Explanations on the coupling between the different machines (25/08/09) (1/7)

- We had a meeting today with Jean-Claude Bau (and Rende and Django) who explained us how it works => Now, everything seems to be clear... Up to now, I considered only the Czero of the machines (called Phase.c below) and the information of the Phase below was missing to fully understand what happens

- 1) Important figures

	Phase	Phase.c
SPS	0	1735
CPS	1	1100
PSB	2	465
LEI	2	790

The Phase.c is the CZERO of the machine, and can be easily obtained from a Terminal, by typing: knobs_open SX.CZERO-CTM (S for SPS, should be replaced by P for PS, B for PSB and E for LEIR)

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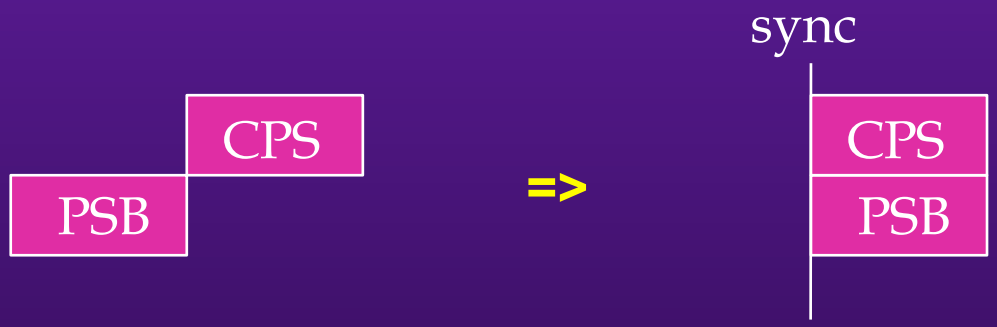
- 2) Treatment in the CBCM
  - 2.1) Drawing in the Editor (with for the moment only PSB and CPS to simplify, with 1 BP each, and a coupling 0/1)

But, how is it treated internally?

There is a pulse (called sync) which comes every 1200 ms. Applying the Phases, it transforms the blocks like below (as PSB should be displaced by 2 BP and the CPS by 1 BP)



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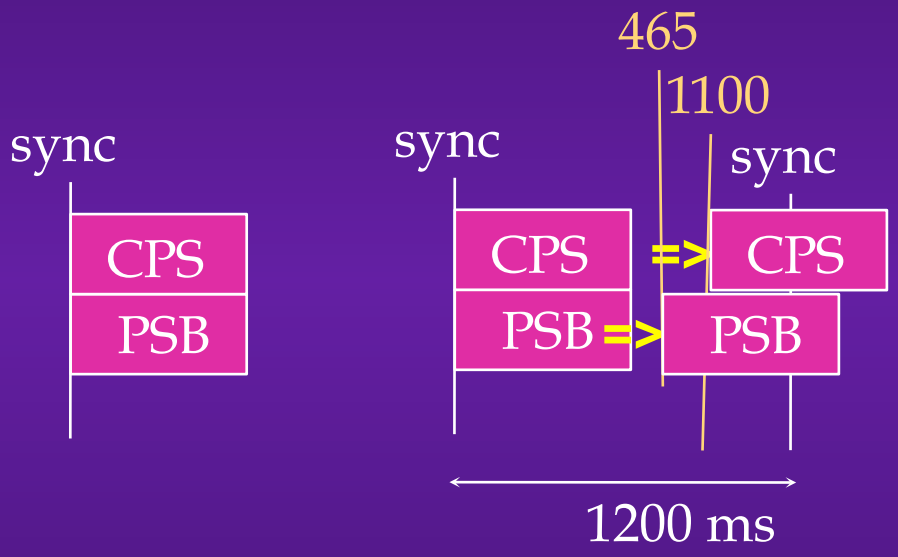
Therefore, the 2 blocks are now in phase

- **2.2) Then, we need to make a finer adjustment using fine timings (in C) to adjust the PSB extraction with the PS injection**



$$C_0^{PSB} + C_{ej}^{PSB} = 465 + 805 = 1270 \text{ ms}$$

$$C_0^{PS} + C_{inj}^{PS} = 1100 + 170 = 1270 \text{ ms}$$

=> Note that the blocks here are not represented with a length of 1200 ms: what is important here is the start

=> So, it is OK: it works! Therefore, the initial coupling (0/1) was the good one

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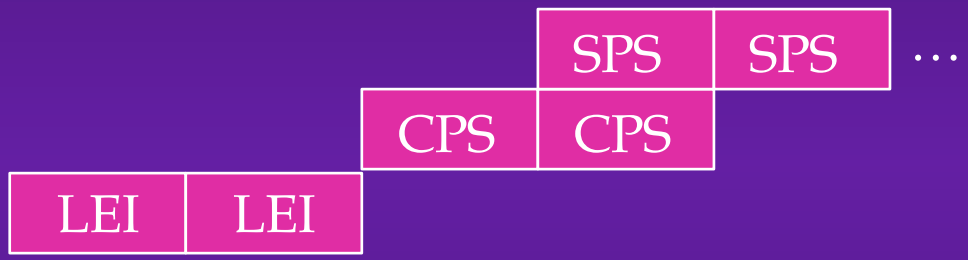
- 3) Now, if we add the SPS, one can apply the same analysis. It is exactly the same in the case of a coupling 0/1/2
- 4) Let's now consider the case of the ions, and try and understand why the coupling is 0/2/3



So, let consider that the coupling is like this, i.e. 0/2/3 and then see if all the timings work

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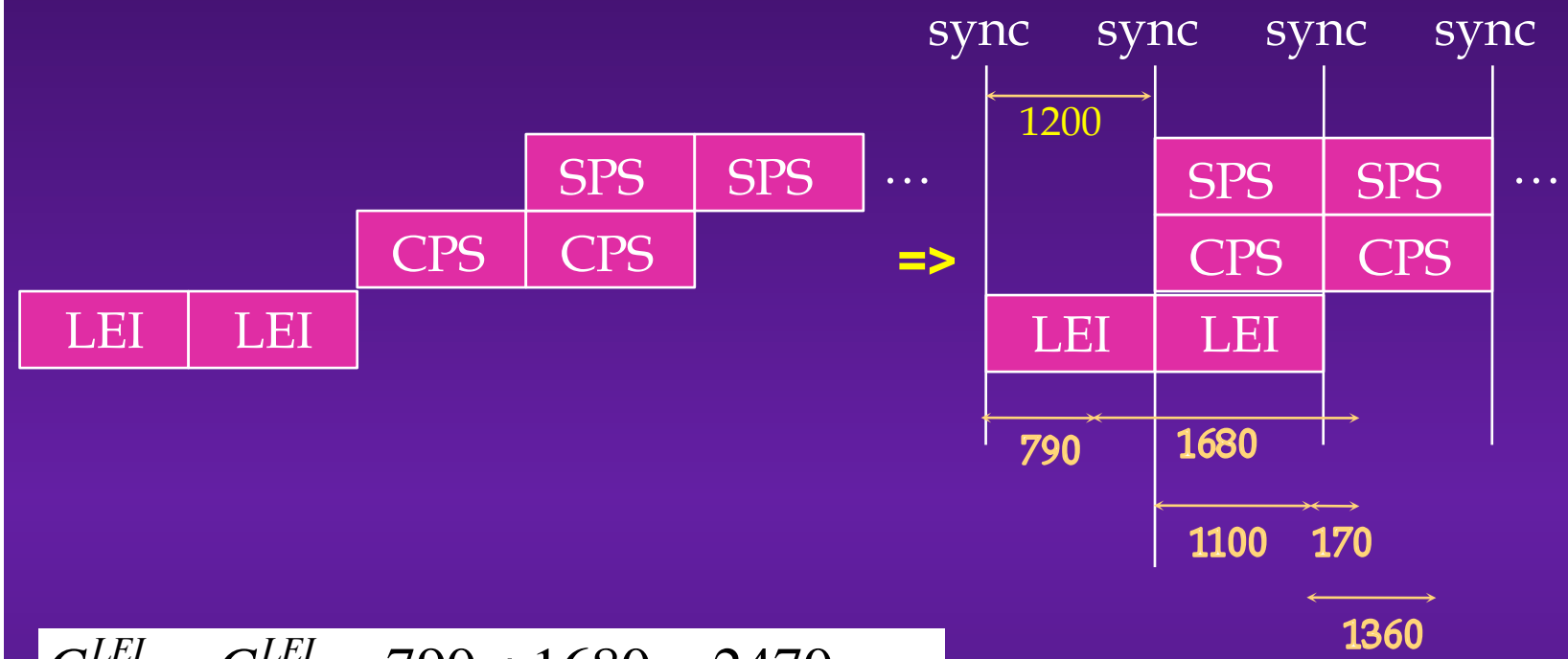

$$C_0^{LEI} + C_{ej}^{LEI} = 790 + 1680 = 2470 \text{ ms}$$

$$1200 + C_0^{PS} + C_{inj}^{PS} = 1200 + 1100 + 170 = 2470 \text{ ms}$$

=> So, the coupling LEI / PS is OK!

$$1200 + C_0^{PS} + C_{ej}^{PS} = 1200 + 1100 + 1360 = 3660 \text{ ms}$$

$$1200 + C_0^{SPS} + C_{inj}^{SPS} = 1200 + 1735 + 725 = 3660 \text{ ms}$$

=> So, the coupling PS / SPS is OK!

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Remark: For AD and LHC there are no phases… Things are different

- **5) General relation between the CZEROs of 2 consecutive machines (n and n+1), the extraction timing of the machine n-1 and the injection timing of the machine n**

$$C_0^n = C_0^{n-1} + C_{ej}^{n-1} - C_{inj}^n$$

Explanations on the coupling between the different machines (25/08/09) (7/7)

- I wrote an Excel file which compute the correct offsets to be entered in the CBCM: 0 / x / y
  - In fact, x is deduced by equating 2 equations, saying that the ejection timing of the previous machine should be equal to the injection timing of the machine
  - And y is deduced applying the same thing for the next machine
- Example with the coupling between LEI / PS / SPS: $\mathrm{BP} = 1200\ \mathrm{ms}$

$$\phi_{LEI} \times \mathrm{BP} + C_0^{LEI} + C_{ej}^{LEI} = C_0^{PS} + C_{inj}^{PS} + \phi_{PS} \times \mathrm{BP} + \mathrm{BP} \times x$$

=>

$$x = \frac{\phi_{LEI} \times \mathrm{BP} + C_0^{LEI} + C_{ej}^{LEI} - C_0^{PS} - C_{inj}^{PS} - \phi_{PS} \times \mathrm{BP}}{\mathrm{BP}}$$

$$y = x + \frac{\phi_{PS} \times \mathrm{BP} + C_0^{PS} + C_{ej}^{PS} - C_0^{SPS} - C_{inj}^{SPS} - \phi_{SPS} \times \mathrm{BP}}{\mathrm{BP}}$$