Giancarlo Noci

The wind flowing in the solar corona

7 July 1932
23 January 2020

Founding father of the exploration of coronal outflows

Giancarlo Noci's insight and ideas laid the foundations of a new area of research in solar physics: the **study of the nascent wind in the solar corona** by means of **novel UV spectroscopic diagnostic techniques** applicable in space UV coronagraphy.

His ideas are at the basis of the **concept and development** of the **UV- VL coronagraphs** flown on the two Space Solar Observatories led by Europe, in collaboration with NASA

SOHO *and* ***Solar Orbiter***

Hosting Institutions

His scientific work at the ***Astrophysical Observatory of Arcetri*** and the ***University of Florence*** started in the sixties.

As a young scientist (late sixties - early seventies) he visited for extended periods the ***Culham Laboratory, Abingdon, UK*** and the ***Harvard College Observatory, Cambridge, US***. Those were exciting years when ***space solar physics was just beginning thanks to rocket flights*** *and the* ***OSO satellite series*****.**

His contribution to science encompassed several aspects of solar physics, e.g.: *solar wind sources, radio emission, spectroscopy, transition region models, coronal/in situ solar wind abundances, non-equilibrium ionization and flows in coronal loops, etc.*

Here, the **focus** is on Giancarlo **investigations of the solar wind** source regions, **seed of the development of the Ultraviolet Coronagraph Spectrometer UVCS on SOHO and the Metis coronagraph on Solar Orbiter.**

Professor at the ***University of Florence*** and the ***University of Padua***, his courses dealt with many subjects from *Cosmology* to *Spectroscopy* and *Space Science*.

Many of his students pursued solar physics and space physics research and became well-known in the scientific international community.

70's Coronal Holes – Sources of the fast wind streams

When he was a young scientist (end sixties-beginning seventies) the **solar wind studies** were in the **early stages.** The OSO satellites and rockets were delivering UV images leading to the **discovery of coronal holes**.

Before Skylab was launched in May 1973 - providing the first clear beautiful X-ray images of the huge coronal hole, called the *boot of Italy* - Giancarlo published a short, fundamental paper '**Energy budget in coronal holes**' (Noci, 1973), based on the physical parameters derived from - at that time - the best-observed **coronal hole in November 9, 1967** (OSO 4, Munro & Withbroe, 1972).

> **'It is shown that the constancy of the ratio between conductive flux and pressure squared as one goes from quiet regions to `holes' (regions of exceptionally low density and temperature) in the solar corona, observed in the case of the first well-studied coronal hole, implies that a strong solar wind is likely to originate in coronal holes.'**

In addition, coronal holes were identified with Bartels' M regions not only statistically but by **linking specific long-lived holes with individual sequences of geomagnetic storms** (Bell & Noci, 1976, at SAO).

2° ESP Meeting
Toulouse 1978

70's *A novel UV diagnostics and coronagraph concept*

The idea of determining the outward expansion of the hot corona - i.e. the speed of the coronal wind - by measuring the **Doppler dimming** (Hyder & Lites, 1970, Beckers & Chapman, 1973) of the resonantly scattered UV lines – first of all the **dominant HI Lyα line at 1216 Å** emitted by neutral hydrogen atoms (Gabriel, 1971) – was put forward **in the 1970s by Noci**, as quoted by Withbroe et al., 1982 and Kohl & Withbroe, 1982.

Noci proposed to observe the intensity of the **resonantly scattered component of the neutral hydrogen, HI Ly alpha**, **in the UV** and the intensity of the **electron-scattered emission in VL (e.g., white light continuum)**. Their ratio compares the emissions of the inferred static corona and of the observed expanding corona, thus measures the bulk outflow velocity of the solar plasma, i.e., the wind speed.

Noci also proposed the diagnostic method based on the **Doppler dimming of O VI 1032-1037 doublet,** which turned out to be crucial for **extending the range of the measurable velocities of coronal outflows** (Noci, Kohl, and Withbroe, 1987).

These ideas contributed to promote the interest for the design of space spectro-coronagraphic instrumentation by part of the **John Kohl group at CFA** and have been at the basis of the development of the ***Shuttle*-deployed *Spartan* satellite** instrumentation and the ***UVCS spectrometer*** on board the ***SOHO* mission.**

80s Participation in the SOHO mission, first cornerstone of ESA Horizon 2000

In the eighties the **first European solar space mission, SOHO -** the **third** large solar observatory in space after **ATM/Skylab and SMM -** was proposed to ESA**. I**n February **1986 SOHO was approved** as part, with Cluster, of the **first cornerstone** of the **ESA** Space Science - **Horizon 2000** program, promoted by **Roger Bonnet**.

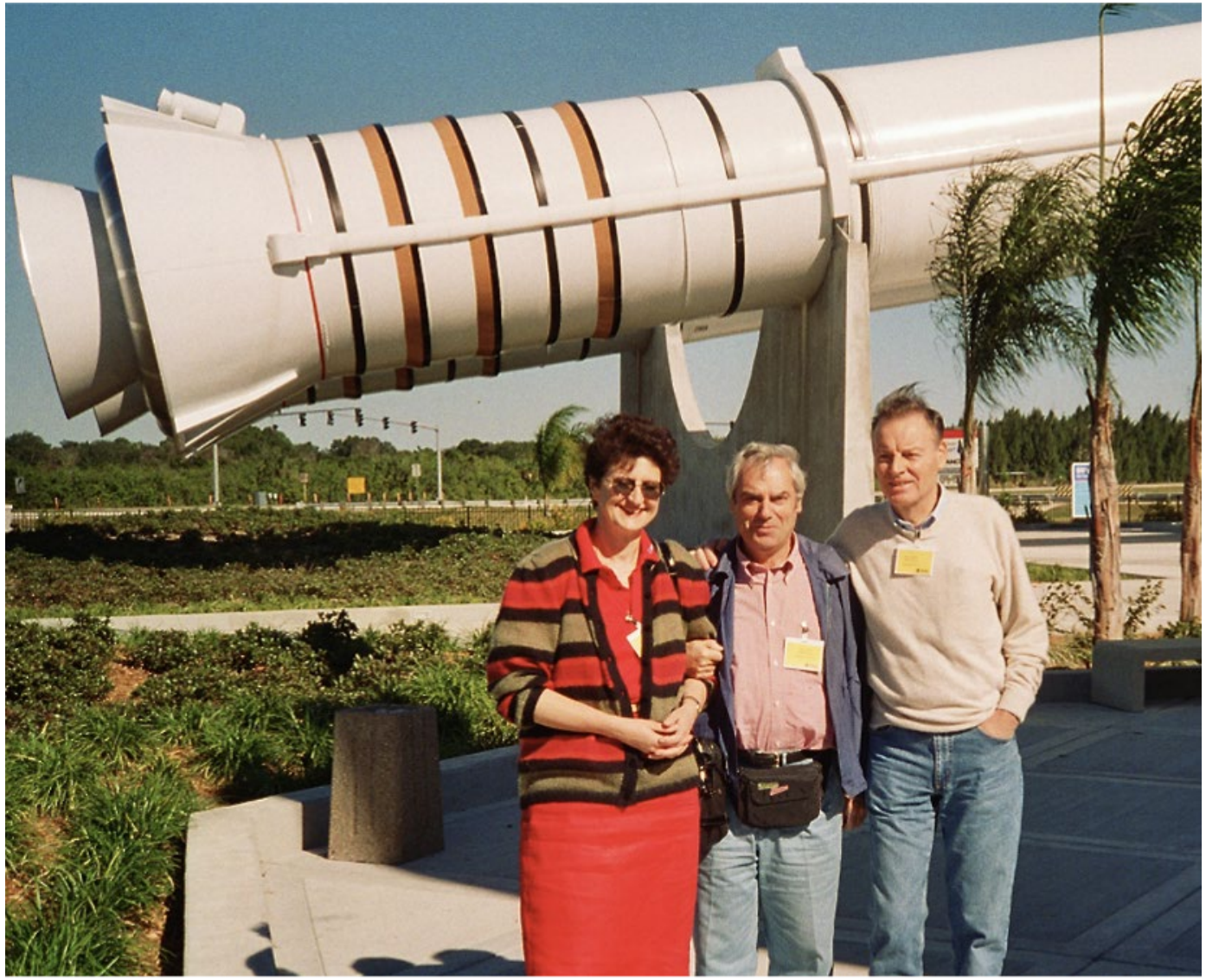
The opportunity was there: during the **phase A study, a UV coronagraph was included** in the SOHO payload thanks to the suggestion of **Martin Huber**, at that time in the ESA SSWG.

Since **Noci' ideas** were at the base of the UV coronagraphy aimed at the coronal outflows studies, it was natural to join **John Kohl (**who was developing UV coronagraphs and was part of the Phase A team as one of the US scientists present in the team in view of an ESA-NASA joint mission) in proposing the **Ultraviolet Coronagraph Spectrometer, UVCS**, for the SOHO payload, with the intent to design and develop the **spectrometer of UVCS in Italy**. The **final proposal,** after the revisions requested by NASA**,** with **John Kohl PI (NASA)** and **Giancarlo Noci Co-PI (ASI)** was submitted in **Jan 1988,** with contributions by **Martin Huber,** and selected.

A detailed history of the SOHO mission and UVCS can be found in *Antonucci, 2022*.

80s Collaborators and friends

During the SOHO Phase A study **Giancarlo Noci**, **Giuseppe Tondello** (SOHO Phase A study team member as expert in laboratory UV spectroscopy) and **myself** (back to Europe after the Solar Maximum Mission experience at GSFC/NASA) realized that this was the right time to participate in SOHO not only with ideas and scientific inputs but also in terms of **hardware contribution**.

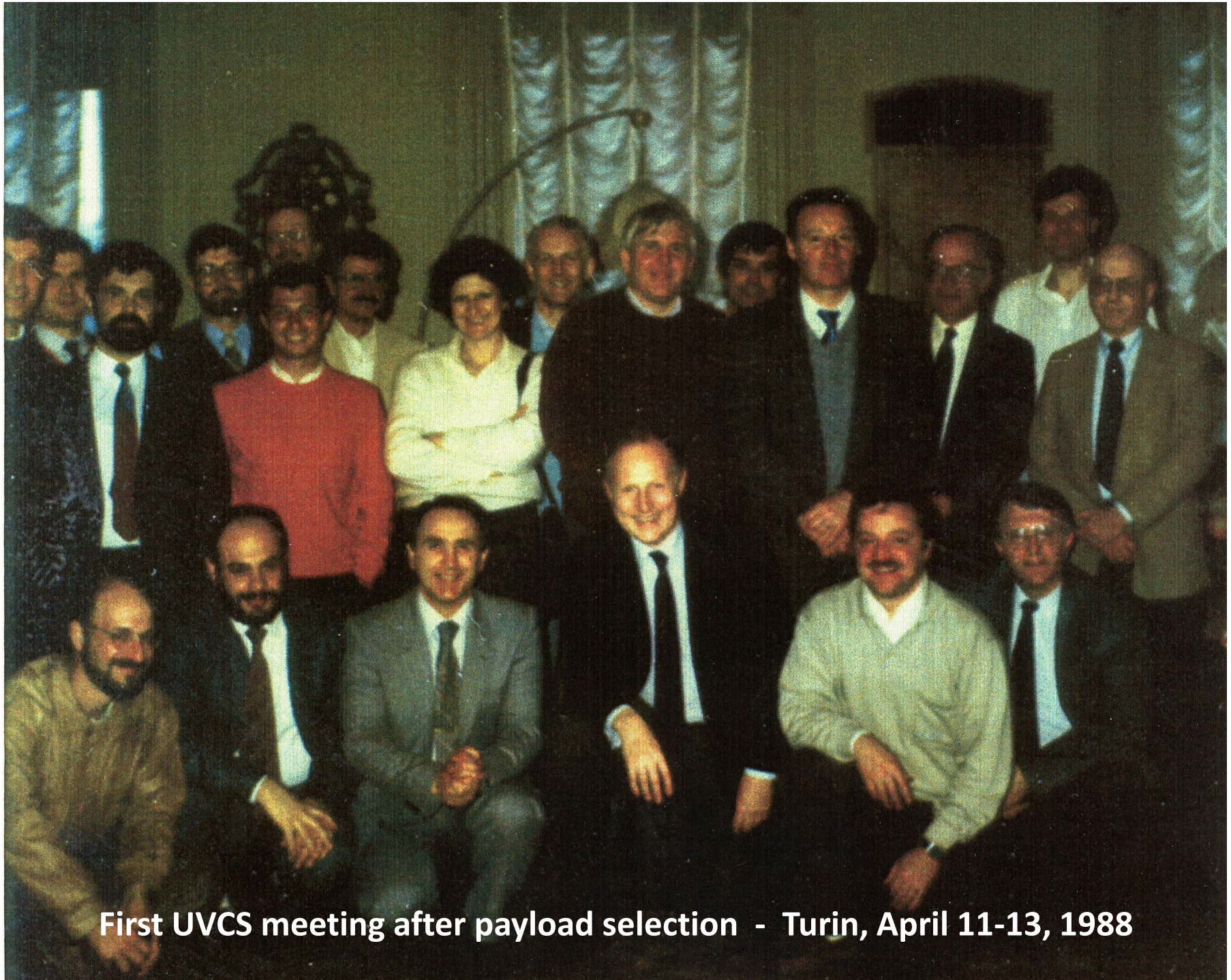


Cape Kennedy - November 1995

1988 UVCS kickoff meeting

Just after payload selection, the UVCS kickoff meeting was held in **Turin** at the Physics Institute of the University, in **April 1988**.

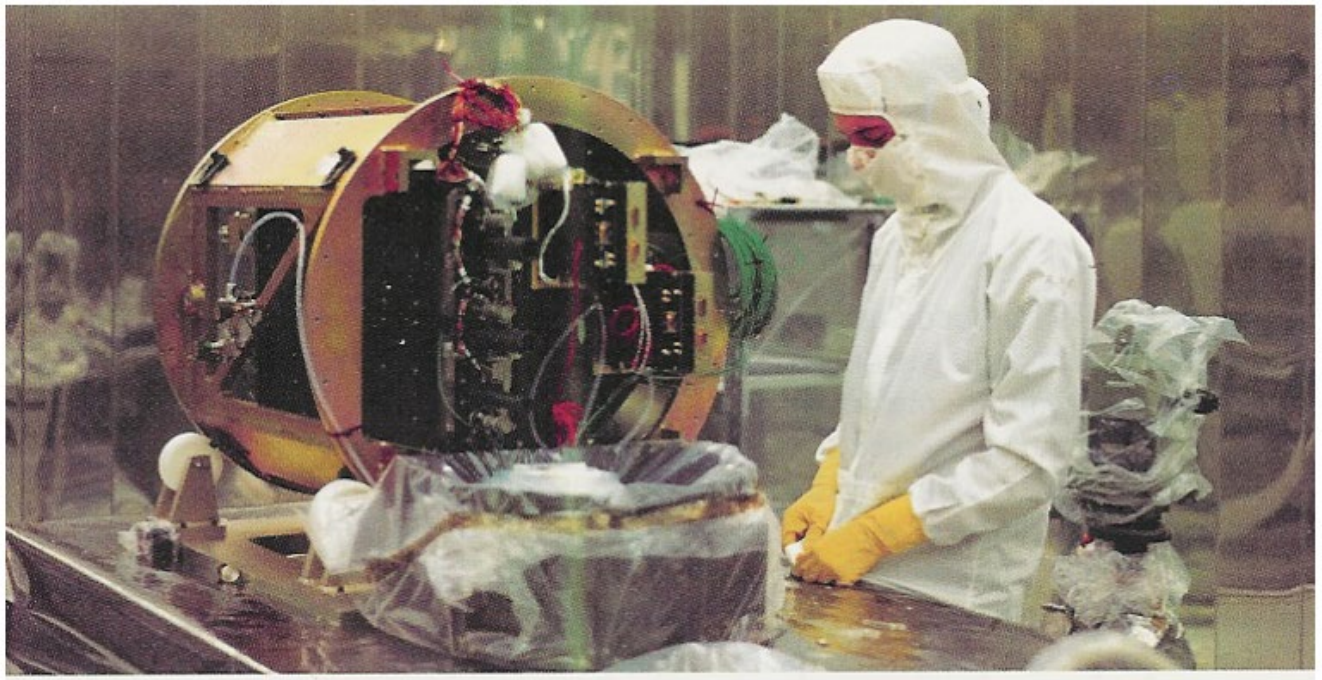
Daniele Spadaro,
Joseph V. Hollweg,
Fabio Reale,
Ester Antonucci,
George L. Withbroe,
John L. Kohl,
Marco Malvezzi,
Giancarlo Noci,
Roger Kopp,
Heinz Weiser
Alfred Buergi,
GianPaolo Tozzi
Martin C.E. Huber
Stefano Livi
Joseph Lemaire



First UVCS meeting after payload selection - Turin, April 11-13, 1988

80s-90s *UVCS from selection to launch*

As **Co-Principal Investigator** Giancarlo Noci played an important role in holding the balance in the UVCS international collaboration and in leading to a successfull delivery one of the core instruments of SOHO: **UVCS. The coronagraph-spectrometer was fully operative** from insertion at L1 in **1996 to 2012)** (launch in 1995)**.**



The **UVCS spectrometer subsystem** on the **Alenia Space** premises in **Turin.**
The **toroidal grating** was developed by **Officine Galileo in Florence.**

UVCS during **integration** at **Matra Marconi Space** in Toulouse

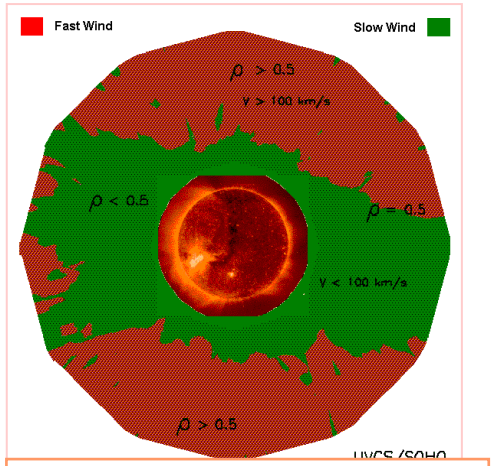
90's Operations & First Results

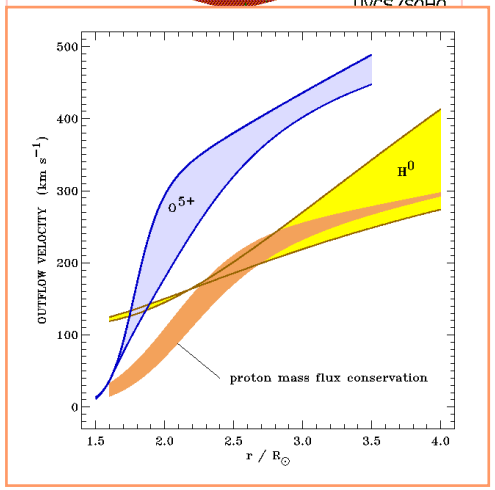
With time **Noci's team** involved in the UVCS development, operations and first data analysis is growing, here:

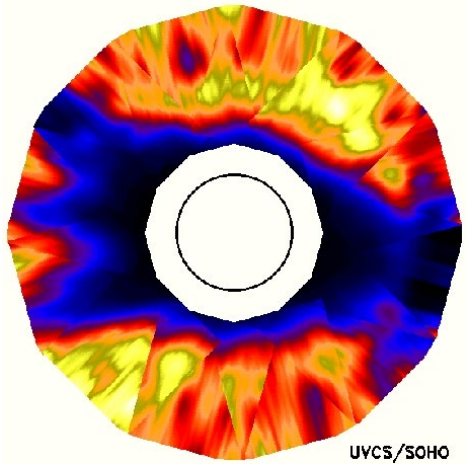
Silvano Fineschi
Angela Ciaravella
Silvio Giordano
Marco Romoli
Joe Michels (CFA)
Ester Antonucci
Giampiero Naletto

UVCS-SOHO Science Meeting, Monselice 1997

The core team: first and second generation - UVCS-SOHO Science Meeting Monselice 1997





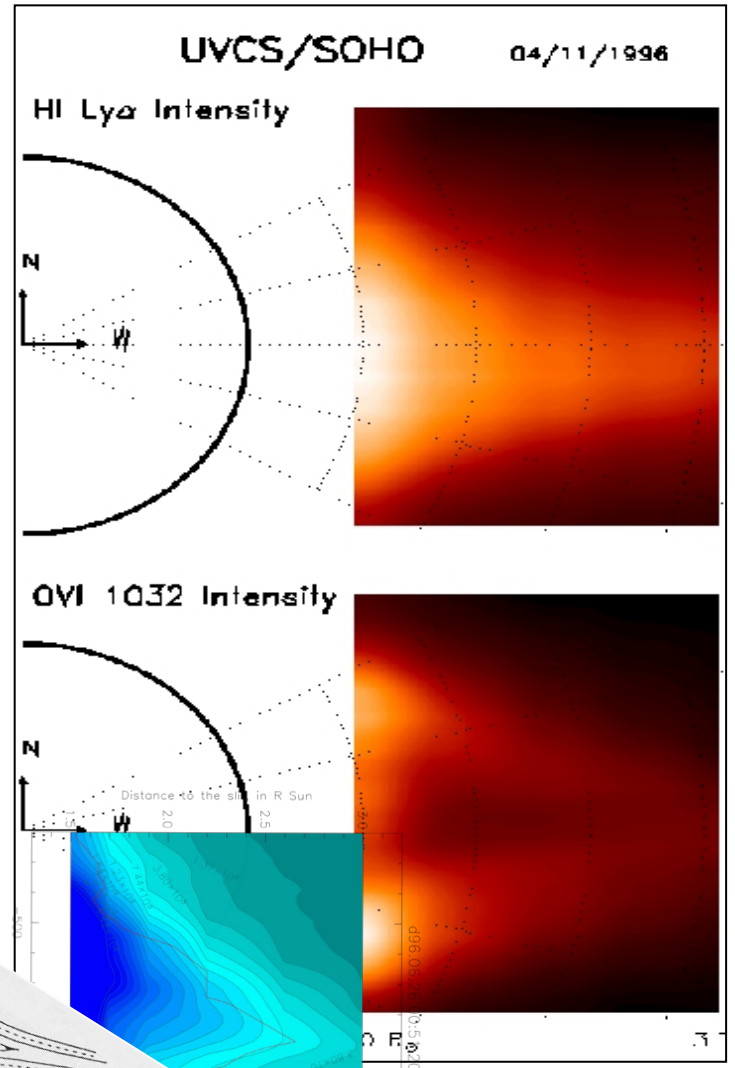


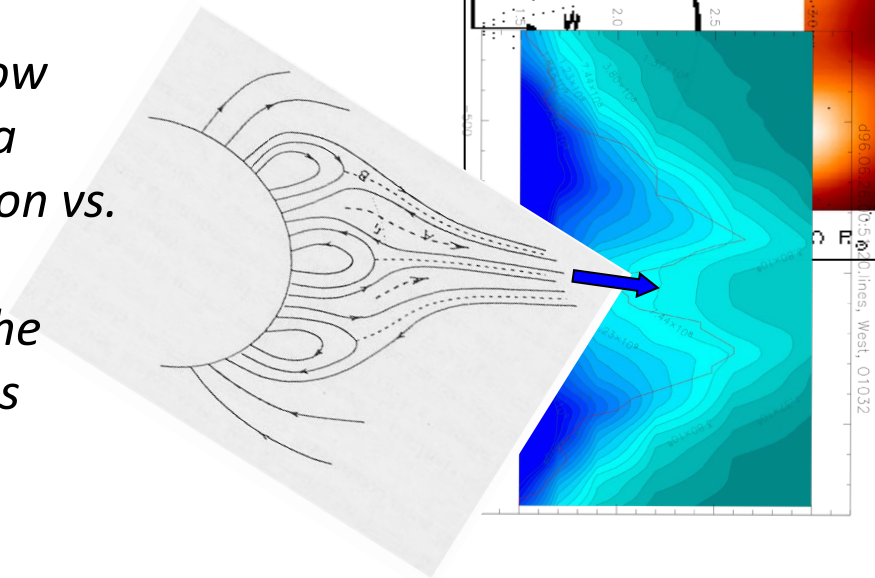
90s First UVCS results

One of the first results was the Noci's interpretation of the **streamer core dimming** observed in the **OVI emission** in terms of the **topology** of the coronal magnetic field and its **modulation** effect on the solar **wind speed** (Noci et al. 1997, Noci & Gavryuseva, 2007.

Further UVCS discoveries during the first year of observations :

- *identification of the fast and slow solar wind regions in the corona*
- *higher acceleration of the OVI ion vs. HI fast solar wind component*
- *higher kinetic temperature of the OVI ions in the fast wind regions*





90s *First UVCS-SOHO international event*

48th **International Astronautical Congress IAF** - **Turin** 6-10 October **1997**

‘Focus on SOHO-UVCS’ Event

Exhibition

UVCS-SOHO paved the way for Metis.

The people who made Metis possible, following Noci's footsteps, in the new century.

IV Metis Science Mtng.
Prague, 5-17 Oct. 2014

Metis selection 2009.

A detailed history of the Solar Orbiter mission and Metis selection can be found in *Antonucci, 2022*

Giancarlo Noci not only has been an outstanding innovative solar physicist but also a person of vast humanistic culture. Often he started his 'thinking day' at the Arcetri Observatory reading with a colleague a 'canto' of the Dante's Divina Commedia.

These are the Dante's words he followed during all his life

'Consider your origins:
you were made .. to follow virtue and knowledge.'

' … fatti … foste …… per seguir virtute e canoscenza.'

Dante, Inferno, Canto XXVI