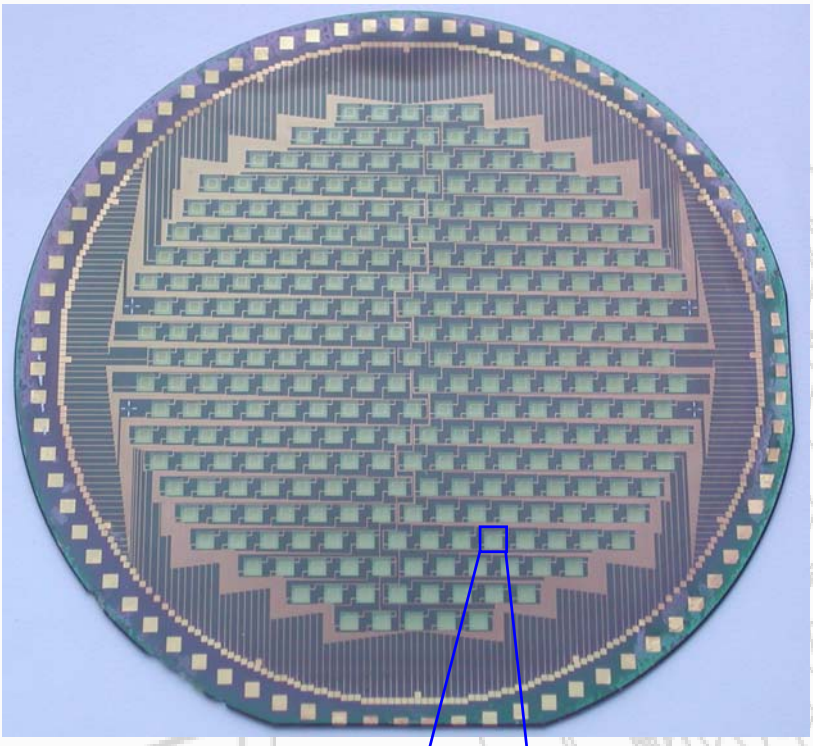
The Large Apex Bolometer Camera
LABOCA



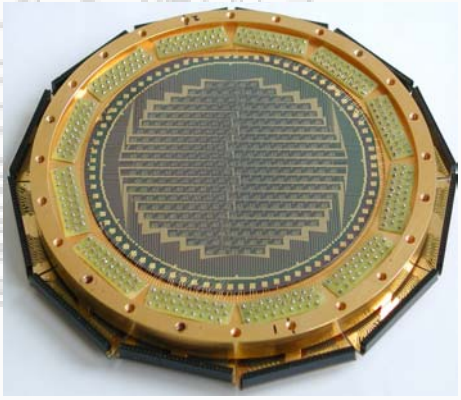
The New Generation

The Bolometer Development Group of the Max-Planck-Institut für Radioastronomie (MPIfR) has a long tradition in the design and production of bolometric receivers. The Large Apex BOlometer CAmera, LABOCA, is a new generation bolometer array, resulting from the experience and the know-how of many years of work in the field.

The first version of LABOCA has semi-conducting thermistors and will be soon installed on the APEX telescope. An enhanced version, with superconducting thermistors is already in preparation.

LABOCA is a collaboration between MPIfR, Astronomisches Institut der Ruhr-Universität Bochum and Institut for Physical High Technology of Jena.

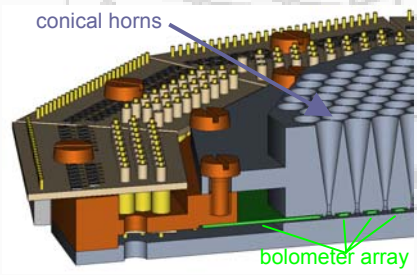
Bolometer Array



Horn Array

LABOCA is an array of 295 composite bolometers. The thermal, electrical and mechanical structure of the array is produced microlithographically on a single Silicon wafer (*in the picture above*). Free-standing Silicon-Nitride membranes have the double role of supporting

membrane (*the yellow square in the picture on the left*). The thermistors (*the small red square in the picture*) are Germanium semiconducting crystals doped by neutron-transmutation. The electro-magnetic radiation, collected by the APEX telescope, is concentrated on the bolometers by an array of conical horns. Bolometers are sensitive to radiation over a very wide range of frequencies and the frequency band of operation is determined by the size of the horns and by filters placed in front of the horn array. The system is designed and optimized to work at the central frequency of 345 GHz with a bandwidth of about 60 GHz, in order to match the corresponding atmospheric window.



substrate but also provide a weak thermal connection to the Silicon wafer. The absorbing element is the combination of a thin layer of Titanium, sputtered on the back side of the wafer, with a square ring of Gold, evaporated on the

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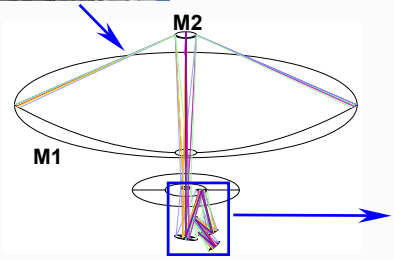
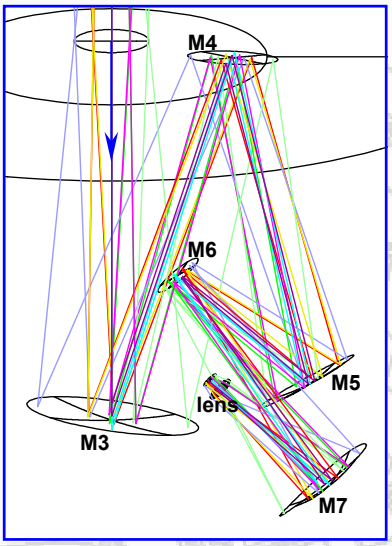
LABOCA@APEX





Beam path through LABOCA's optics. M3 is in common with APEX-SZ.

LABOCA will be a facility instrument on the APEX telescope. It will work in the Cassegrain cabin, shared with the APEX-SZ instrument. The division of the telescope beam between the two large instruments led to a high complexity of the tertiary optics. After telescope's primary and secondary mirror, the optical design includes other 5 mirrors (*3 concave, M3, M5, M7 in the picture on the right, and 2 flat, M4, M6*) plus a Quartz lens at the cryostat window. The mirror M6 can be replaced, when needed, by a polarization module which makes LABOCA also able to perform polarization observations.

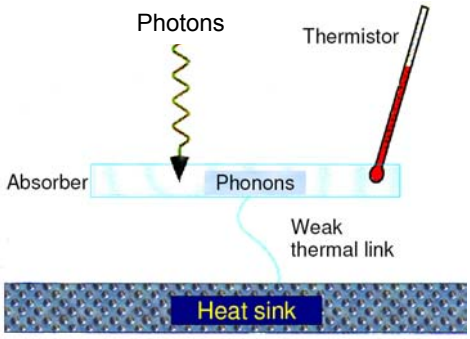
A 50 cm concave mirror being manufactured at MPIfR. The surface accuracy is 5 micron.

The backside of the mirror.

Electronics & Data Acquisition

The first amplification stage works at a temperature of about -180°C, inside the LABOCA's cryostat. The second amplification stage, at room temperature, is equipped with microprocessors to execute time-critical tasks, like real-time flat-fielding. The amplified signals of the 295 bolometers are acquired simultaneously at 200 Hz by a digital data acquisition system based on 16-bit analog-to-digital converters. The acquired data are sent in real-time, via Ethernet link, to the APEX control software. Time accuracy of 1 ms is guaranteed by a real-time inerface to the telescope's GPS clock. The hardware can be remotely controlled via network through a simple command interface.

Composite Bolometer



An absorber is kept at very low temperature (0.3 degree above absolute zero) by a weak thermal link to a heat sink. When electromagnetic radiation (photons) is absorbed, its energy is transferred to the absorber whose temperature will increase. A ultra-sensitive thermometer (thermistor) transforms the temperature variations of the absorber in electric signals, consequently amplified and processed by computers.

Data Reduction Software

A new data reduction software package, called *Bolometer Data Analysis* (BoA) has been written specifically to be used for data obtained with bolometer arrays. Boa is based on the high-level scripting language Python. The software will provide instantaneous feedback to the telescope's control software for pointing and focusing, correlated sky-noise removal algorithms and a sky opacity monitor. BoA is a collaborative effort of the MPIfR and the Astronomisches Institut der Ruhr-Universität Bochum.

The Next Generation

An array of 288 composite bolometers with superconducting thermistors and superconducting quantum-interference devices (SQUIDs) for multiplexing and amplification, is already in preparation, in collaboration with the Institut for Physical High Technology of Jena.

www.mpifr-bonn.mpg.de/staff/gsiringo/laboca