

Overview of APEX capabilities

Carlos De Breuck



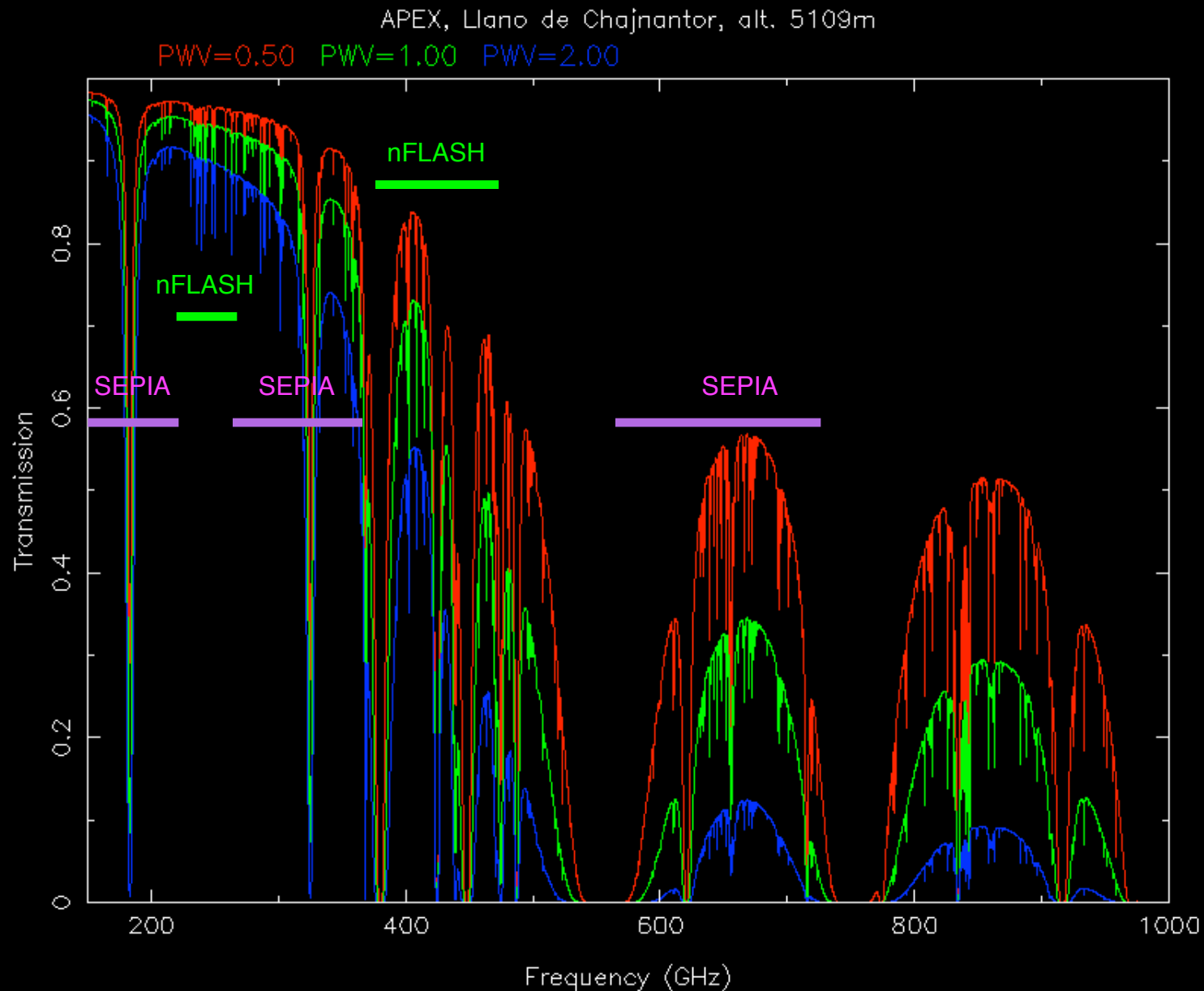
The APEX project

- Collaboration 55% MPG (MPIfR Bonn), 32% ESO, 13% Sweden (Onsala).
- All facility instruments open to all partners, as well as PI instruments in collaboration with the instrument teams.
- Telescope has just been upgraded to enable science operations till end of 2022, with improved surface accuracy & new wobbler.
- All observations are done in service mode to adapt to optimal weather conditions.

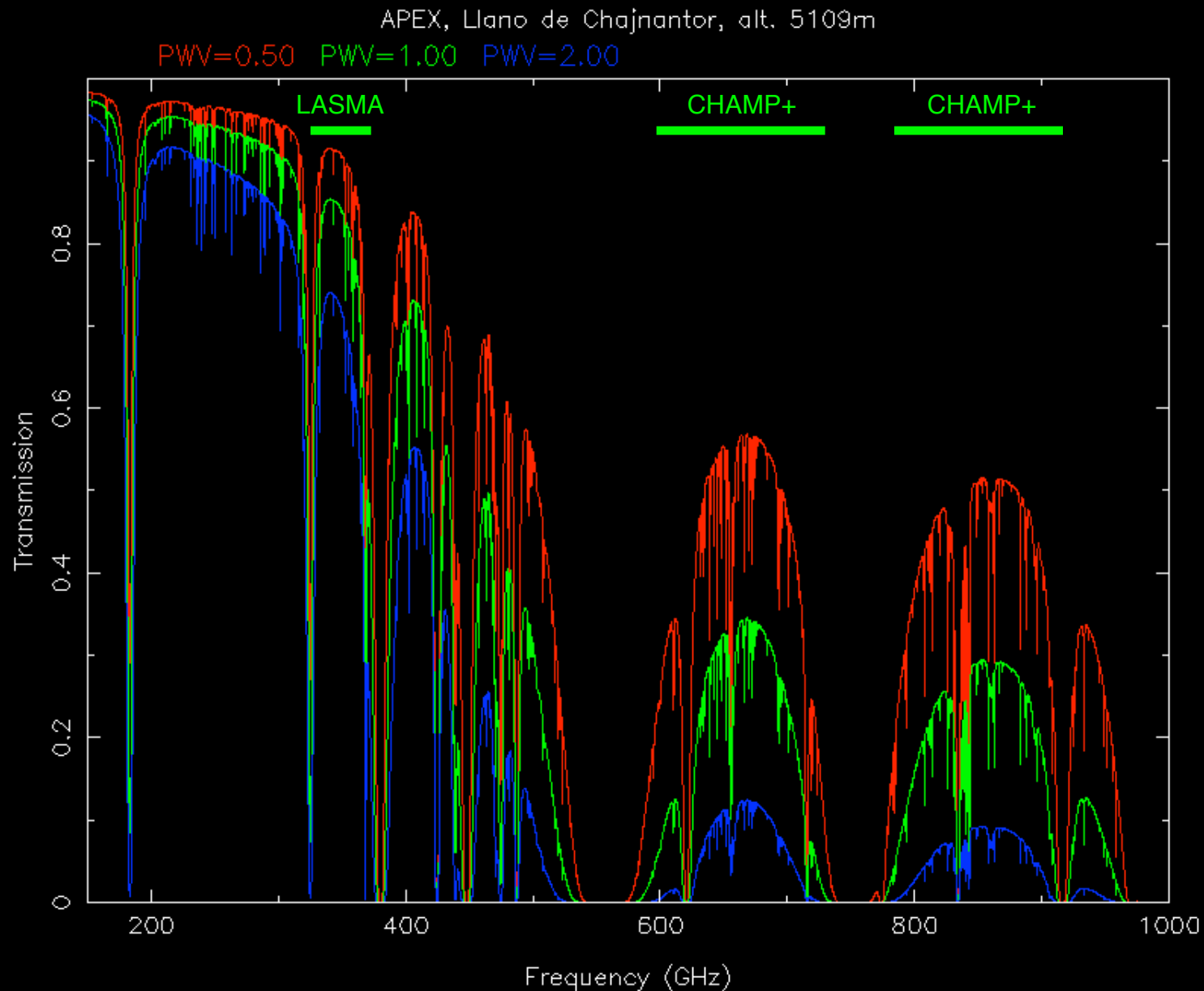
APEX instruments

- Heterodyne single pixel spectrometers (2SB 4-12 GHz IF bandwidth):
 - SEPIA: 159-211 + 270-375 + 600-722 GHz
 - nFLASH: 200-260 + 385-500 GHz
- Heterodyne arrays (7 pixels 2SB 4-12 GHz IF):
 - LASMA: 270-375 GHz (PI MPIfR)
 - CHAMP+: 620-720 + 780-950 GHz (PI MPIfR)
- Bolometer arrays:
 - LABOCA 870 μ m
 - Artemis 350 + 450 μ m
- Broadband spectrographs:
 - ZEUS-2 195-640 μ m

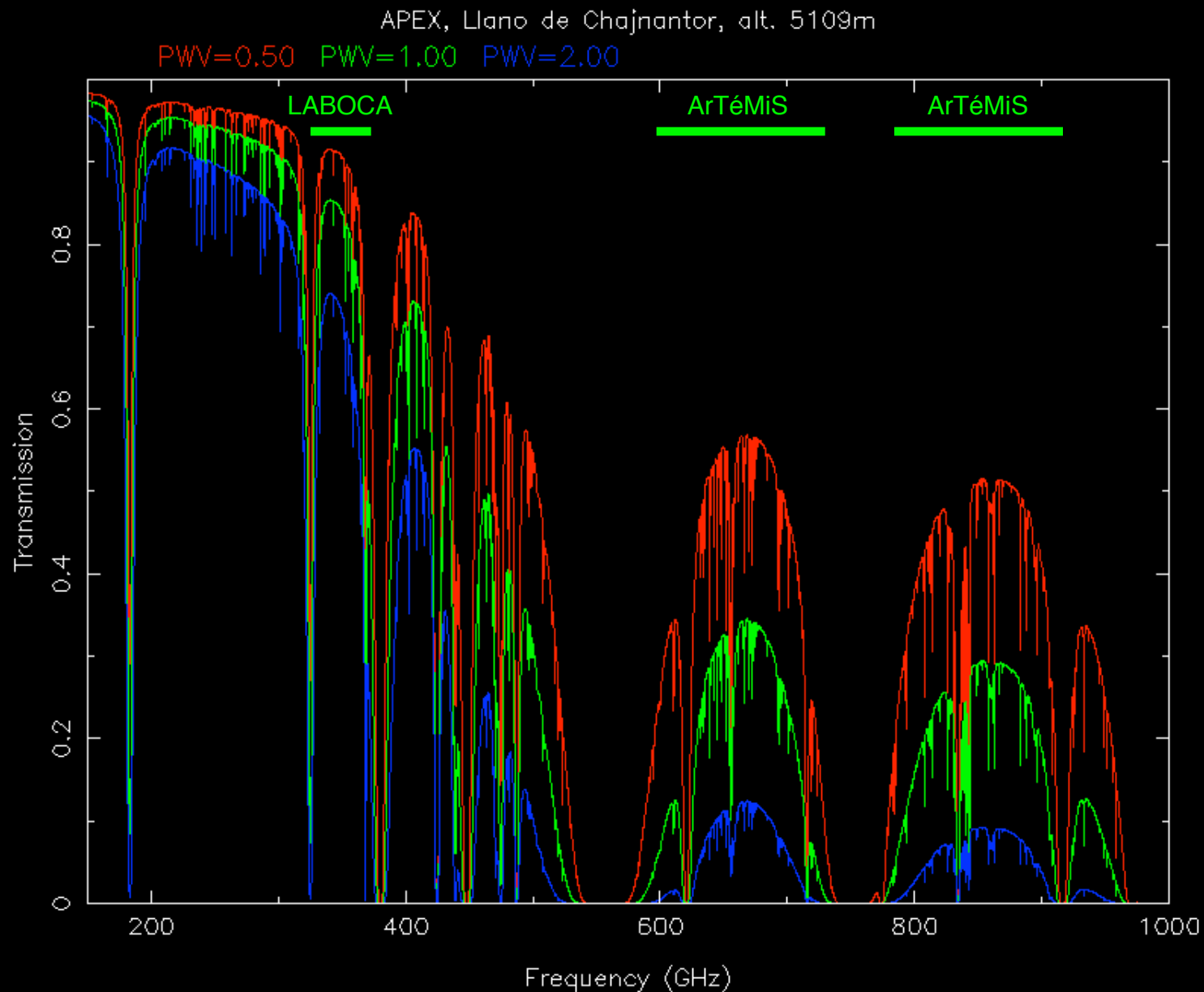
APEX Facility Heterodynes



APEX PI Heterodyne arrays



APEX bolometers

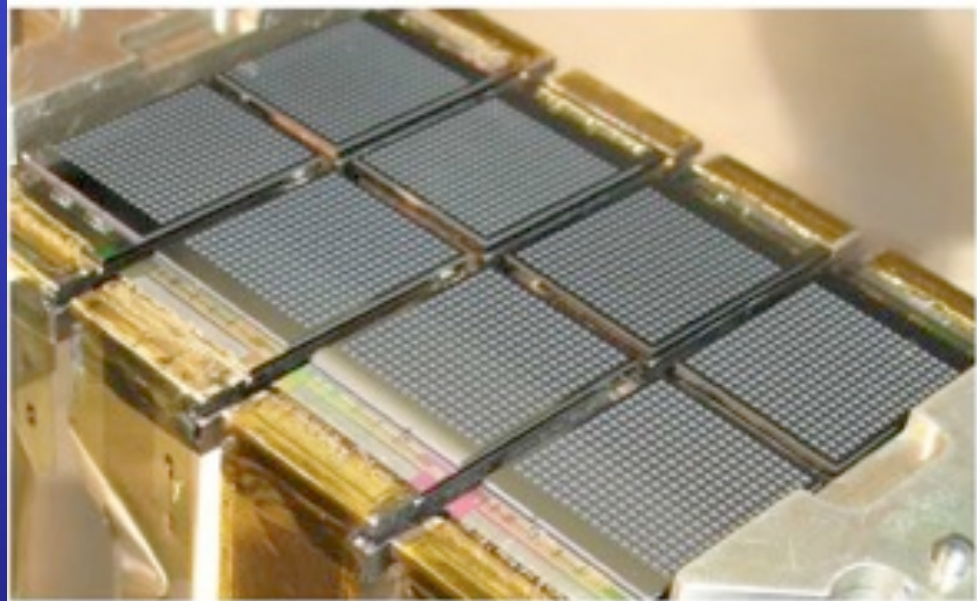
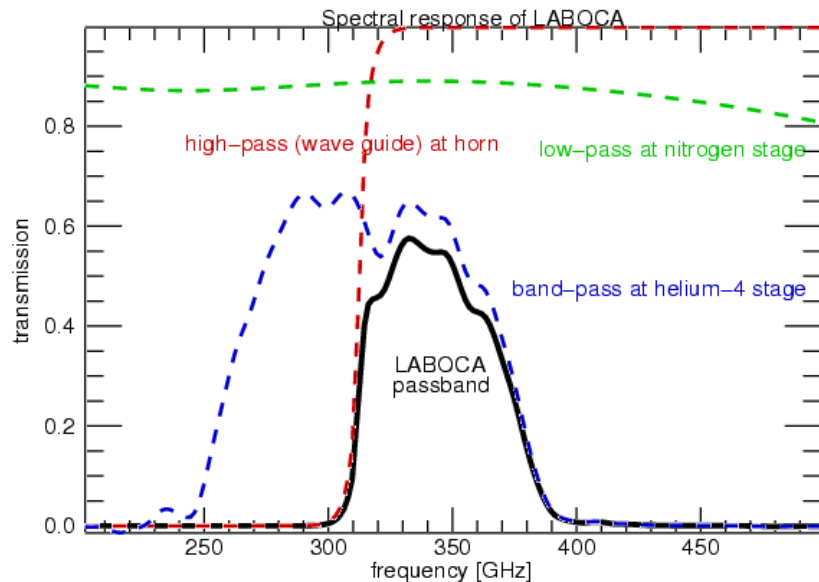


APEX backends

- All APEX heterodyne front-ends are connected to Fast Fourier Transform Spectrometer (FFTS) backends with 32k or 64k channels, bandwidths of 2.5 GHz (XFFTS) or 4 GHz (4GFFTS).
- Maximum spectral resolution is 0.015 - 0.07 km/s depending on frequency.
- New Facility IF processor + backends will allow to select the number of channels in case the maximum spectral resolution is not needed (significantly reducing data volume).

APEX bolometers

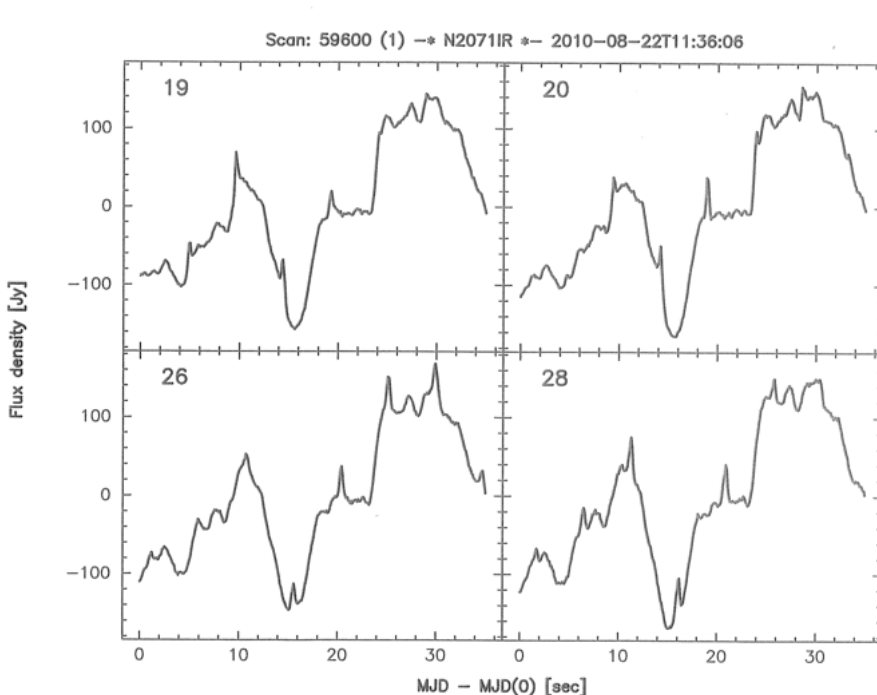
- LABOCA 870 μm array is now covering 10'x6'.
- ArTéMiS 450 μm + 350 μm array is covering 4'x2' simultaneously.
- Broad bandwidth makes them very sensitive for continuum observations.



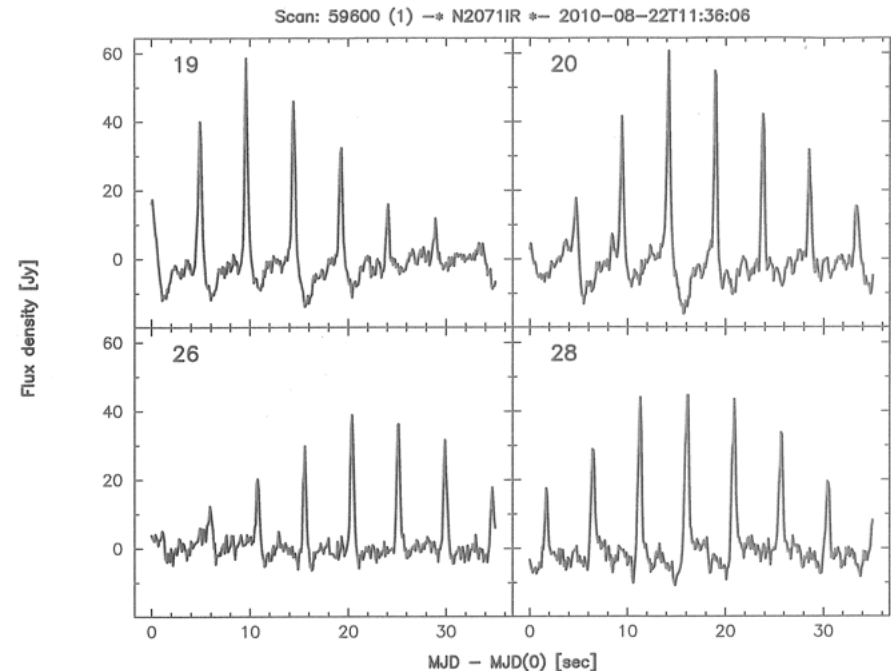
LABOCA time streams

- Sky \gg brighter than sources (except Jupiter).
- Sky signal is seen by all bolometers, allowing removal of correlated sky noise.

Before sky subtraction

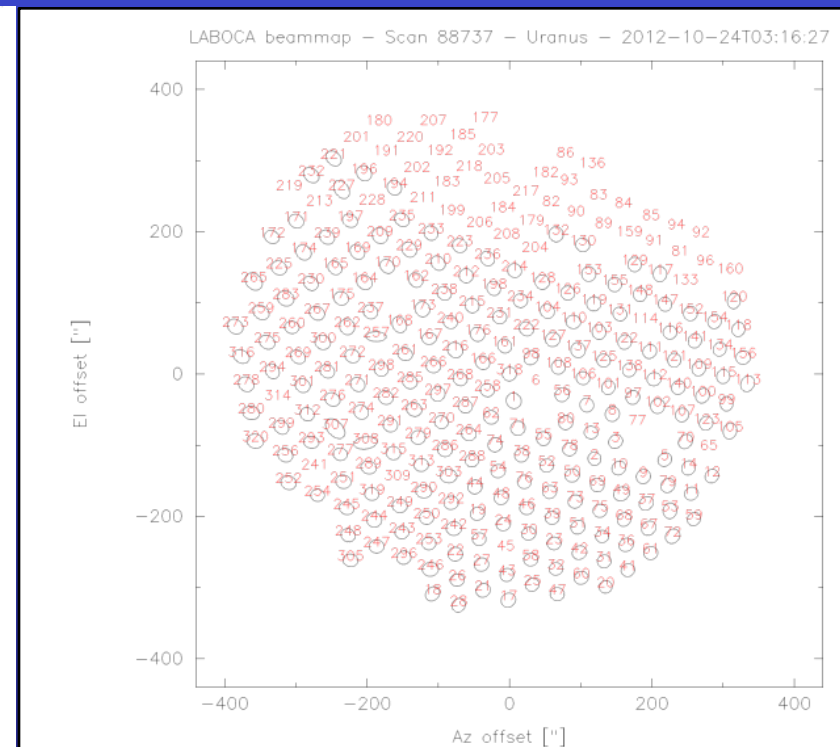
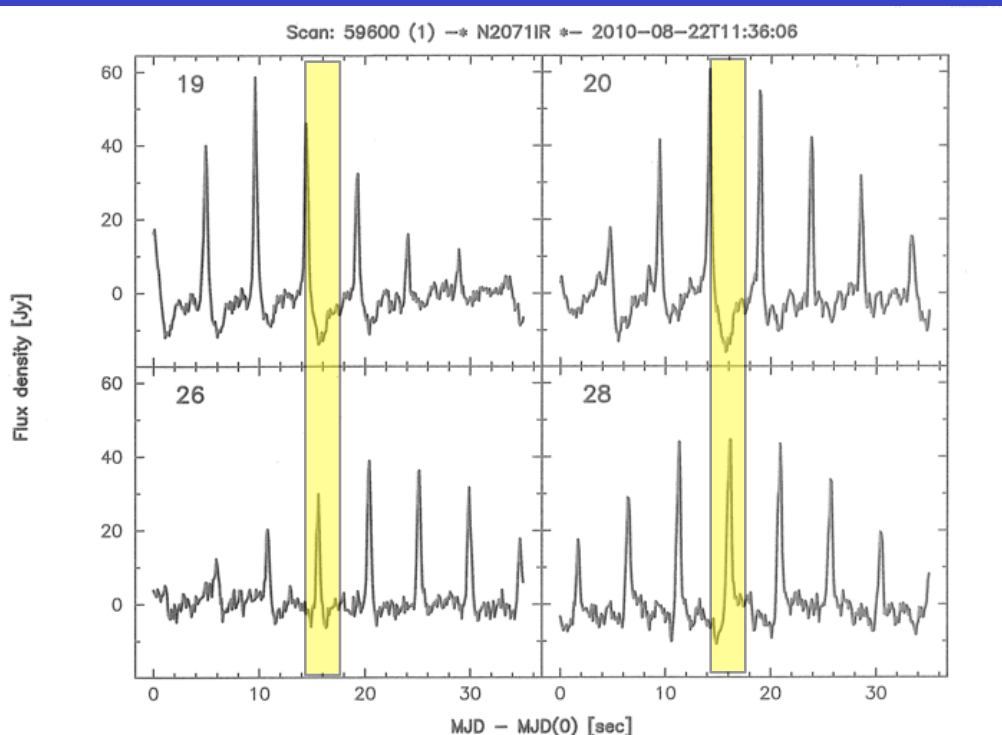


After sky subtraction



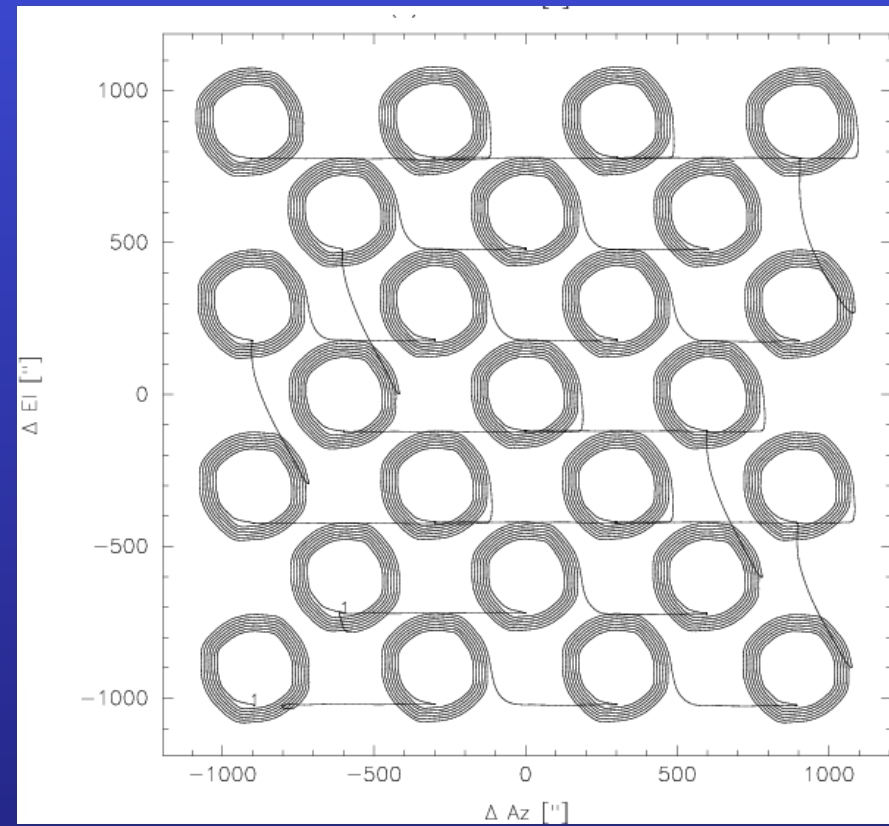
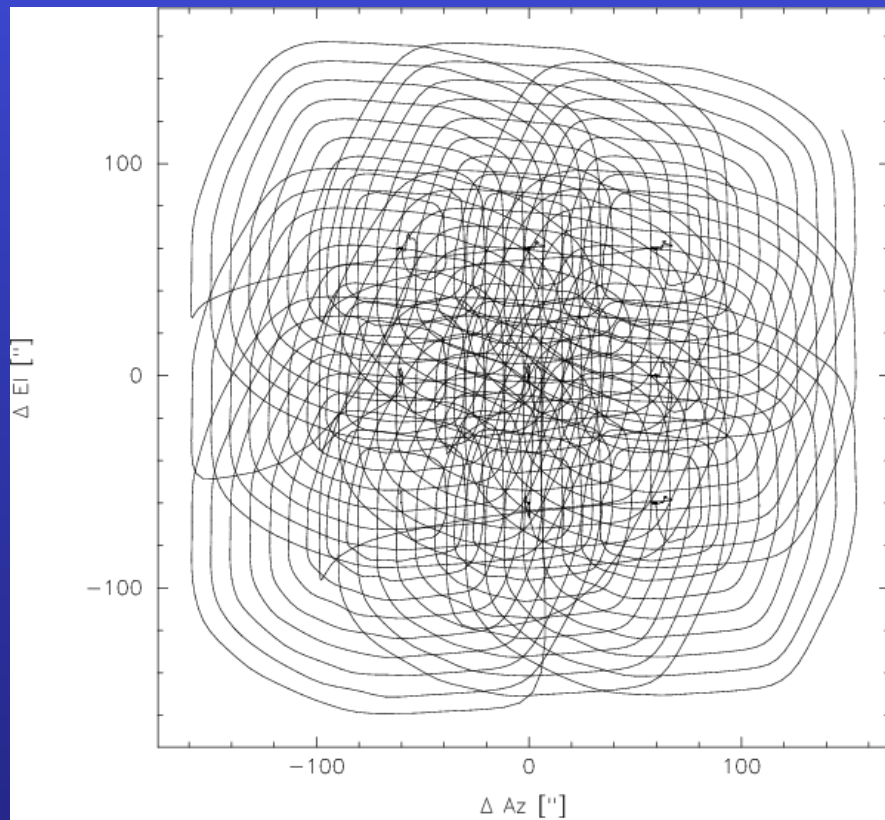
From time streams to maps

- Signal from a source is detected by several nearby bolometers while scanning.
- Use receiver parameters to map timestream on a RA-DEC map + correct for relative gains (flatfield).



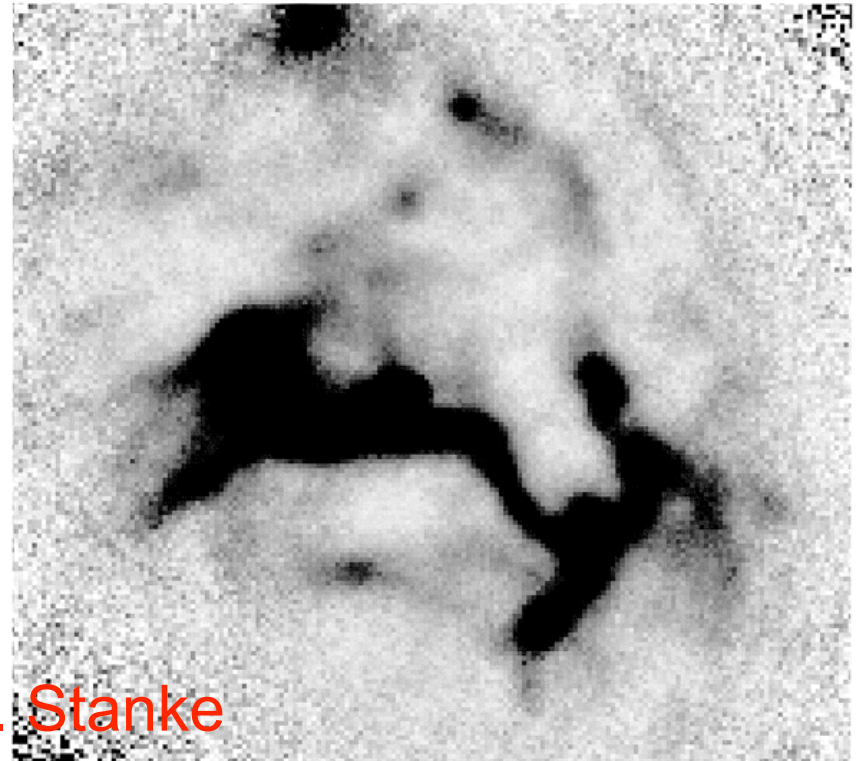
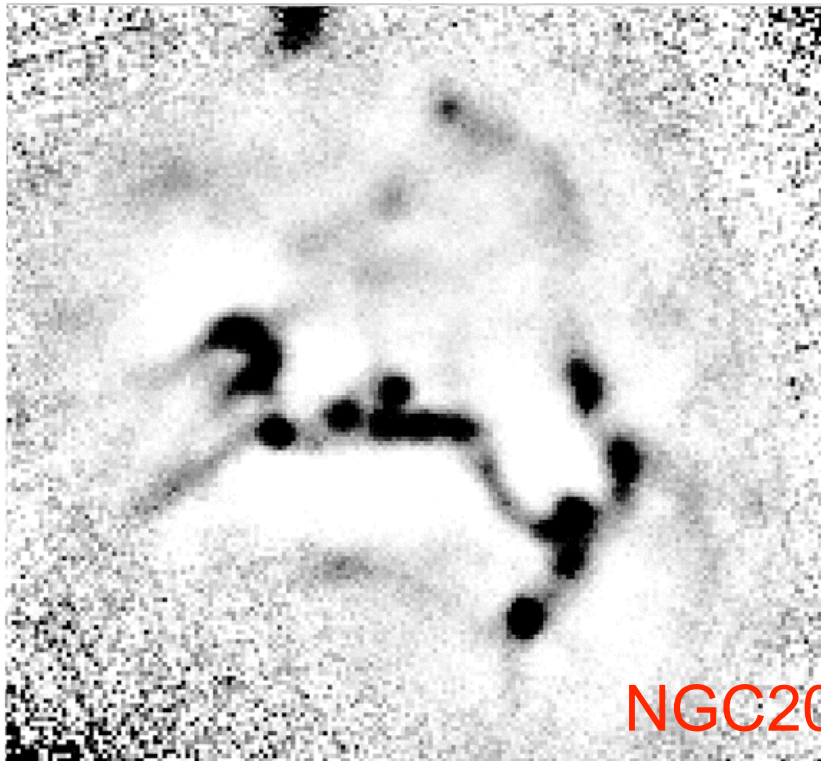
Fast scanning patterns

- Telescope needs to move faster over bolometer pixels than sky variations.
- Most used pattern are (raster of) spirals.
- For $>30'$ maps, On The Fly becomes more efficient.



Iterative source models

- Extended source structure may resemble sky noise variations in the time streams.
- Insert source model into time streams.
- >30 iterations needed to "clean" maps.



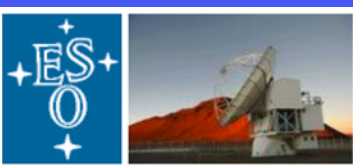
NGC2068, T. Stanke



APEX archive at ESO

- All APEX data are stored in the ESO archive, and from there distributed to PIs.
- Working on improving the network connection to make the data available within 2 days after observations.
- For bolometers, you want to download the MBFITS files. May want to revert to original file names using script: <http://www.eso.org/sci/data-processing/faq/arc2orig.sh>
- For heterodyne, you do NOT want the MBFITS, but rather the CLASS data, contained in the .TAR file.

Heterodyne data from ESO archive



SCIENCE ARCHIVE FACILITY

APEX D
Query Res

How to use?

Other Instruments

Archive FAQ

Archive Facility HOME

ESO HC

- To request the raw data please use the *Mark Raw* checkboxes, and then press the button labeled *Request marked datasets*, or, if available, press directly the button labeled *Request Dataset*, and log in with your [ESO user portal account](#).
- To request the associated data products, please follow the **Data Products** link to retrieve the observing logs and (in most cases) the quick reductions of the data, along with the scripts used to generate them. For **heterodyne observations**, the calibrated **CLASS** file is also therein included, while the corresponding [uncalibrated FITS files](#) cannot be handled with standard reduction software, and are not needed.
- Datasets for which the proprietary period has expired are highlighted in **green** and are publicly available.
- Datasets that are still under the proprietary period are highlighted in **salmon** and can only be downloaded by the corresponding PI.
- Datasets that are not yet available in the Archive are marked with a "N/A".
- Warning:** The exposure time for LABOCA may be underestimated due to the continuous data taking setup, which records only the exptime of the first subscan.
- Any comments or suggestions for improvement of this form can be sent to archive@eso.org.
- Note:** We request that any publication using APEX data adds the following acknowledgement as a footnote after the first mentioning of APEX in the body of the text:
"Based on observations with the APEX telescope under programme ID PPP.C.NNNN. APEX is a collaboration between the Max-Planck-Institut fuer Radioastronomie, the European Southern Observatory, and the Onsala Observatory."

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Mark Raw	Data Products	More	HDR	Object	Target Ra, Dec	Target l, b	DPR CATG	DPR TYPE	DPR TECH	Instrument Type	ExpTime	LINE	Rest Frequency [GHz]	Sky Frequency [GHz]
<input type="checkbox"/>	E-098.A-0513A-2016 products		Header	SPT0418-47	04:18:39.67 -47:51:52.7	254.695740 -45.018277	SCIENCE	OBJECT	SPECTRUM	APEXHET	400.000	SPT0418OIII	649.402778	649.359983
<input type="checkbox"/>	E-098.A-0513A-2016 products		Header	SPT0418-47	04:18:39.67 -47:51:52.7	254.695740 -45.018277	SCIENCE	OBJECT	SPECTRUM	APEXHET	400.000	SPT0418OIII	649.402778	649.359655
<input type="checkbox"/>	N/A		Header	SPT0418-47	04:18:39.67 -47:51:52.7	254.695740 -45.018277	CALIB	CAL	SPECTRUM	APEXHET	30.000	SPT0418OIII	649.402778	649.359393
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Get .TAR with CLASS file from this link!

Phase 3 reduced APEX data

- PIs are encouraged to upload reduced data products in the ESO archive.
- For bolometers: already available data from LESS and ATLASGAL surveys.
- For heterodynes, ALLSMOG data available, SEDIGISM to follow soon.

Phase 3 reduced APEX data

[GENERIC](#)[SPECTRAL](#)[IMAGING](#)[VISTA](#)

PHASE3 ARCHIVE INTERFACES

[HELP](#)[DATA TYPES](#)[FAQ](#)[DATA RELEASES](#)[DATA STREAMS](#)

This form provides access to **reduced or fully calibrated data sets**, and **derived catalogs**, that were contributed by PIs of ESO programmes or calibration data), and then integrated into the ESO [Science Archive Facility](#) starting April 2011, through the [Phase 3 process](#). Included are op

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Observation/Temporal Parameters

☐ [Telescope](#)

Any
APEX-12m
ESO-3.6
ESO-NTT
ESO-VISTA

☒ [Instrument](#)

Any
APEXBOL
APEXHET
EROS
FEROS

☐ [OBSTECH](#)

Any
CONTINUUM
ECHELLE
ECHELLE,ABSORPTION-CELL
ECHELLE,ABSORPTION-CELL,SLIC#3

Hints on APEX proposals

- LST pressure is not uniform. Galactic Centre is often more highly oversubscribed.
- PWV > 2mm conditions (200-300 GHz) are less demanded. Larger proposals solicited.
- 24h operations \Rightarrow sources observable in both periods. For high frequency work, submit when sources are observable during night + morning.
- Highlight synergy with other telescopes where possible (ALMA, VLT, ...).