

# Tor Hagfors

18 December 1930 – 17 January 2007

Donald Farley  
Cornell University  
Ithaca, NY



- Versatile theorist
- Scientific leader and politician
- Creative engineer

A man of many diverse talents

# Major areas of research

- Planetary radar astronomy
  - Scattering from rough surfaces, including polarization effects (Hagfors scattering law)
- Incoherent scatter from the ionosphere
  - Volume scattering from a “soft” target, namely a plasma in thermal equilibrium

# A brief chronology

- 1955-59. Norwegian Defense Res. Establishment (NDRE)
  - Communication via ionospheric scattering
  - PhD in 1959
- 1959-61. Stanford University
  - Radar astronomy and theory of incoherent scatter
- 1961-63. Returned to NDRE
- 1963-67 and 1969-71. MIT Lincoln Laboratory
  - Planetary radar (Moon, Hagfors scattering law, mapping Venus with interferometry)
  - Scattering from the auroral electrojet
  - Incoherent scattering theory (especially collisional effects)

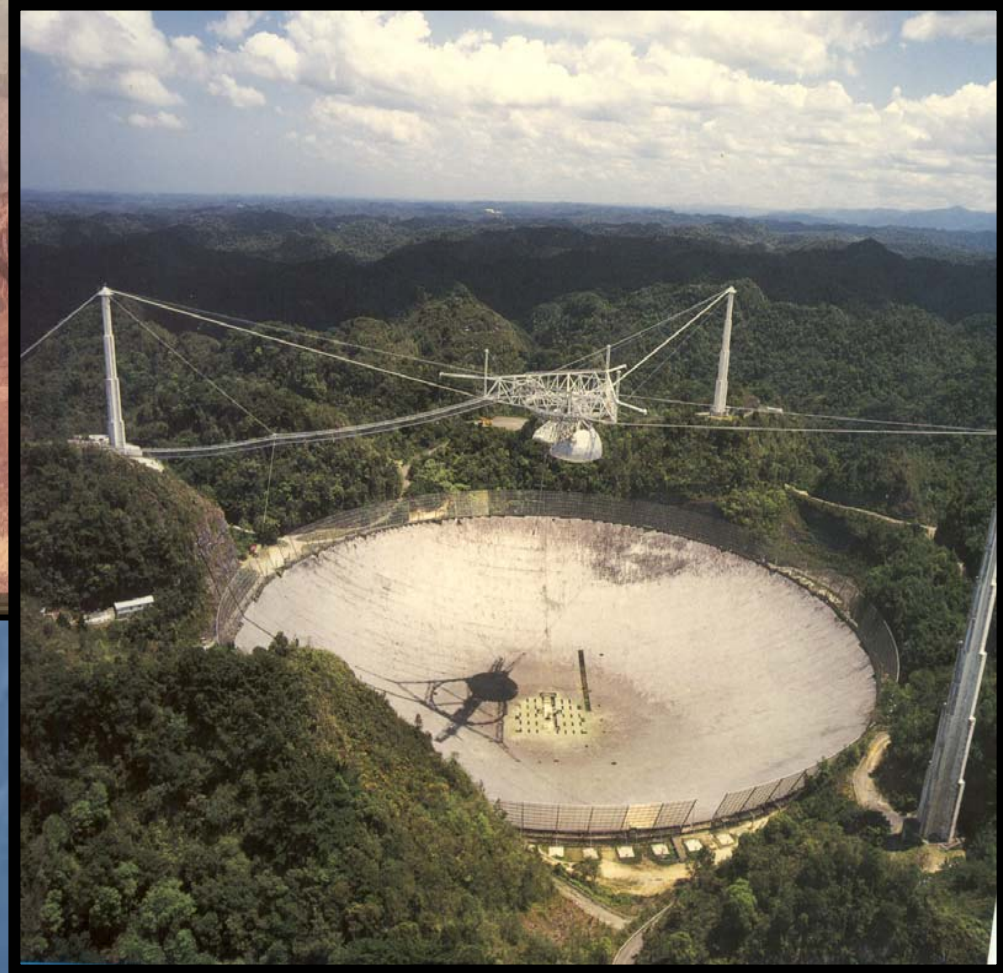
# Chronology (2)

- 1967-69. **Director of Jicamarca Observatory**
  - ISR vertical drift velocities (with error theory)
  - Passive moon observations
- 1971-73. **Director of Observations, Arecibo Observatory**
  - Theory of ionospheric modification by high power RF (heating)
  - "Chirp" observations with resolution  $\sim 100$  m
  - Radar astronomy observations of Venus [w/ Don Campbell]
- 1973-82. Univ. of Trondheim (Norway), Prof. of EE
  - Communication & information theory
  - Radar techniques and technology
  - Antenna theory
- 1976-82. **Founding Director of EISCAT**
  - Fund raising and coordinating 6 European research councils
  - Concepts for tri-static antenna, data taking and analysis

Arecibo  
Director 1971-73  
NAIC Director 1982-92



Early Jicamarca  
Director 1967-69



# Arecibo



Early



Later



# Founding Director and frequent user of EISCAT



## Trebent radar synar jonosfären

Atmosfären mer än fem mil upp från marken skall undersökas med hjälp av radarantennar stationerade på tre orter i norra Norden.

Av TOR HAGFORS  
Teckningar: Hans Nilsson





# EISCAT Inauguration



# EISCAT years



June 2007

CEDAR Workshop, Santa Fe

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# Chronology (3)

- 1982-92. Cornell Univ. (USA), Prof. of Astron. & EE
- 1982-92. **Director of National Astron. & Ionosphere Center (NAIC) at Cornell (NAIC oversees Arecibo)**
  - Theory of Langmuir waves in HF modified plasmas
  - Chirp technique for high resolution observations
  - Antennas and radar astronomy
  - Developed concepts for Gregorian feed of AO (*major* upgrade)
- 1988-89. Sabbatical at **MPI-Lindau** (Germany)
  - Radar astronomy using lunar reflections for long baseline interferometry

# Chronology (4)

- 1992-98. University of Oslo, Prof. of Astronomy
  - Lectures on radar astronomy
  - Research on scattering from Galilean satellites
- 1992-99. **Director, Max-Planck Inst., Lindau (Germany)**
  - Dealt with numerous political issues within Germany and within MPI associated with German reunification
  - Numerous scientific projects
  - Began collaboration on ISR text with D. Farley
- 1999-2007. *Very active "retirement"*
  - MPI, U. Tromsø, U. Nagoya, U. Lancaster, EISCAT, Svalbard, Mars Express, CONSERT (comet probe)
  - Author or co-author of ~ 30 or so papers during retirement

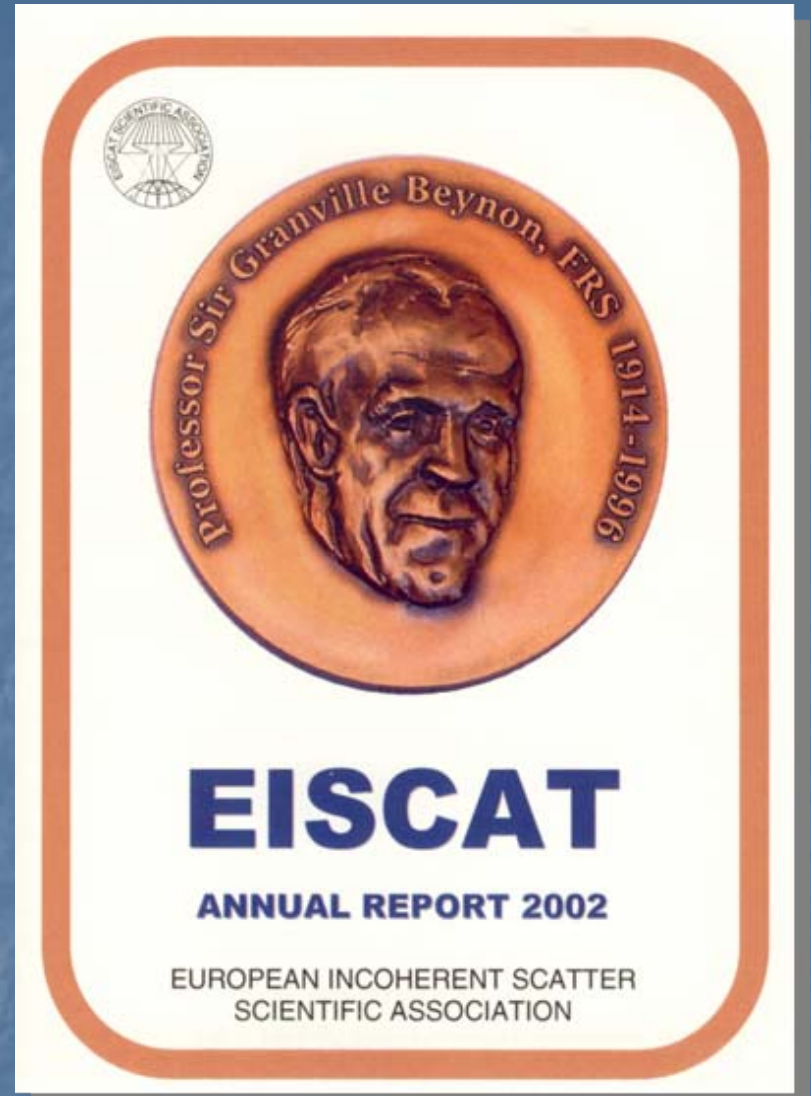
# Memberships

- Memberships
  - Amer. Astron. Union, AGU, IEEE, URSI
  - Several European professional societies
  - Many European research councils and advisory committees
  - Reviewer of papers and proposals for numerous journals and research councils

# Honors

- 1978 Royal Norwegian Society of Science
- 1987 URSI VanderPol Gold Medal
- 1988 IEEE Fellow
- 1989 Humboldt Senior Scientist
- 1996 Roy. Norweg. Acad. of Science and Letters
- 1998 Assoc. Member Royal Astron. Society
- 2000 "Hagfors" asteroid named
- 2002 Sir Granville Beynon medal (EISCAT)
- Two honorary doctorates
  - U. Oulu, 2002,
  - U. Tromsø, 2003)
- Three named lectures
  - Waynick, Penn State, 1999
  - Harang, Tromsø, 2002
  - Gordon, Arecibo, 2003

## Early Meeting



Medal in 2002

# Publications

- Over 150 papers (mostly in journals) on many topics
- Mostly on surface and volume scattering
  - Forward and meteor scatter 11
  - Surface scatter (lunar, Venus, Saturn's rings) 20
  - Astronomy techniques 8
  - Other astronomy 2
  - Incoherent scatter 21
  - RF heating (especially AO and EISCAT) 29
  - EISCAT (including design) 17
  - AO upgrade and Gregorian feed 3
  - Auroral physics 6
  - Satellite EM probing of Mars & a comet (ROSETTA, CONSERT) 8
  - Other (general reviews, optical probing, tomography, ...) 23



# Tor's human side

Tor was definitely not all work and no play. He enjoyed life, liked to party, and was very witty at times, especially when the subject was politics!

He was a good friend to many, good to work with, and was generous in giving credit to others.



Tor liked parties!

# ISEA 10 – Turkey 2000



(from Ron Woodman video)



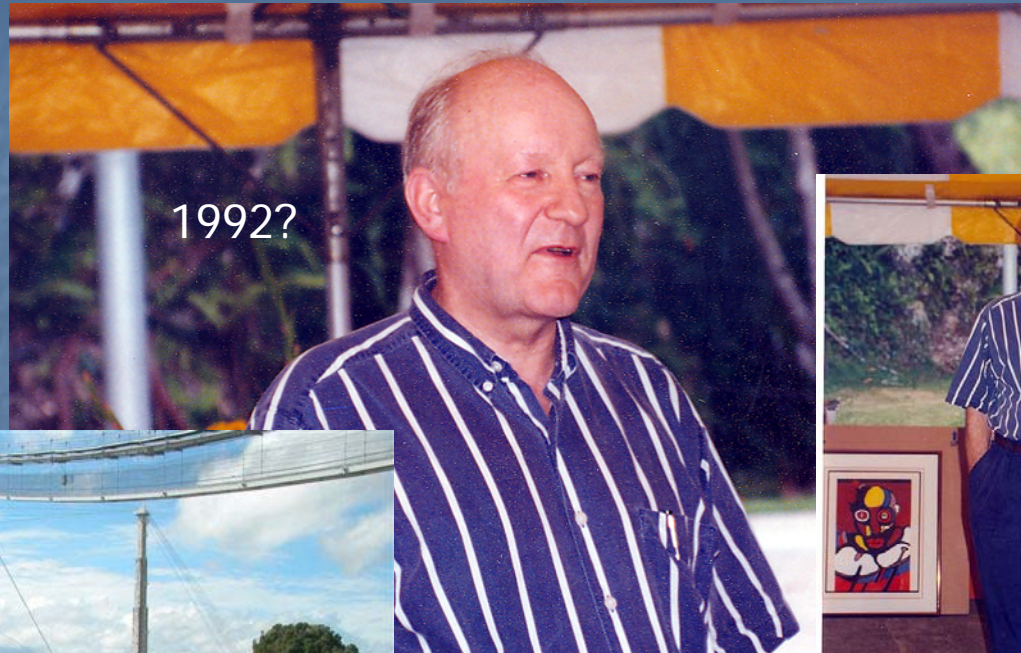
# Tor, Jürgen, Markku



# Germany?



# Arecibo (2)



June 2007

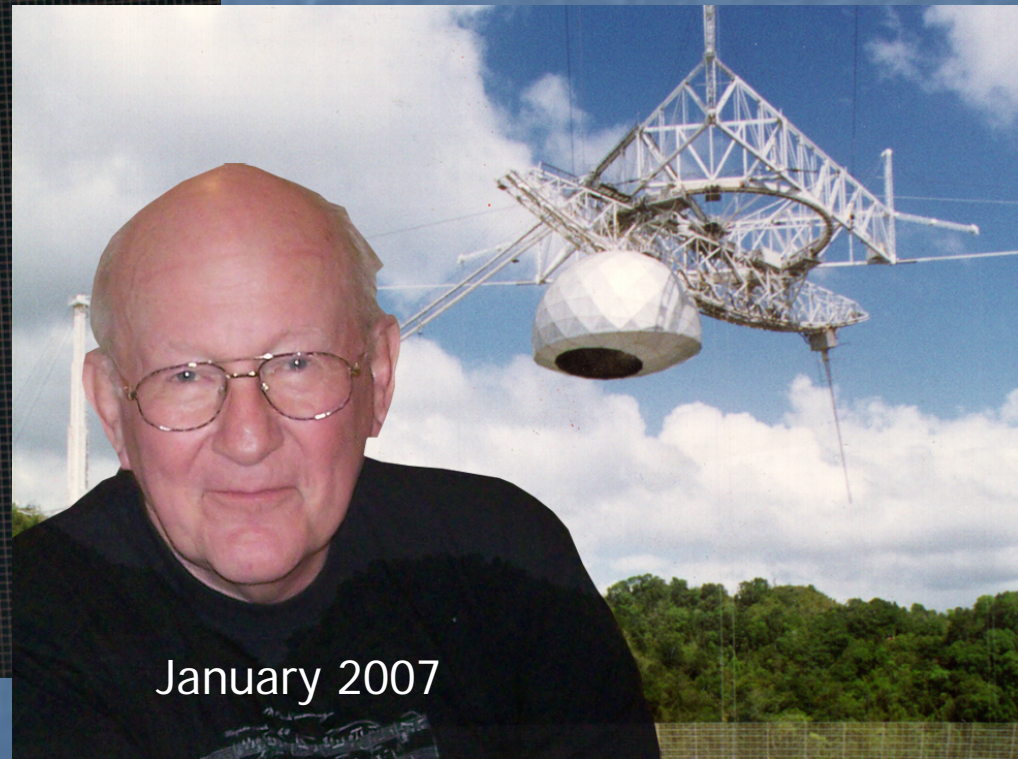
CEDAR Workshop, Santa Fe

## Some remarks by Don Campbell:

"In his slightly formal way, Tor liked to enjoy himself and was always ready for a party, and some of the parties in Arecibo were memorable. He was spontaneous, once diving into the Observatory's pool fully clothed on a dare from our young daughter. We went sailing in the Virgin Islands on several occasions ... These trips were great opportunities for relaxation, swimming, and, without fail, a few rum and cokes.

"I want to finish by saying how much Tor was admired as a scientist and teacher by the people who worked with him. He had a passion for doing science, clearly derived great enjoyment from it, and communicated this to all of us who worked with him as students and colleagues. Rather than being remembered for the many awards and medals he received, I think that Tor would want to be remembered primarily as someone who loved to do science."

# Arecibo (3)







- Versatile theorist
- Scientific leader and politician
- Creative engineer

We have lost a wise and creative colleague, a man who enjoyed his life to the full, and a good friend to many of us. He left us too soon.