Archeops simulations, quicklook and online processing DRAFT 0.0

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Abstract

We give a short summary of our ongoing efforts towards simulating archeops data and preparing the Archeops online "quick-look" analysis.

1 Objectives

The objectives are to be ready for Archeops quicklook. We identify the following main tasks to be executed online (list to be completed):

- quick deglitching
- cosmic ray hits statistics
- data visualisation on plots for all detectors
- computation of pointing for all bolometers
- check consistency with galaxy crossings in the data
- computation of expected dipole and dust signals for computed pointing, for all detectors
- calibration on dipole and on dust - comparison
- calibration on available point sources (planets...)
- subtraction of dipole and dust signals (first-order) for noise estimation
- noise level and noise spectrum assessment (as a function of bolometer parameters), comparison with predictions
- check for payload pendulation using star sensor and gyro (as a function of spinning frequency?)
- look for payload pendulation effects in the data

- extract balloon altitude from GPS information
- look for balloon altitude effects in the data
- bolometer data reprojection on maps

Simulated data are required to implement and test raw-data to TOI software, and TOI to useful information quicklook packages.

2 Strategy and methods

The strategy we adopted is to simulate data for the Archeops mission in Trapani using and adapting existing software in IDL. The data simulated in this way includes relevant instrument, mission and observing strategy information, and bolometer signals for all six Trapani bolometers. Bolometer signals include signal from the sky (dust using Schlegel map, CMB dipole, CMB anisotropies generated using CMBFAST). It can or will include low-frequency drifts and sidelobe signals from Sky and Earth (best estimates), as well as rough estimates of correlated drifts due to atmospheric emission (if required and relevant). The method and structures for the simulation is inspired from the work done by the Planck HFI team for phase A and the answer to the AO (especially from LAMBADA and TANGO softwares).

Partial information is stored in a file containing for each data point the following information: Universal time, Longitude and Latitude of Balloon above the mediterranean sea, Azimuth, and sky specific intensities in the directions pointed at by each individual detector.

This information is then read and converted into raw archeops data in the archeops.h format of Alain Benoit. The simulated data includes simulated star sensor data computed using balloon position, time and azimuth-elevation information of the optical axis, using a star catalog, and can/will include GPS, gyro and magnetometer information if required and relevant.

This permits to develop and check the phase 1 of the quick look analysis: using star sensor information to recover pointing information, and comparing with input pointing computed; real-time plotting of the data, checking dipole signal and galaxy crossings, assessing noise level, reprojecting data on sky.

The use of IDL has been chosen for the simulations because of the practical consideration of the very short time left to produce a useful quick-look analysis for Trapani. We do the first order simulations for Trapani using adaptations of existing software. Preference is given to C/C++ in any new developments relevant to the production of TOI from raw data, in a way compatible with a JAVA user-interface. Some quicklook IDL tools are or will be adapted from existing LAMBADA or IDL-library visualisation software.

3 Data simulation: Current status

The available IDL software useful for data simulations include packages for loading instrument and mission parameters, packages for computing the geometry of observations, and packages for reading data from existing sky maps. These programs are available to the Archeops collaboration (ask Jacques Delabrouille, j.delabrouille@cdf.in2p3.fr).

3.1 Instrument and mission parameters

LOAD_ARCHEOPS.PRO loads instrument and mission parameters. Relevant used structures are:

band:	band.nu0	central frequency
	band.width	$\delta\nu/\nu_0$, set to 0.25
	band.tabnu	table of frequencies between 1 and 1000 GHz
	band.filter	table of corresponding transmissions
beam:	beam.fwhm	FWHM
	beam.shape	string, 'GAUSSIAN', 'TOPHAT', 'DIRAC',...
	beam.pixsiz	pixel size for main beam map
	beam.map	map of main beam, typically DBLARR(7,7)
lobe:	lobe.pixsiz	size of the pixel for the 4π lobe map
	lobe.map	lobe map, of the type SINEMAP used in LAMBADA
det:	det.channel	integer giving the channel number
	det.etendue	beam etendue for the detector in m.sr
	det.dtheta	position shift of detector FOV towards spin axis
	det.dpsi	position shift of detector FOV along the scan
	det.nep	NEP
	det.nep_units	NEP units
	det.efficiency	radiation absorption efficiency
	det.band	structure of type "band"
	det.beam	structure of type "beam"
	det.lobe	structure of type "lobe"
ins :	ins.det	array of structures of type "det"
	ins.ndet	number of detectors for instrument
	ins.nchan	number of frequency channels of instrument
	ins.theta	scan angle, 49° for Trapani
	...	
mis :	mis.duration	six hours
	mis.launch_lon	degrees E
	mis.launch_lat	degrees N
	mis.launch_site	'TRAPANI' for the Sicily mission
	mis.start_date	July 8th, 20h UTC
	mis.time_zone	set to 0, work in UTC
	mis.fspin	spinning frequency
	mis.nturns	number of turns
	mis.drift_speed	DBLARR(2) wind, m per second, $[\rightarrow E, \rightarrow N]$
	mis.lon_bal	longitude of balloon at the beginning of each circle
	mis.lat_bal	latitude of balloon at the beginning of each circle
	mis.ra_spin	RA 2000 of spin-axis at the beginning of each circle

mis.dec_spin	dec 2000 of spin-axis at the beginning of each circle
mis.lon_spin	longitude in degrees
mis.lat_spin	latitude in degrees
mis.coord	coordinate system, equatorial by default
mis.equinox	equinox 2000 by default
mis.zbal	altitude in m
mis.time	in hours since startdate, for each data sample
mis.nni	number of revolutions
mis.nnj	number of points per revol.

3.2 Detector pointings

POINTING_ARCHEOPS.PRO loads detector pointings in a structure:

fov :	fov.lon_beam	DBLARR(mis.nnj, mis.nni, ins.ndet)
	fov.lat_beam	DBLARR(mis.nnj, mis.nni, ins.ndet)
	fov.lon_spin	DBLARR(mis.nnj, mis.nni)
	fov.lat_spin	DBLARR(mis.nnj, mis.nni)
	fov.coord	'q','e' or 'g' for equatorial, ecliptic, galactic
	fov.equinox	2000, useful only if fov.coord='q'

Although fov.lon_spin and fov.lat_spin seem to be redundant with mis.lon_spin and mis.lat_spin, they are meant to allow the simulation of spin-axis deviations due to pendulations (to be coded and optimised).

3.3 Reading Data

READ_MAP_WITH_ARCHEOPS.PRO reads data on maps

INPUTS:	ins, mis, fov :	for mission
	template:	a map
	spectrum:	an IDL function name, as 'dbnu_dt' or 'dust_spectr', to integrate in the bands loaded in "ins.det.band", using function BANDINTEGRATE.PRO
OUTPUTS:	dat: DBLARR(mis.nnj, mis.nni, ins.ndet)	
KEYWORDS:	maptype:	for the moment only 'sinemap' and healpix 'ring' are implemented, 'sinemap' is the default
	beamsmooth:	to smooth the map using the input (asymmetrical) main beam maps if necessary, currently being implemented.

BANDINTEGRATE.PRO integrates a spectrum in a band of the type of the structure 'band'.

3.4 Sidelobes

A model of the archeops lobe has been obtained from GRASP8 computations of a Planck 30GHz LFI lobe, by proper reorientation of the pattern. It is of course indicative only. The lobe.map has the format of a 'sinemap'. Convolution tools exist to compute the sidelobe convolution

signal from the sky, but still need to be interfaced. Convolution tools are in preparation to compute the sidelobe convolution signal from the Earth, using as an input Earth temperature as a function of latitude and longitude.
JD include map of sidelobe pattern adapted for Trapani detectors.
JD include results of sky sidelobe computations for the Trapani configuration.
(TBD) include map of Earth temperature data.

3.5 Atmosphere

We use Pardo ATM code to estimate the atmosphere opacity and emissivity between 38 and 42 km, at zenith angles between 47 and 51 degrees. The objective is to estimate the effect of pendulation or of altitude shifts of the balloon.

Integrating the atmospheric emission over the three bands with a top-hat transmission allowed us to estimate the power per unit surface and solid angle received from the atmosphere at the altitudes and zenith angles quoted above. We compare this power with what we expect from the CMB and from 30μK anisotropies in table 1.

	143GHz	217GHz	353GHz
4° zenith angle shift	2×10^{-11}W.m^{-2}.st^{-1}	5×10^{-10}W.m^{-2}.st^{-1}	2×10^{-7}W.m^{-2}.st^{-1}
4 km altitude shift	3×10^{-11}W.m^{-2}.st^{-1}	8×10^{-9}W.m^{-2}.st^{-1}	10^{-6}W.m^{-2}.st^{-1}
CMB $\Delta T = 30\,\mu K$	4×10^{-12}W.m^{-2}.st^{-1}	8×10^{-12}W.m^{-2}.st^{-1}	8×10^{-12}W.m^{-2}.st^{-1}

Table 1: Order of magnitude variation of the power expected from the atmosphere for a 4 degrees shift in zenith angle and for a 4 kilometers shift in altitude in each band. We also quoted the power expected from the CMB and from 30μK anisotropies.

3.6 Generating Simulated Raw data in mac format

The data generated with the IDL packages is used as input to generate raw archeops data. In the current version, bolometer data is stored, and azimuth-elevation information from IDL is used to read the GSC star catalog and simulate star sensor data. The pointing of the star sensor is directly computed from UTC, azimuth and elevation information to simulate the signal on the two bars of the star sensor. The pointing computed in this way is compared to the pointing computed with IDL for the central detector, for consistency.

White noise and cosmic ray glitches are added at this stage of the simulation to interpolated data. Raw telemetry blocks are then generated (at the moment, param, reglage, GPS, bolo and star sensor blocks) and saved in the standard archeops format.

4 Visualisation software and TOI production

4.1 Real-time display of stellar sensor data

In the archediab real-time software, star reconstruction is performed, and stars are displayed in a radar-like fashion. In parallel, the attitude reconstruction software runs, finds the orientation

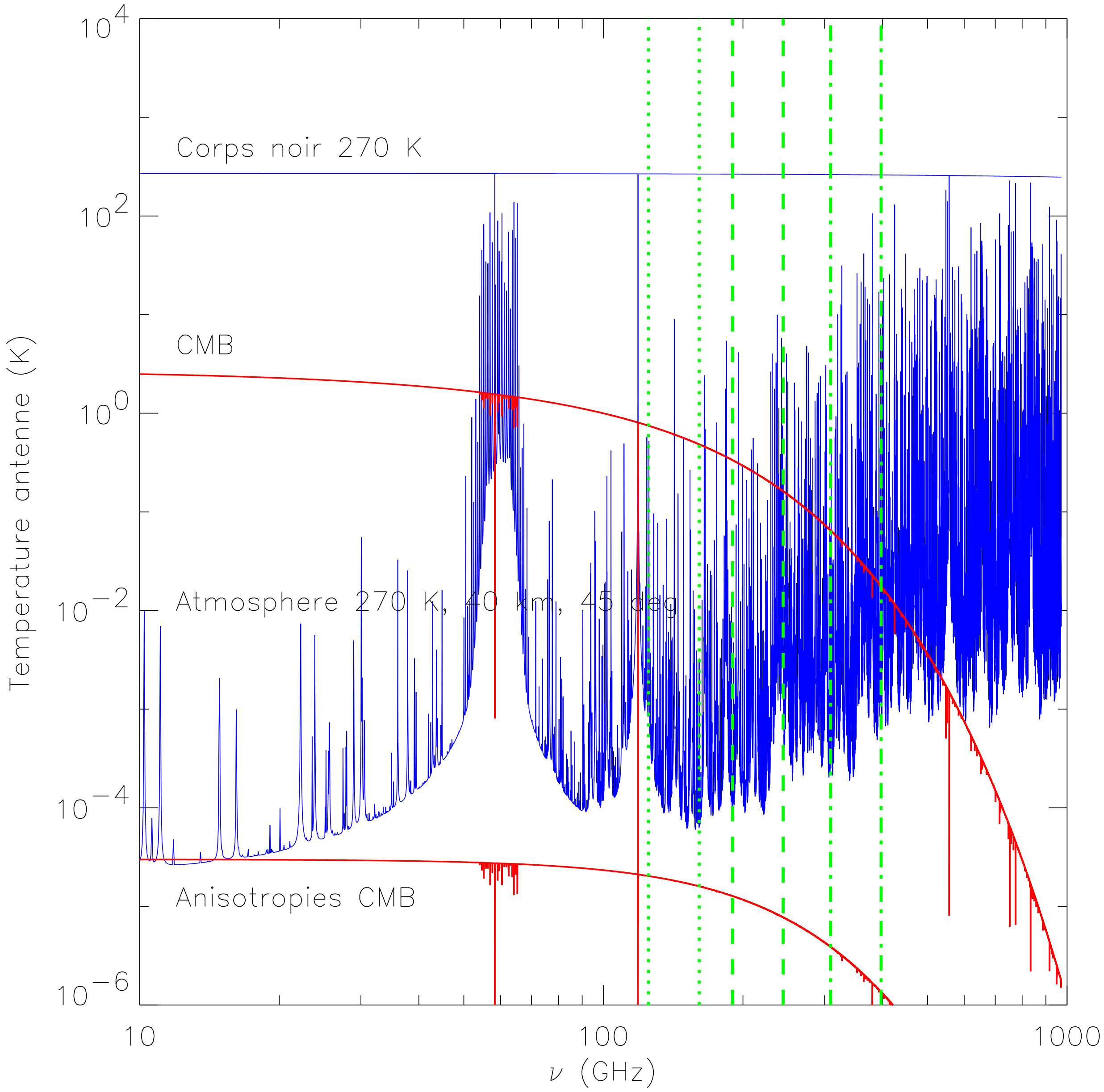

Figure 1: This figure shows the levels of CMB emission, atmosphere emission at 40 km and elevation 41°, and 30 μK CMB anisotropy

of the axis, the rotation speed and phase, and displays a prediction of forthcoming star crossings.

4.2 Getting pointing information from stellar sensor data

FC describe this.

4.3 Production of TOI from archeops files

A Time-ordered information (TOI) server is being developed, in C++. Its object-oriented architecture will allow an evolution towards Java and CORBA for future missions. A list of low-level TOI informations can be requested, such as pointing information, balloon position, bolometer configuration and signal, along with a start and a stop time. For each time for which a "triggering" TOI gets a new value, a new set of values for all TOI's becomes available, consiting either of new, extrapolated or interpolated values.

A very simple program using this C++ architecture will save ASCII tables that can be read in IDL for nearly-real-time analysis of data in Trapani.

4.4 Other visualisation software

Projection of data on map ready. JD describe the software.