

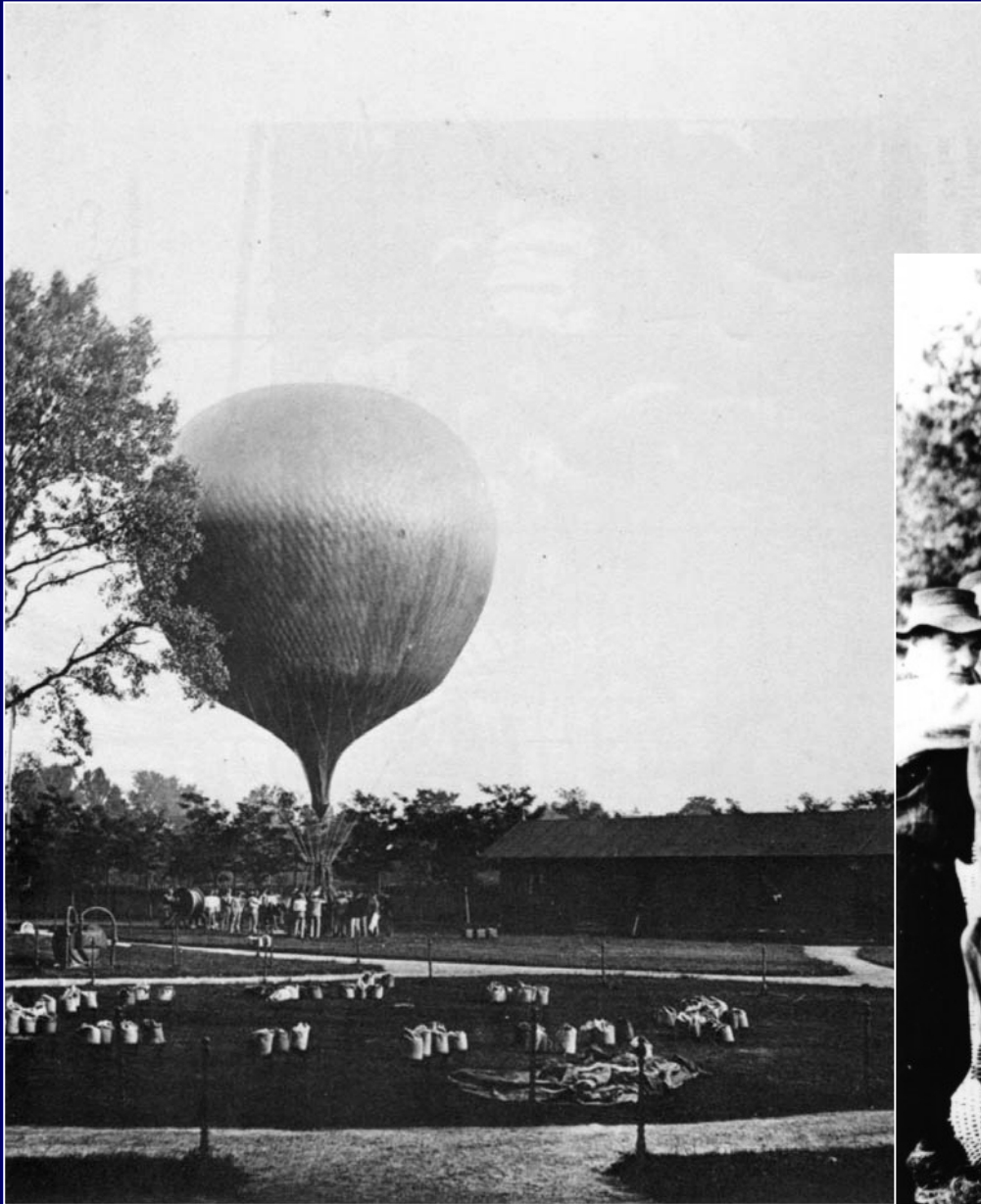
Neutrino-Astronomie im ewigen Eis

Forschung und Abenteuer am Südpol

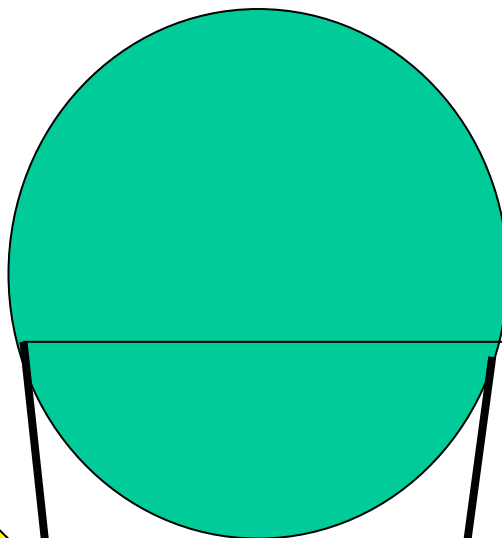
Christian Spiering
DESY



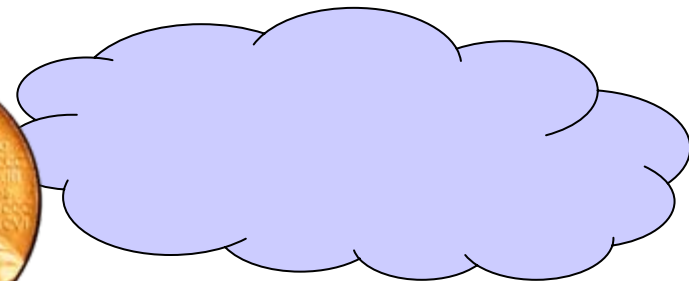
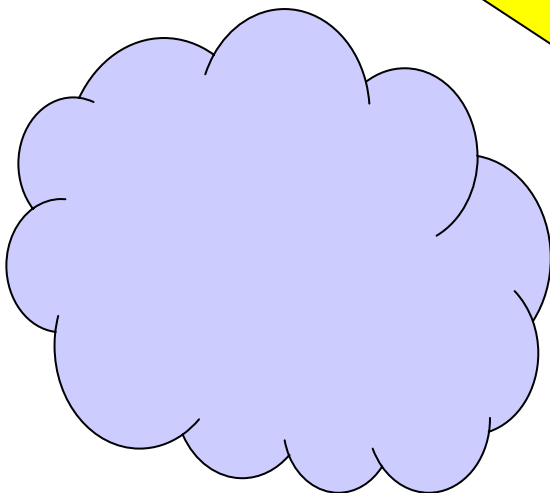
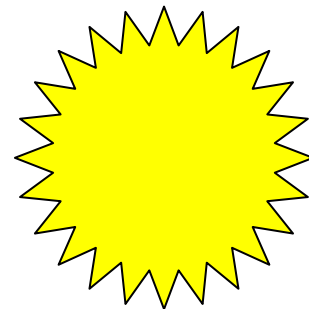
Victor Hess 1912



Upps !?



Nobelpreis 1936



Primäres
Teilchen



Stratosphärischer Ballon
(40 km Höhe)

~ 20 km
Höhe



Reaktion des Primärteilchens



Hess' Ballon
(bis 5 km Höhe)



Teilchen-Detektoren

primary
particle



stratospheric balloon
(40 km altitude)

~ 20 km
altitude

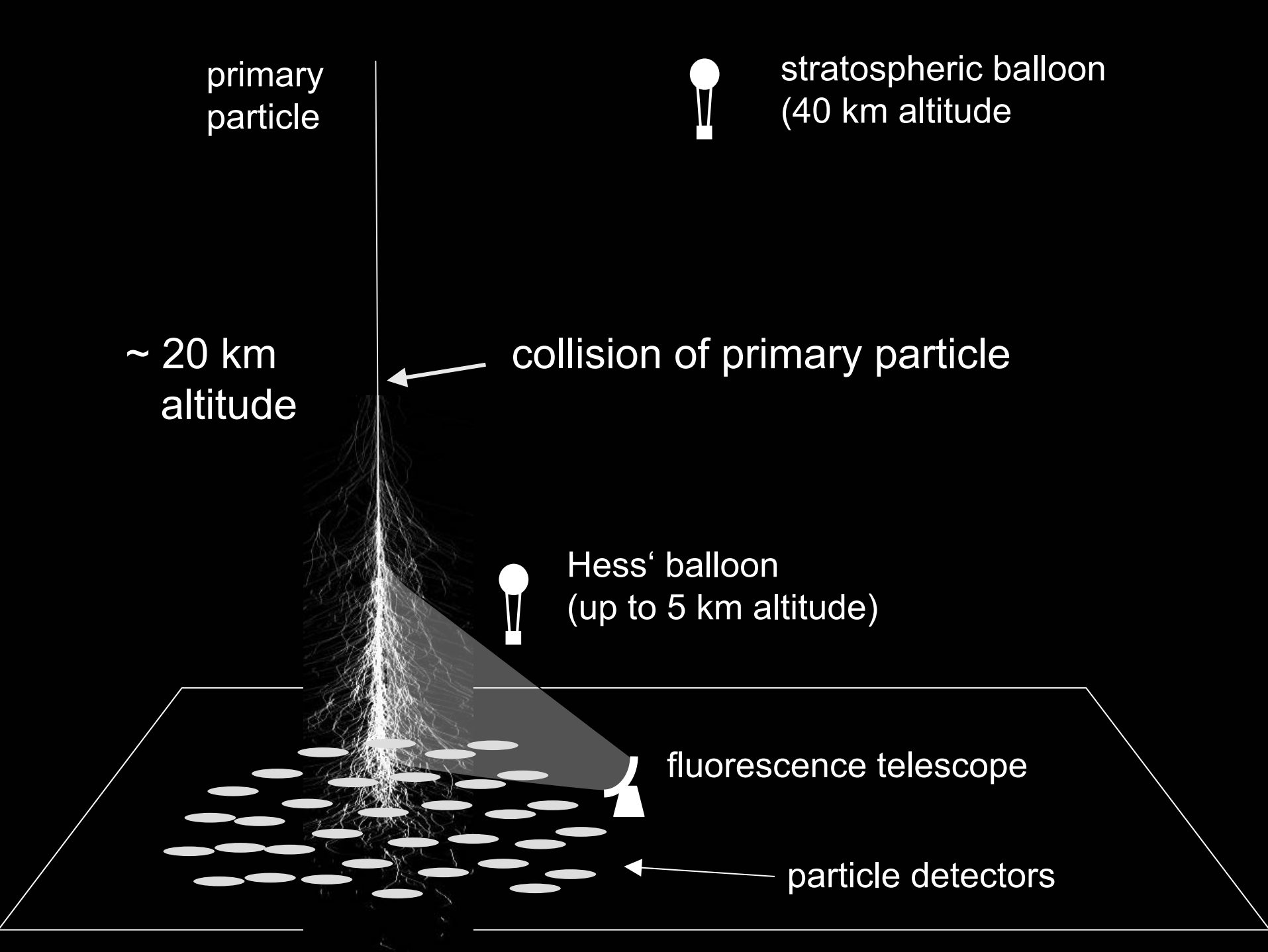
collision of primary particle

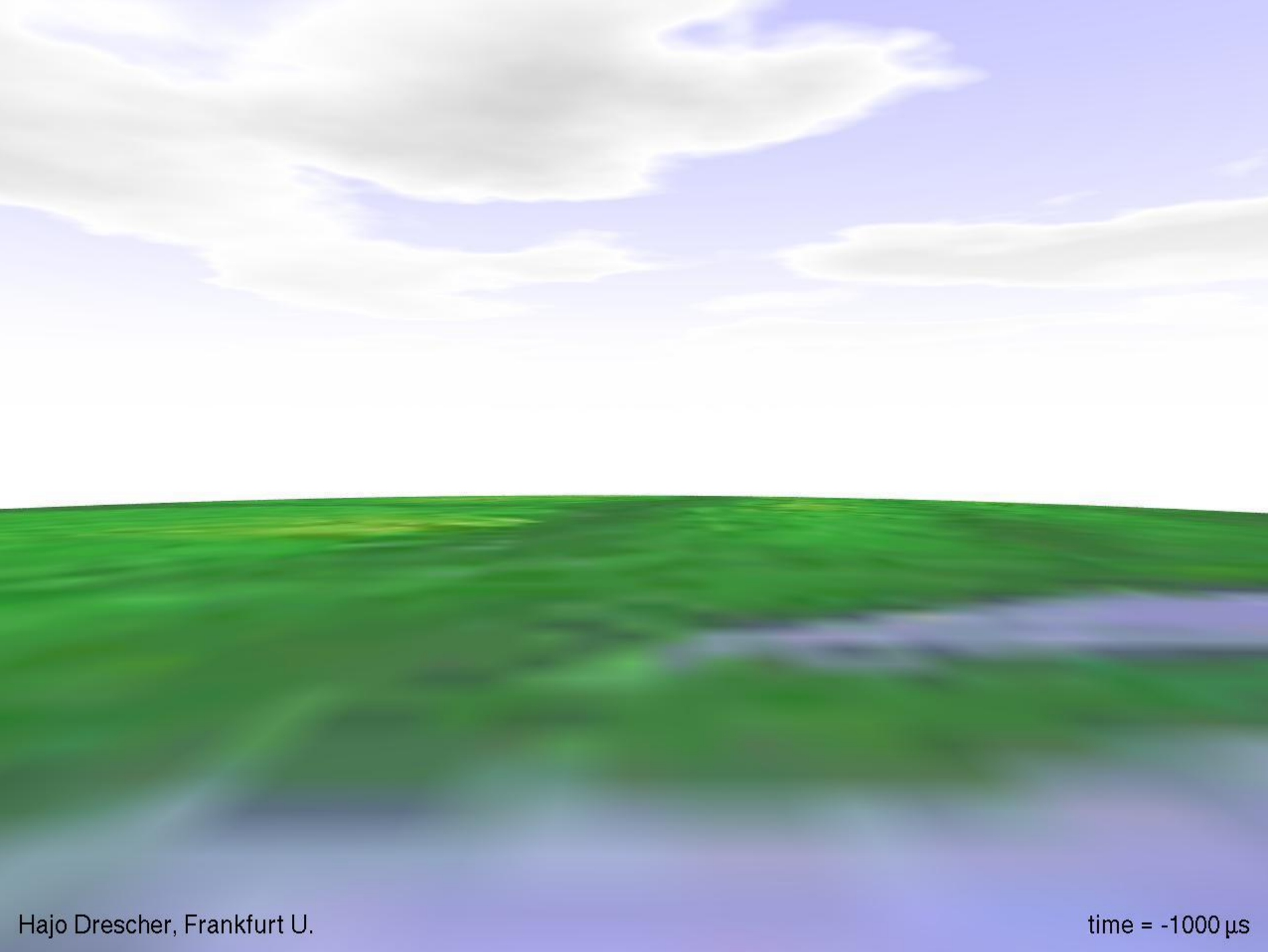


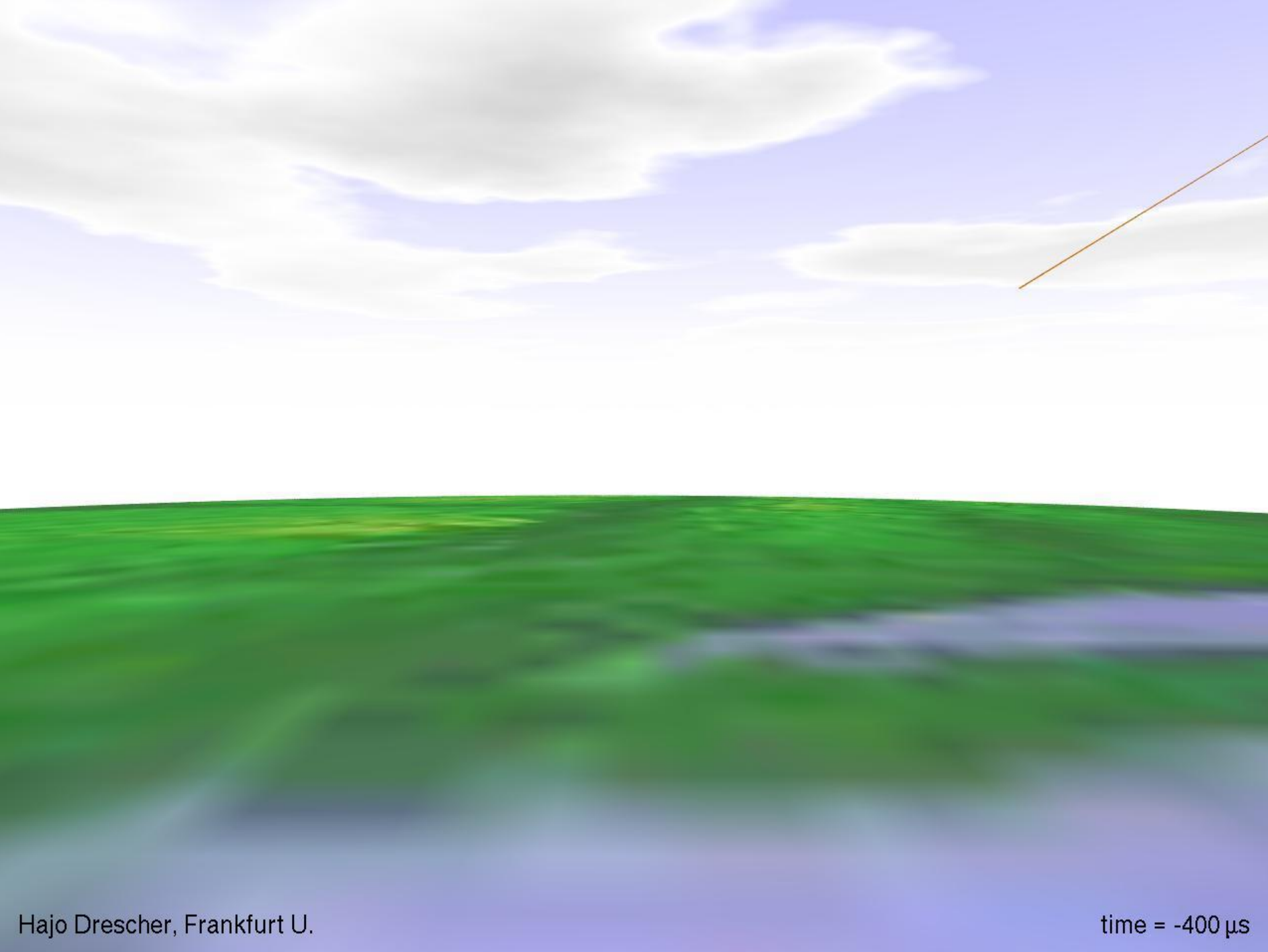
Hess' balloon
(up to 5 km altitude)

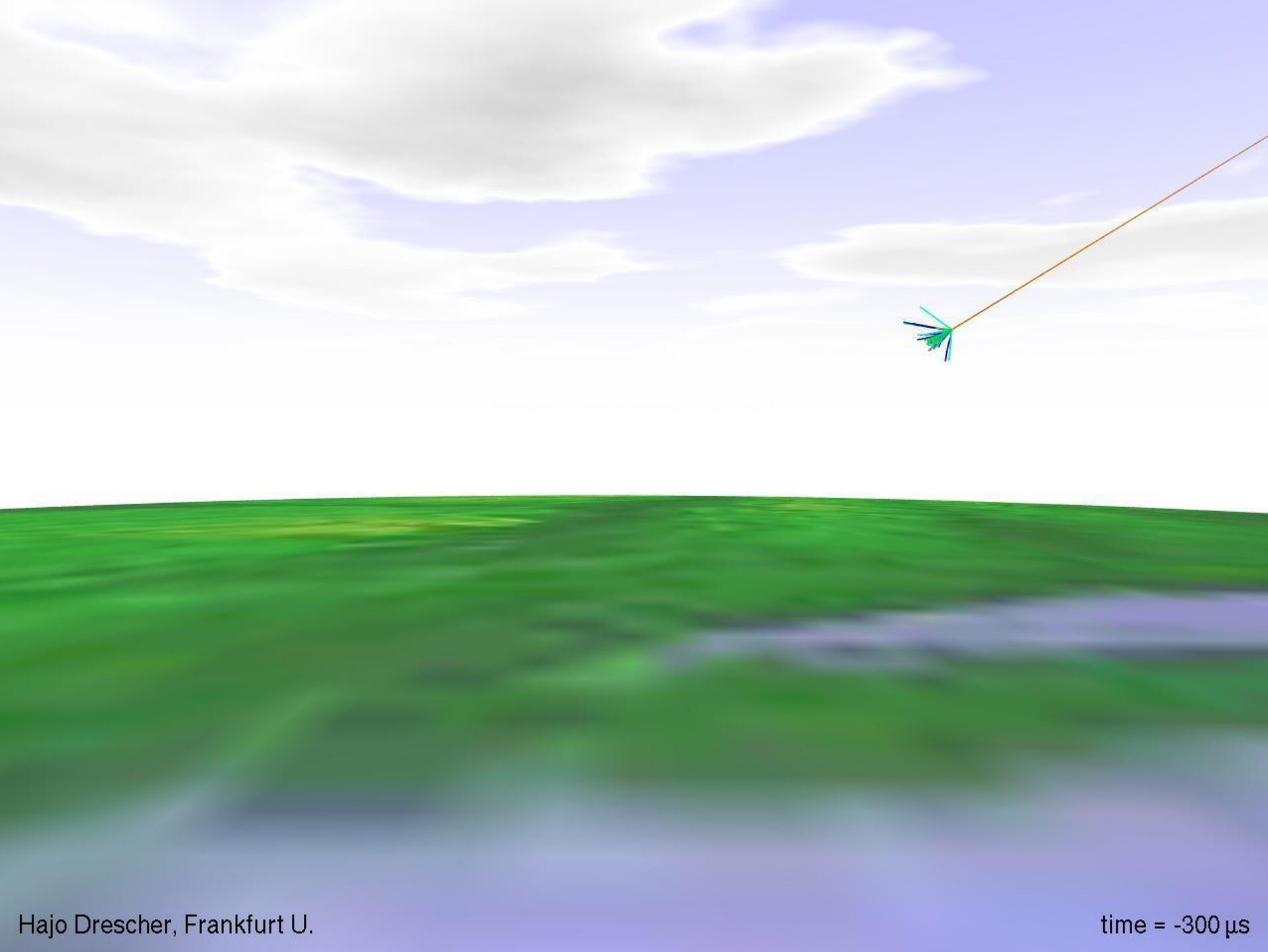
fluorescence telescope

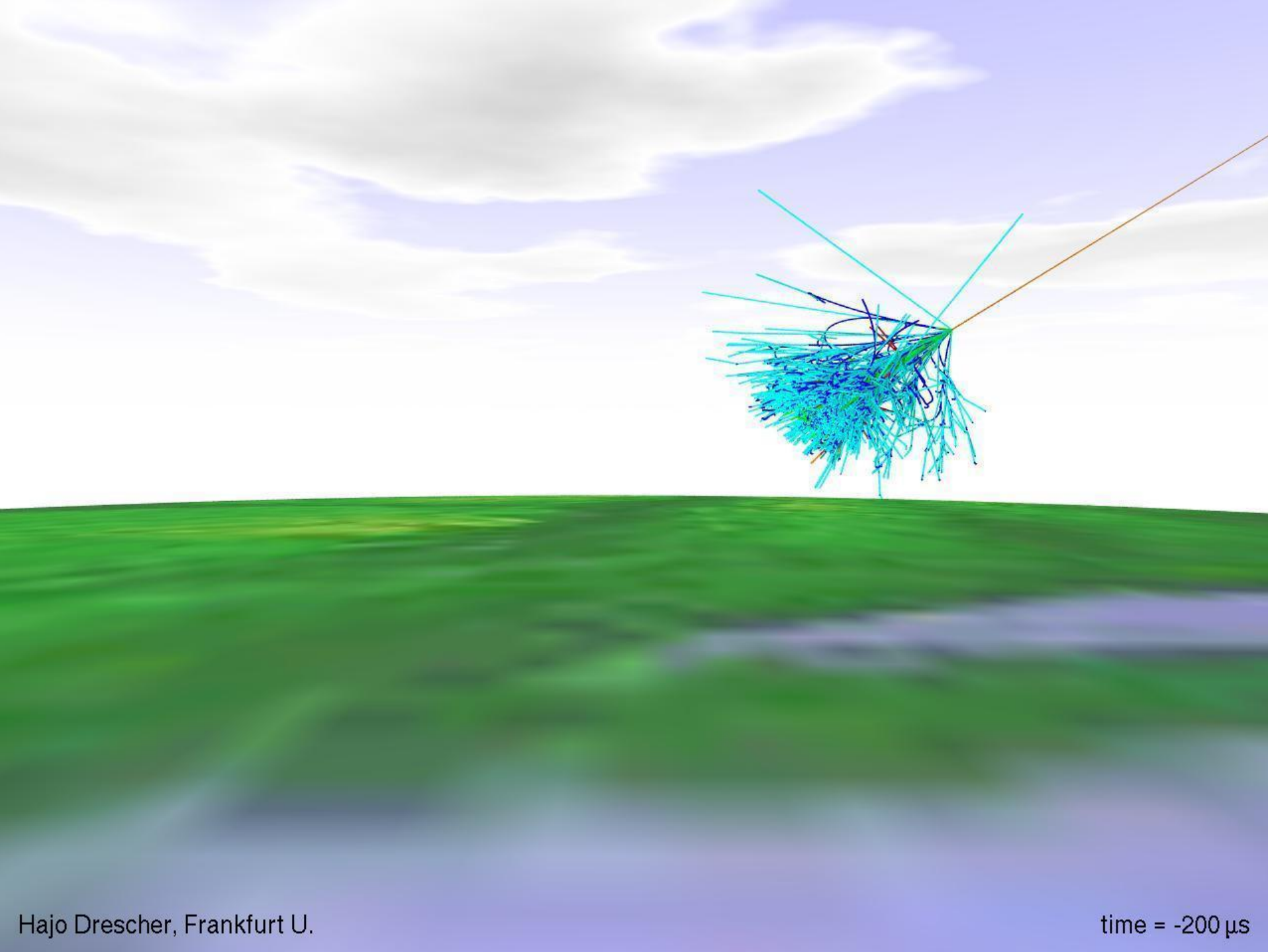
particle detectors

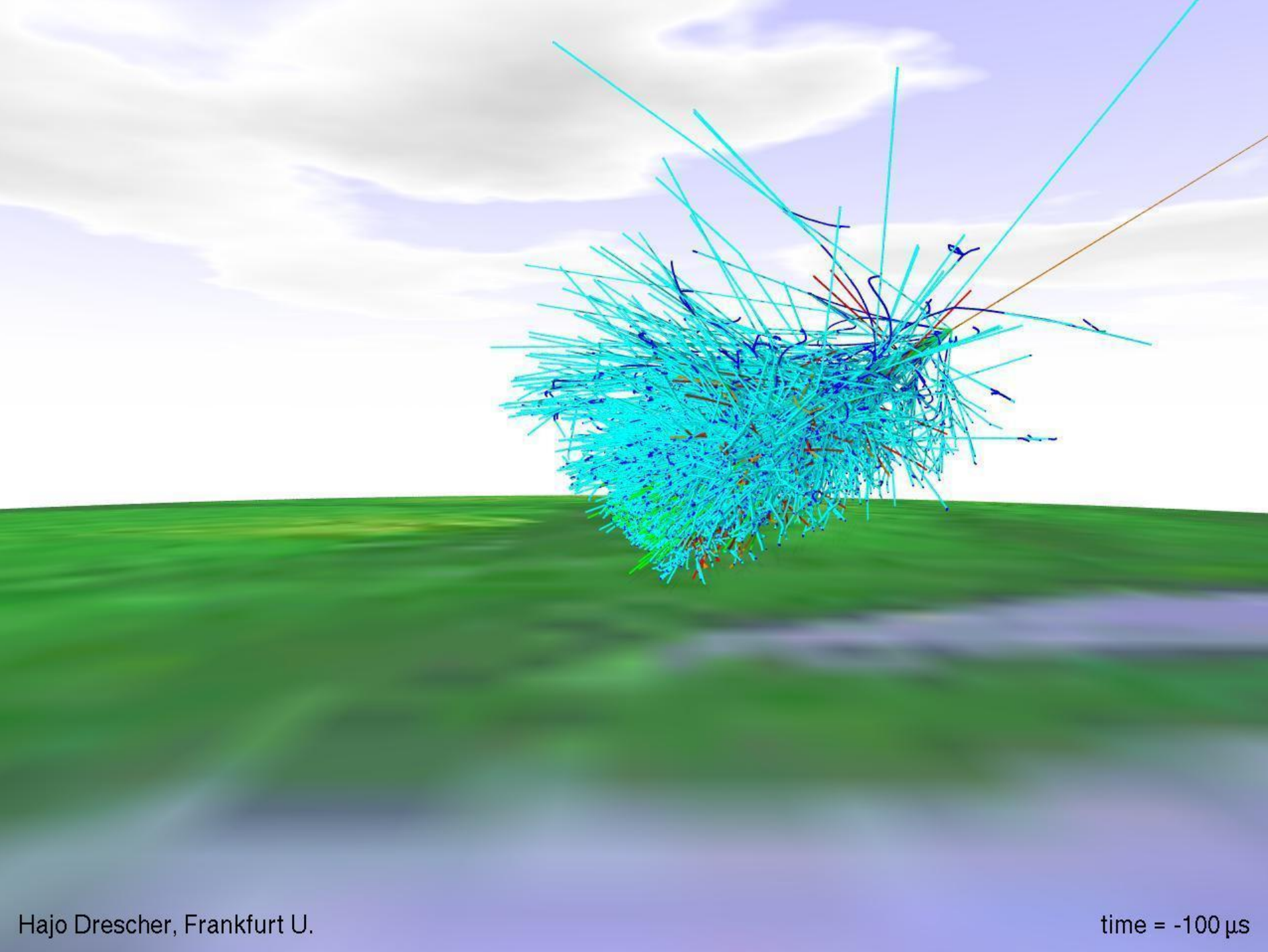


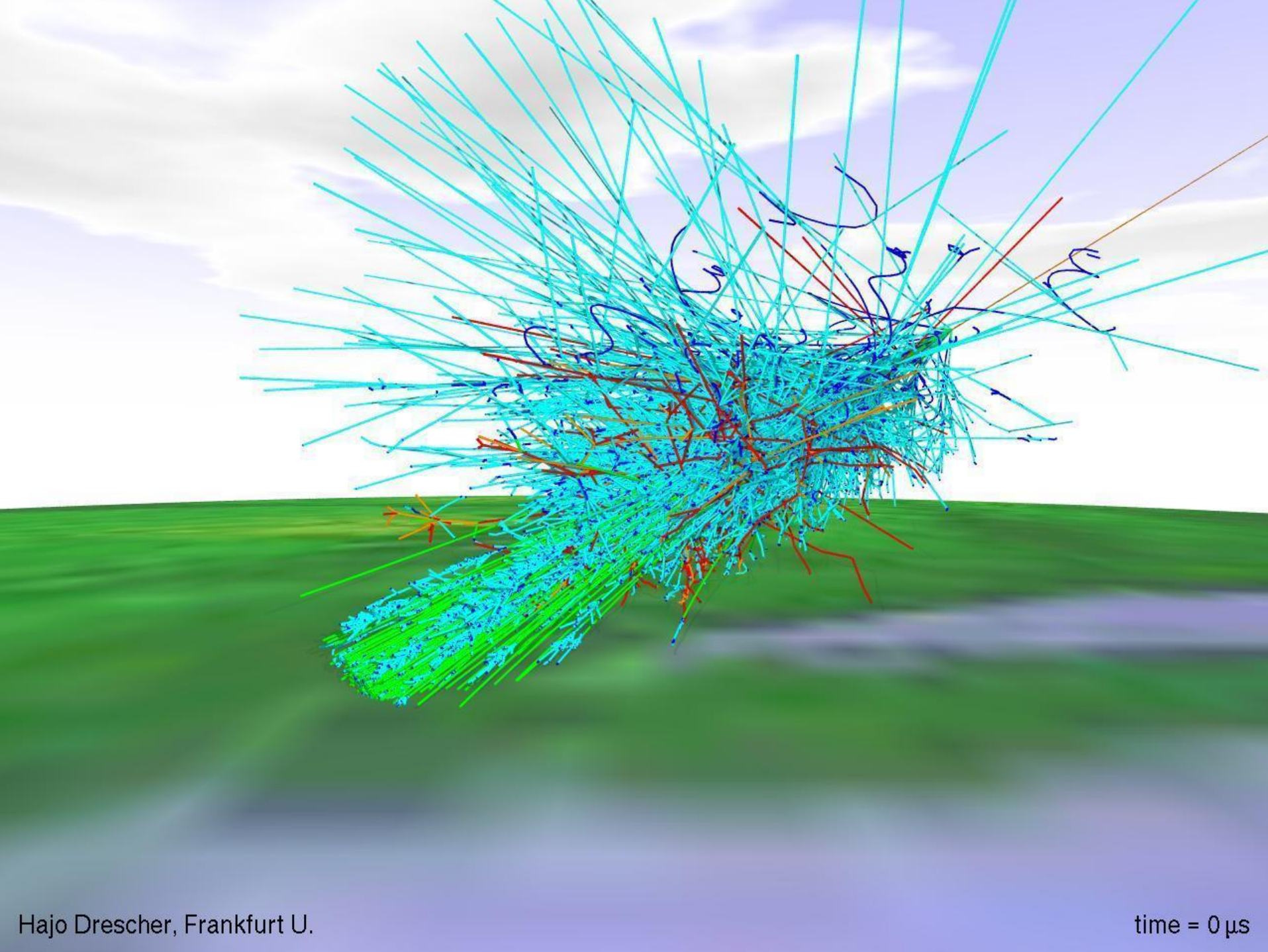


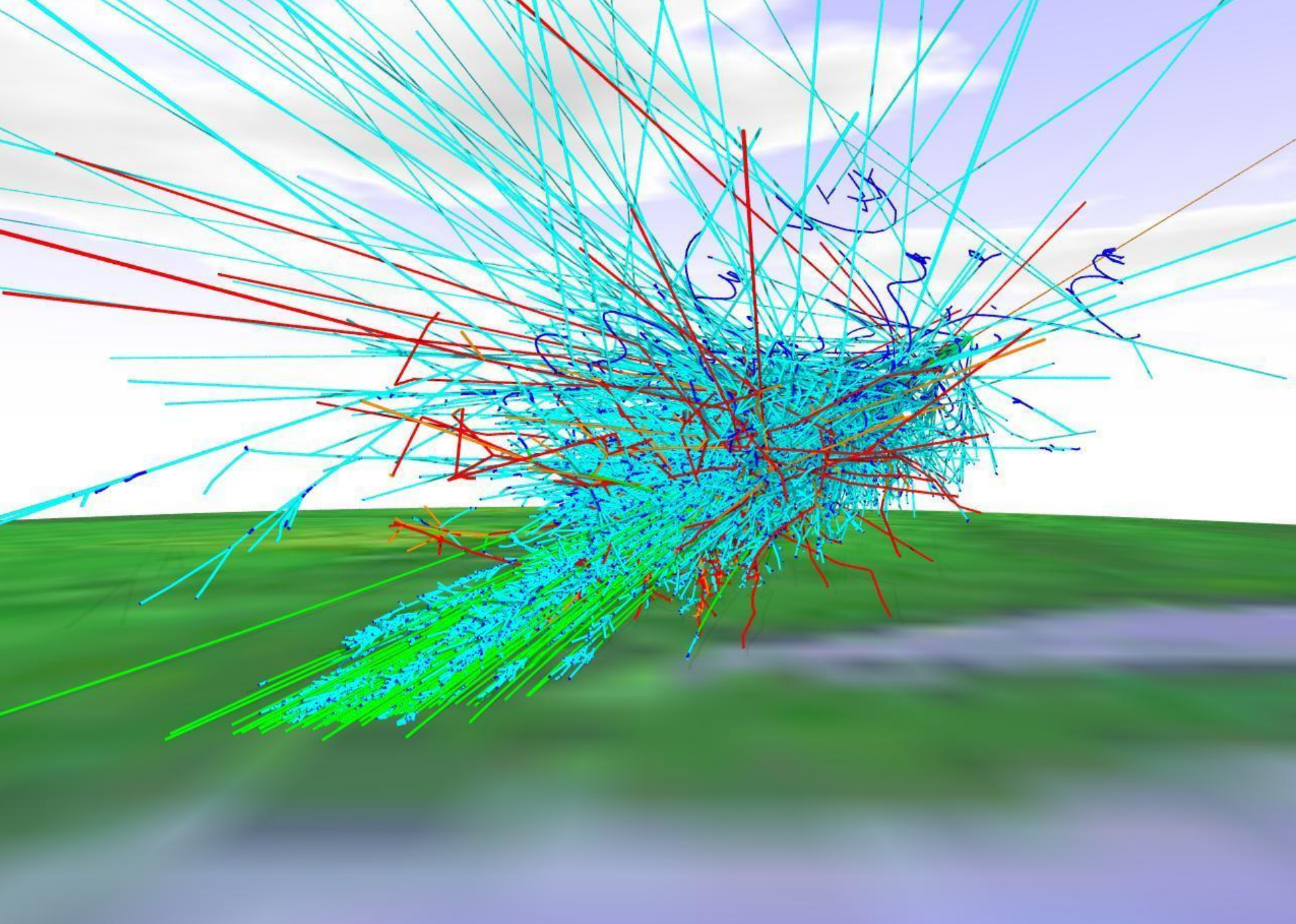




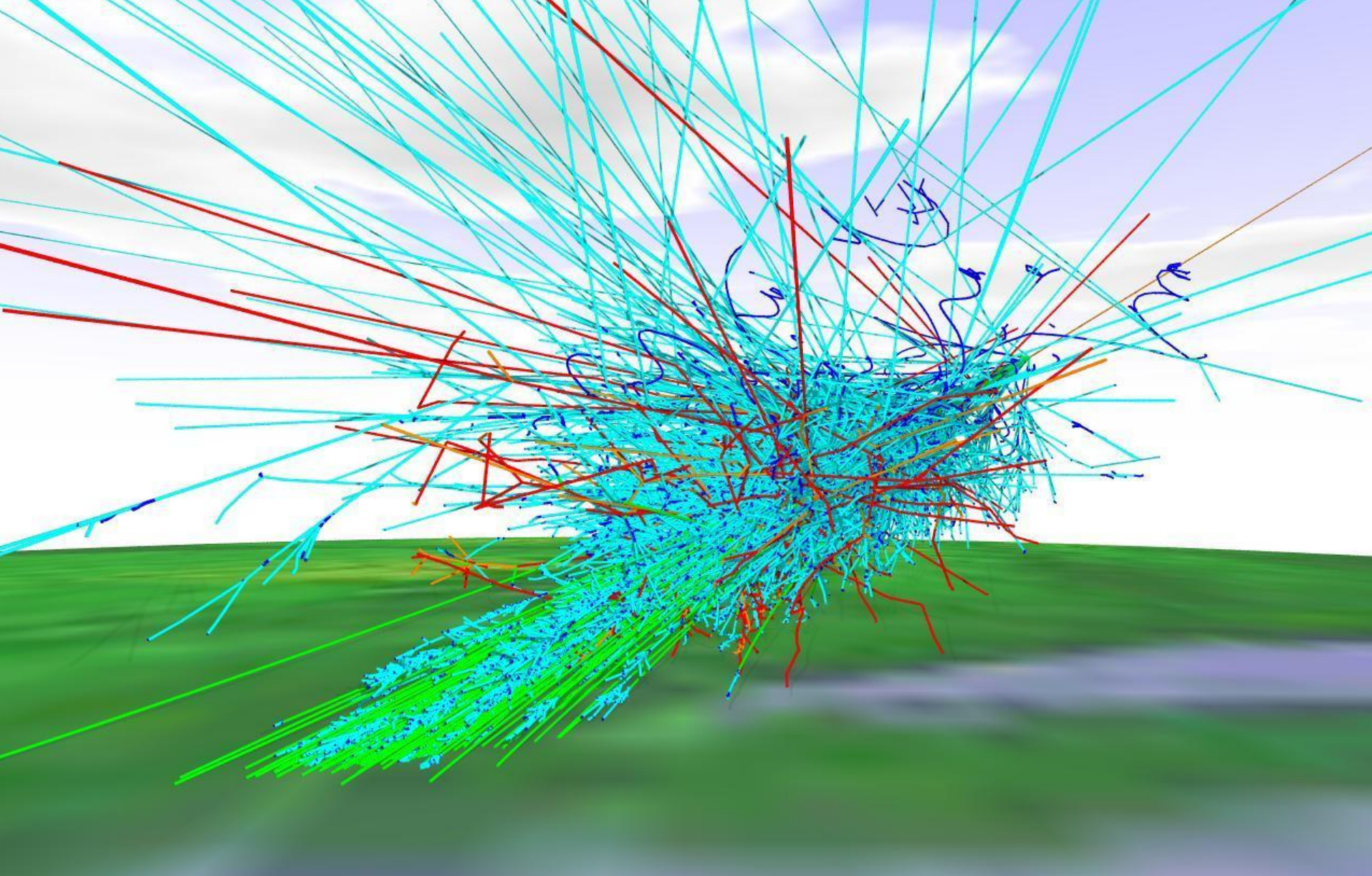








Hajo Drescher, Frankfurt U.



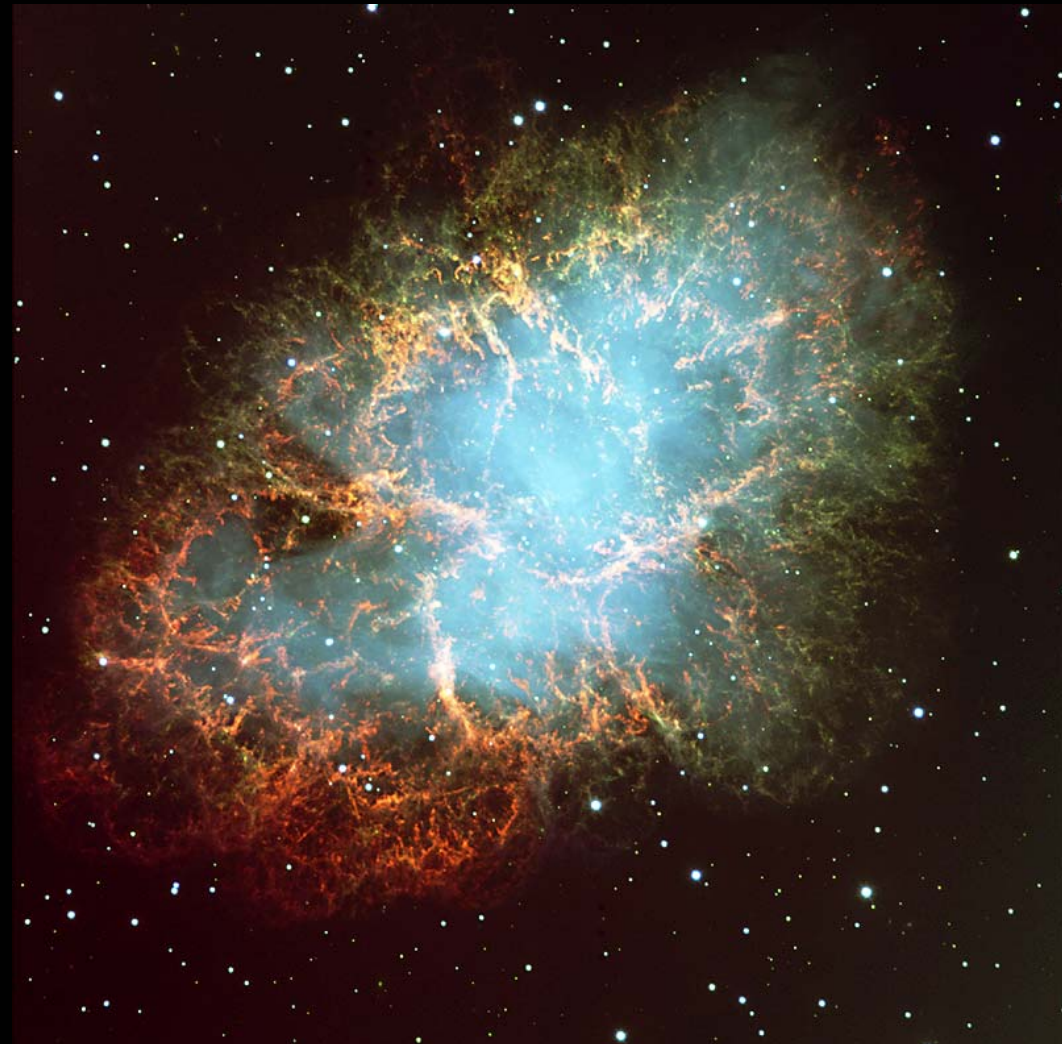
Energie: LHC \times 10 000 000

Hajo Drescher, Frankfurt U.

Supernovae: Stosswellen in interstellares Medium

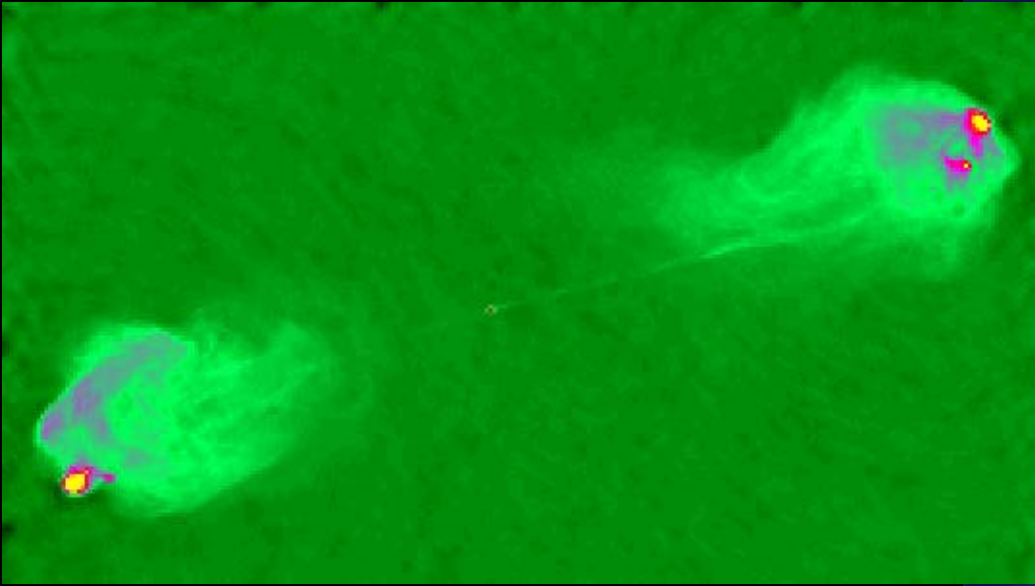
LHC × 1000

Krebs-Nebel

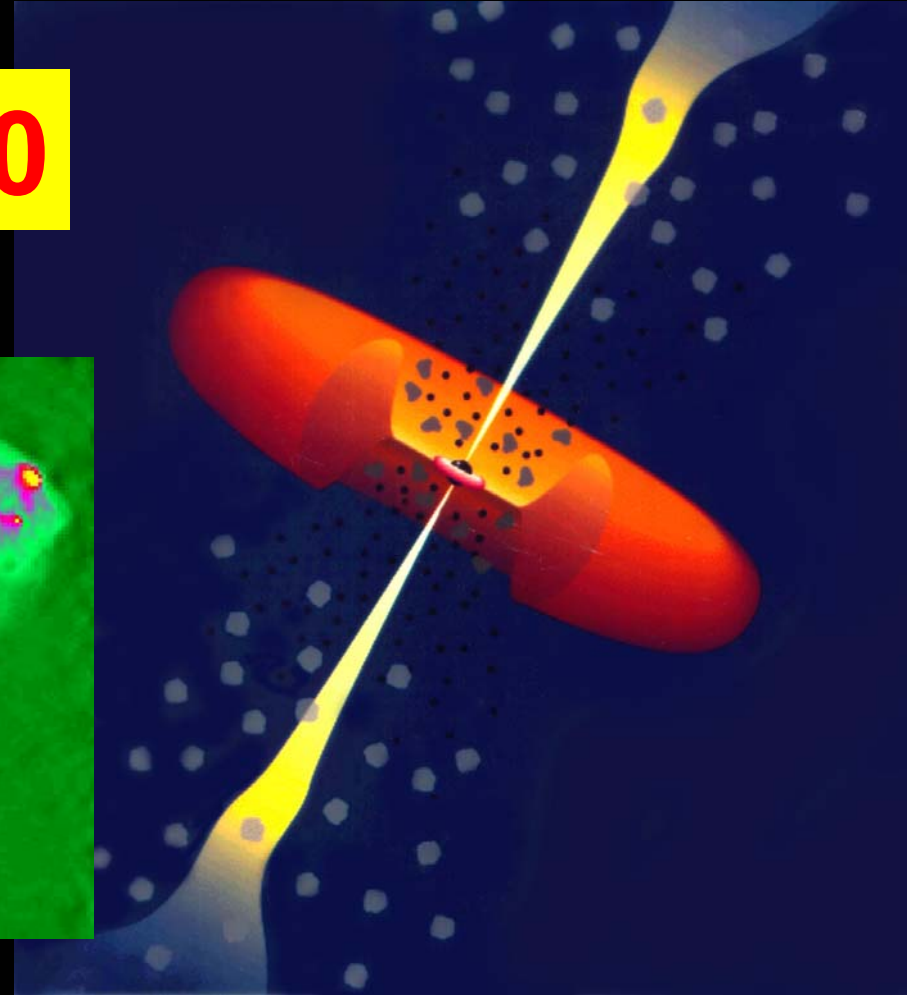


Aktive Galaxien: Akkretionsscheiben und Jets

LHC \times 10 000 000

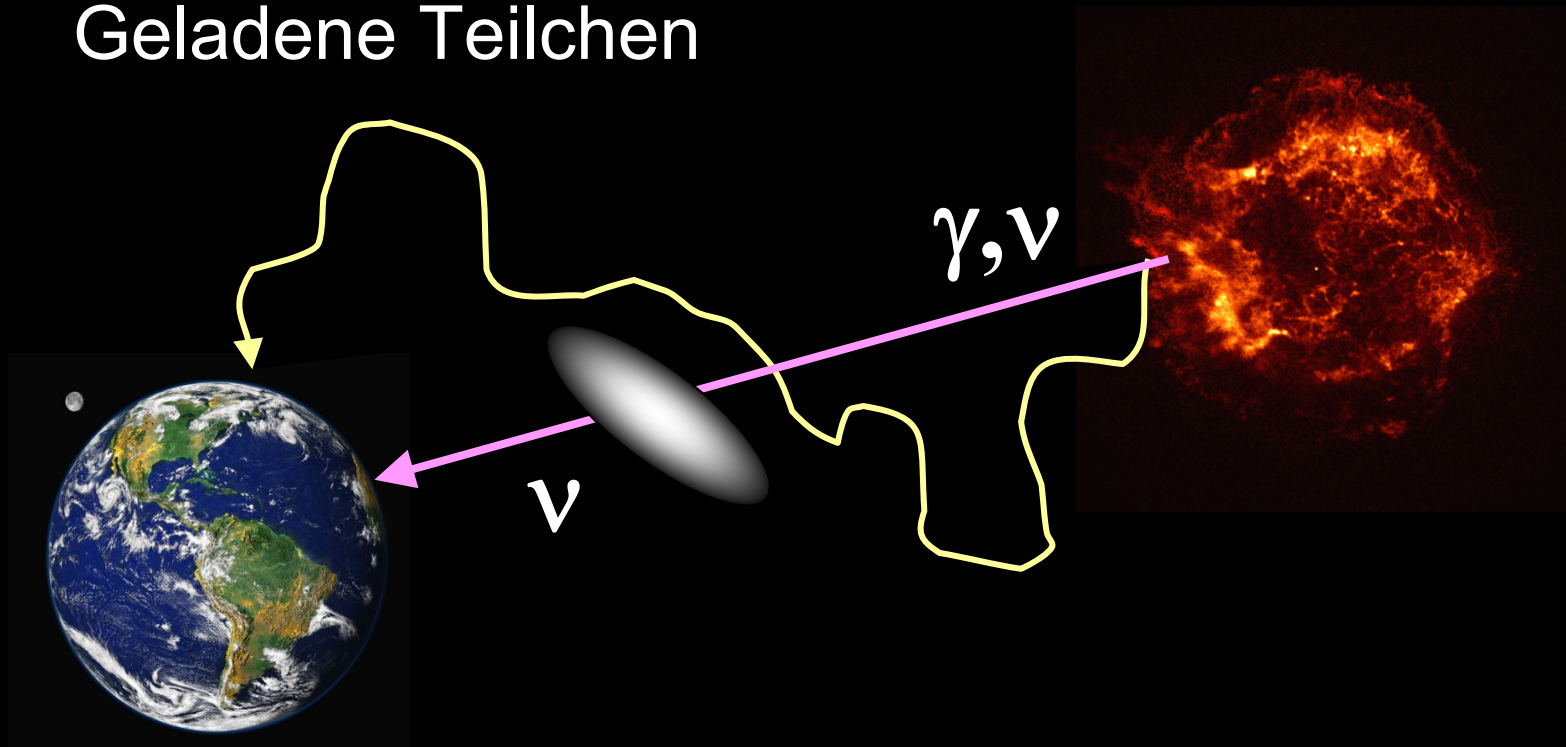


Radiobild von Cygnus A



Verschlungene und gerade Wege

Geladene Teilchen

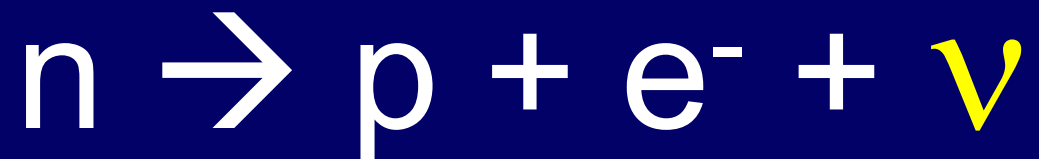


Radioaktiver Zerfall und das Postulat des Neutrinos



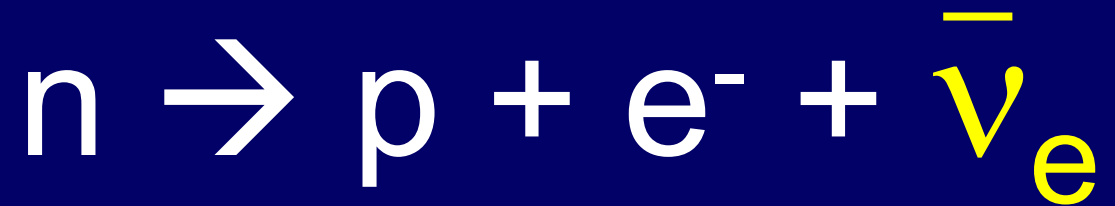
Wolfgang Pauli, 1930

Radioaktiver Zerfall und das Postulat des Neutrinos



Wolfgang Pauli, 1930

Radioaktiver Zerfall und das Postulat des Neutrinos

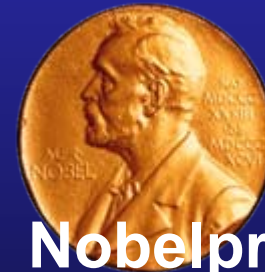
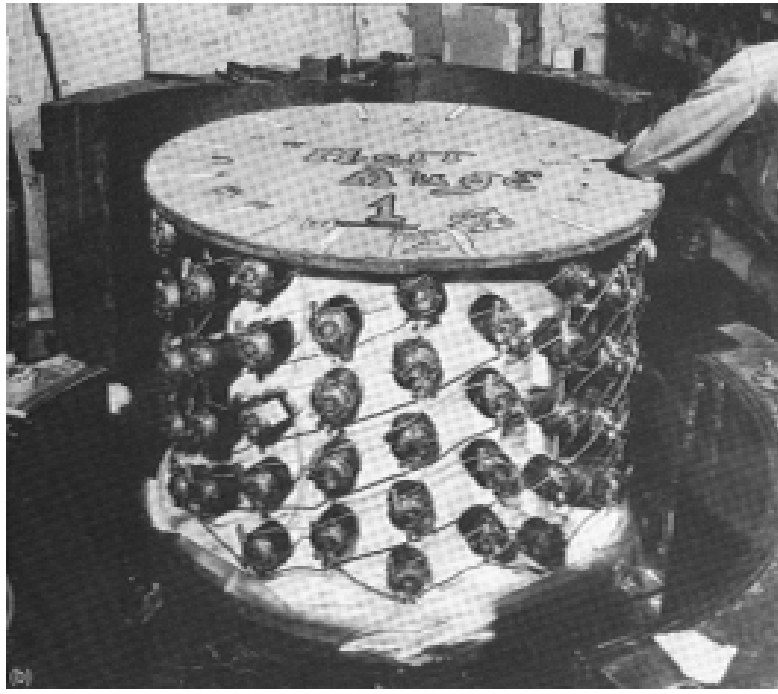


Wolfgang Pauli, 1930

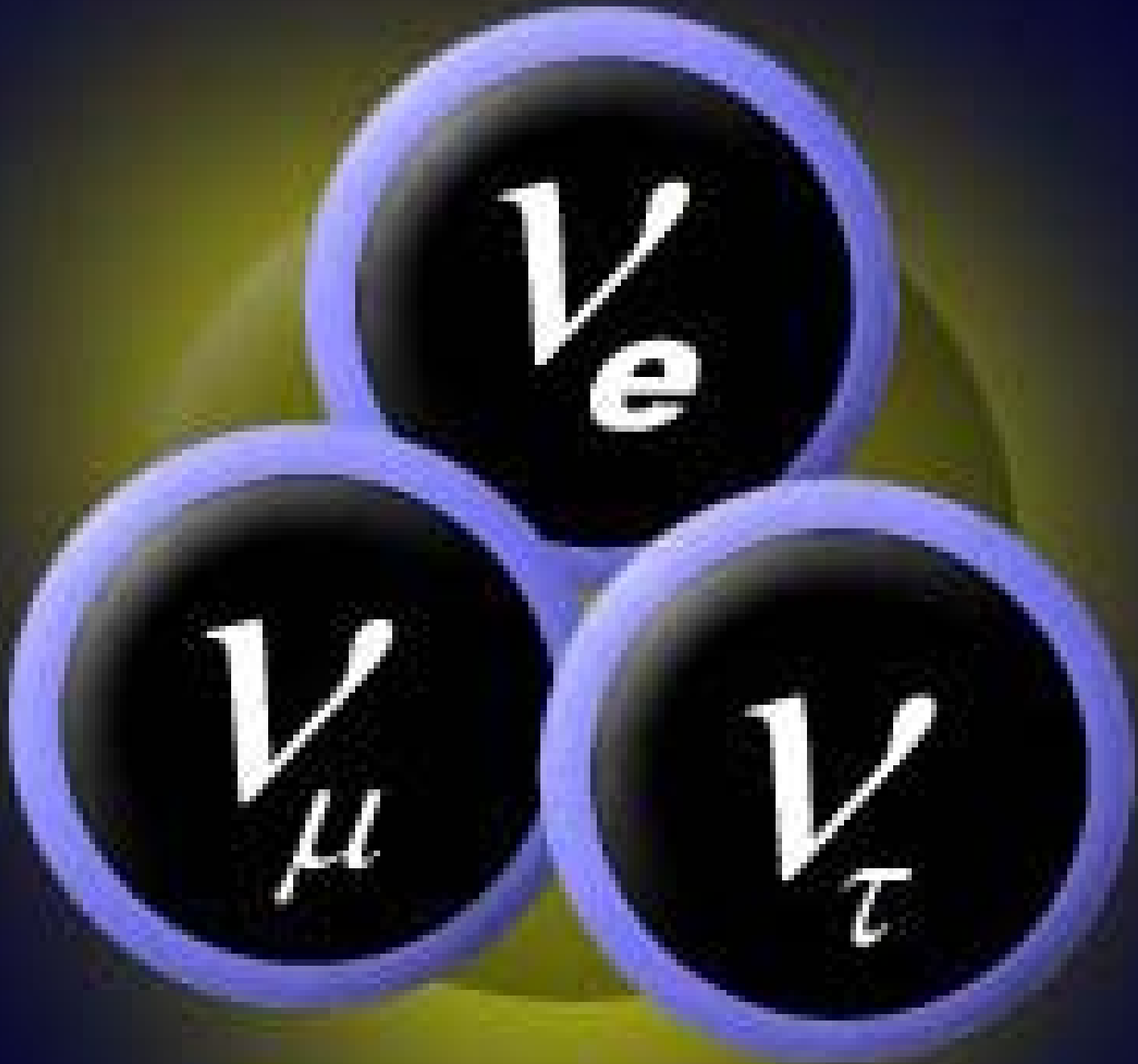



1956: Die Entdeckung des Neutrinos

Cowan und Reines



Nobelpreis 1955



- 
- **Masse (fast) Null**
 - **Extrem schwach reagierend**



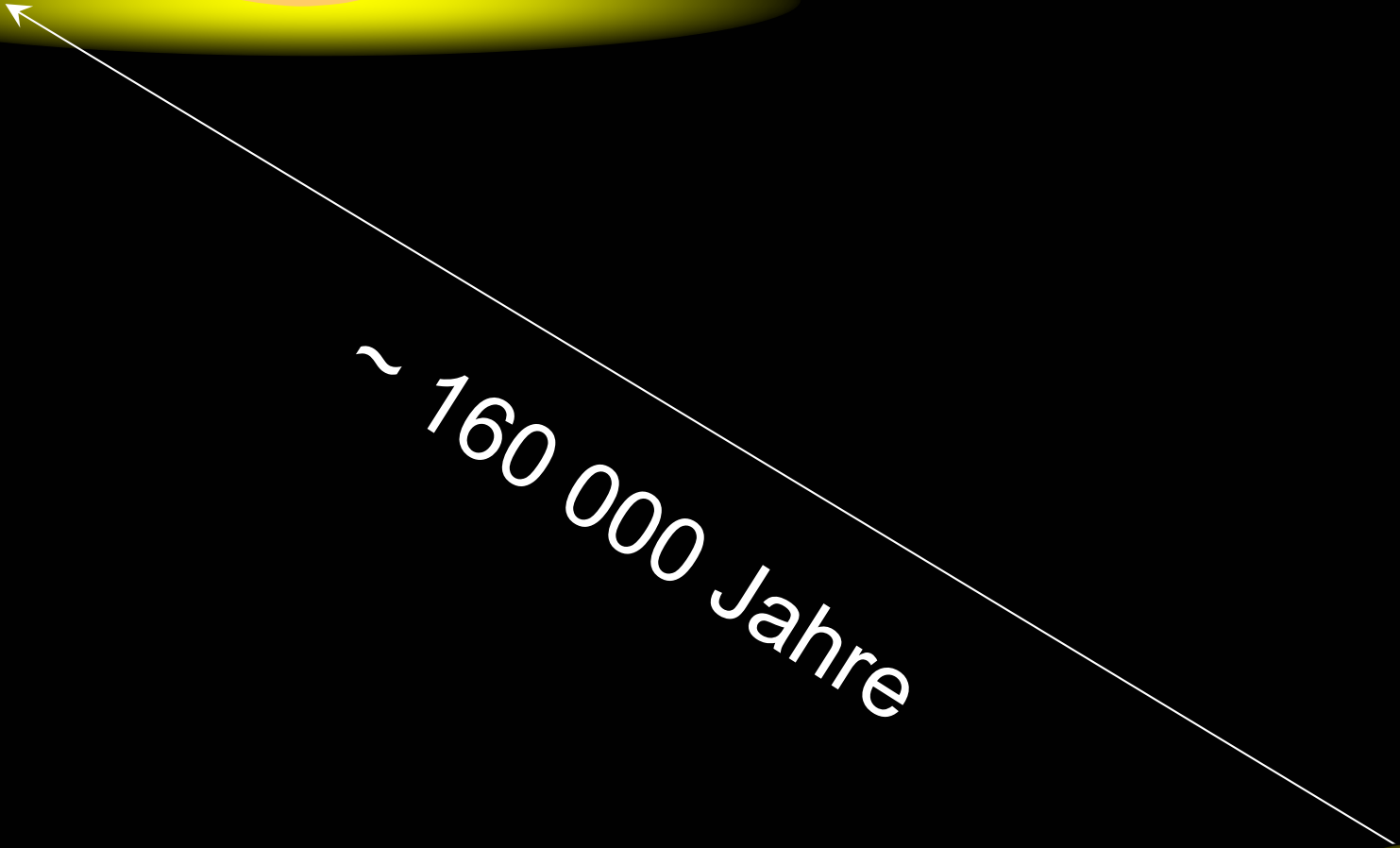
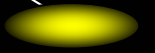
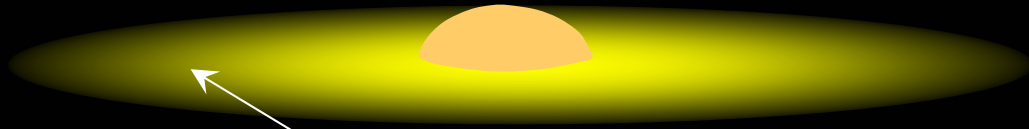
23.2.1987

**Die Geburt der
Neutrino-Astronomie**

Supernova 1987A in der Großen Magellanschen Wolke



23.2.1987



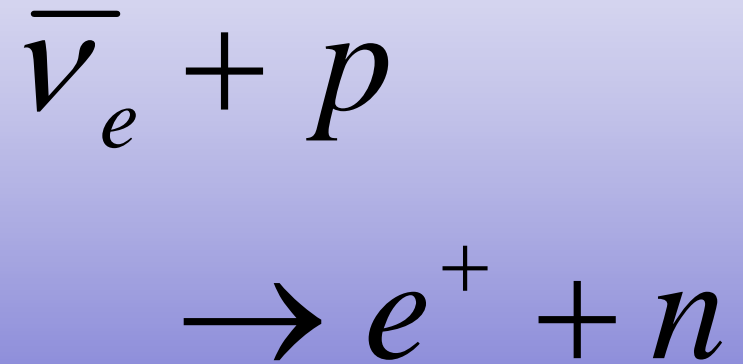
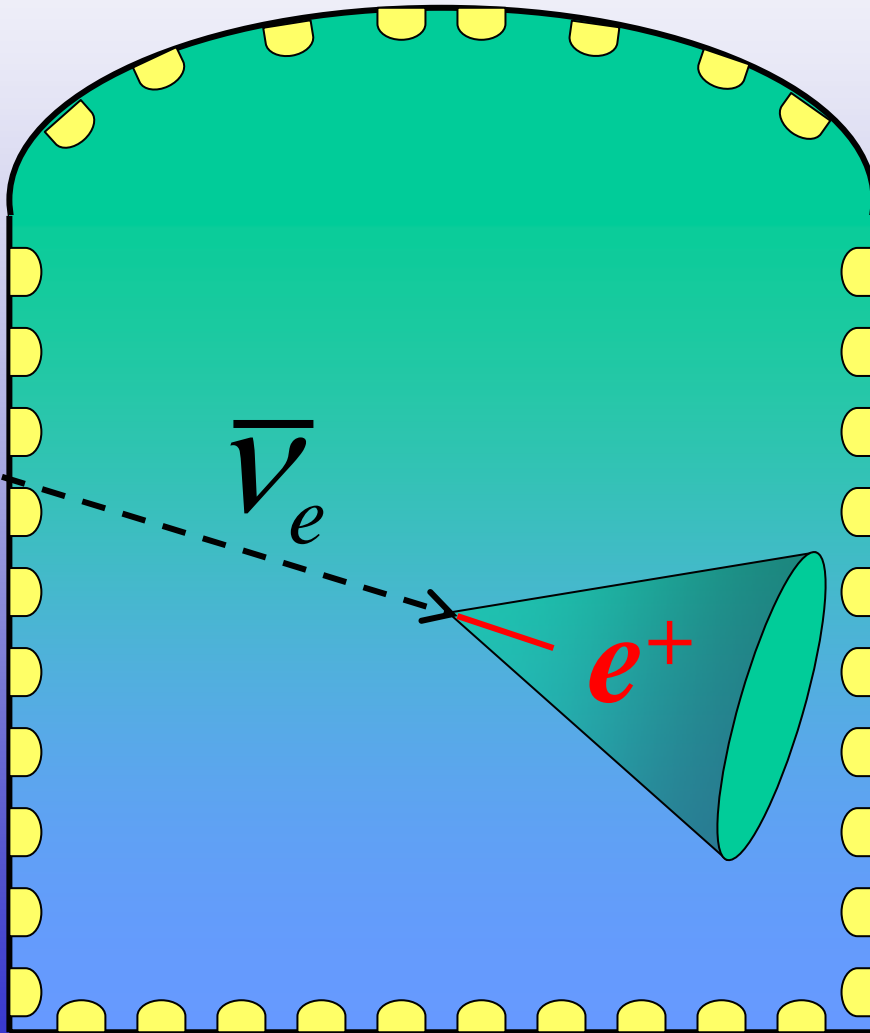
~ 160 000 Jahre



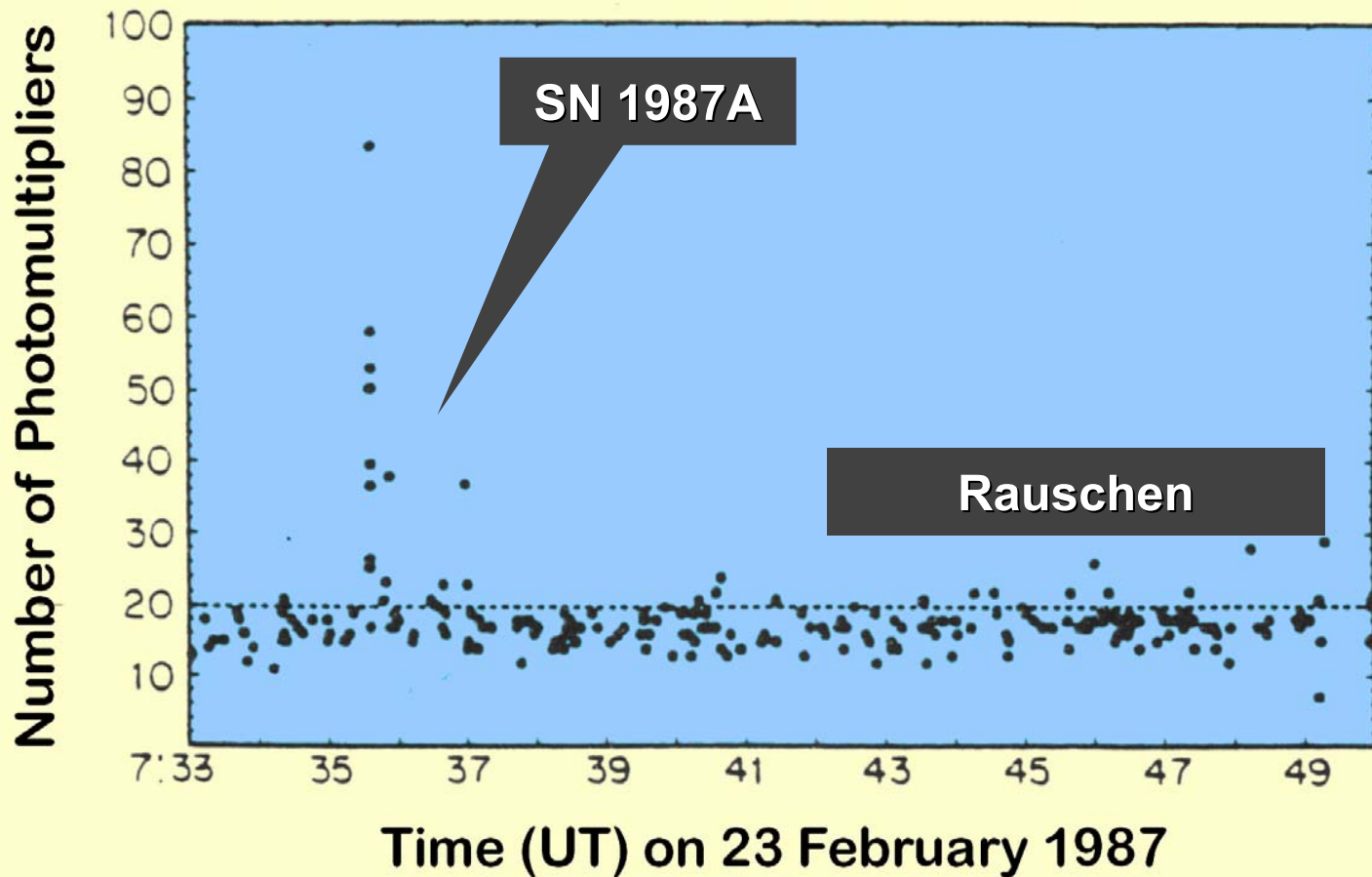
Super-Kamiokande

Japan

Neutrinos in Kamiokande

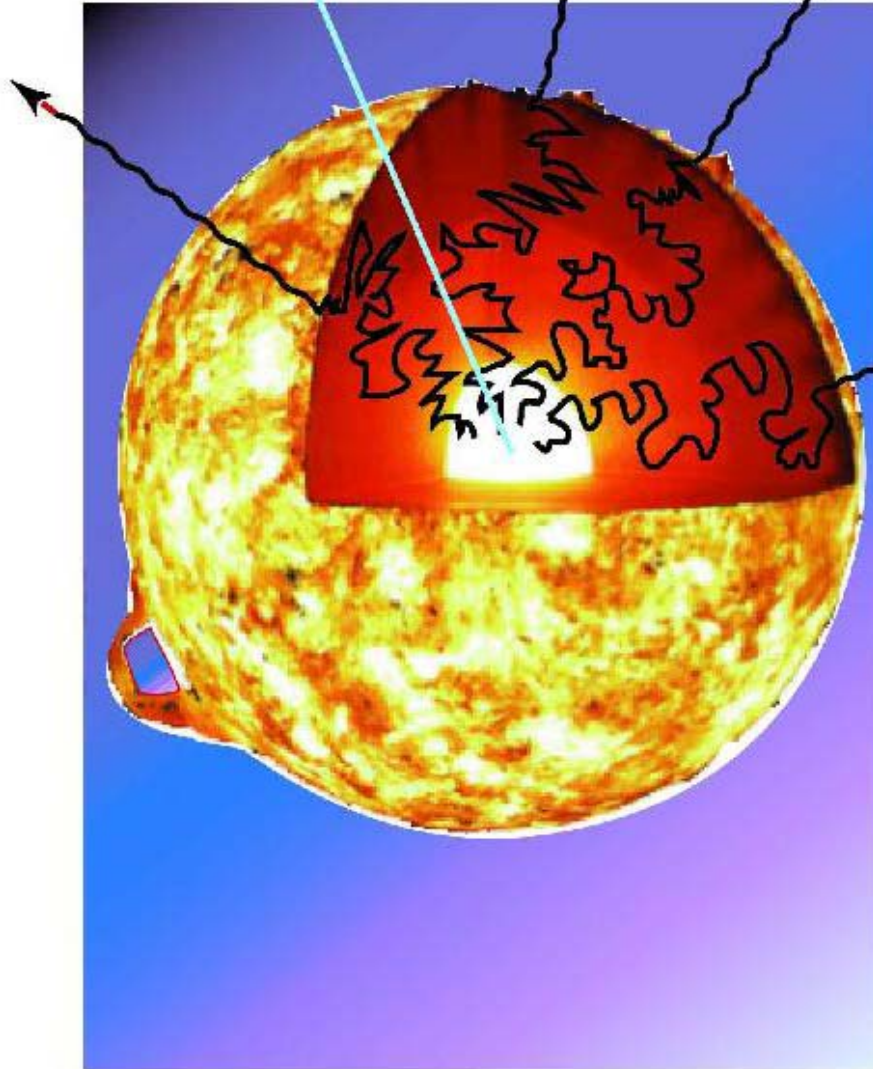


Neutrino-Signal von SN-1987A in Kamiokande



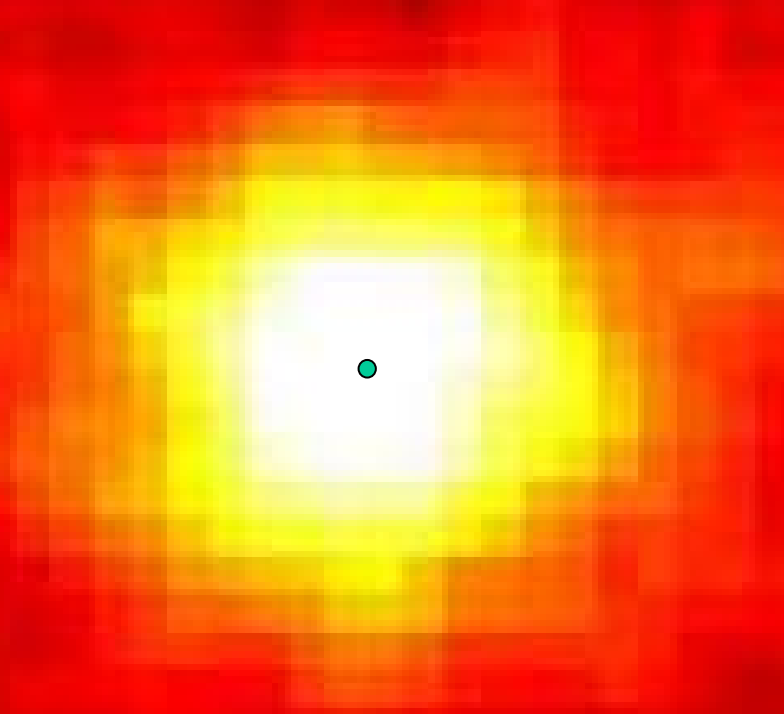
Neutrinos

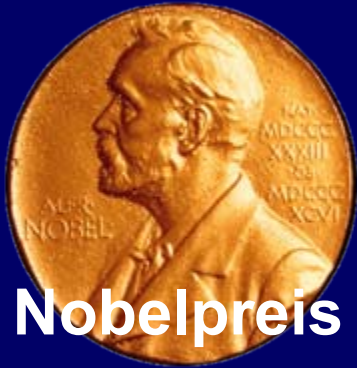
Neutrinos von der Sonne



Photonen

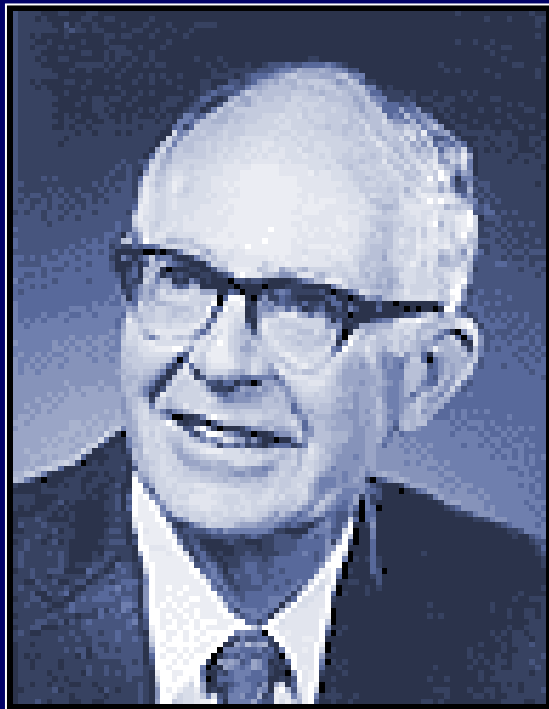
Die Sonne in Neutrinos





Nobelpreis 2002

.. für Öffnung des Neutrino-Fensters
zum Universum



Raymond Davis jr.



Masatoshi Koshiba

Neutrino-Astronomie bei hohen Energien

Myonen können in Wasser
oder Eis kilometerweit fliegen ...

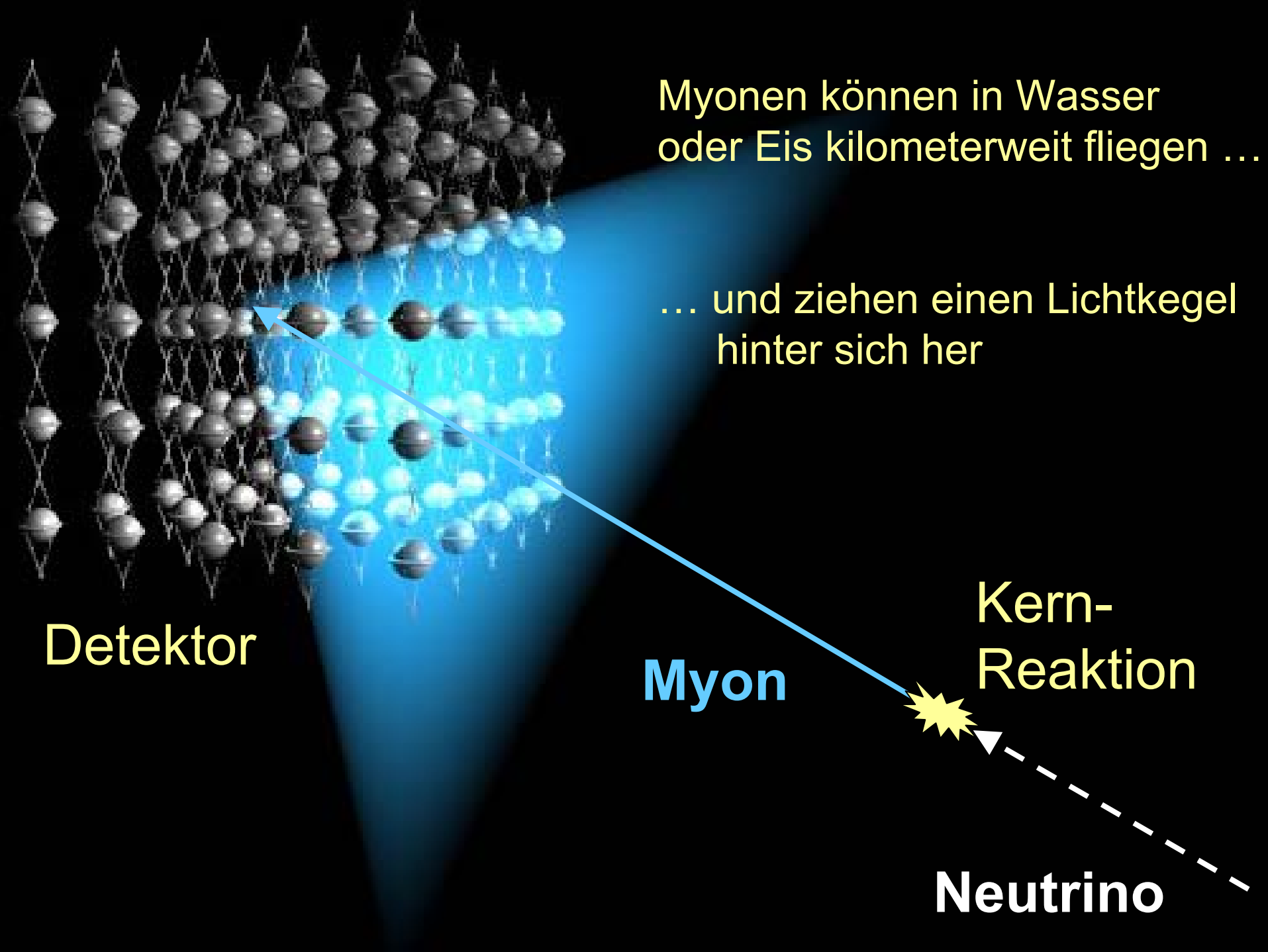
... und ziehen einen Lichtkegel
hinter sich her

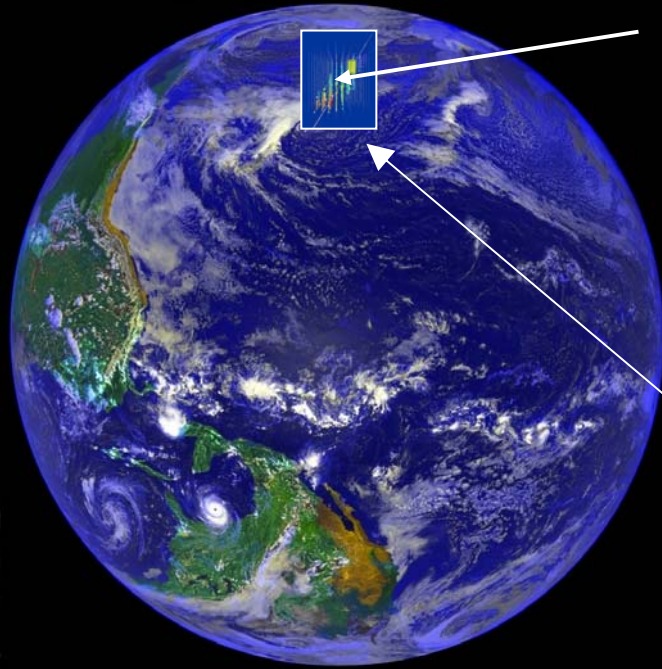
Detektor

Myon

Kern-
Reaktion

Neutrino





**Neutrino
Teleskop**
tief in Wasser oder Eis

ν

Nur Neutrinos können die Erde durchqueren.

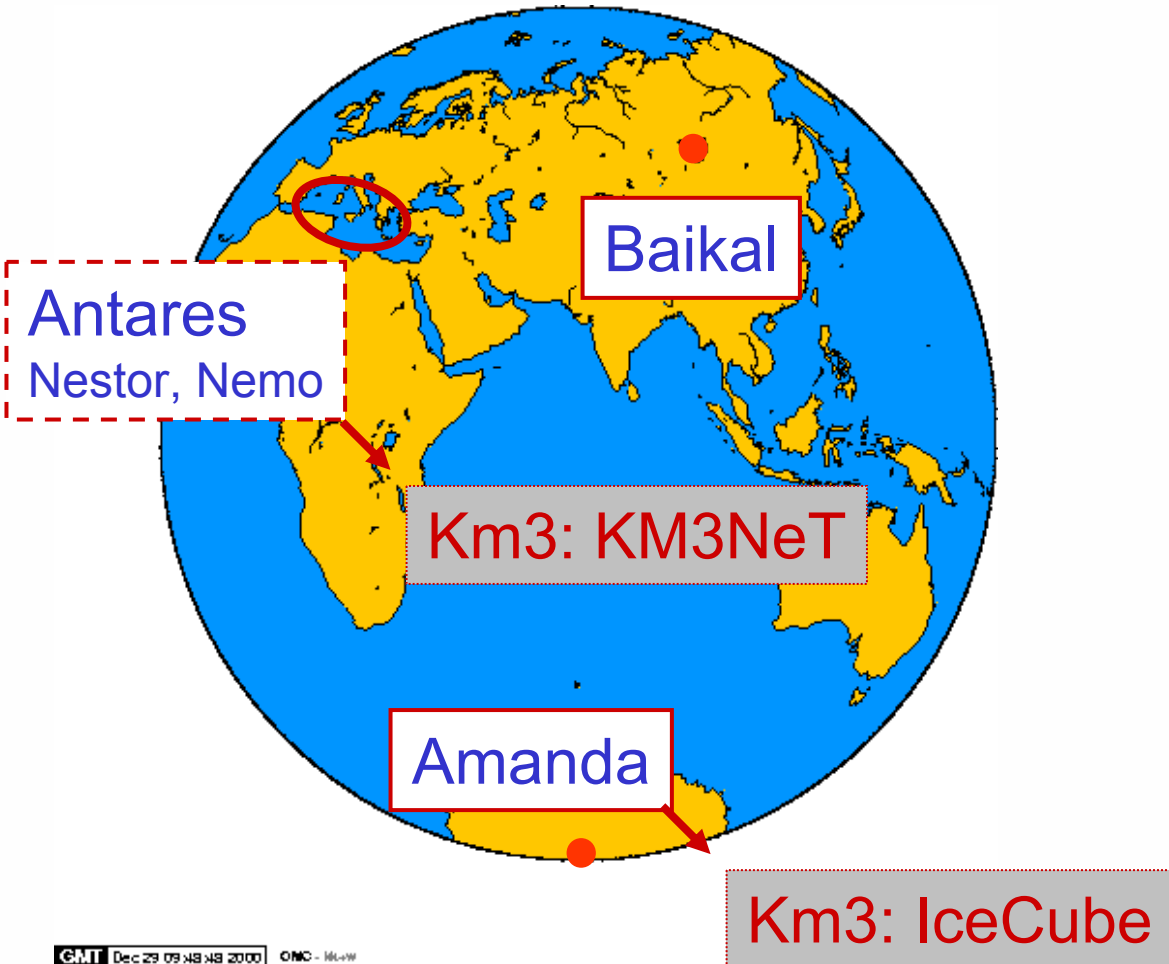
→ für klare Identifikation:

„Sieh“ nach unten !

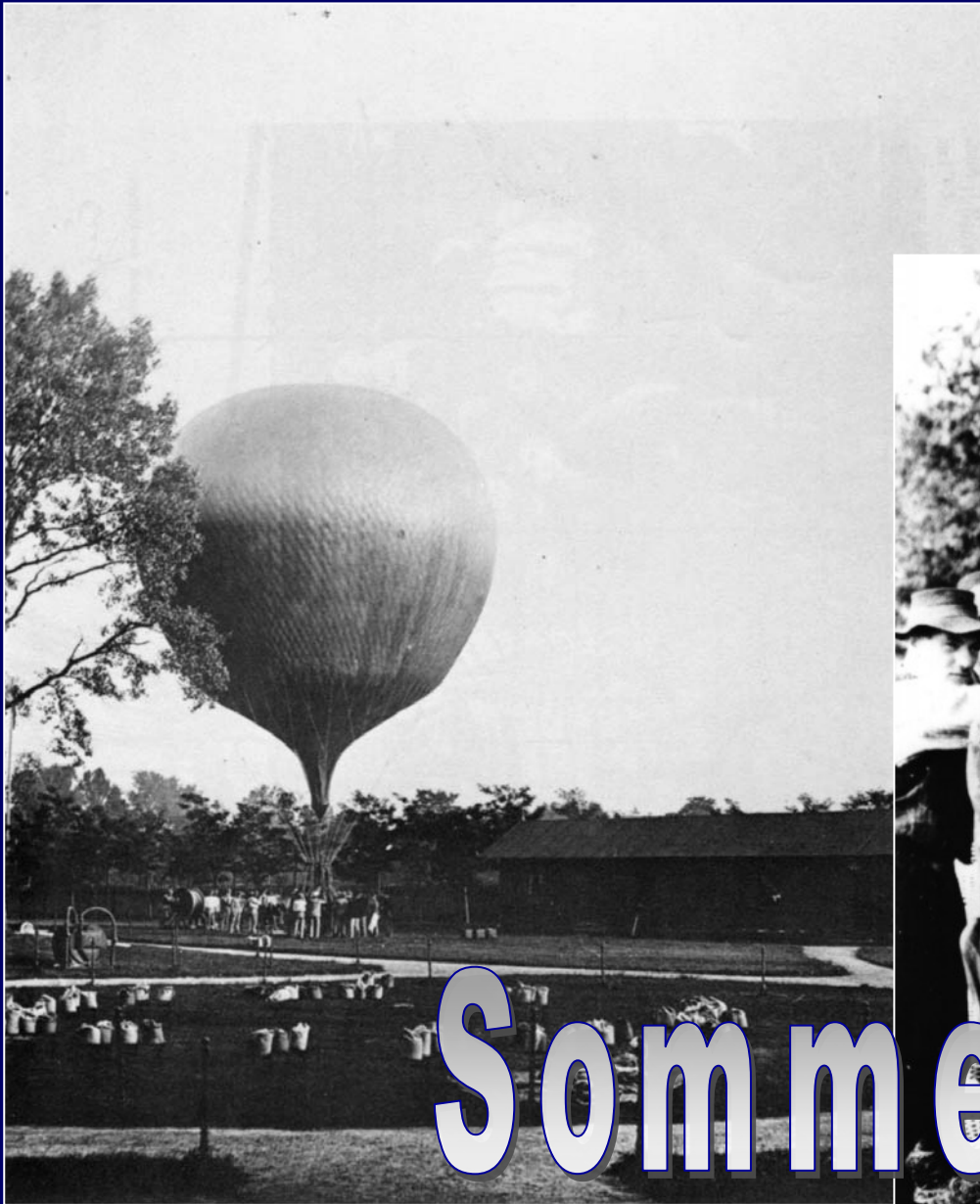
(und benutze die Erde als Filter)

**Aktive
Galaxie**





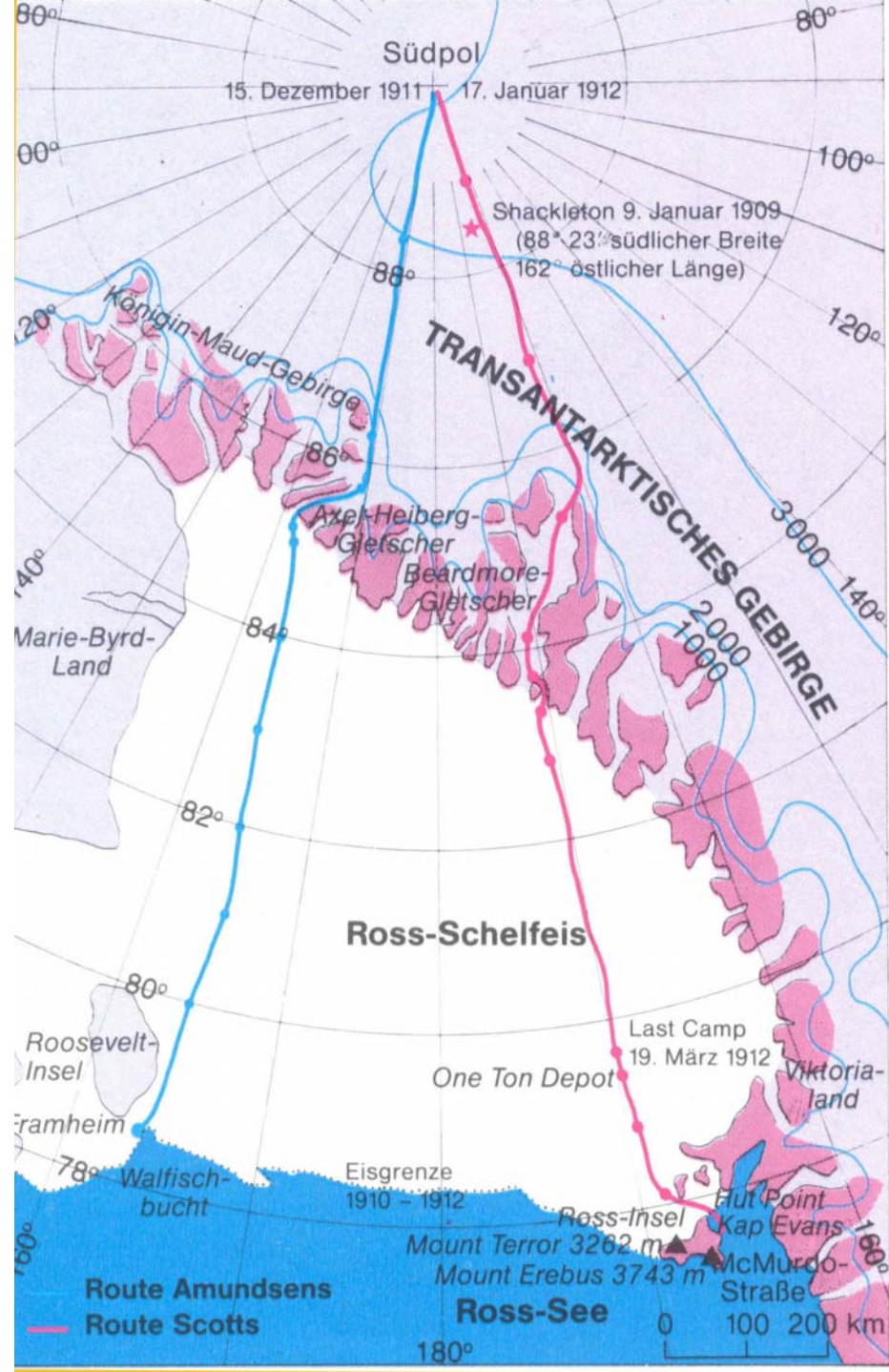
Victor Hess
1912



Sommer 1912

17. 1. 1912
Südpol

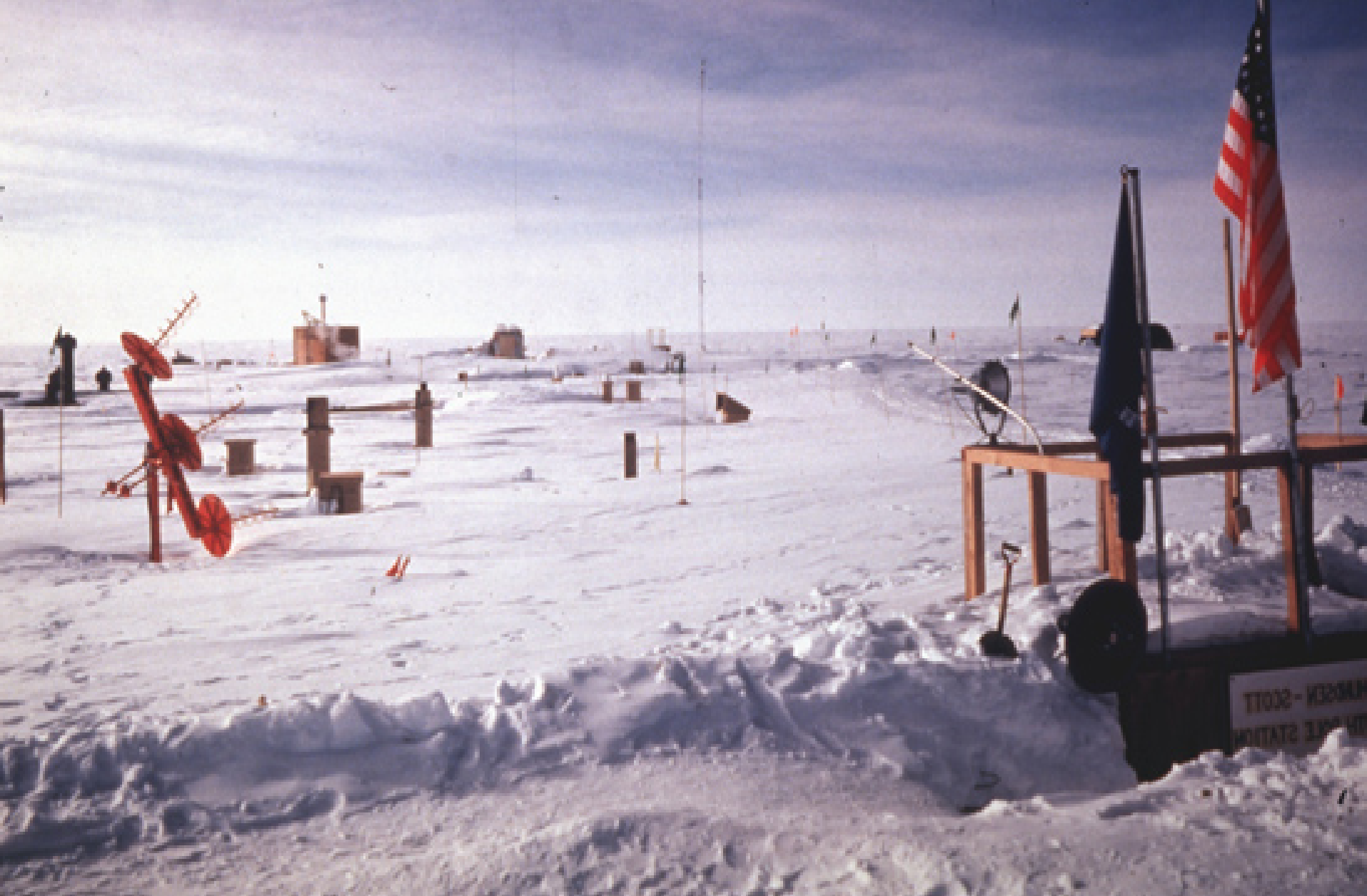




31. Oktober 1956: Die Que Sera Sera landet am Südpol



Februar 1957: Die erste Südpolstation

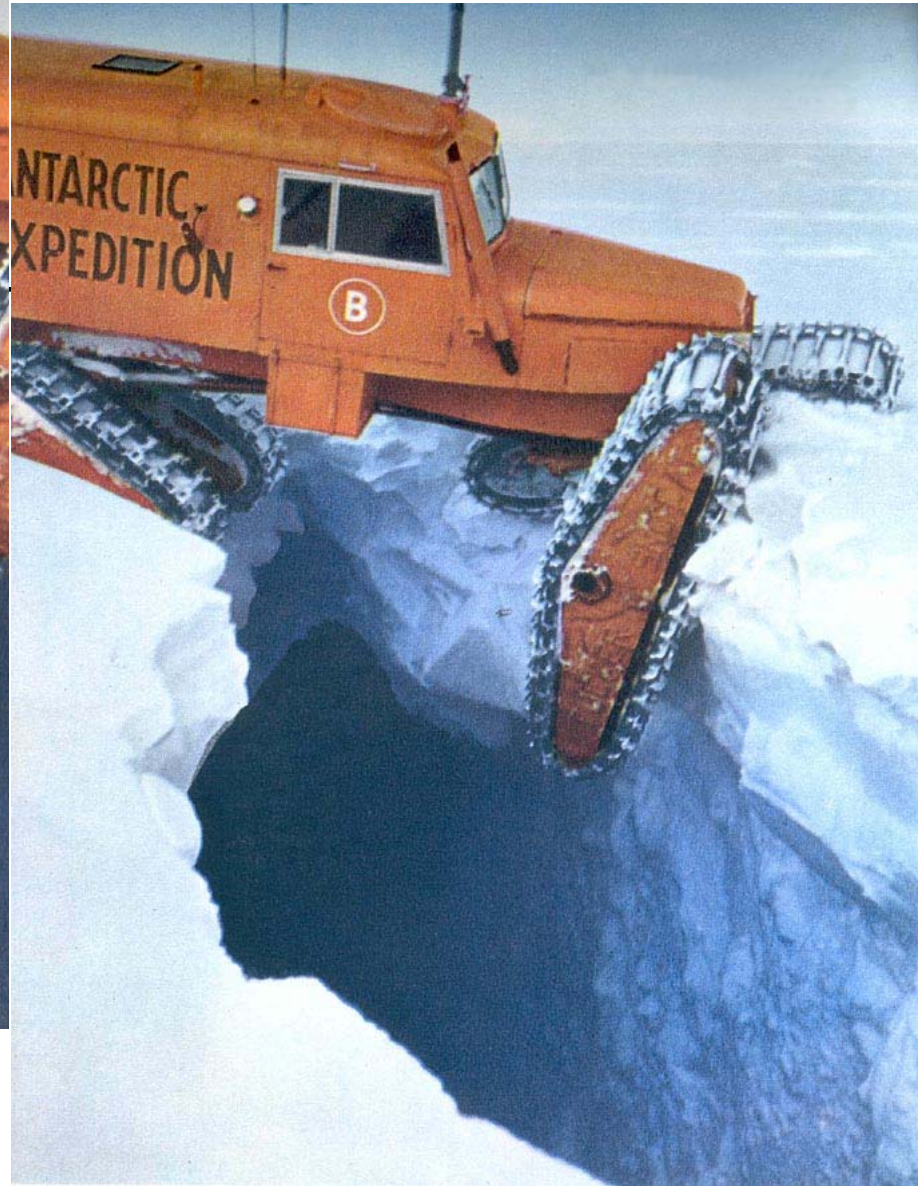
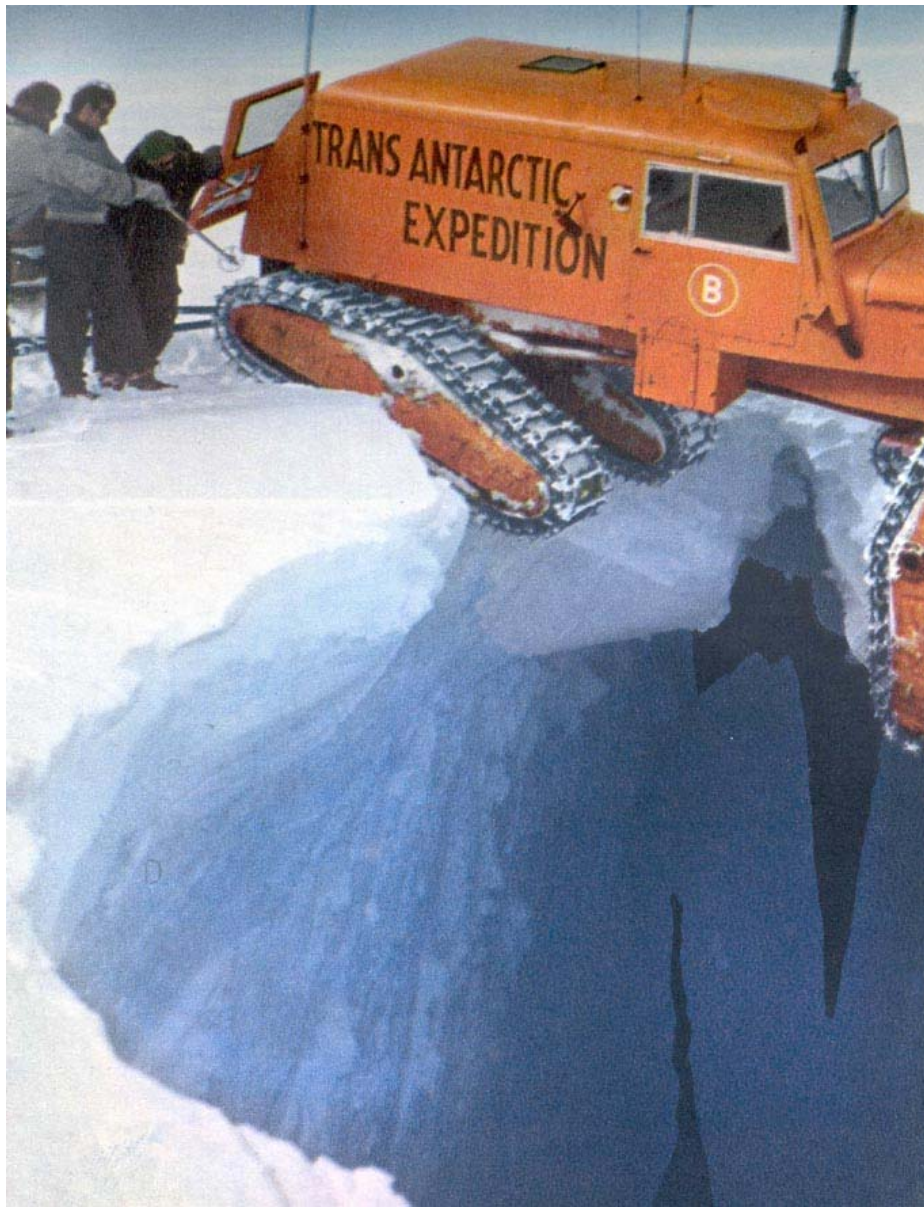




**Antarktis-Durchquerung
1957/58**

Edmund Hillary

Vivian Fuchs





1967 – 74: Eine neue Südpolstation

Design-Kriterien:

15- 20 Jahre Betriebszeit

Maximale Besatzung: 33 (Männer)



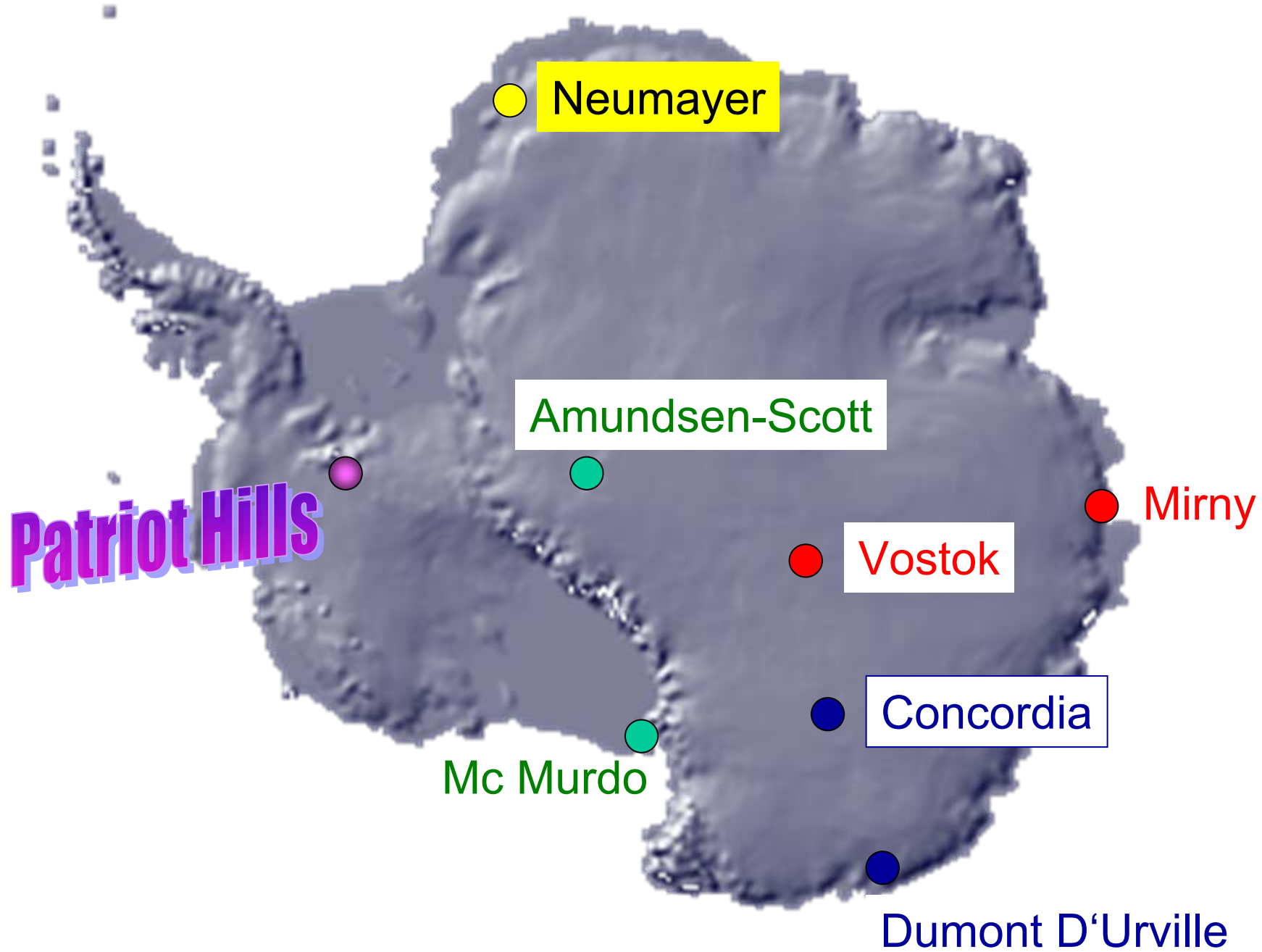




PHOTO BY CHARLIE KAMINSKI

SOUTH POLE DEC 2, 2000















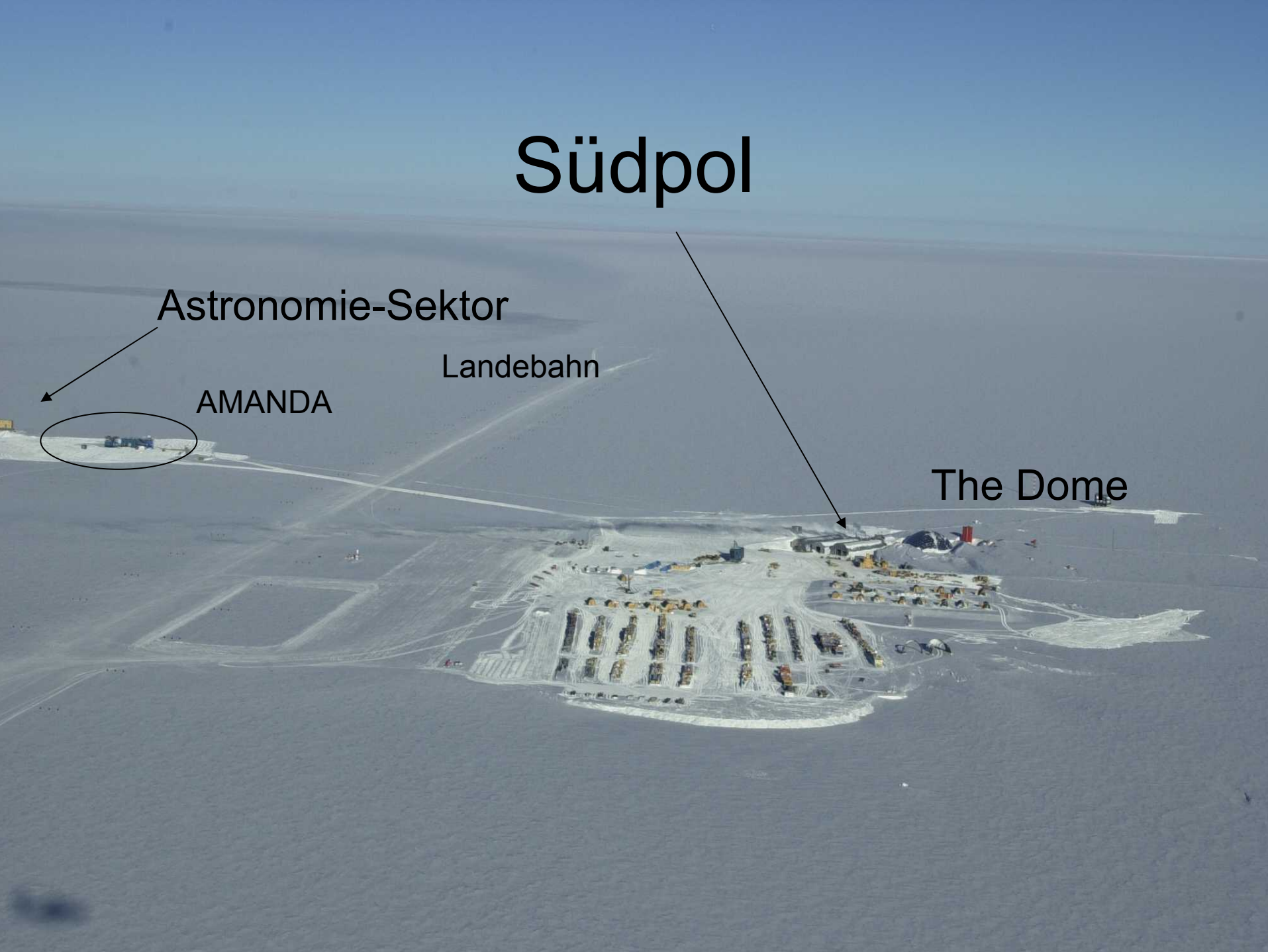
Südpol

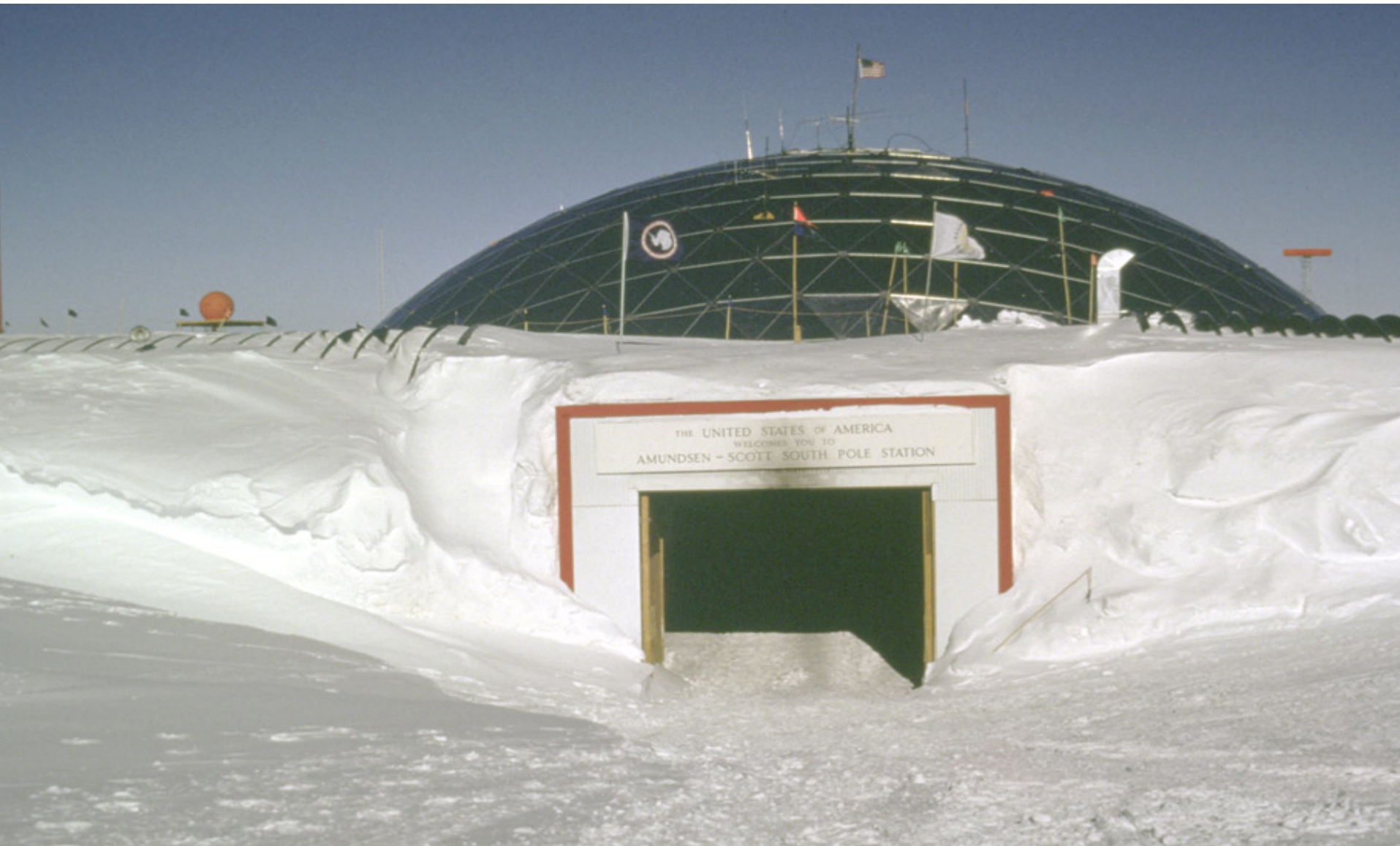
Astronomie-Sektor

Landebahn

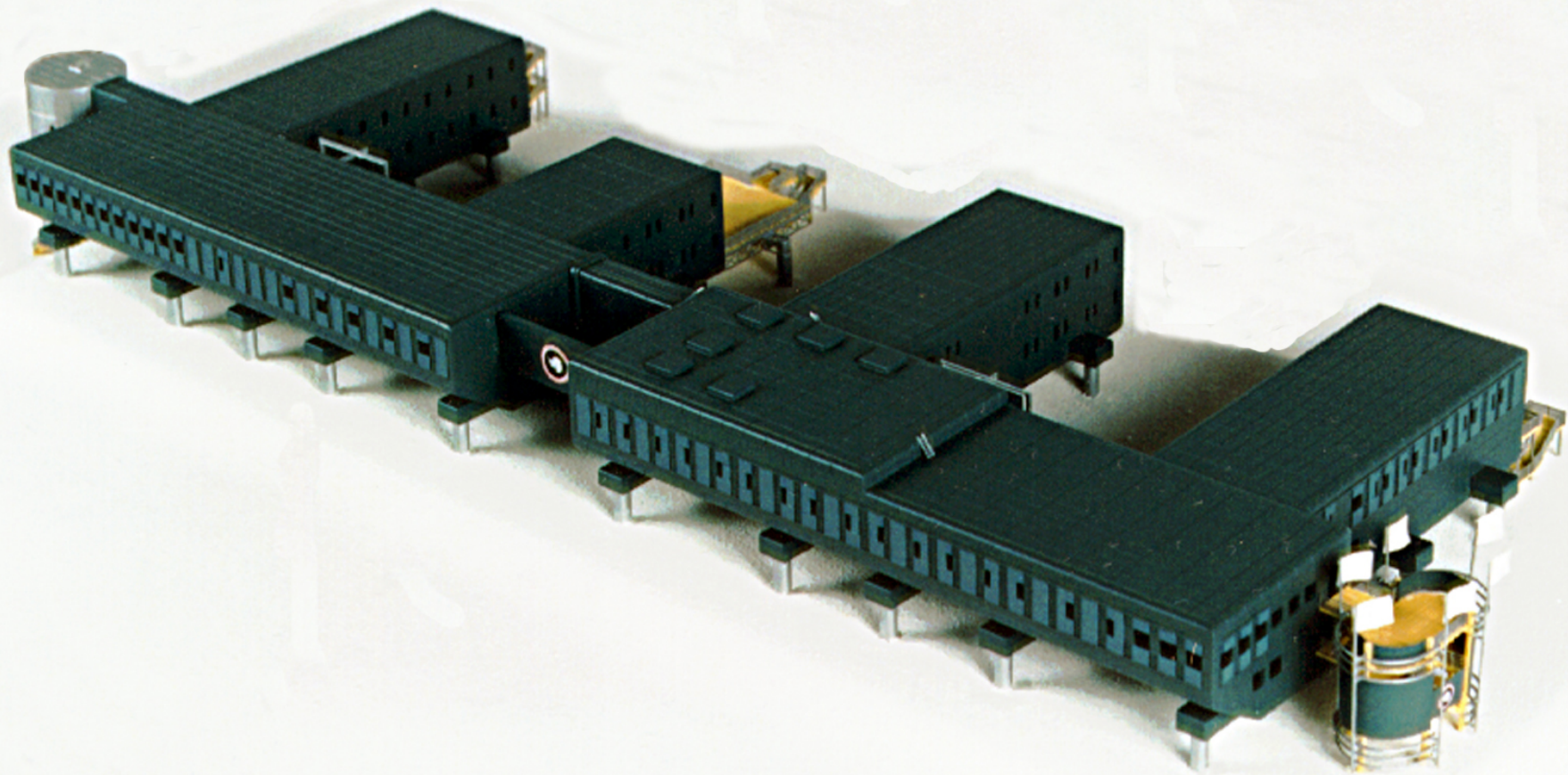
AMANDA

The Dome





THE UNITED STATES OF AMERICA
WELCOMES YOU TO
AMUNDSEN - SCOTT SOUTH POLE STATION

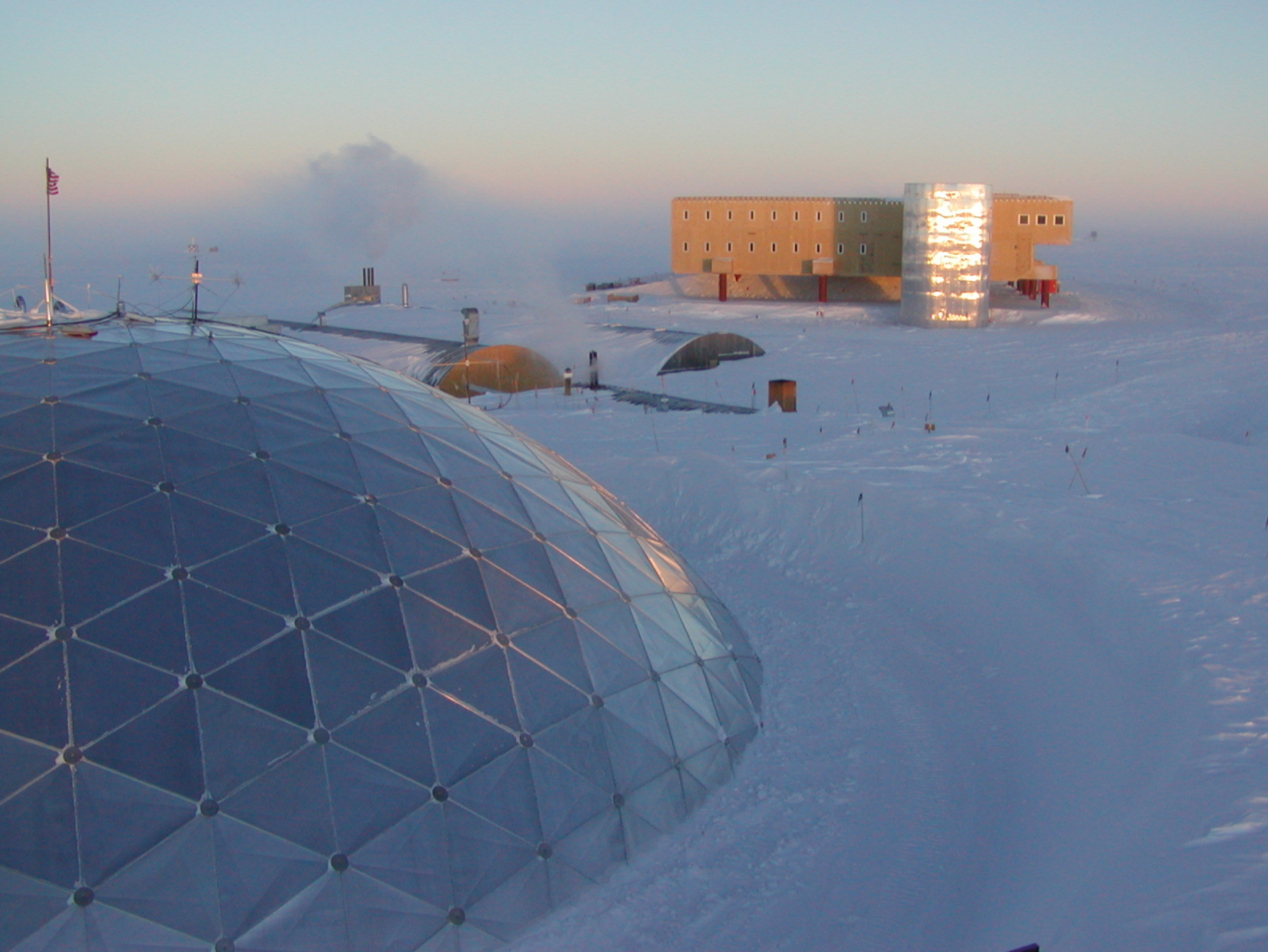


Februar 2000











DANGER





Dezember 2005





GEOGRAPHIC SOUTH POLE



ROALD AMUNDSEN

ROBERT F. SCOTT

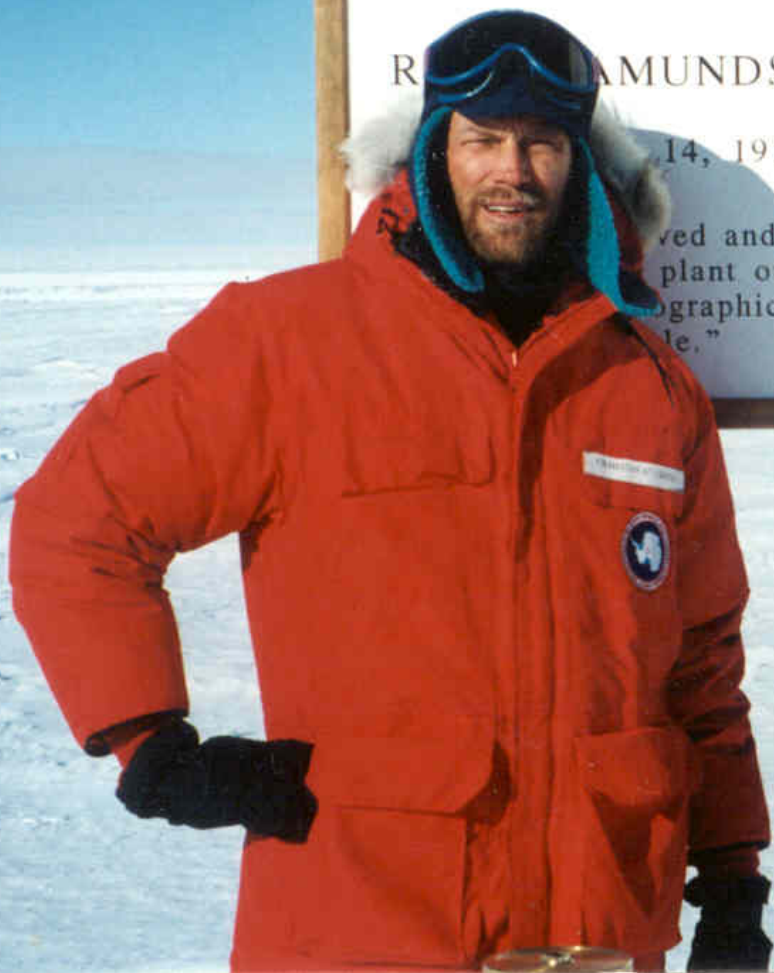
NOVEMBER 14, 1911

JANUARY 17, 1912

...ved and
plant our
ographical
le."

"The Pole. Yes, but
under very different
circumstances from
those expected."

ELEVATION 9,301 FT.













Die Abenteurer

2800 km
92 Tage

13.Nov.89

Messner und Fuchs

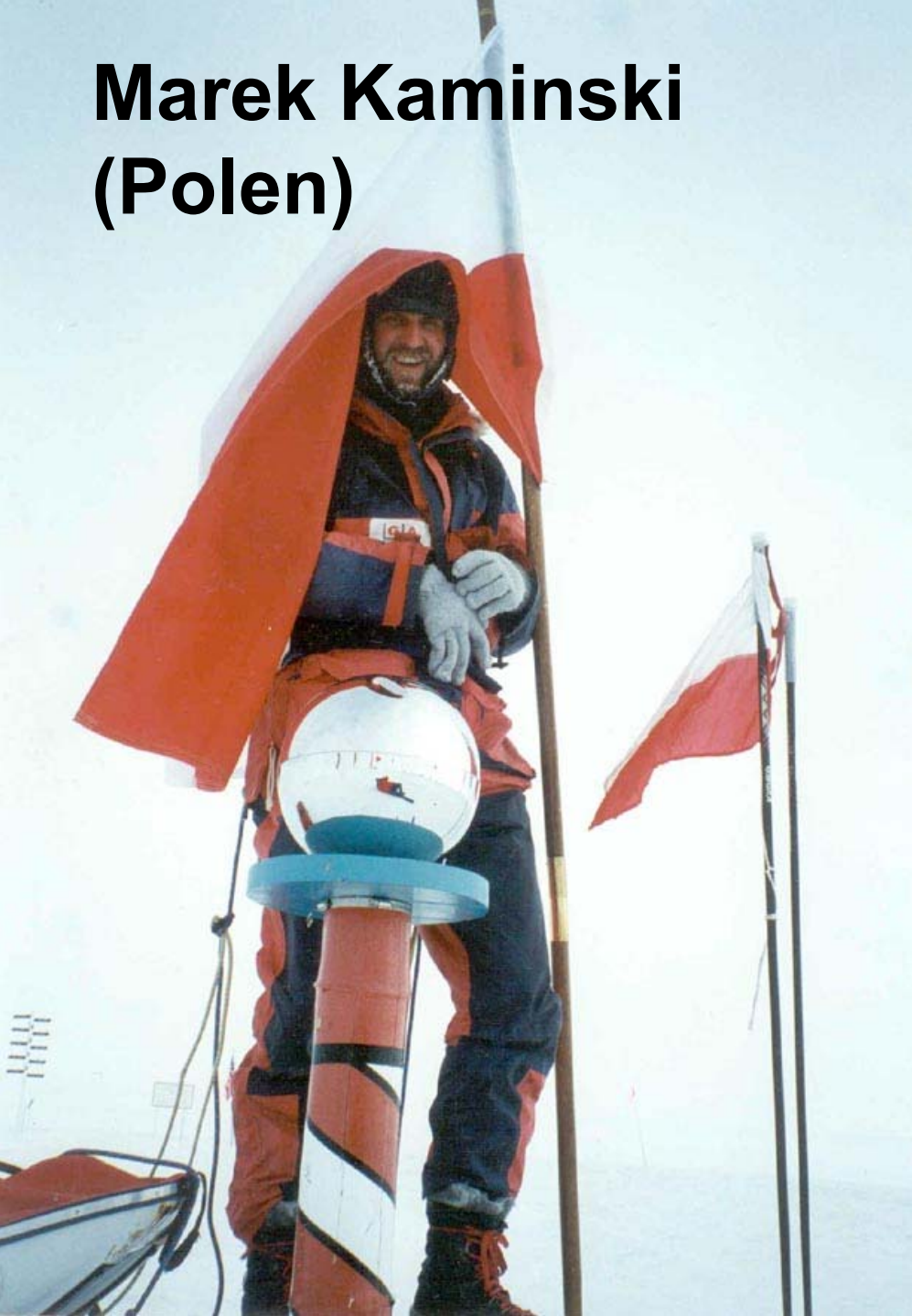


Versuch einer Durchquerung
- allein
- ohne Unterstützung
- volle Länge

Borge Ousland
(Norwegen)
1995/96



Marek Kamiński (Polen)

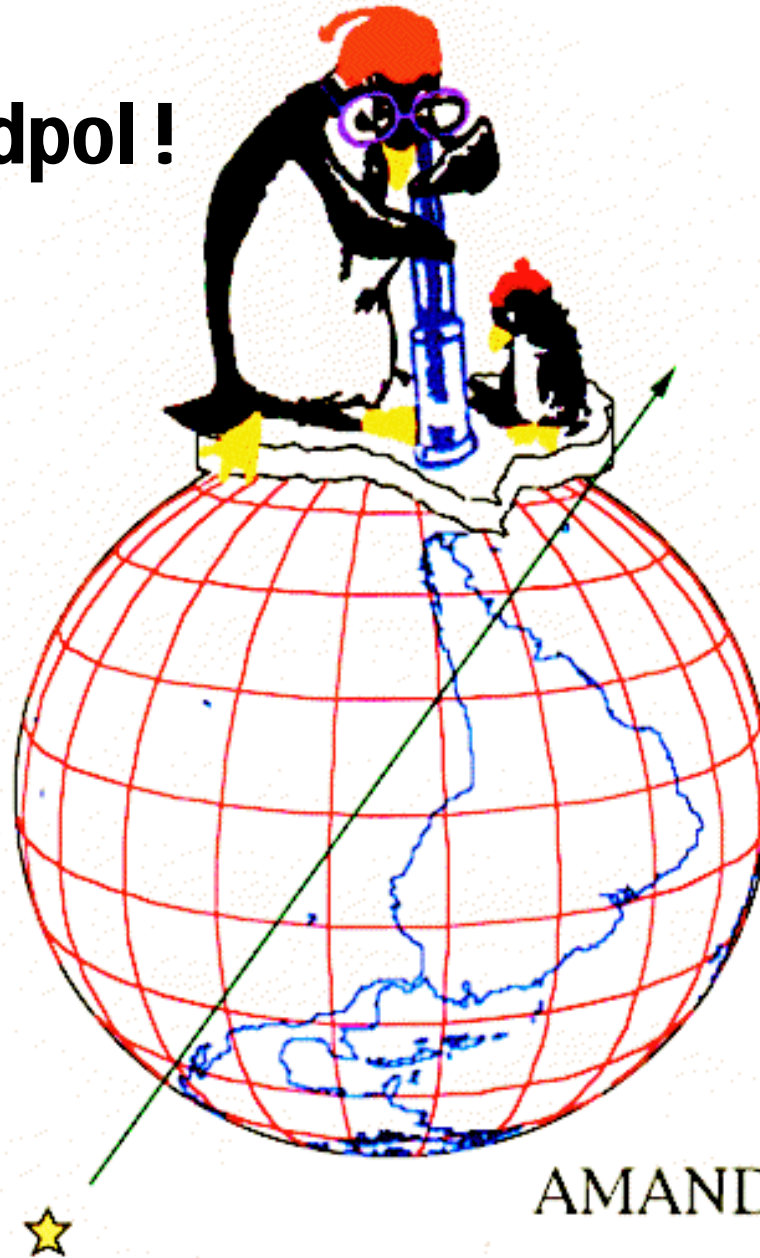


Marek Kaminski

Borge Ousland



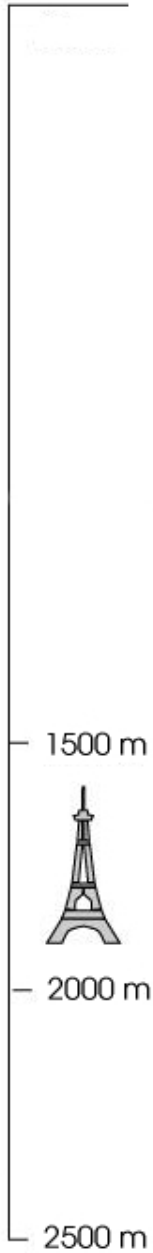
**Und nun:
Neutrinos am Südpol !**



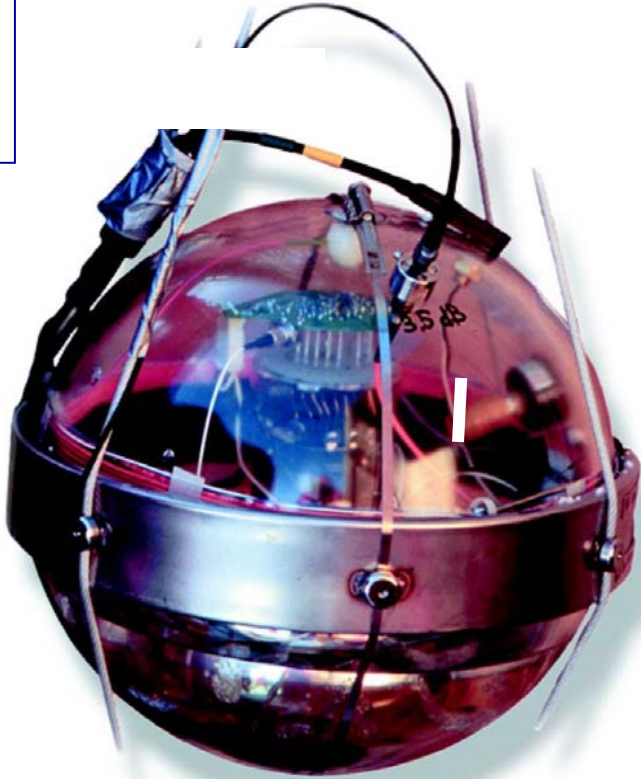
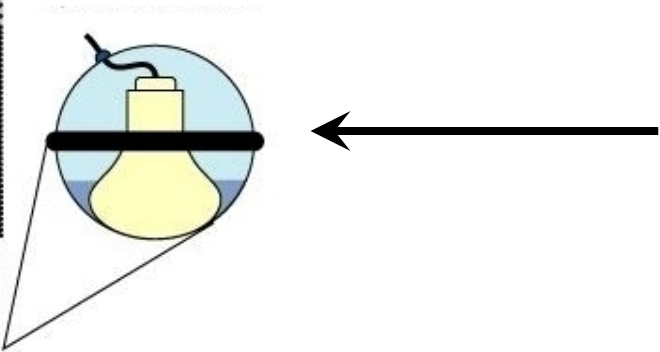
AMANDA und IceCube

AMANDA

Depth



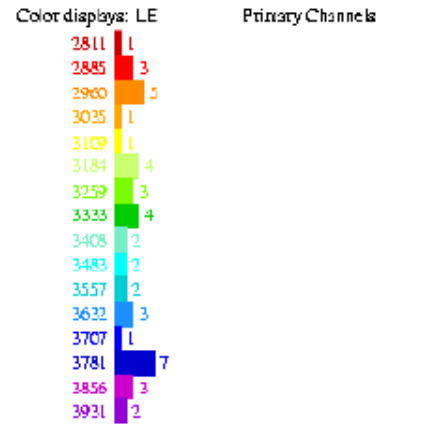
677 optische Module
an 19 Trossen



Installation
1996-2000



Neutrino-reaktion in AMANDA

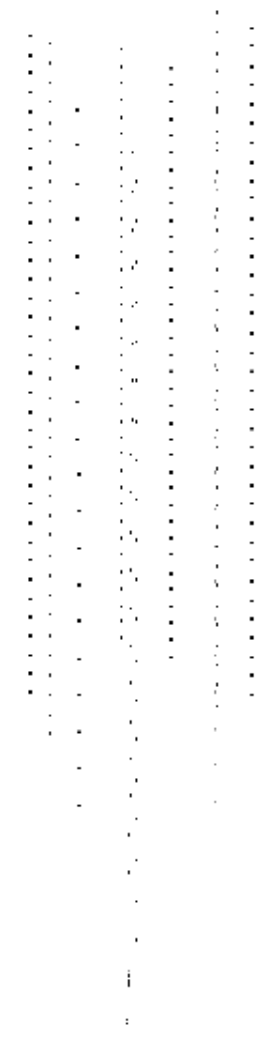


Primary Channels



No external geometry file is opened.
 Detector: amanda-b-10, 10strings, 302 modules
 Data file: /home/itsboada/anim_events/strict19.f2k
 File contains 19 events.
 Displaying data event 1197960 from run 0
 Recorded y/rdy: 1997/285
 18132.0091381 seconds past midnight.
 Before cuts: 44 hits, 44 OMs
 After cuts: 44 hits, 44 OMs
 Antineutrino

	x	y	z
Vertex pos :	12.4	-16.1	6.8 m
Direction :	0.03970	0.41614	0.90844
Length :	Inf m		
Energy :	? GeV		
Time :	3205.100000 ns		
Zenith :	155.3°		
Azimuth :	264.6°		



$\nu + \text{Kern}$

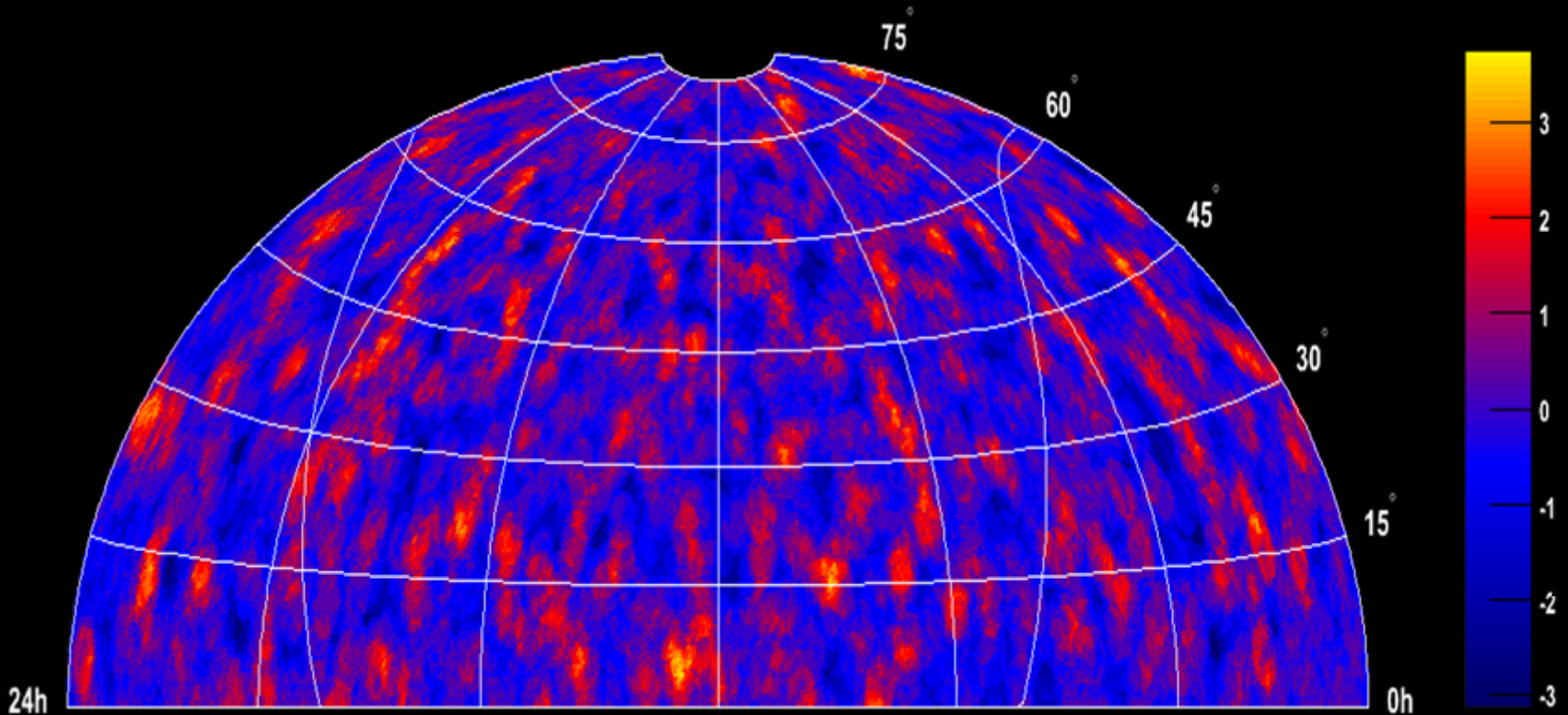
$\rightarrow \mu + \text{Kern}$





2000
das jahr der
physik

AMANDAs Himmelskarte

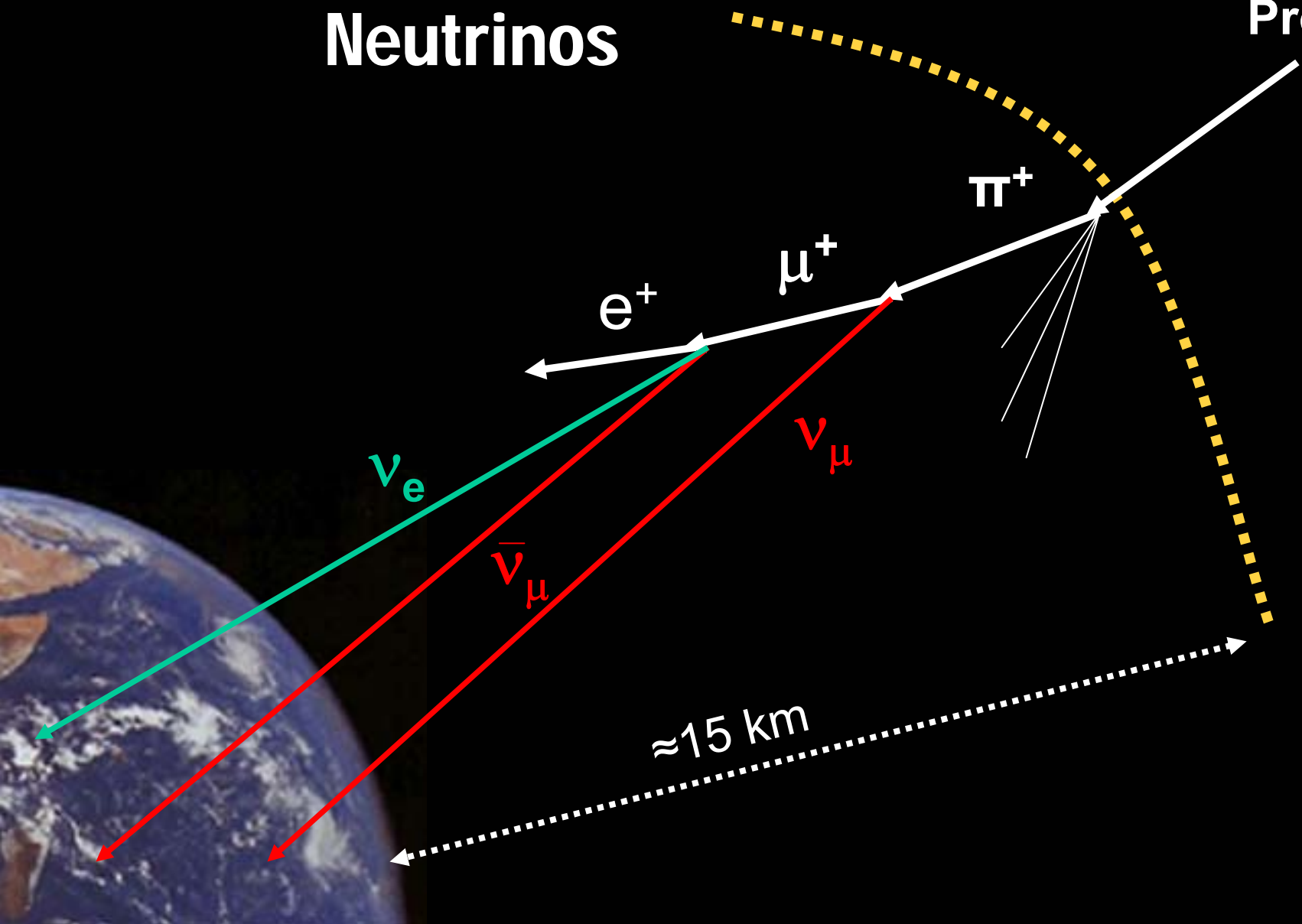


AMANDA-II: 2000-2004, 4282 ν von der nördlichen Hemisphäre

Kein signifikanter Überschuss aus irgendeiner Richtung

„Atmosphärische“ Neutrinos

kosmisches
Proton



π^+

e^+

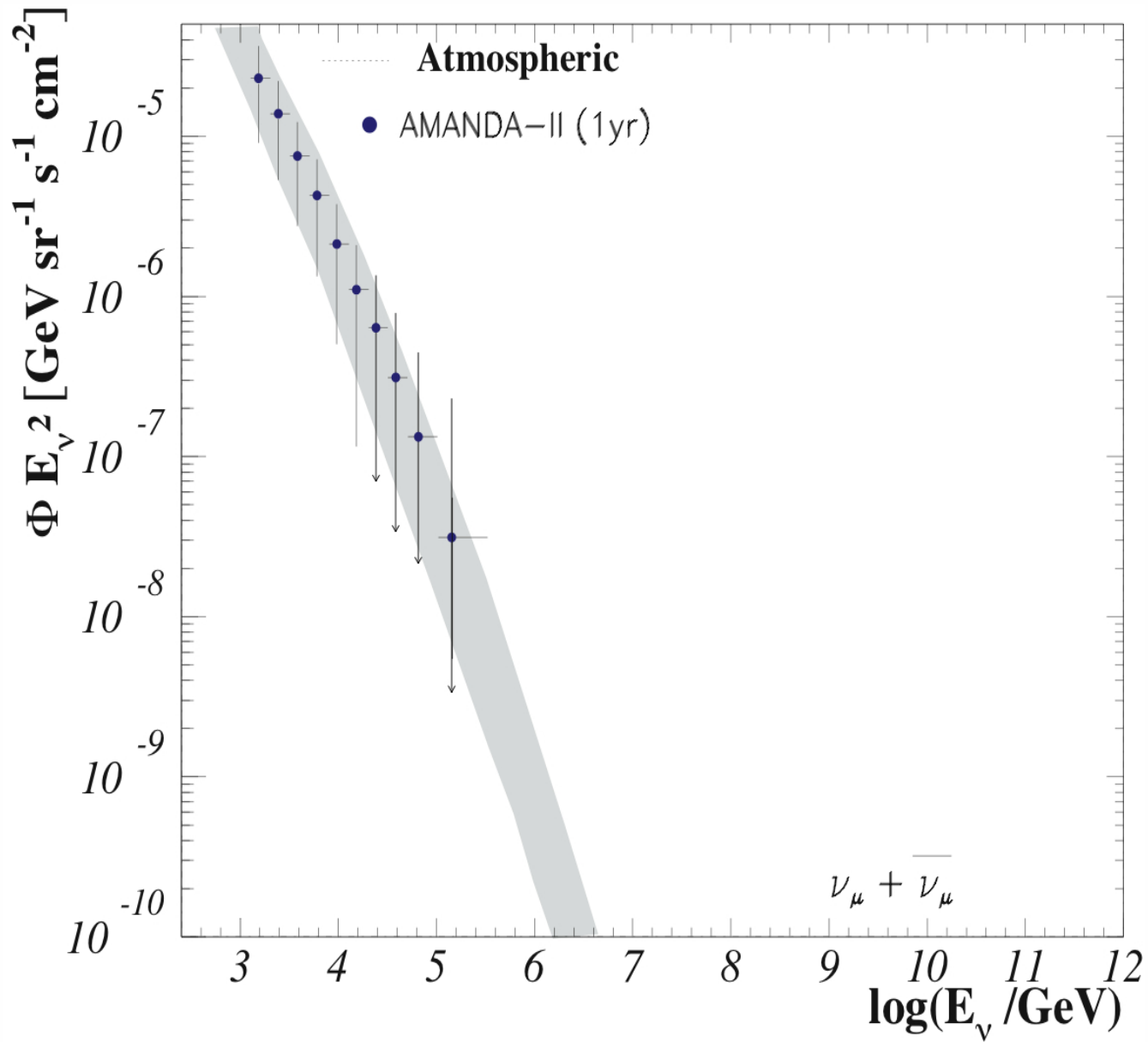
μ^+

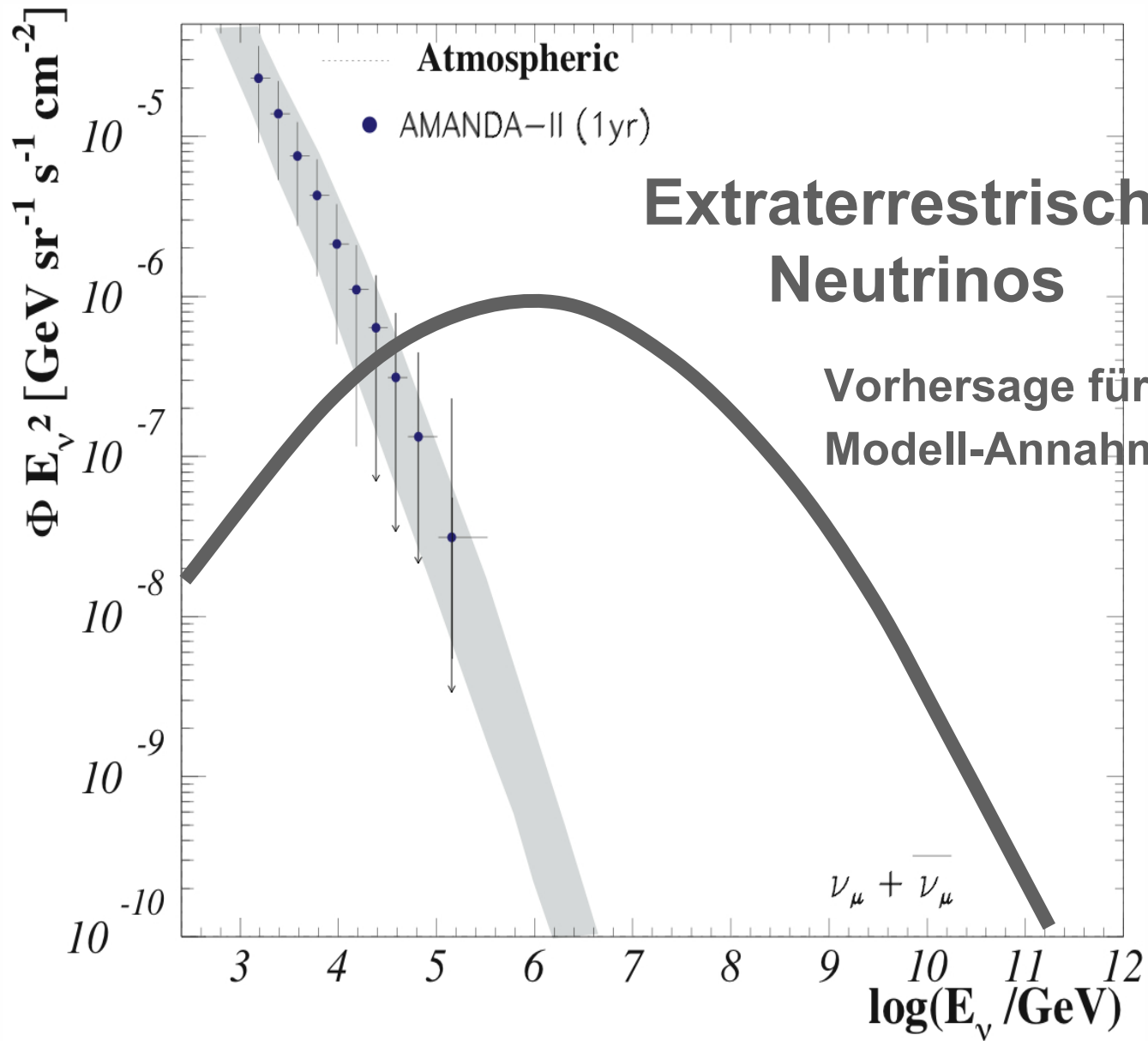
ν_e

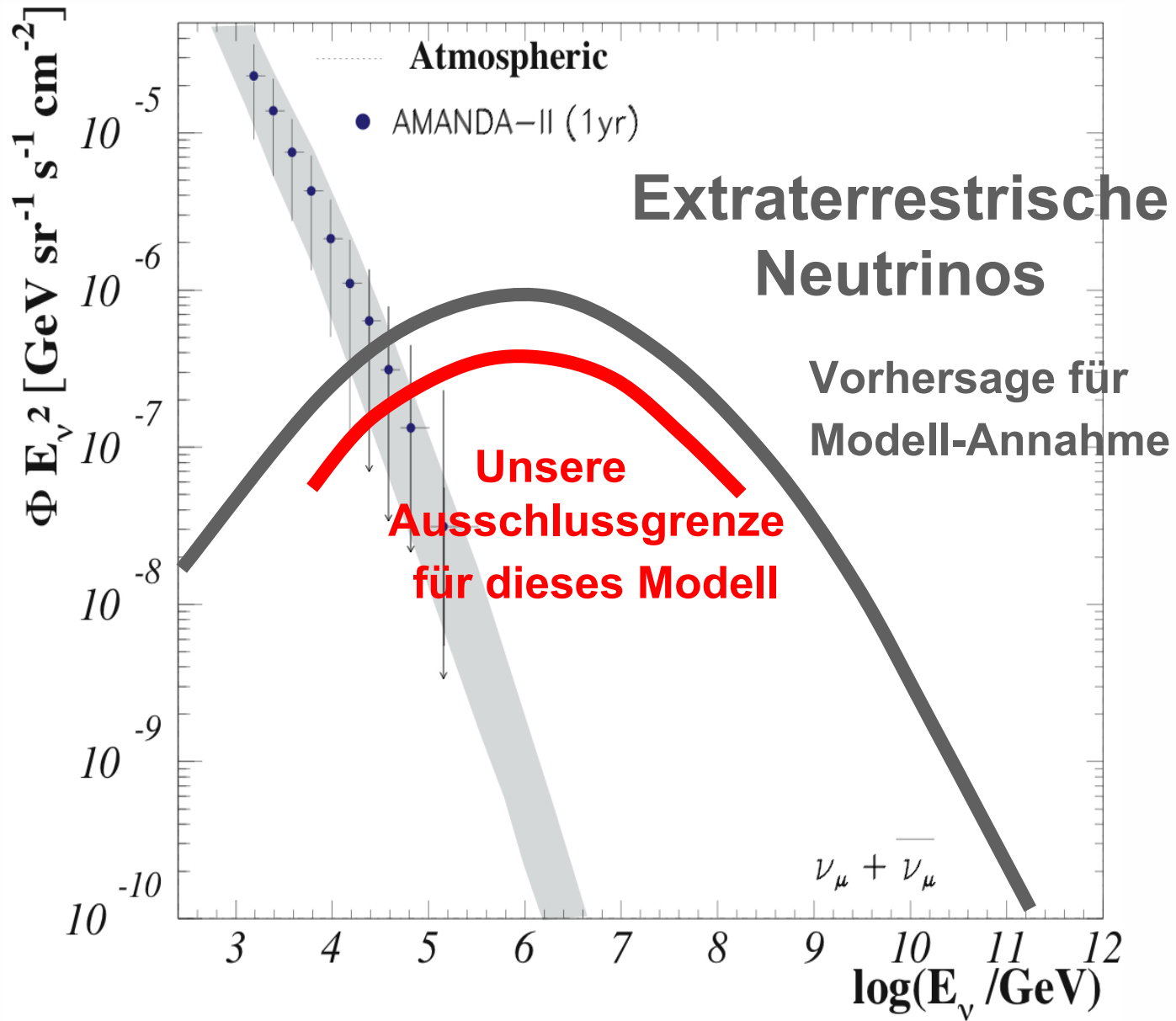
$\bar{\nu}_\mu$

ν_μ

≈ 15 km

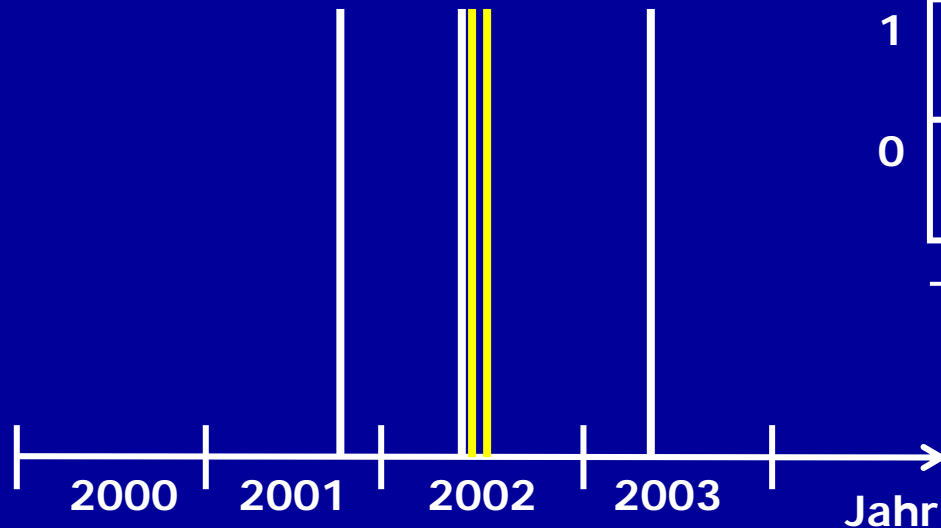




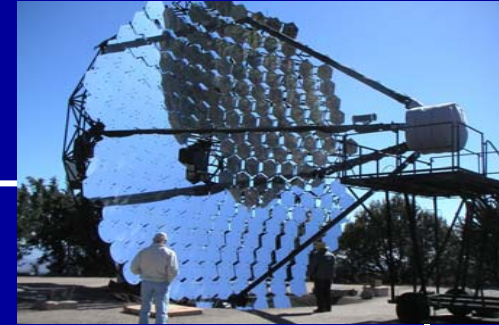
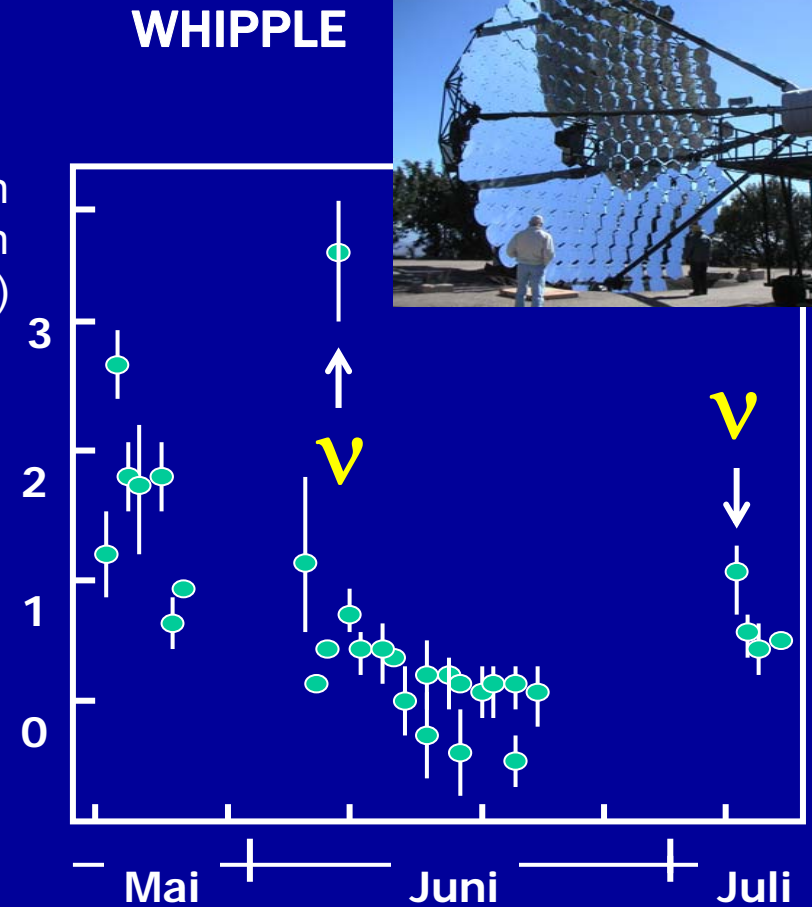


Zufall oder Entdeckung ?

Ankunftszeit von
Neutrinos aus der
Richtung der AGN
ES1959+650



Fluss von
TeV-Photonen
(willk. Einheiten)

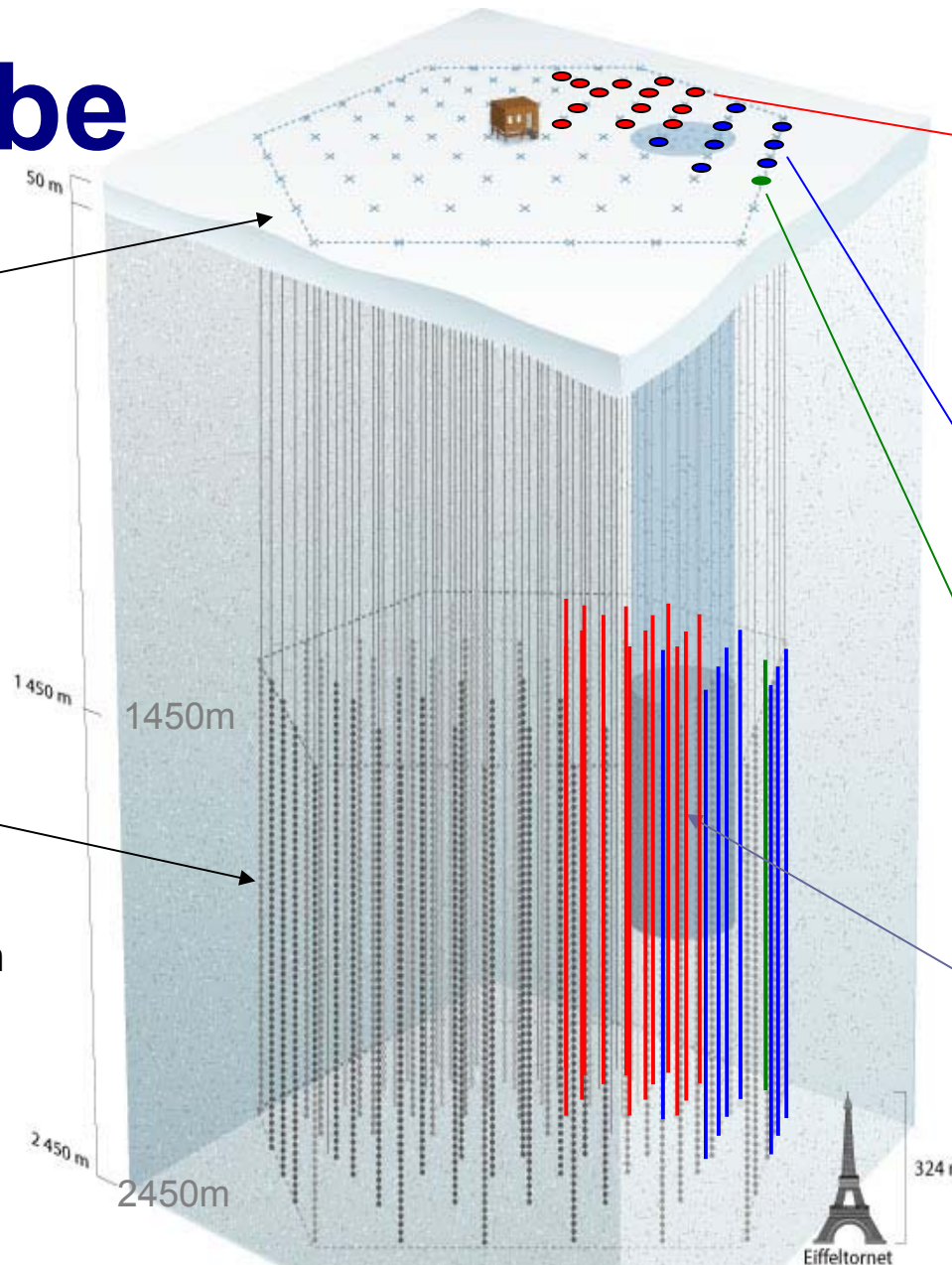


IceCube

IceTop

IceCube

80 strings of 60 optical modules each



2006-2007:
13 strings deployed

Current configuration
- 22 strings
- 52 surface tanks

2005-2006: 8 strings

2004-2005 : 1 string

AMANDA-II
19 strings
677 modules

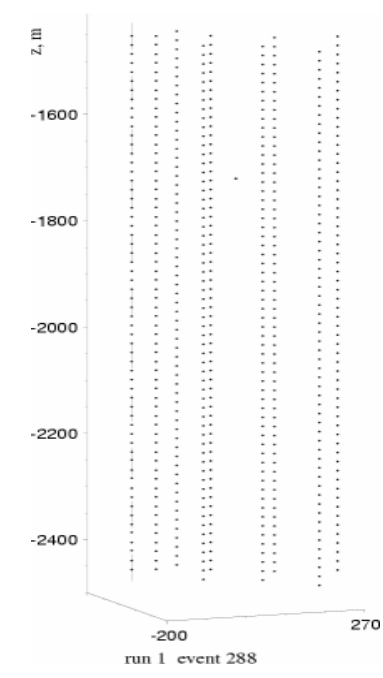
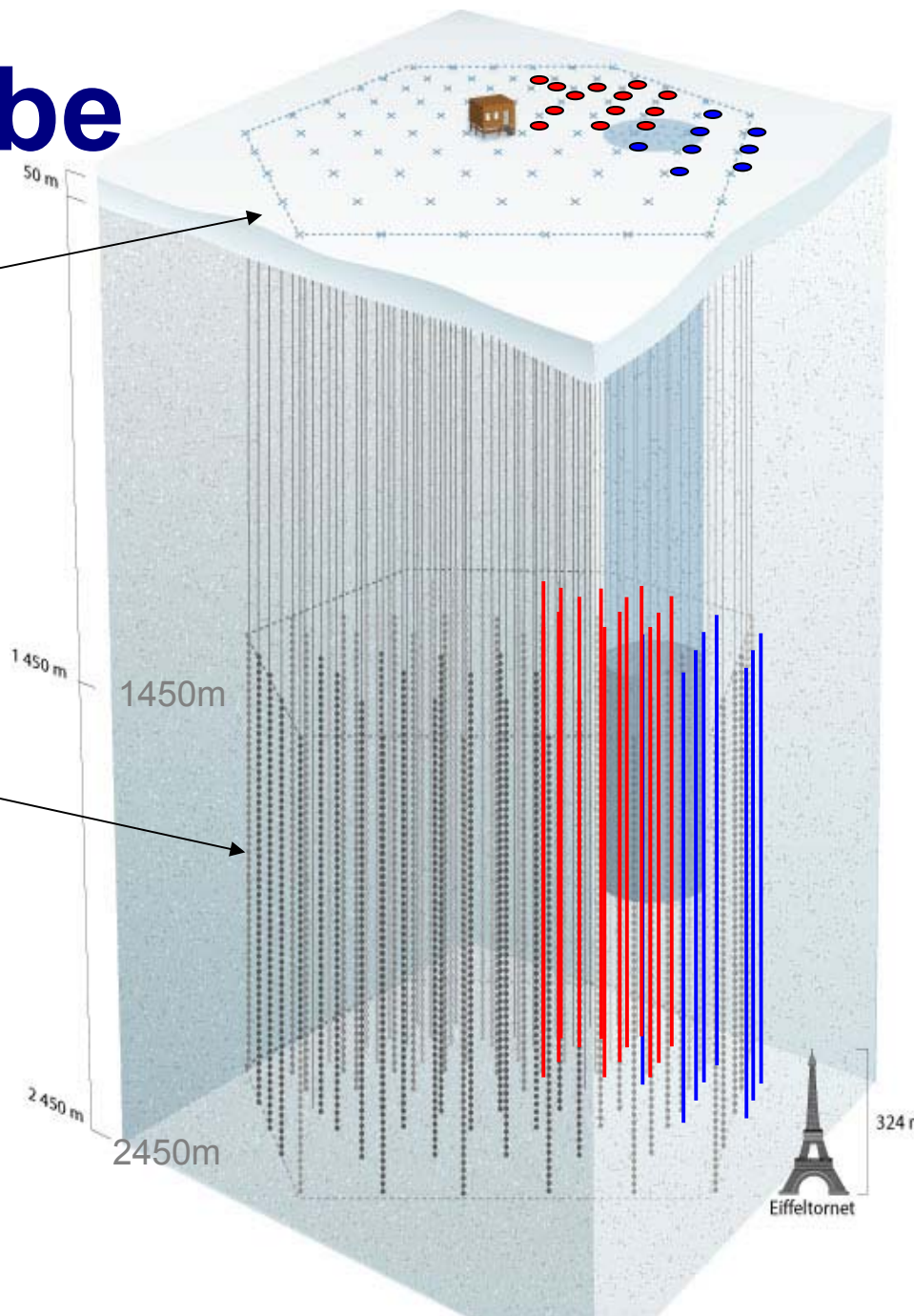
2007/08: add 14 to 18 strings and tank stations

Completion by 2011.

IceCube

IceTop

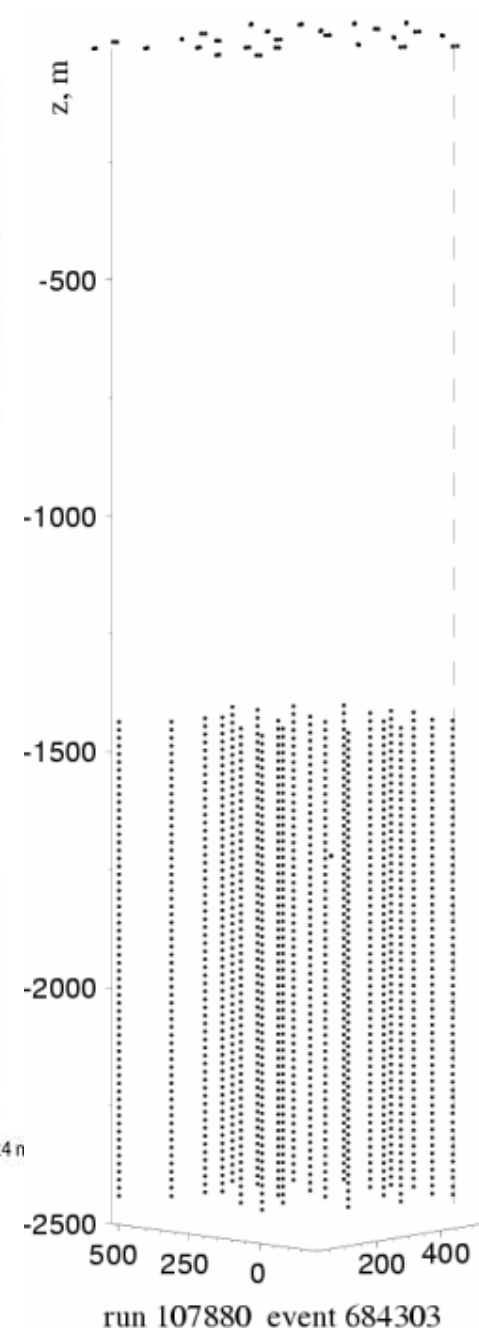
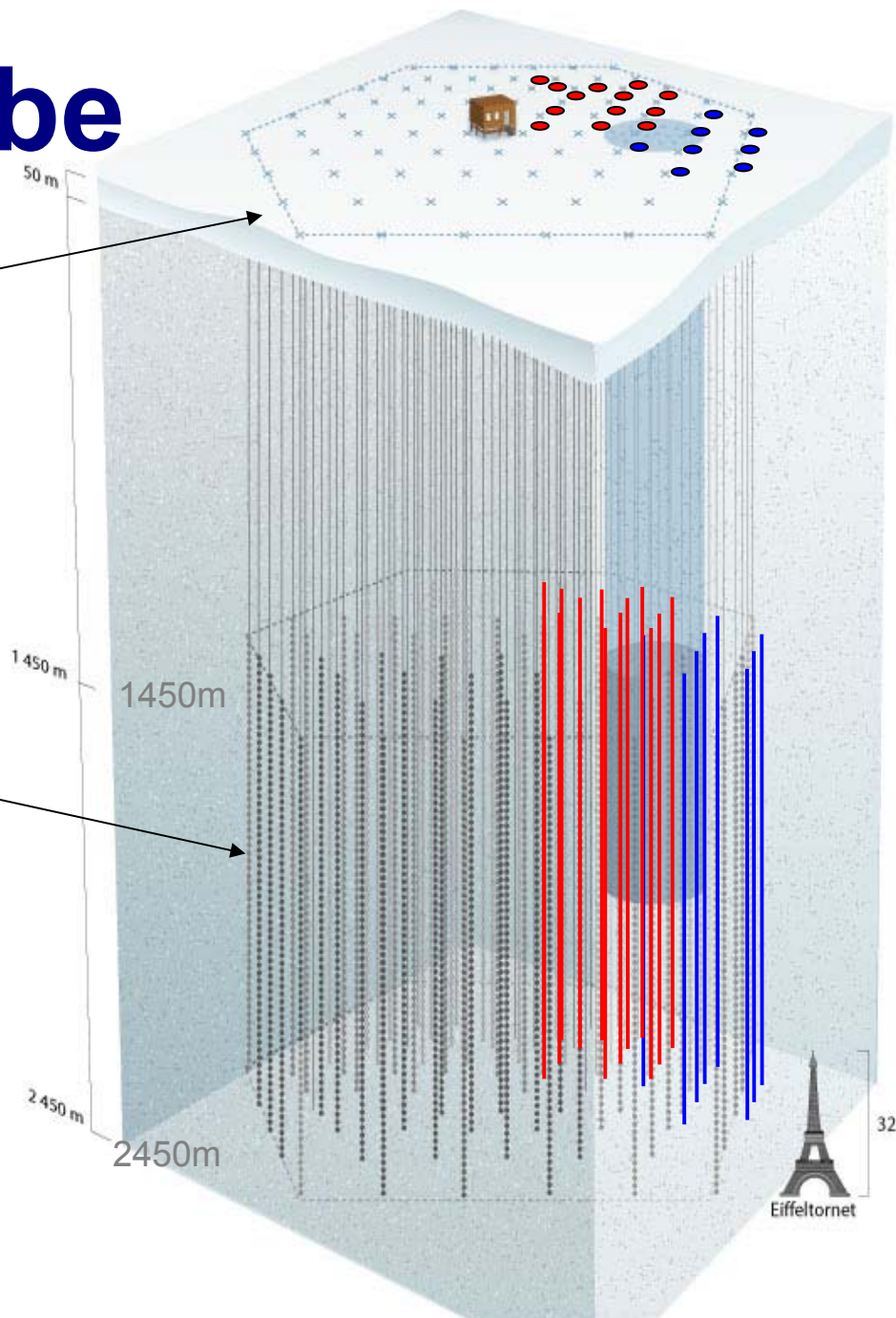
IceCube

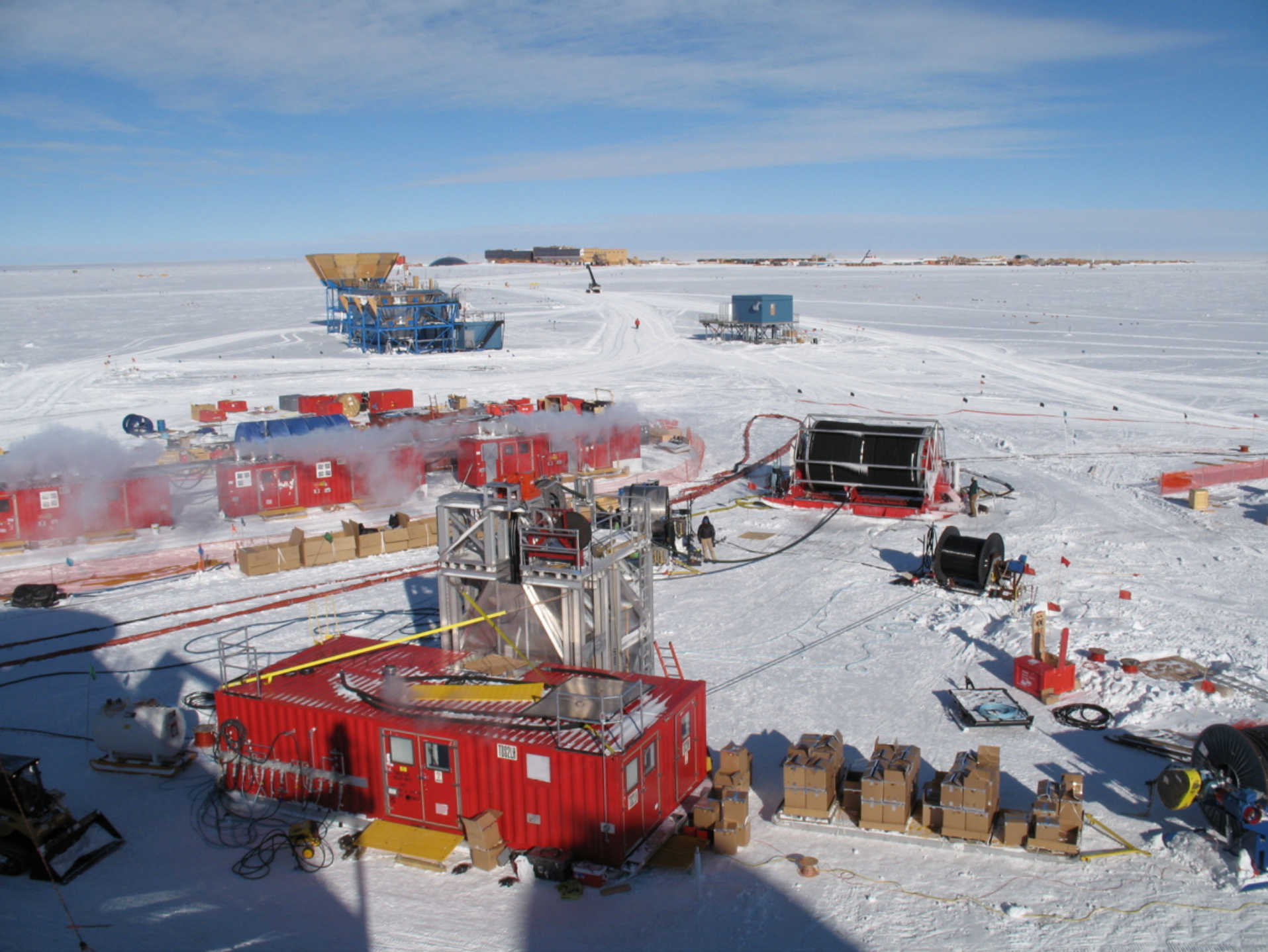


IceCube

IceTop

IceCube





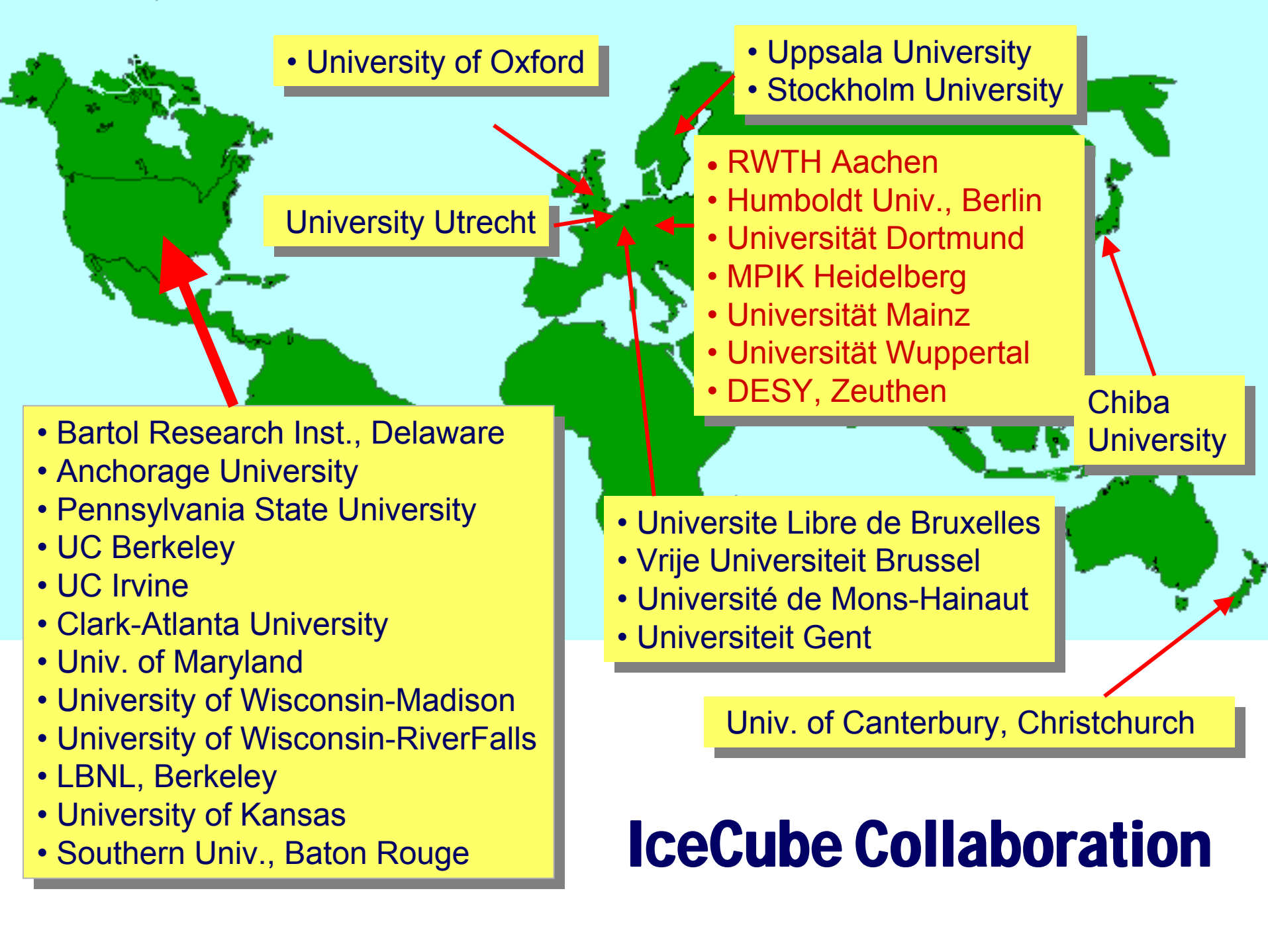


NEW YORK
UNIVERSITY
POLICE ACADEMY
NEW YORK UNIVERSITY INSTITUTE
NEW YORK, U.S.A.



Das neue IceCube-Labor





• University of Oxford

• Uppsala University
• Stockholm University

University Utrecht

• RWTH Aachen
• Humboldt Univ., Berlin
• Universität Dortmund
• MPIK Heidelberg
• Universität Mainz
• Universität Wuppertal
• DESY, Zeuthen

Chiba University

• Bartol Research Inst., Delaware
• Anchorage University
• Pennsylvania State University
• UC Berkeley
• UC Irvine
• Clark-Atlanta University
• Univ. of Maryland
• University of Wisconsin-Madison
• University of Wisconsin-River Falls
• LBNL, Berkeley
• University of Kansas
• Southern Univ., Baton Rouge

• Universite Libre de Bruxelles
• Vrije Universiteit Brussel
• Université de Mons-Hainaut
• Universiteit Gent

Univ. of Canterbury, Christchurch

IceCube Collaboration

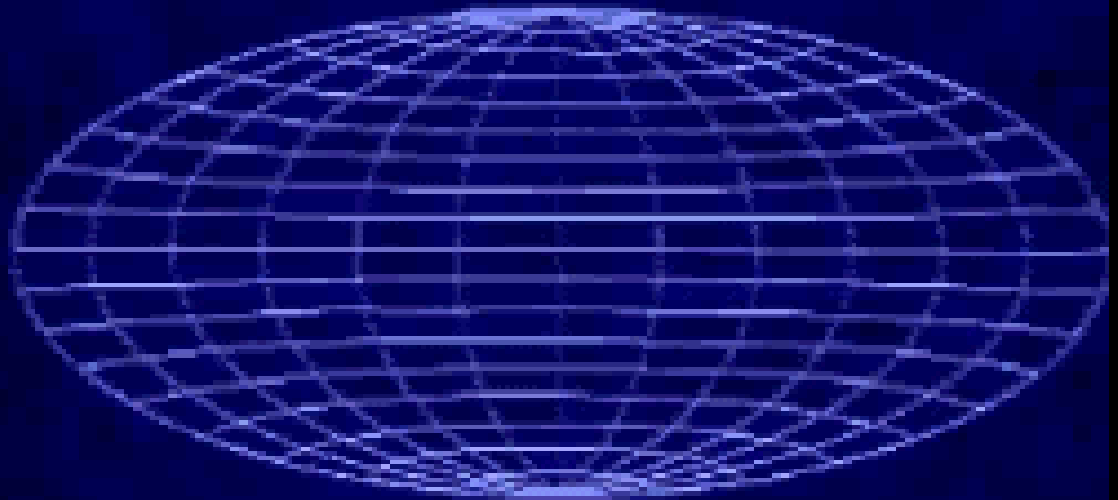


Vela Satellit, 1969

Gamma-Ray Bursts

Geheimnisvolle Signale –
aus der UdSSR oder aus dem Kosmos ?

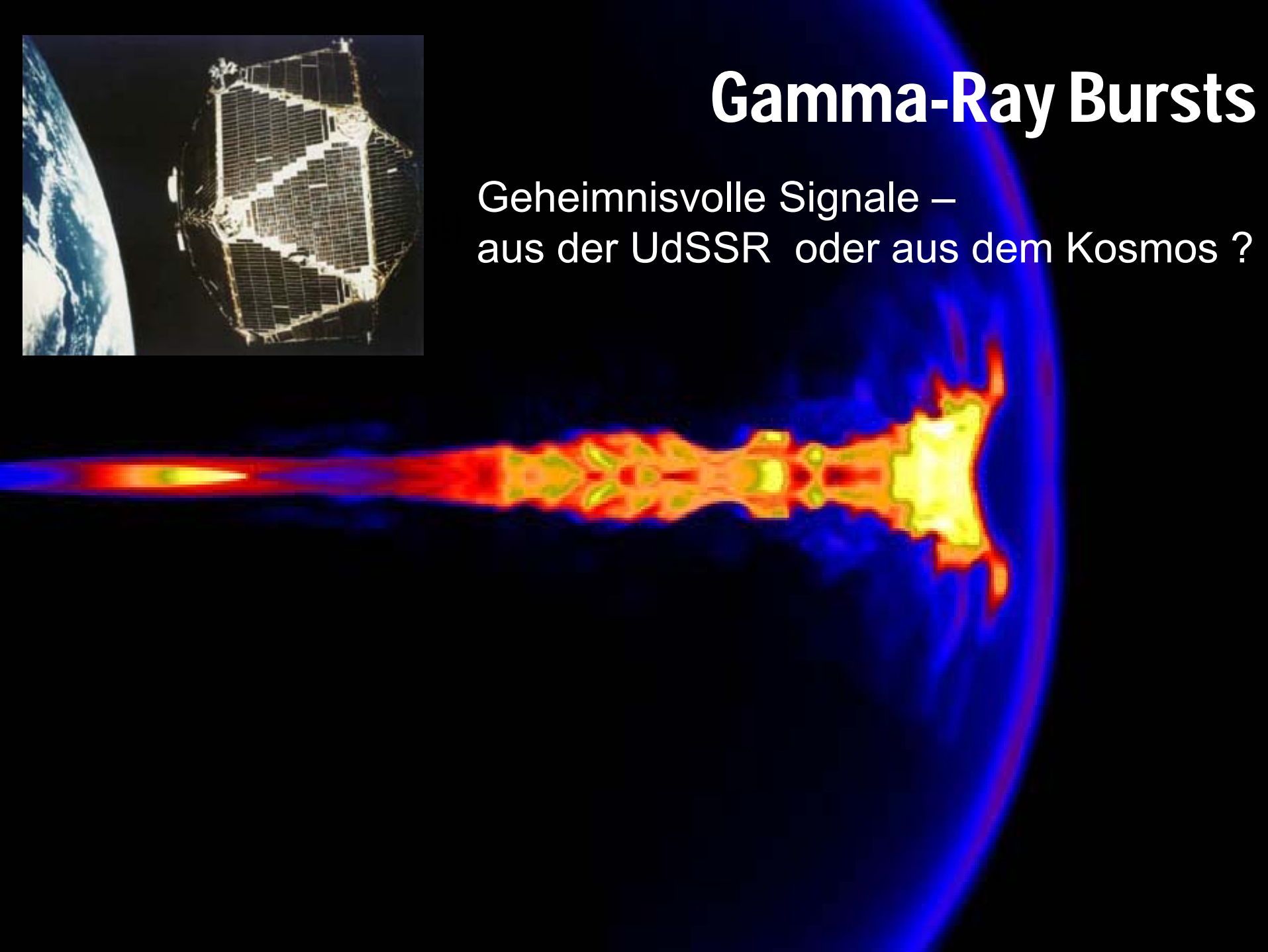
Unregistered HyperCam



BATSE: 1991-2003

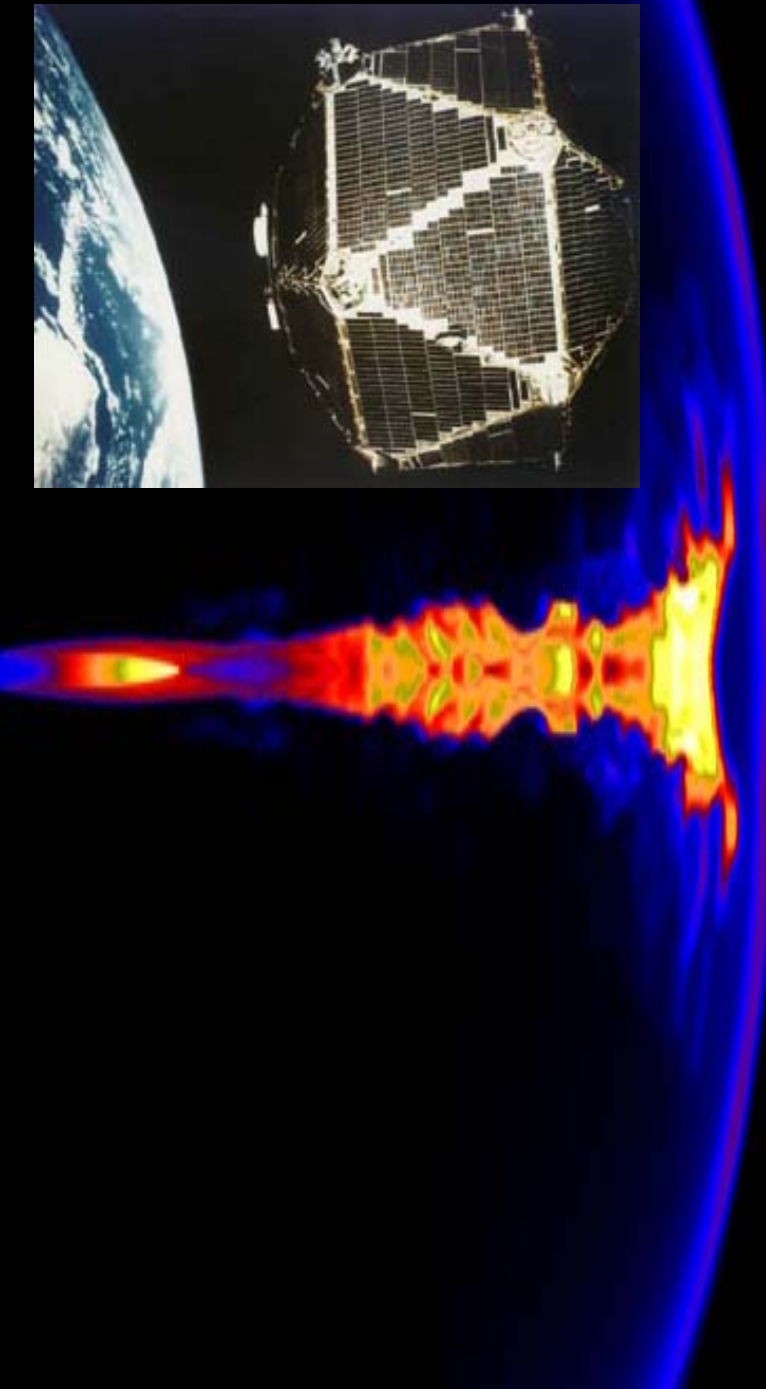
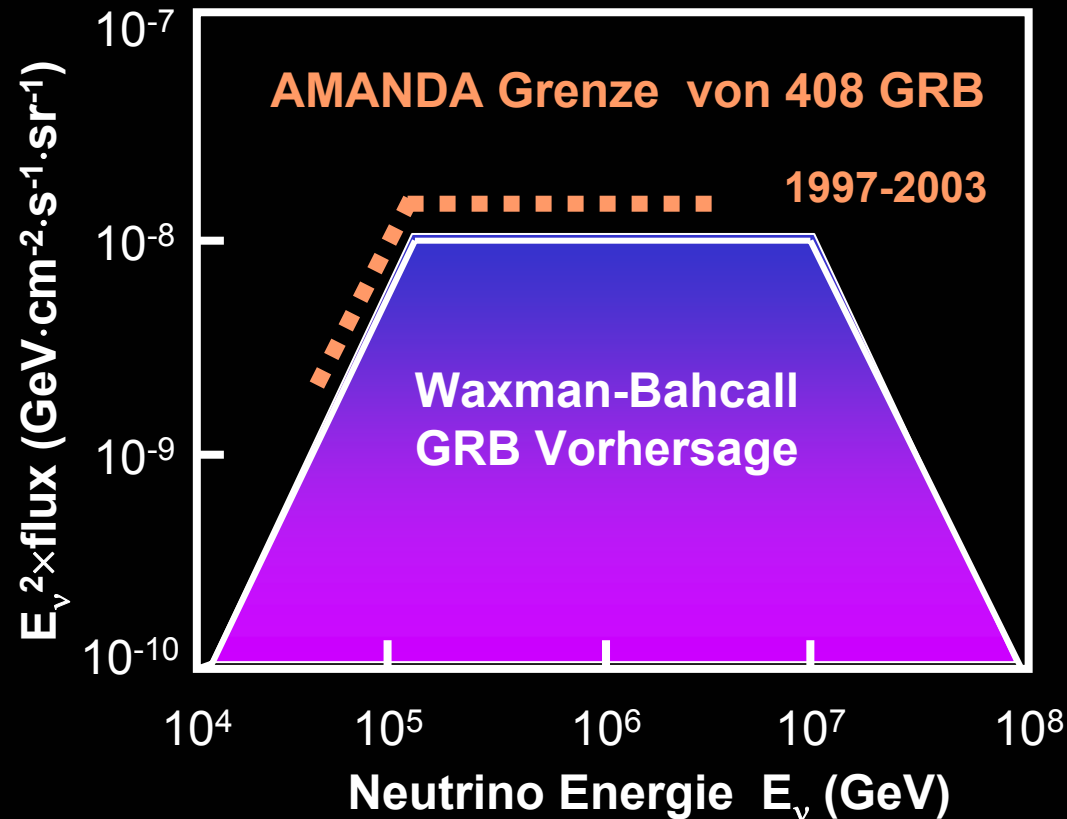
Gamma-Ray Bursts

Geheimnisvolle Signale –
aus der UdSSR oder aus dem Kosmos ?

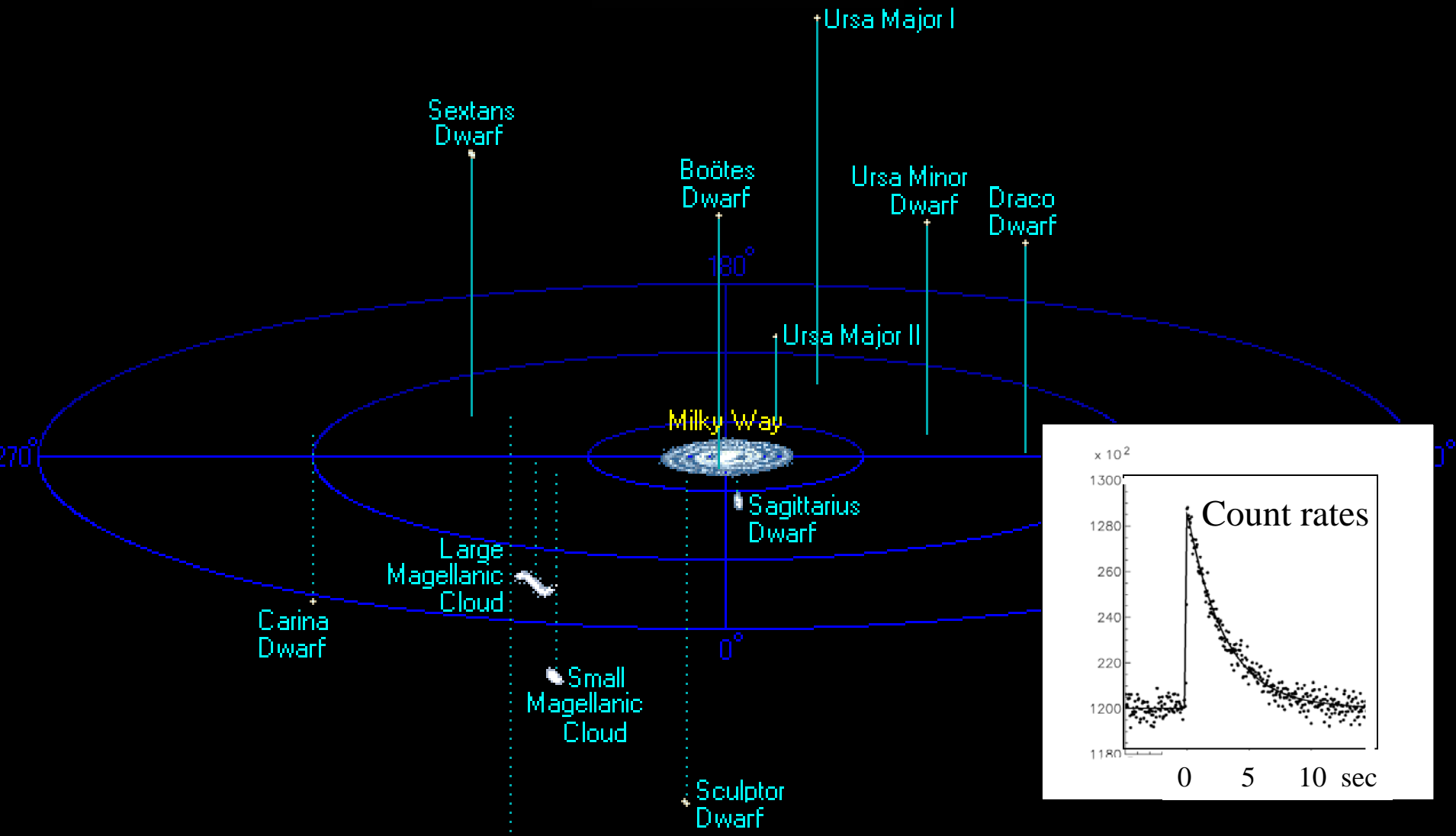


Gamma-Ray Bursts

Mit IceCube können wir innerhalb eines Jahres prüfen, ob die höchst-energetischen kosmischen Strahlen alle aus GRBs stammen.



Das Traum-Ereignis: Eine Supernova in unserer Galaxis





v **p**
p

Das Unerwartete

v

n

p



Ende