PAUL SCHERRER INSTITUT

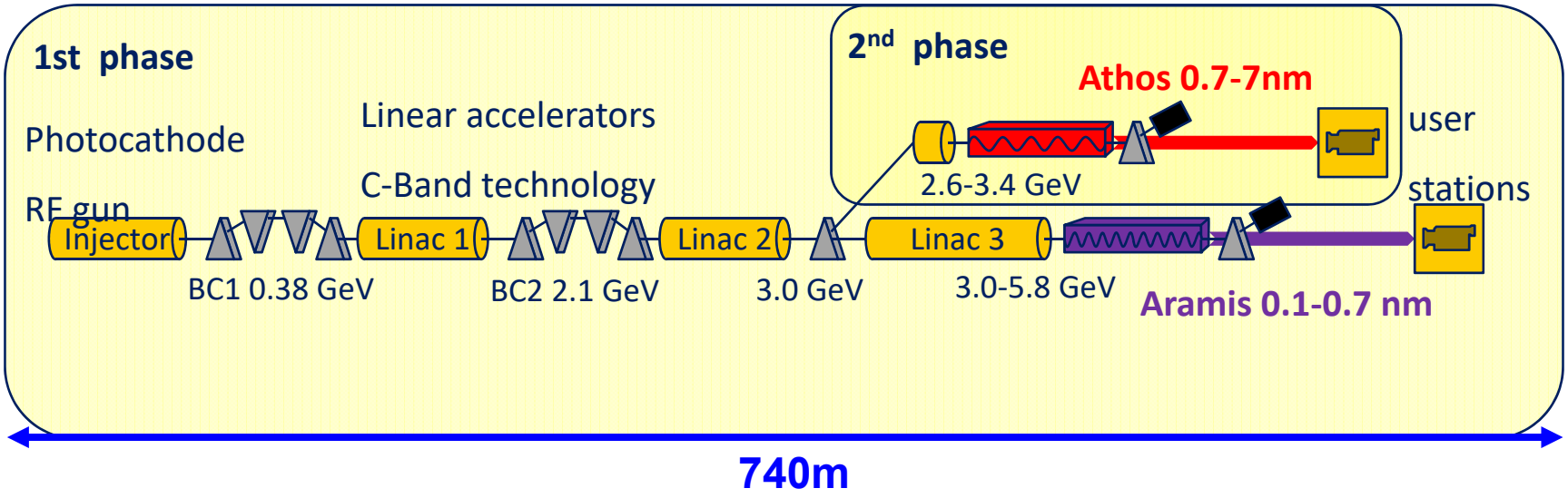
Babak Kalantari for Controls :: Paul Scherrer Institut

SwissFEL Timing System
First Operational Experience

ICALEPCS'17, Barcelona

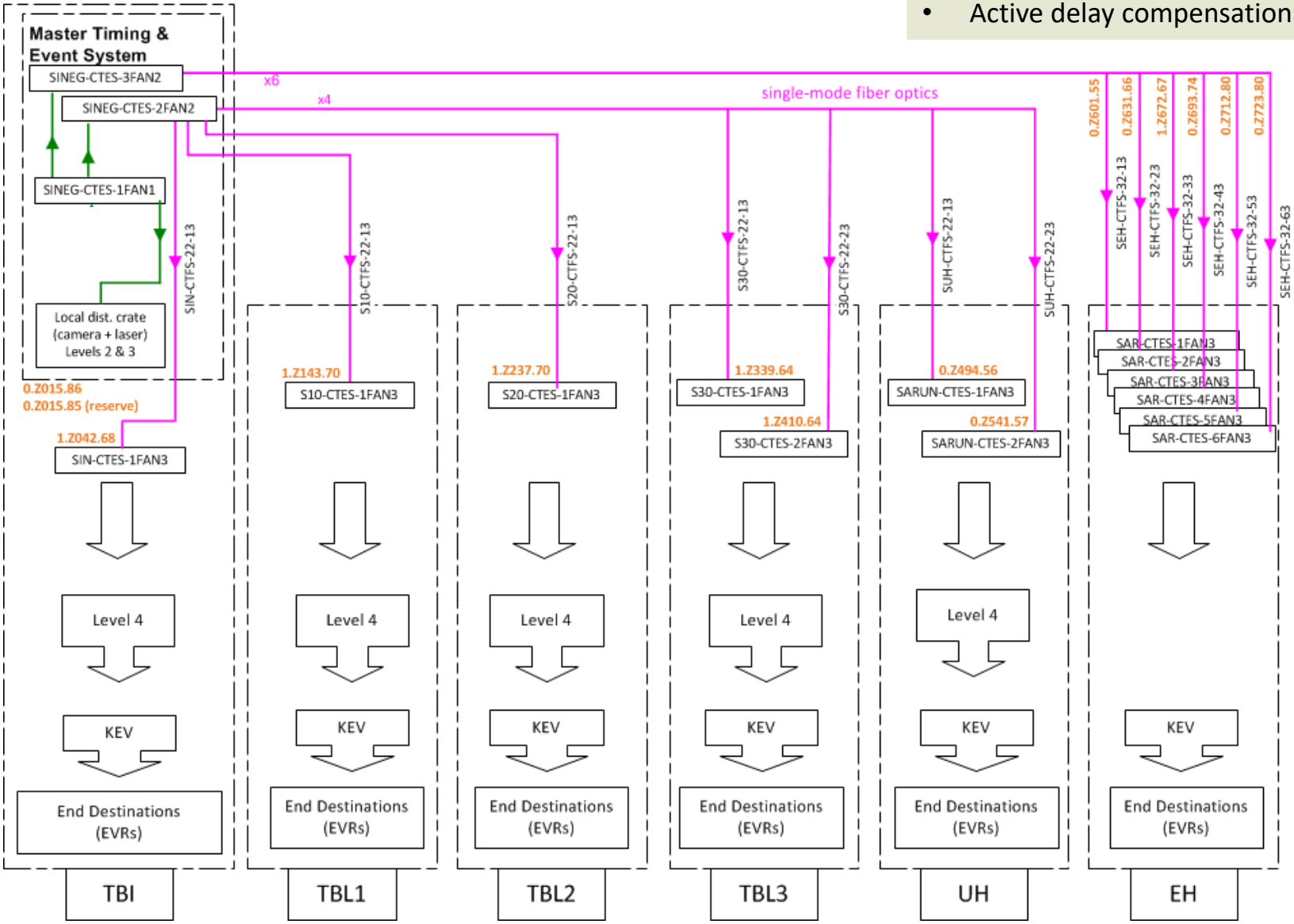
SwissFEL Timing Overview

- Provide precise triggering across the facility
- Rep- and beam rate controls
- Distribute operation-critical machine parameters
- Assist machine/beam synchronous DAQ and controls
- Assist Machine Protection System (MPS)



Timing System Overview

- Rep rate **100 Hz**
- Reference clock **142.8 MHz**
- Active delay compensation



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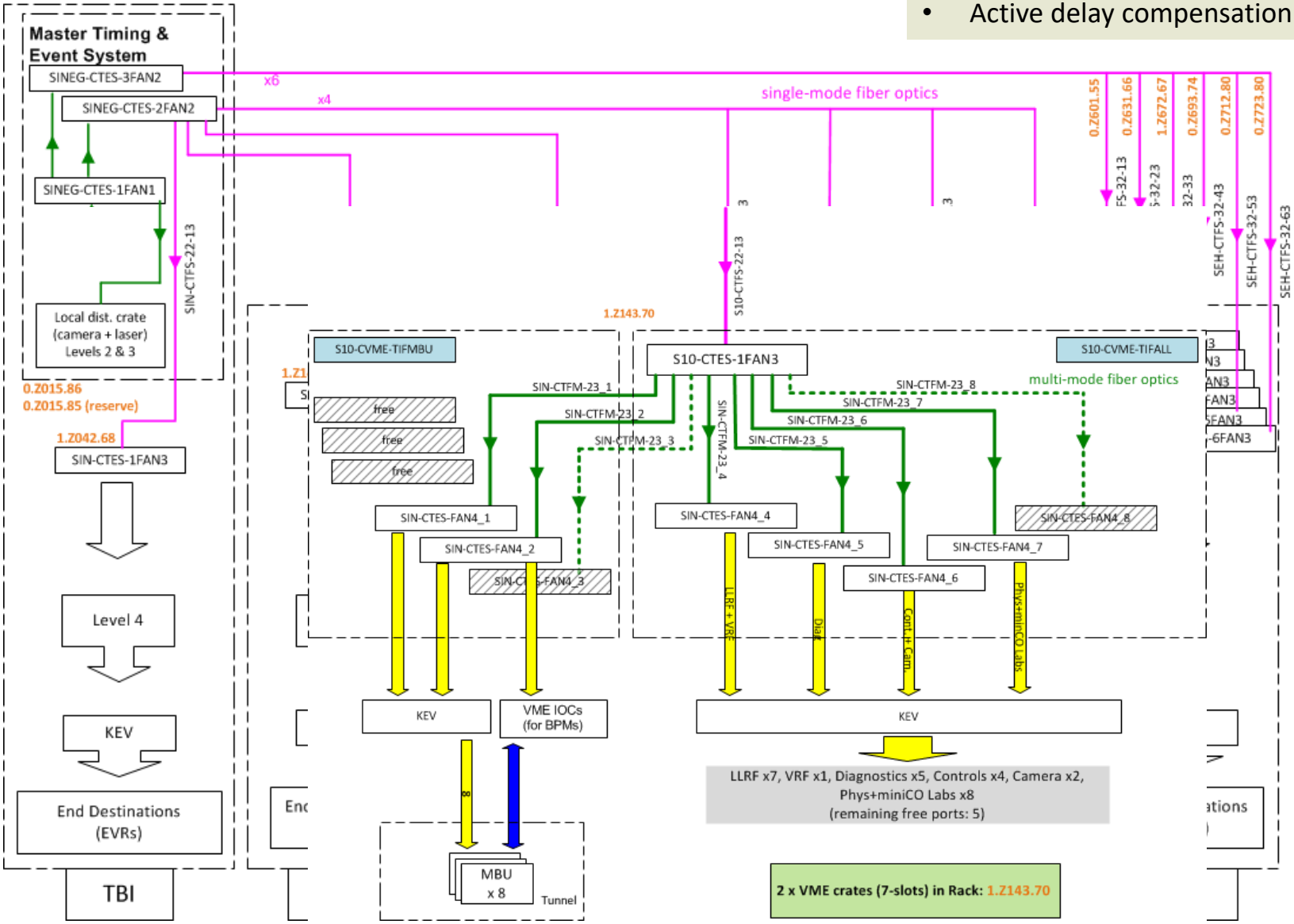
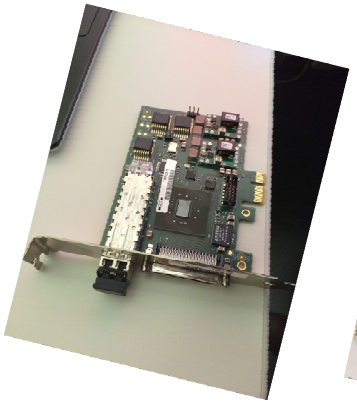
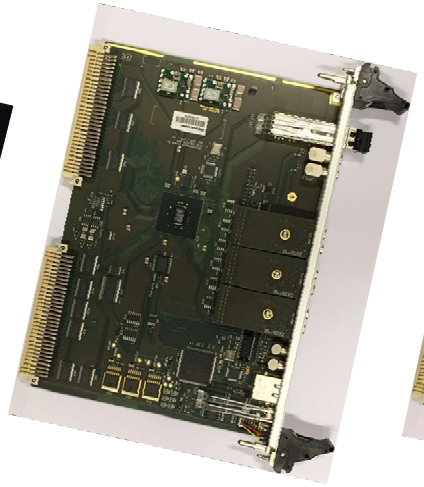


Dealing with different form-factors

- VME, PCIe, embedded (FPGA)
- Provide same interface (software configuration, UI)
- Embedded EVR's increasing **-> non-standard interface must be managed!**





Timing device	VME-EVM	VME-EVR	PCIe-EVR	Embedded EVR
In operation 1 year ago	15	8	0	6
In operation **today**	67	142	45	**152**

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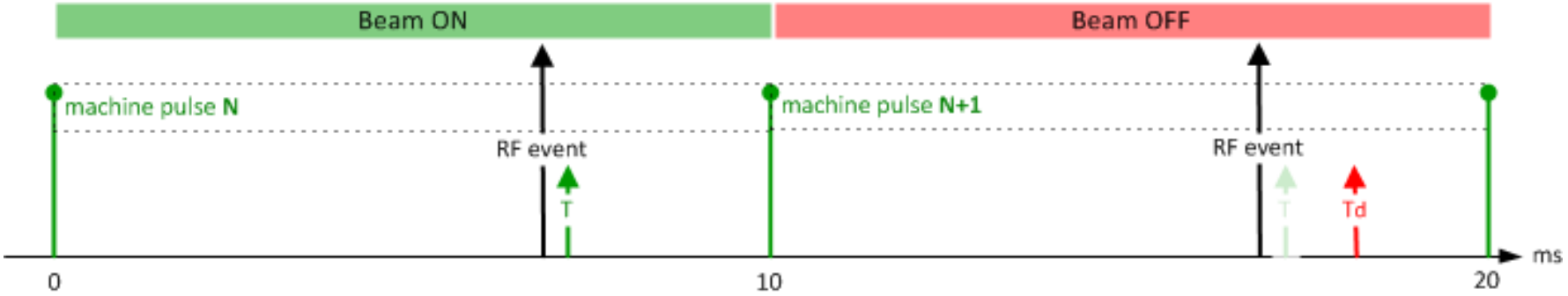
Beam Rate Control

- Event rep rate handling is a challenge -> flexible + independent + synchronous

Beam Rate Control

- **Green** is RF with normal trigger -> Acceleration -> Beam **ON**
- **Red** is RF trigger with delayed trigger -> No acceleration -> Beam **OFF**

➢ Continues triggering maintains stable subsystem operation (Laser, RF, etc.)



- Software controlled: operator's beam rate setting
- Hardware controlled: assist machine protection (beam stopper)

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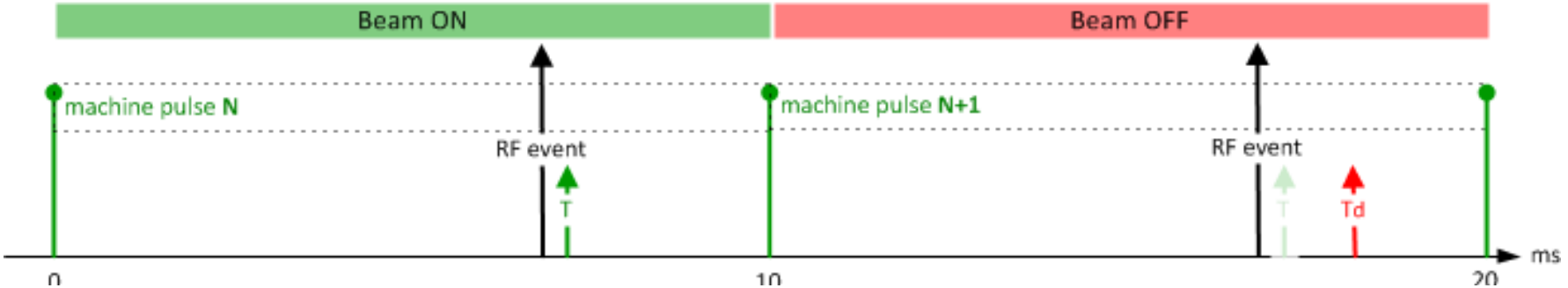
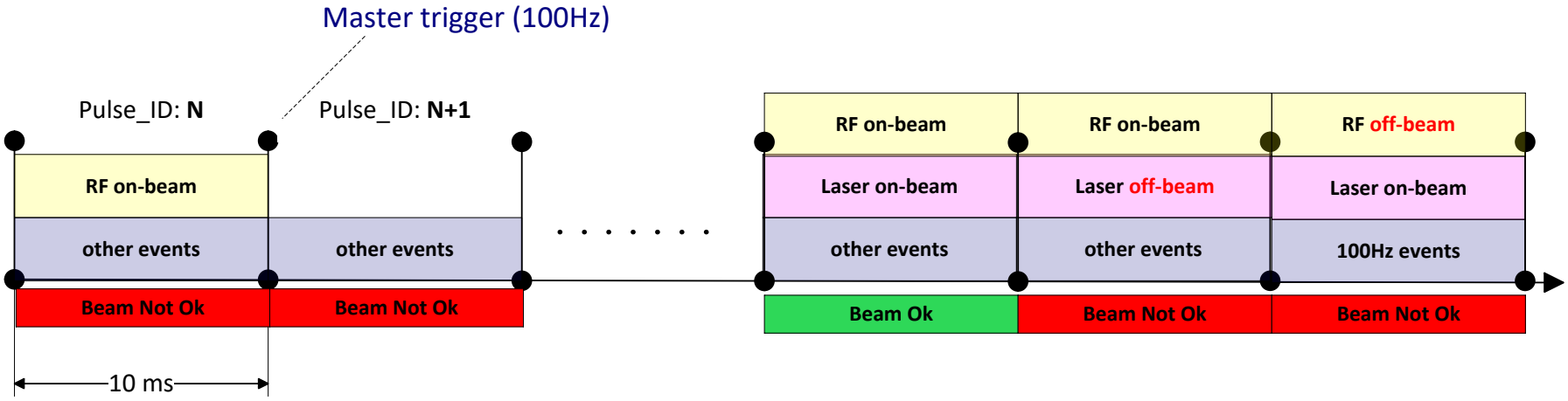
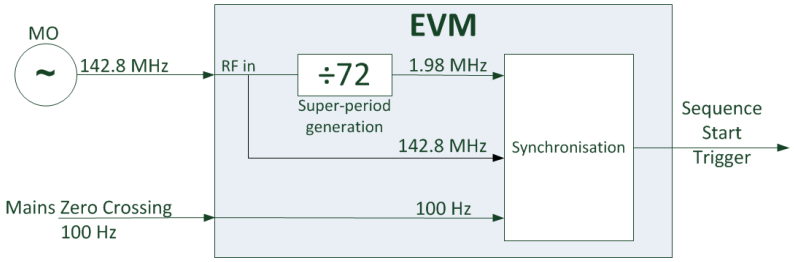
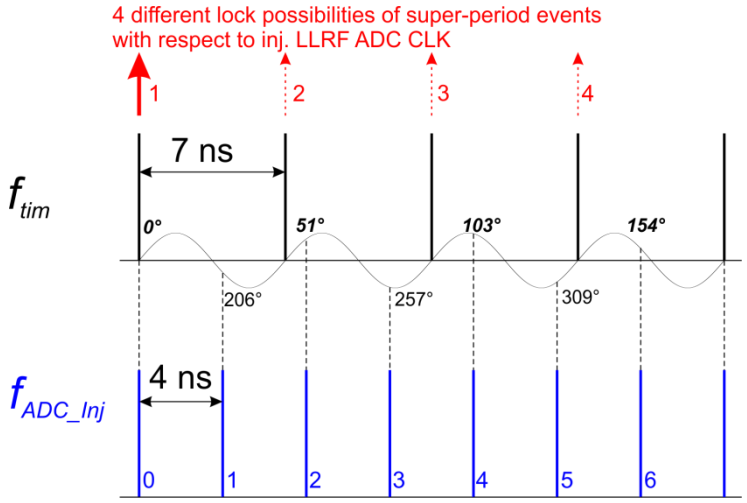


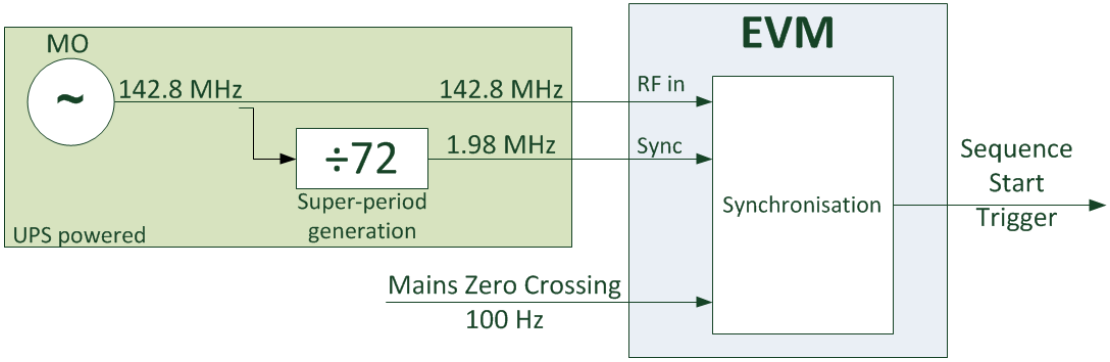


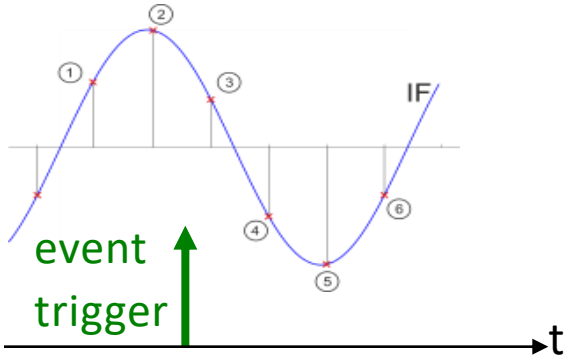
Master restart / power up

- Events are synced with internal super-period
- Relative phase of unrelated clocks across subsystems









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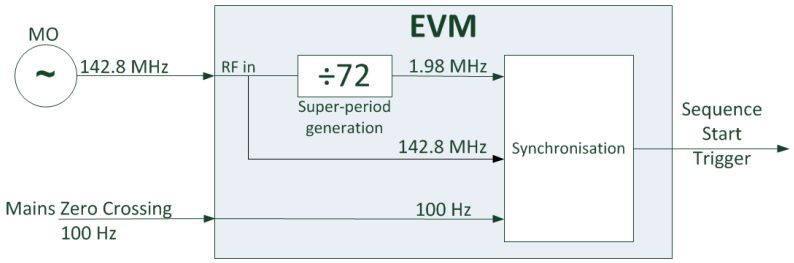

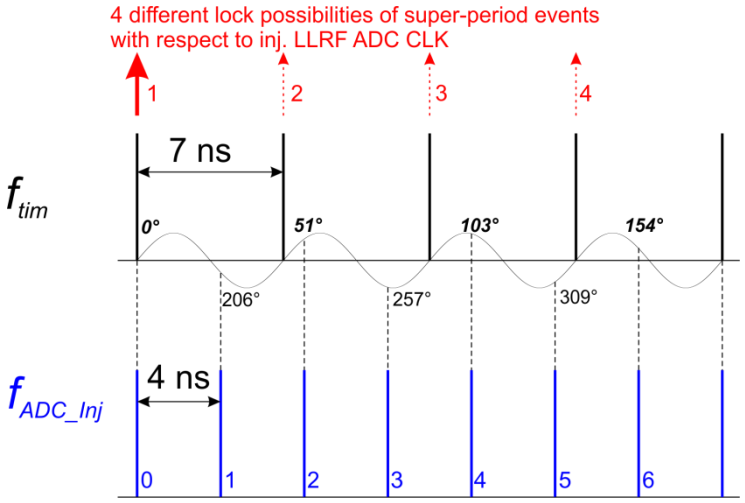

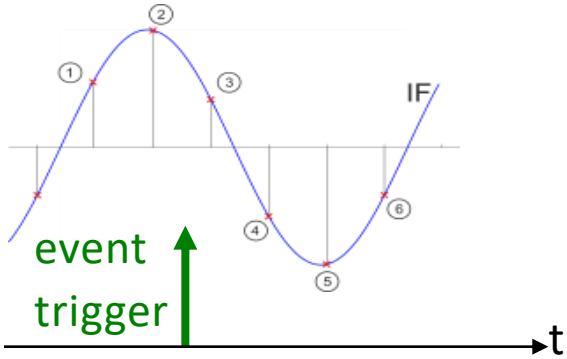

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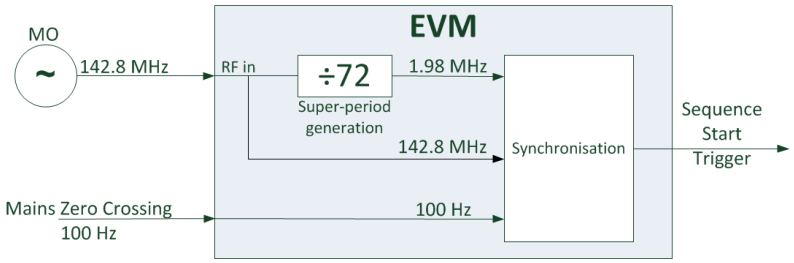
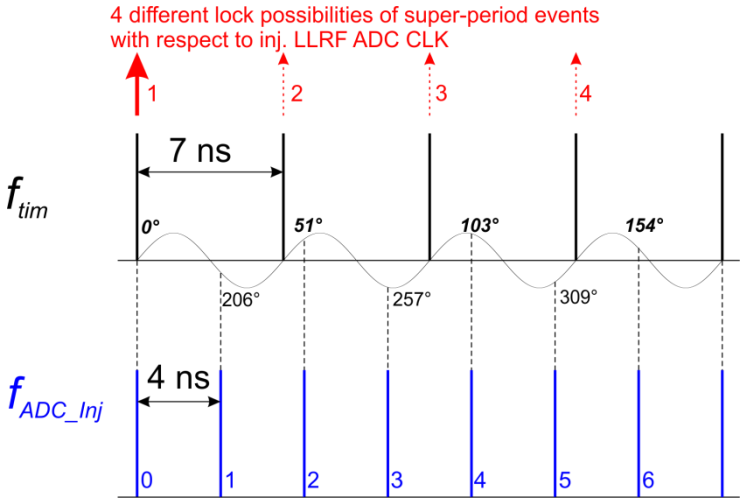
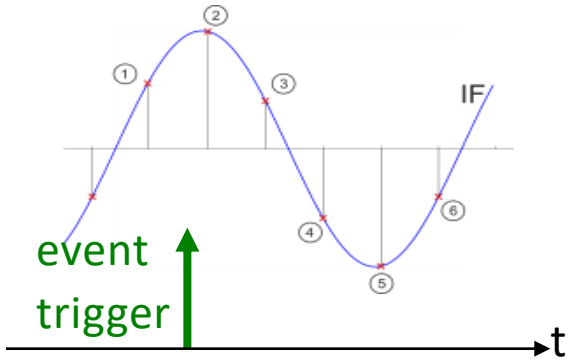




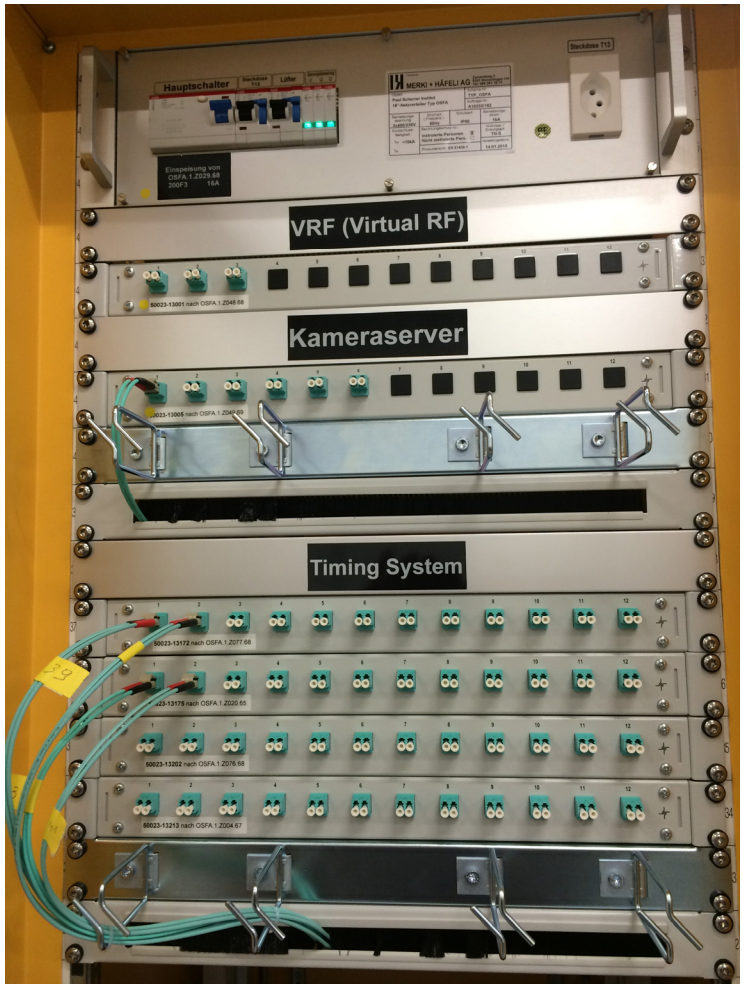


Timing Network Diagnostics

- Art of “spaghetti”

Timing Network Diagnostics

- Make it cleaner!
- will nice cabling and labeling help?



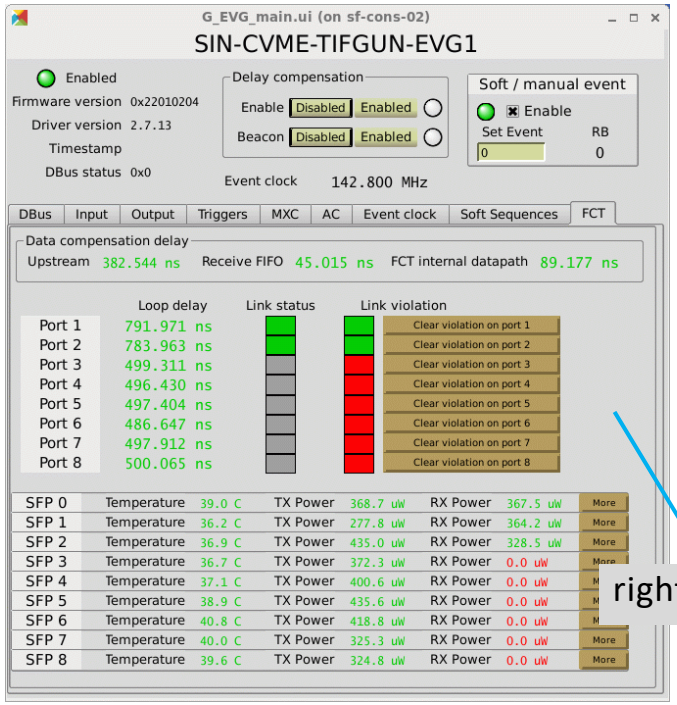
Timing Network Diagnostics

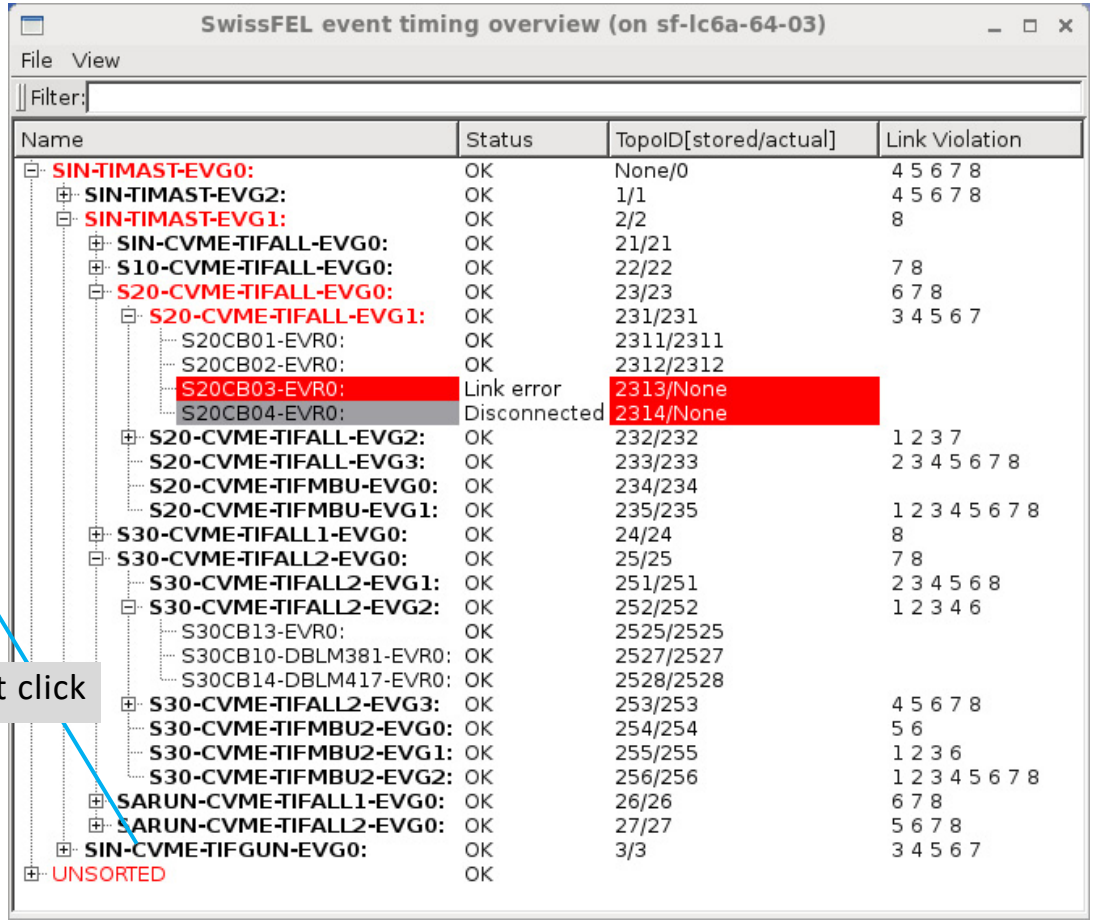
- Screw it up!

➢ only swap a patch and forget!

Dynamic Topology Survey

- Each node gets its topology id from its parent
- Each parent sends its own id plus ports number to the connected child
- Topology id is updated dynamically

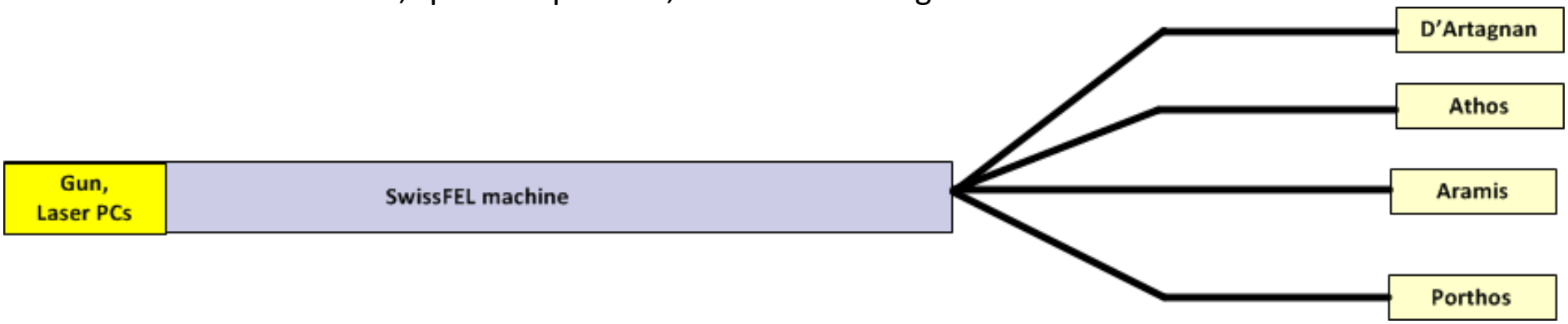




right click

Complex Triggering Application (CTA)

- Generate flexible trigger-and-acquisition patterns (e.g. pump-probe)
- Independent CTA for each end-station -> CTA runs locally + forwards global events
- Upload desired trigger pattern; start pattern playing upon:
  - user's demand, specified pulse ID, occurrence of a global event



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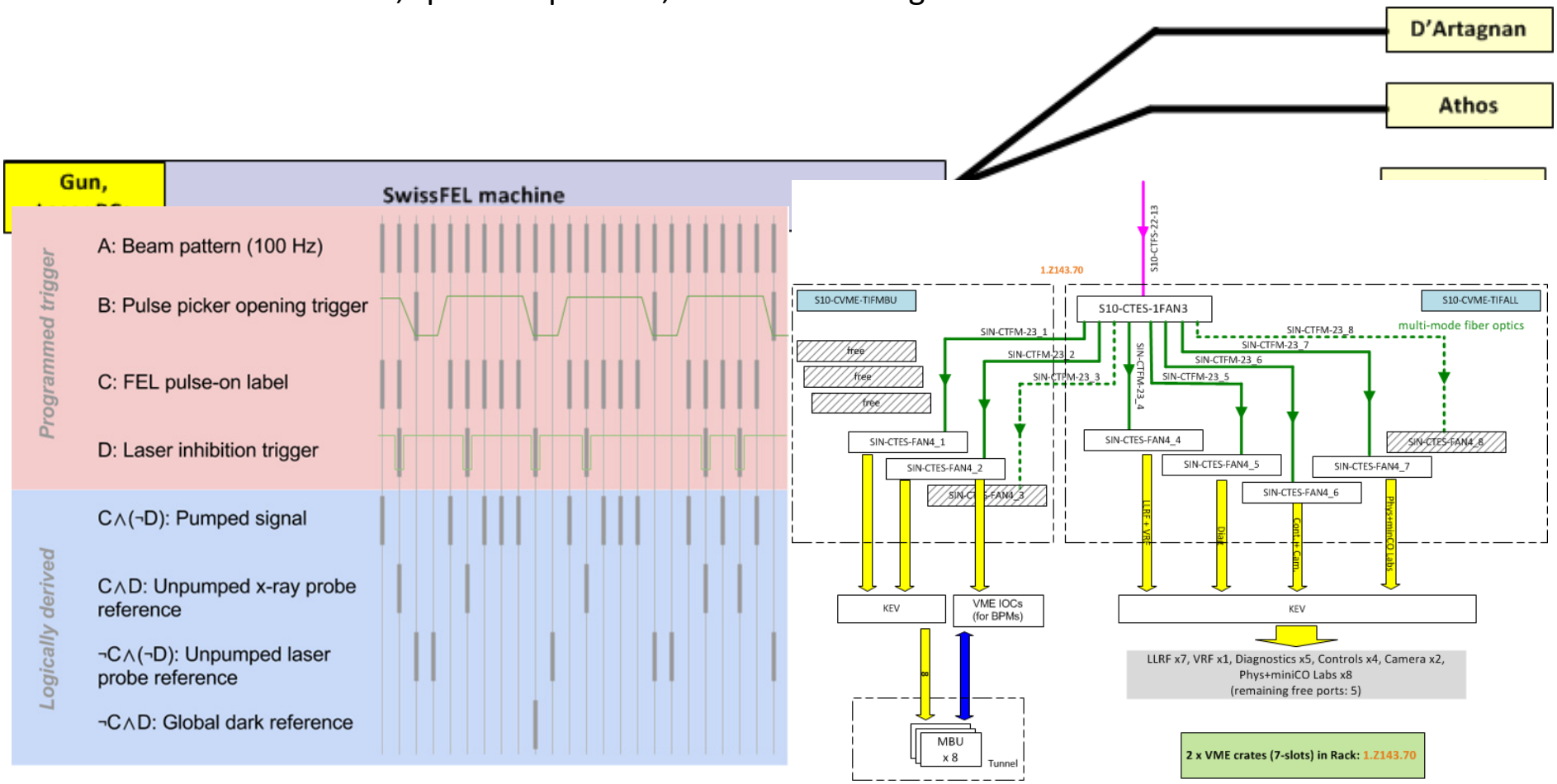

My thanks go to

- GFA Controls
- Expert groups: LLRF, DI, Laser, …
- MRF
- Cosylab