Nancay LOFAR SuperStation

Workshop at ACP, Paris

17/18 Jan 2008

(Gijs, Rene,Casey,Ger from NL-LOFAR)

(http://www.lesia.obspm.fr/plasma/Lofar/)

Philippe Zarka: Nancay LSS concept

LOFAR "Super" station (LSS) concept

Aim :

- Increase significantly the station sensitivity (thus its "weight" in the correlation with other stations) by ~1 order of magnitude
- Without increasing much its cost (by a factor <2)

Basic idea :

- Add to a standard LOFAR station a set of 96 antennas, that will feed the 96 RCU
- Each antenna is a mini-phased array of N elementary antennas (N~10)
- Analog phasing of these mini-arrays (delay lines or other tbd method)
- Each one connected to one RCU input (LBL channel)

  → LSS sensitivity increased by a factor ~N

  → at cost of the new set of antennas + their adaptation to RCU, phasing (and control/command) system

Technical issues

- Type of elementary antennas ?
  - Bandwidth (10 – X MHz ?)
  - Beam/FoV
  - Tests and calibration
  - cost, resources (size, power) …
- Mini-arrays and LSS configuration
  - mini-arrays all identical ?
  - compact/extended ?
- Phasing scheme / command
- Adaptation of mini-arrays to RCU input (specific filters …)
- Local products
  - switch Gbit link to local ?
  - storage + processing resources ? (TBB ?)

→ feasibility, cost + resources, instrument model/simulation, timeline ?

Karlsson, Konovalenko, Rucker
SRI, Graz, Austria and Kharkiv, Ukraine)

Ukrainian Carpathian mountains

Ukrainian Carpathian mountains

Scientific motivation

- Solar radio emissions
- Passive detection of CMEs
- Solar wind parameters and interplanetary plasma by means of interplanetary scintillation
- In combination with a radar: detect radar signals bounced off CMEs and coronal density structures
- Jovian radio emissions enables studies of: magnetic field, magnetosphere, plasma environment (specially the Io torus), Io-Jupiter interaction, decametric emissions, rotation period, etc
- Planetary electrostatic discharges: SED, UED
- Detection of exoplanets
- Origin, evolution and end-stages of radio sources

Upcoming activities

- Preparation of full-scale proposal for LOFAR-CM by early summer 2008 (FFG, ASAP-6)
- Proposers
  - Space Research Institute, Graz, Austria
  - Institute for Radio Astronomy, Kharkiv, Ukraine
  - LESIA, CNRS, Meudon, France
  - TIMPANI, Rakhiv, Ukraine
- In case of successful proposal, project (and financing) could start in early 2009

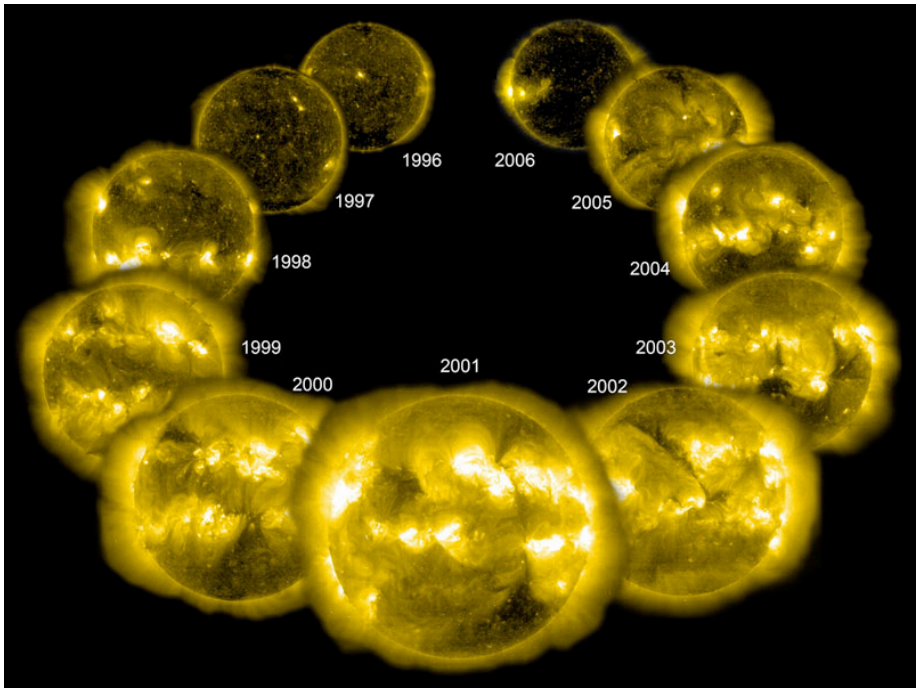
Ionospheric issues

Non-isoplanaticity (low freq, large FOV)

Solar cycle (next maximum ~2012)

Array scale > refractive/diffractive scale

TID's, (Kolmogorov) turbulence



Soho-solarcycle,

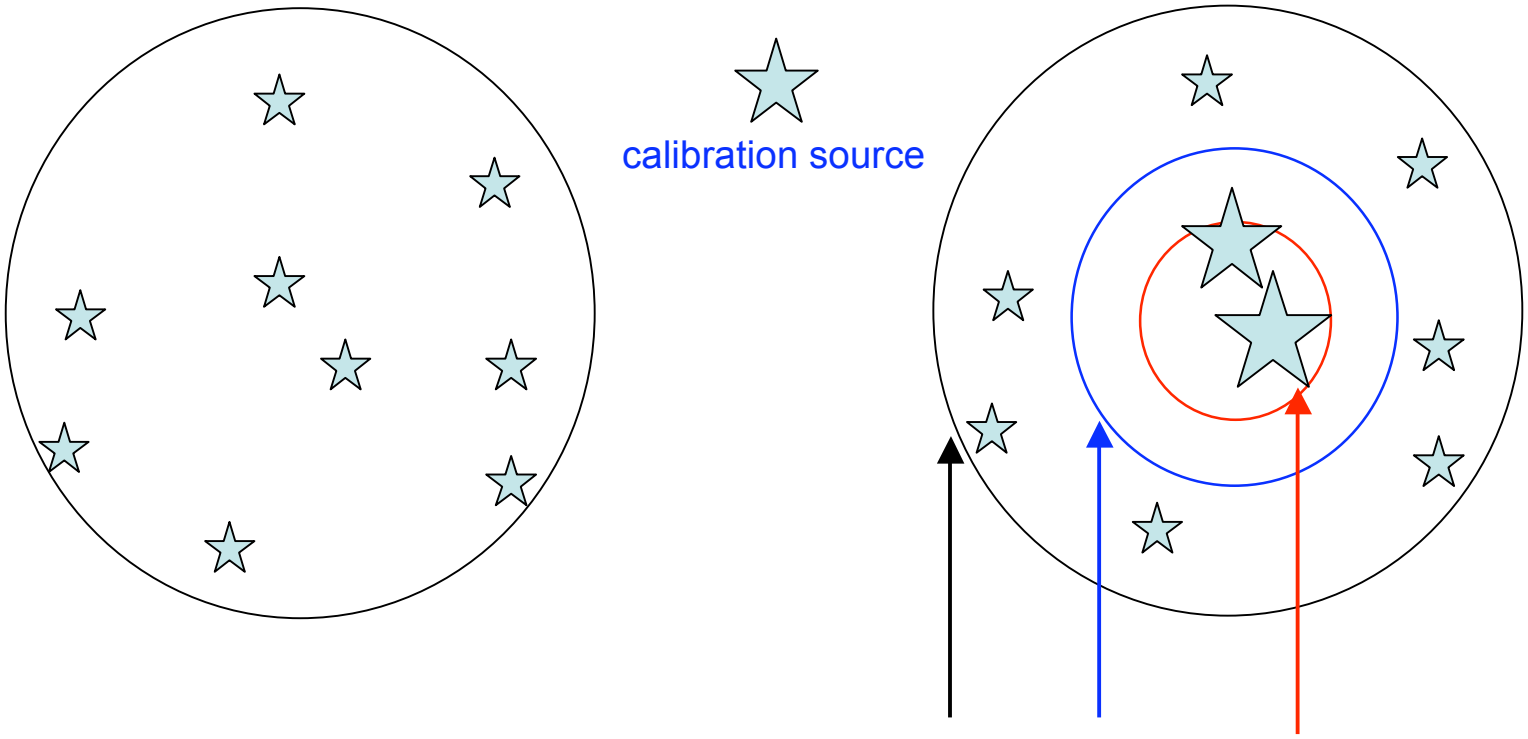
APOD 5 dec07

Tools/approaches:

- Bandwidth synthesis (sensitivity, freq-dependence,..)
- Peeling individual sources
- Large scale screen modelling (MIM, Noordam)
- GPS-TEC starting model (Anderson, Mevius)
- Utilize 2-D frozen flow approximation
- Simulations (LIONS, van Bemmel et al)
- 3-D tomography solutions (multiple screens/layers: => EoR KSP needs ?)

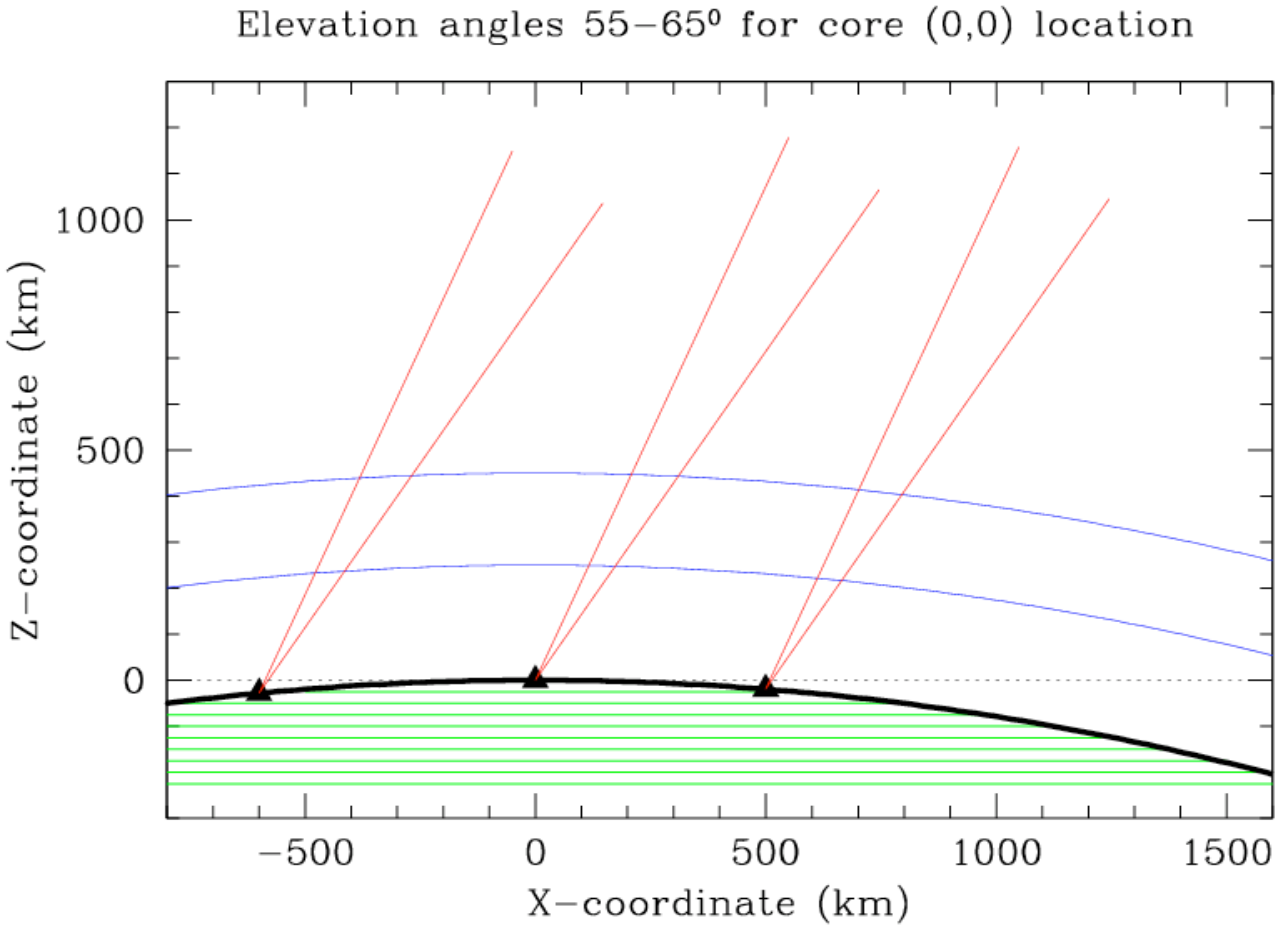
The size of Eu-stations and LOFAR wide-field calibratibility

1) The number of detectable sources per beam does hardly depend on the size (∝ sensitivity) of the station !
2) But the S/N per source in the smaller effective beam does increase by a factor 3 !!



Relative beamsizes for stations of: 65^{m} ~110^{m} and 195^{m}

When stations are > 100 km apart signal from celestial sources do not traverse same ionospheric volume



Ionospheric modelling across the wide FOV will require rapid multi beaming and 3-D tomography