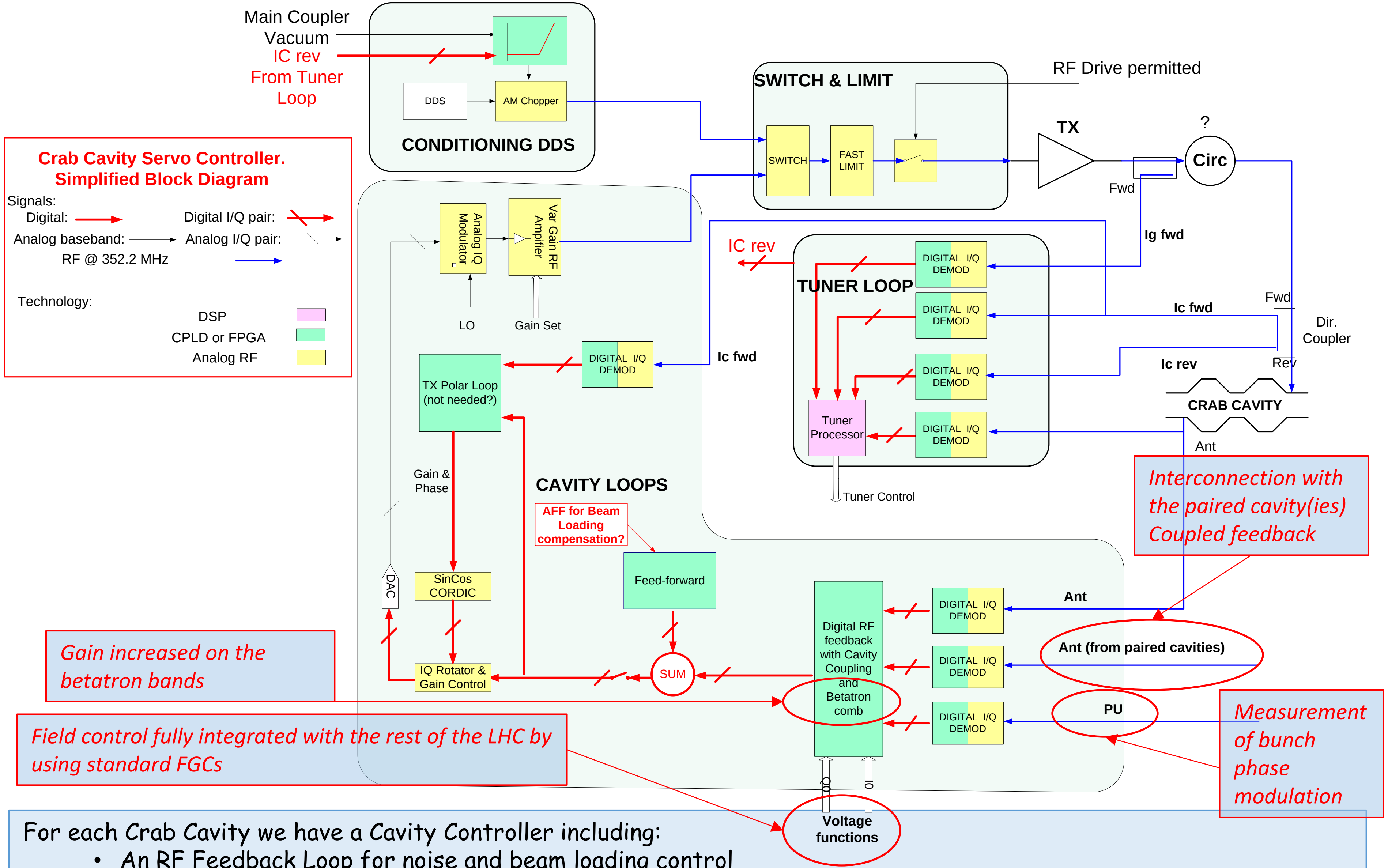
LLRF for SPS CC test

P. Baudrenghien

LLRF HARDWARE

LLRF Hardware design

- Close synergy with the Linac4 352.2 MHz system
- Hardware is tuned for 400 MHz and firmware is developed to have prototypes ready for the SM18 test by mid 2015
- One Technical Eng. ½ FTU per year in 2015,2016,2017
- One fellow (June 2015?)



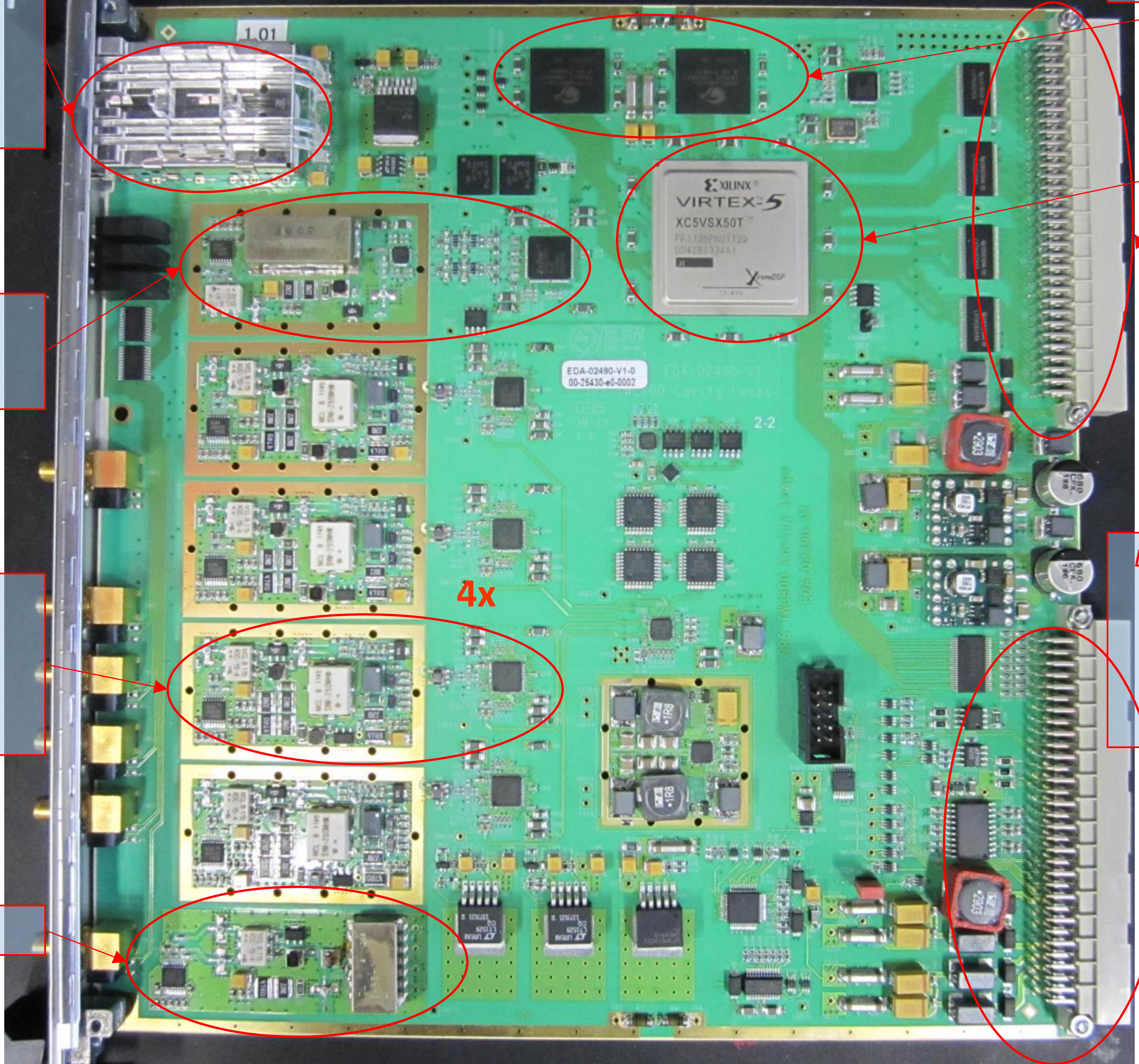
For each Crab Cavity we have a Cavity Controller including:

- An RF Feedback Loop for noise and beam loading control
- A TX Polar Loop to reduce the TX noise and stabilize its gain/phase shift
- A Tuner Loop to shift the cavity to a detuned position during filling and ramping. Then smoothly bring the cavity on-tune with beam for physics
- A field Set Point for precise control of the cavity field.

Version: 20111111

SPS 800 MHz TWC prototype

G. Hagmann BE-RF-FB designer



2 x Duplex Optical Serial Links
2 in & 2 out
2Gbits/s
(≤3.2Gbits/s)

SSB Modulator
IF (I & Q) ≈25MHz
Dual TxDac 16 bits

RF Demodulator
RF&LO mixing
IF ≈25MHz
14 bits ADC
Fs=4·IF ≈100MHz

LO Distribution

SRAM 2x8 Mbyte for diagnostics

Xilinx Virtex 5 SX

VME P1 backplane for slow controls/read out

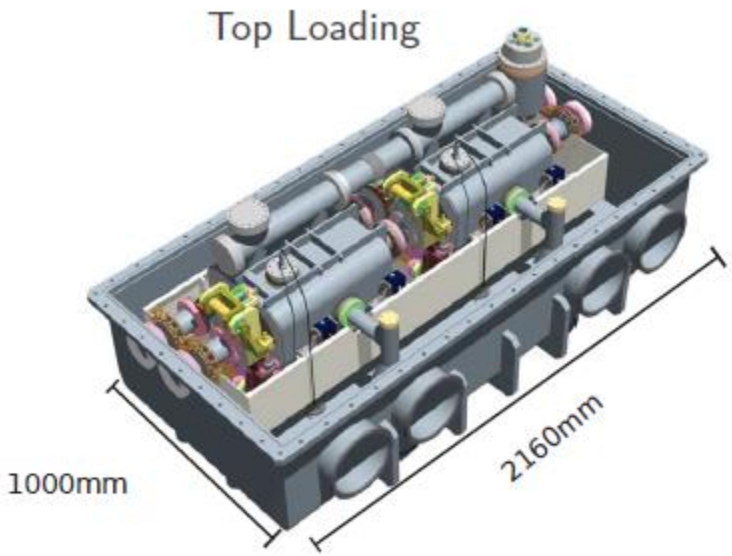
Dedicated backplane (P2):

- Power Supply
- Clocks
- Interlocks
- …

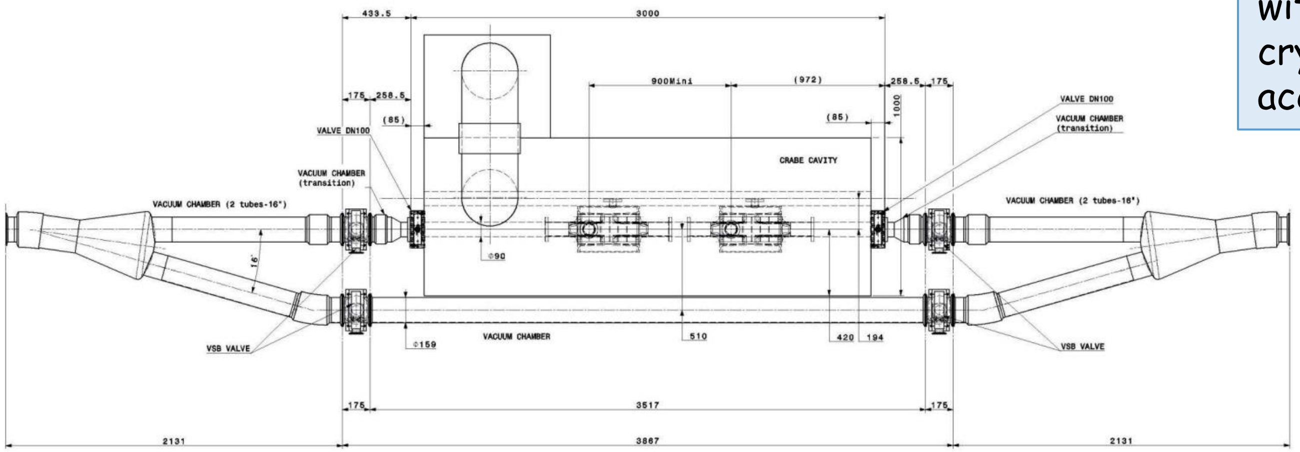
PLANNING

Planning

- 2013-2014 Cavity Testing
- 2015-2016 LLRF developments
- 2017-? SPS tests: 2 cavities in one cryostat
- 2015-2017 (LS2?) Prototype Cryomodule
- 2018-2020 (LS3?) Production
- In operation in the LHC after LS3



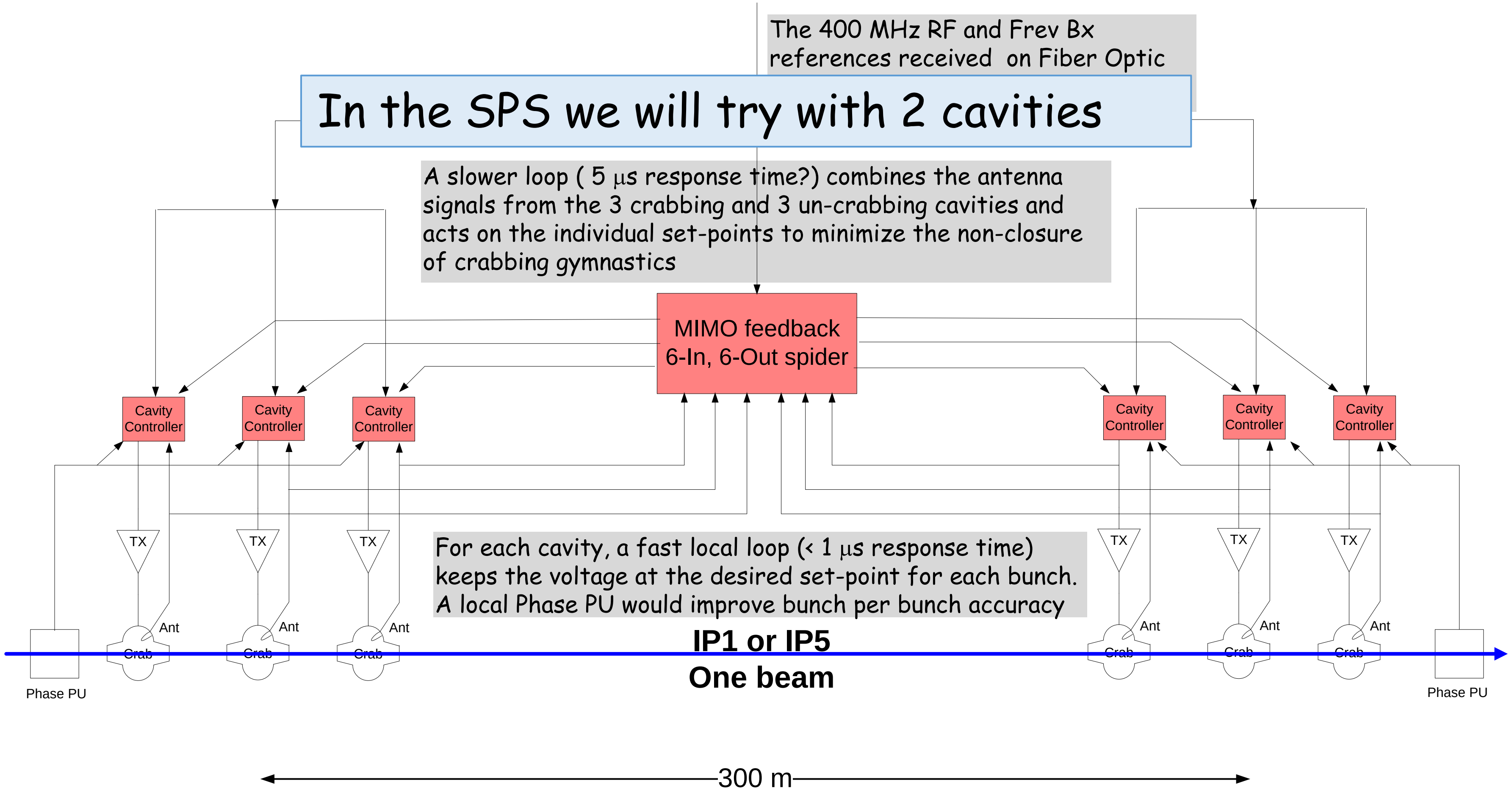
Proposed SPS cryomodule with 2 Crab Cavities. The cryomodule is designed to accept all three CC makes



Courtesy EN-MME

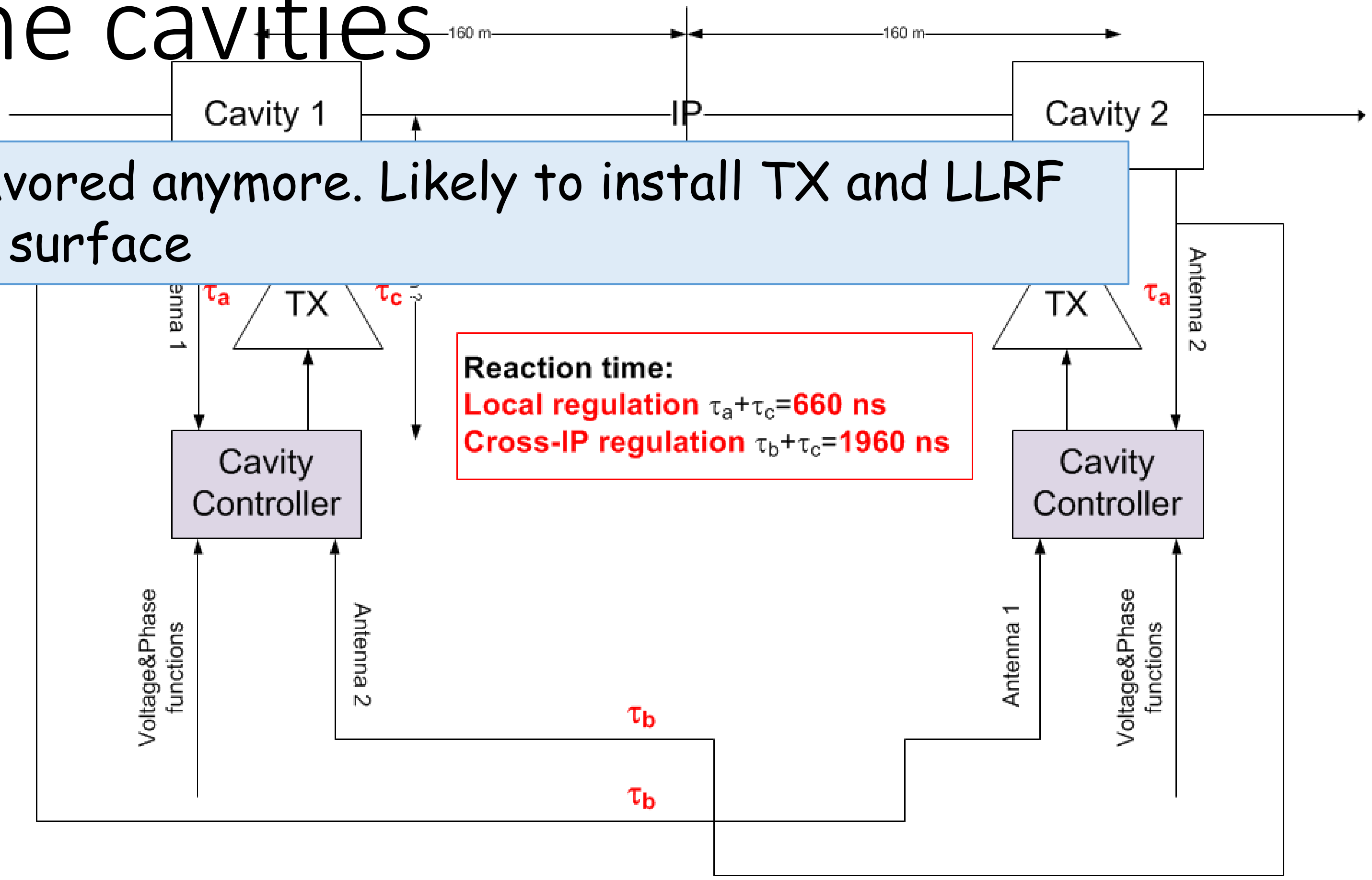
SPS testbench with 2 Crab cavities in the LSS4. The cryomodule can be moved in and out of the beam line (2016-)

The Crab Cavity systems (IP1 and IP5)



SPACE and INFRASTRUCTURE

LHC: **New galleries** with LLRF, TX, circulator next to the cavities



Not favored anymore. Likely to install TX and LLRF on the surface

Asymmetric architecture:

τ_a is the delay of the local antenna signal 20 x 3.7 ns = 74 ns rounded to **80 ns** (10 % margin)

τ_b is the delay of the opposite antenna signal (320+20) x 3.7 ns = 1258 ns rounded to **1380 ns**

τ_c is the drive path delay, including LLRF, TX, circulator and coax = 300 ns + 100 ns + 50 ns + 20 x 3.7 ns = 524 ns rounded to **580 ns**

Space and Infrastructure SPS

- One rack per cavity (1 VME crate per cavity), plus space in front of rack for instruments (NWA, oscilloscope), table with PC,...
- In addition space must be provided for the following services: Internet, timing, functions
- The equipment (TX, LLRF) must be accessible with RF in the cavities, at least during commissioning. Inaccessible with beam?
- Must be in a radiation-free zone (digital electronics: FPGA)
- LLRF must be close to TX (10-20 m as in LHC) but need not be very close to the cavities anymore
- Reasonably comfortable (noise, dirt,…)