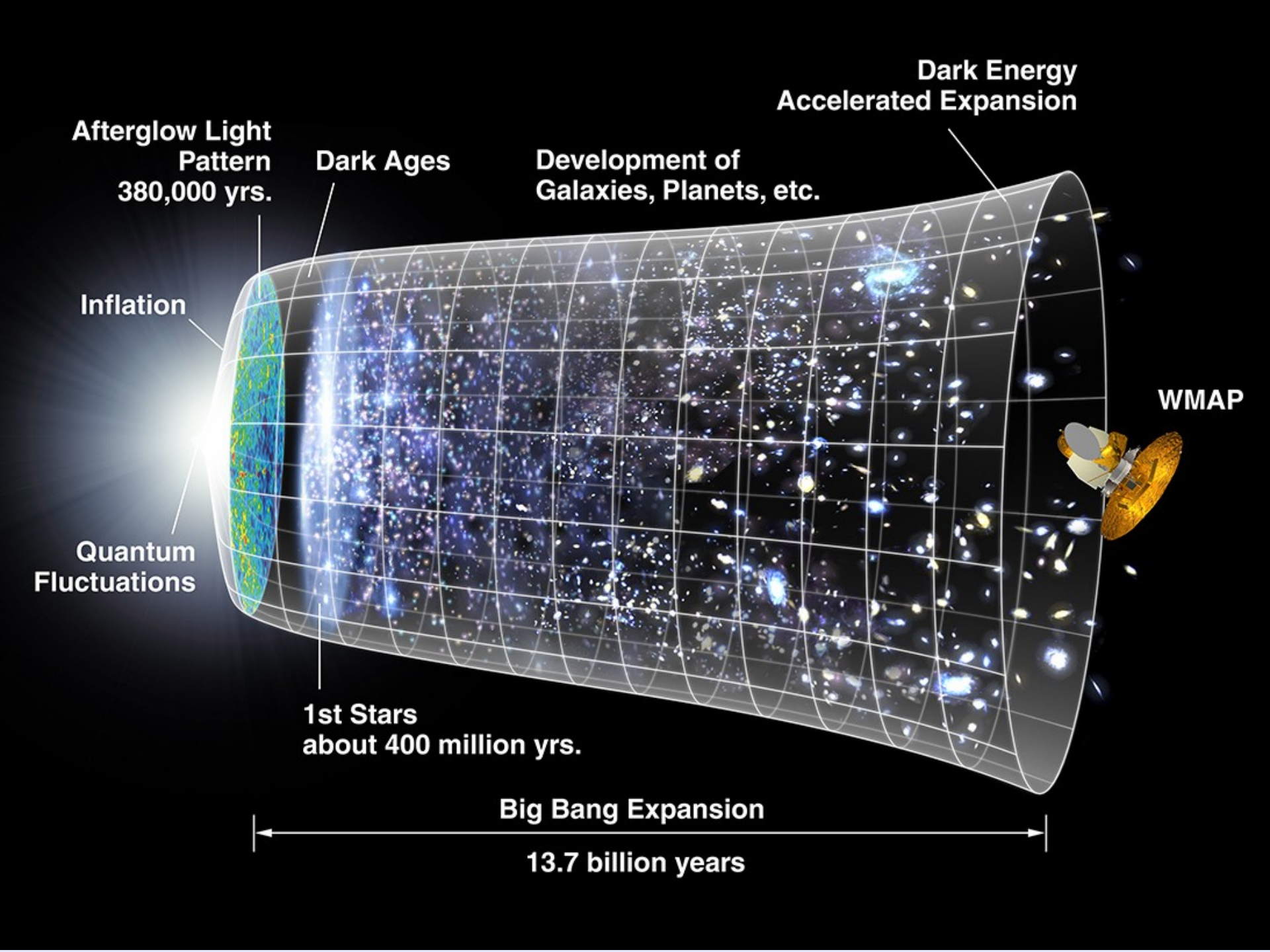
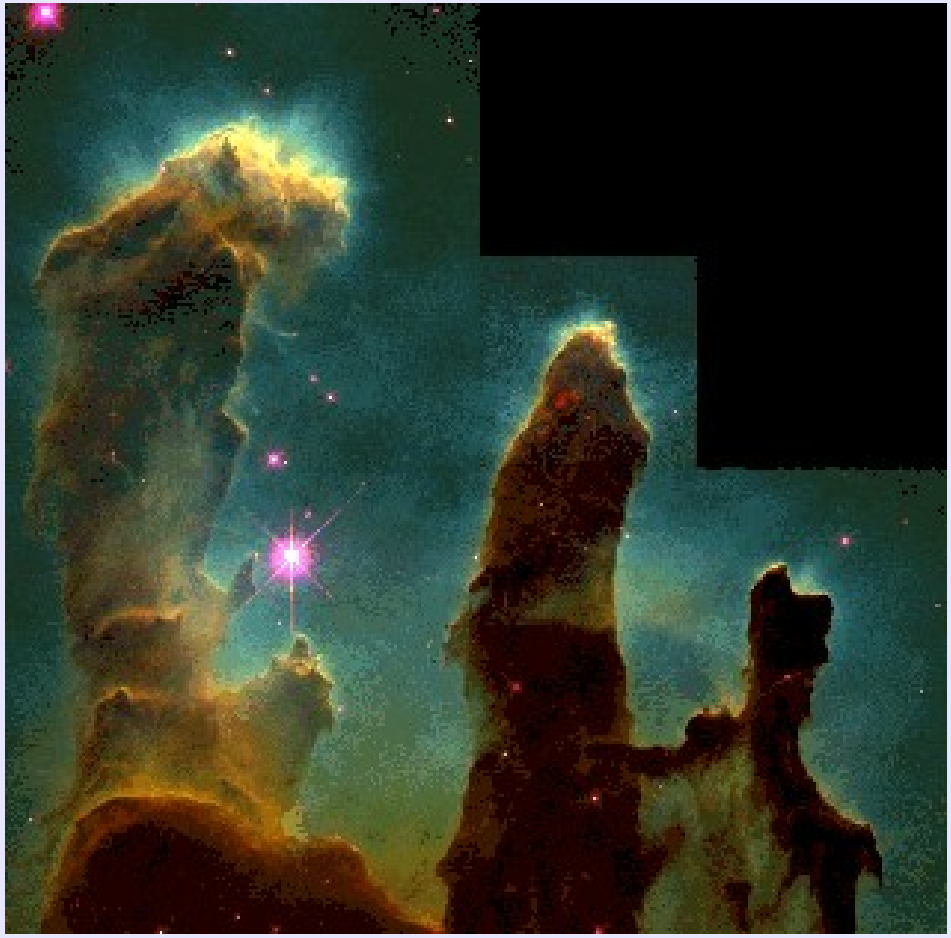
Balloon-borne Large Aperture Submillimeter Telescope

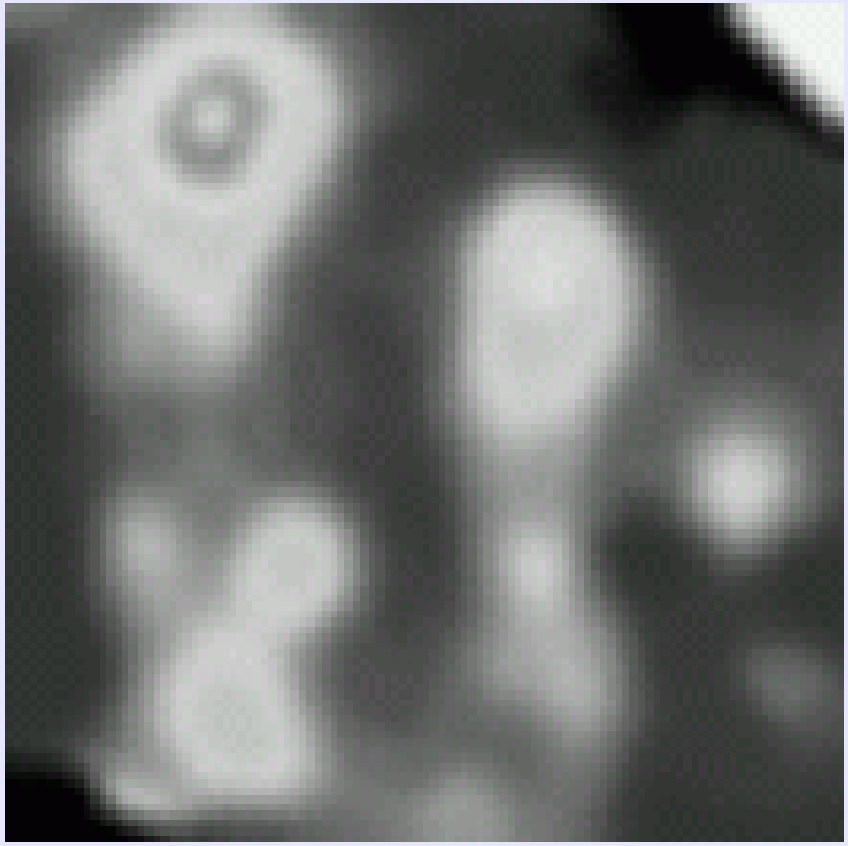
Gaelen Marsden


Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
380,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
WMAP
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.7 billion years

Observing Star Formation

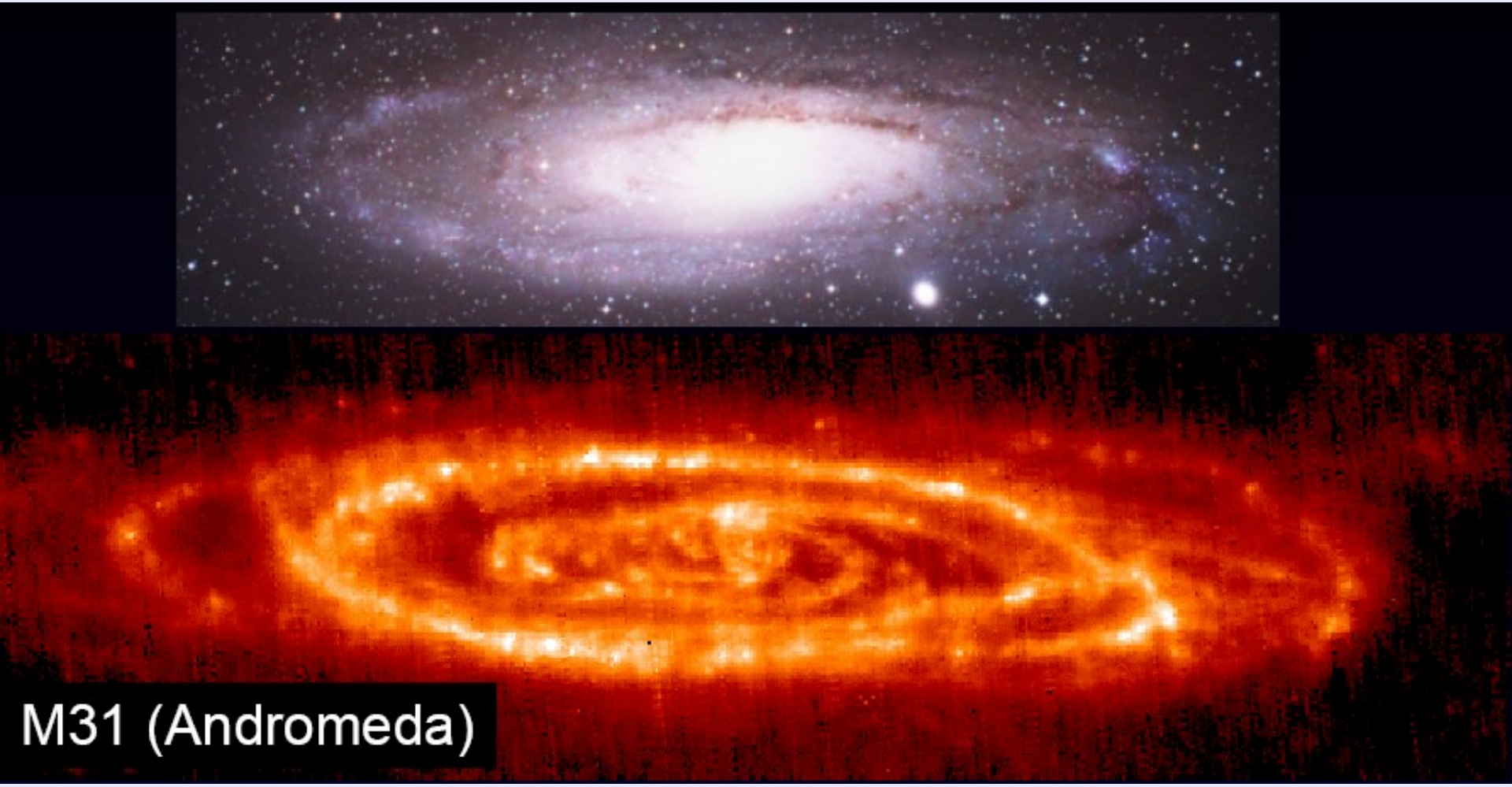


Optical



Submillimetre

Optical

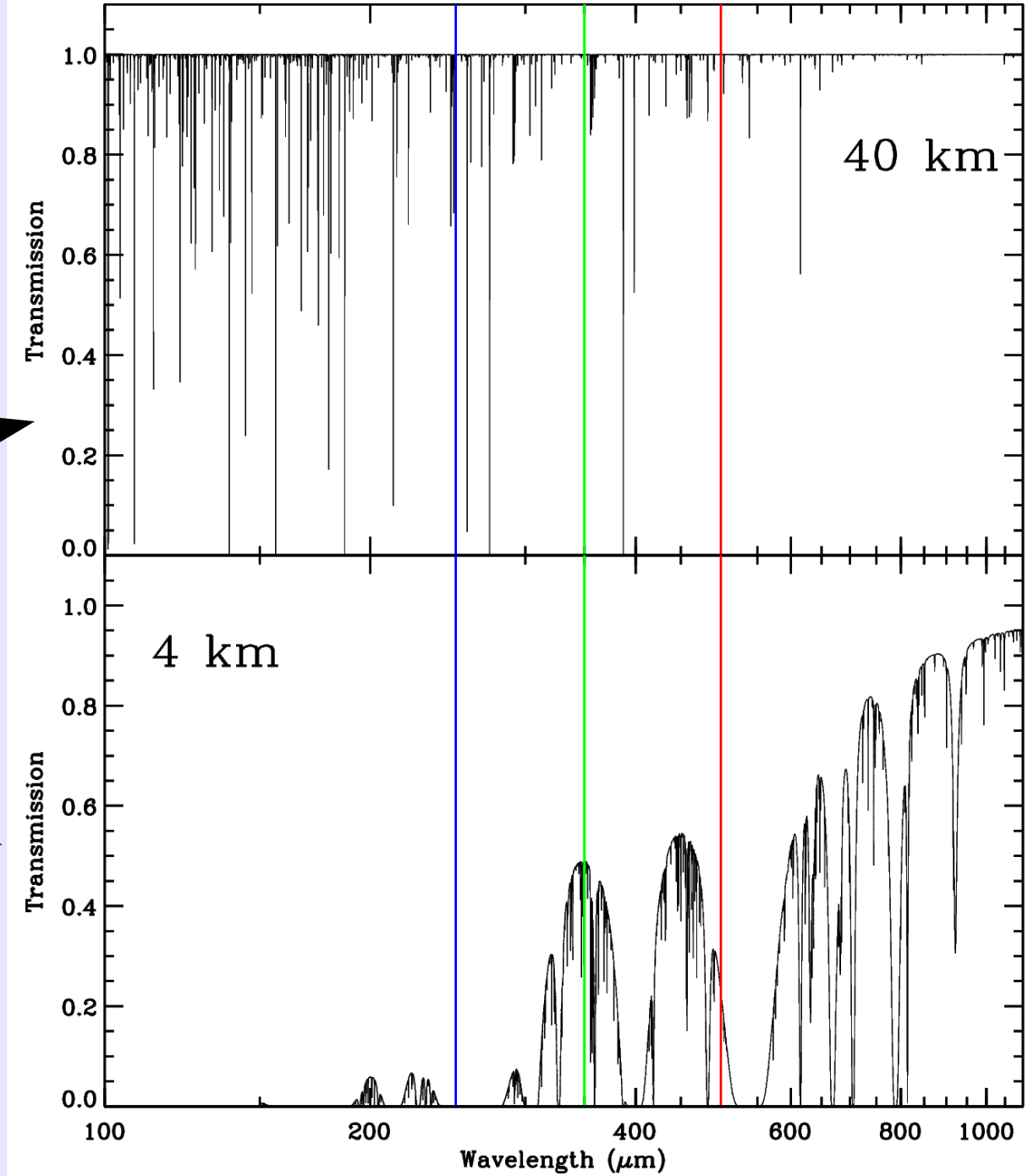


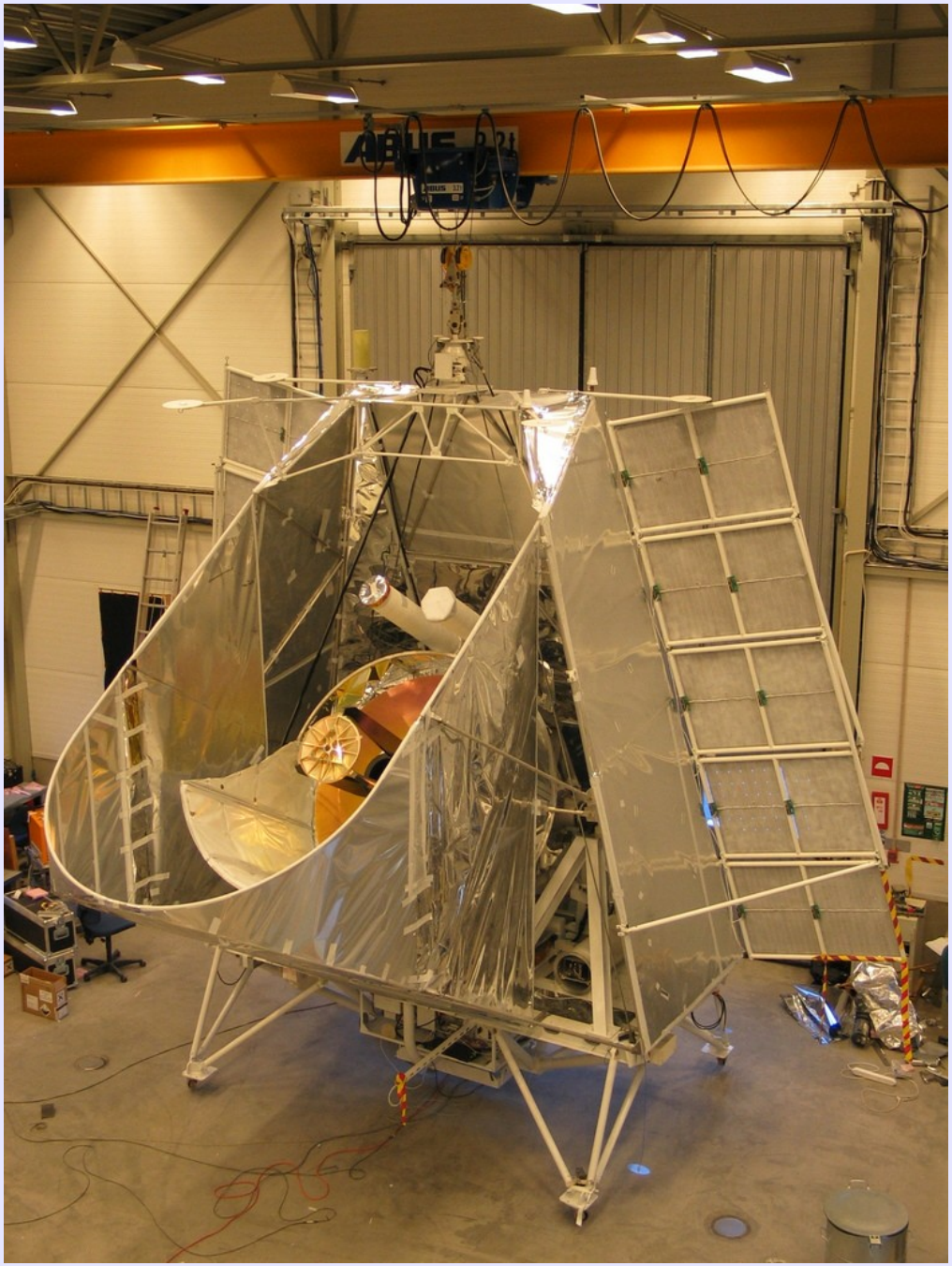
Far-Infrared

Atmospheric Transmission

Balloon

Ground





BLAST

- 2-metre primary mirror
- Detectors arrays at 250, 350 and 500 µm
- Cryostat cools detectors to ~300 mK
- az/el pointing
- Gyroscopes + optical star cameras
- Solar power + rechargeable batteries
- Sun shields

2006 Optics

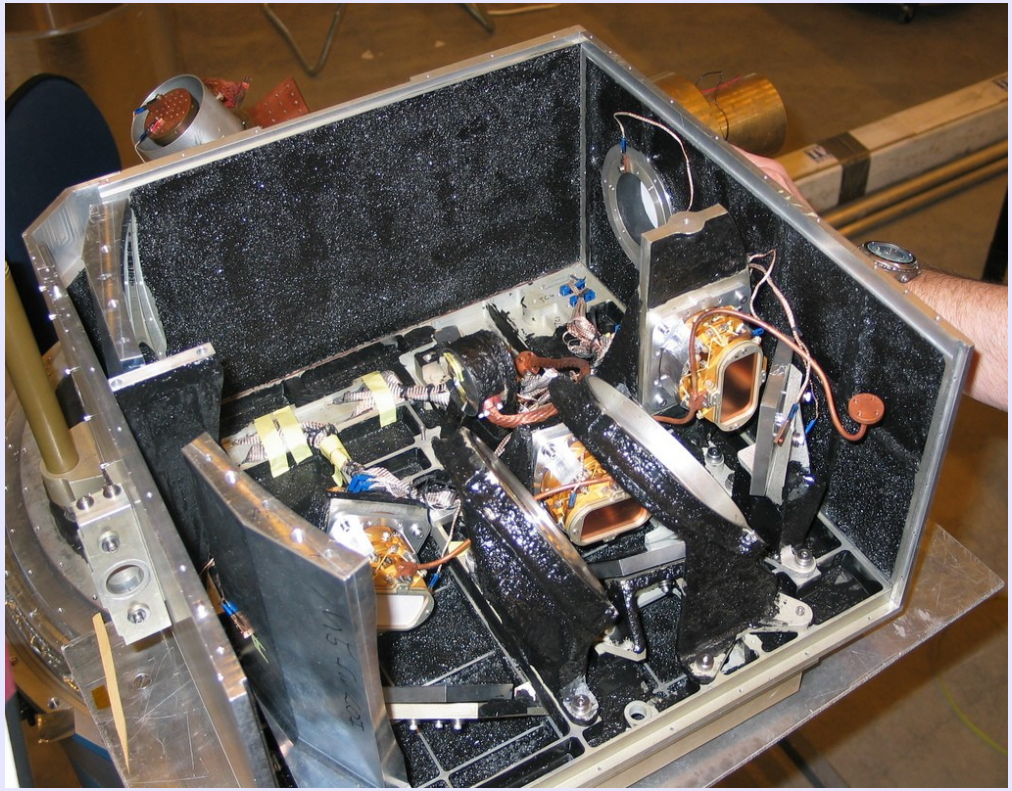
- 2-metre aluminum primary
- 50-cm focus-able secondary
- Carbon fiber struts

Cryostat

- Cryogens (LN & LHe)
- Fridge (^{3}He)
- detectors/optics
- ~13 day hold time

(upside down!)

Optics Box

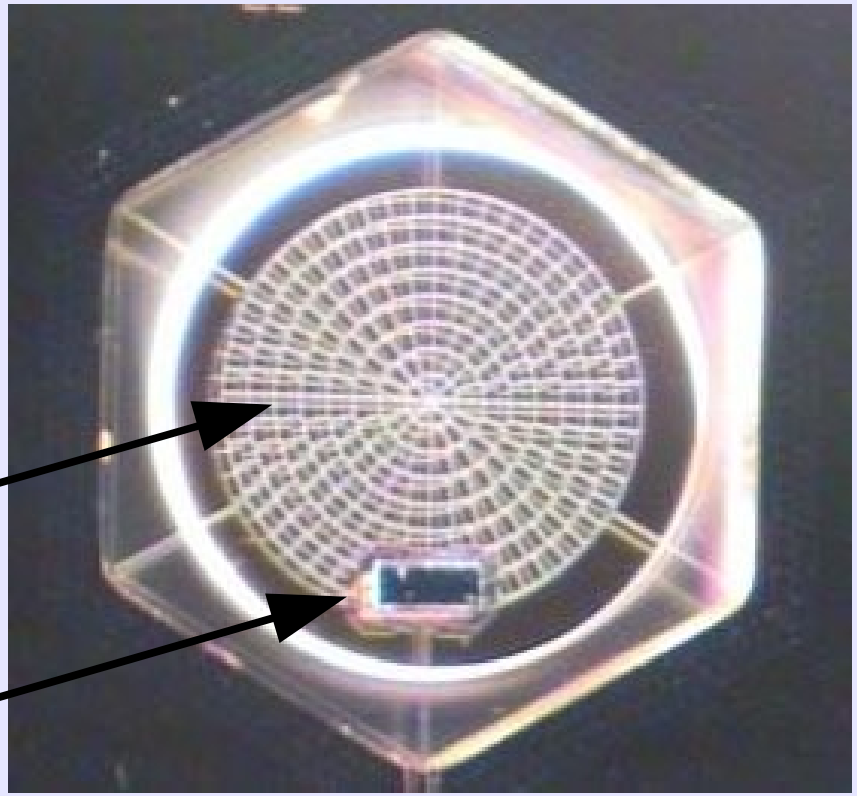


- Correcting optics
- Filters
- Detectors

Bolometer Array

5 cm

500 µm Bolometer

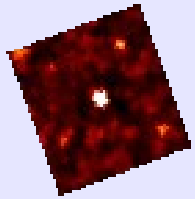


"Spiderweb" absorber

Thermistor

2 mm

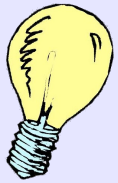
Incident power is very small!



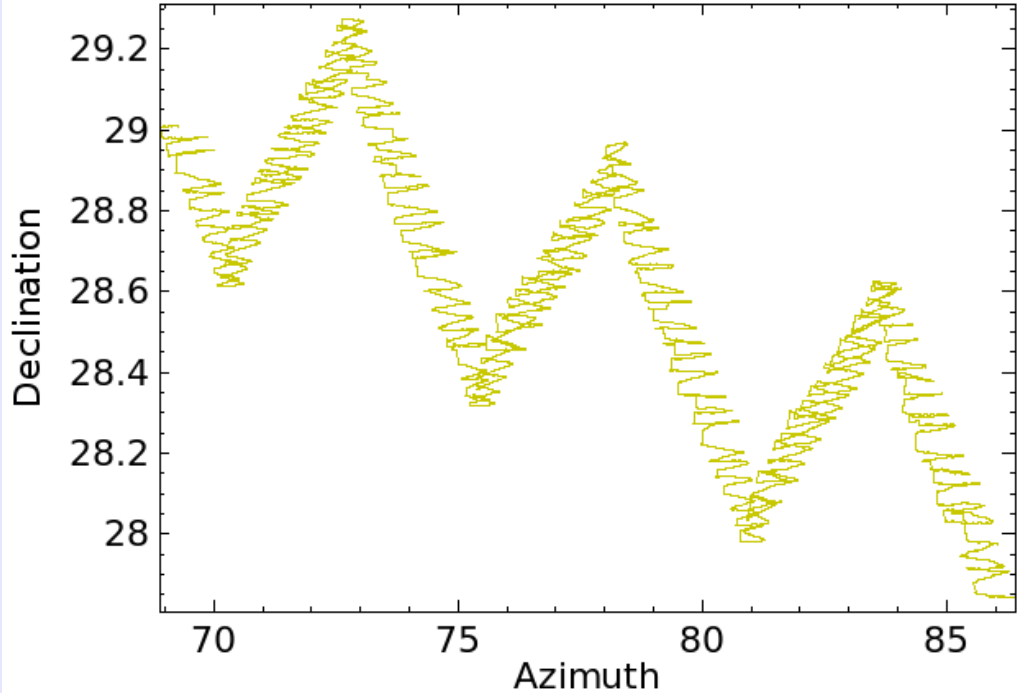
Energy absorbed by detector from brightest extragalactic source

=

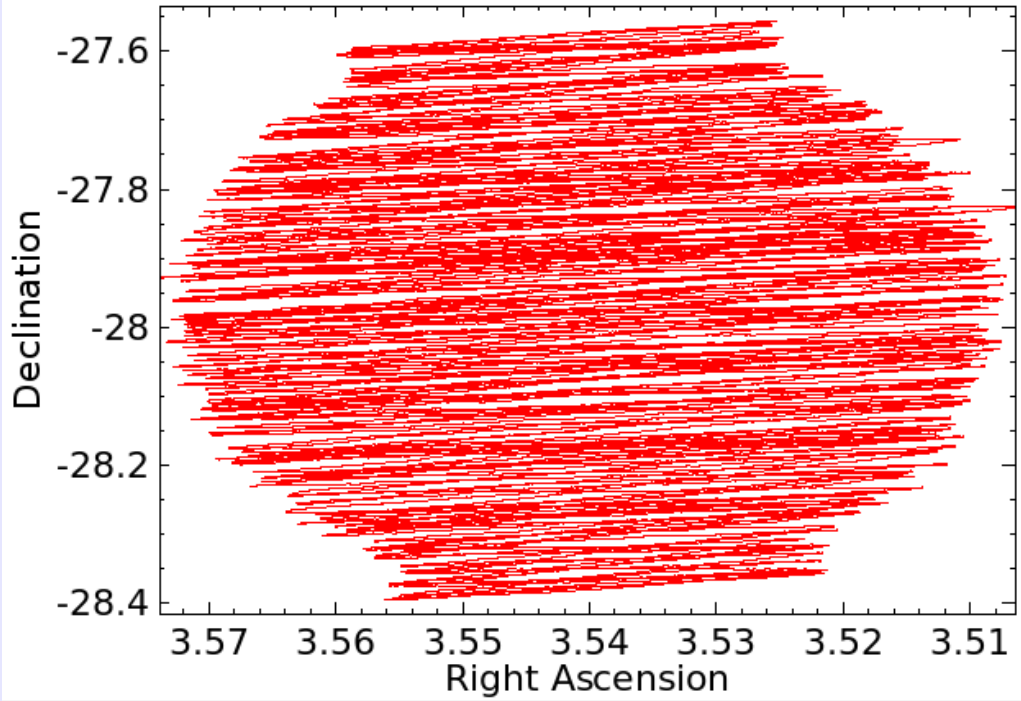
Energy absorbed by eye from 100W light bulb 20 km away

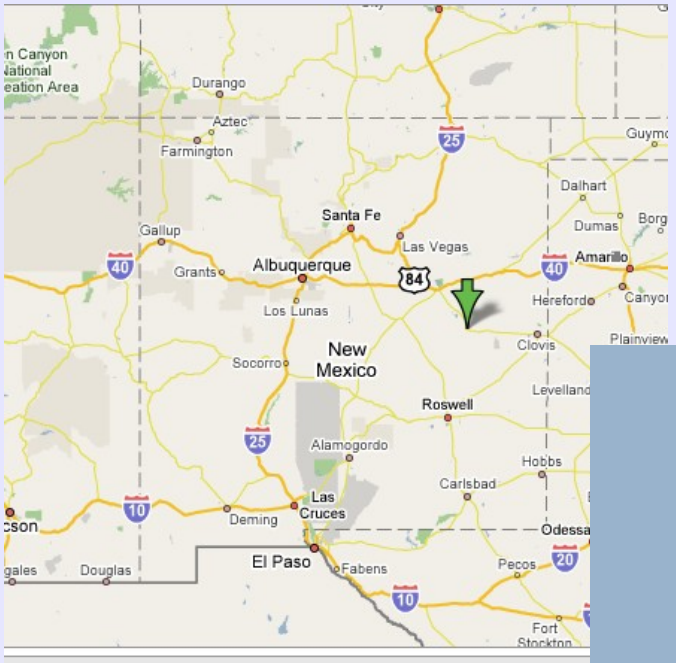


What the telescope is doing

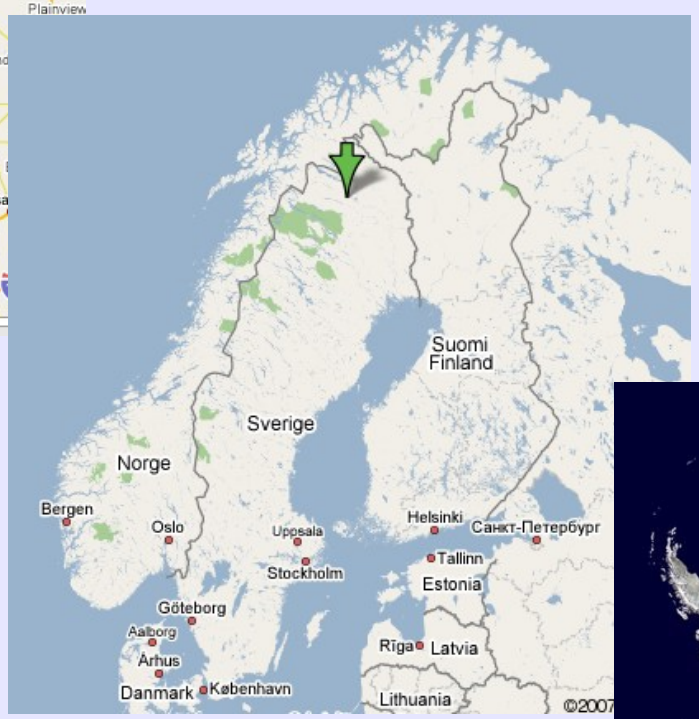


What the sky coverage looks like





2003
Ft. Sumner, NM



2005
Kiruna, Sweden

2006
McMurdo, Antarctica


Getting Outfitted at the CDC
Christchurch
WATER BOTTLE
CAP, VAZEE
MITTEN, COBALITT
GLOVE, LEATHER
SOCK TUBE, WOOL
HAT, FULL/KNIT
MITTEN, WIND
GLOVE, INSULATED
MITTEN, GAUNTLET
LINER, GLOVE THERMAX
BALACLAVA, POLAR-FLEECE
GAITER, NECK, FYFLEECE
GOGGLES, SNOW
SOCK FOR, INNER
BOOT, FOR
ATTENTION
WHEN RETURNING OR EXCHANGING CLOTHING YOU MUST BRING YOUR CLOTHING ISSUE FORM WITH YOU


U.S. AIR FORCE
3120

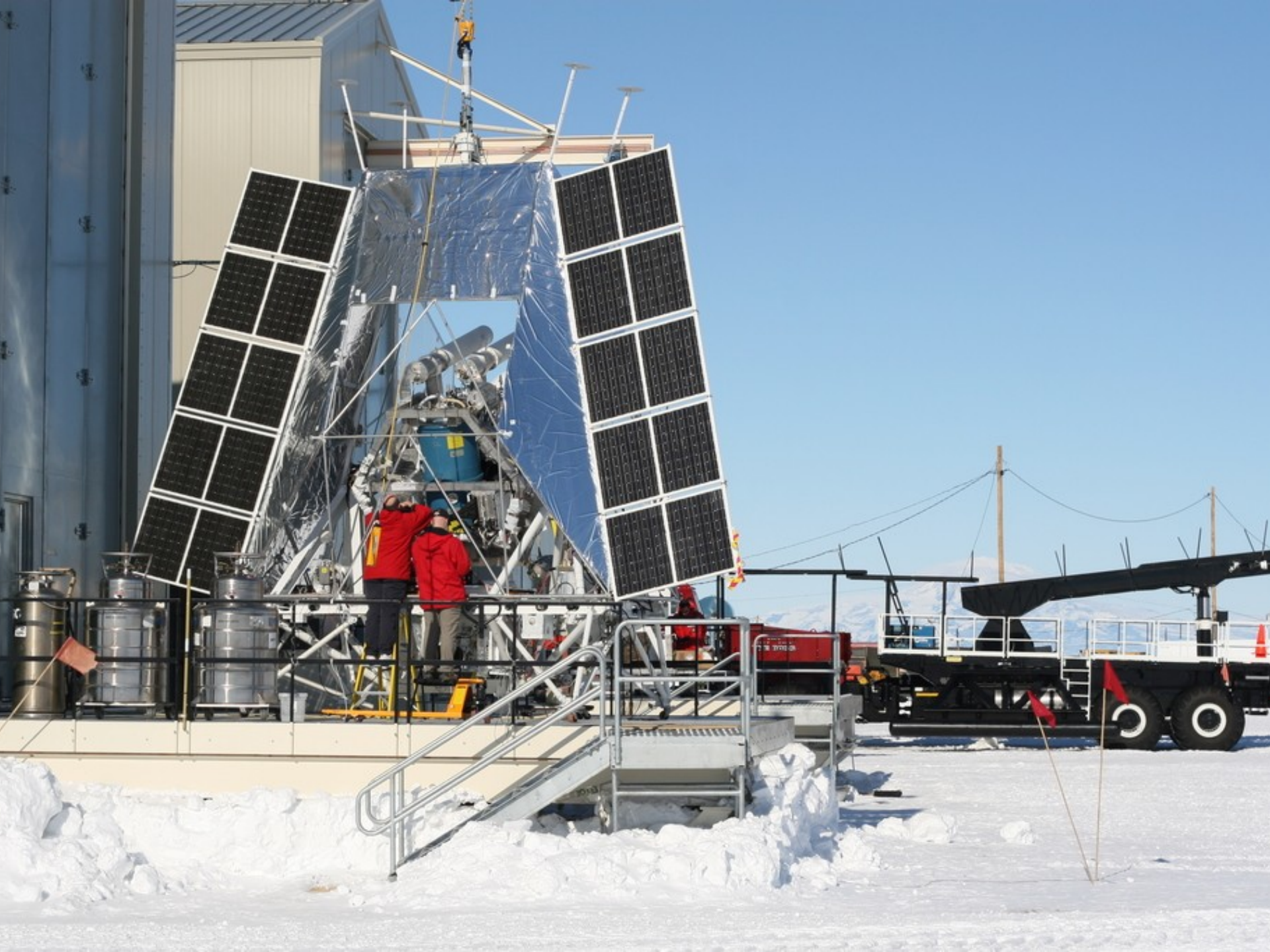

A-333-S
ICECUBE
SURFACE CABLE
590M
S71

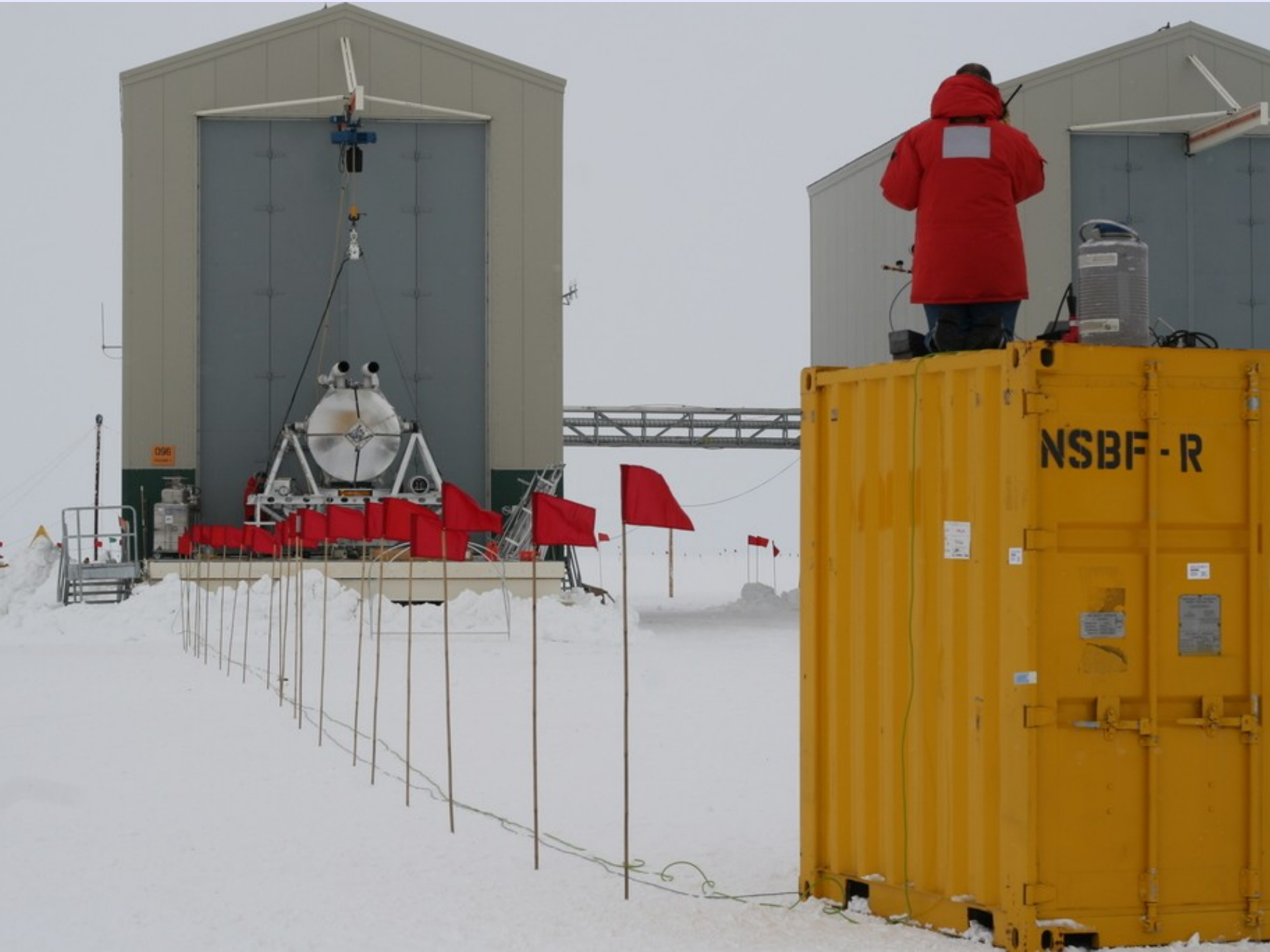

U.S. AIR FORCE
3120
AMC
33120

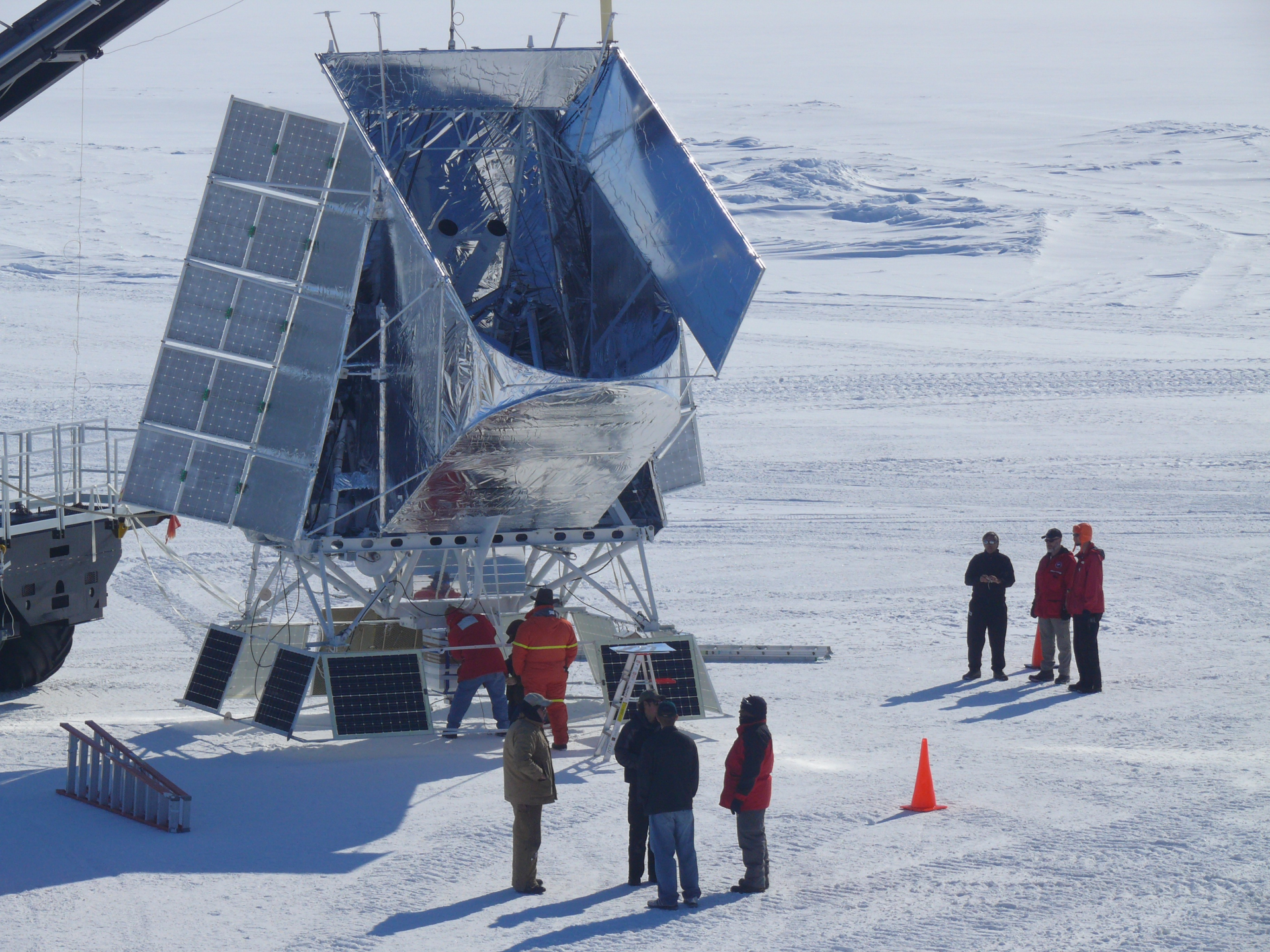

'IVAN' THE
TERRA BUS
FOREMOST

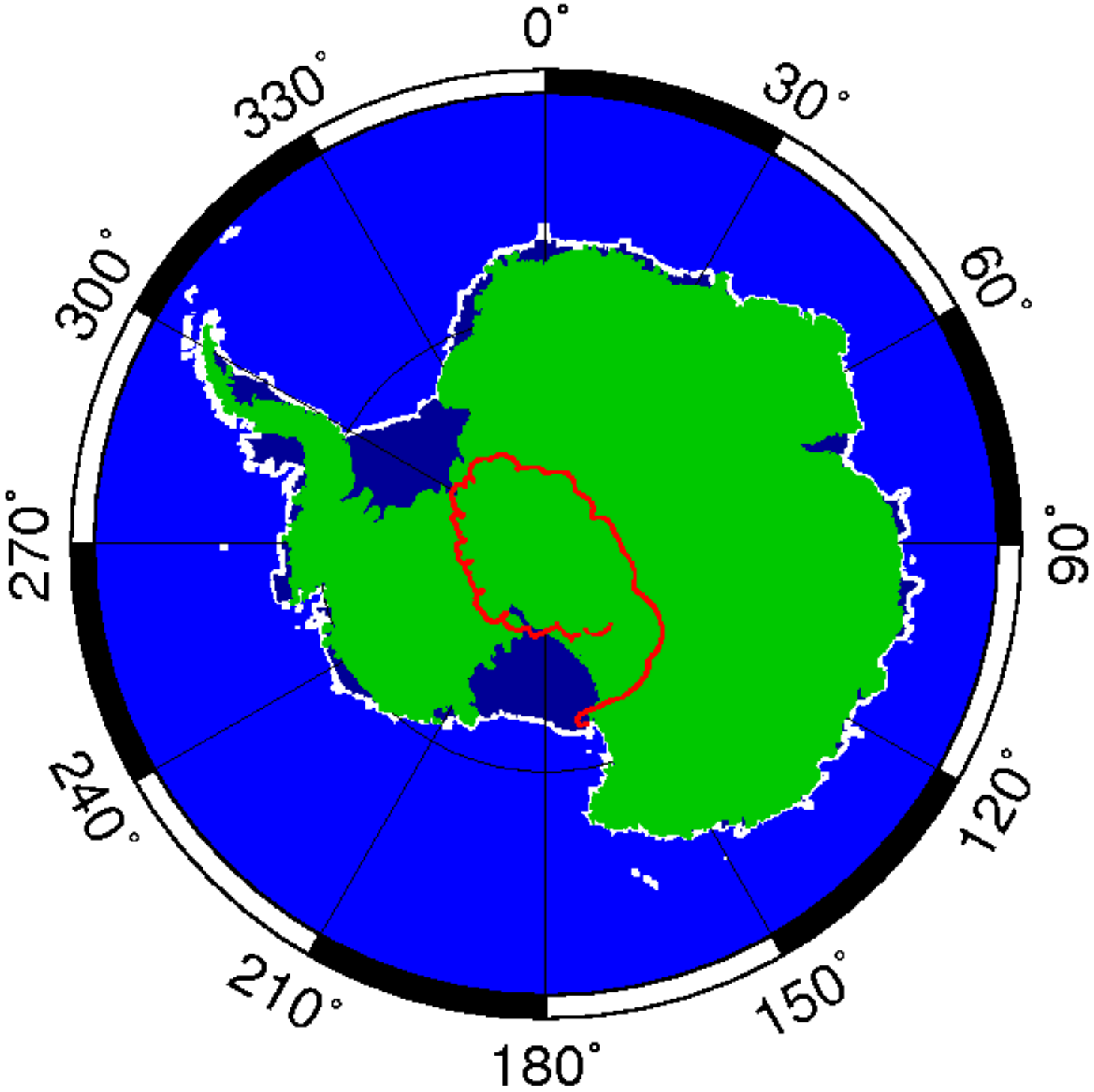

ODEN
ODEN

(Show video)




NSBF - R




0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°

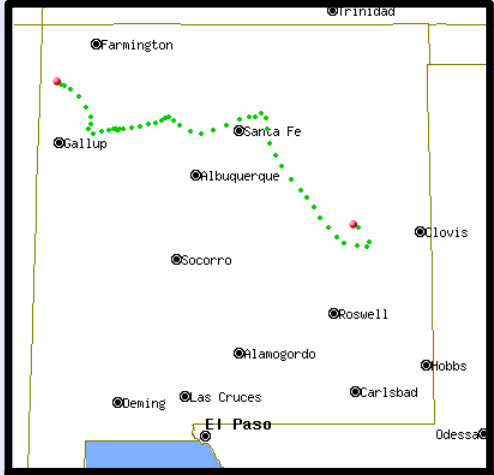
Data Recovered!

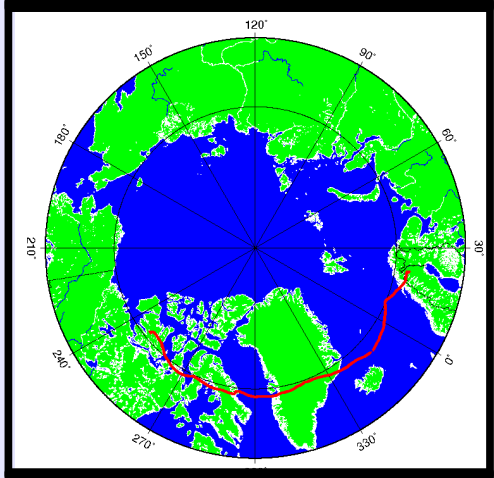
Flight Summary

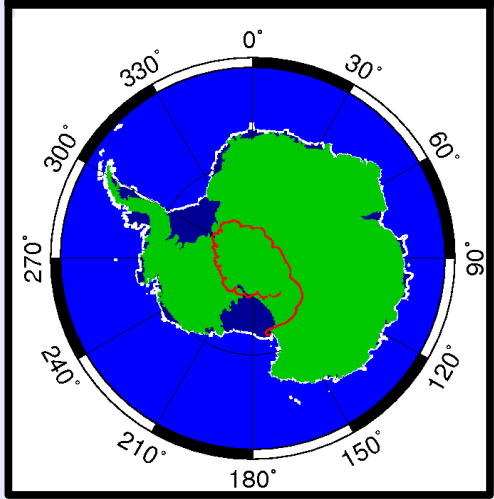
2003: Ft. Sumner, NM (1 day)
- 500 µm array only, aluminum mirror
- troubles with pointing
- no science results

2005: Kiruna, Sweden (5 days)
- 3 arrays, carbon fiber mirror
- problem with optics -> Galactic only
- 1st results published early 2008

2006: McMurdo, Antarctica (11 days)
- improved focusable aluminum mirror
- excellent performance
- 1st results published April 2009

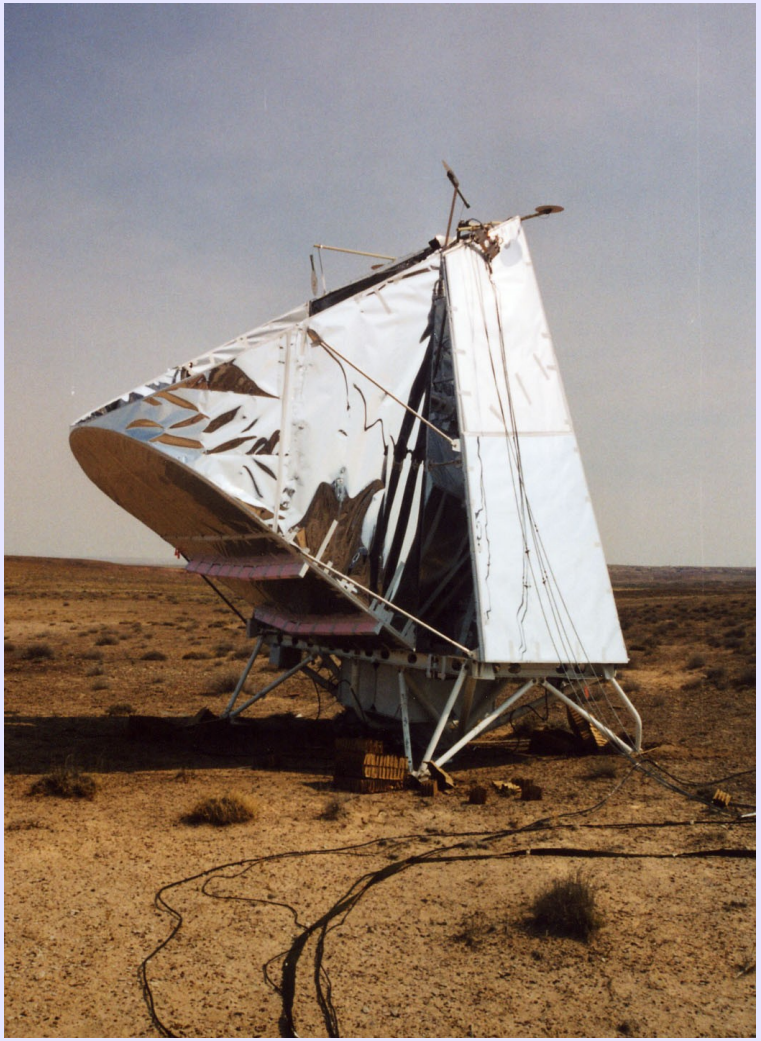






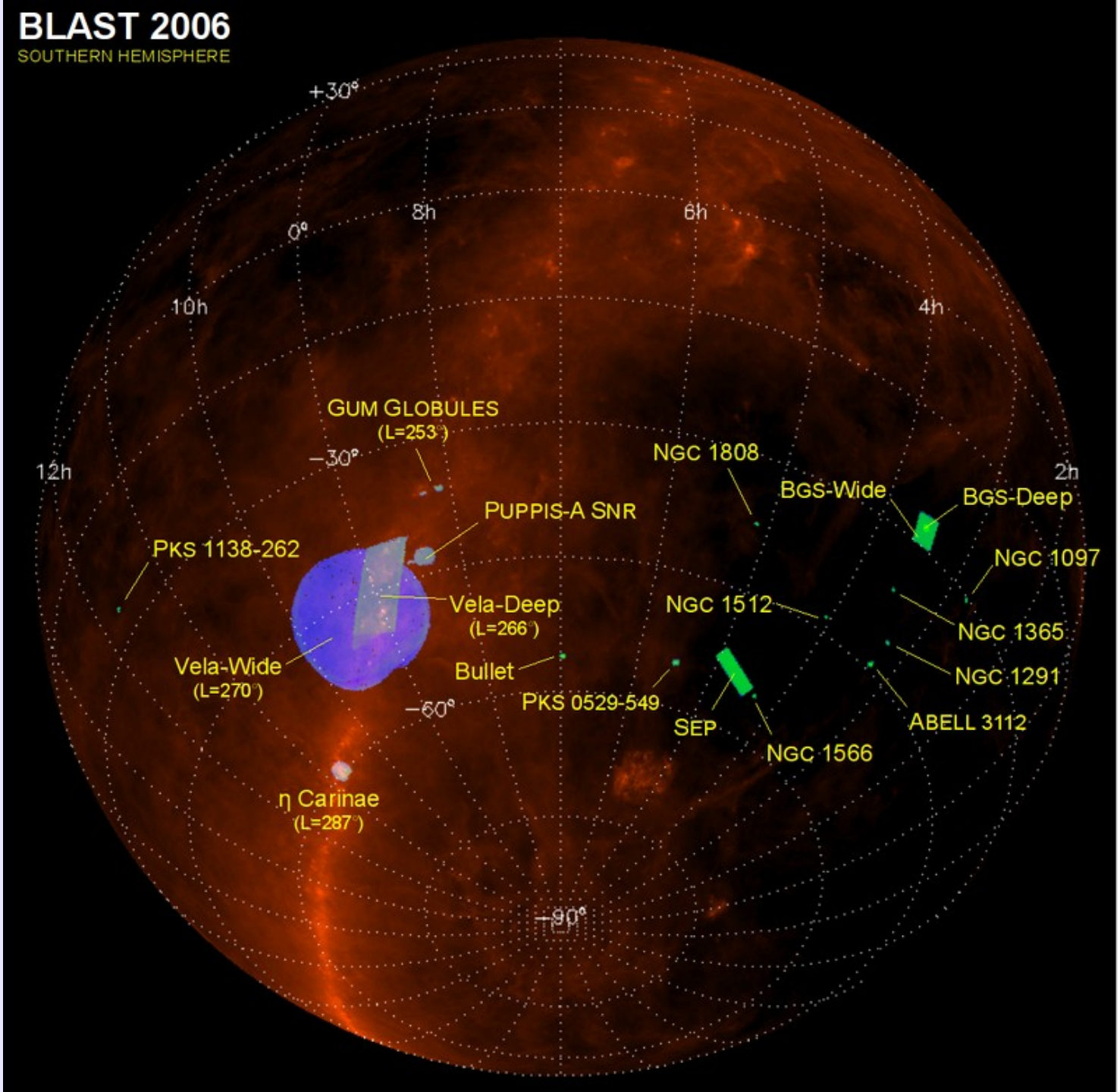
Landings

Kiruna

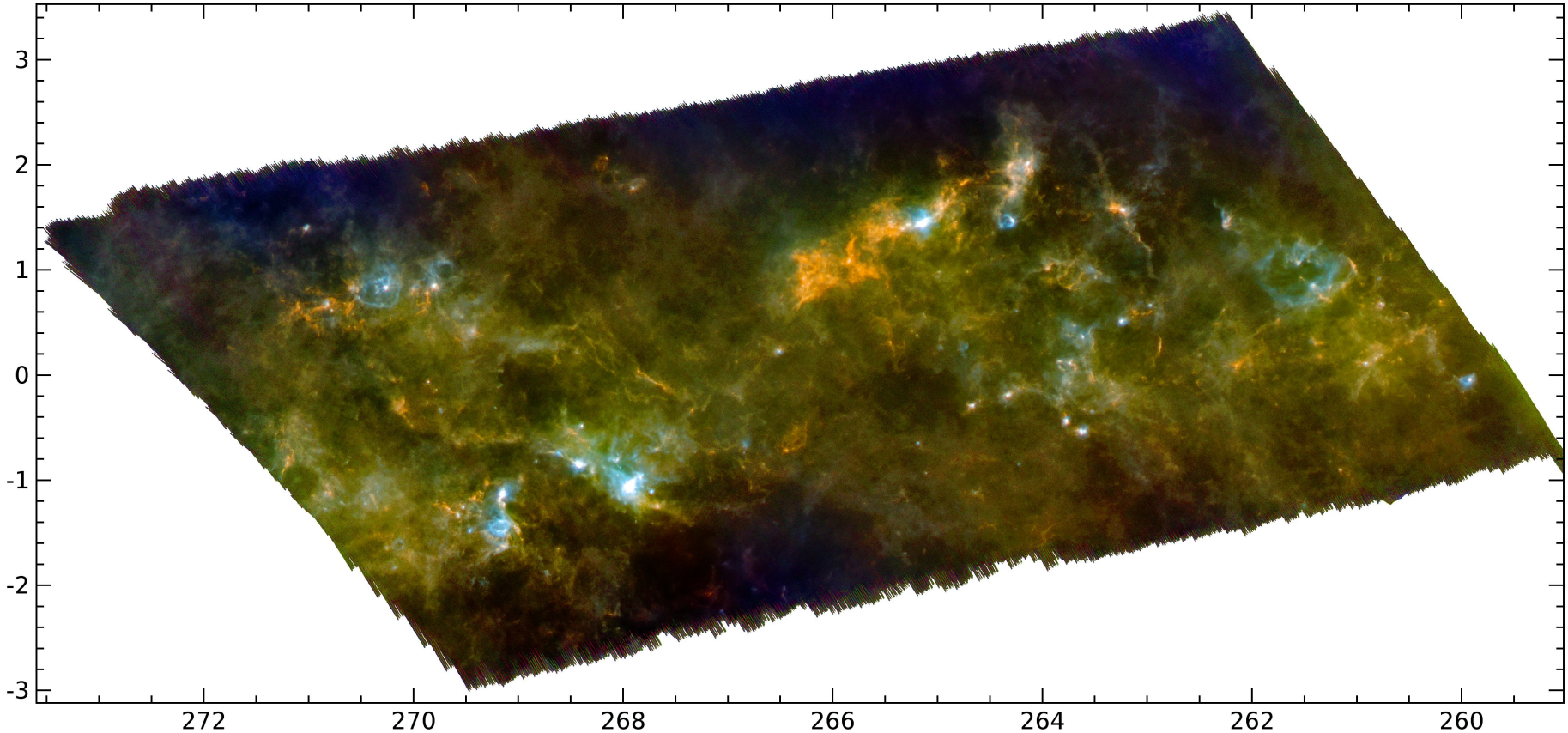


Ft. Sumner

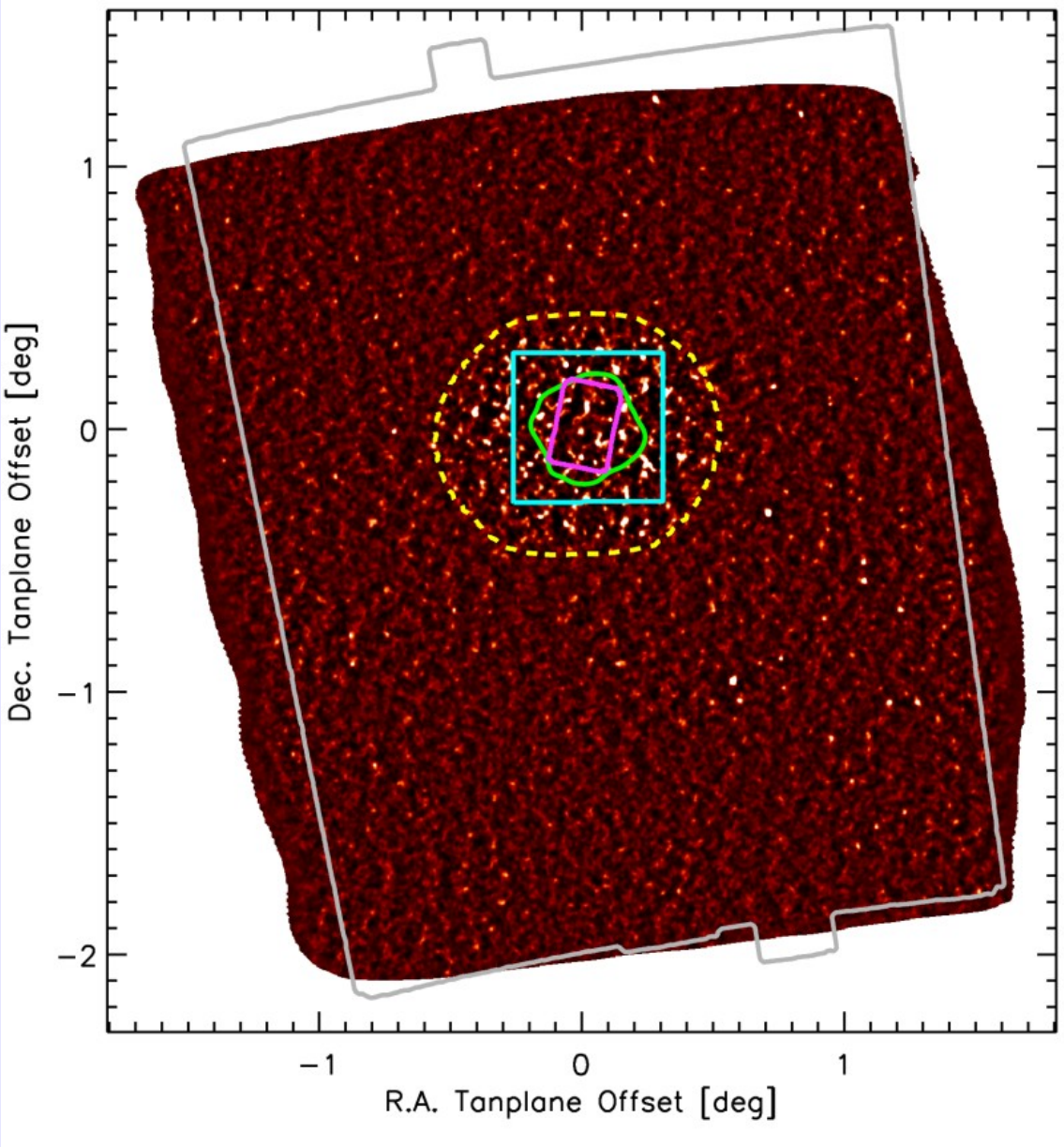
McMurdo


BLAST 2006
SOUTHERN HEMISPHERE
+30°
0°
8h
6h
10h
4h
12h
2h
−30°
−60°
−90°
GUM GLOBULES
(L=253°)
PUPPIS-A SNR
PKS 1138-262
Vela-Deep
(L=266°)
Vela-Wide
(L=270°)
Bullet
PKS 0529-549
η Carinae
(L=287°)
NGC 1808
BGS-Wide
BGS-Deep
NGC 1097
NGC 1512
NGC 1365
NGC 1291
ABELL 3112
SEP
NGC 1566

BLAST 3-colour Galactic image

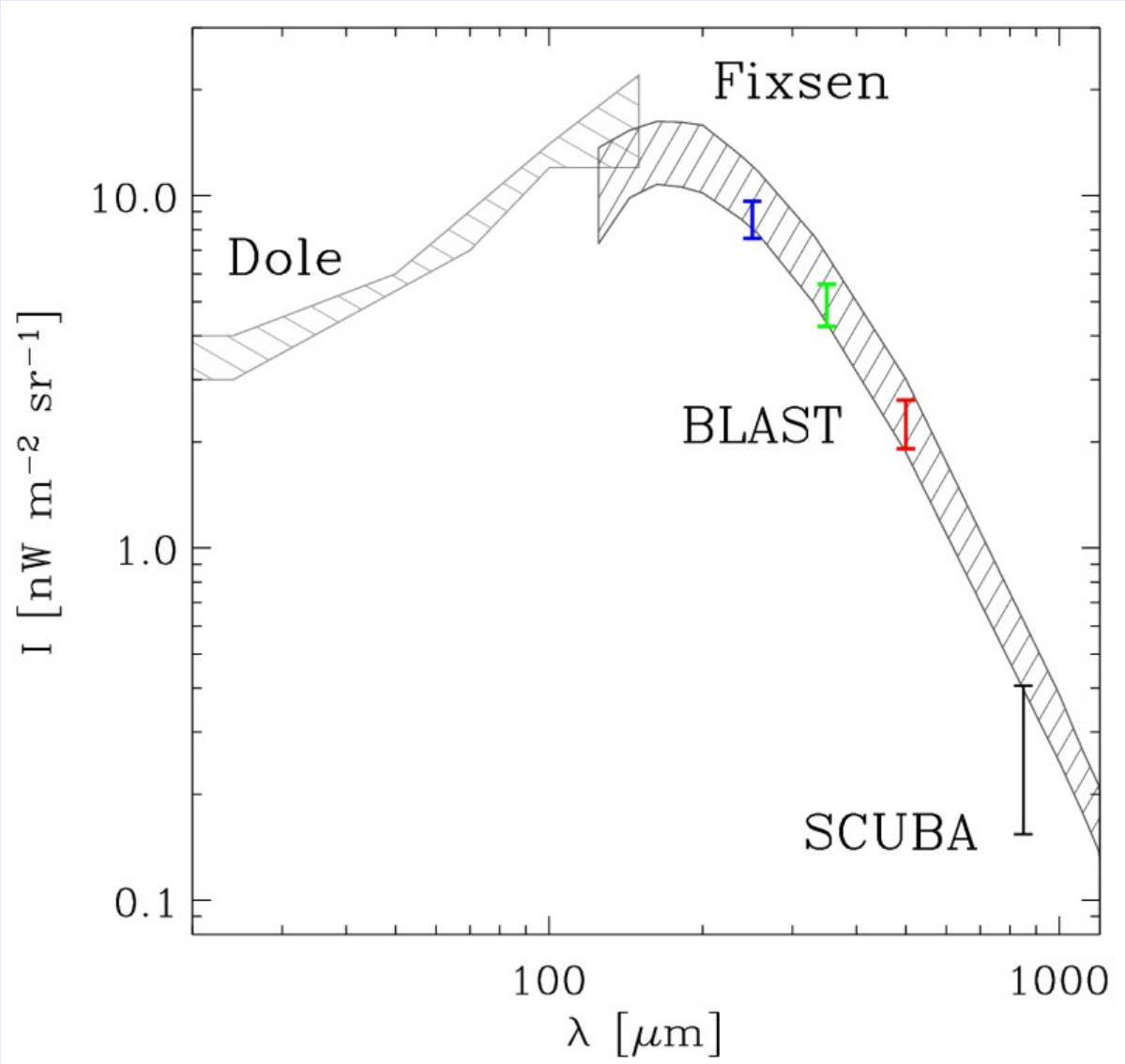


Extragalactic Map

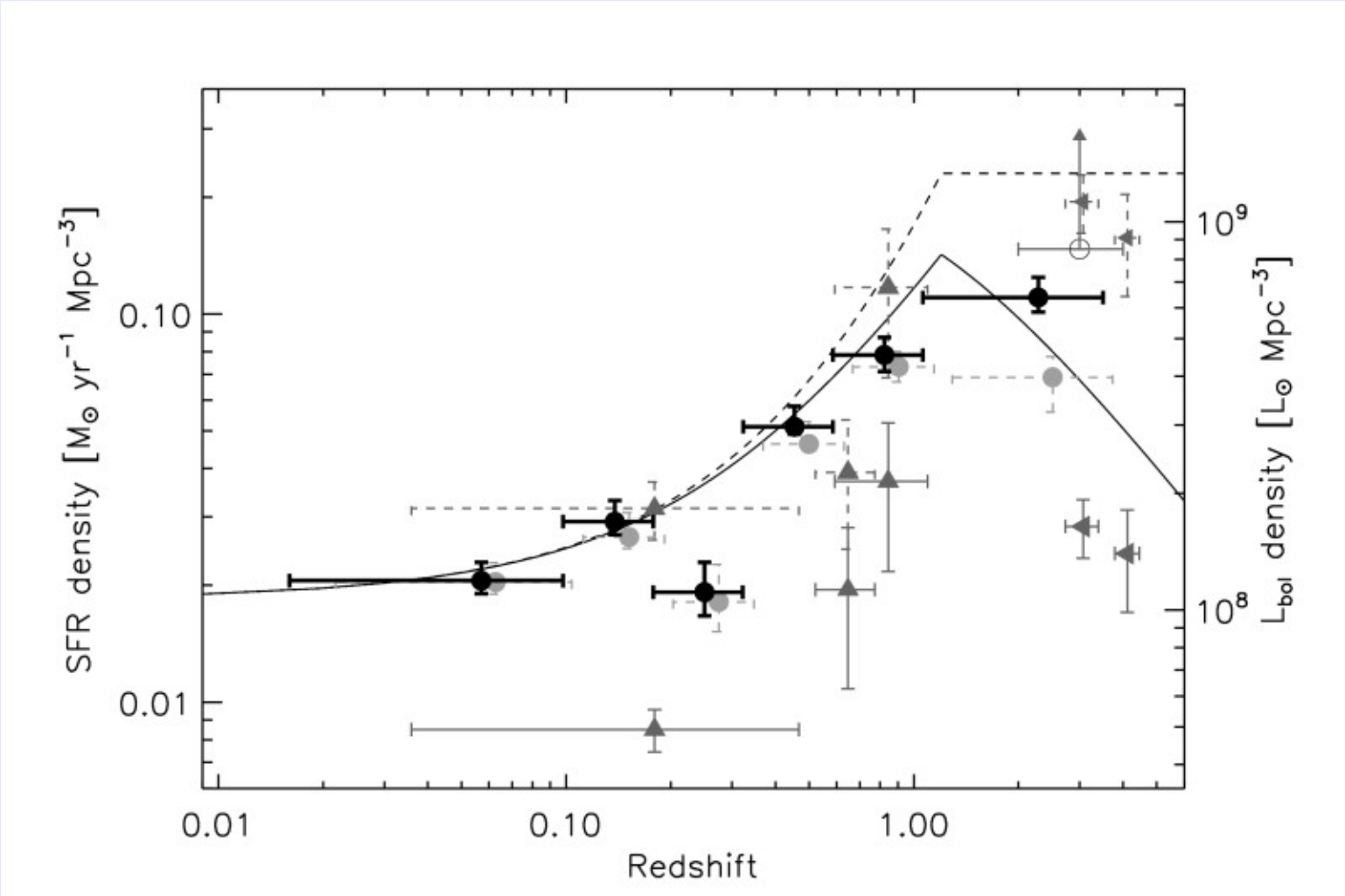


- 10 sq. deg. blank field extragalactic map.
- 1 sq. deg. Deep field in centre

CIB measured by BLAST



Star formation history



1999

BLAST proposed

2000

Design work begins

2001

Construction begins

Cryostat delivered to Brown

Gondola delivered to UBC

2002

Gondola shipped to UT

Cryostat shipped to Penn
Gondola shipped to Penn

2003

Gondola/cryostat integration
Star camera developed

Integration in Ft. Sumner

LAUNCH!

2004

Build 2nd star camera

Gondola back to UT

Cryostat to UT for integration

ISC flown on Infocus

2005

Receive 2nd detector array

Integration in Palestine TX, ship to Sweden

Receive last array
Integration in Sweden
LAUNCH!

2006

Redesign and rebuild

Integration and optics testing in Palestine, TX
Ship to Antarctica

Integration in Antarctica
LAUNCH!

2007

Data distributed amongst team members

BLAST05 papers submitted

2008

BLAST05 papers published
BLAST documentary premieres

BLAST06 paper submitted to Nature

2009

Nature paper published
Other BLAST06 papers (and data) released

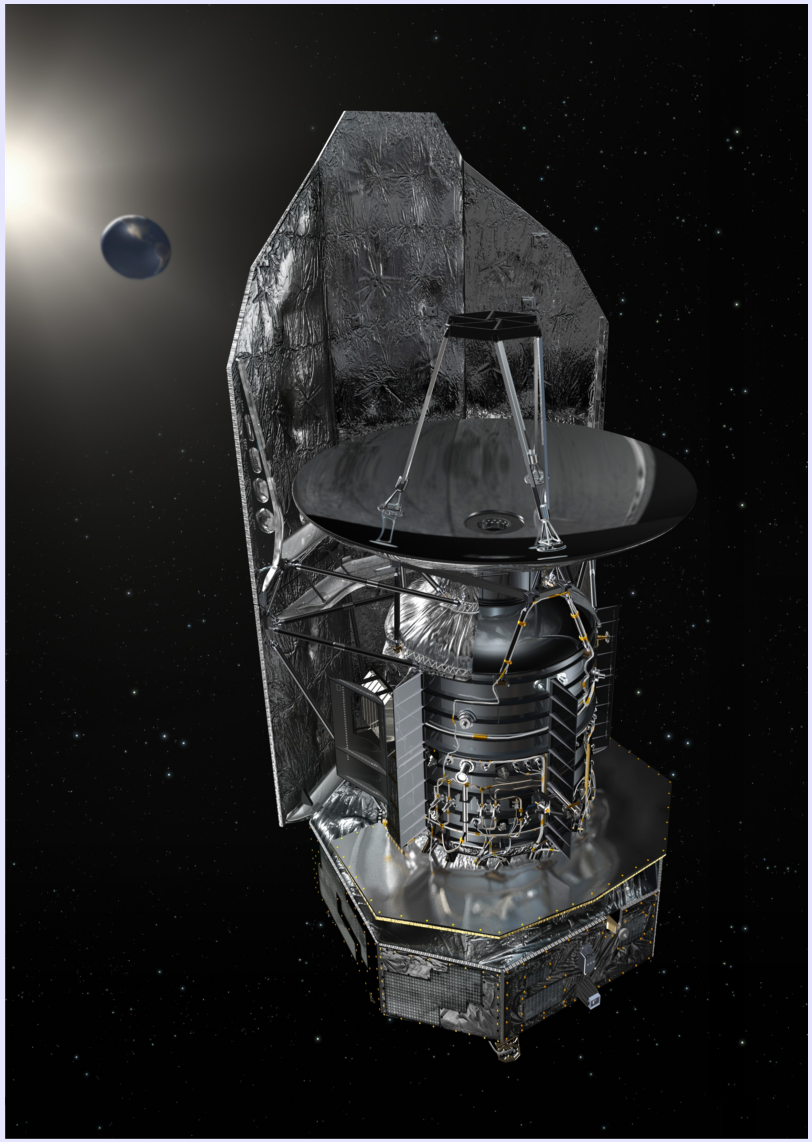
Herschel launches

More papers published

2010

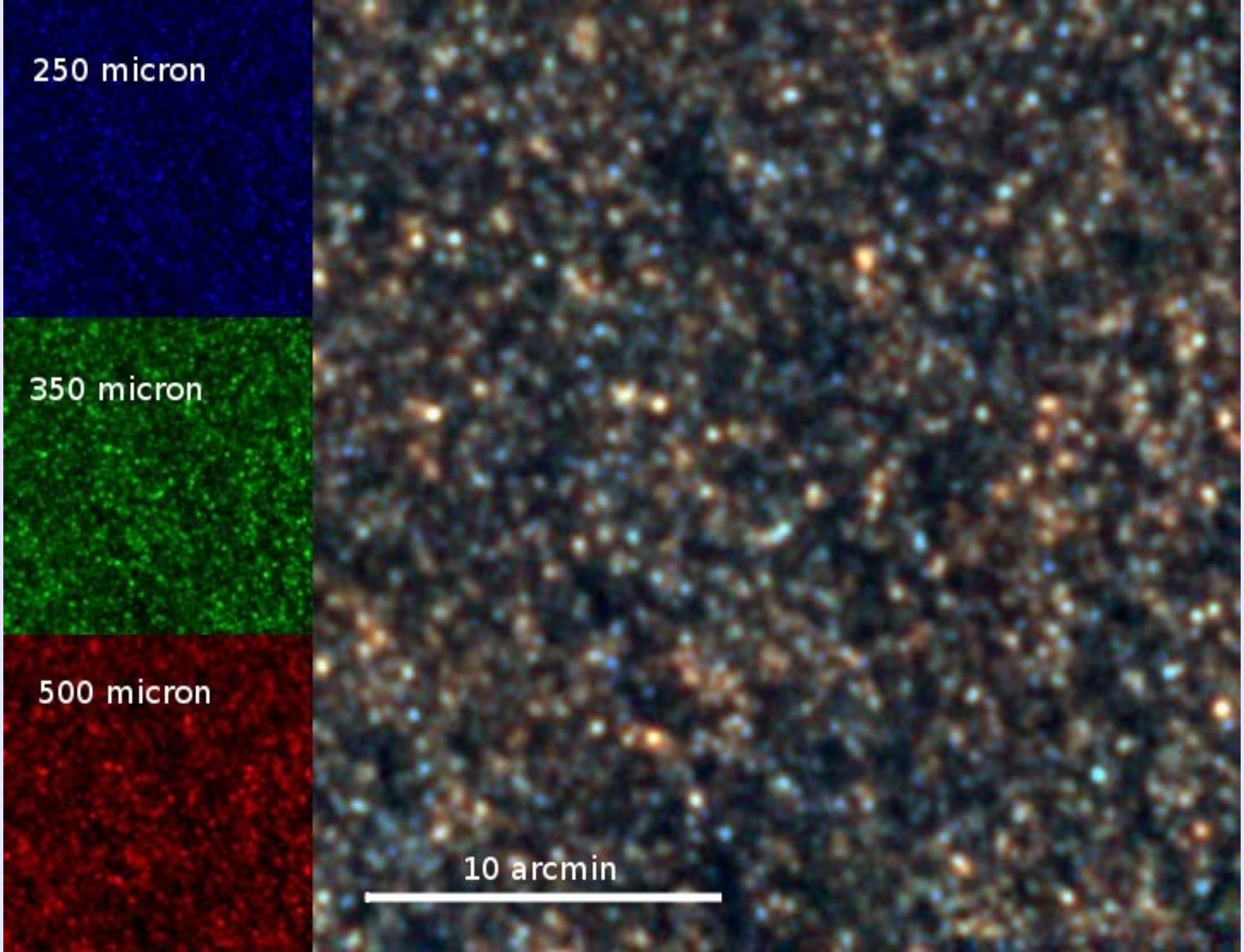
What's Next?

Herschel/SPIRE



- 3.5 metre mirror
- Detectors used by BLAST are copies of SPIRE detectors
- Launched May 2009, observations now underway

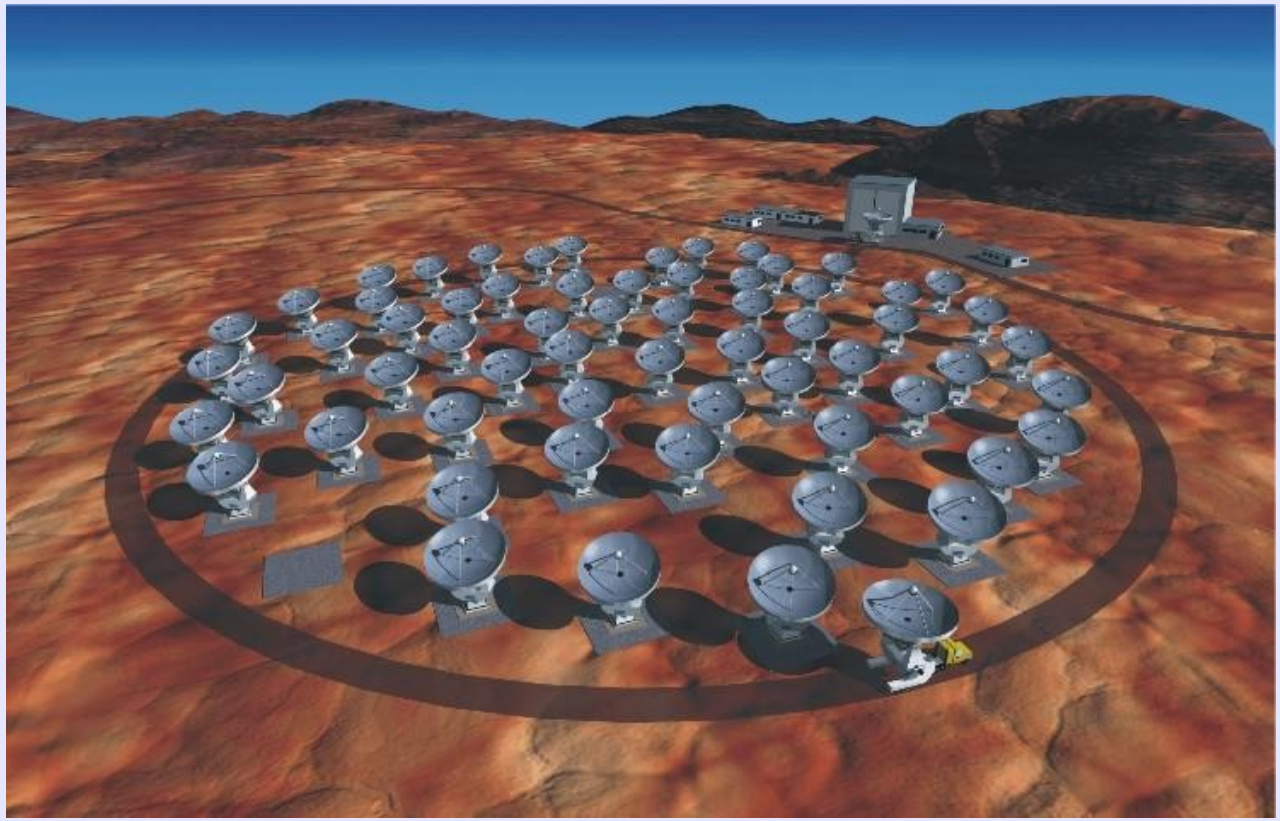
http://sci.esa.int/herschel/


250 micron
350 micron
500 micron
10 arcmin

SCUBA-2

- New detector technology
- 6000 pixels
- 450 and 850 μm
- Online this year

ALMA



- 60 X 12 m dishes
- Unprecedented sensitivity and resolution
- 2010?

http://blastthemovie.com

UPenn
Mark Devlin (PI)
Simon Dicker
Jeff Klein
Marie Rex
Chris Semisch
Matt Truch

INAOE (Mexico)
David Hughes

UBC
Ed Chapin
Mark Halpern
Gaelen Marsden
Douglas Scott
Don Wiebe

U of Puerto Rico/IRA-INAF
Luca Olmi

U of Miami
Josh Gundersen
Nick Thomas

Brown University
Greg Tucker

Cardiff University
Peter Ade
Matt Griffin
Peter Hargrave
Phil Mauskopf
Enzo Pascale
Carole Tucker
Bruce Sibthorpe
Lorenzo Moncelsi

U of T
Peter Martin
Barth Netterfield
Marco Viero

JPL
Jamie Bock

Université Paris Diderot
Guillaume Patanchon

http://blastexperiment.info