COGGING MEETING

Cogging and Fine Adjustment procedures

Present:

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Subject:

Understand how we can perform the cogging efficiently and define a common procedure from coarse cogging to fine adjustment. Related slides and minutes can be found here.

Meeting structure:

After a first part dedicated to definitions from Philippe and agreement on main principles, the second part was focusing on building a preliminary procedure to get progressively (but surely) a good cogging and fine adjustment of phase shifter of beam2 wrt beam1.

Agreed definitions and statements:

Cogging and fine adjustment procedures are here defined for 450GeV. The same parameters will be used for higher energies. The phase shifter of beam2 will be fine adjusted during captured beam, when the experiment BPTXs or trackers will give better resolution feedback on ΔZ.

Bcref availability:

- The BCref is a high energy Bunch Clock reference, which frequency will be set before each cycle according to the target energy, and will be constant and available during the full hypercycle except during the resync (SETUP). Ultimately, the BC1 and BC2 will be locked to this reference at FLAT TOP.
- This signal has been introduced to allow the experiments to run at the constant target frequency as soon as the cycle starts (avoiding the ramping frequency).
- It is as well a guaranty for the RF system to have ultimately a pure reference (by opposition to the DDS source) to increase the beam lifetime.
- The BCref hardware is available, but the commissioning has not yet been done and will be performed during 2010. ***Experiments confirmed that they will run on BC1 and BC2 during runs until the BCref is commissioned.***
- The BCref as defined above is useful for experiments to ease the reset procedure of QPLLs (have a reference Bunch Clock to which the QPLLs could lock after a reset and thus center their analog locking range to the right frequency) despite the fact that it will not be synchronous with other clocks. ***Hence, the RF group will keep BCref ON and up-to-dateto top frequency as much as possible, even if it is not related to beam for the moment***.

Buckets1:

- Buckets1 are individually defined for the 2 beams
- The bucket1 are first adjusted to configure the beam dump, and then, the Frev is shifted by the RF system (cogging and phase shifting).

Cogging (or coarse adjust):

- The Cogging is the choice of the Frev (= Revolution Frequency = orbit) coarse phase of one of the beam versus the other (by steps of one RF period (2.5ns)) to get the buckets 1 of each beam collide in IP1 and IP5. ***It is an iterative process requiring a dump between each change of phase***.

Fine adjustment (or phase shifting):

- The fine adjustment is the fine rotation of one beam versus the other following a 'continuous' Parabolic-Linear-Parabolic (PLP) function with a resolution of 1/128 of a degree of the 400MHz (about 21fs!). This is a continuous process, which can be performed as soon as the beam is captured and has a significant lifetime.

It has been agreed that the cogging and fine adjustment will be done KEEPING THE BEAM1 UNCHANGED. All the phase adjustments will be done on BEAM2.

Agreed cogging procedure:

We agreed on a procedure in 4 main steps, bringing us from a first estimate of the position of the bucket ONE to a fine adjustment of collision points. We also agreed on a common type of information to be measured and shared by the experiments.

Parameter to be shared:

The parameter which will be used for all the steps of the cogging is the one we call ΔZ, described below:

ΔZ will be the distance in cm between calculated crossing point (one value from BPTX and one from trackers if available) versus theoretical crossing point*. *ΔZ will be positive when the calculated collision point is ahead of the theoretical IP clockwise. Inversely, if the calculated IP is behind the theoretical IP, then the sign of ΔZ will be negative.

For example, if ATLAS BPTXs give an estimated crossing point 10cm far from the theoretical crossing point in the direction of ALICE, ΔZ will be +10cm.

To ease the interpretation of ΔZ shared by the 4 experiments, it should have comparable values for the 4 experimentss, regardless of the bucket number used during the run.

Step1: parasitic measurements to prepare cogging (with single beams not captured)

(Day1, Day2 of Mike's Schedule(see at the end of this document) - Phase Injection and Circulating 450GeV Beam)

- Day1 (Injection and first turn b2, Injection and first turn b1):

Beam not captured. Parasitic measurements made by experiments. Collect all data (ΔZ with a resolution of +-35cm (2.5ns)) to check consistency and prepare for cogging. A resync will be applied before each injection. Note that another bucket that bucket1 may be used. We will find a way to know the bucket number to allow experiments understand their measurements. ***The RF group won't try to optimize the cogging during the day1***, as many parameters can still change before capture. However, the RF team is very interested to get regular feedback from experiments to quickly detect unexpected behavior of the RF system.

Step2: start cogging (with single captured beams)

(Day 2 and 3: Circulating Pilot and RF capture b1 and b2)

- Day2 (Circulating Pilot and RF capture b1):
    - Parasitic measurement of captured beam1/bucket1 (more precise and meaningful resolution (5cm), because based on statistics taken on 1000s of turns).
- Day3 (Circulating Pilot and RF capture b2):
    - first: parasitic measurement of captured beam2. Confirm δZ transmitted by all experiments with high résolution (5cm).
    - then: active cogging : coarse (2.5ns steps) phase correction of orb2 by operation and RF team (4h). Requires pilot bunches 5e9 in bucket 1 and captured beam.
- Following days:

First estimation on the target fine phase shift based on the precise measurements made in Days2 and 3.

Step3: confirm cogging + start phase shift (with 2 beams not colliding)

(Day12 : two beam Operation setting-up – 450GeV)

- Day12:
    - Operation and RF confirm cogging value with 2 beams and 2 buckets with a resolution of 2.5ns (estimated duration : 2h).
    - Operation and RF start fine phase shift with feedback of BPTX (if beam lifetime>1h with a resolution of 5cm (or better) (estimated duration : 4h). The initial phase shift values of this phase will be based on the estimation made with measurements of days2 and 3.

Step4: confirm phase shift (with collisions)

(Day13 : 450GeV collision setting-up)

- Day13:
    - Operation and RF confirm and adjust the fine phase shift with feedback from trackers with a resolution <0.5 cm. (estimated duration 4h)

Schedule from Mike Lamont referred to in this document – 03.11.09

We will adjust the schedule in case of change.

Phase	Day	Shift	Time estimate (h)	Activity	Beam	Target values
Injection and circulating 450 GeV beam	1	M	8	**Injection and First turn b2**	B2, pilot	Beam thread around ring with splash events
	1	A	8	**Injection and First turn b1**	B1, pilot	Beam thread around ring with splash events
	1	N	8	**SF**		
	2	M	8	**Circulating Pilot and RF capture b1**	B1, pilot	BWS and BSRT setting up
	2	A	8	**Circulating Pilot and RF capture b1**	B1, pilot	c.o establised. >5h beam lifetime-BWS/BSRT setting up
	2	N	8	**SF**		
	3	M	8	**Circulating Pilot and RF capture b2**	B2, pilot	BWS and BSRT setting up
	3	A	8	**Circulating Pilot and RF capture b2**	B2, pilot	c.o establised. >5h beam lifetime-BWS/BSRT setting up
	3	N	8	**SF**		

450 GeV two beam operation	12	M	8	**Two Beam Operation setting-up - 450 GeV**	2x2, 5e9	Two beams stored, Lifetime ~10 hours
	12	A	8	**Two Beam Operation setting-up - 450 GeV**	2x2, 5e9	Common correction, …
	12	N	8	**SF**		
	13	M	8	**450 GeV collision setting-up**	Solenoids ON	Luminosity system setting-up
	13	A	8	**450 GeV collision setting-up**	Solenoids ON	Beams colliding in all IR, Long.pos. O.K.
	13	N	8	**450 GeV collisions**	2x2, 5e9	