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TO: SAFIRE / FIBRE / CSO PEOPLE

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SUBJECT: BITS, BITS, BITS…

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STATUS BITS AT THE CSO

The purpose of this document is to list all the status bits which will be used at the CSO for FIBRE, and, presumably, for SAFIRE. I further describe the observing mode FIBRE will use.

Antenna status bits: two TTL bits for the primary mirror, "Idle" and "Acquired".

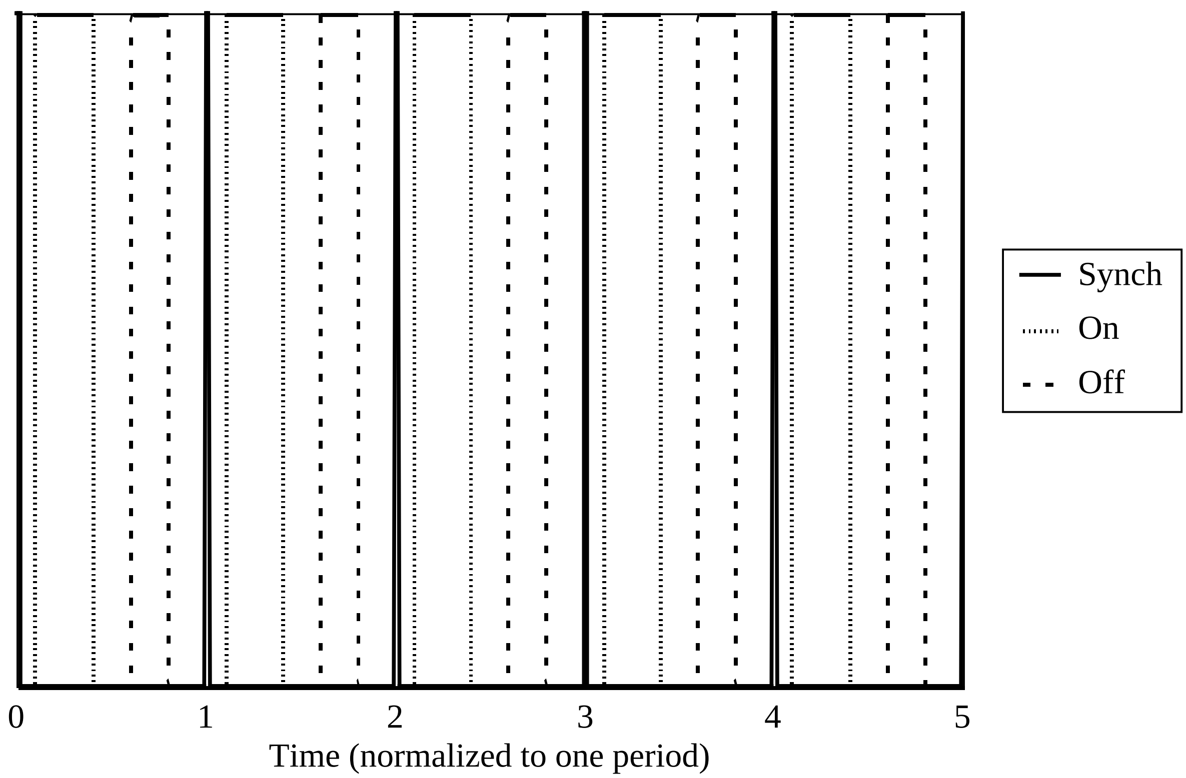
IDLE	ACQ	Meaning
0	0	Telescope is slewing towards a source position *or* has temporarily lost tracking.
0	1	Telescope is tracking an object on the sky.
1	0	Telescope is not doing anything – usually not a good thing.
1	1	Telescope is pointing at a fixed position; used for drift scans.

In practice, the only time we are likely to observe is when the status is (0,1). We must acquire the data in real time on the PC (assumed to be running the IRC and acquiring all detector data) in order that we know which data to flag as "bad" because we weren't looking anywhere useful.

Secondary status bits: three TTL bits for the secondary mirror, "On-Beam", "Off-Beam", and "Synch". The explanation should be obvious. Most of the time, the Synch bit isn't used; we may want it for our own nefarious purposes. The plan as it stands now is that we will synchronize the Fabry-Perot to move on the falling edge of the Off bit. This indicates the end of a single motion of the secondary mirror.

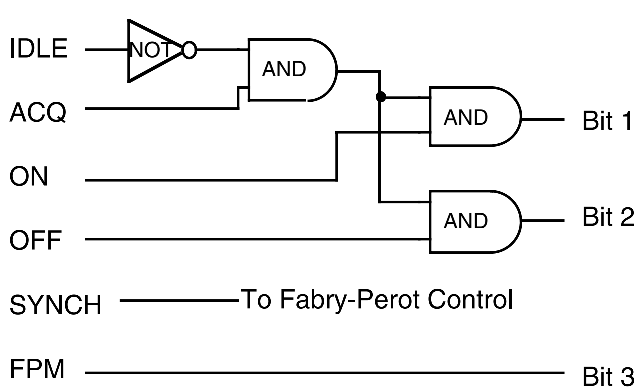
For working numbers, the following is generally true: the secondary is best used at its highest efficient frequency of 4Hz. The efficiency if roughly 35% "On", 35% "Off", and 15% slewing between each position. This assumes a throw (angular separation of the beams) of approximately 60''. The maximum throw is about 240''. Being slew-rate-limited, smaller throws will yield higher efficiencies. The throw is usually chosen to be symmetric about the pointing axis of the primary mirror, but the fraction of time spent in each beam is not precisely identical.

Here's a schematic timing diagram for the secondary status bits.



Fabry-Perot bits: The Fabry-Perot must communicate to the PC when it moves. In addition to sending out the 16 bits to the control card, the Mac controlling the Fabry-Perot (FP) will have to send a single bit which I shall call "FP Moving" to the PC. I propose that the bit be set high before the FP is commanded, then sent low when the FP commands have all been issued.

The data acquisition system will need to use most of the above bits to know what to do with the data stream. I propose the following scheme:



I'm not convinced that the FP motion has to be acquired into bit 3.

The truth table for bits 1 and 2 is as follows:

IDLE	ACQ	ON	OFF	Bit 1	Bit 2
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	0	0	0
0	0	1	1	0*	0*
0	1	0	0	0	0
0	1	0	1	0	1
0	1	1	0	1	0
0	1	1	1	1*	1*
1	0	0	0	0	0
1	0	0	1	0	0
1	0	1	0	0	0
1	0	1	1	0	0
1	1	0	0	0	0
1	1	0	1	0	0
1	1	1	0	0	0
1	1	1	1	0	0

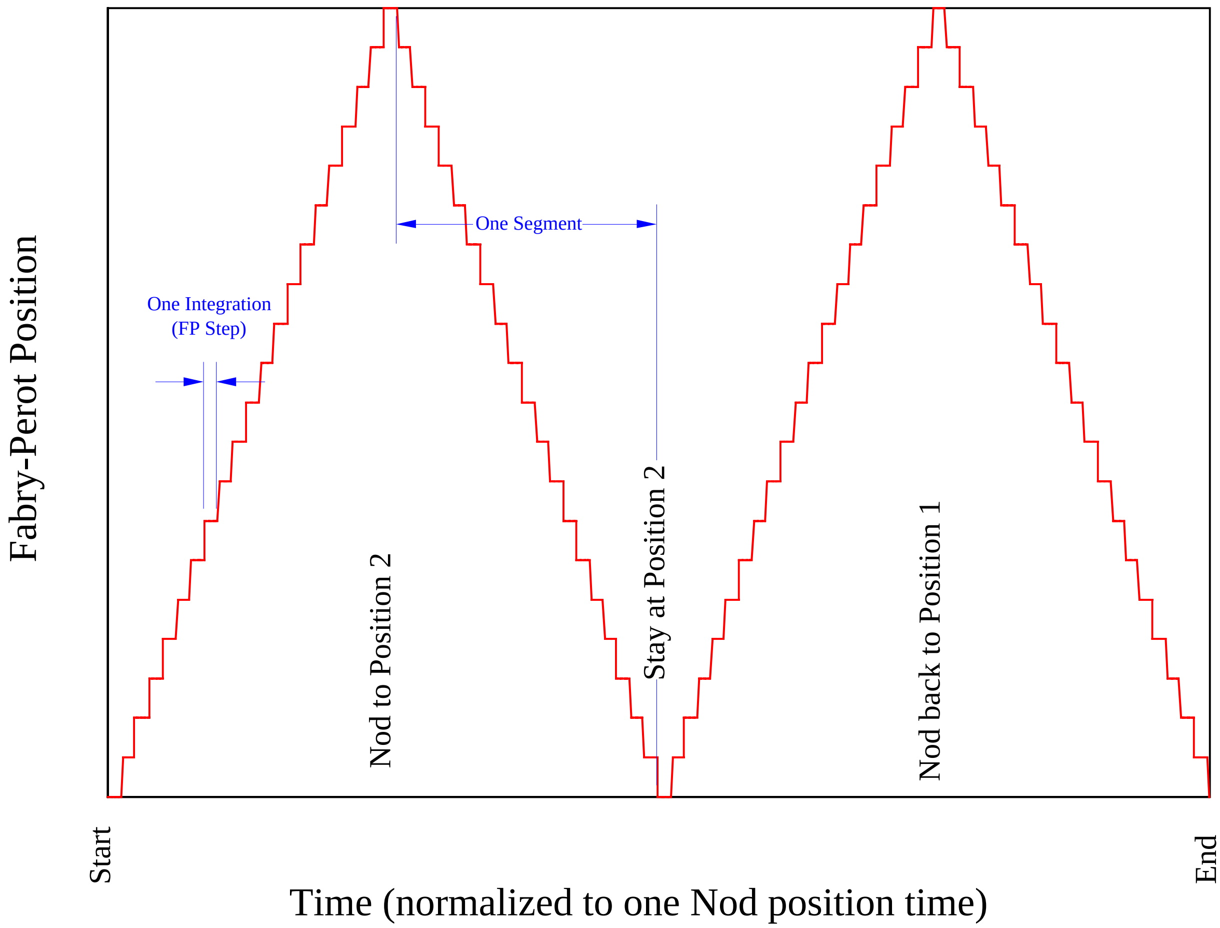
* The electronics which generate the On and Off bits should *never* yield (1,1).

During observation, the IRC software should probably coadd data into bins marked "On" and "Off" depending on the state of bits 1 and 2. Data when both bits are off could be dumped. As a result, one issue is that different amounts of time (i.e. numbers of frames) will appear in the On bin and the Off bin. These signals will need to be normalized to the amount of data in each bin. Another question for the IRC folks is whether it is trivial to have synchronous coaddition as this implies.

The CSO will be operated in "Nod" mode, where we switch the definition of "On" and "Off" beams on the sky. The bits remain the same, but the PC will have to know which Nod position we're in so that it knows whether "On" means looking at the source or away from the source. Confused yet? Just remember that the primary *and* the secondary mirror can both move between positions named "On" and "Off" such that:

Primary	Secondary	Field Being Observed
On	On	The Source
On	Off	Blank sky to the right (or left)
Off	On	Blank sky to the left (or right)
Off	Off	The Source

It seems that the most efficient way to operate will be to slew the FP over its whole range, with one chop cycle per FP step, once per Nod:



For a maximal FP scan, something of order 200 FP steps are needed; the chop rate will be 4Hz. This implies 50s per Nod position; the whole series shown above would take 200s. The option shall be available to sample more than one chop cycle per FP step.

I shall define some nomenclature:

On_Source	The condition of, or the data taken when, the source being observed.
Off_Source	The condition of, or the data taken when, the blank sky being observed (to the left or right, as defined in the “Field Being Observed” table.
Chop	A single period of motion of the chopping secondary; usually 0.25s (assuming a 4Hz chopping frequency).
Integration	A single stored set of data representing the sum of all data for all bolometers during one FP step (a single step in the above schematic.
Segment	The period of time to take all integrations for a single nod position (the first quarter of the above schematic)
Chops_per_Int	The number of chop cycles per integration
Ints_per_Seg	The number of integrations per nod position; also the number of Fabry-Perot steps.
OO_Cycle	An On-Off cycle, the set of4 segments shown in the schematic above. This is a “symmetric” OO_Cycle; an “asymmetric” OO_Cycle would consist of just the first two segments.
Chop_Frequency	The rate at which the secondary mirror selects between the On and Off beams; usually 4Hz.

To summarize, a single spectrum taken at a single point on the sky would consist of one OO_Cycle, which is comprised of 4 Segments, consisting of 1-200 Integrations made up of 1+ Chops. The total time, excluding overhead for telescope motion and waiting time, is given by T=4*(Chops_per_Int)*(Ints_per_Seg) / Chop_Frequency

The telescope should hand to the PC at the beginning of every OO_Cycle some data to be attached as a header for every OO_Cycle. This header information should consist of at least (1) a time stamp for the beginning of the scan (2) position on the sky for the primary, nod distance, and chop distance (3) Fabry-Perot step information (4) Chops_per_Int and Ints_per_Seg. The PC and the Mac should wait at the end of every Segment to hear from the telescope for a “go ahead” signal. Then the Mac will take data at the next falling edge of the Off bit, and the PC will capture data, counting the number of Chops and Integrations, until it has accumulated the proper number of Integrations to make up a Segment.

Further information regarding the flow of control and data shall be determined later.