Neutron Chopper controls at ESS

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Denim 2018

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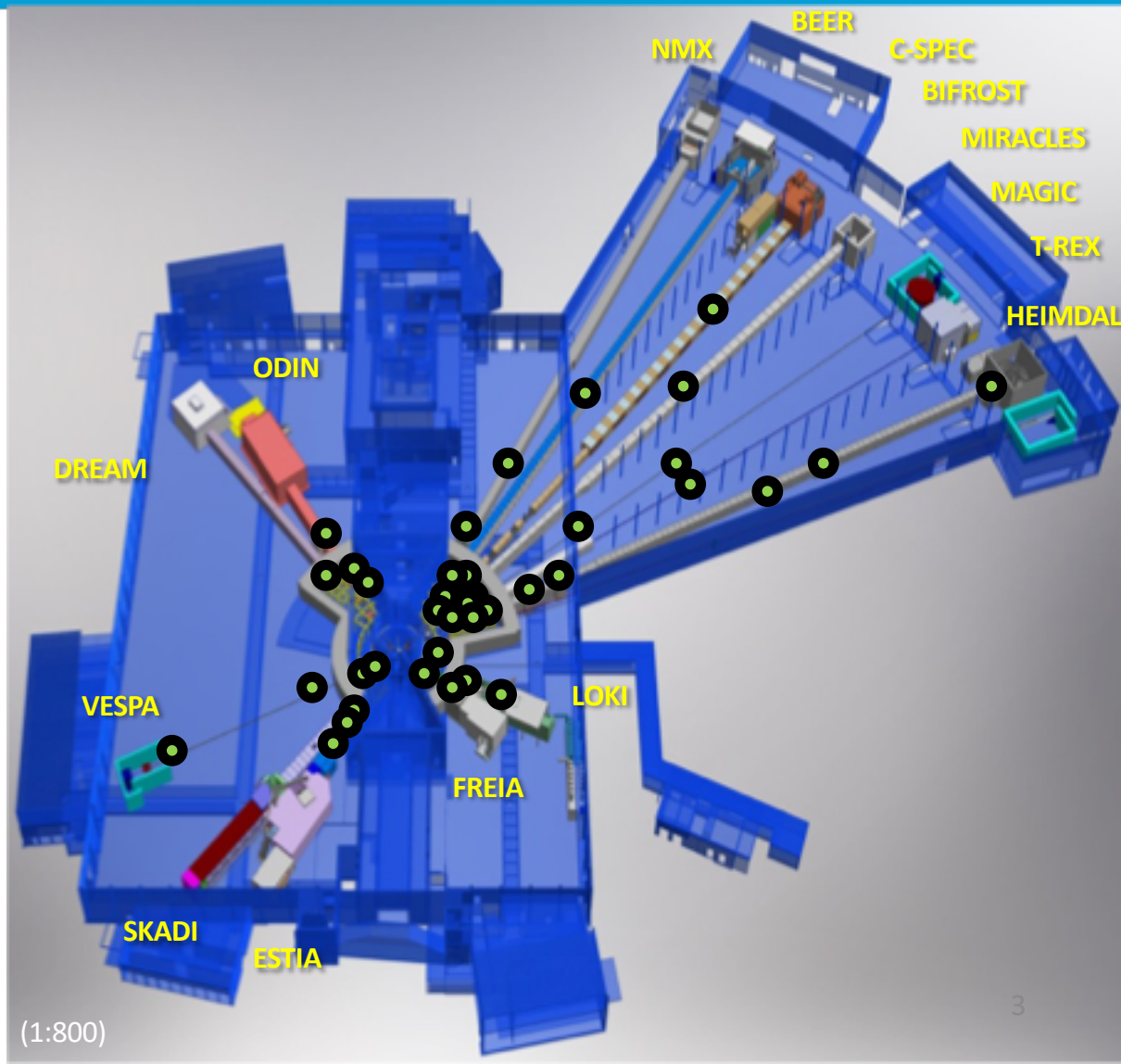
1 October, 2018

Outline

- Overview of Neutron Choppers at ESS
- Controls architecture
- Hardware
- Chopper timing/synchronization
- Q/A

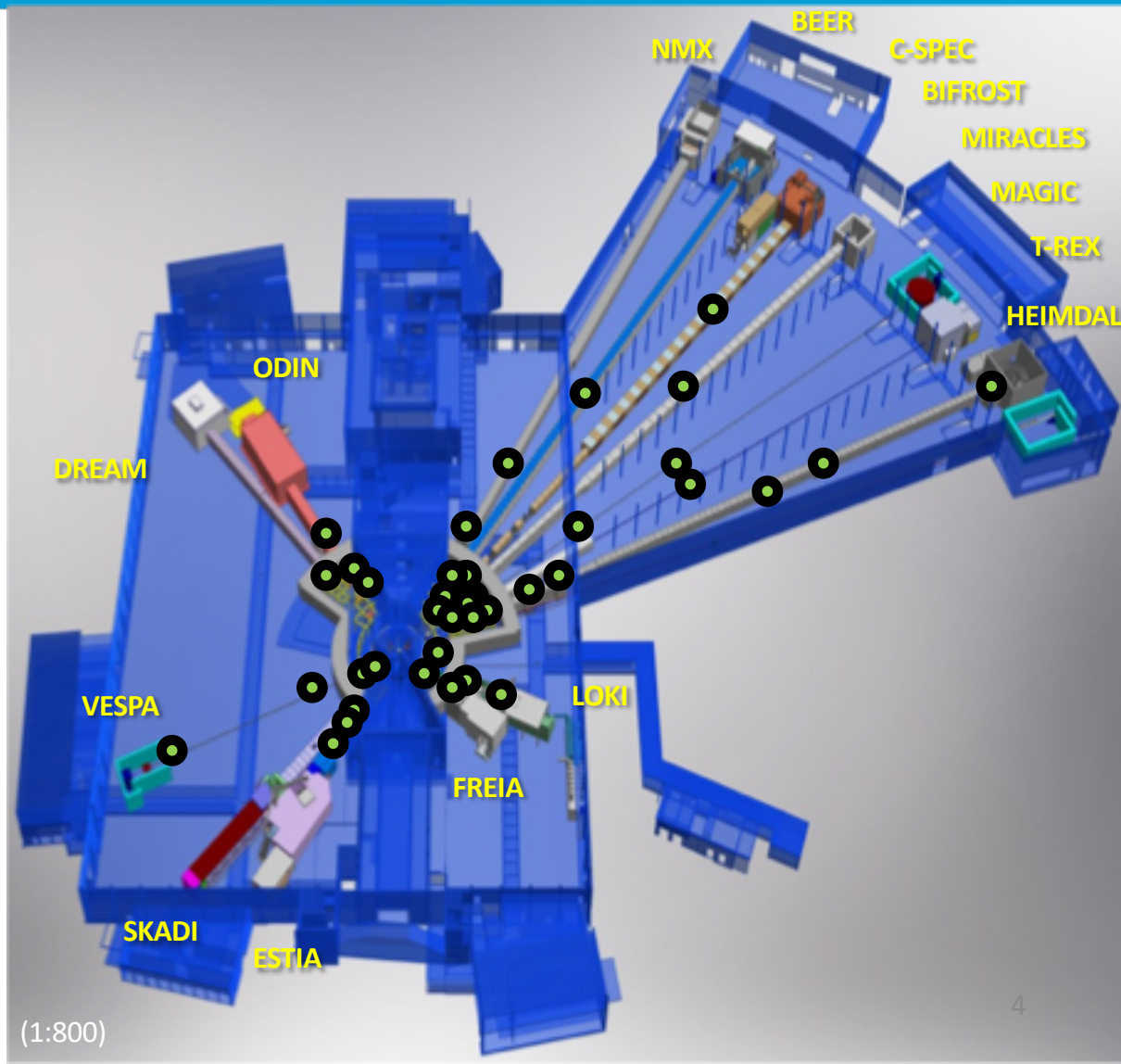
Overview of Neutron Choppers at ESS

- 15 instruments using a total of ~102 choppers in the facility.
- ~50 of those choppers are located inside the bunker.



Overview of Neutron Choppers at ESS

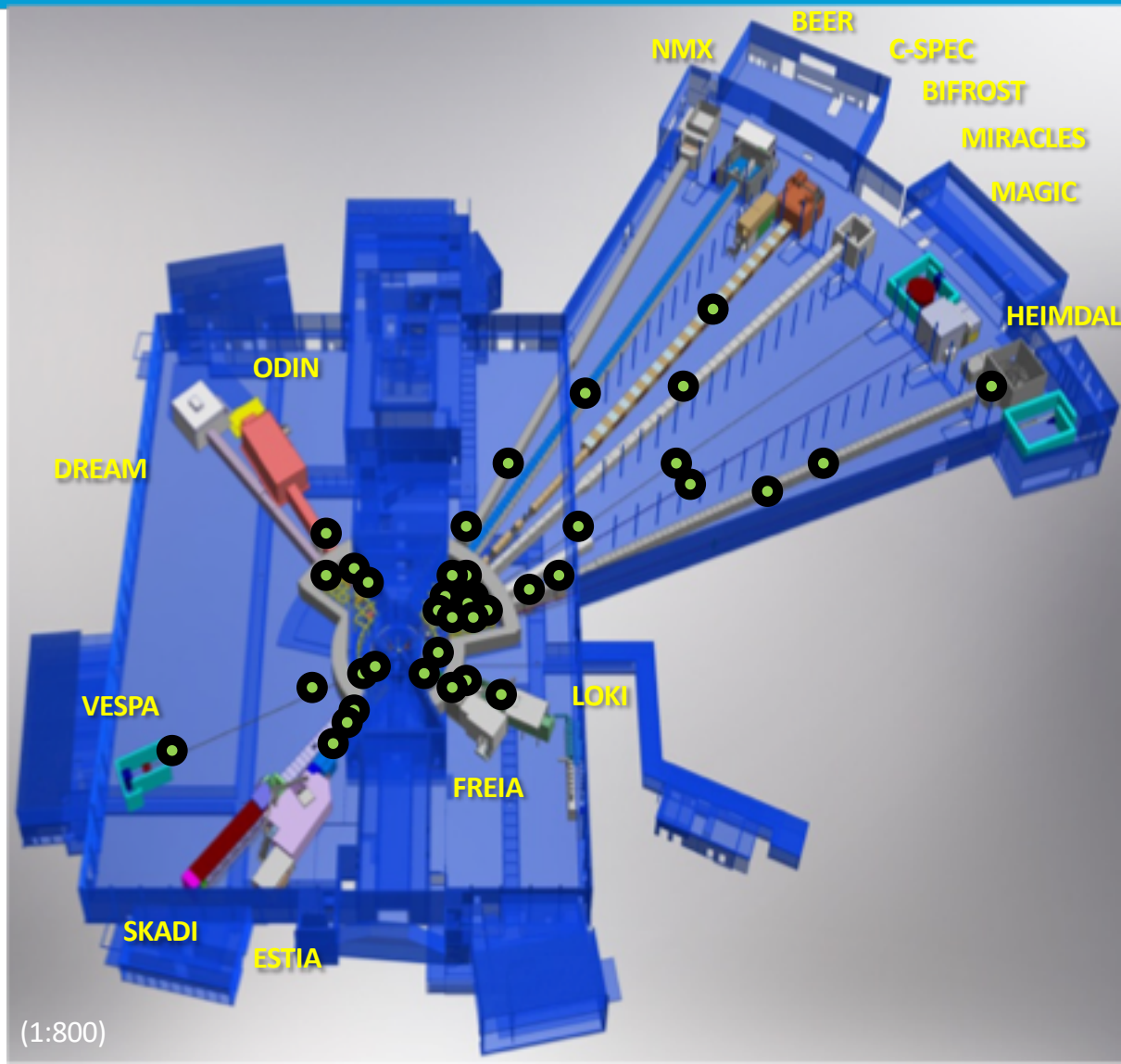
- Every instrument team is free to build/buy the chopper system that best fits their scientific needs and budget.



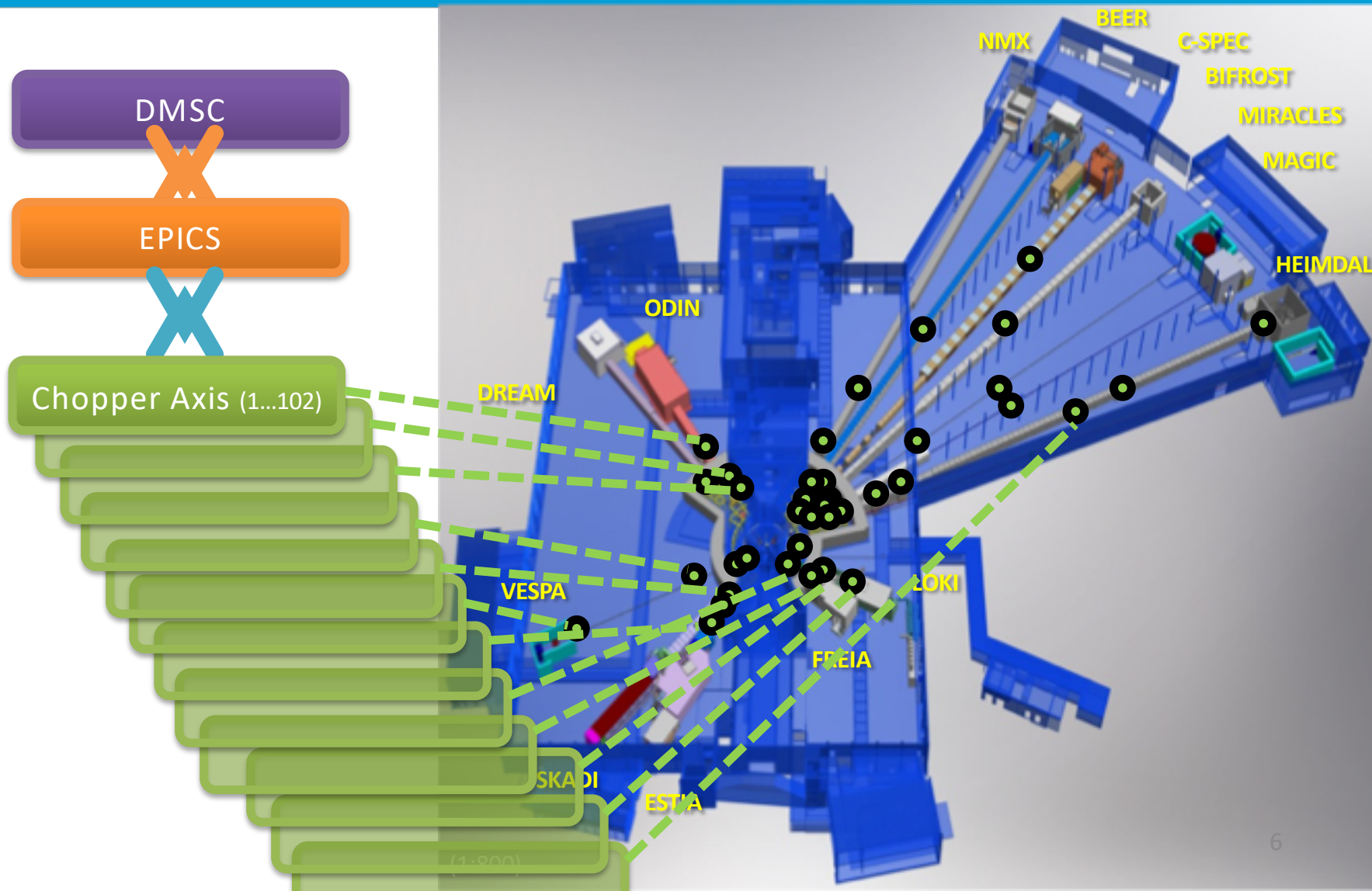
For a large scale facility

Standardise:

- Controls and monitoring
- Integration process
- Software maintenance
- Hardware
- Timing



Controls architecture



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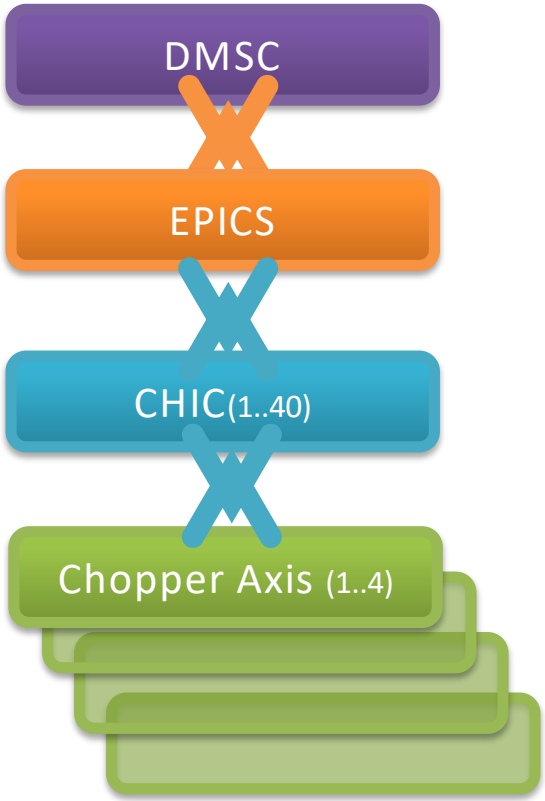
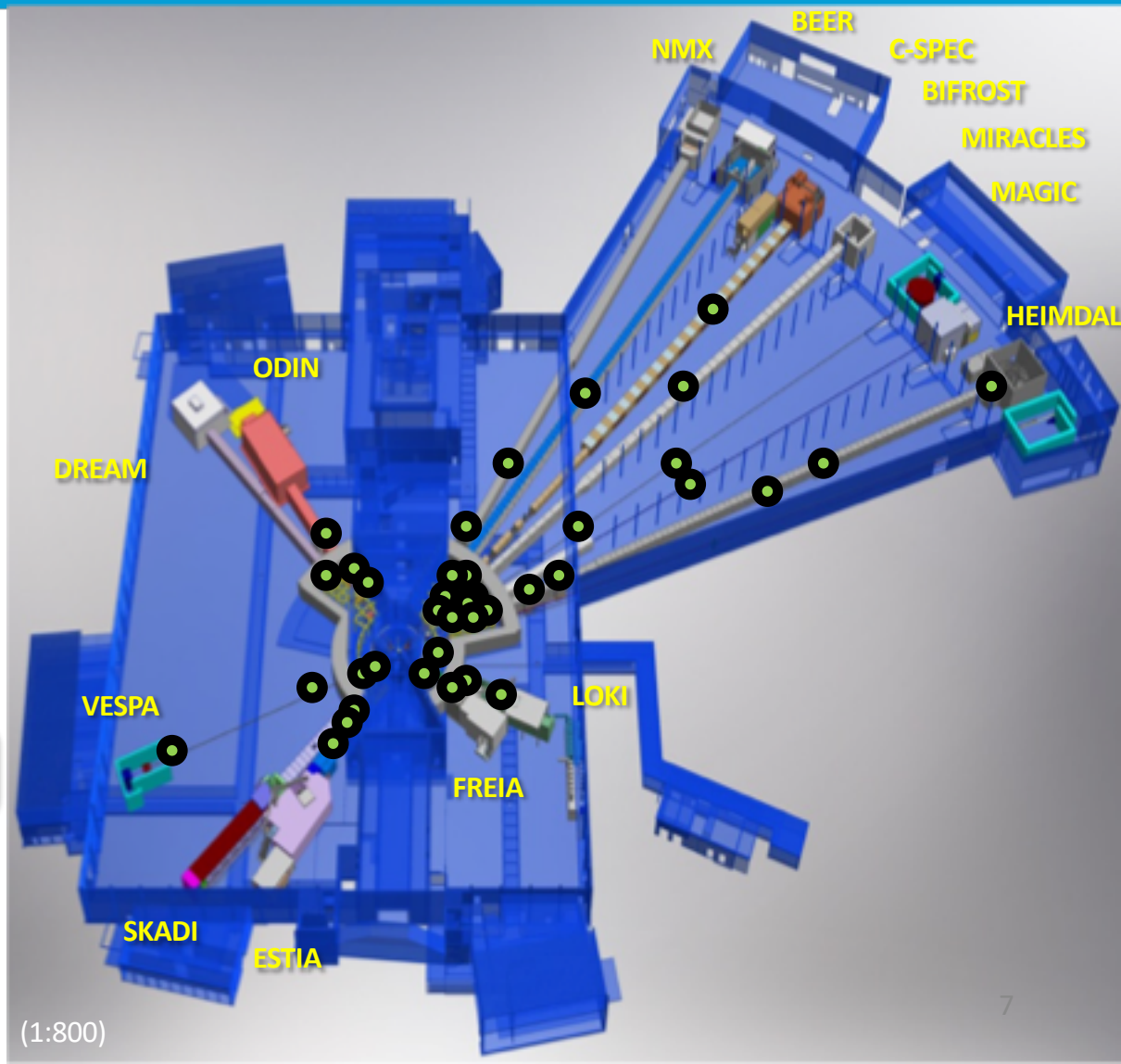


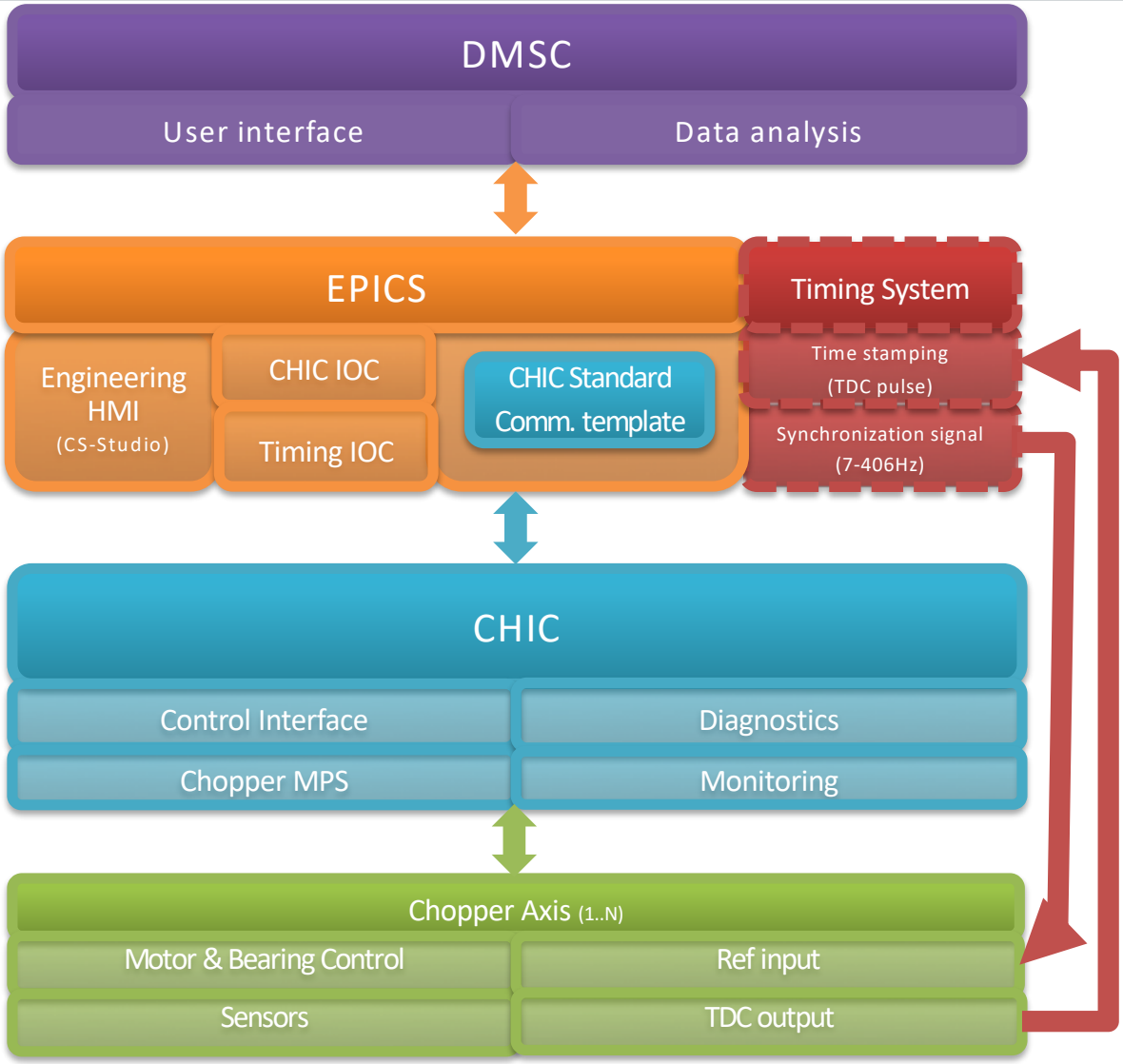


Controls architecture

CHIC- Chopper Integration Controller

- Allows the implementation of all the standarisation needed by acting as a "transducer" between EPICS and the chopper drives.
- It is a monitoring system (predictive maintenance) for external measurements such as vibration, cooling, vacuum and disk temp.

Controls architecture



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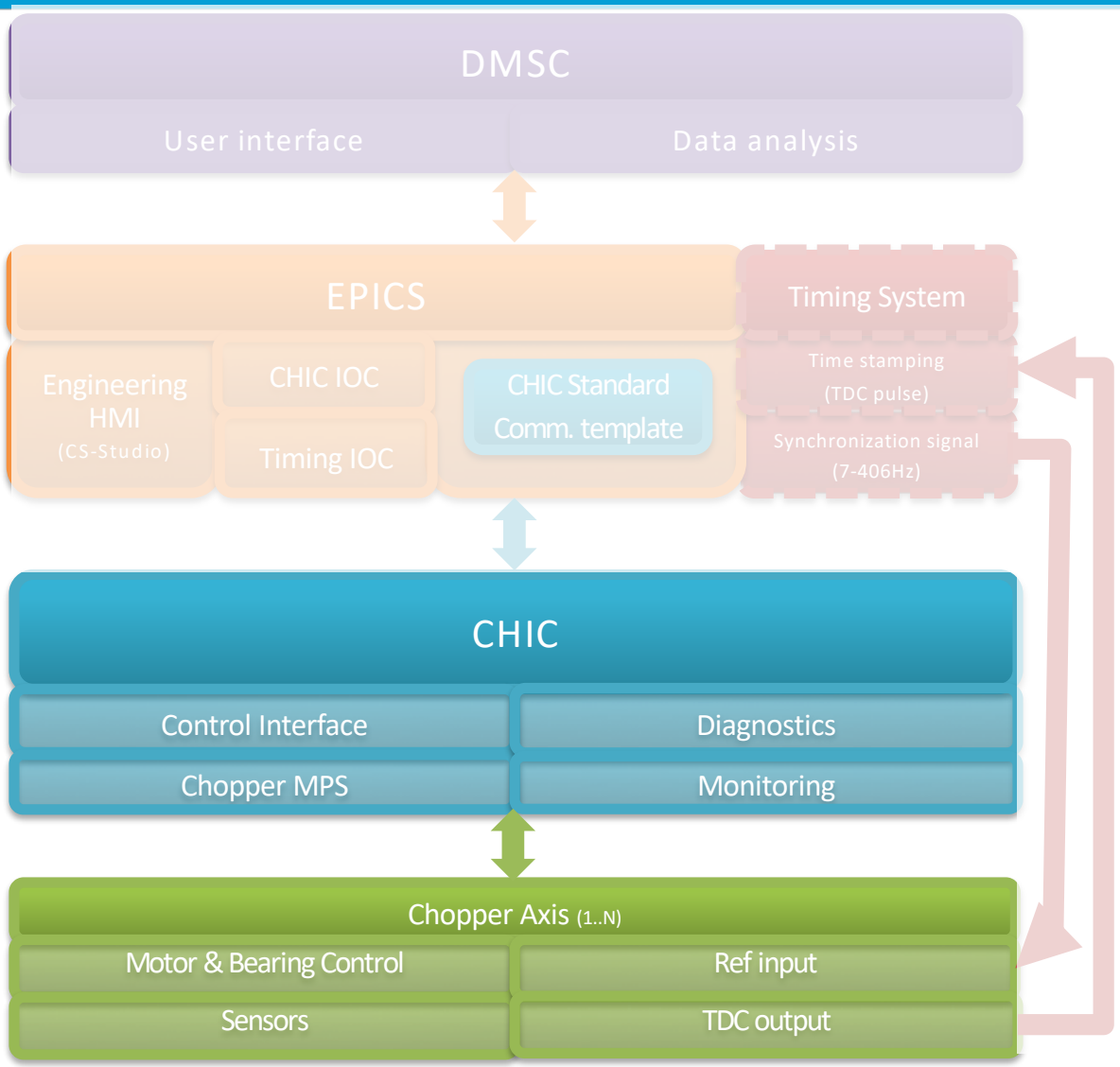
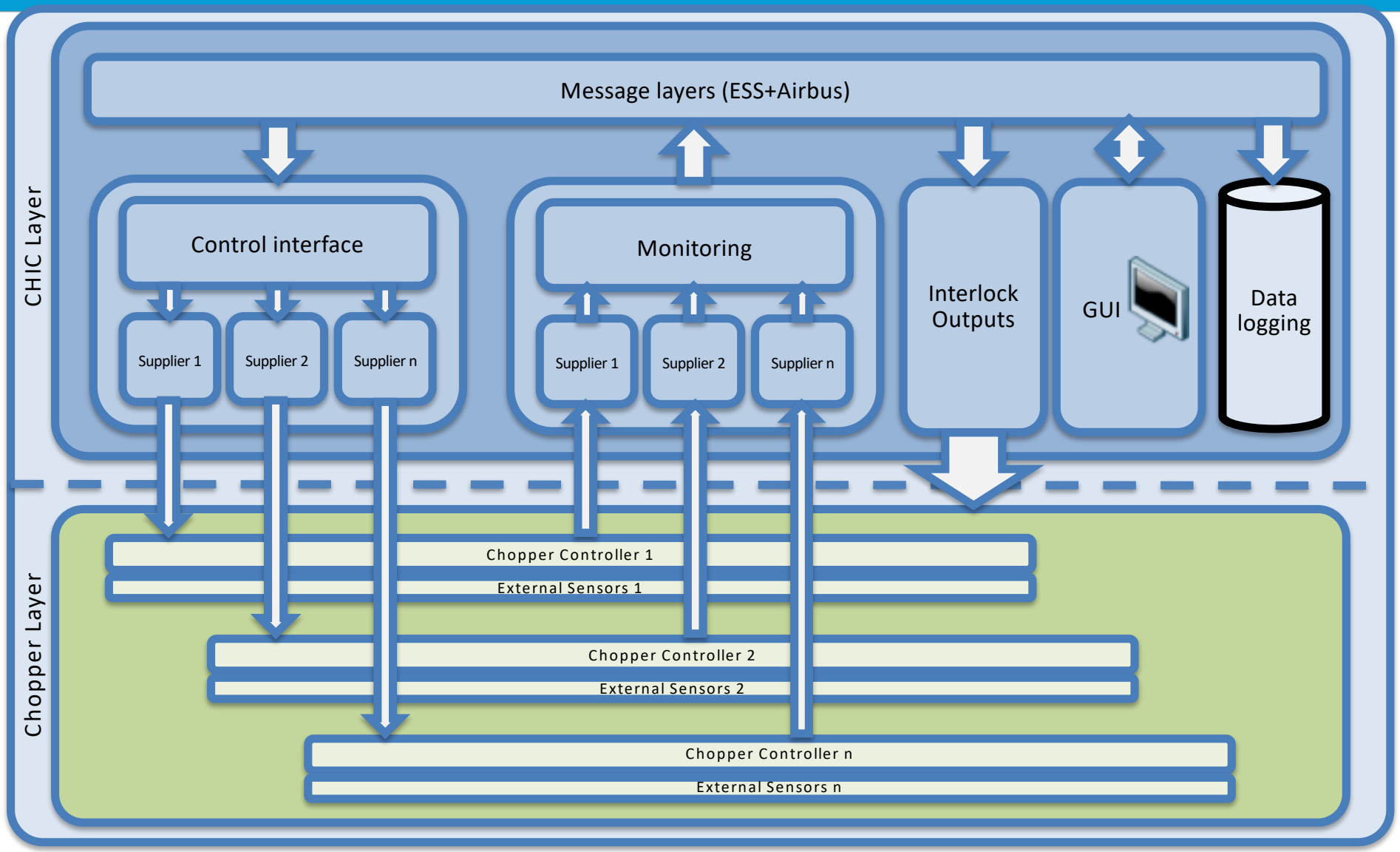
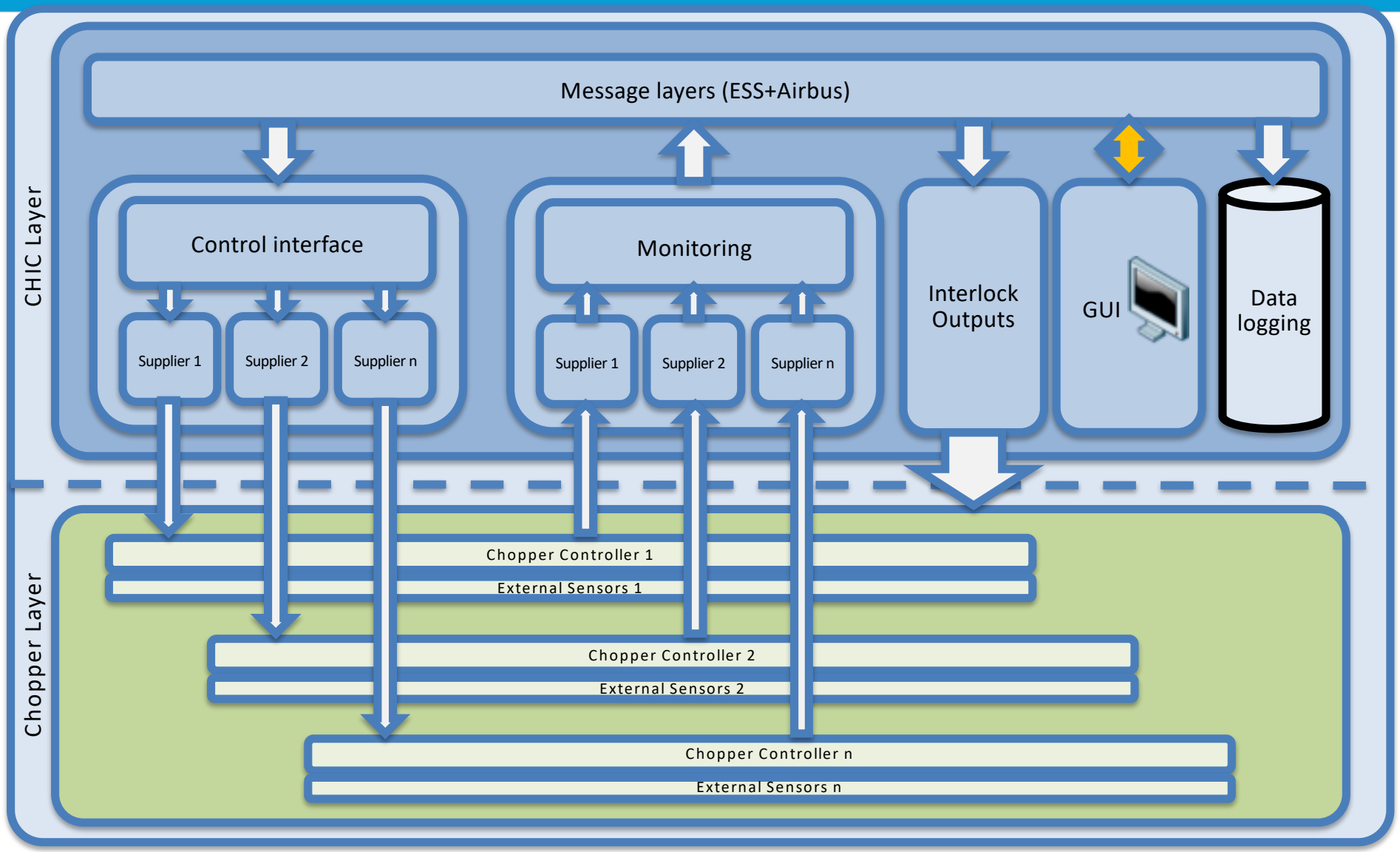


Standard Control and monitoring



Standard Control and monitoring

Sending a new command



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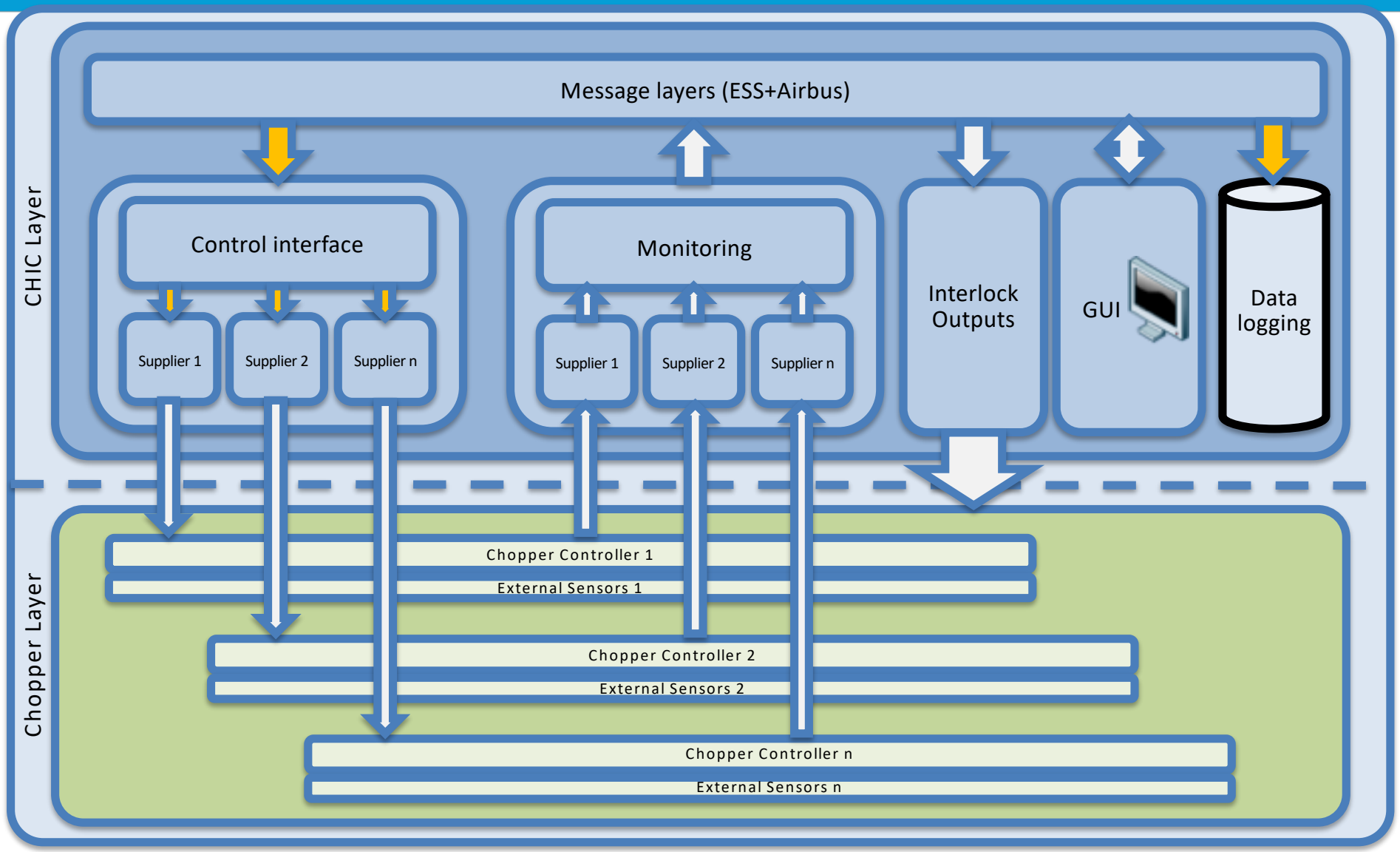

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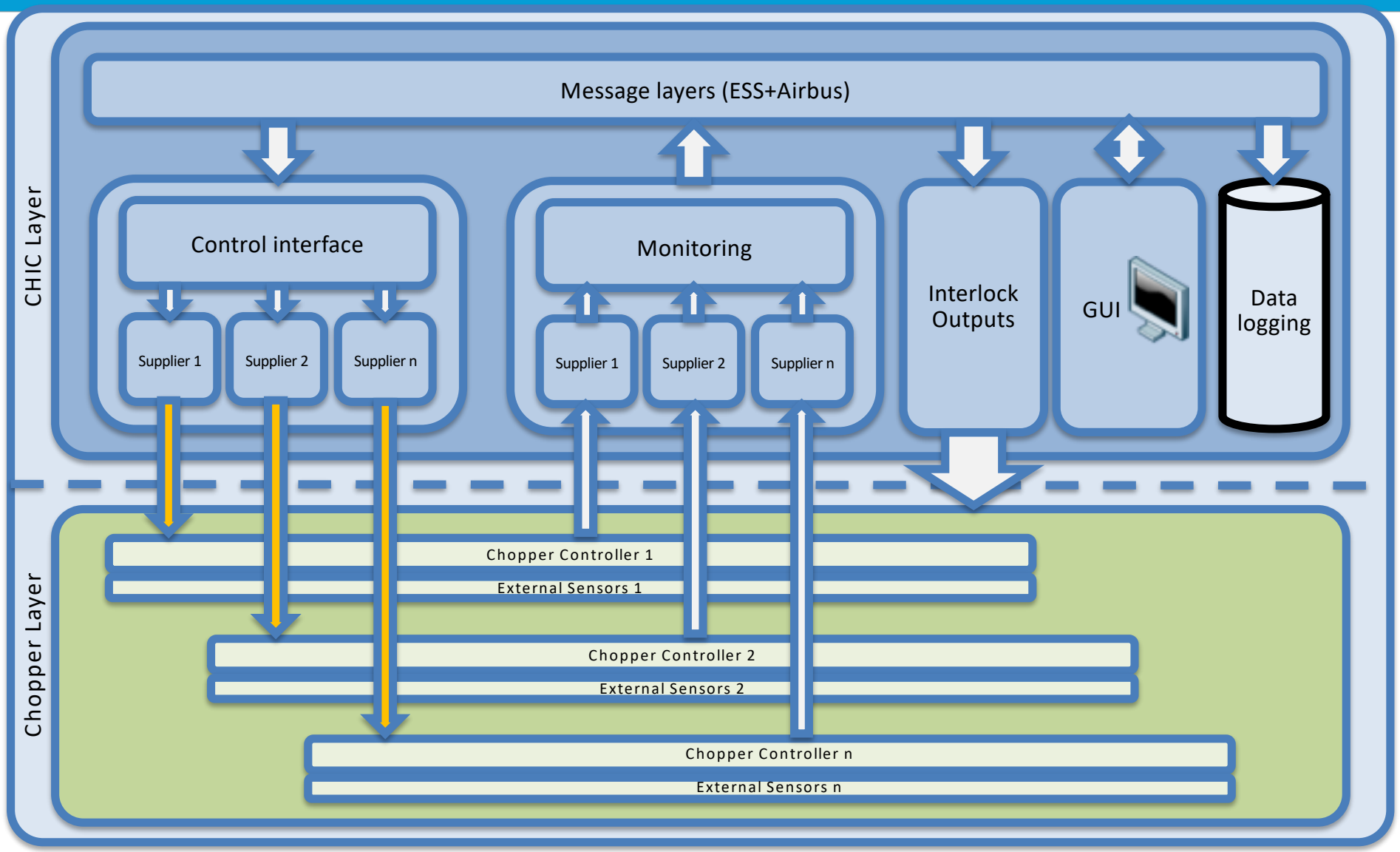

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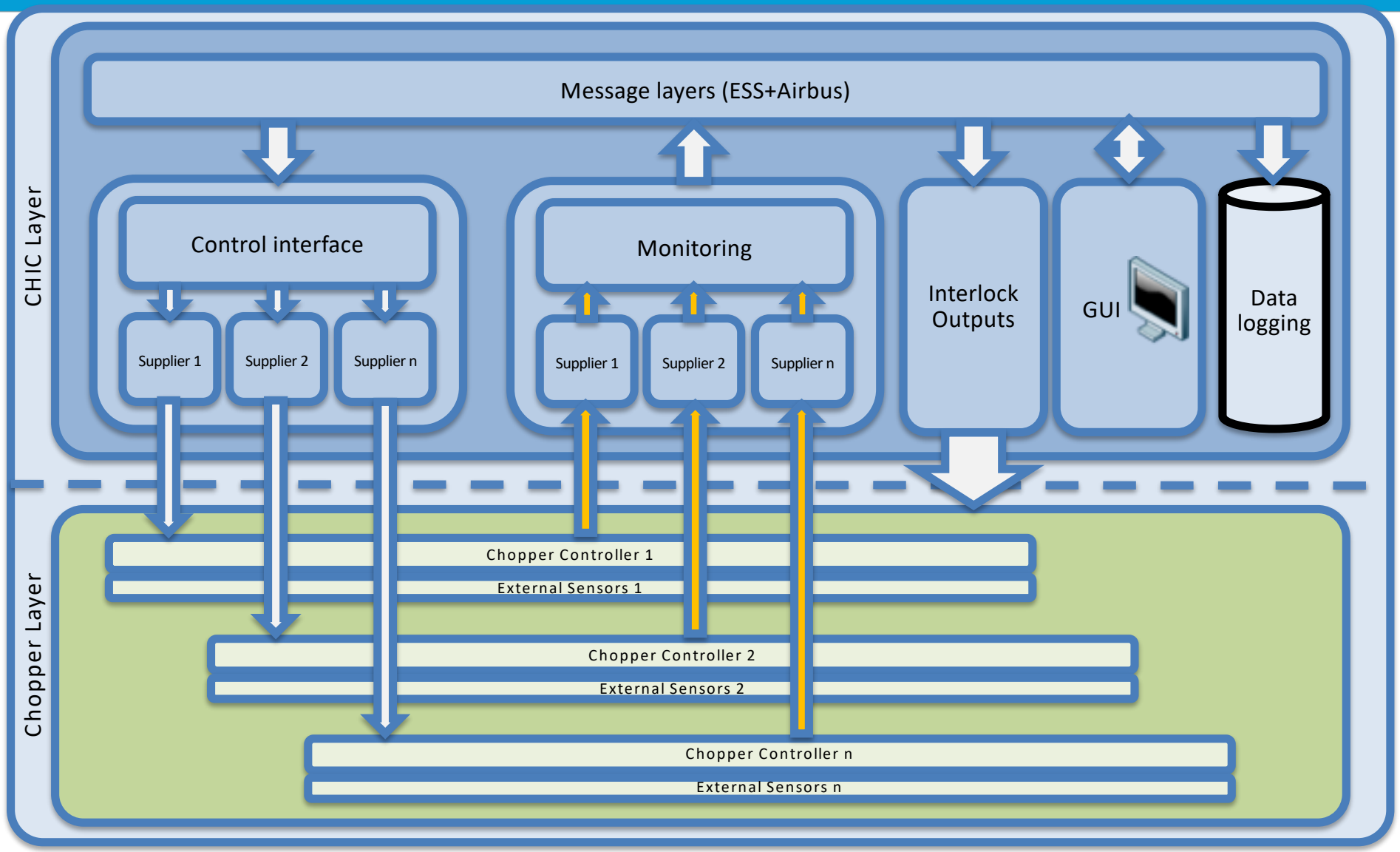

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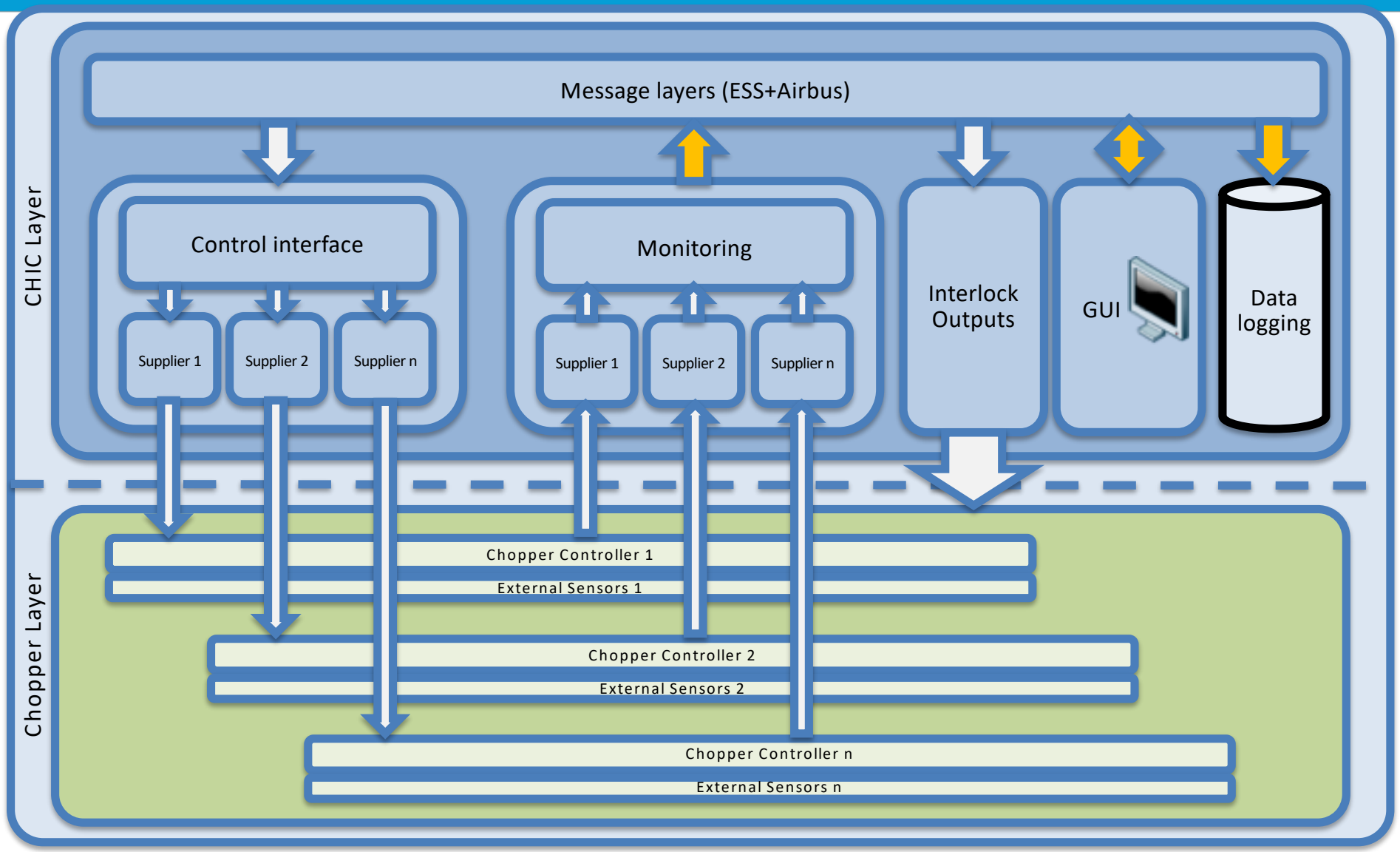
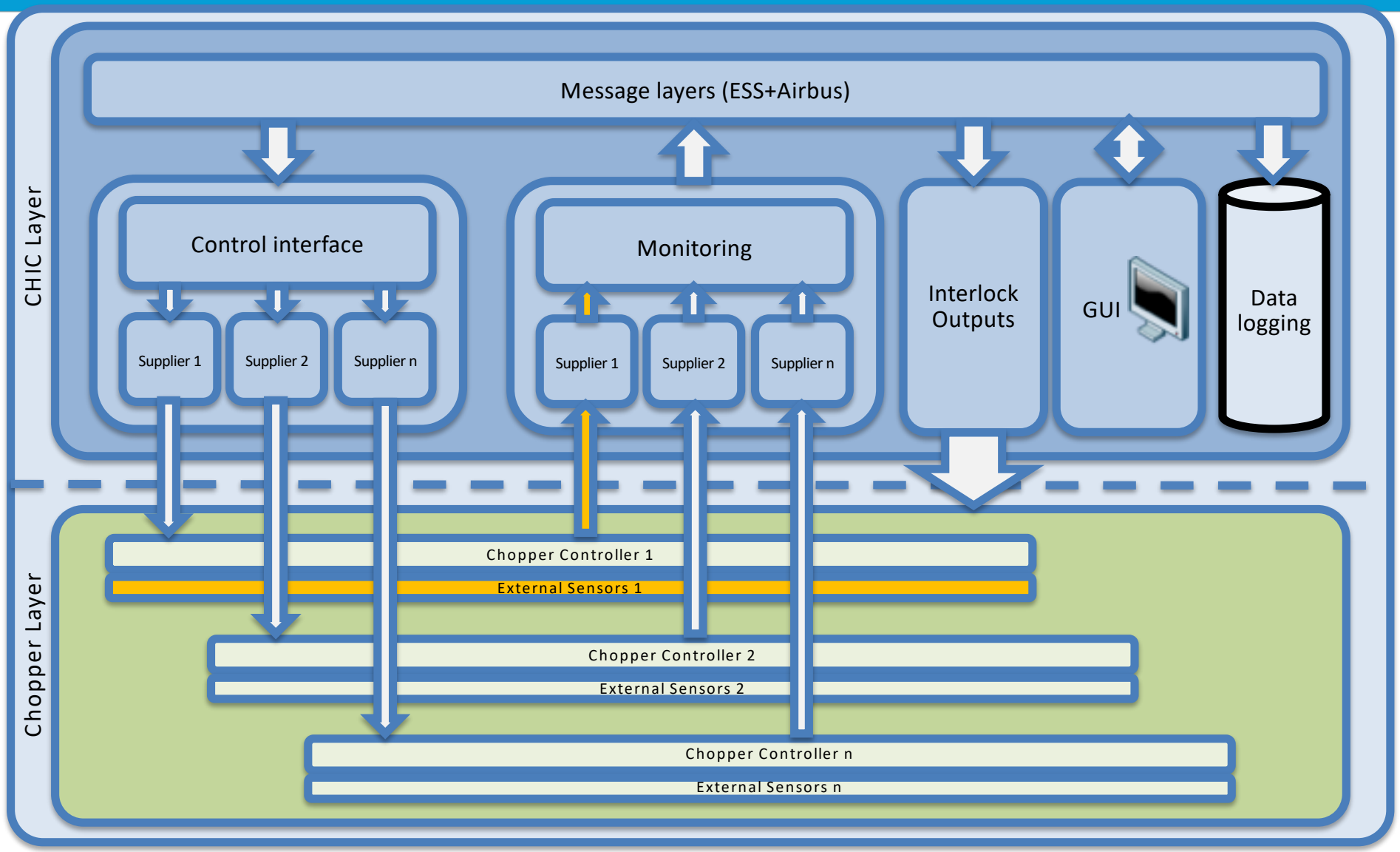


Standard Control and monitoring

Something went wrong



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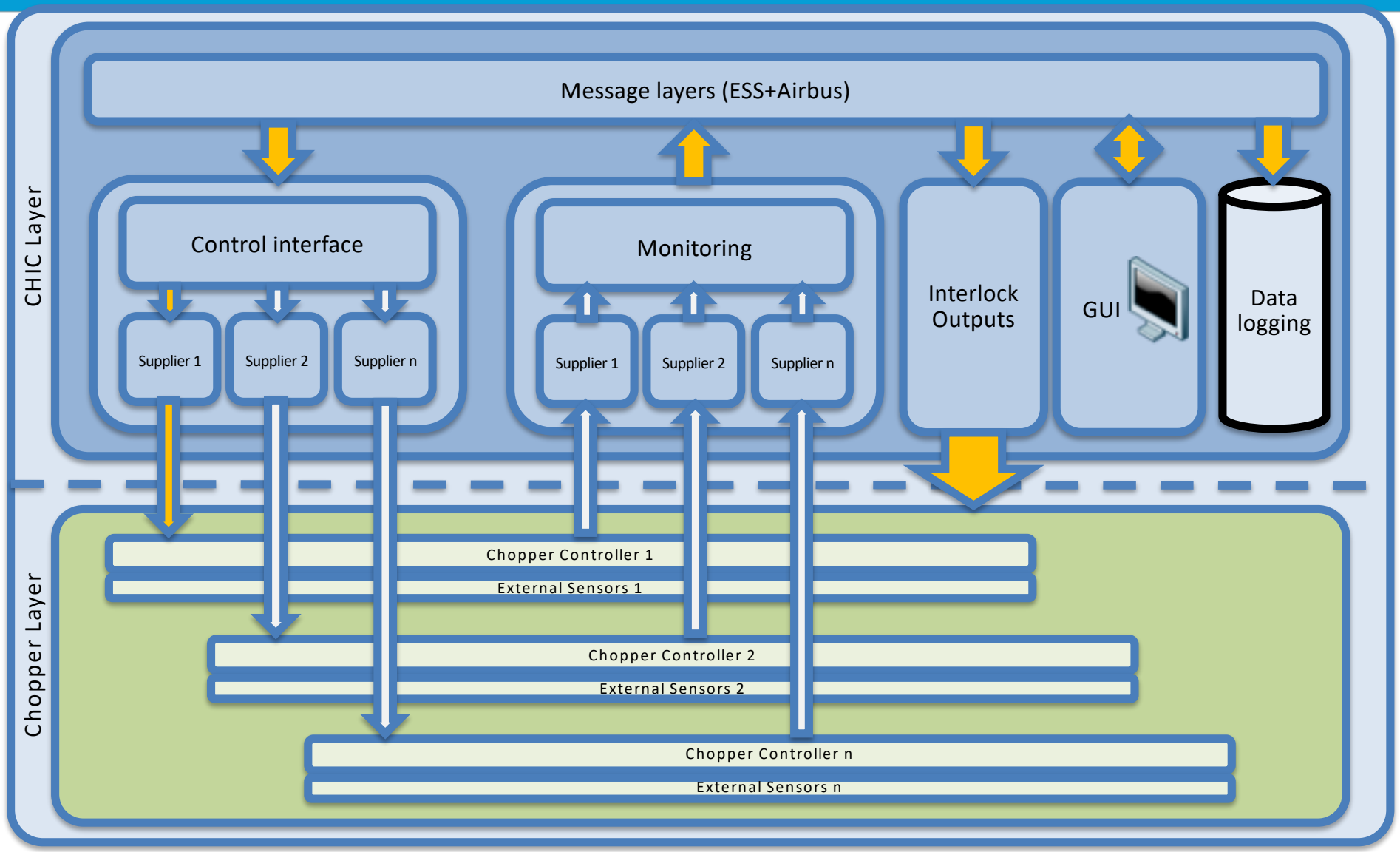

For a large scale facility

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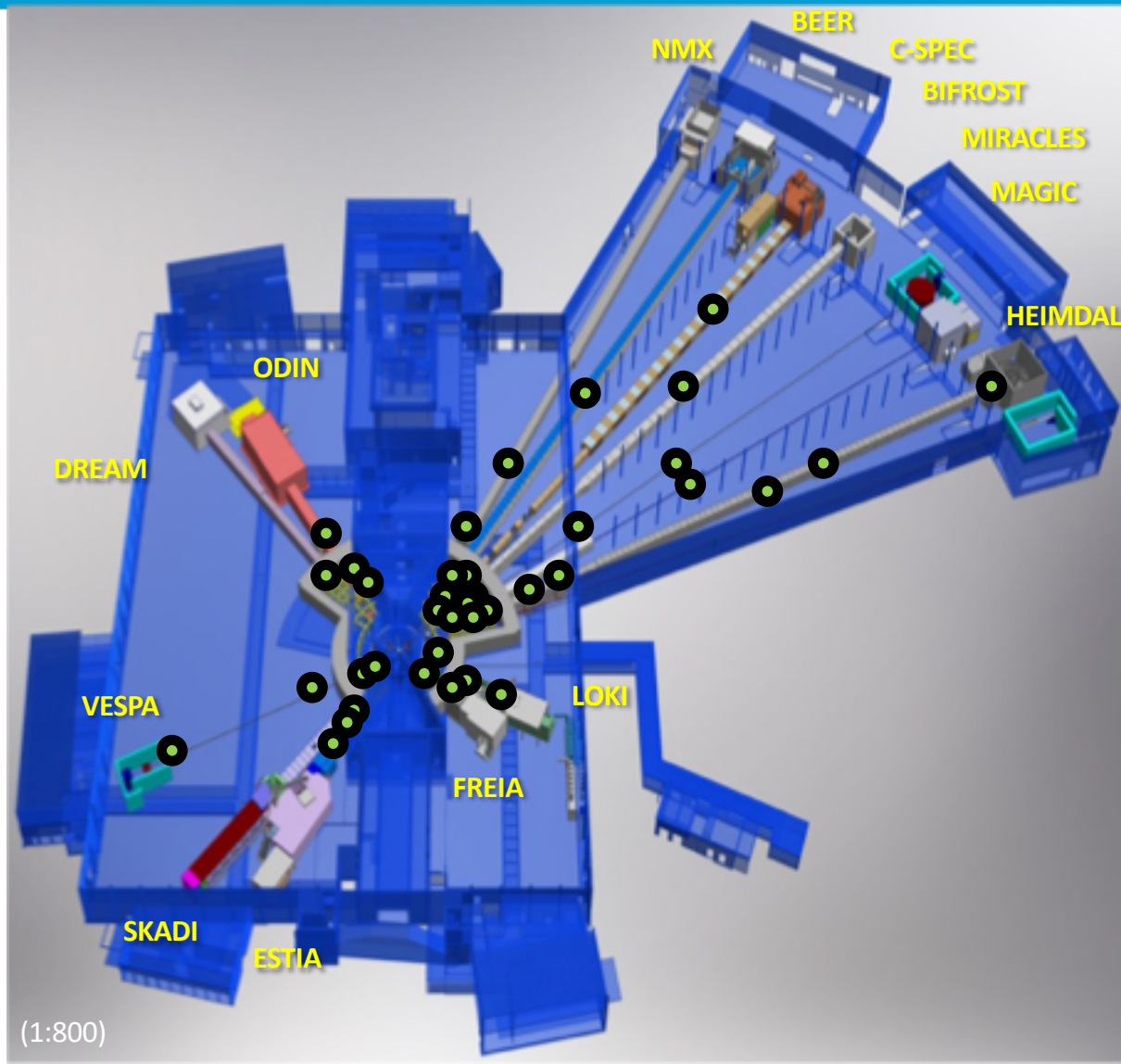

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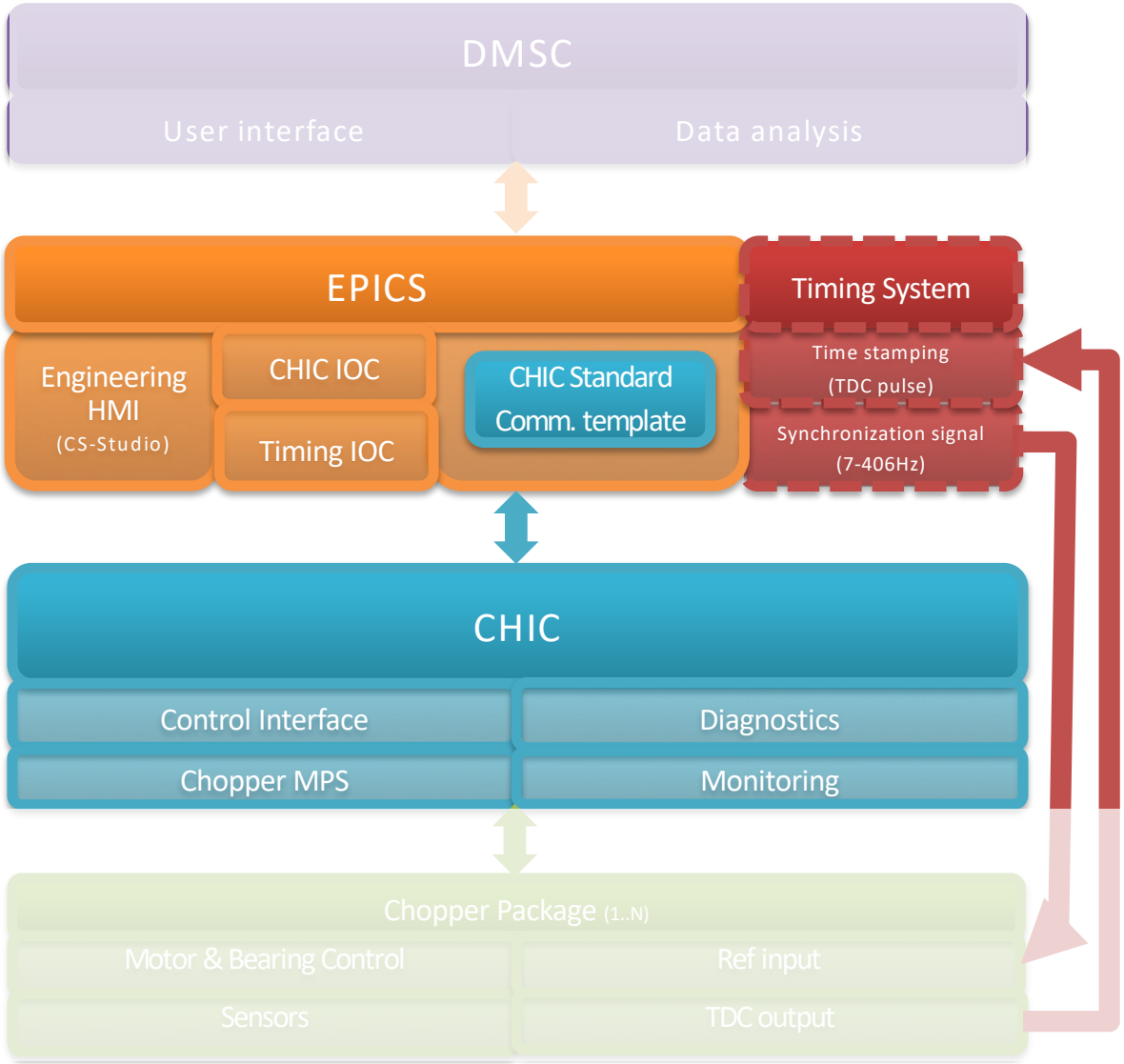

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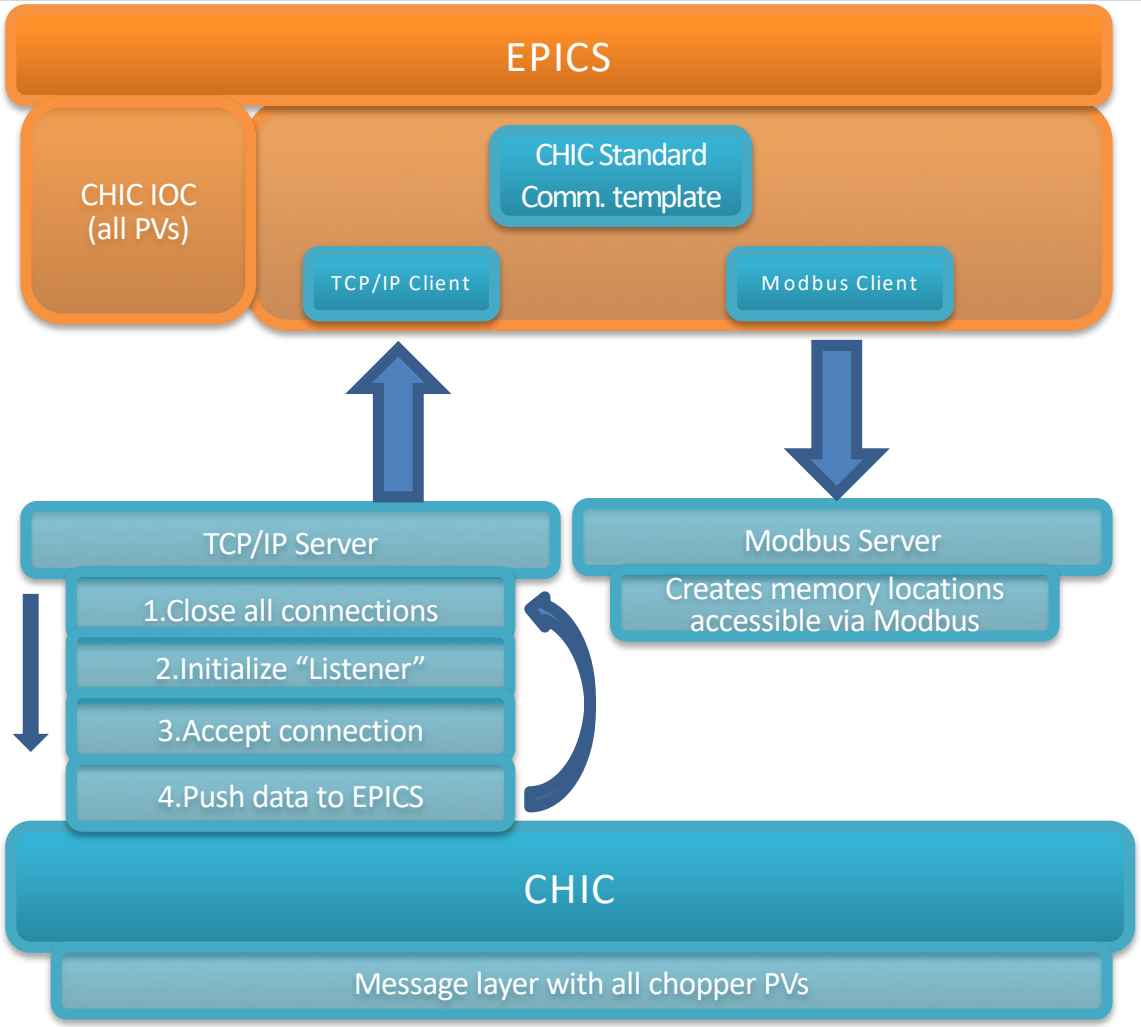

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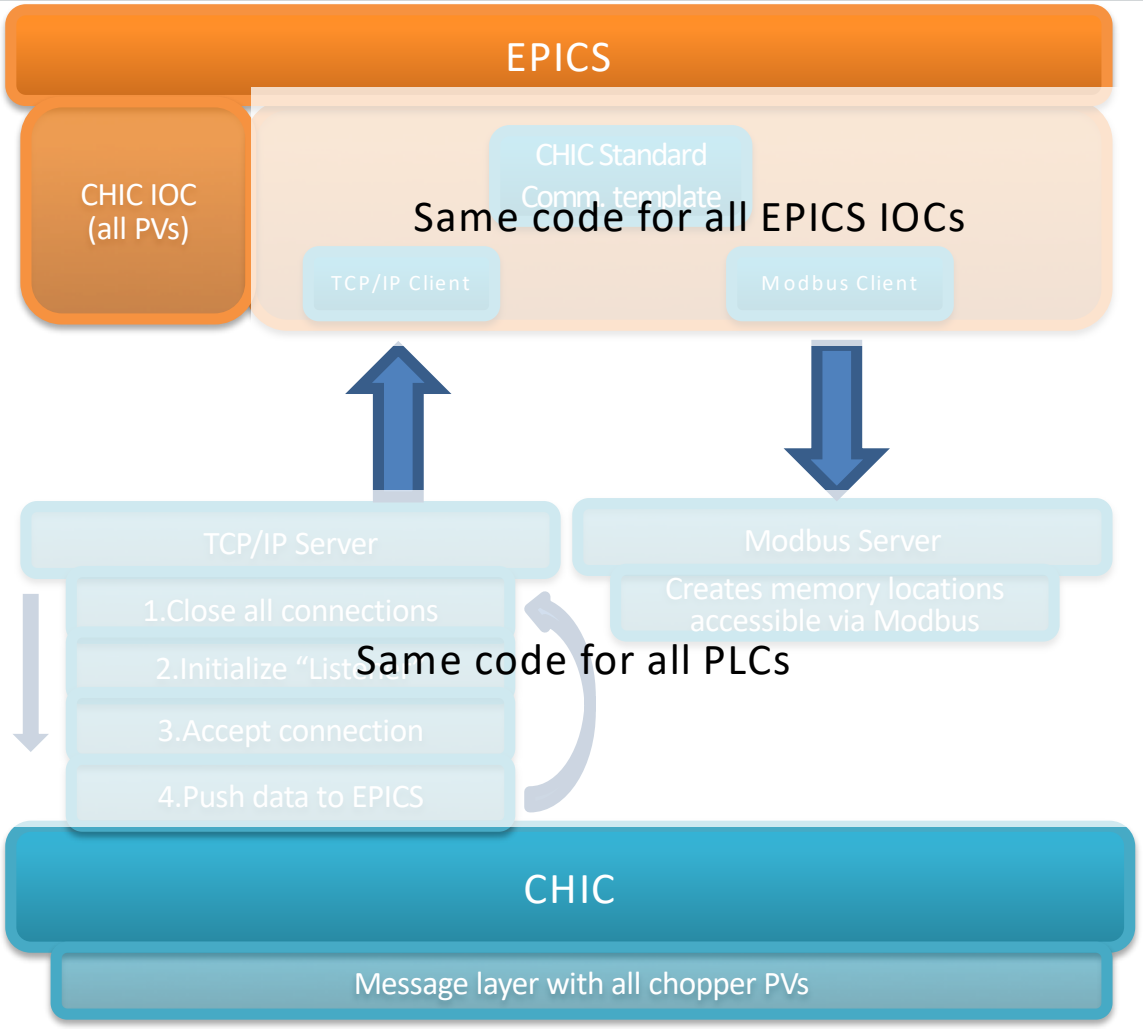
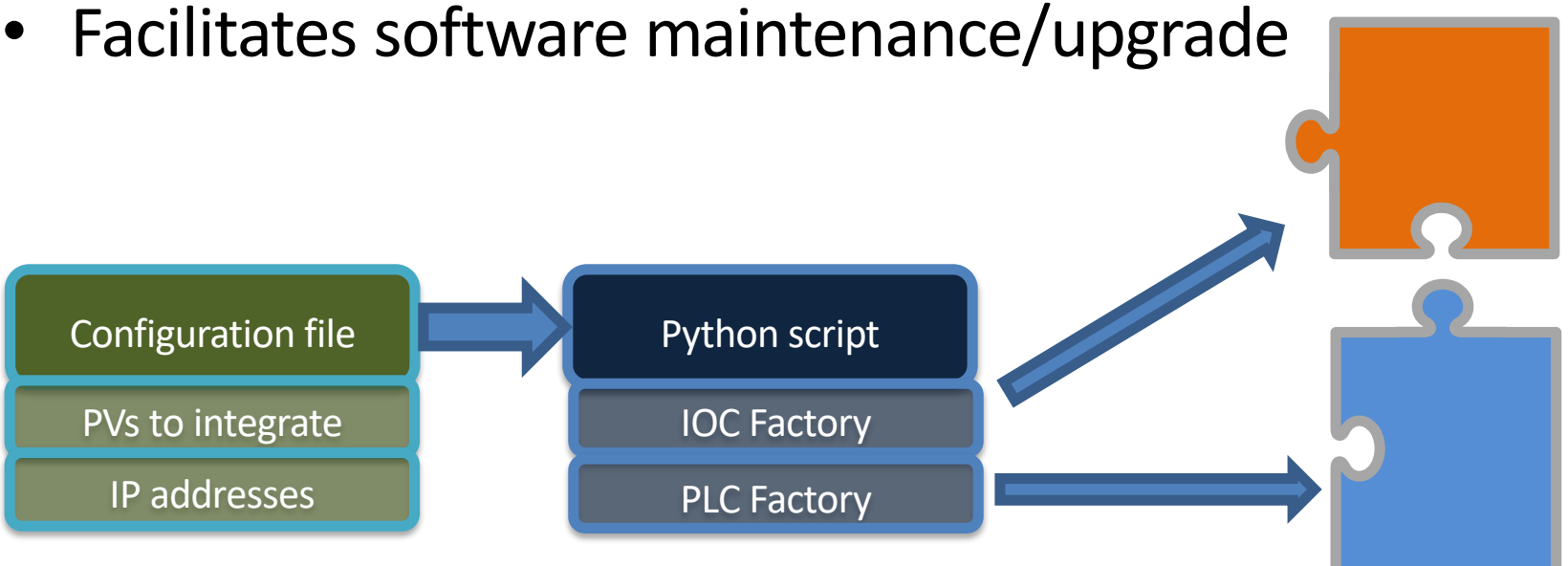


Standard integration process

- Configuration file with process variables for control and monitoring.
- The script creates two equivalent sets of code. PLC and EPICS code.
- Generated codes are with all variables linked.
- Facilitates software maintenance/upgrade



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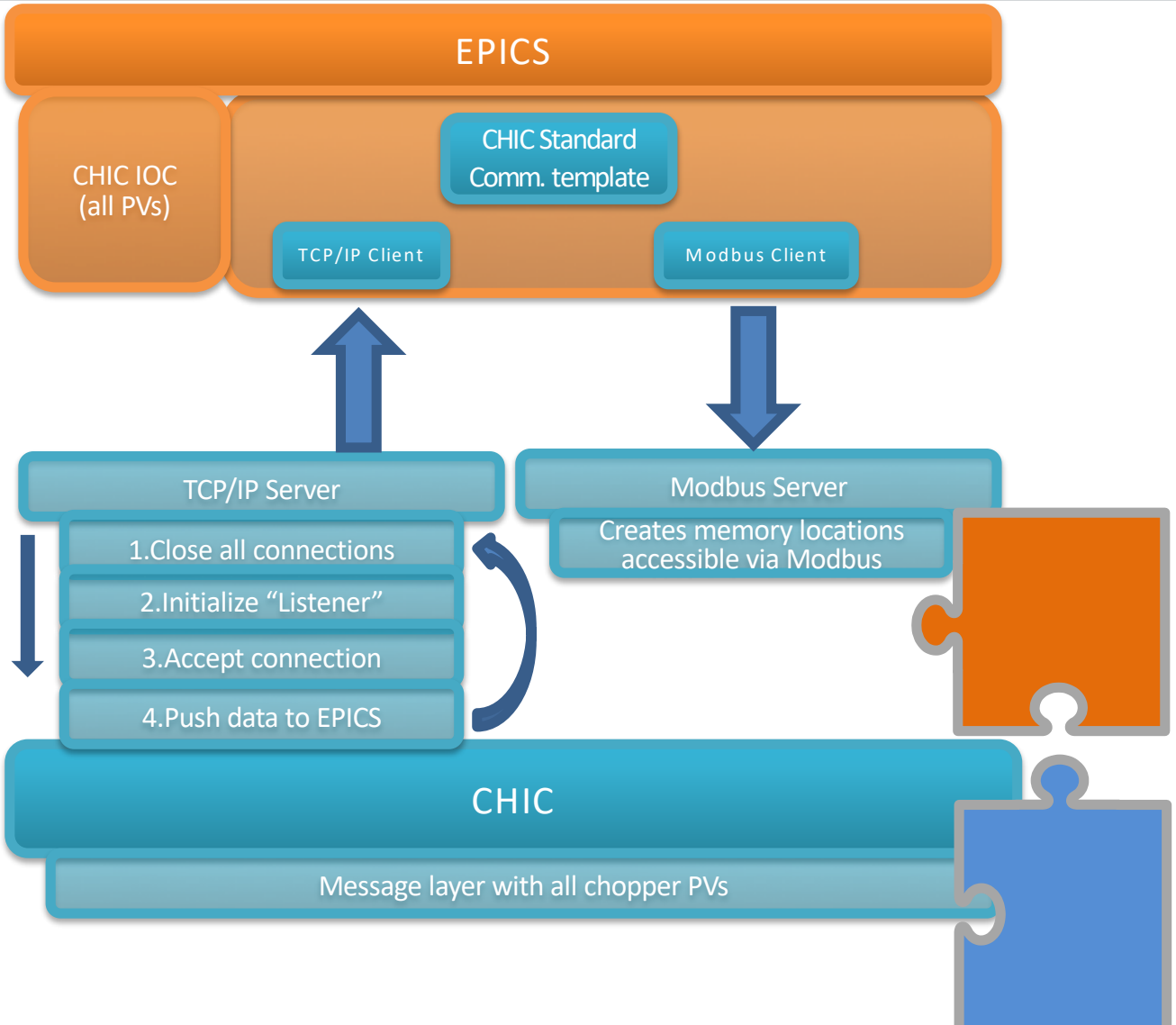

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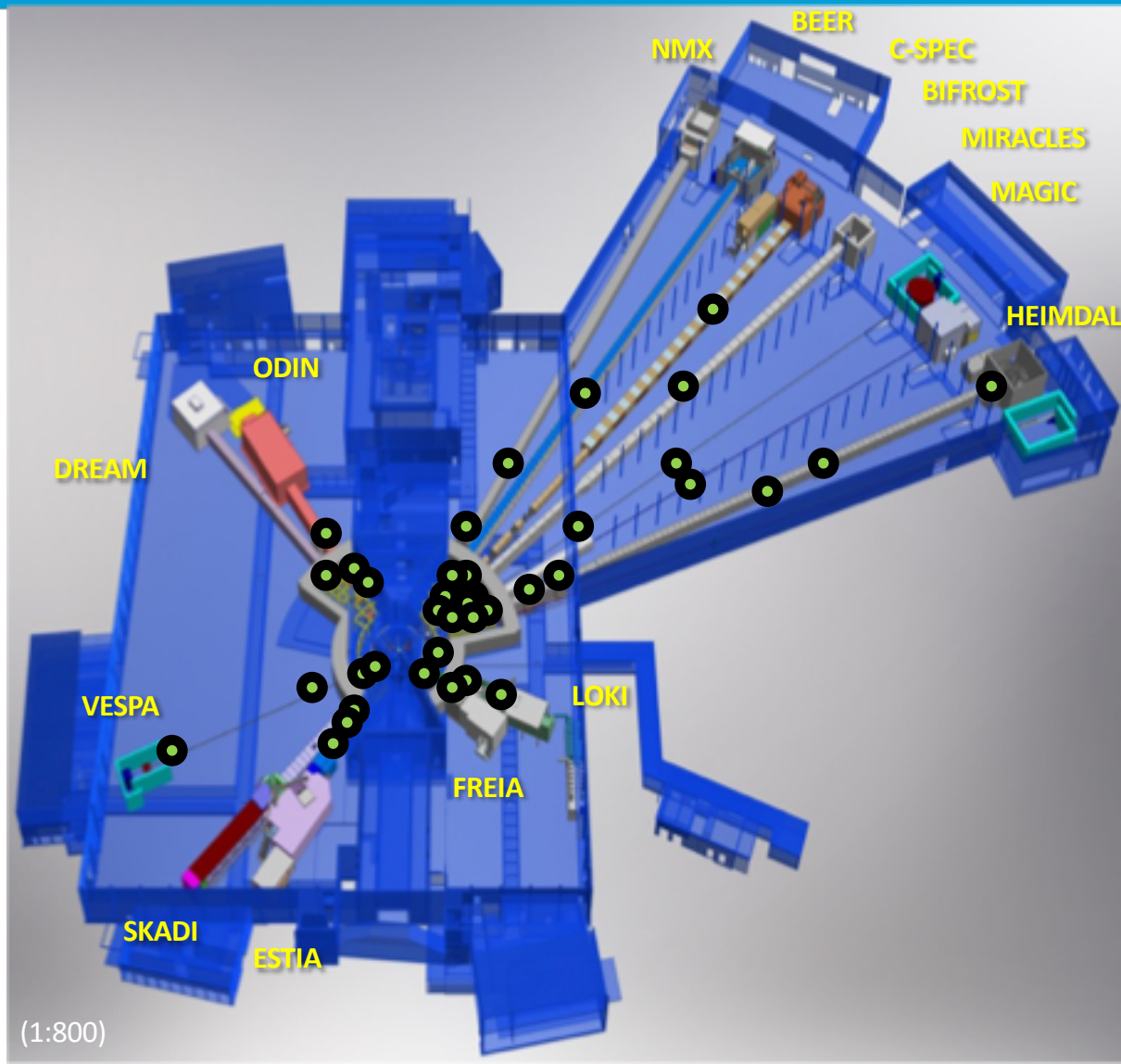


Hardware

1. Subrack of 4U height
2. PLC (Beckhoff)
3. Vibration Monitoring
4. 2 x Power supply
5. Remote controlled network switch
6. Analog I/Os
7. Digital I/Os
8. Fieldbuses (Ethernet ports)
9. External hard drive

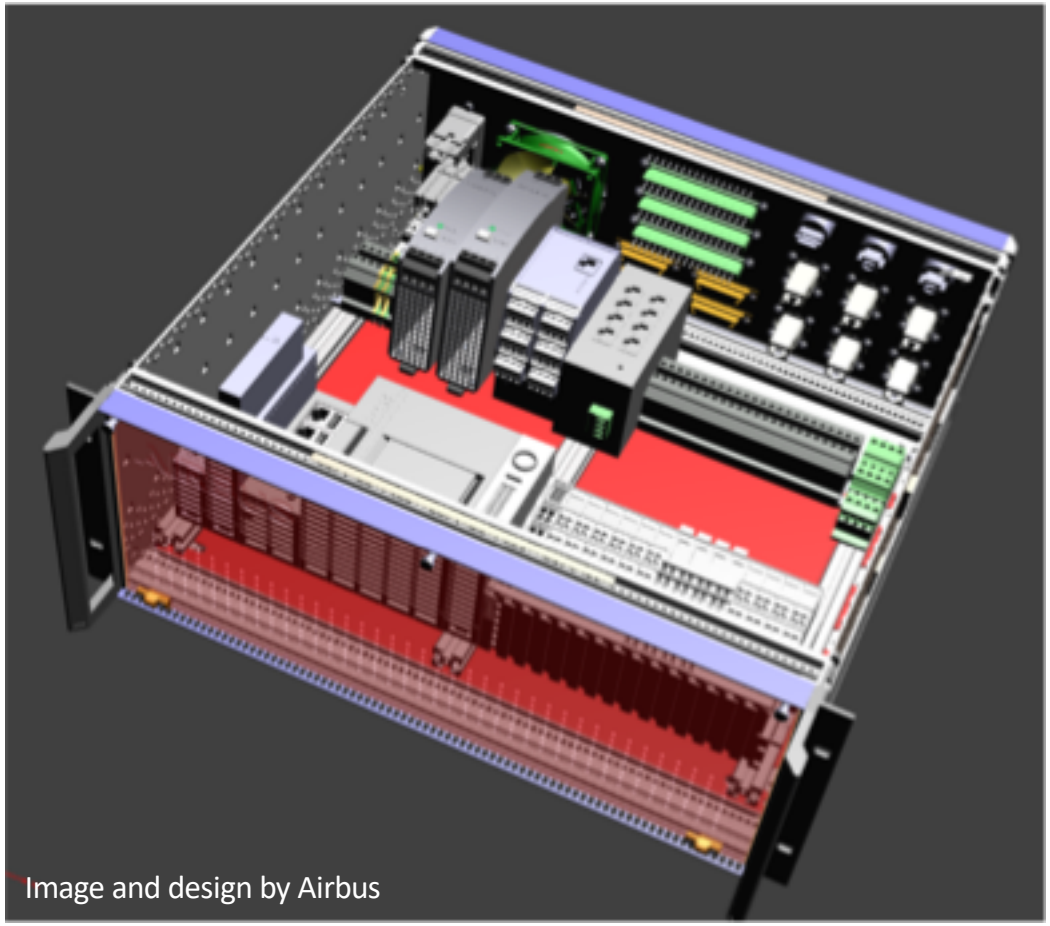
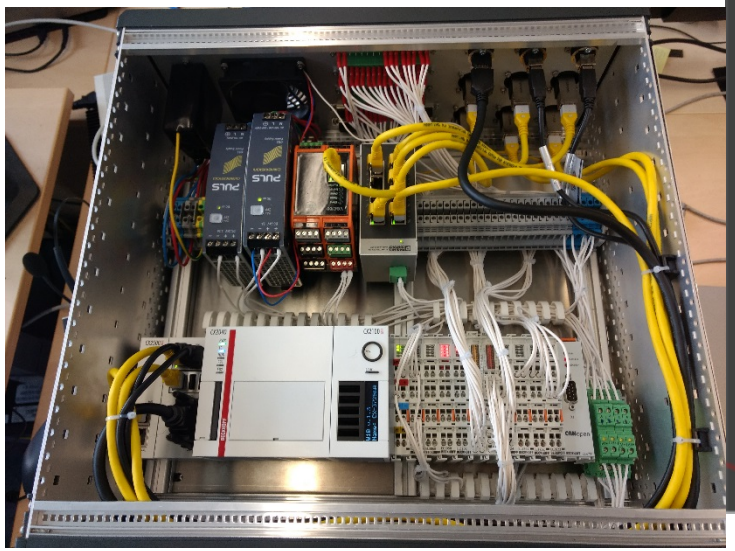


Image and design by Airbus

CHIC crate (In-kind with Jülich)

- First prototype:
  - Controls up to 4 chopper drives (due to rack space limitations)



Chopper control rack

- Variant of the ESS chopper standard rack
  - Designed according to ESS electrical standards and SE legislation.
- ~40 chopper racks to be installed at ESS
- Part of the control system in-kind with Jülich and Airbus.
- Per rack:
  - 1 CHIC
  - 1 EPICS IPC
  - 1 Timing system
  - Up to 4 chopper drives
  - Power distribution unit
  - UPS
  - Cooling unit
  - Network switch

Prototype chopper control rack

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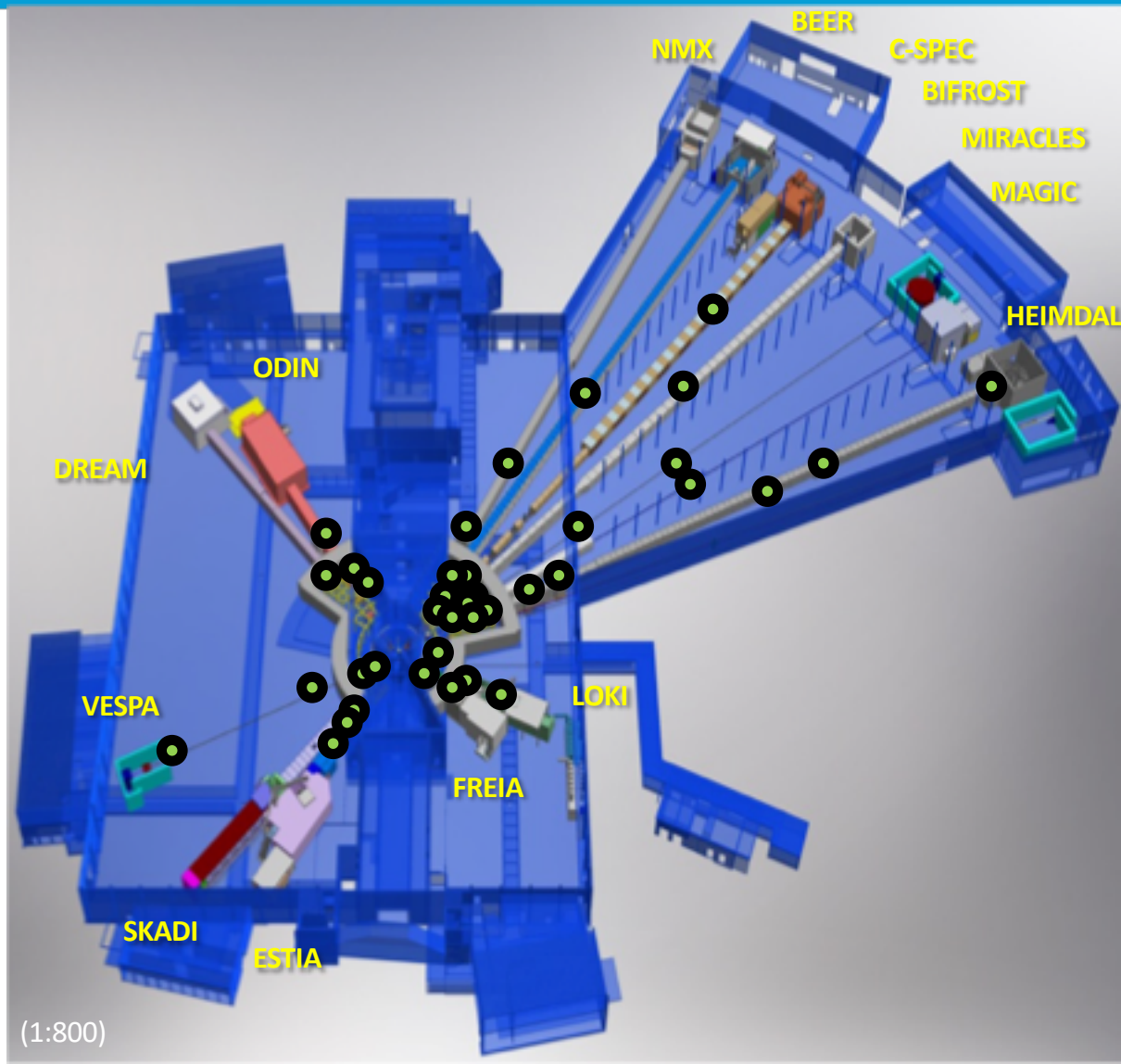
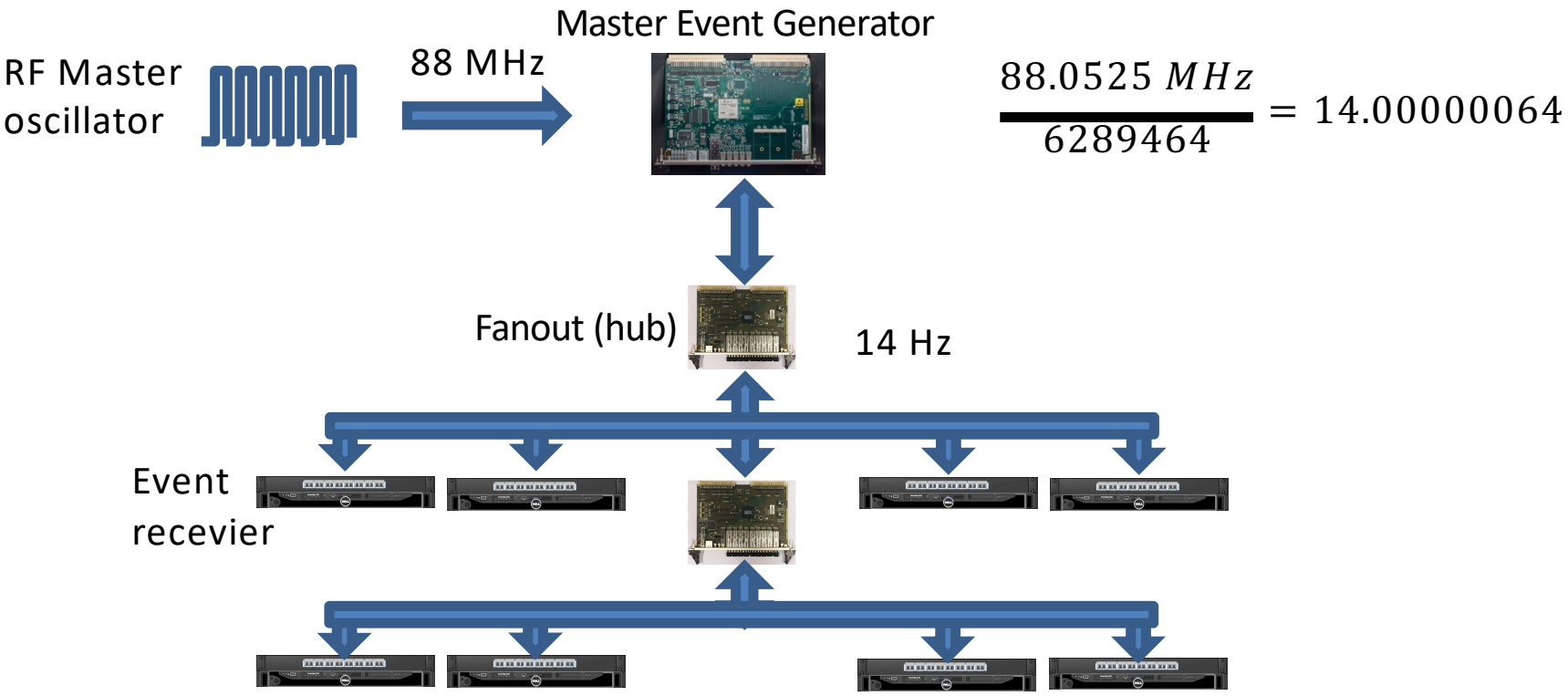
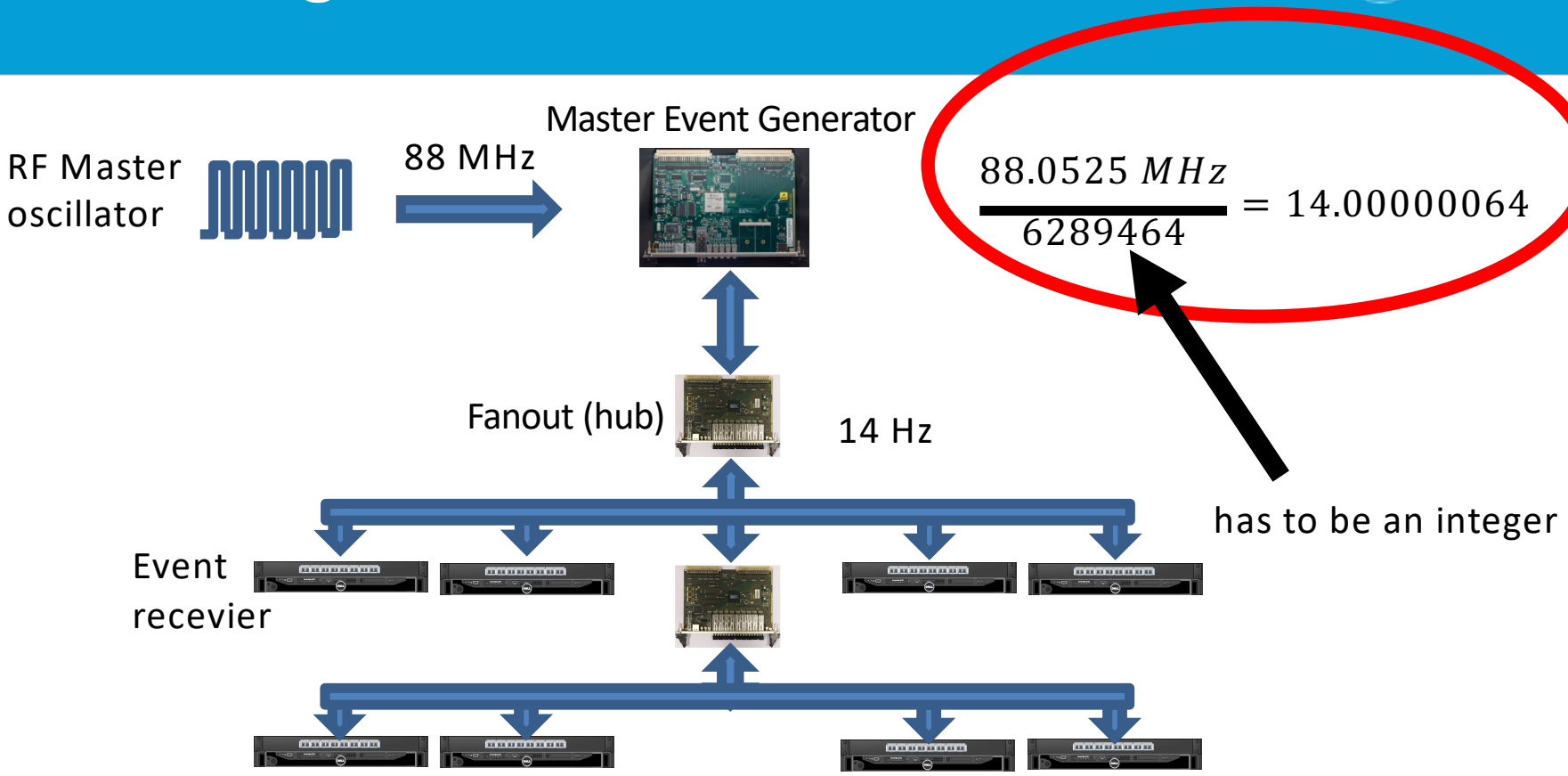


ESS Timing



- The 14 Hz operating frequency will be generated by down conversion from RF in the event generator (divide 88.0525 MHz by 6289464 to get 14.00000064 Hz)
- All timing sequences, events, etc., generated in hardware
- One event generator for ESS

ESS Timing



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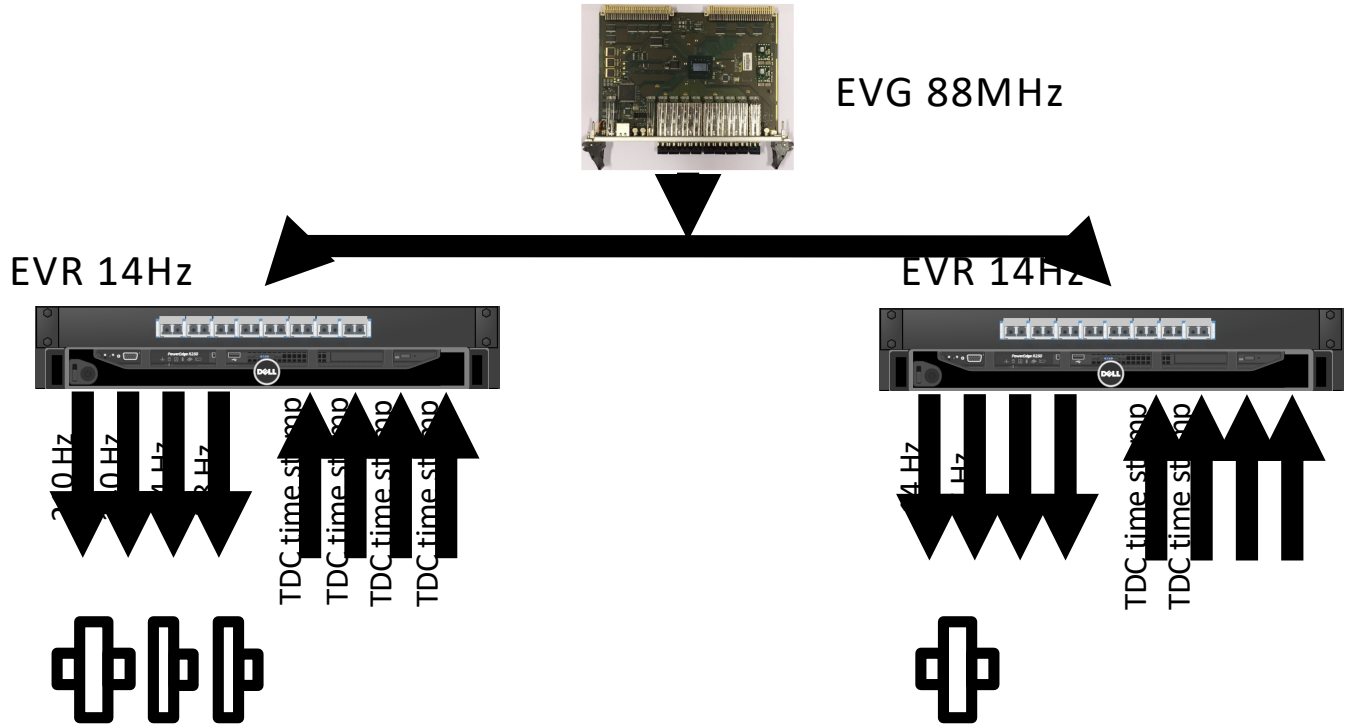
ESS Chopper Timing

- Every rack will have an event receiver (EVR) that will provide reference frequencies to the choppers.
- Frequencies from 3.5Hz to at least 336 Hz will be created. (14Hz-350Hz tested)



ESS Chopper Timing

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- Bifrost requires 210,0000095 Hz with the closest integer I will get 209,9998092 Hz

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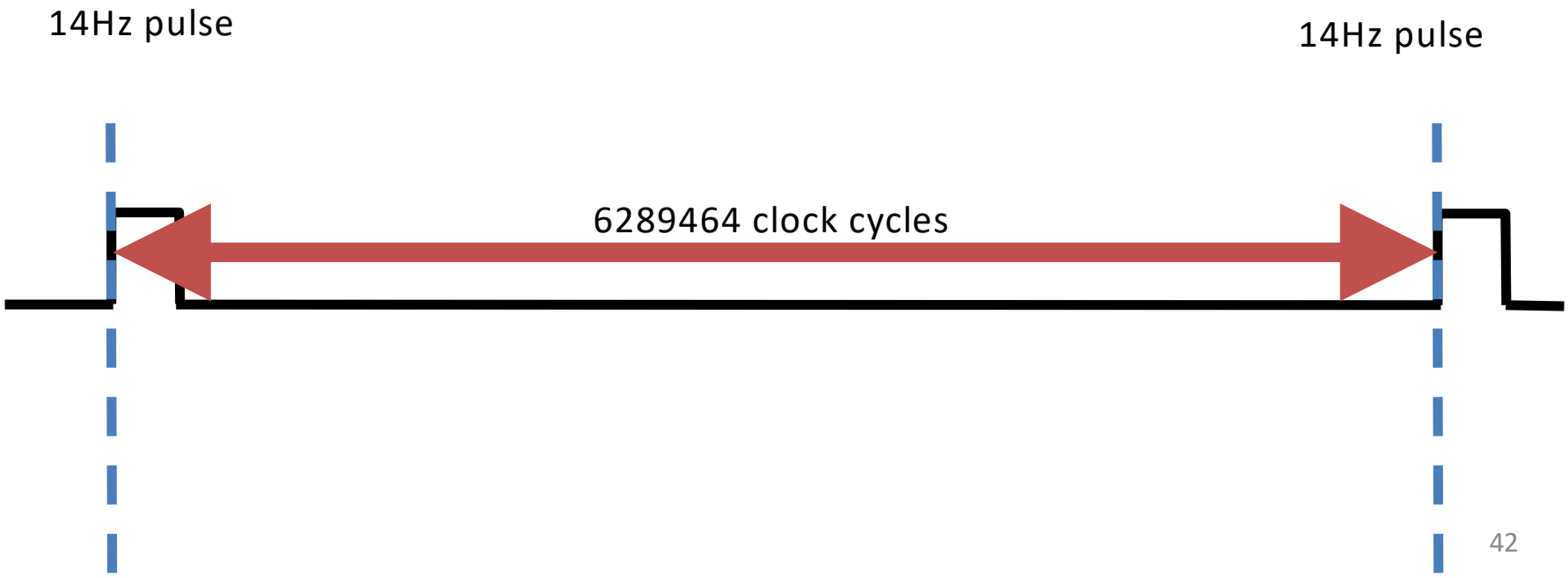
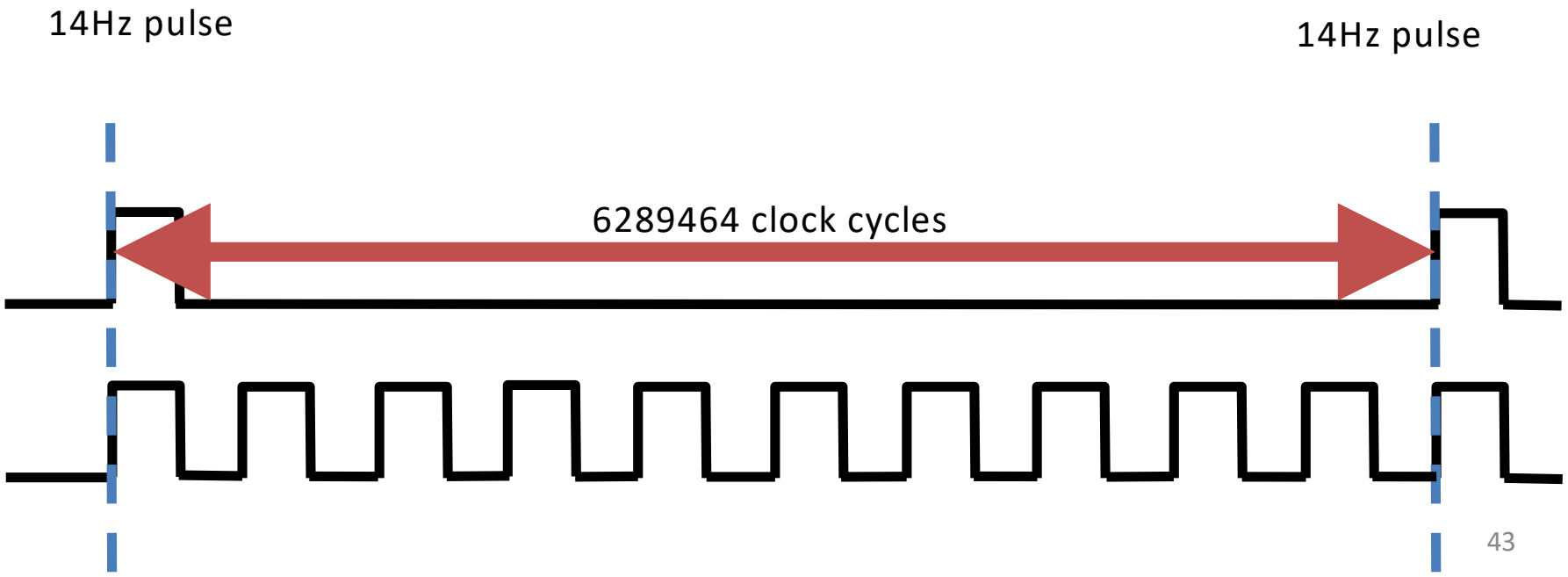
There is a solution

ESS Chopper Timing

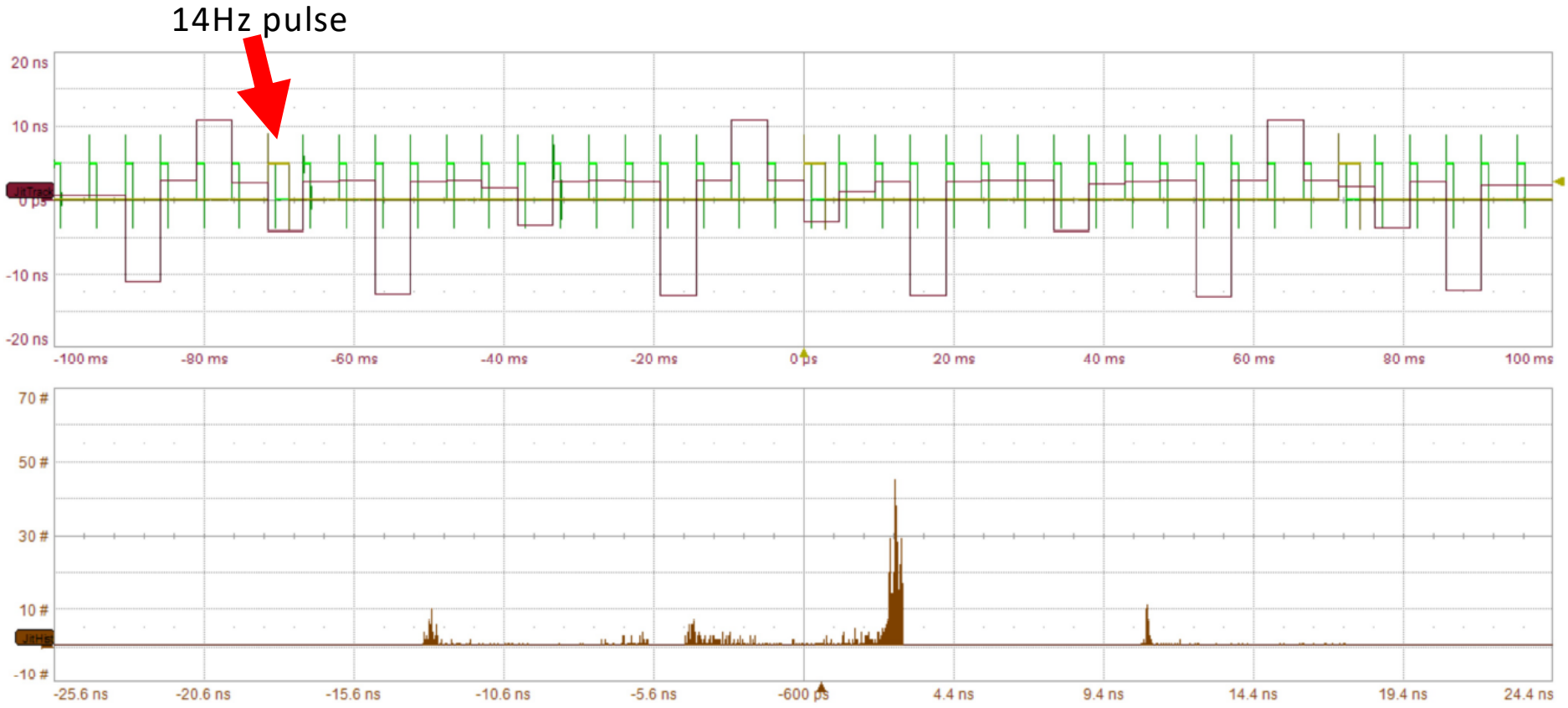


ESS Chopper Timing

- Pulse train consists of pulses generated at specific clock cycles
- The predefined ”pulse train” is triggered by the 14Hz event
- The “pulse train” is regenerated at every 14 Hz pulse
- Every pulse in the pulse train can be adjusted back and forth in time with a resolution of 11,3 ns.



Experiment 210Hz



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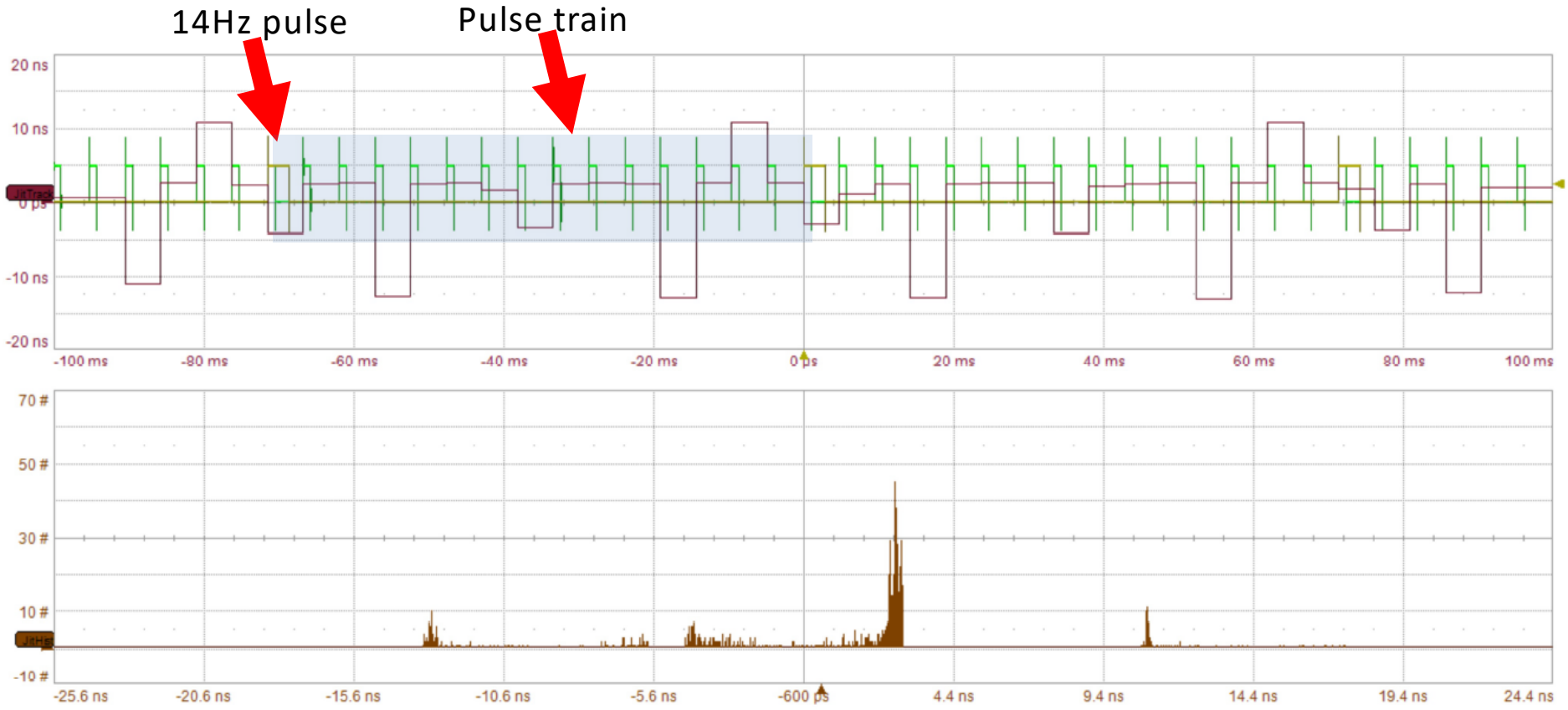

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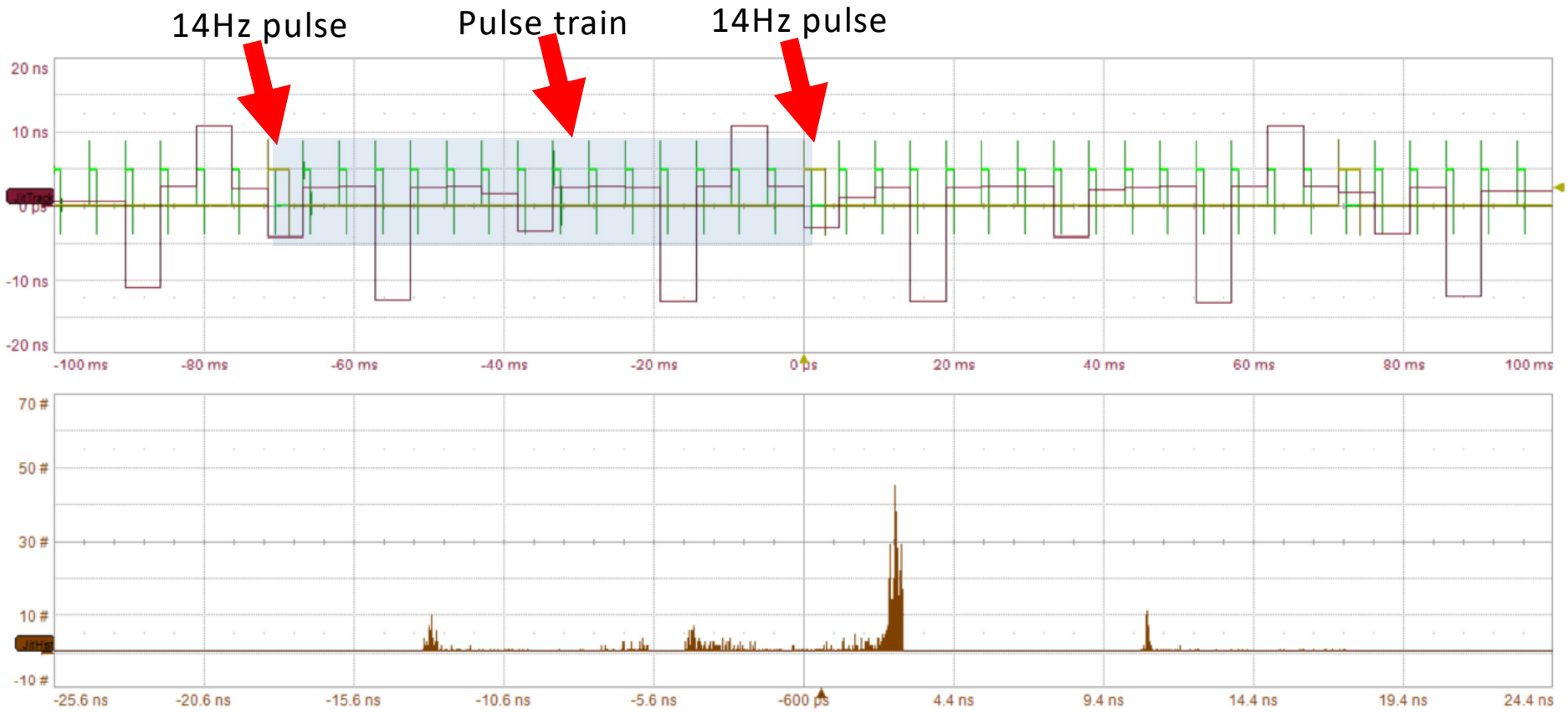

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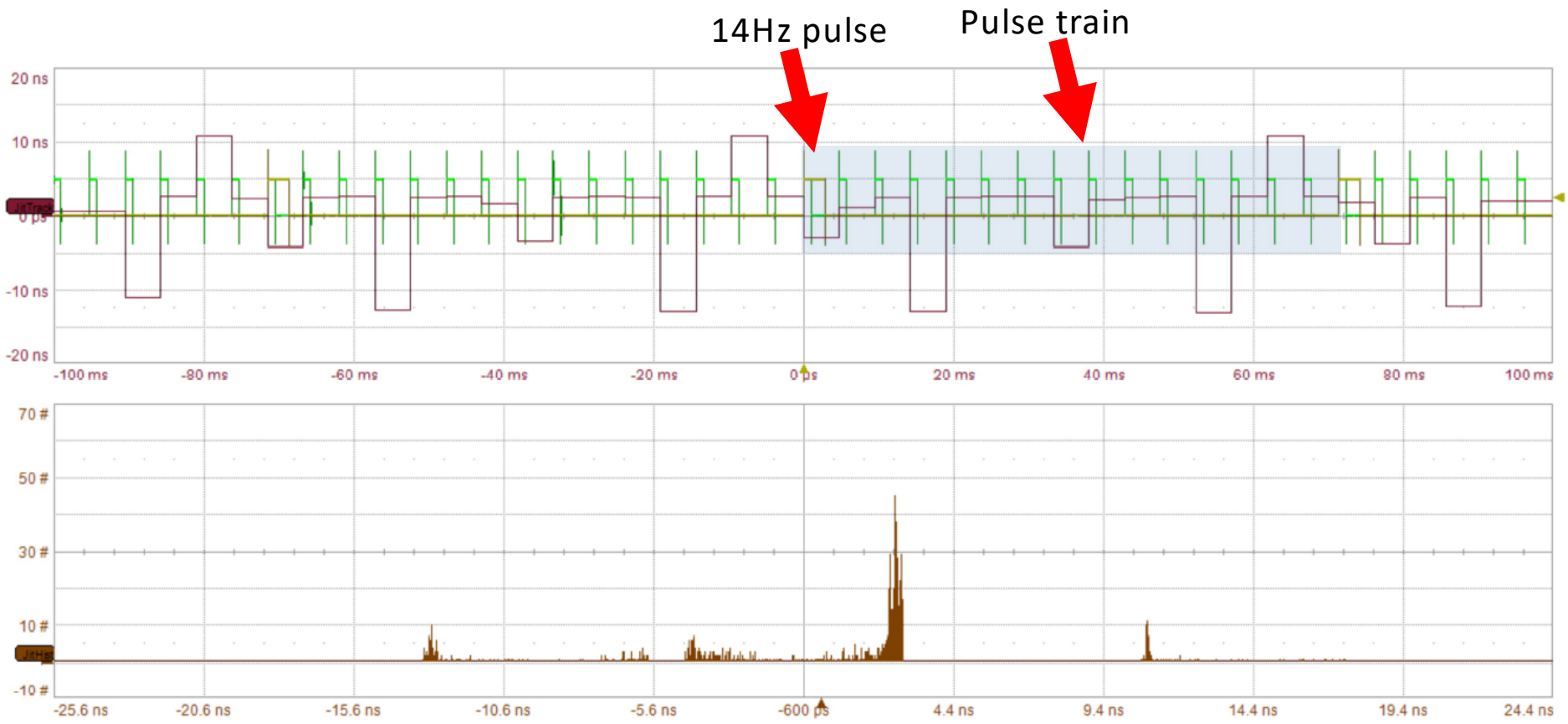

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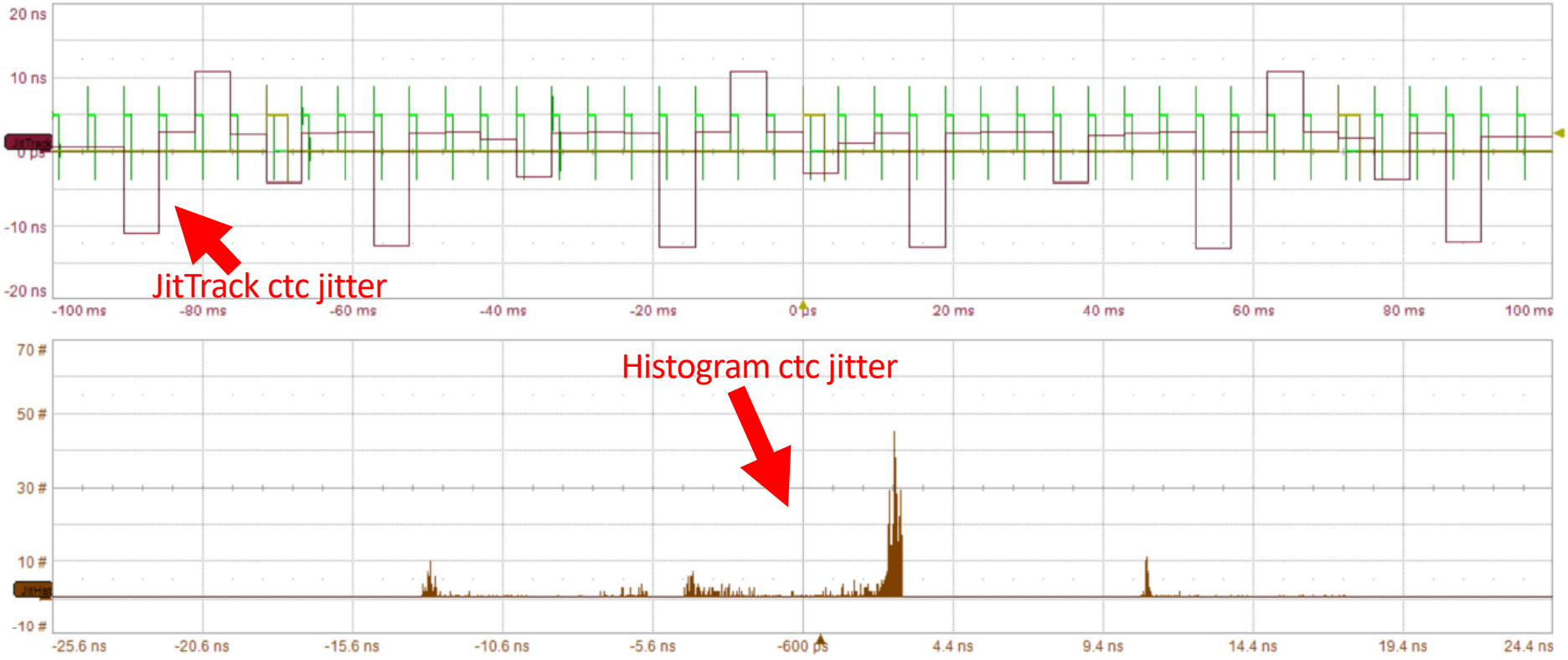

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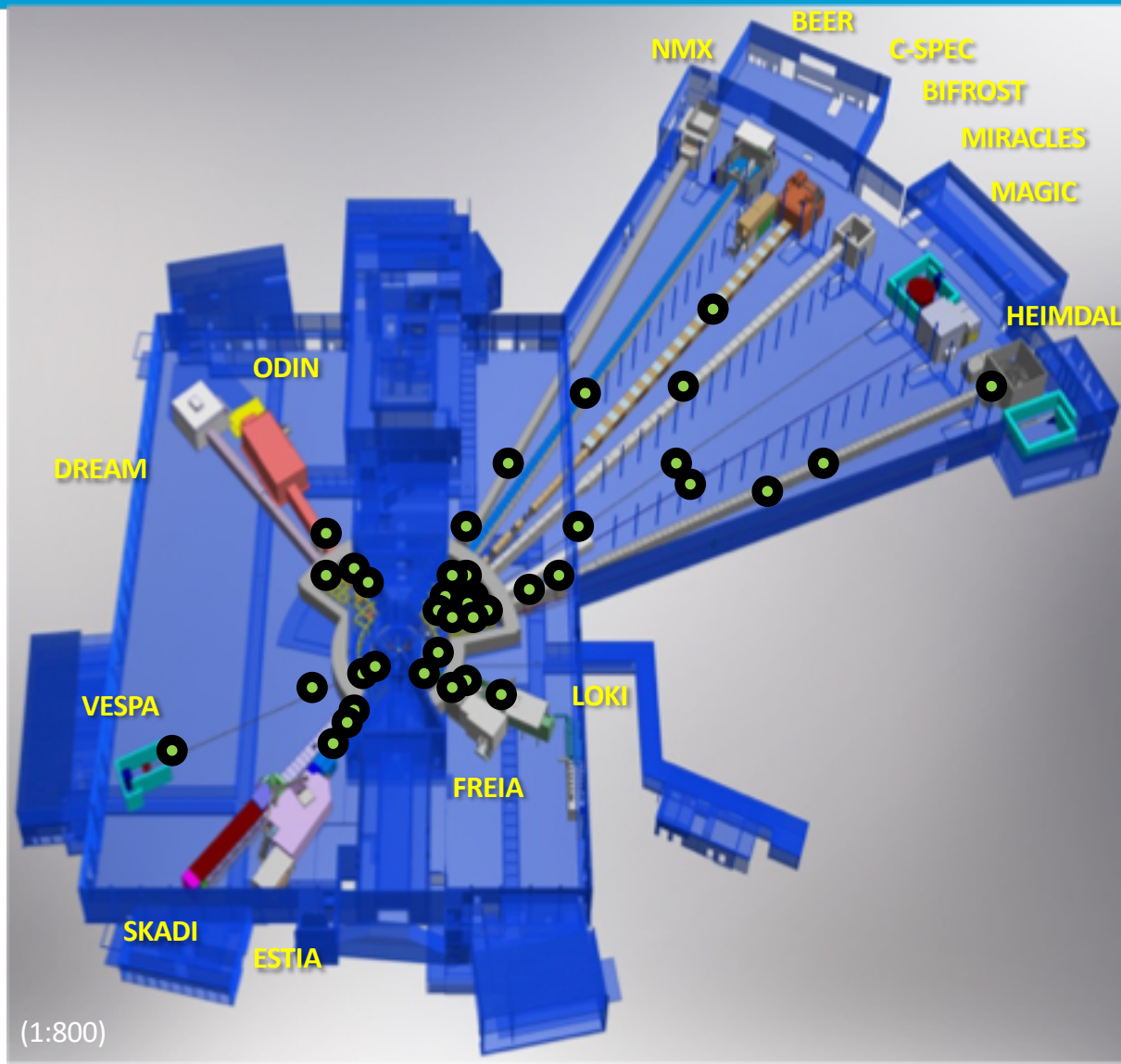
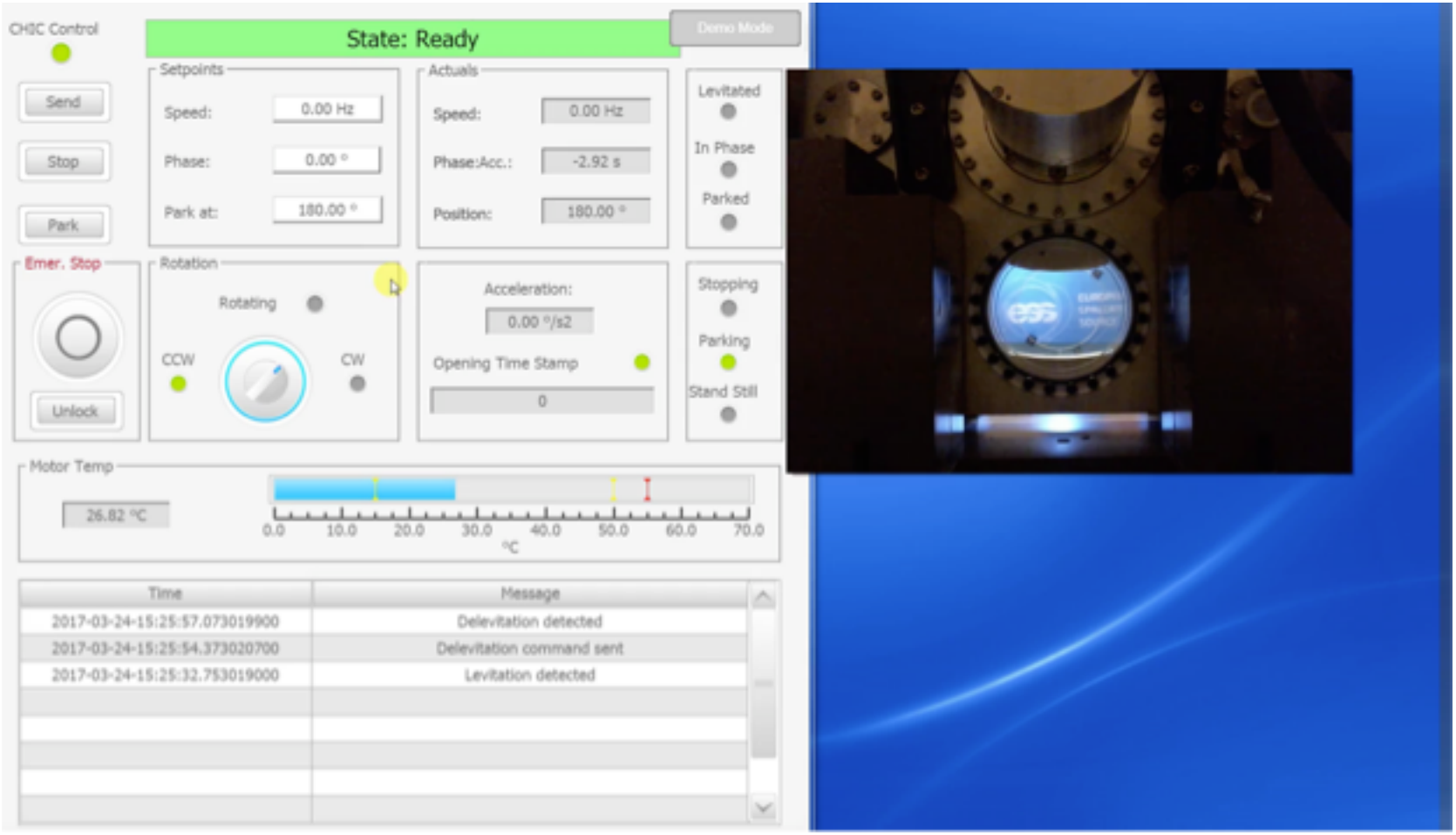


Acknowledgements

- Markus Olsson
- Nikolaos Tsapatsaris
- John Sparger
- Kristian Löki
- Miklos Bóros
- David Brodrick
- Nicklas Holmberg
- Javier García
- Thomas Gahl
- Airbus Space and Defense

We hope to say in the future:

- Any neutron chopper system in the world is compatible with ESS control system.
- ESS does not have drifting choppers.

SKF control from the CHIC