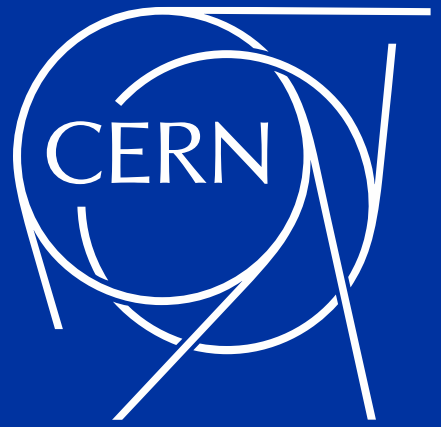


White Rabbit Timing (WRT)

Status Update

G. Kruk on behalf of the White Rabbit Timing team

15.10.2024

Outline

- Introduction
- White Rabbit Timing Network
- WREN Boards v1
- Front-End Software
- Next Steps
- Summary

White Rabbit Timing

- **Physical Network**
  - RS-485 copper cables, GMT repeaters → fibers and WR switches (**1Gb**)
  - Manual link delay calibration → automatic, sub nanosecond
  - One directional ➔ Possibility of many transmitters
- **Central Timing Receiver (CTR) → White Rabbit Event Node (WREN)**
  - 8 → 32 counters
  - More external inputs: 6+8 (VME), 2+4 (PCIe)
  - More internal clocks: 1KHz, 1MHz, 10MHz, 40MHz, 1GHz, **RF Frev and Bunch (LHC & SPS)**
  - Simpler generation of pulse trains
- **Front-End Library**
  - Simpler API, C++ only
  - Implemented for WREN, CTR and Mock
  - No timService process on the FEC
- **New LTIM FESA class**

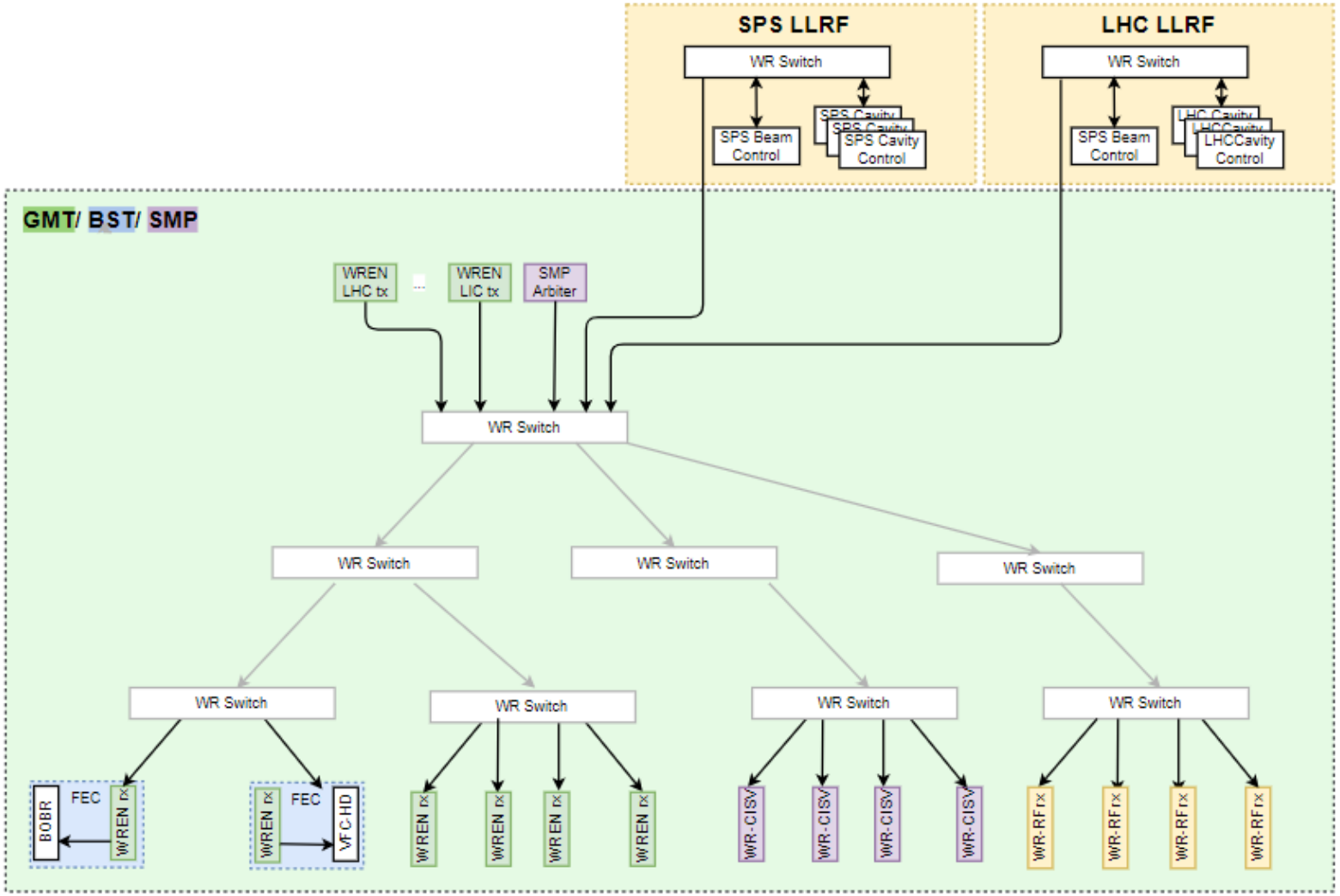
Beam Synchronous Timing & Safe Machine Parameters

- **Beam Synchronous Timing (BST)**
  - Selected timing events, along with telegram values and RF clocks
  - Encoded into frames by BST Master and distributed via a dedicated BST network
  - Received and decoded by dedicated BOBR modules or VFC-HD-core

- **Safe Machine Parameters (SMP)**
  - Beam energy and intensity, safe beam flags, …
  - Data collected from various sources by the SMP arbiter module
  - Today distributed:
    - Via dedicated links to critical users
    - Via GMT at 10Hz to FESA classes

GMT / BST / SMP / RF over WR

- **GMT**
  - Reception by WREN
- **SMP**
  - Reception at 10Hz by WREN
  - Reception at 1KHz by CISU
- **RF Clocks**
  - Reception by WREN
  - Reception by WR2RF (precision)
- **BST**
  - WREN as a local BST Master



High-Level Plan

When	Milestone
Q4 2024	Tests start by Equipment groups in labs
Q1-Q2 2025	Installation of WRT on selected operational pilot FECs
Q2 2025	Migration of 3MeV Test Stand, SM18 and FAIR Test Facility
LS3	Renovation of the LHC and the SPS (Including North Area and AWAKE) Aligned with the renovation of SMP and BST
LS4	Renovation of the remaining machines

Current Status

White Rabbit Timing Network
Optical Fibers Installation

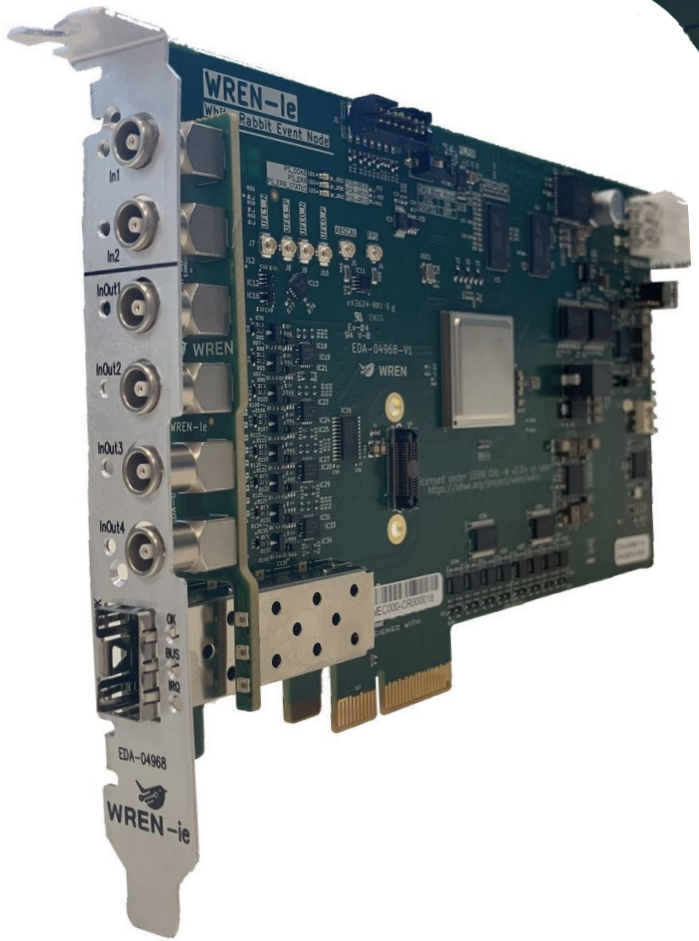
When	Where
Now	Equipment groups' labs (see next slide)
YETS 2024/25	LHC Experiments' labs
YETS 2024/25	LINAC3 / LEIR (for pilot FECs)
Q2 2025	SM18 & FAIR test facilities (3MeV TS already done)
LS3	The entire accelerator complex (LS3 installation plans by EN-EL expected in Q4'24)

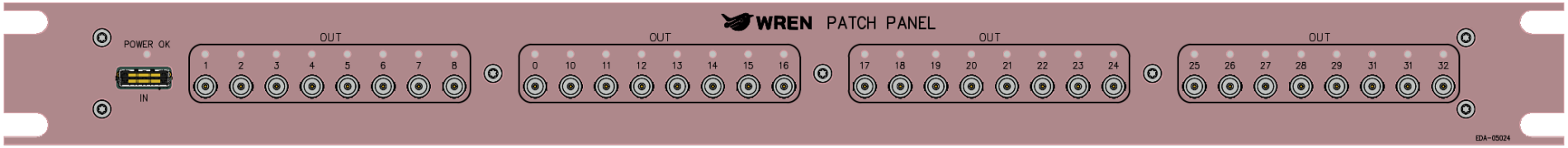
White Rabbit Timing Network
Priority List

Group	Room	Status
SY-ABT	865/2-A08	Installed
SY-BI	865/R-B05 866/R-D02	TBC
SY-EPC	866/1-C04	Installed
SY-RF	864/R-C08	TBC
TE-MPE	272/S-008 30/5-040	Installed
TE-MSC	30/3-036	Installed

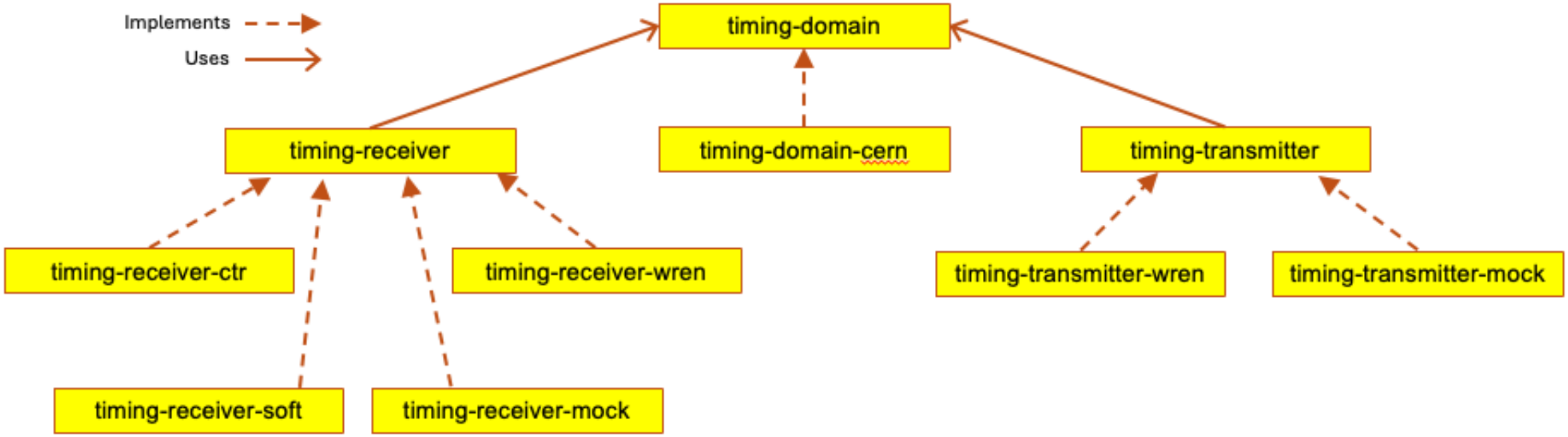
WREN Boards v1

- **VME**
  - 6 fixed inputs (In1..In6) [new]
  - 8 configurable I/Os (InOut1..InOut8)
  - BST Outputs (P0, P2)
  - ~30 produced
- **PCIe**
  - 2 fixed inputs (In1..In2) [new]
  - 4 configurable I/Os (InOut1..InOut4)
  - ~20 produced
- **Patch Panel**
  - 32 outputs (Out1..Out32)





Front-End Software: Library



Front-End Software: LTIM and WREN (v 10.x.y)

- **LTIM**
  - Management of triggers (pulses, interrupts)
  - Conceptually the same as old LTIM, few changes in property and field names
    - e.g. OutEnable → Enabled
  - New configuration options reflecting the capabilities of WREN
- **WREN**
  - Pin directions (for configurable pins): In, Out
  - Input active edges: rising, falling
  - Input labels
  - Output levels (aka polarity): active high (TTL), active low (TTL_BAR)
  - Output gates: OR, AND
  - Module diagnostics

Front-End Software: CLI test program (wrtdr)

- **Configuration of the WREN board**
- **Management of LTIMs**
- **Subscriptions on interrupts (Central Timing events and LTIMs)**
- **Diagnostics and troubleshooting**

Front-End Software: Status

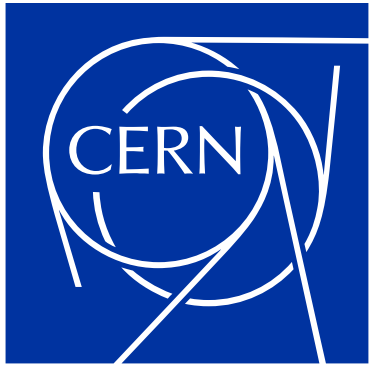
- **Integration with FESA framework done**
  - Not supporting yet selectors different than USER e.g. SPS.DYN_DEST.AWAKE
- **CLI test program done**
  - Demo on Friday
- **Finishing support for fixed inputs**
  - Change with respect to WREN v0
- **Final adjustments of the public API**
  - timing-domain, timing-receiver, LTIM, WREN
- **Preparing a dedicated transmitter FEC**
  - Mirroring super cycles played by the operational LIC Central Timing
  - LHC events transmission planned for Q1 2025

Next Steps

- **Meeting this Friday, with more technical details**
  - Present the APIs, tools and release procedure
  - Get your feedback
- **Release timing libraries and the FESA framework**
  - Around mid-November
- **Installation of WR switches and WREN boards**
  - By BE-CEM-IN
- **Complete WRT EDMS 2.0 document and send it for approval**
  - With updated milestones for 2025 and LS3

Summary

- **The project is moving according to the plan**
  - Although we do have a bit of delay
- **Technical meeting this Friday to get your feedback**
- **We still need a few weeks to wrap it up → Aiming at mid-November**
  - Release of the FEC software stack
  - Transmission of LIC events
  - Installation of WR switches and WRENs
- **LHC events to be transmitted in Q1 2025**



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