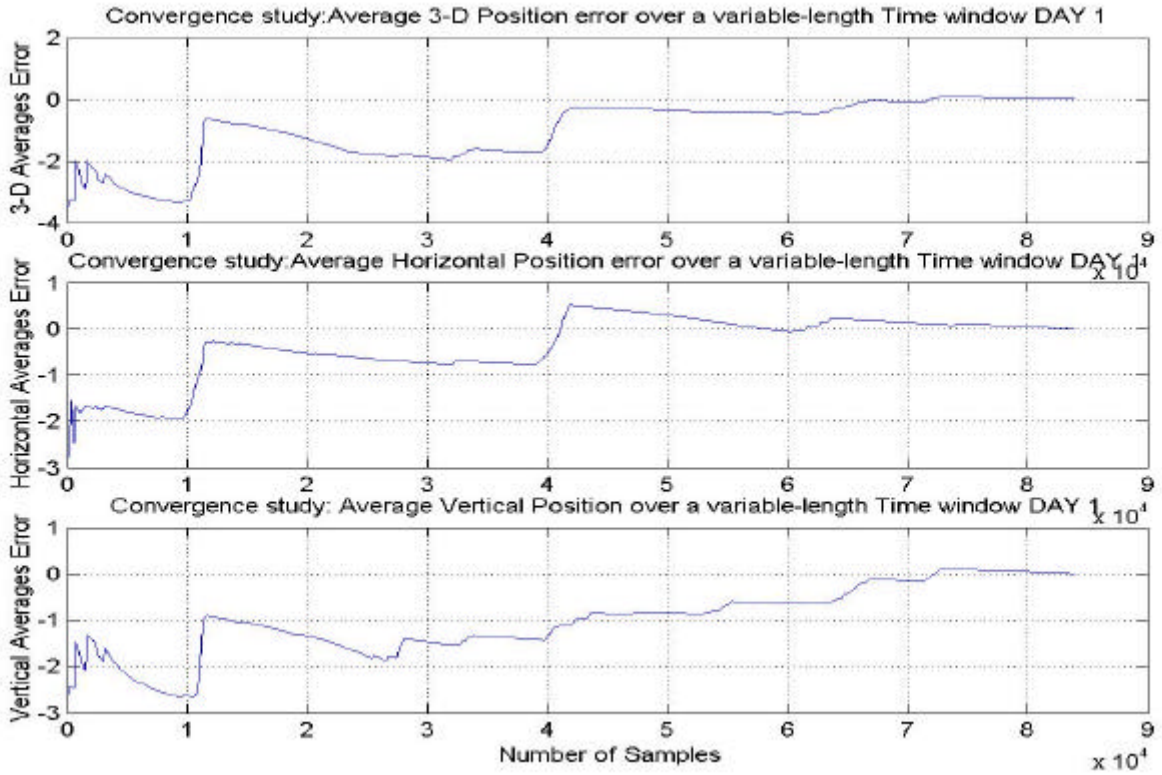
- Correlation study of spectral response of Position Errors and frequency of broadcast messages





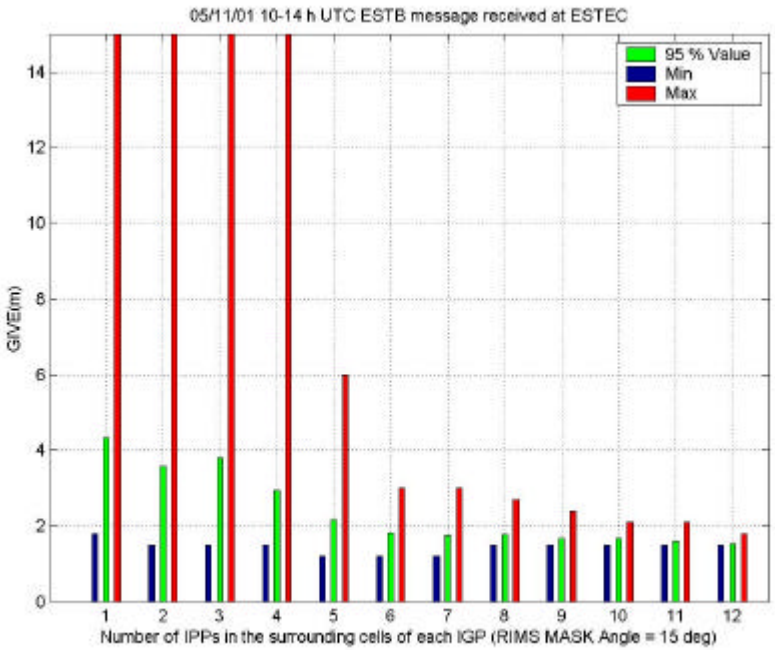
Convergence of ESTB performance

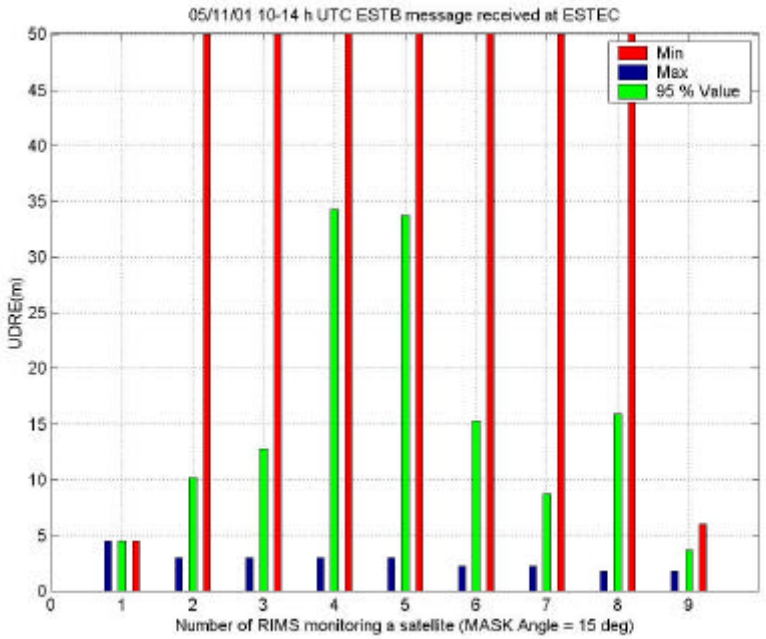
- Important parameter to set-up static trials
- Characterisation of ESTB XPE Confidence levels
- Verification of XPE/XPL statistical distributions
- Stability of performances



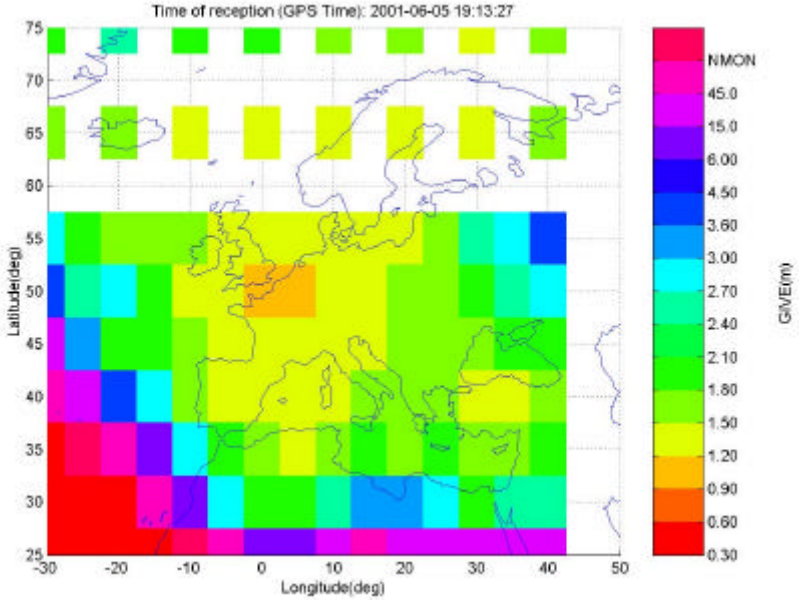
Calibration of Simulation models

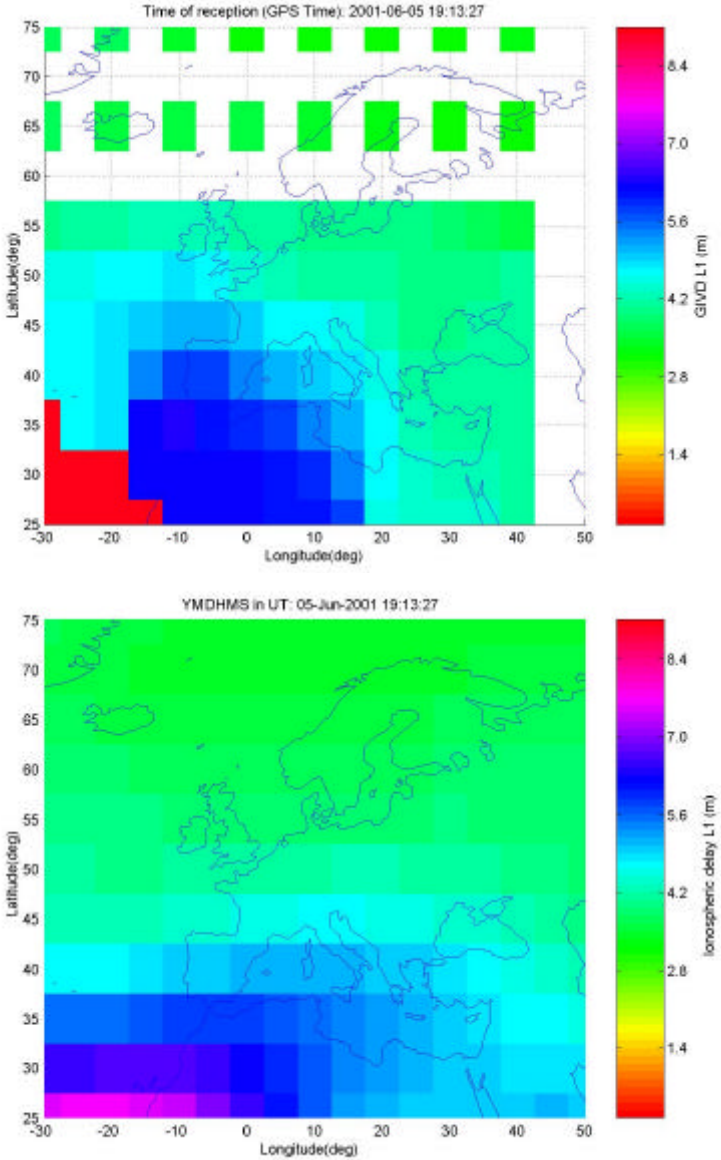
- Study of UERE Budgets
- Modelling of GIVE as a function of the number of IPPs in the surrounding cells
- Modelling of UDRE as a function of the RIMS monitoring conditions of a satellite





UDRE/UIVE bounding



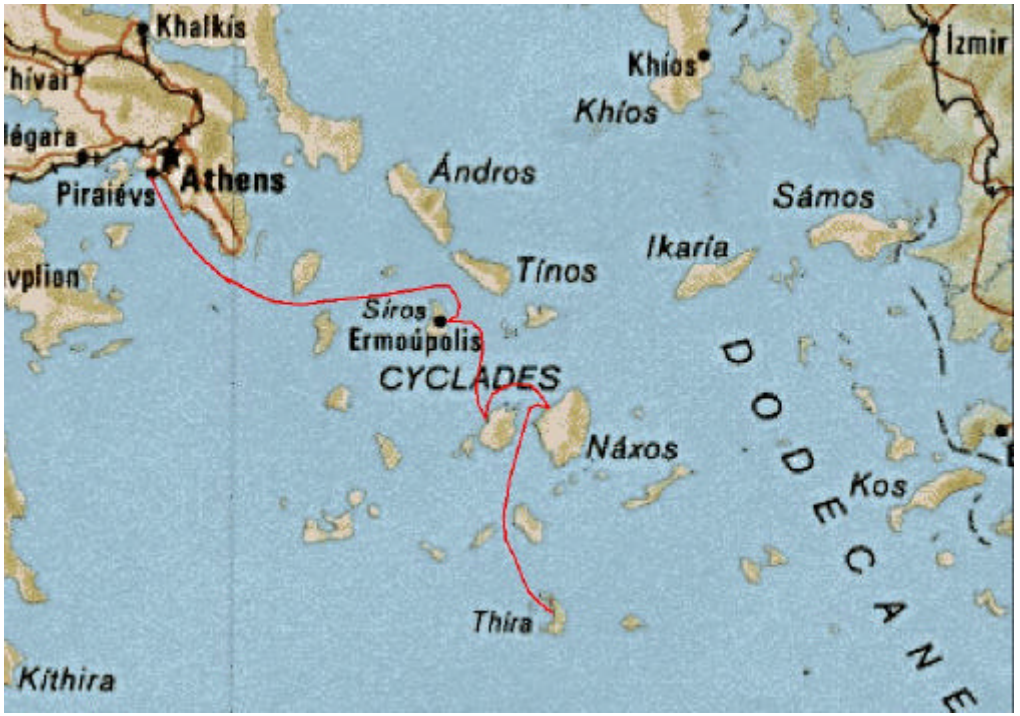


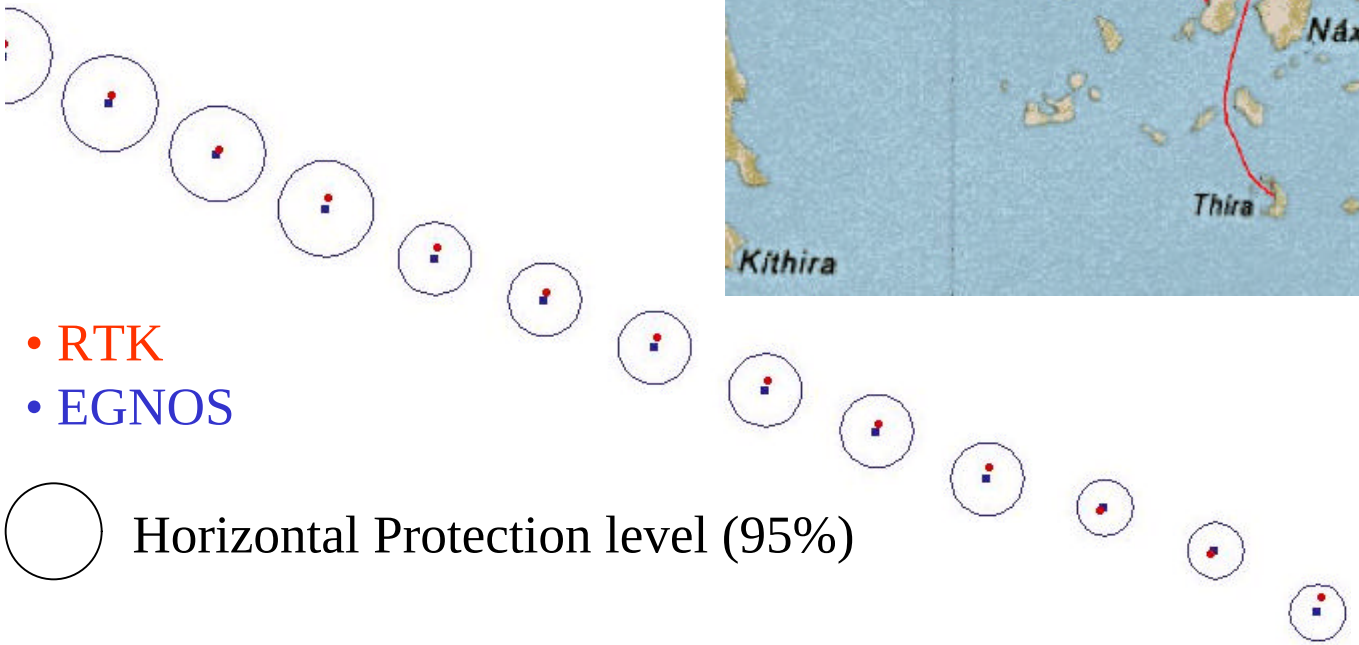
GIVE Example

- GIVD (ESTB) vs GIVD (IGS)
- GIVE bounding True GIVD error

Support to EGNOS trials

- Data collected in situ with Aquarius receiver
- Post-Processing done at RNEU
- RTK / EGNOS navigation solution + Integrity PL





- RTK
- EGNOS

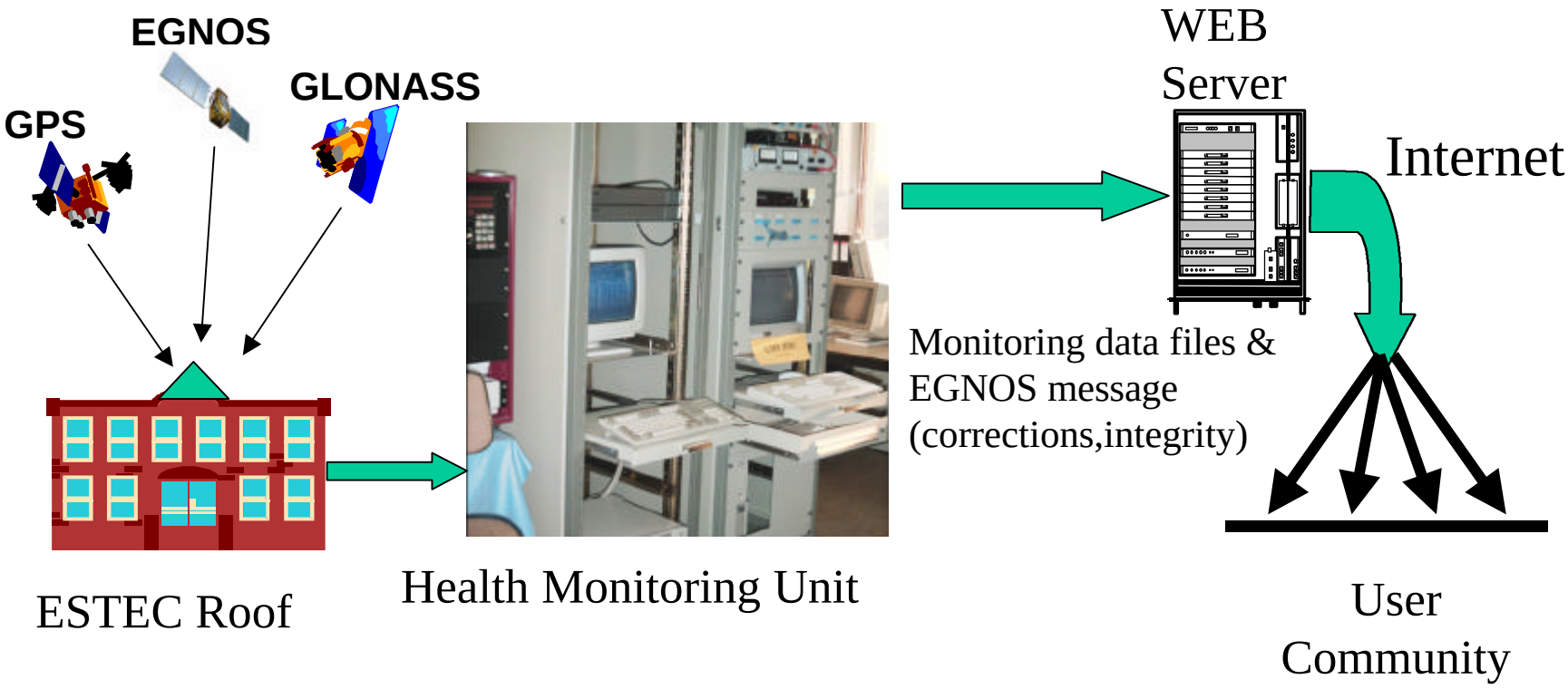
Horizontal Protection level (95%)

Support to ESTB Helpdesk for receivers assessment

- Investigation into **GPS/EGNOS receivers in the market** suitable for use with ESTB SIS
- **Confirmation of compatibility between EGNOS and WAAS receivers**
- **Verification of receiver** GEO satellite numbering
- **Application of ESTB SIS and corrections** (Configuration of the receivers)
- **ESTB Coverage**
- **ESTB Performance and monitoring of SIS**

Developing a data service to the user community

- Support to **SISNET project** with infrastructure set-up in ESTEC
- **HMU+EGNOS in the Web (under construction)**



Activities ongoing

- **Re-enforcement of equipment**
  - Acquisition of Ecurev equipment
  - Purchase of latest commercial EGNOS/WAAS receivers in the market
  - Upgrade of Multi-Standard Receiver

- Support to **ESTB Expansion mode study** with some trials over Africa

- **Definition of new trials** involving several transport sectors (train, maritime, land-mobile…)

- **Go deeper into ESTB performance analysis** at
  - system level
  - parameter level
- **Follow up of ESTB and WAAS Test Beds**