HIFI AOT description

Herschel Open Time Key Programme Workshop

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On behalf of the AOT designers (V. Ossenkopf, P. Morris, T. Marston, …)

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Why do we need observing modes ?

- The HIFI detectors are affected by drifts, that need to be monitored and cancelled out on various timescales

→ Observing modes consist of sequences of single (*total power*) observations towards various line-of-sights

- Observations *ON-source* and *OFF-source*
  - Cancel out sky background
  - Cancel out instrumental noise
- Observations of *internal calibrators* (photometric references)
  - Calibrate instrument response function (*bandpass*)
  - Scale data into a physical unit (e.g. brightness temperature)

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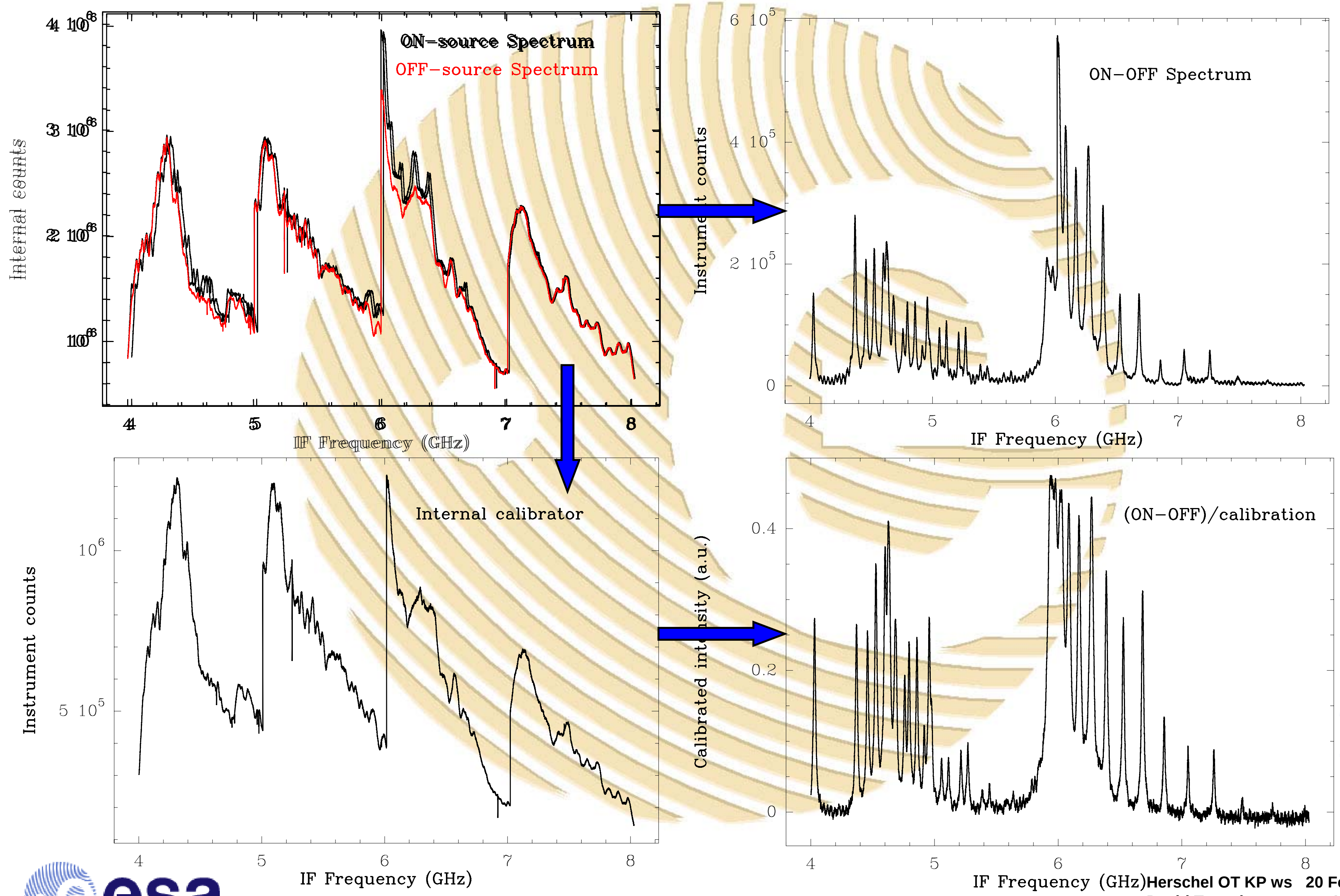
Need for observing modes: an example



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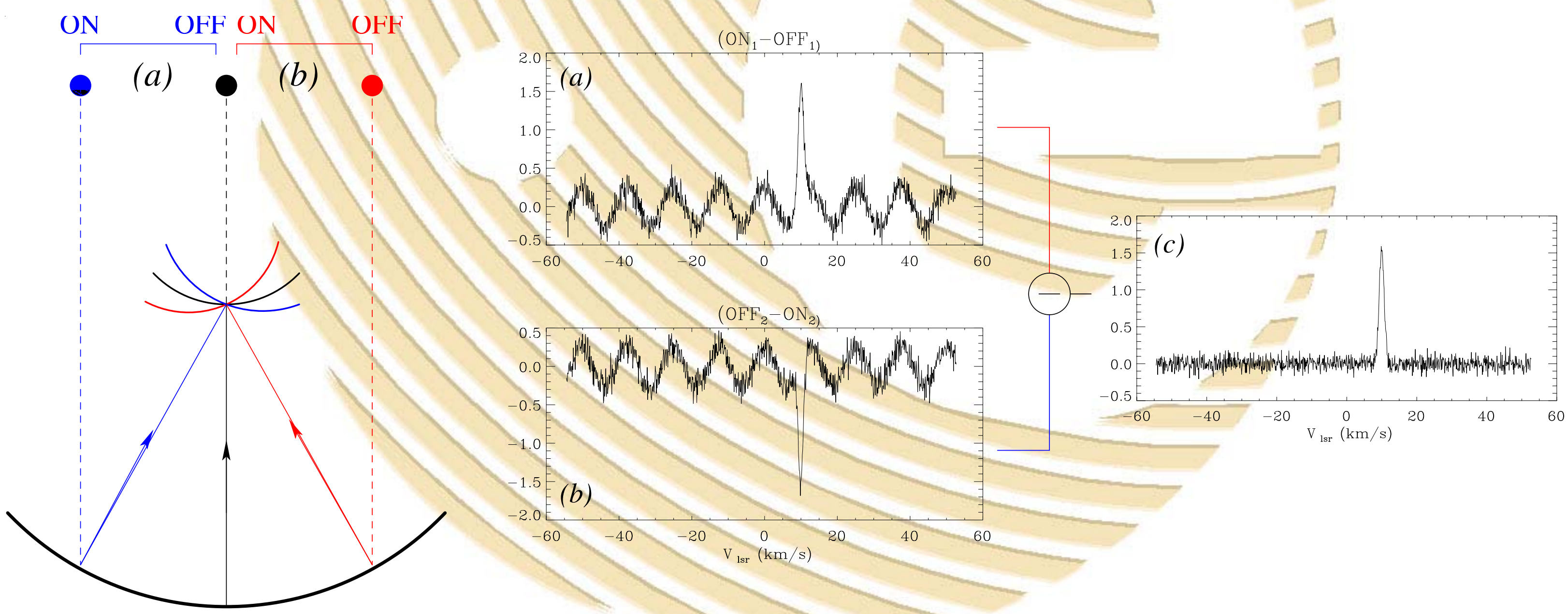
The HIFI reference schemes

- *Position Switching*: the whole telescope is moved between the various line-of-sights on the sky
- *Dual Beam Switching*: the internal chopper mirror is switched to a nearby position (< 3 arcmin)



The HIFI reference schemes

- *Position Switching*: the whole telescope is moved between the various line-of-sights on the sky
- *Dual Beam Switching*: the internal chopper mirror is switched to a nearby position (< 3 arcmin)
  - *Slow-chop* option: when not interested in accurate measurement of the continuum
  - *Fast-chop* option: for a more accurate measurement of the continuum (e.g. absorption line measurements), or *very* broad lines
  - Note that chopper direction on the sky moves with the date

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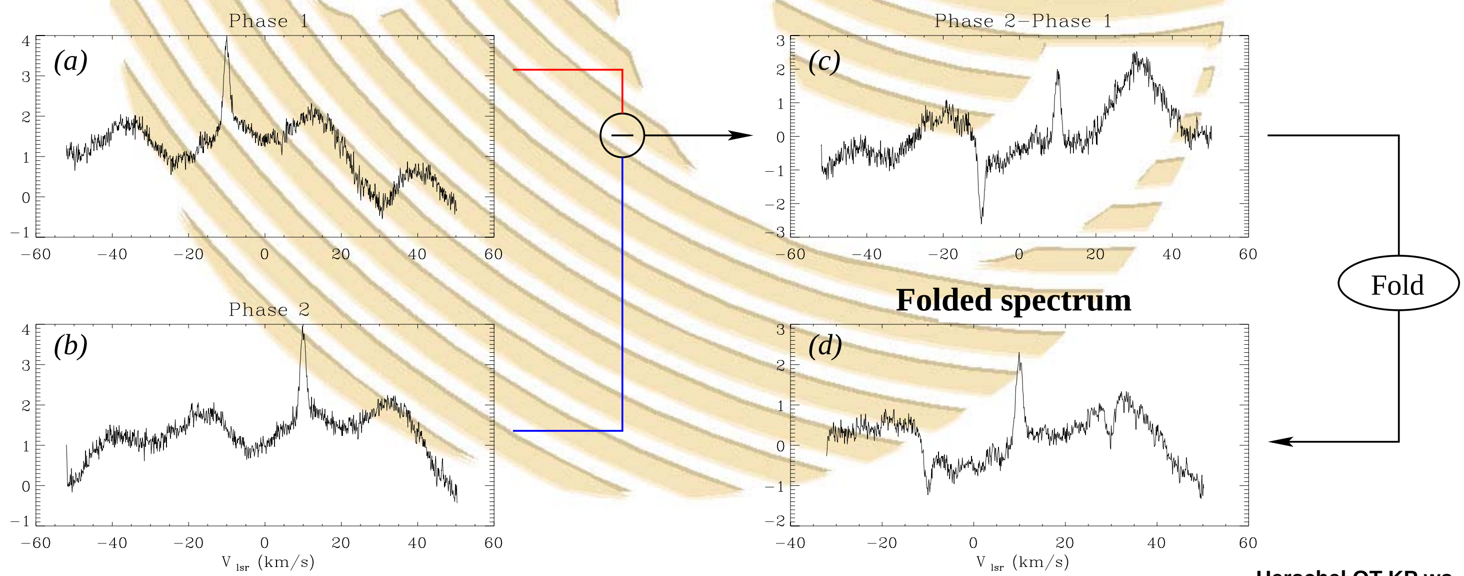
- *Frequency Switching*: change the tuned frequency to shift the observed line to another part of the IF spectrum



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The HIFI reference schemes

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- *Load Switching*: the internal chopper mirror is switched between the sky line-of-sight and the internal photometric reference

The HIFI pointing modes

- *Single point* observations
- *Mapping* observations (*raster*-like, or *On-the-fly*)

Observations are allowed for only 1 tuned frequency (*LO* frequency)

Combination of observations at several frequencies need clustering (*concatenation*)

- *Frequency surveys*

Observations offer several frequencies but are allowed for only 1 line-of-sight

The HIFI AOTs

The resulting AOTs offer an as complete and versatile as possible combination of pointing and reference modes

Reference mode:	AOT I Single point observations	AOT II Mapping observations	AOT III Spectral scans
Position-switch:	Observing mode I-1 Fixed point position switch	Observing mode II-1 On-The-Fly map	
Dual beam switch:	Observing mode I-2 Point with dual beam switch	Observing mode II-2 DBS raster map	Observing mode III-2 DBS spectral scan
Frequency switch:	Observing mode I-3 Point with frequency switch	Observing mode II-3 Frequency switch OTF map	Observing mode III-3 Freq. switch spectral scan
Load chop:	Observing mode I-4 Point with load chop		

See talk by T. Marston

See talk by J. Martin-Pintado

See 2nd part of my talk

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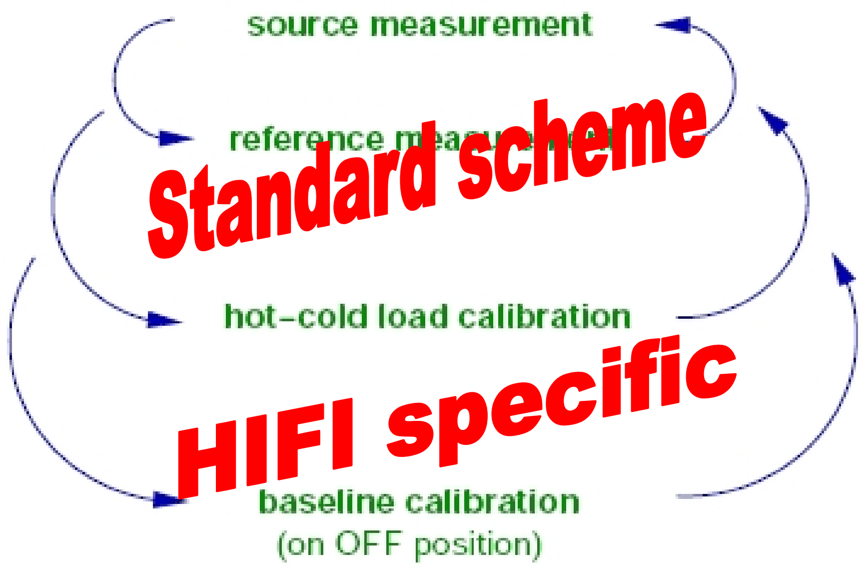
The timing of observations

Reference loop
length determined by system Allan time t_A

Bandpass calibration loop
length determined by band-pass stability time $t_{A,\mathrm{load}}$

Baseline calibration loop
length determined by standing wave Allan time $t_{A,\mathrm{sw-diff}}$



Observations are organised according to a hierarchical structure of loops reflecting the various timescales of the instrument stability (measured in terms of *Allan times*)

The timing of observations

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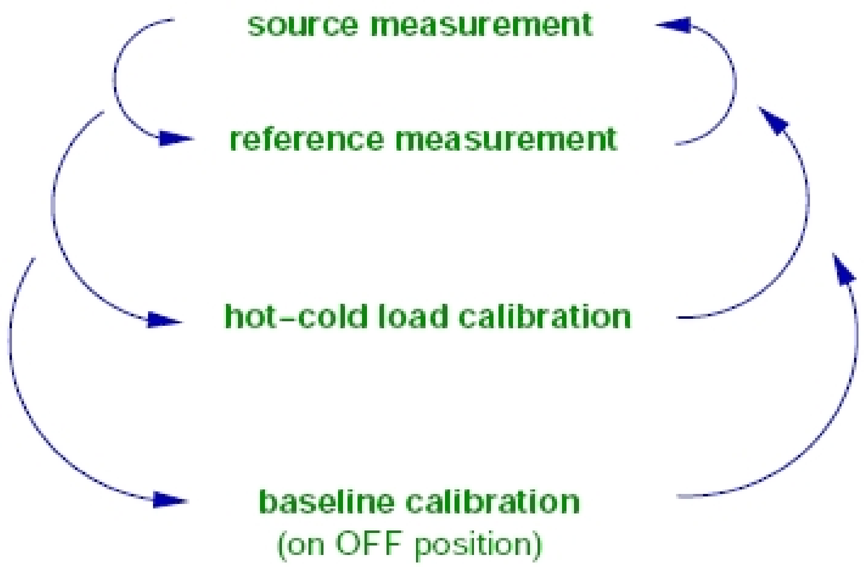


- Allan times vary with the instrument spectral resolution

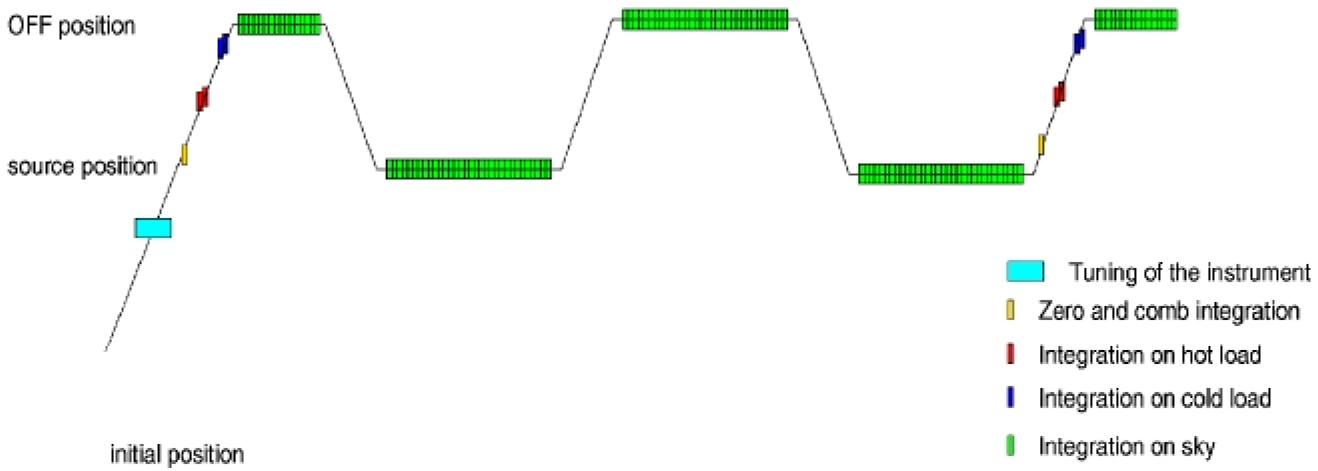
➡ the loop periods will depend on the spectral resolution

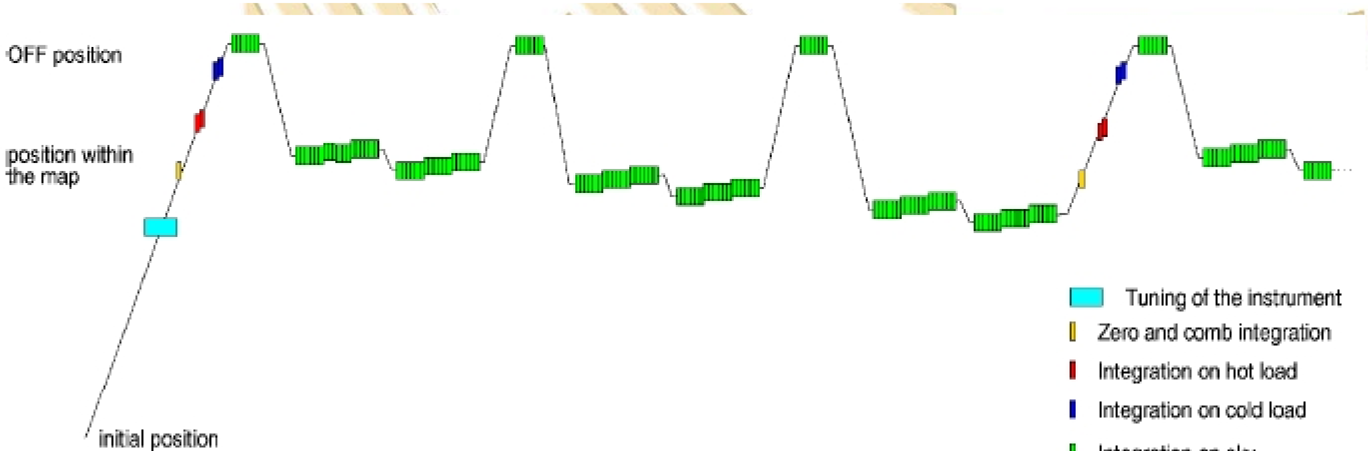
- *Continuum* Allan times ~4 times < *spectroscopic* Allan times

➡ timing differ for observations aiming at the continuum

The timing of observations: examples

Example of position switching timeline



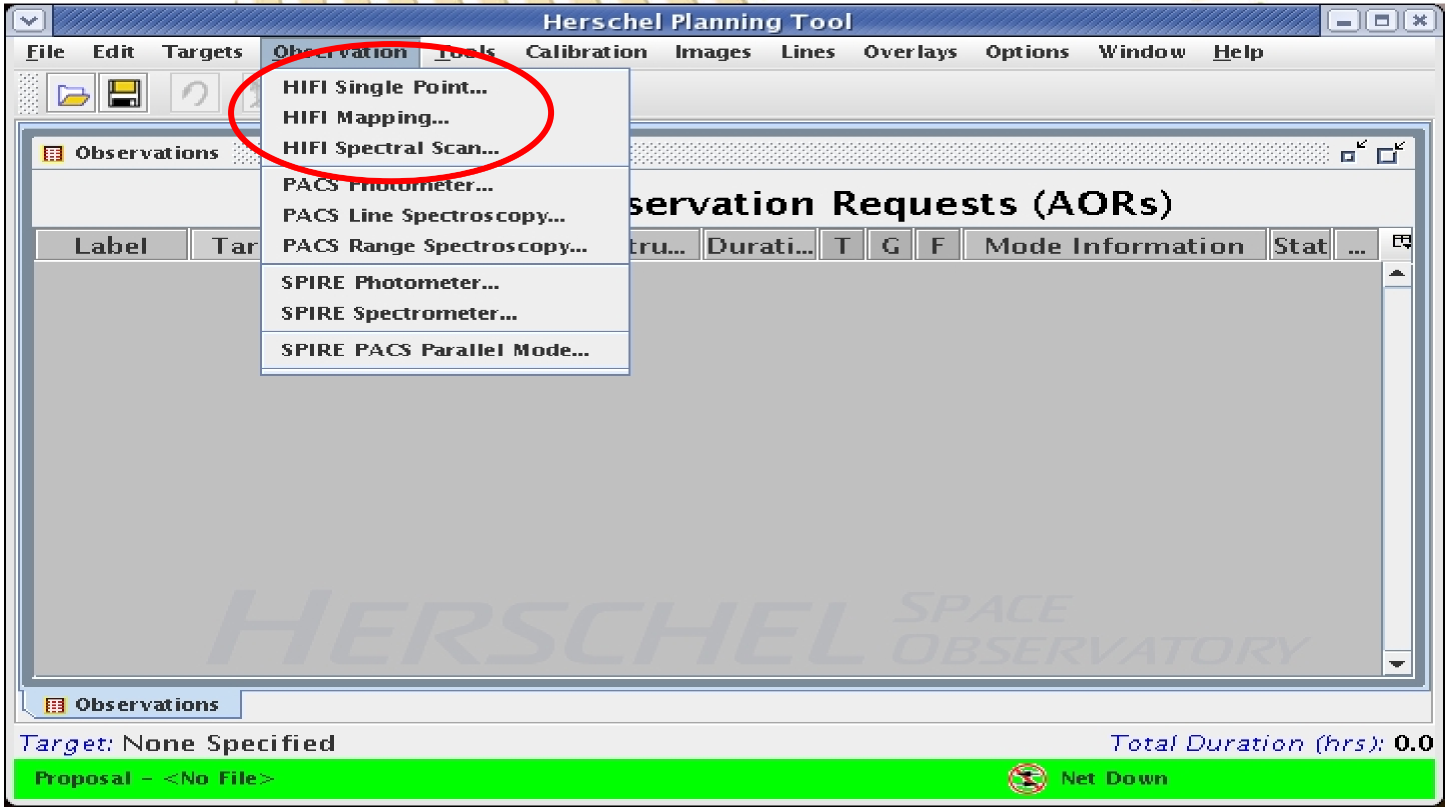


Example of on-the-fly mapping timeline

HIFI observations: preparation and time estimates

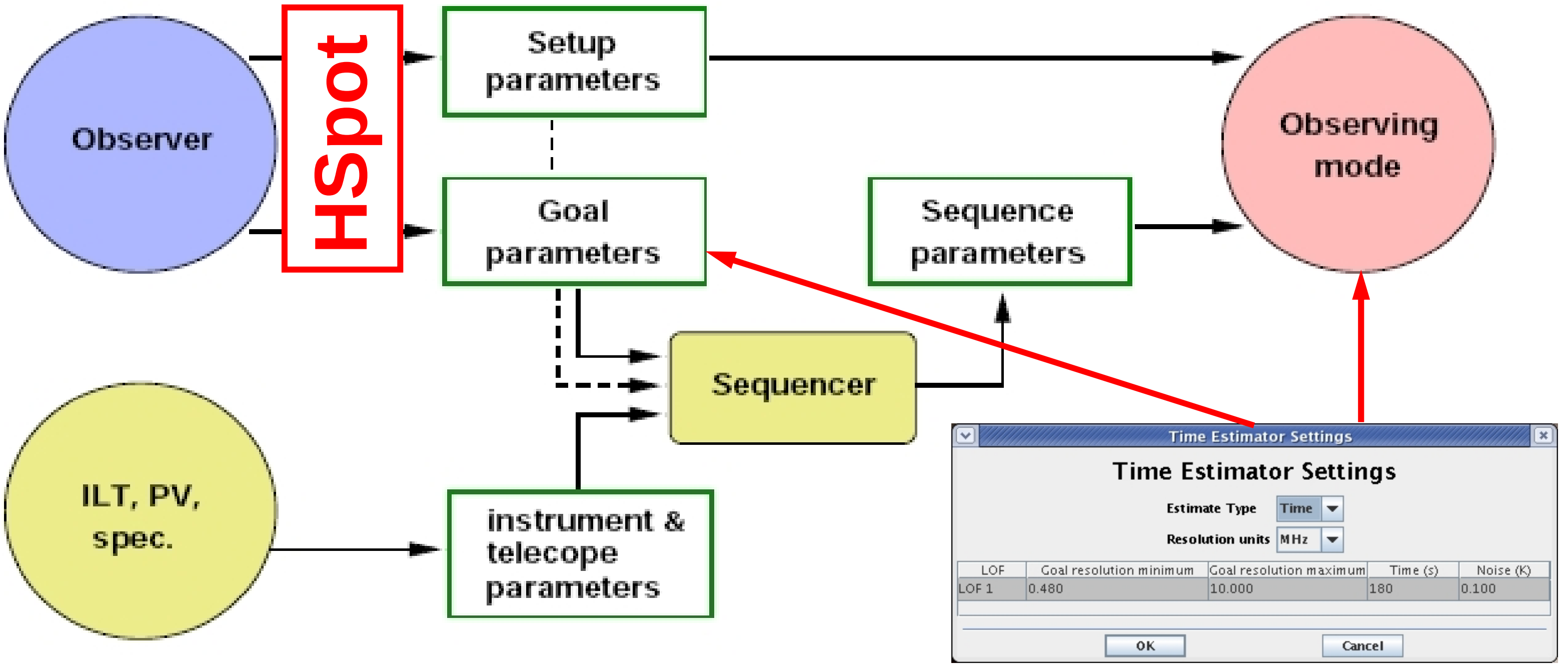
User interface offered in the HSpot tool

http://herschel.esac.esa.int/



HIFI observations: preparation and time estimates

- Observing sequence parameters (number of loops/cycles, elementary readout times, etc) are derived from *goal parameters* via a *sequencer*
- The *sequencer* optimises the timeline to minimise the noise per observing time



Frequency surveys with HIFI

HIFI Spectral survey: specifications

- *Single source* observations
- *Multiple frequency* settings extended over frequency coverages larger than the IF bandwidth
- Largest frequency coverage per AOR is presently limited to that of a complete LO band (H/W stabilization issue)
- Use of the *WBS* spectrometer only (instantaneous coverages of 4 GHz @ 1.1 MHz resolution)
- Offered with 2 reference schemes
  - *Dual-beam-switching* (in *slow*-chop or *fast*-chop). Relatively inefficient mode (< 10%, frequent re-tuning and telescope motion)
  - *Frequency-switching (efficiency slightly improved).* Possible use of an additional *OFF-position* to cancel out standing waves

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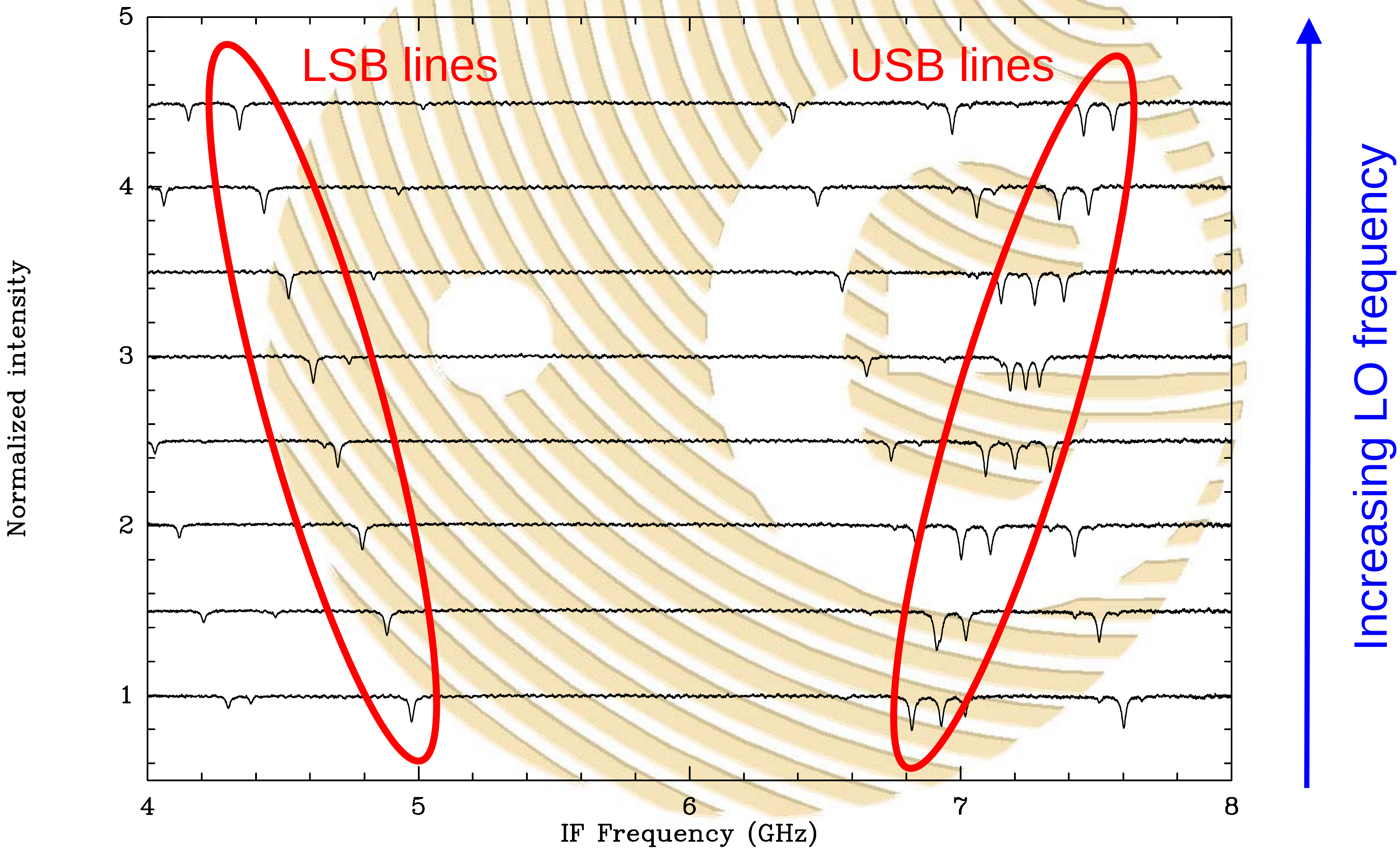
HIFI Spectral survey: redundancy

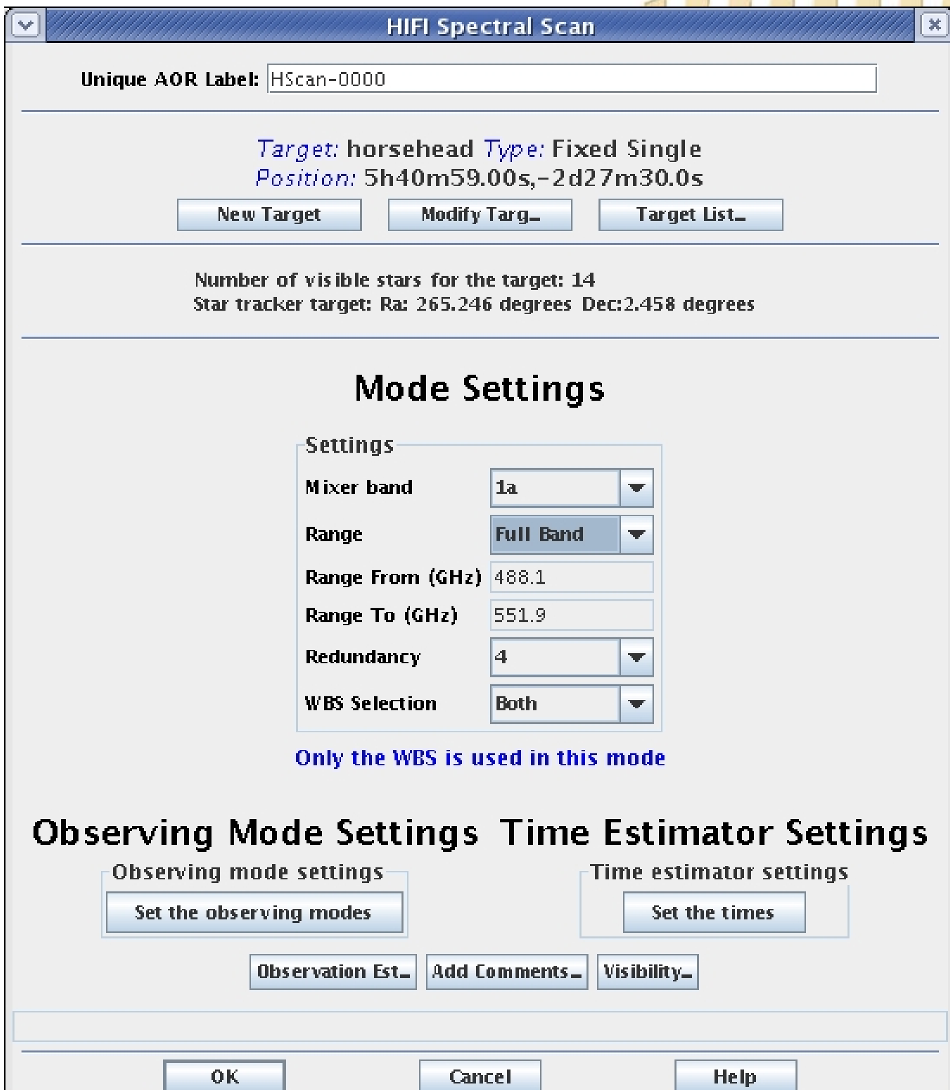
- Because HIFI is a *double-side-band (DSB)* instrument, observations need to be *deconvolved* in order to assign sky frequencies to spectral lines
- Because lines belonging to different side-bands will move in opposite directions in the IF at various LO frequencies, observations at frequency steps smaller than the IF bandwidth allow to distinguish the lines in either side-bands
- The number of independent LO tunings per IF bandwidth is called *redundancy*.
  - Low redundancy (2-3) are sufficient to deconvolve very simple spectra (assignment can almost be done by eye)
  - High redundancy (6-8) are needed for crowded spectra, esp. since they will mix very strong and very weak lines

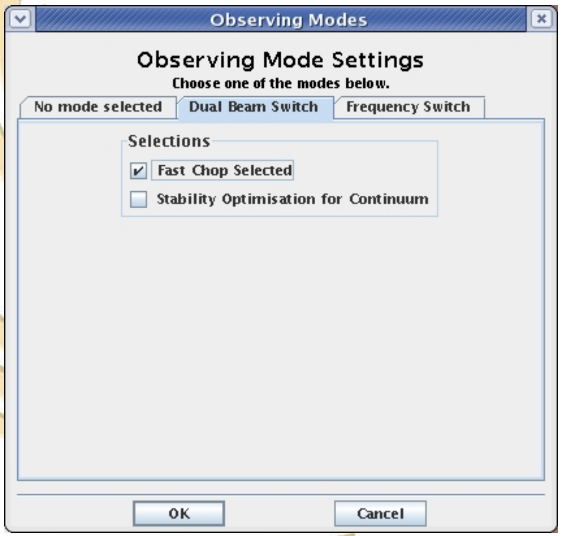
HIFI Spectral survey: redundancy

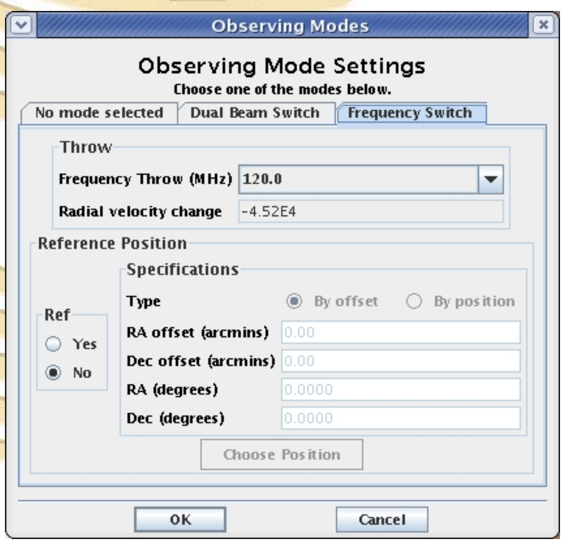
Example of methanol survey with HIFI-QM: high redundancy



HIFI Spectral survey: HSpot interface







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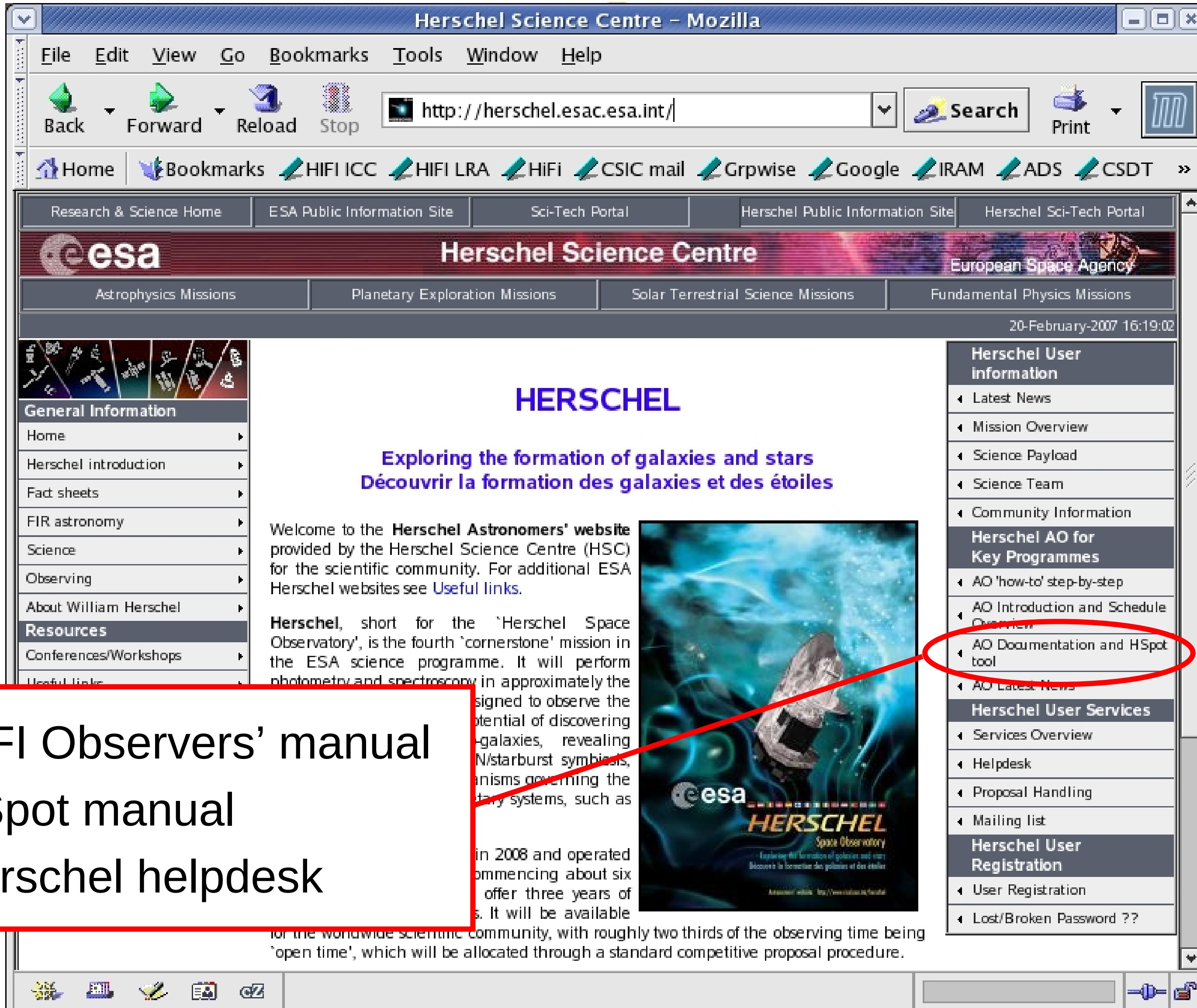
To know more



- HIFI Observers' manual
- HSpot manual
- Herschel helpdesk

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