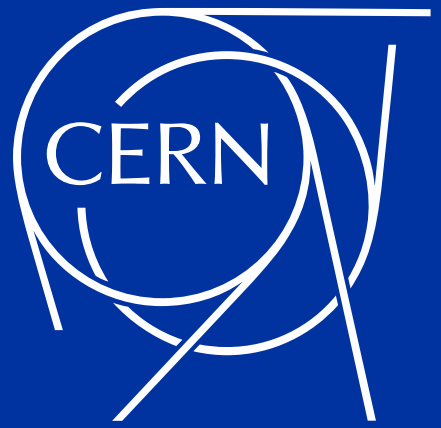


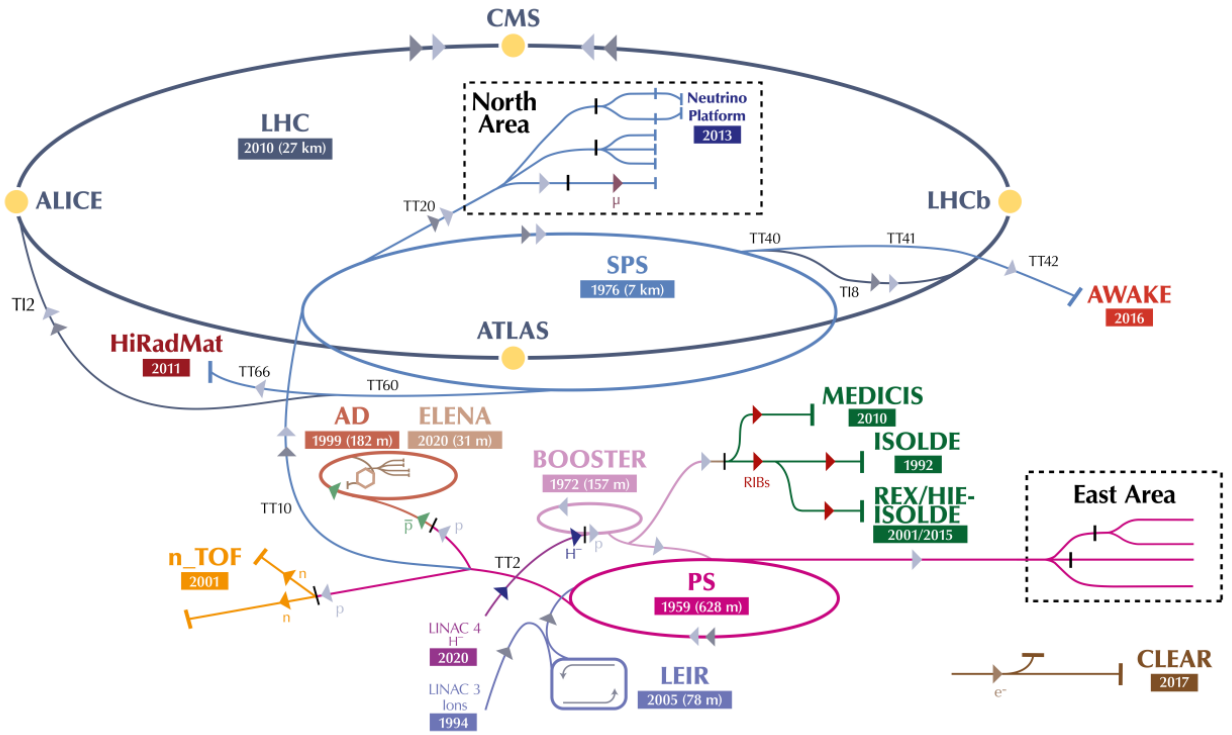
Update of CERN Proton Synchroton (CPS) Beam Controller based on MicroTCA architecture

Francisco Javier Diaz Ferreira, 11th December 2024

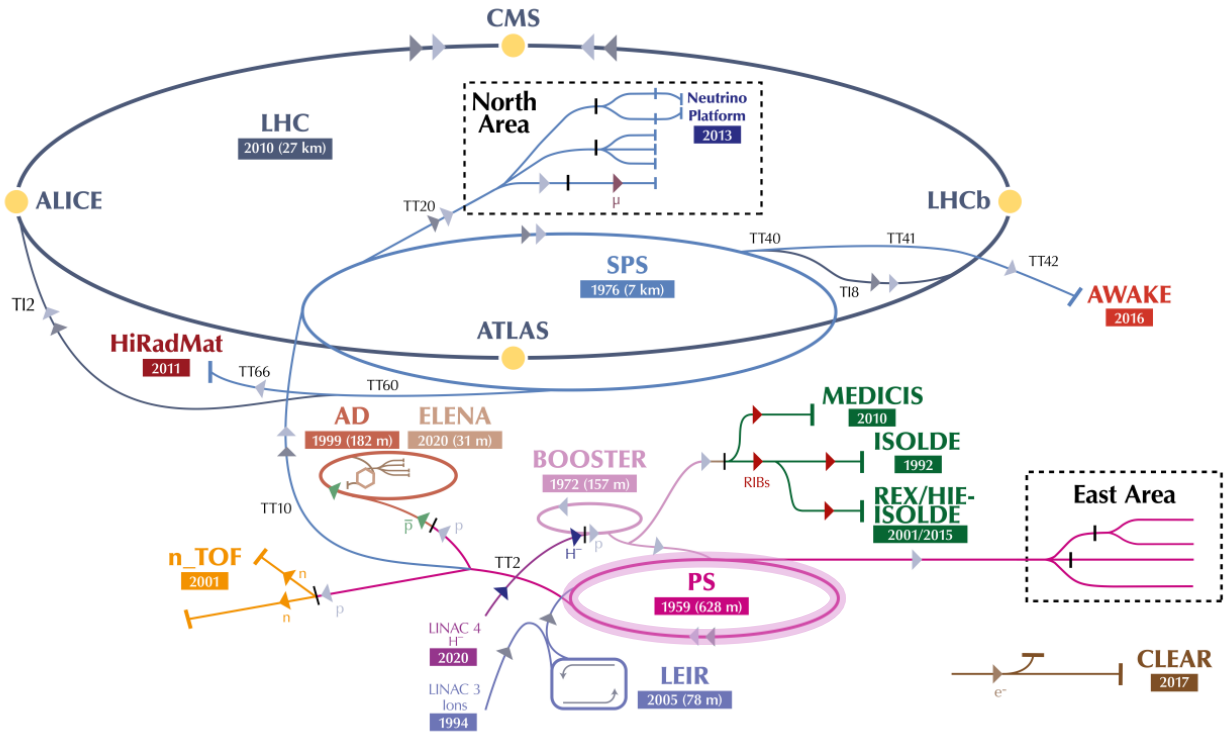
Overview

- **CPS Introduction and motivation for the upgrade with MicroTCA**
- **Proposal of the system architecture and hardware**
- **Development and testing stages and deadlines**
- **Future projects**

CERN Proton Synchrotron (CPS or PS)

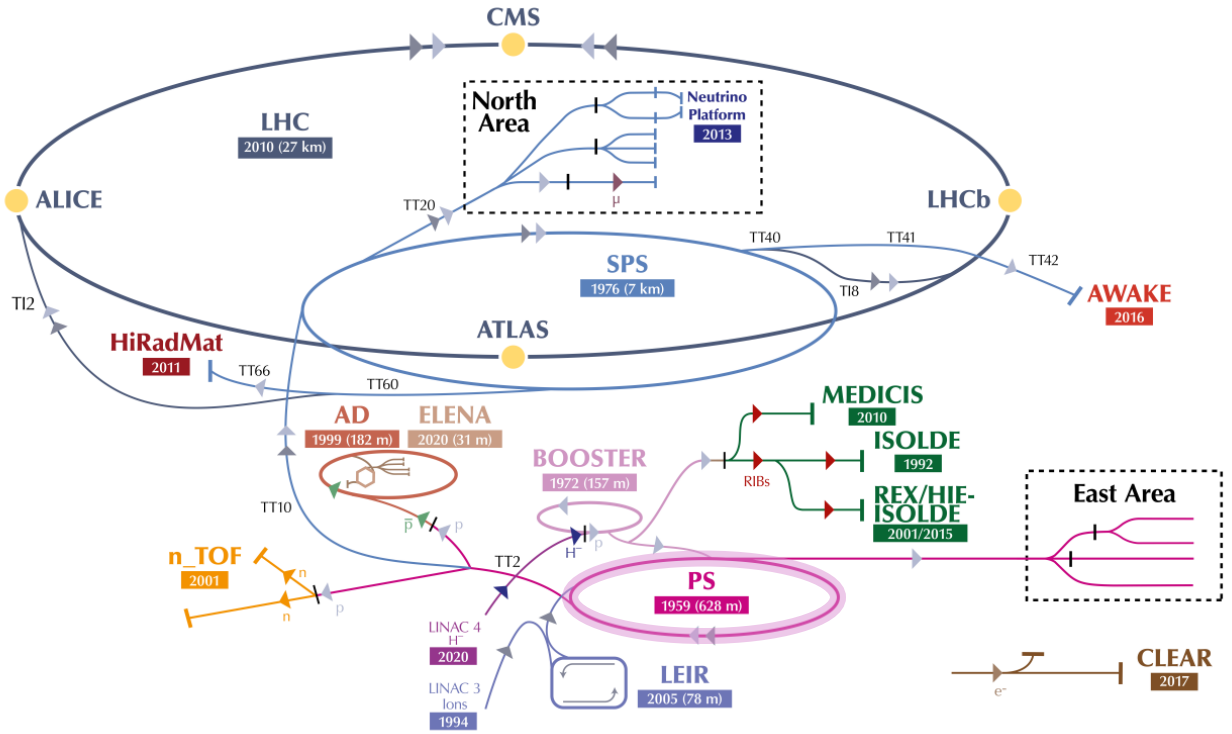


CERN Proton Synchrotron (CPS or PS)



CERN Proton Synchrotron (CPS or PS)

- **Oldest operating machine**
- **First multiplexed injector in the complex**
- **Responsible for most RF gymnastics**
- **Accelerates through relativistic transition**



Motivation

- **High-Luminosity LHC (HL-LHC) -> injectors upgrade, including the CPS**
  - Doubling proton intensity
  - Need for new RF gymnastics
  - System obsolescence
  - Maintenance difficulty

Motivation

- **High-Luminosity LHC (HL-LHC) -> injectors upgrade, including the CPS**
  - Doubling proton intensity
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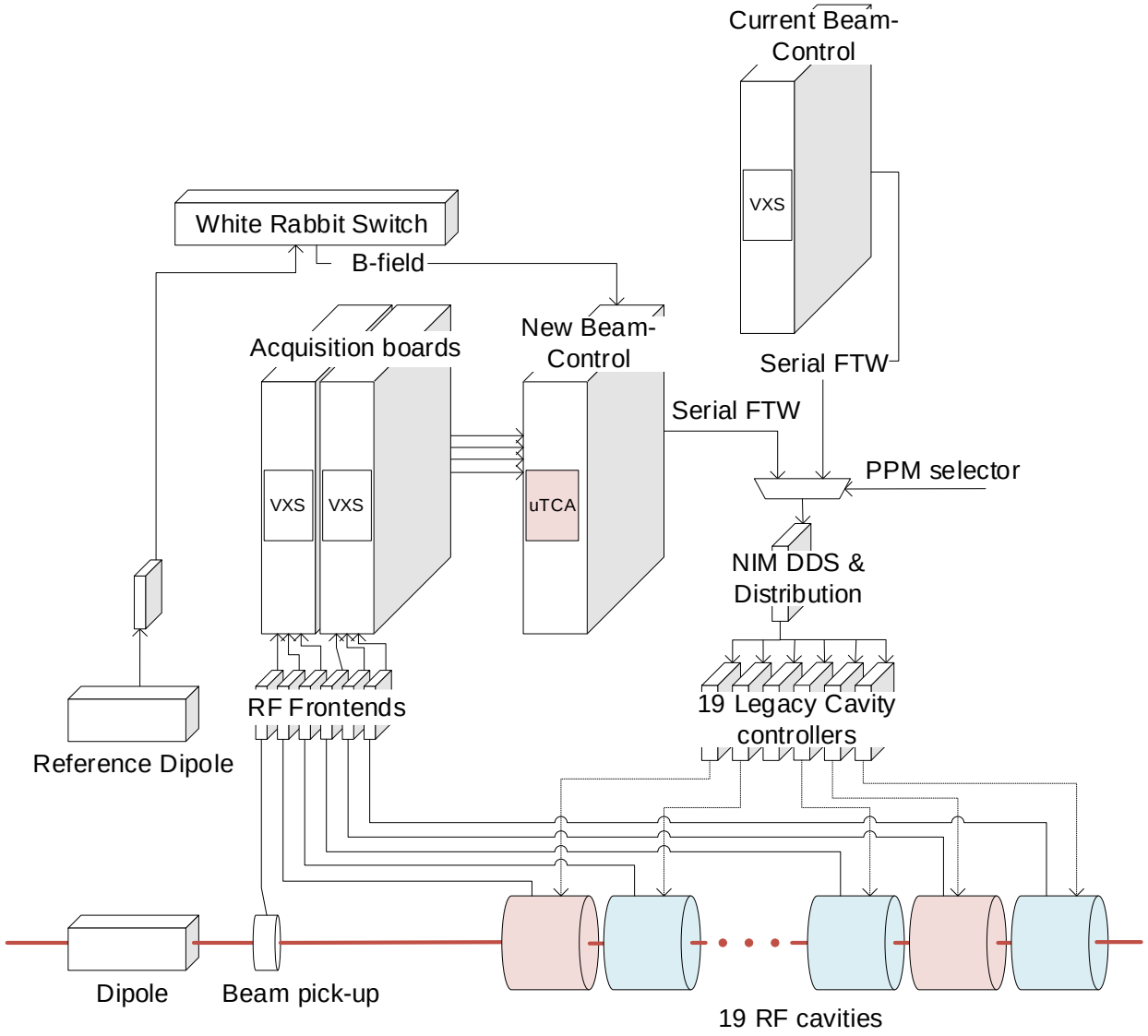
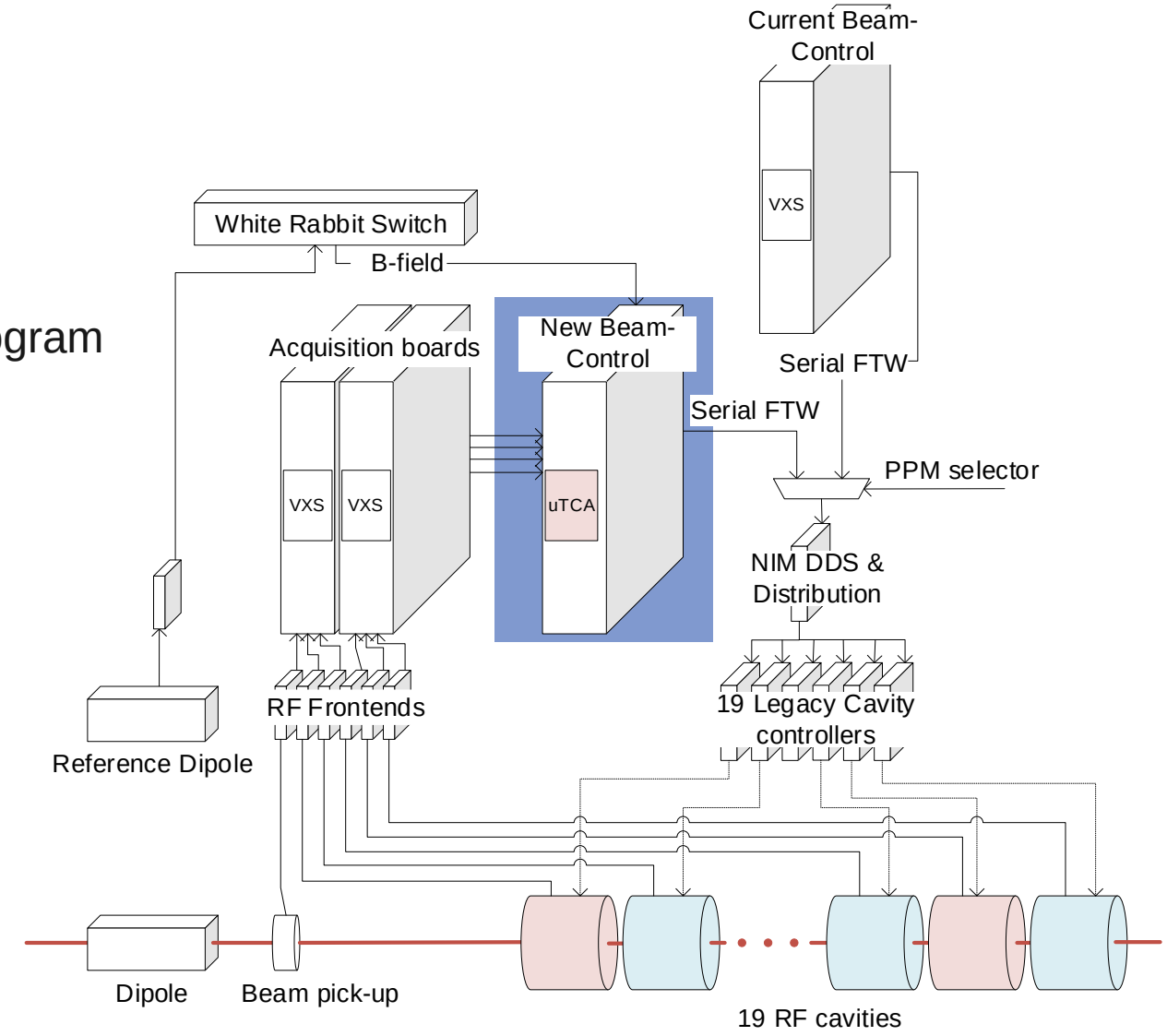
  - System obsolescence
  - Maintenance difficulty
- **MicroTCA**
  - COTS
  - White rabbit integration
  - PCIe bandwidth
  - P2P & trigger lanes
  - Redundancy & remote diagnostics
  - Use in other CERN machines

Architecture



Architecture

- **MicroTCA**
  - Beam-Control: beam-base loops, frequency program
  - RTM: White Rabbit and fiber acquisition



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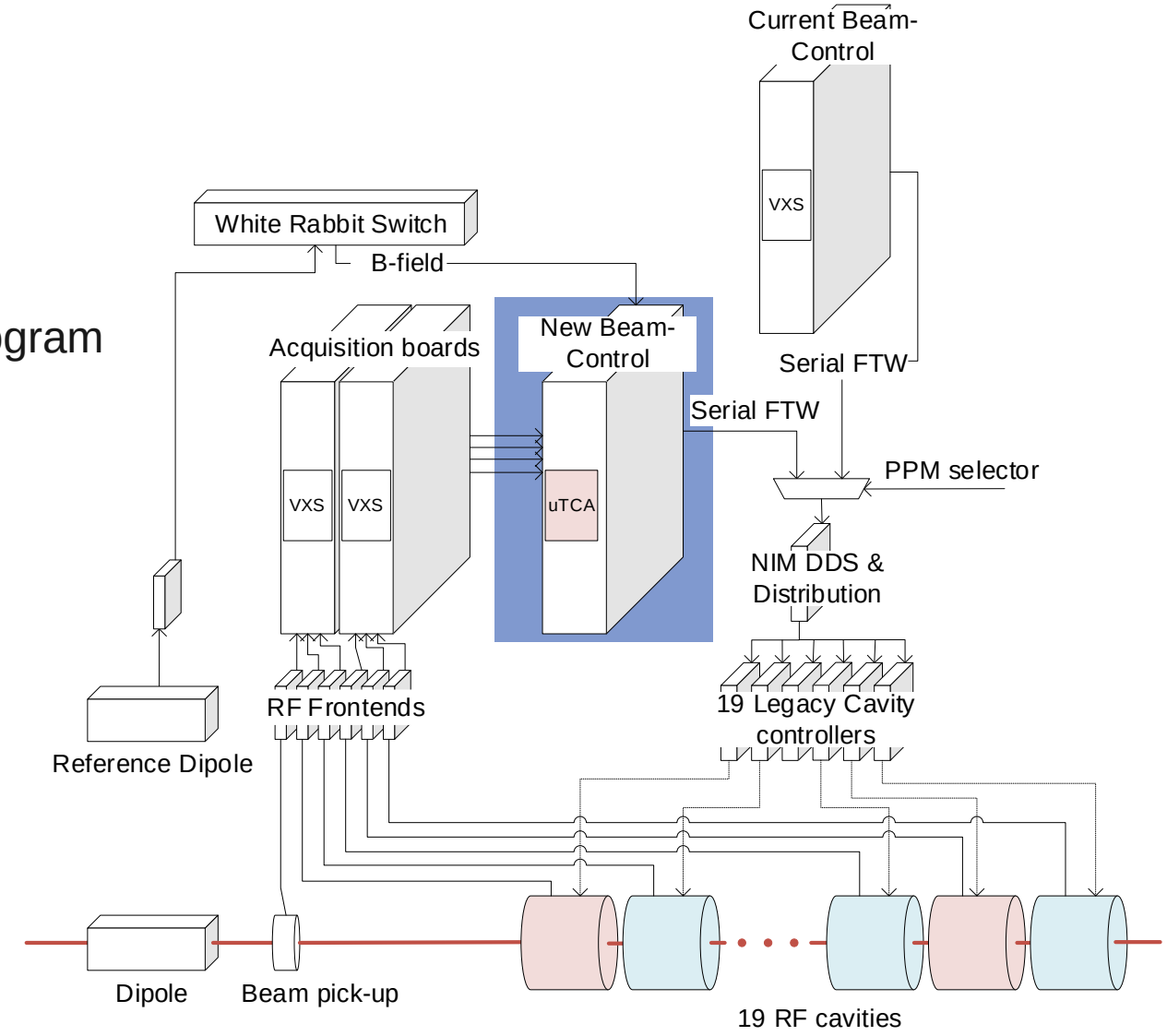
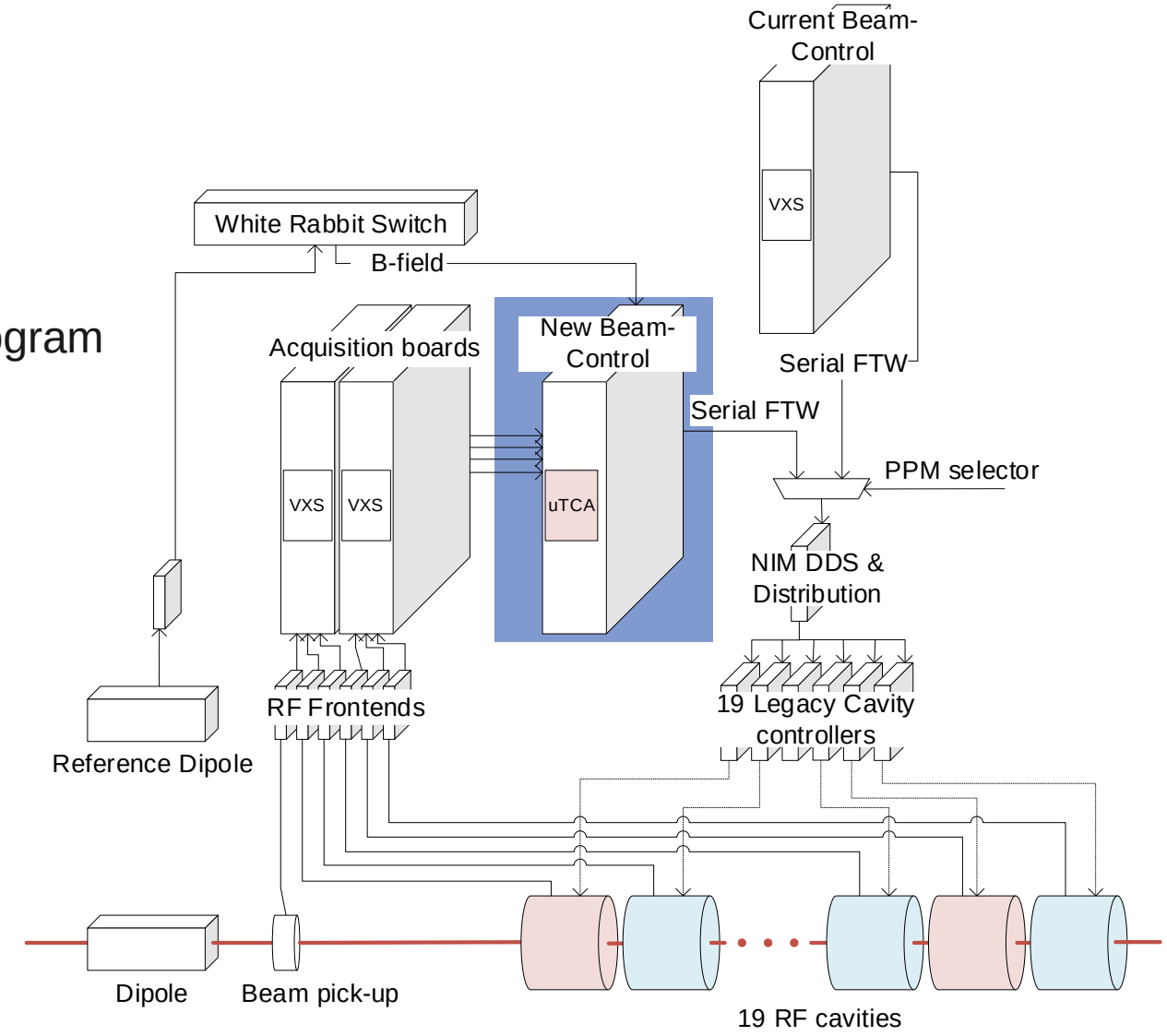


Architecture

- **MicroTCA**
  - Beam-Control: beam-base loops, frequency program
  - RTM: White Rabbit and fiber acquisition
- **White-Rabbit based RF synchronization**
- **VXS**
  - Digitalization of accelerator signals to IQ pairs

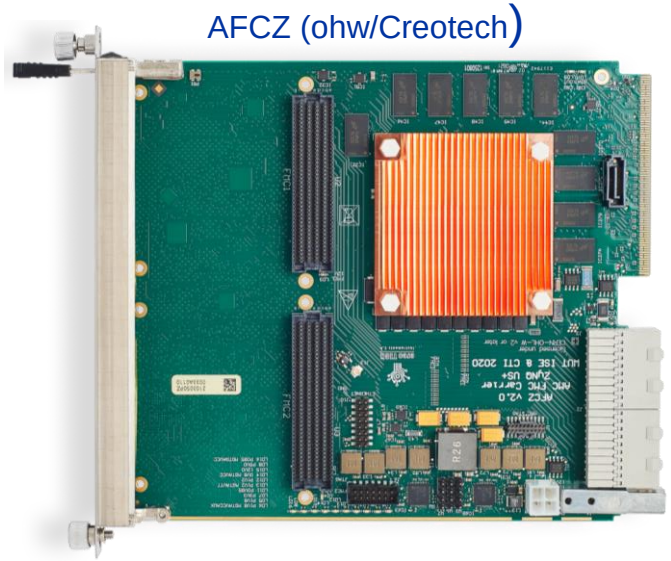


Hardware

1x AFCZ

- Beam control firmware

AFCZ (ohw/Creotech)



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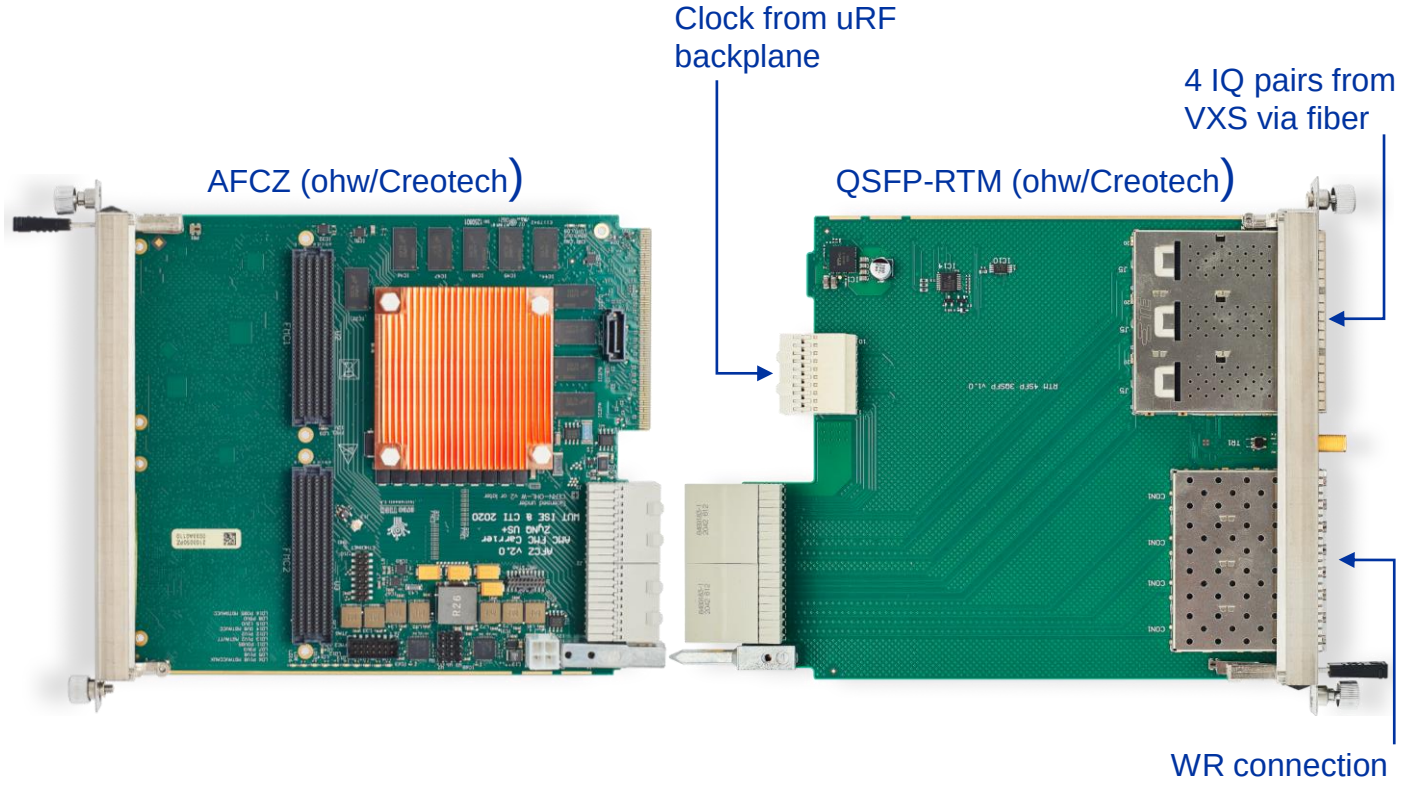
1x AFCZ

- Beam control firmware

1x QSFP-RTM

- WR reception and broadcast
- IQ pairs reception



Hardware

1x AFCZ

- Beam control firmware

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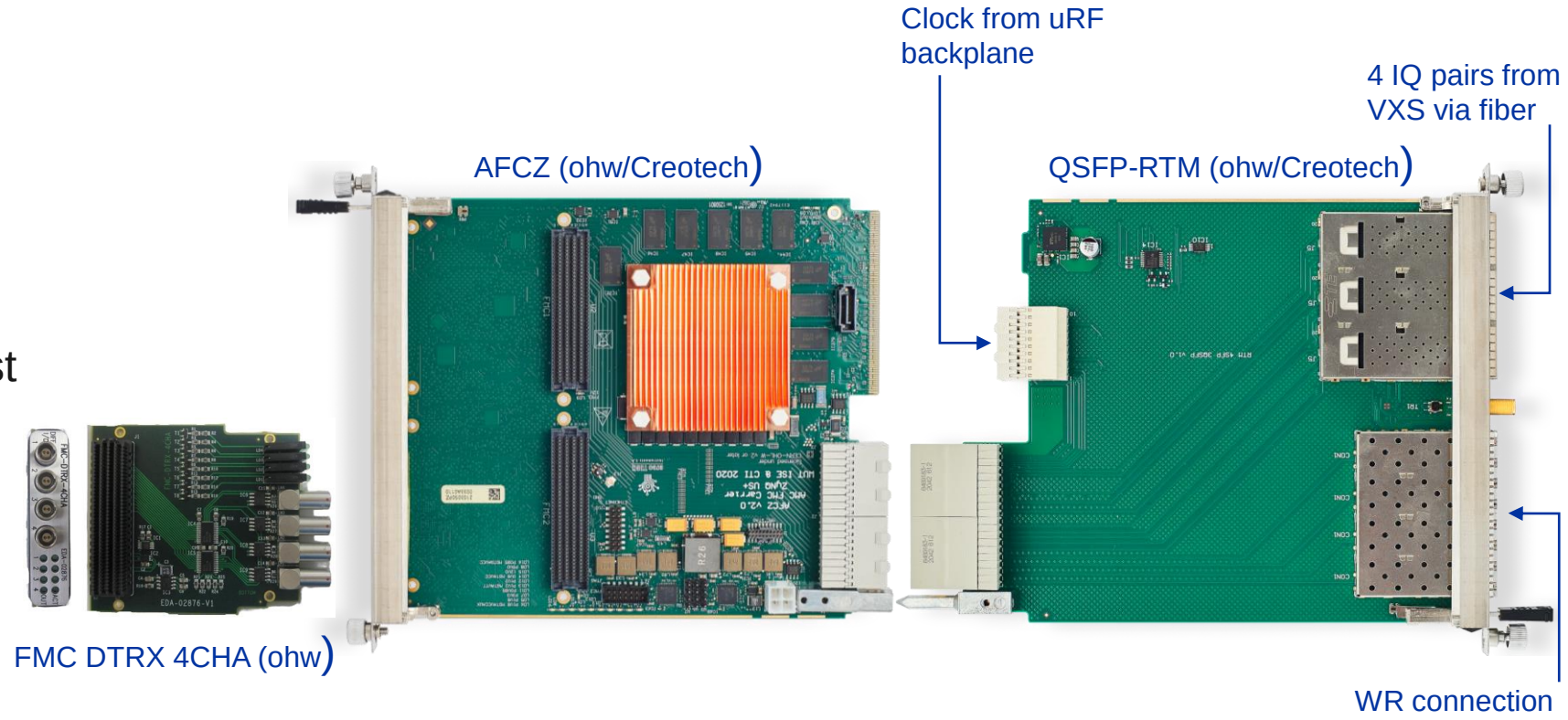
- WR reception and broadcast
- IQ pairs reception

1x FMC-DIO32LVDS

- FTW distribution



Hardware

- **Crate 9U with RF backplane MTCA.4.1 (Schroff)**
  - NAT-MCH
  - NAT COMEx (RTM of MCH)
  - 2x 600 W NAT Power modules
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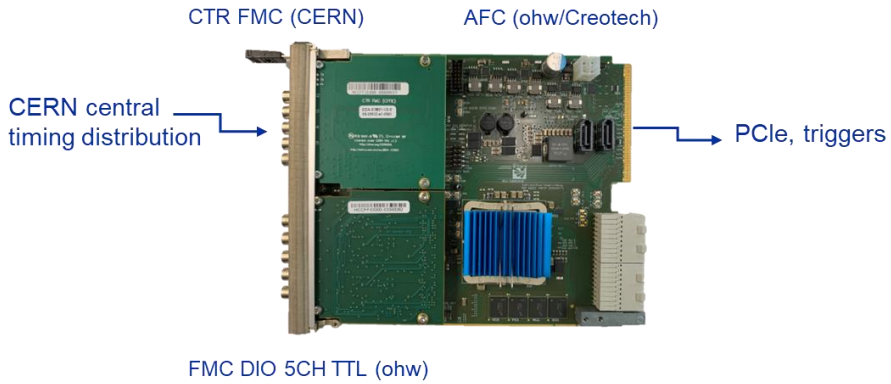

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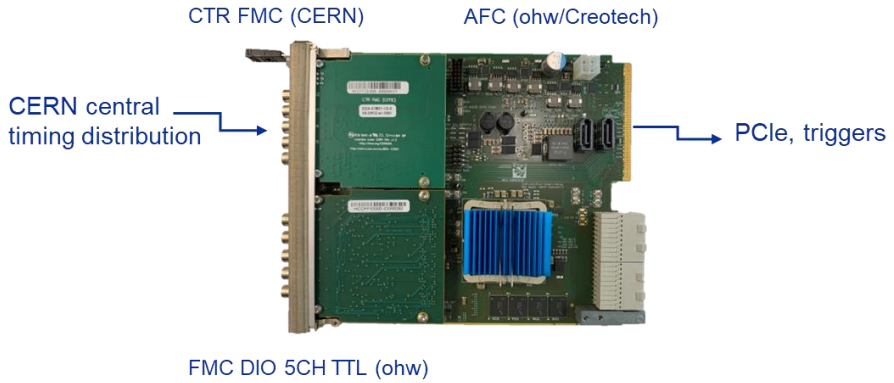
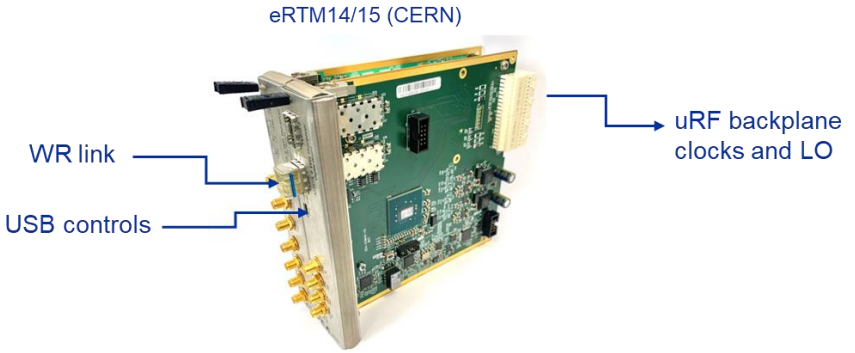
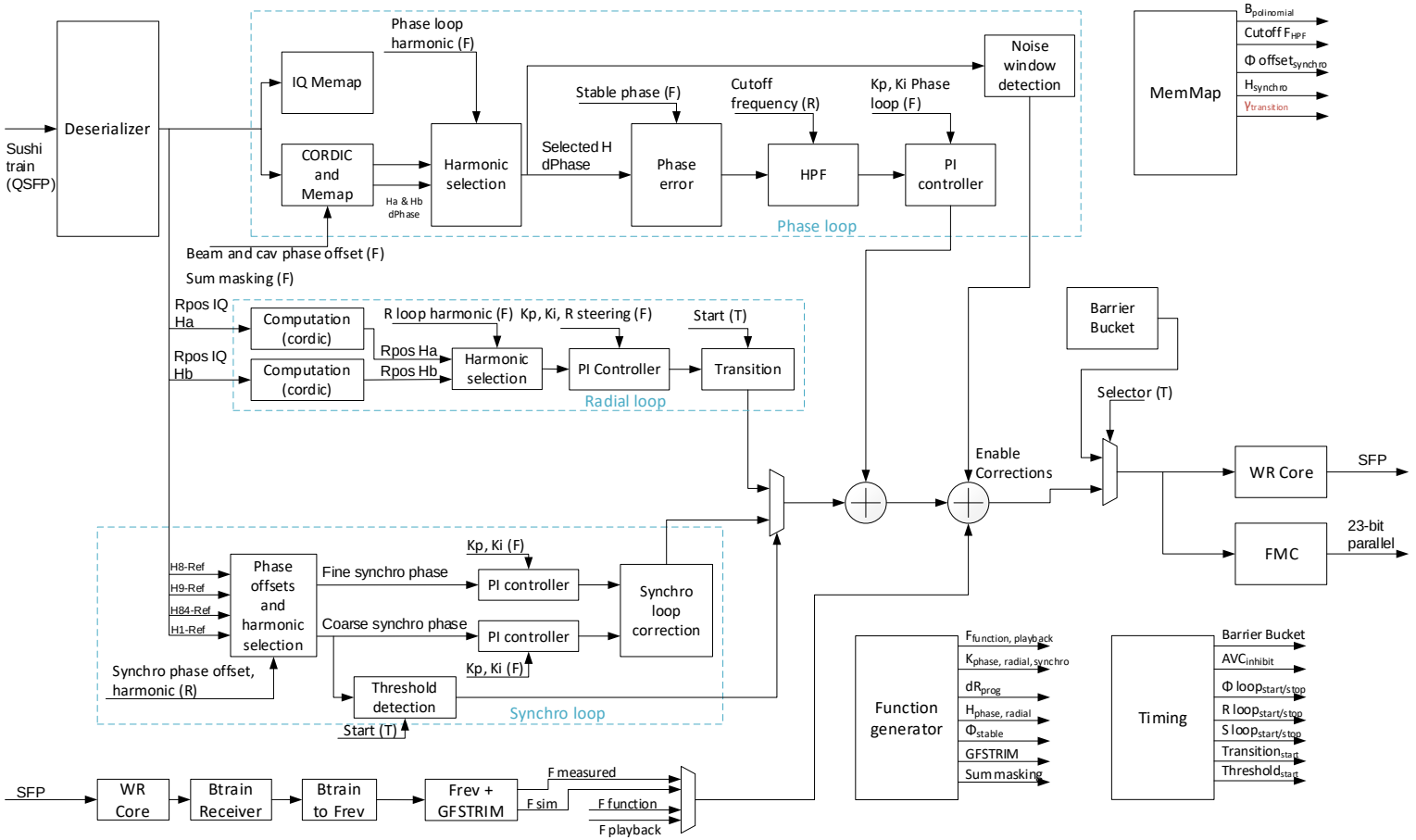
- **Clock distribution**
  - eRTM14/15 (CERN ohwr)



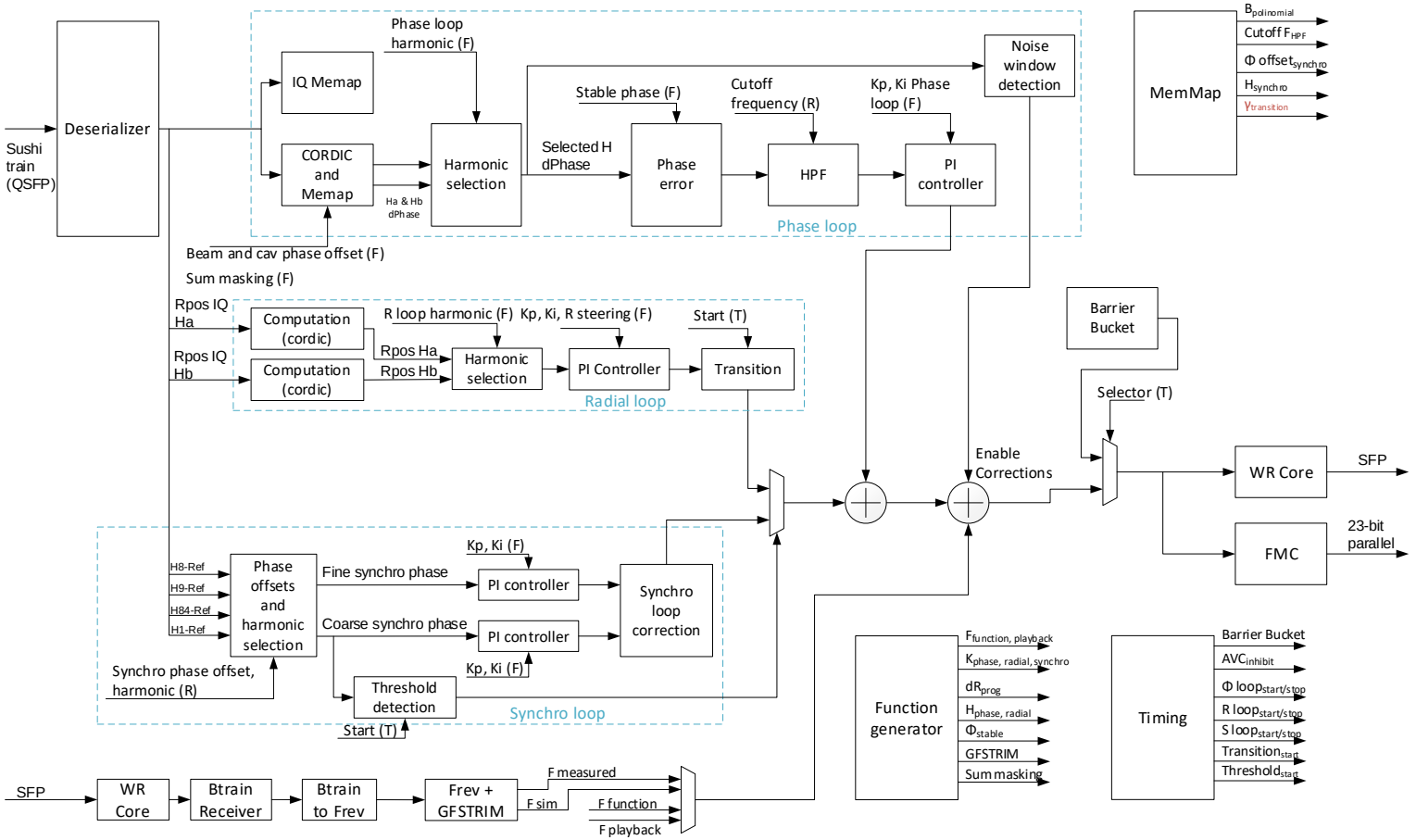


Beam-Control



Beam-Control

- **Computes beam loops**
  - From cavity voltages
  - From beam pick-ups



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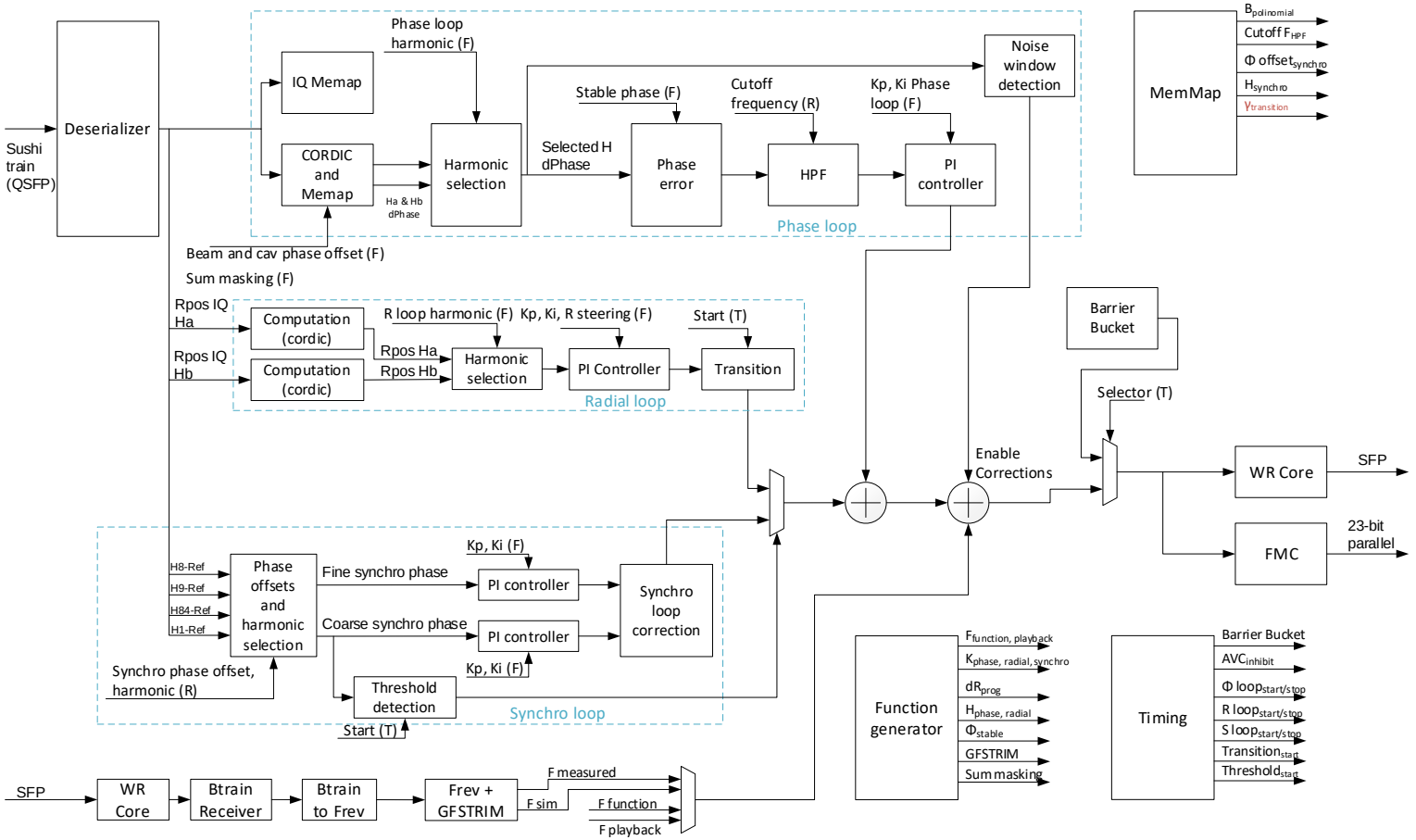
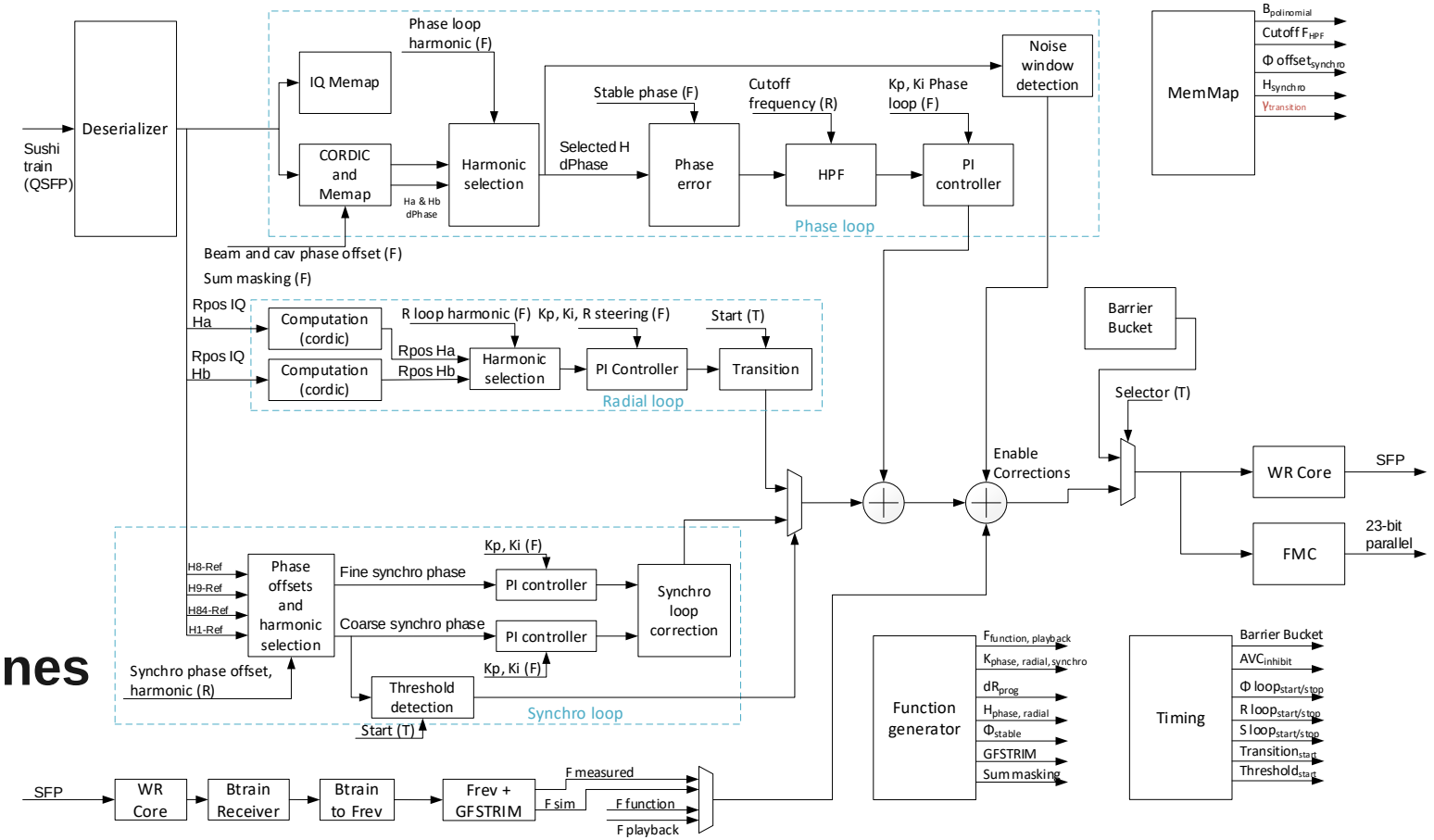
- **Generates FTW**
  - Open frequency + loops
  - Sends through FMC and WR

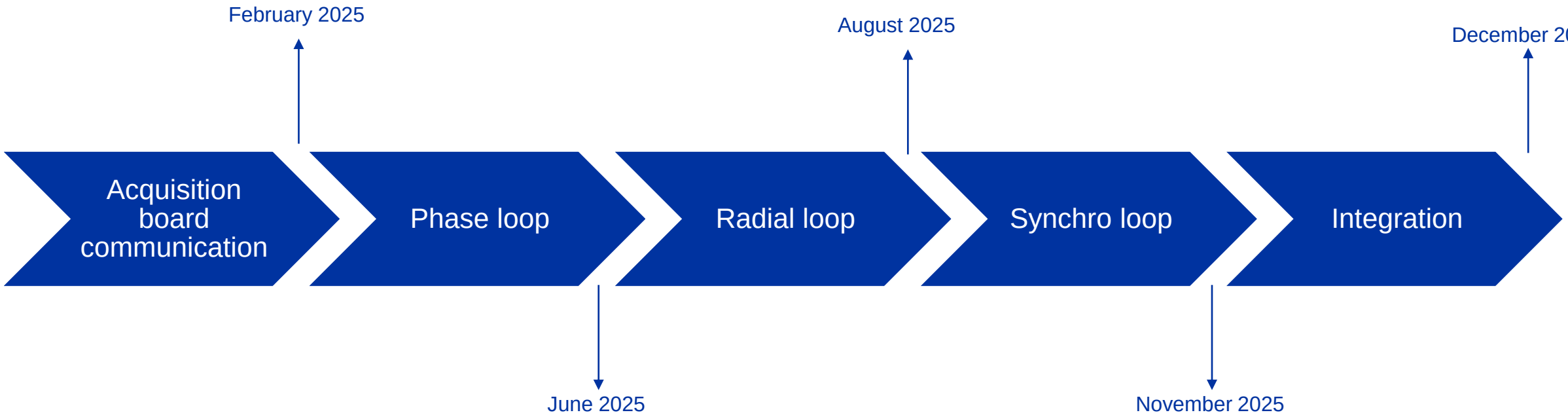


Beam-Control

- **Computes beam loops**
  - From cavity voltages
  - From beam pick-ups
- **Generates FTW**
  - Open frequency + loops
  - Sends through FMC and WR
- **Synchronizes with target machines**



Development stages

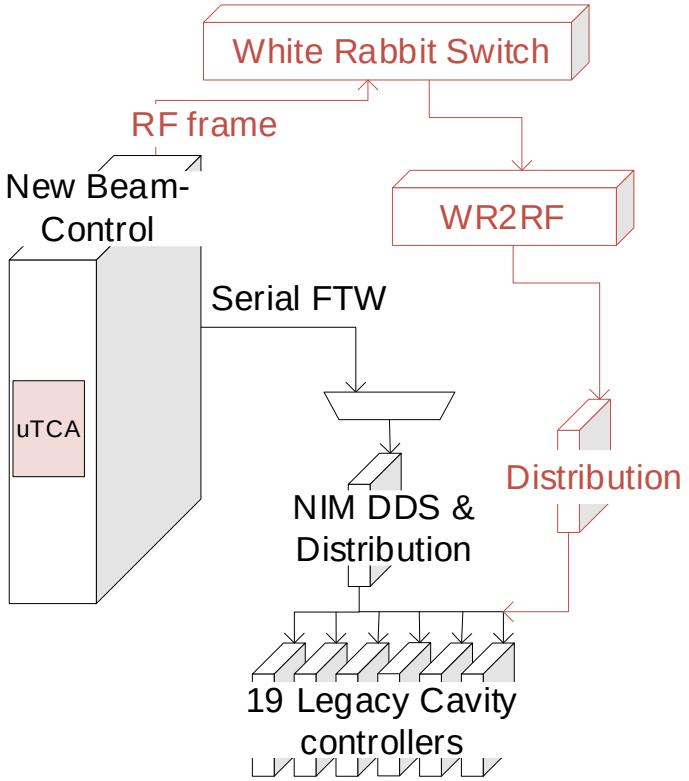


…I´ll update you next year…

Future projects

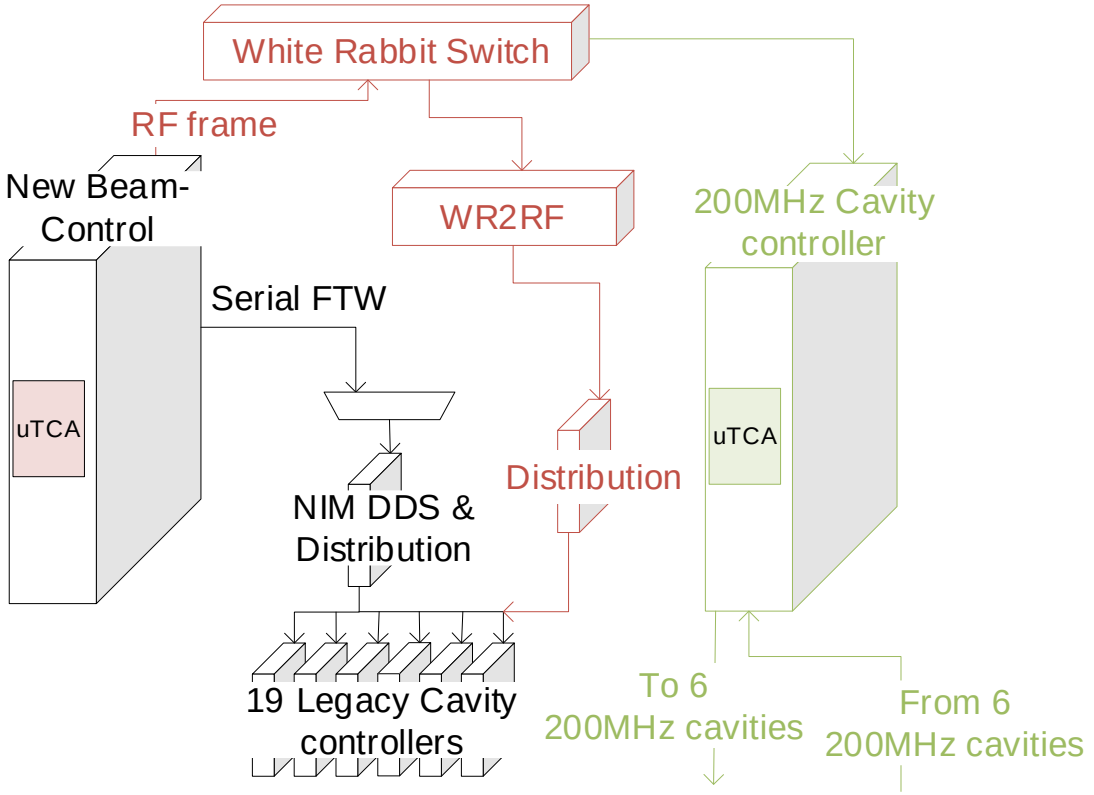
Future projects

- **Upgrade distribution of FTW (2026)**
  - Via a WR Switch
  - Dependent on signal delay budget



Future projects

- **Upgrade distribution of FTW (2026)**
  - Via a WR Switch
  - Dependent on signal delay budget
- **Upgrade 200MHz cavity controllers (LS4)**
  - Based on microTCA controller developed for SPS



Acknowledgements

CERN SY-RF-LL

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CERN SY-RF-CS (LLRF Software)

Y. Brischetto

CERN SY-RF-BR (Beams & RF studies)

H. Damerau, A. Lasheen

Questions ?

If you want to keep in touch: francisco.javier.diaz.ferreira@cern.ch

References

- **Status of the CERN SPS MicroTCA Low Level RF**
  - https://indico.desy.de/event/41197/contributions/156814/attachments/87109/116268/MTCA_2023_SPS_AS.pdf
- **Status of the beam control renovation of the Proton Synchrotron at CERN**
  - https://www.indico.kr/event/29/contributions/391/