DE LA RECHERCHE À L'INDUSTRIE

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LASER MEGAJOULE TIMING SYSTEM

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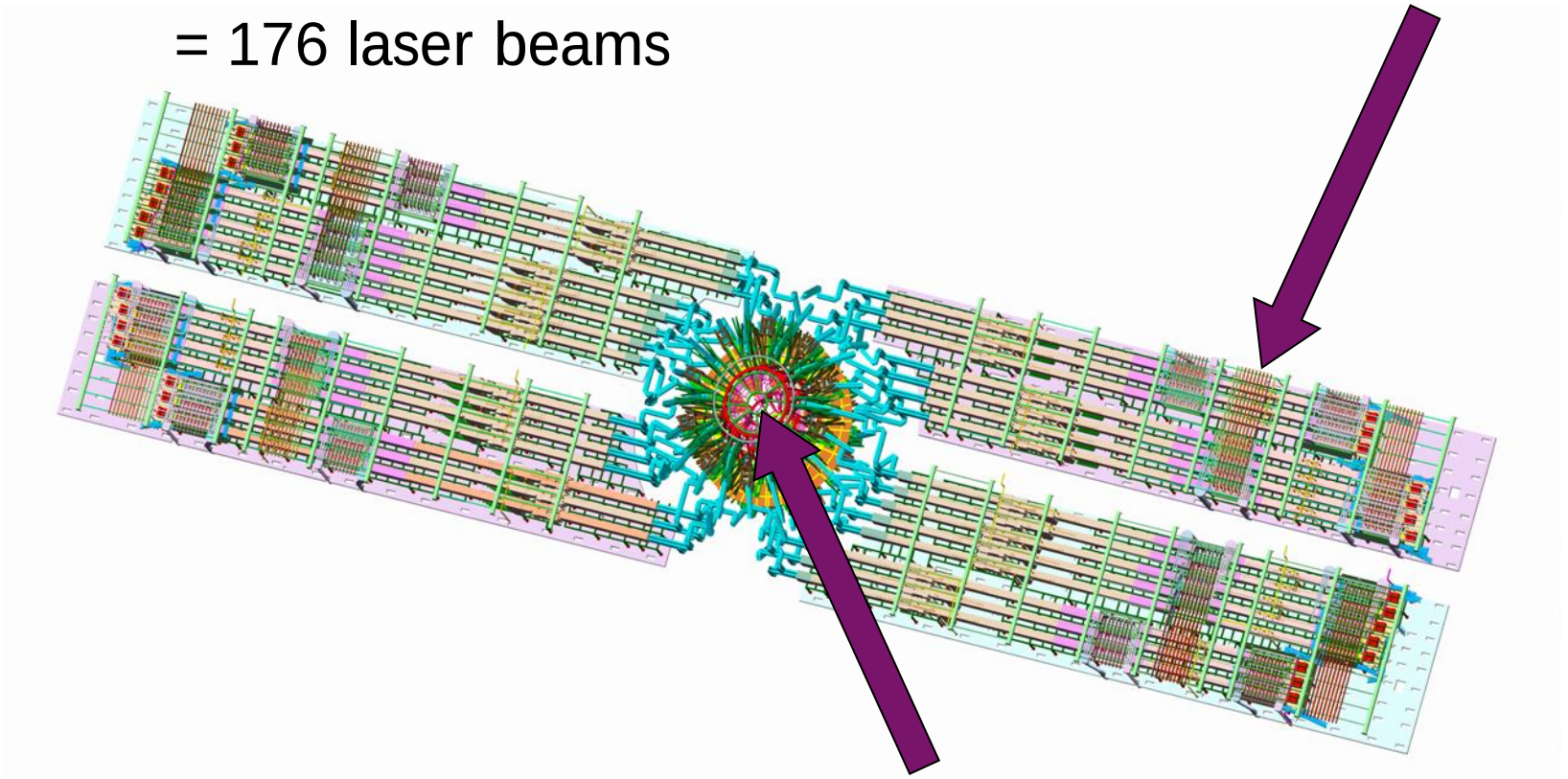
Presentation overview

- LMJ FACILITY
- TIMING SYSTEM REQUIREMENTS
- TIMING SYSTEM COMPONENTS
  - STANDARD AND HIGH PRECISION TIMING SYSTEM
  - ULTRA-HIGH PRECISION TIMING SYSTEM
  - FIDUCIAL SYSTEM
  - SUPERVISORY COMPONENTS
- CONCLUSION

The LMJ facility

22 bundles of 8 beams located in 4 bays

= 176 laser beams



More than 1 MJ of 350 nm UV light on a target

Timing system requirements

- Main specification : quadruplets have to be synchronised to better than 40 ps rms despite the fact that laser sources are separated within the building by several hundred of meters
- This determines the accuracy needed on pulse shaping devices and waveform laser diagnostics
- The same performance is required for fiducial pulses used to temporally mark laser and plasma diagnostics and for signals used to trigger them
- Laser operation requires furthermore real-time triggering of front end devices, power conditioning, Pockels cells, flash lamps and alignment sensors.

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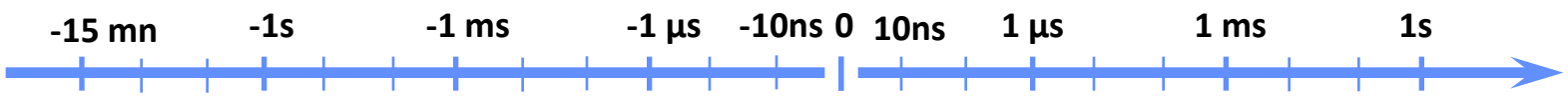

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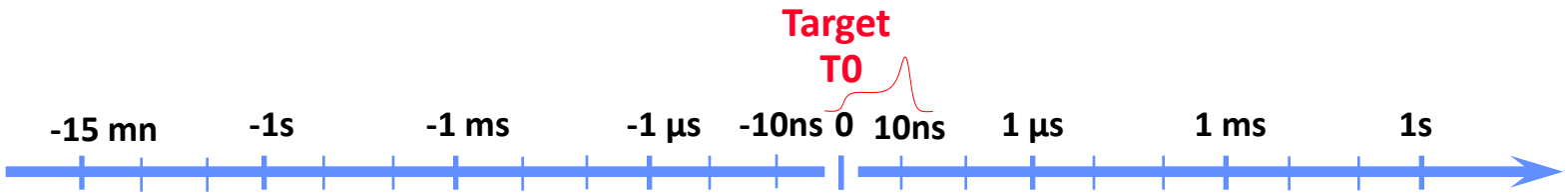

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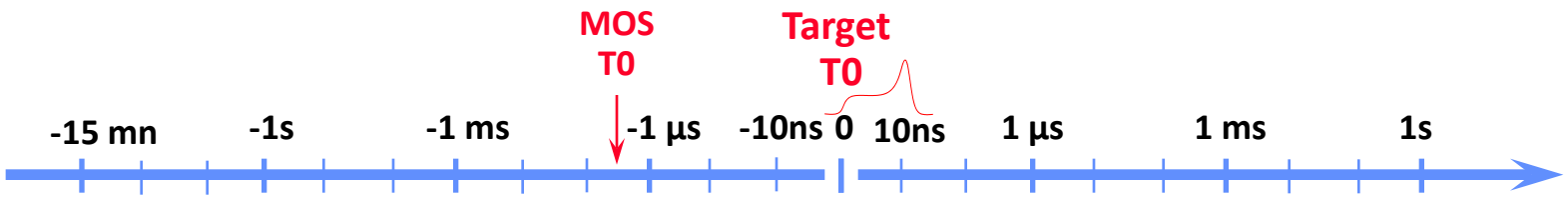

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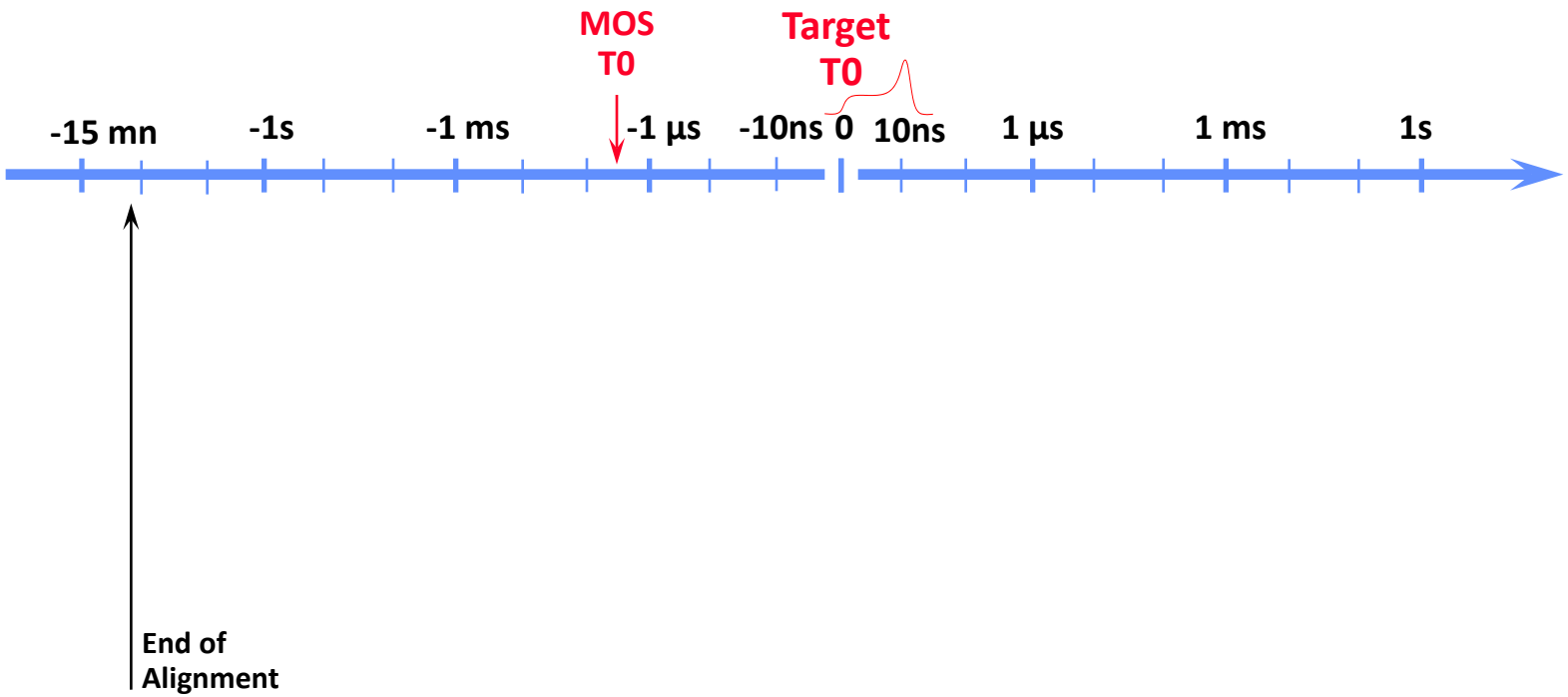

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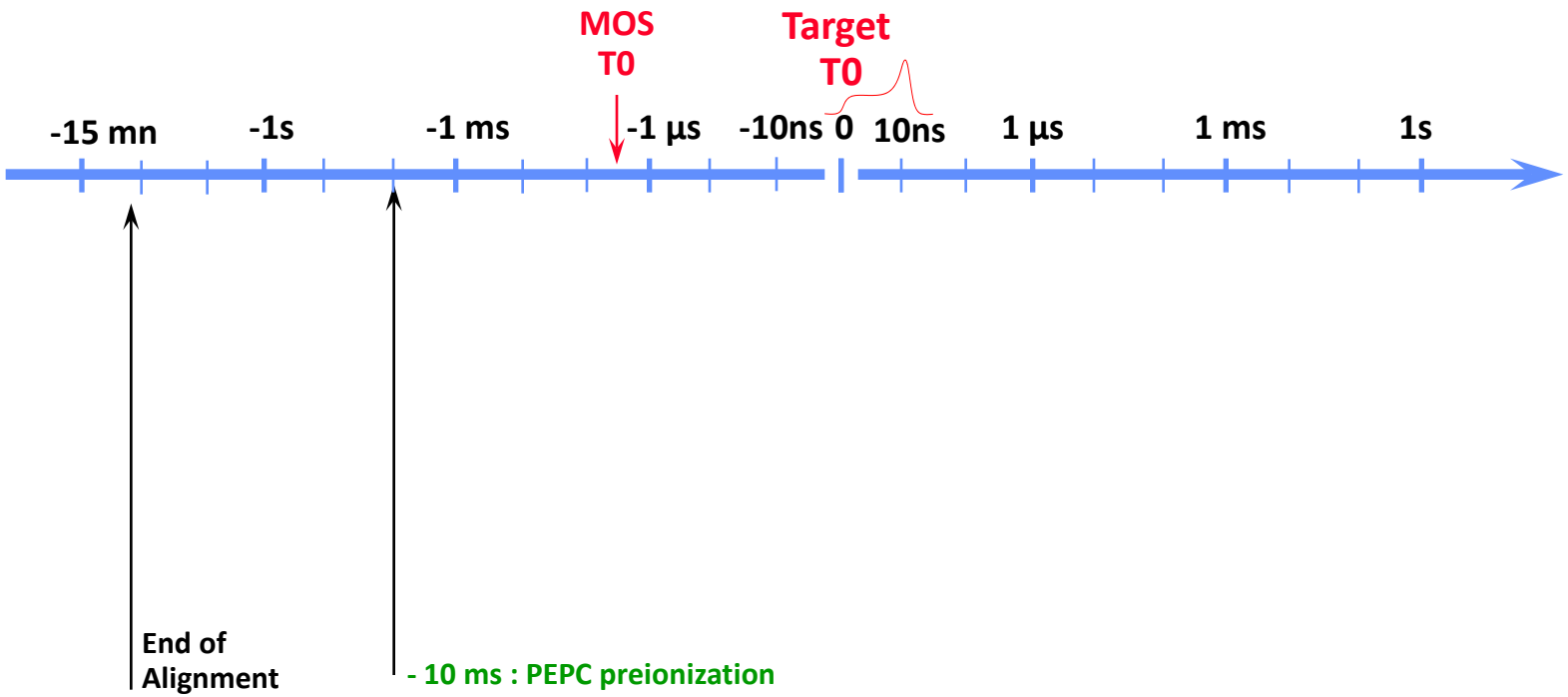

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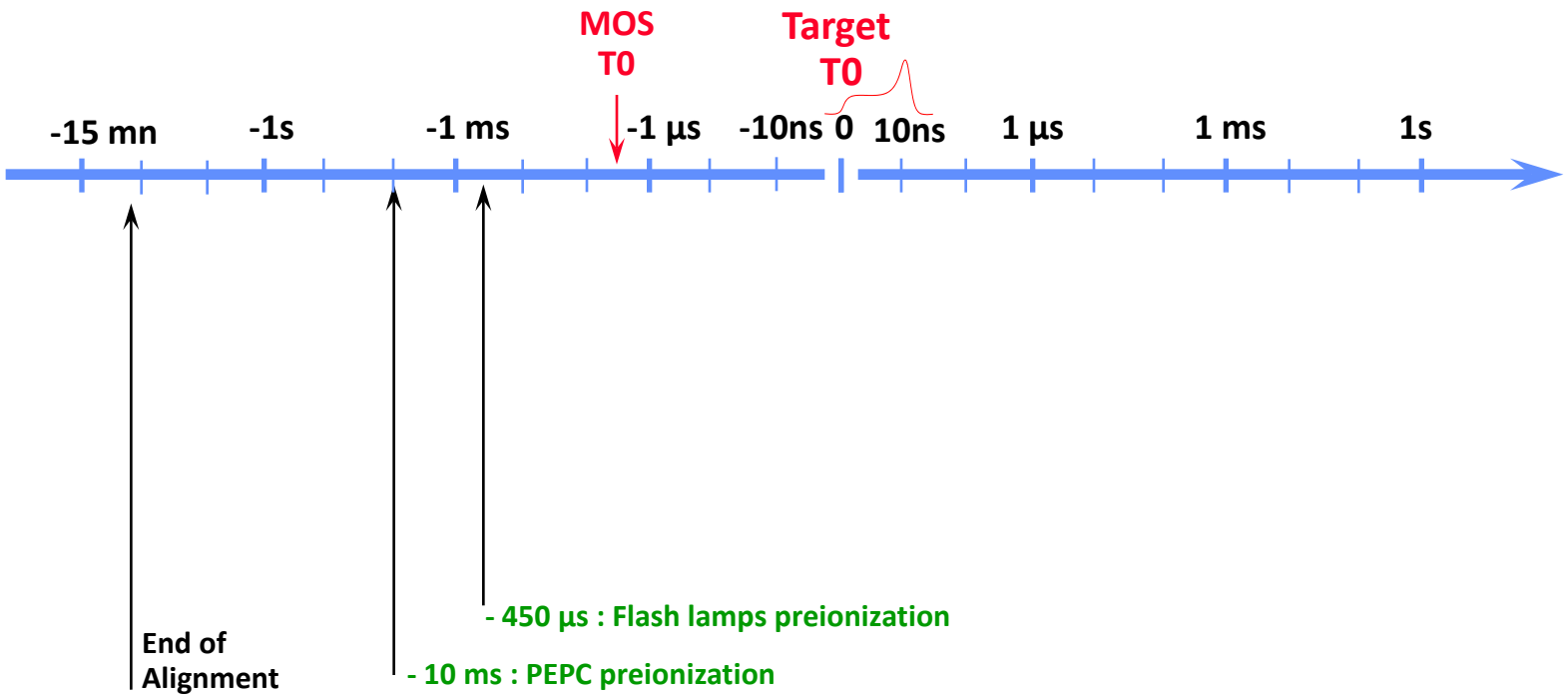

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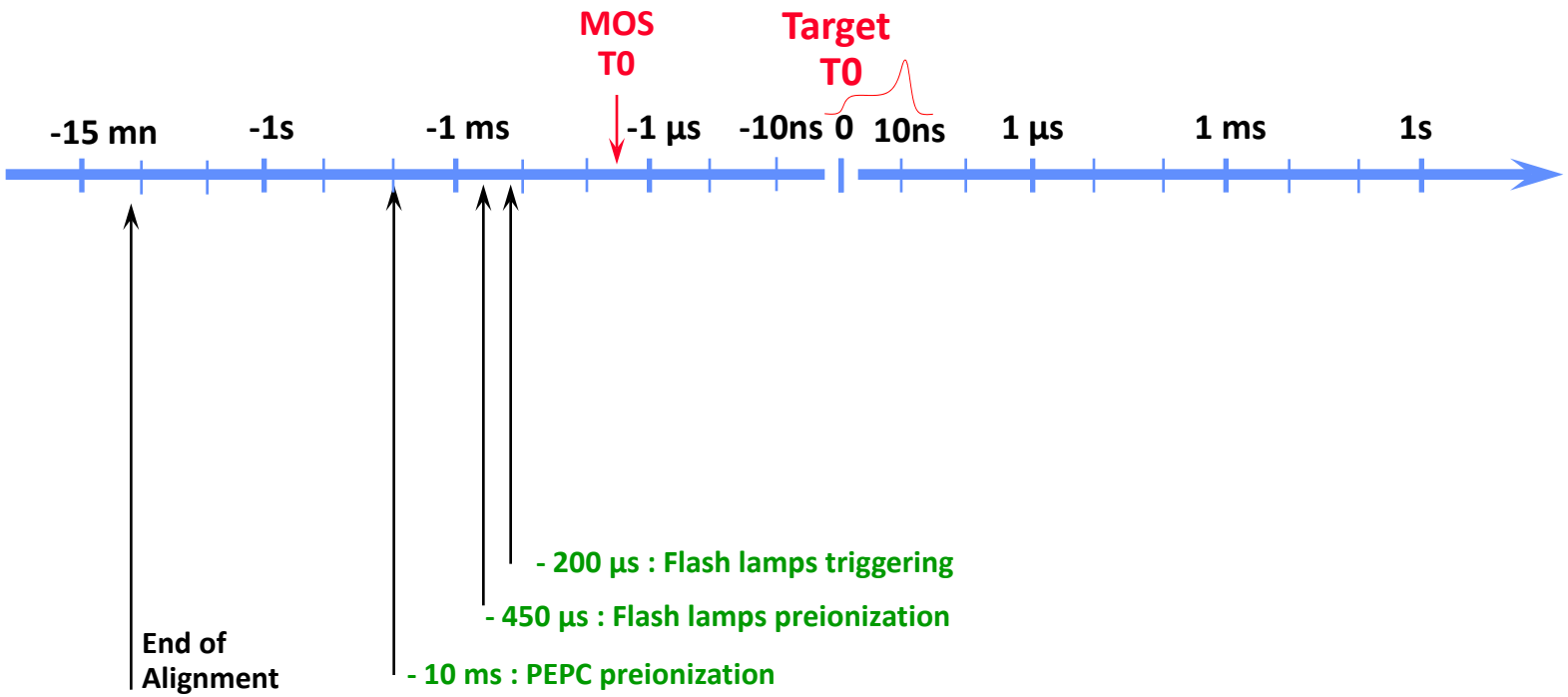

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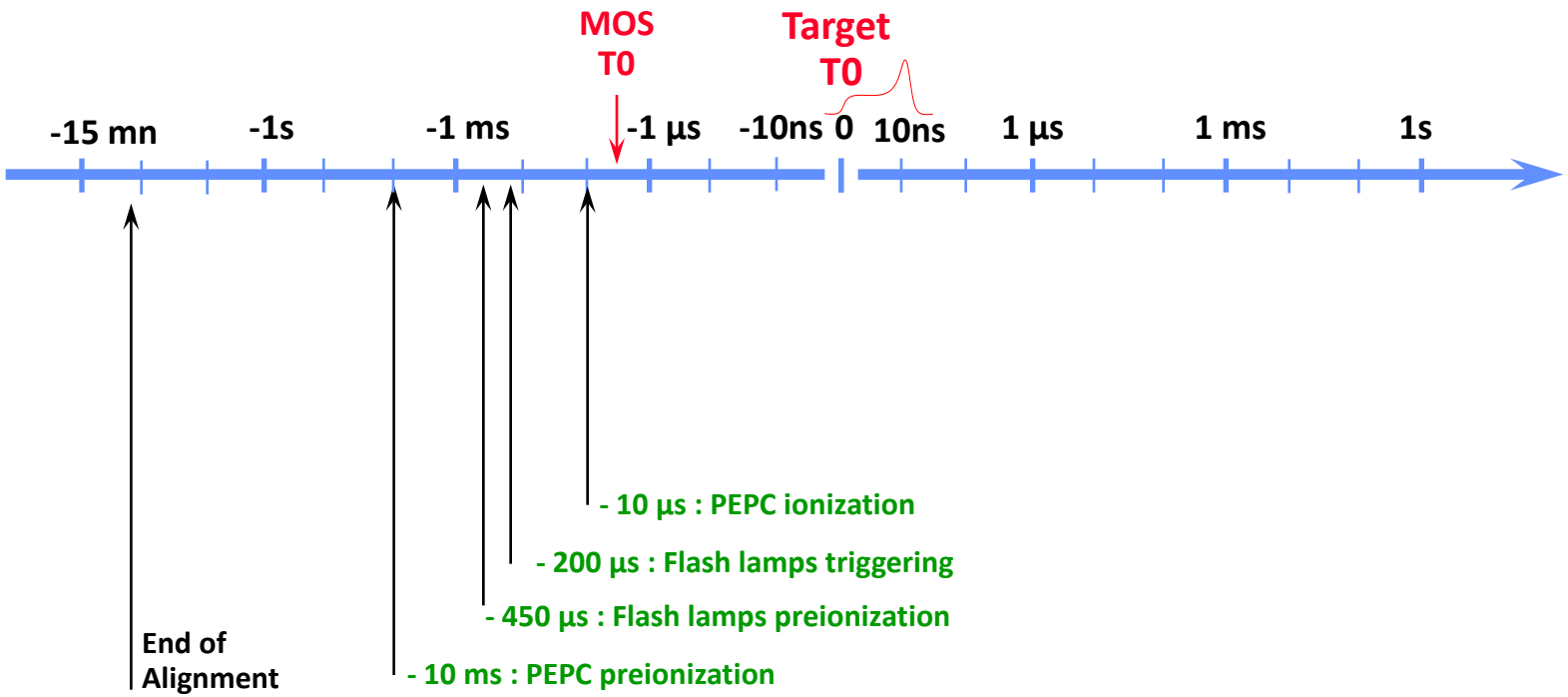

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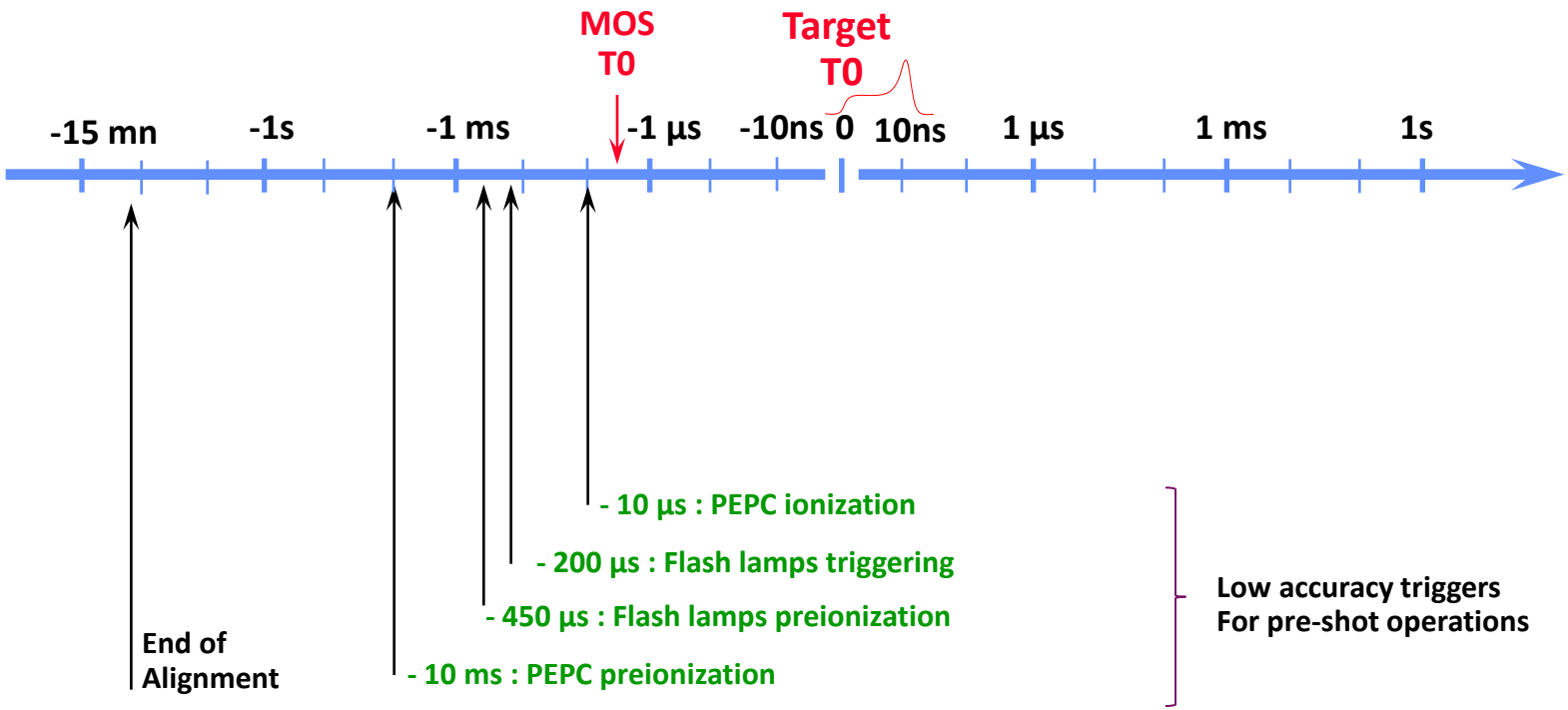

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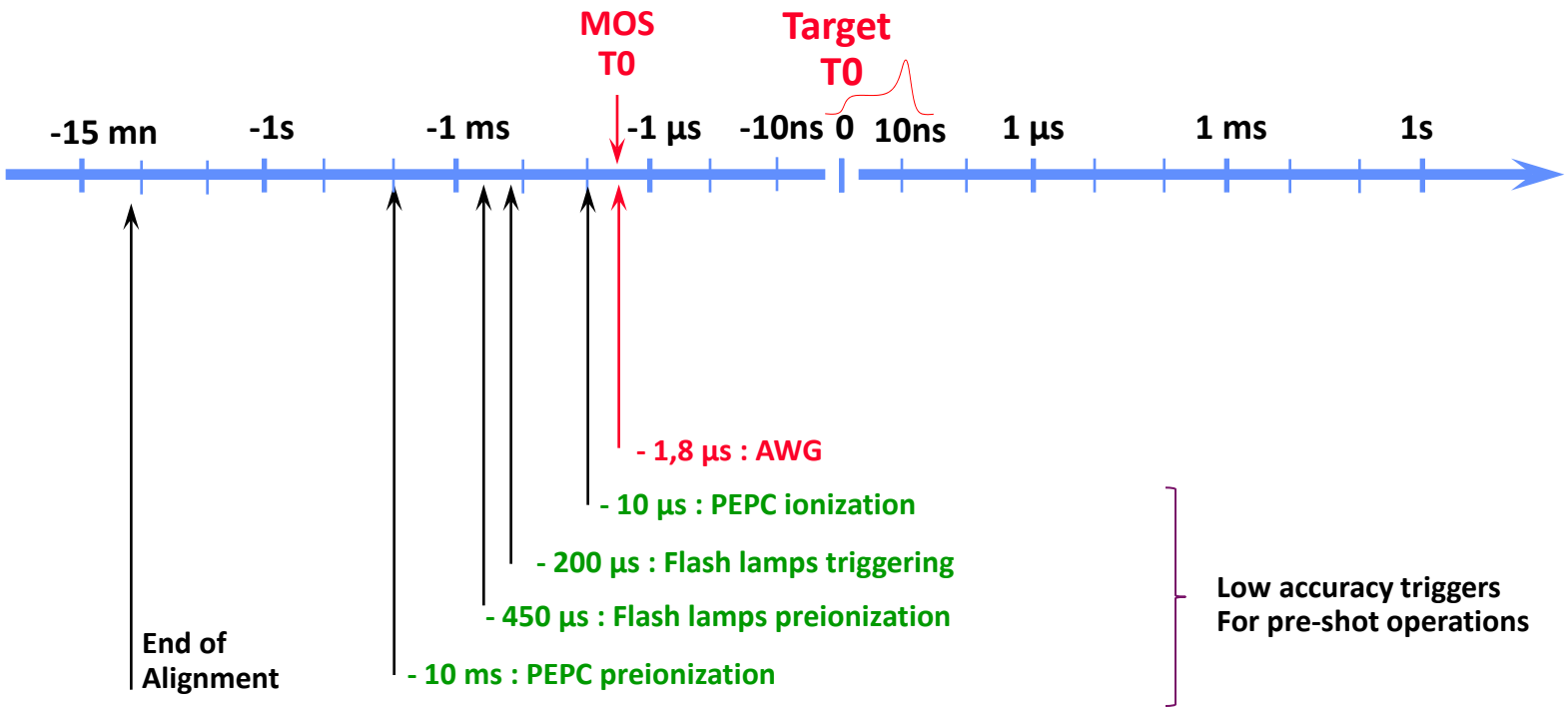

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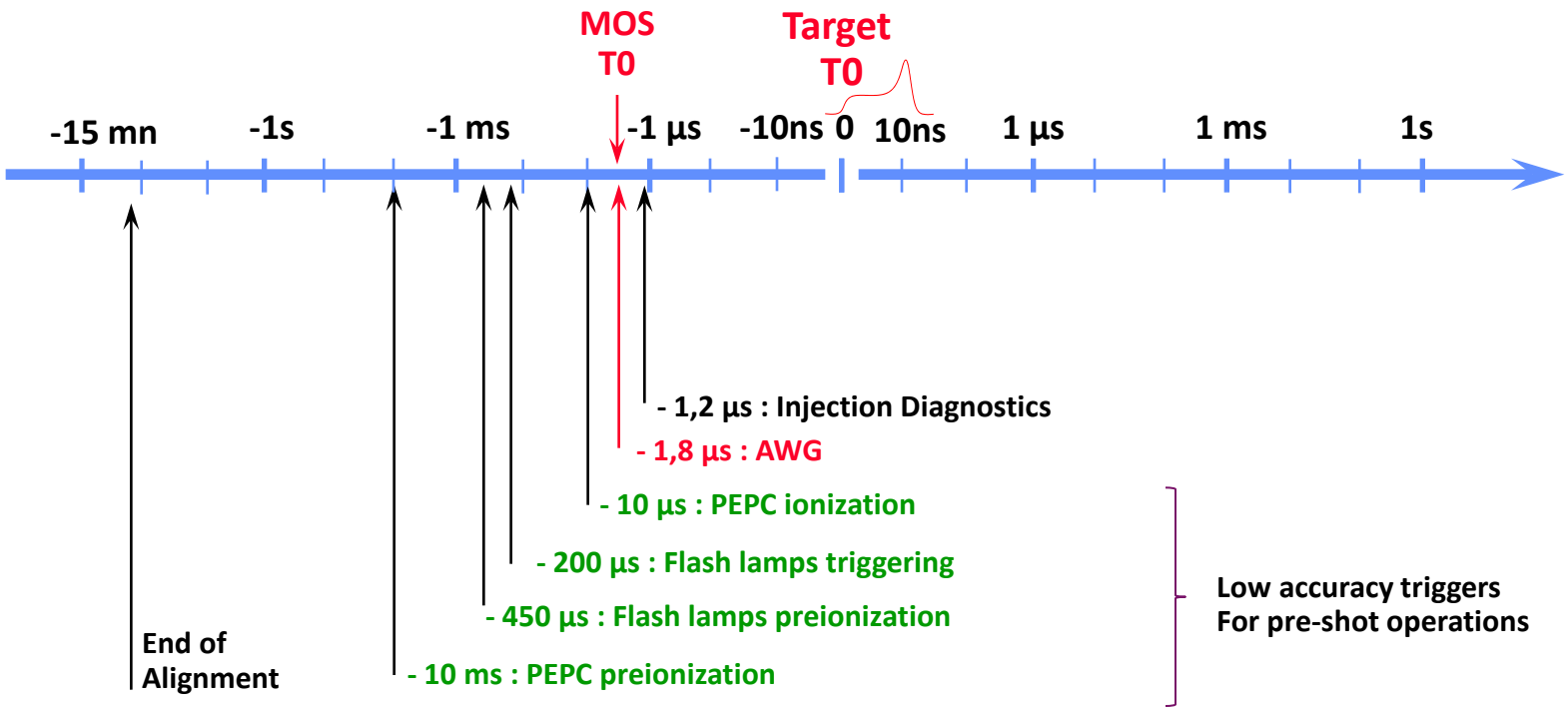

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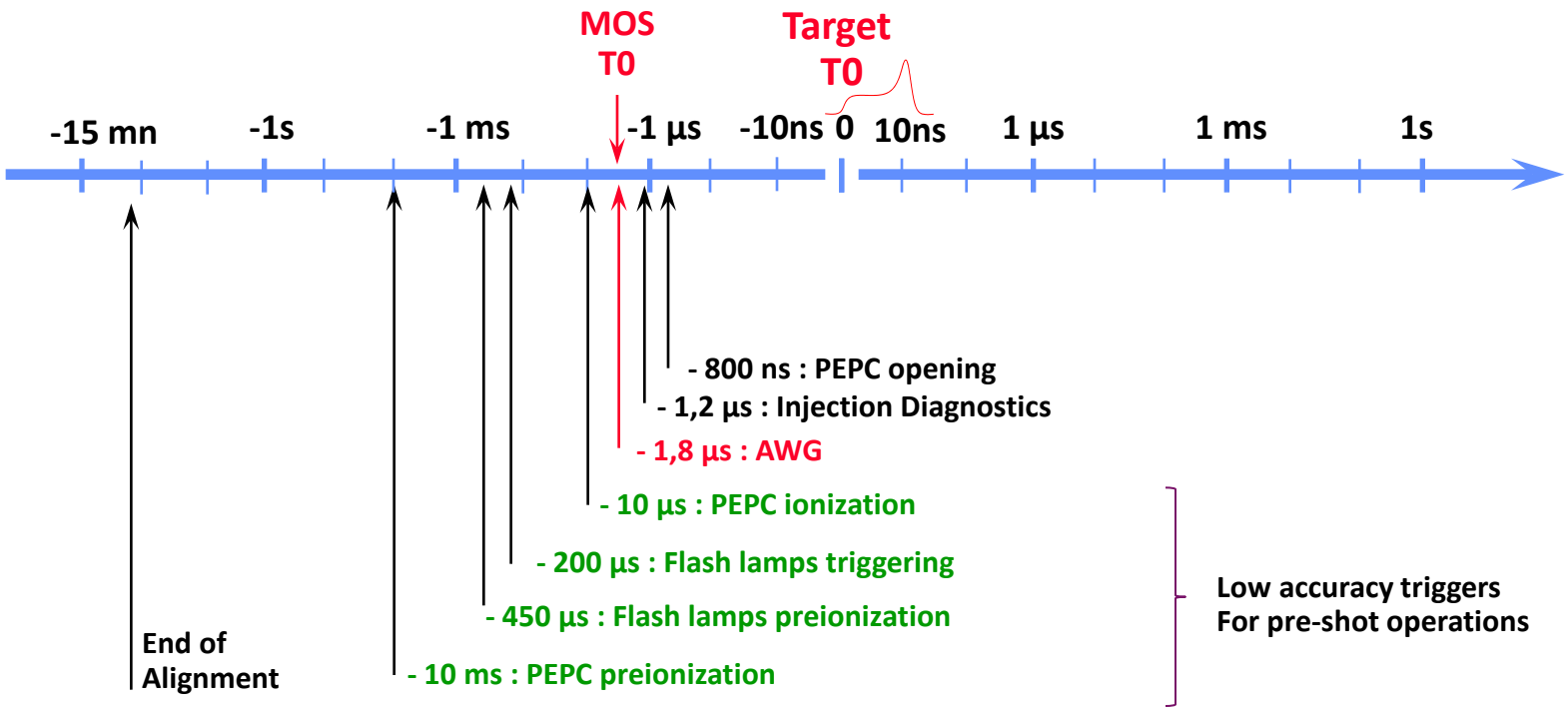

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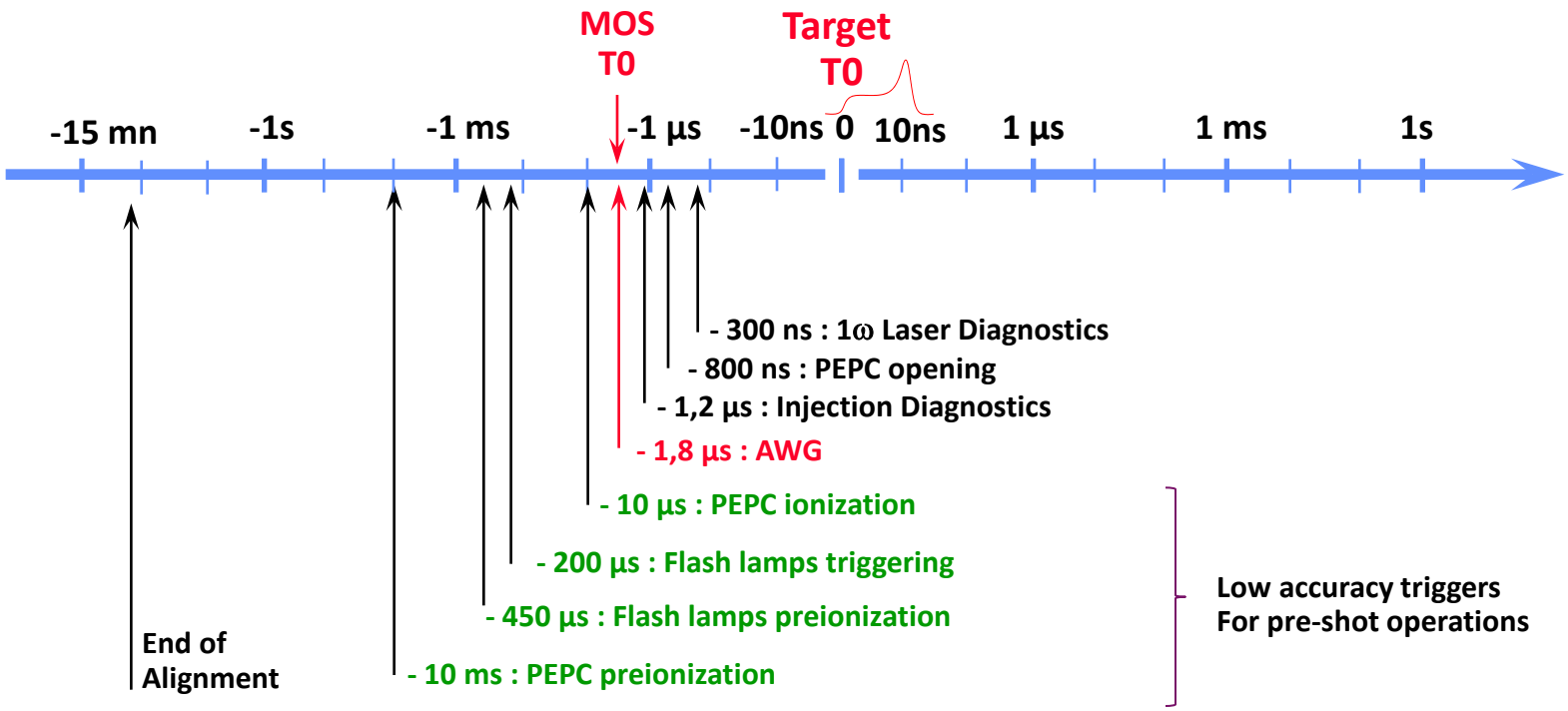

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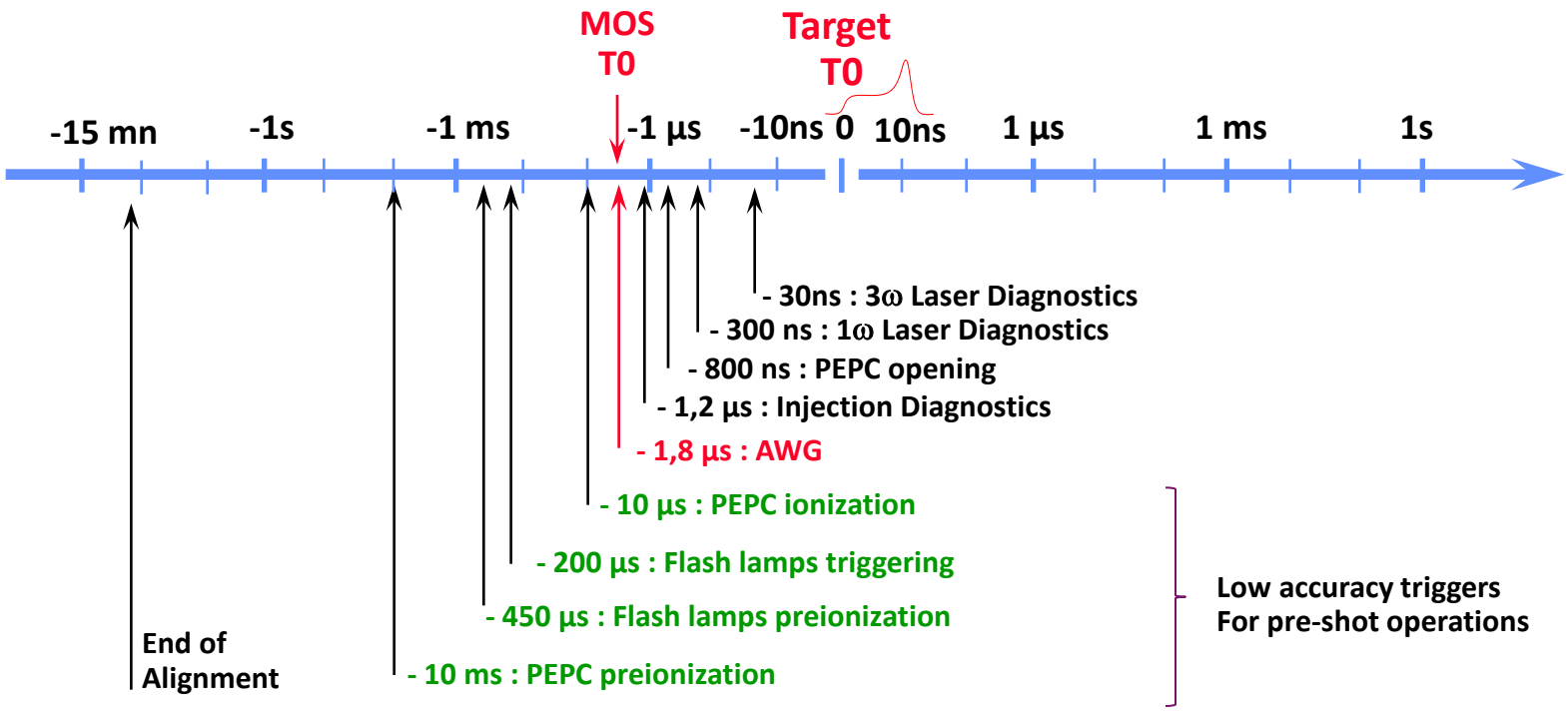

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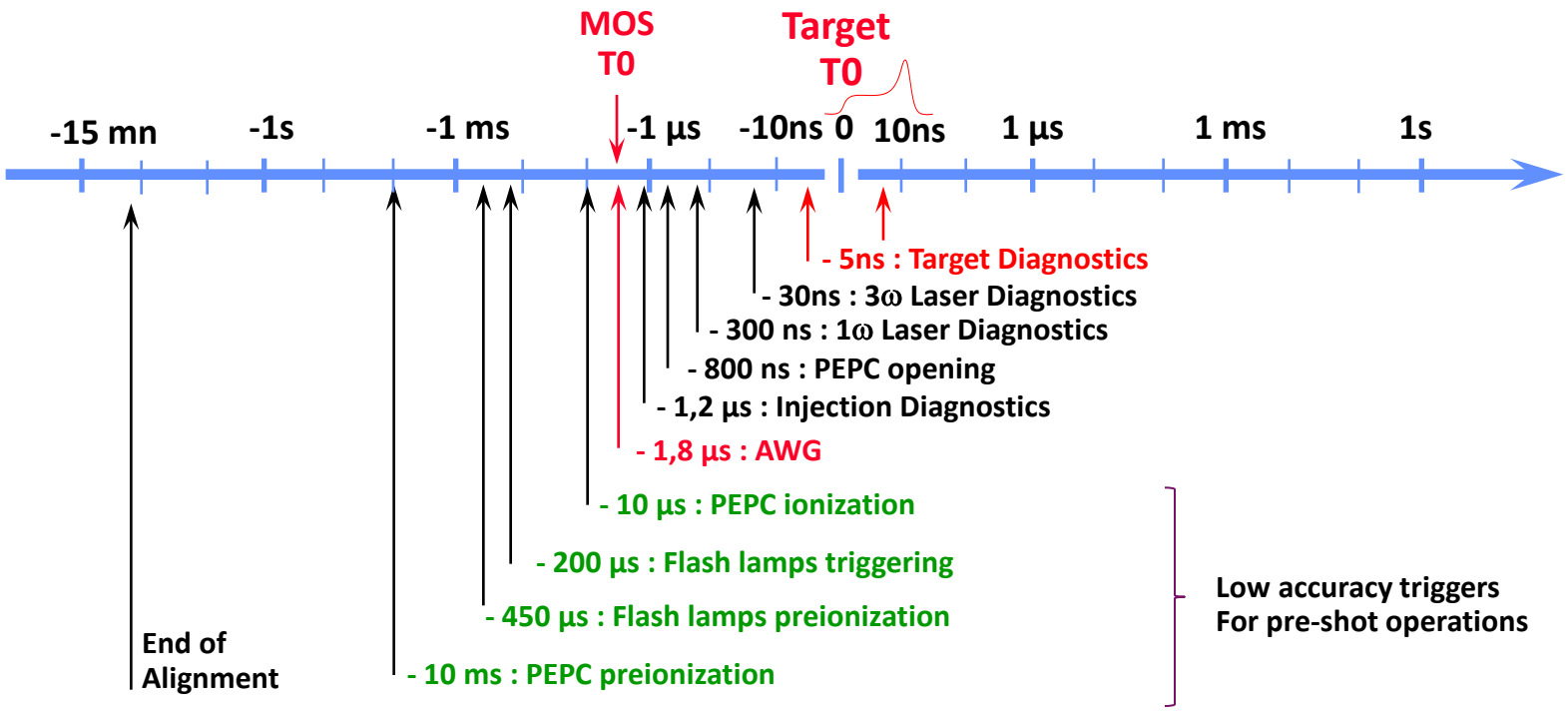

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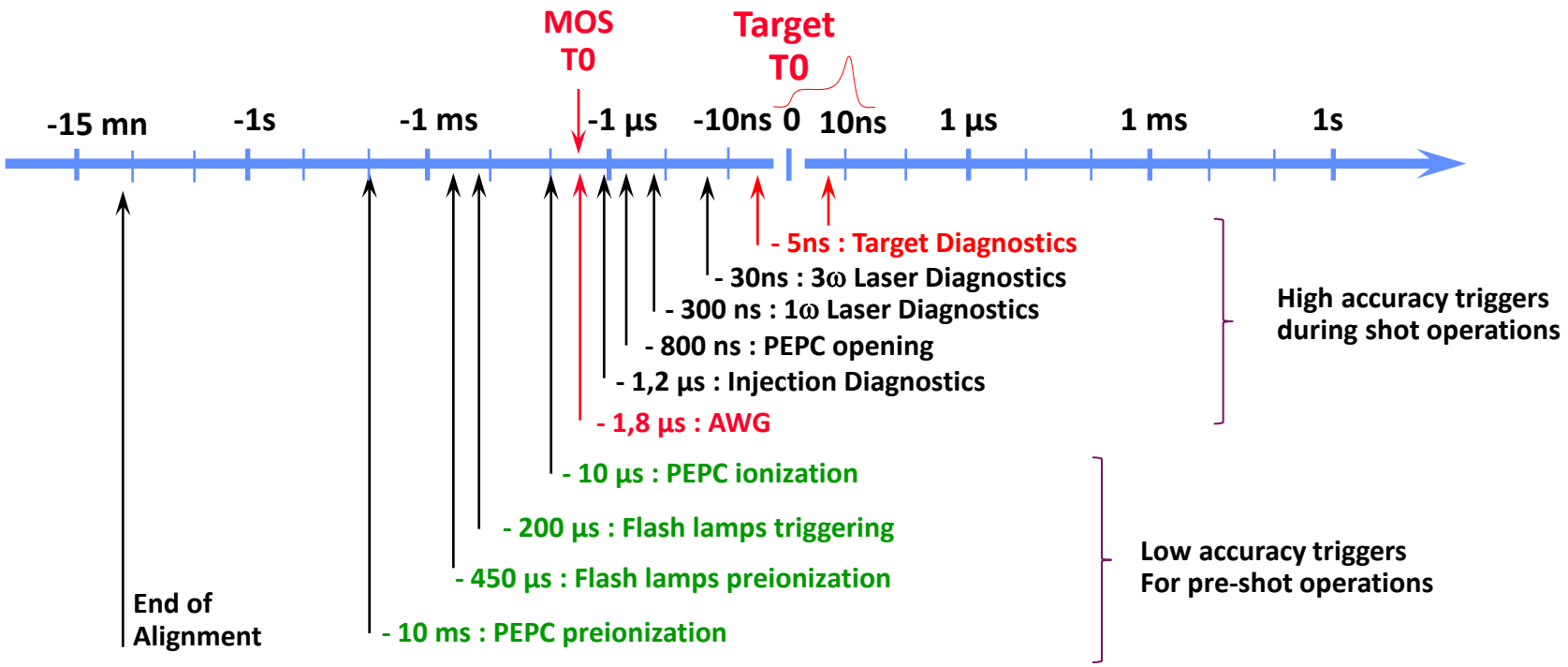

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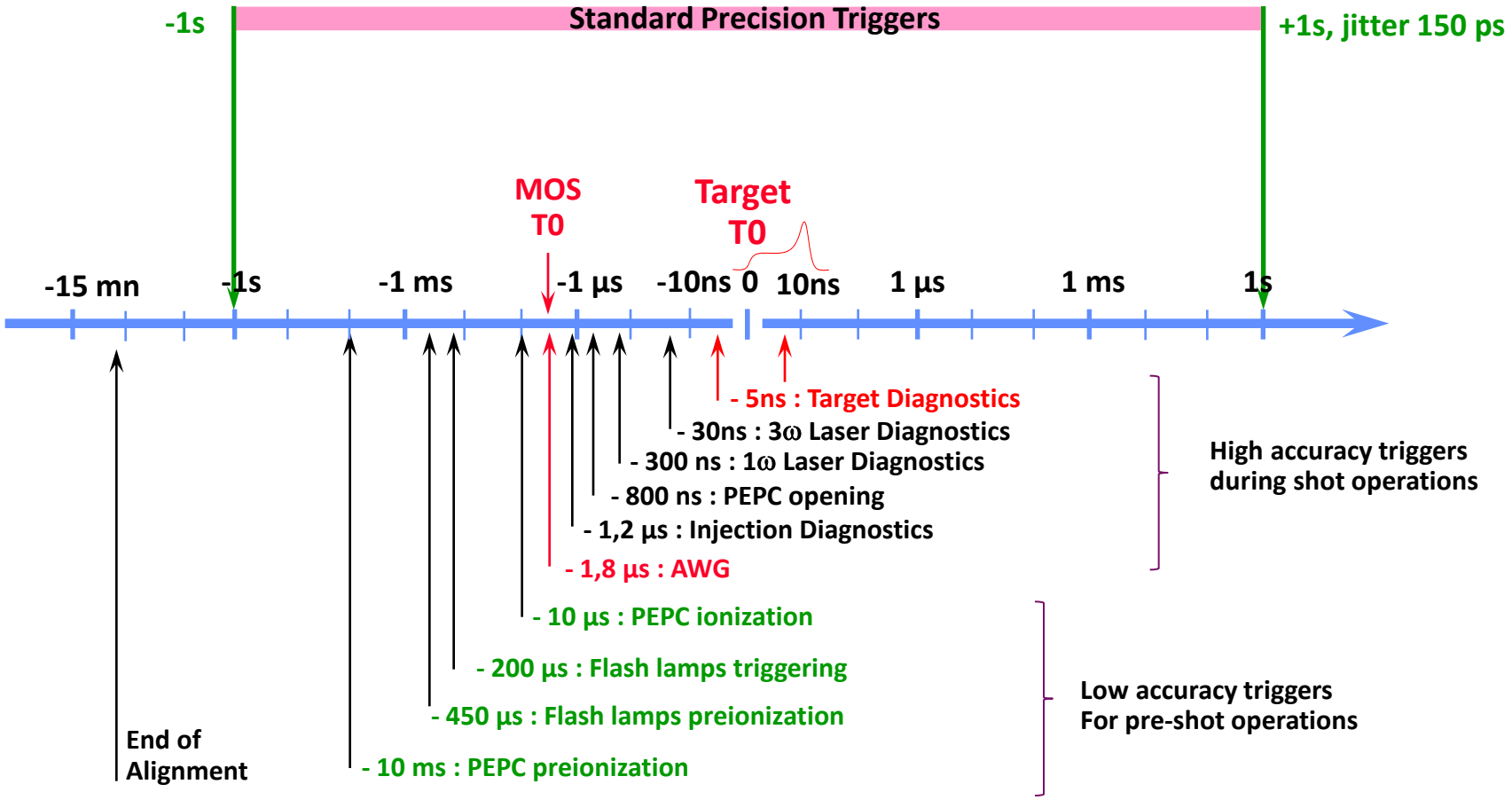

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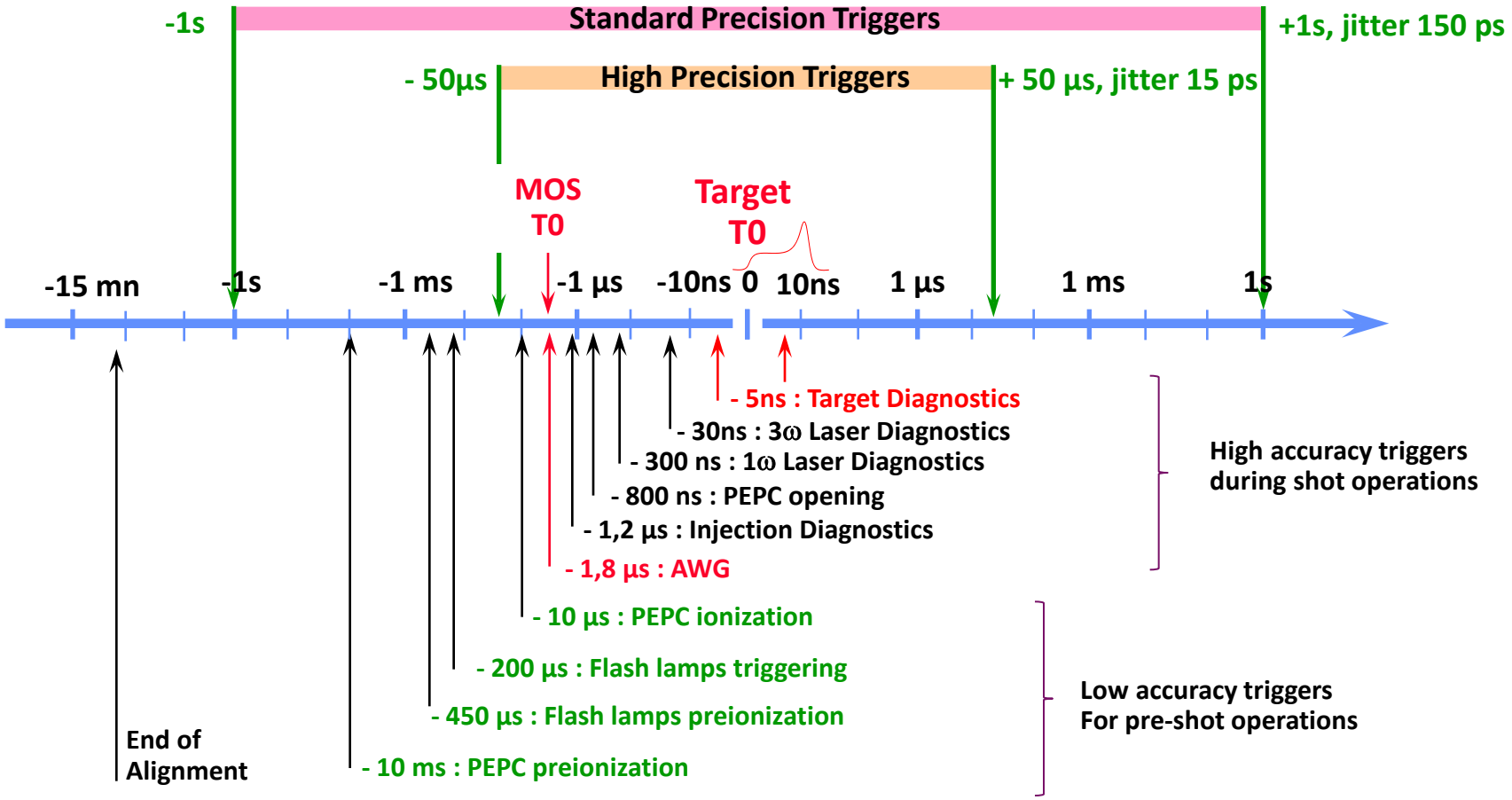

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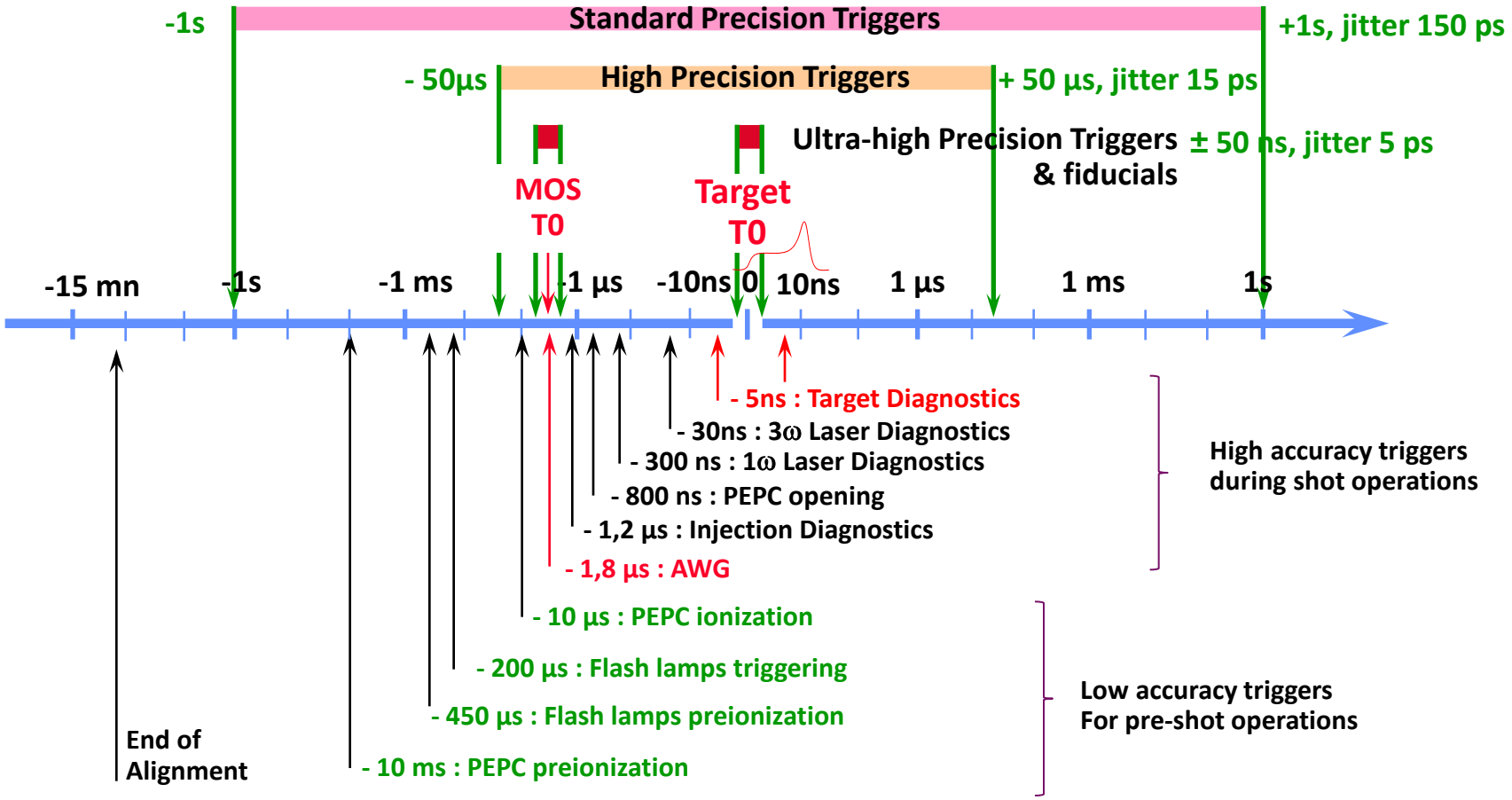


Performance and quantities needed

	Range	**Jitter** (rms)	**Wander** (peak-to-peak, over 1 week)	**Quantity**
Standard Precision T riggers	±1s	150ps	<2ns	~2000
High Precision T triggers	±50µs	15ps	<20ps	~80
Ultra-high Precision T triggers	±50ns	5ps	<10ps	~100
Fiducials	±50ns	5ps	<10ps	~200

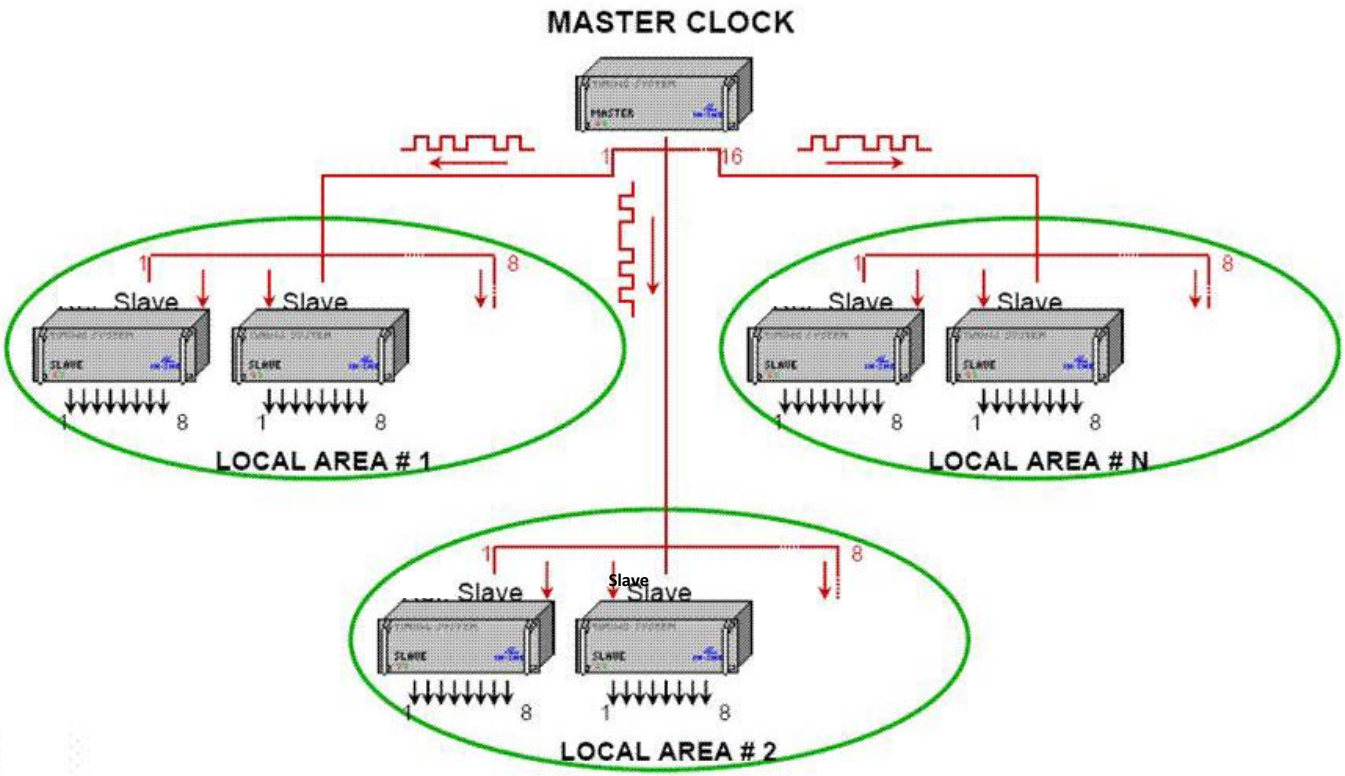
Major components of the LMJ Timing System

The LMJ Timing System is made of 4 major components :

- The Standard and High Precision Timing System (SHPTS) responsible for the Standard Precision Triggers and High Precision Triggers
- The Ultra-high Precision Timing System (UPTS) responsible for the Ultra-high Precision Triggers
- The Fiducial System responsible for electrical fiducials needed to mark laser and plasma diagnostics
- The Supervisory Components that offers GUI's necessary for system monitoring and management and a uniform API that allows client programs to create an manage "Synchronisation Groups"

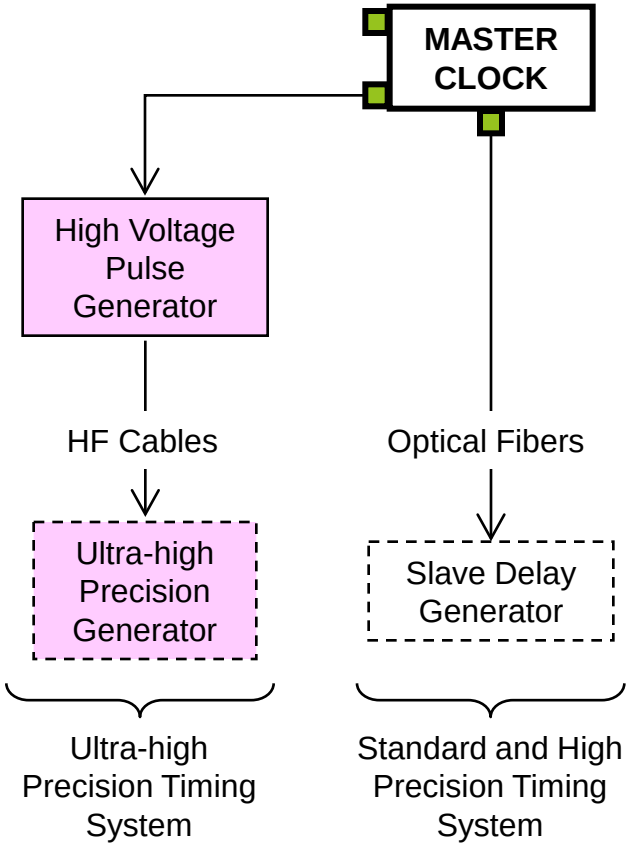
Standard and High Precision Timing System

- Standard Precision Triggers: ±1s, 150ps jitter, <2ns/week wander, ~2000 quantity
- High Precision Triggers: ±50μs, 15ps jitter, <20ps/week wander, ~80 quantity



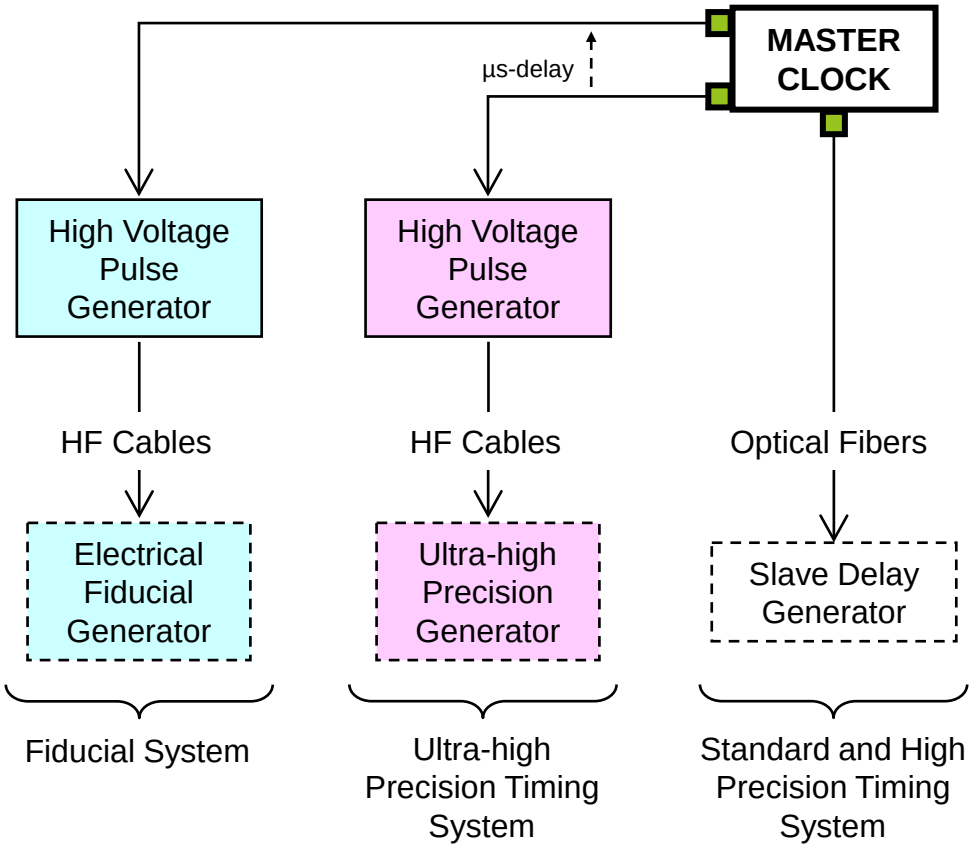
Ultra-High Precision Timing System

- Ultra-high Precision Triggers: ±50ns, 5ps jitter, <10ps/week wander, ~100 quantity

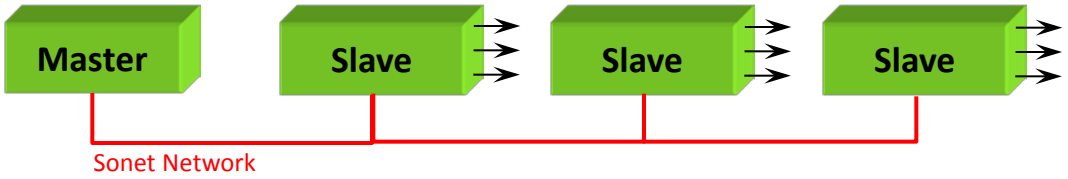


Fiducial System

- Fiducials: ±50ns, 5ps jitter, <10ps/week wander, ~200 quantity



Supervisory components Architecture



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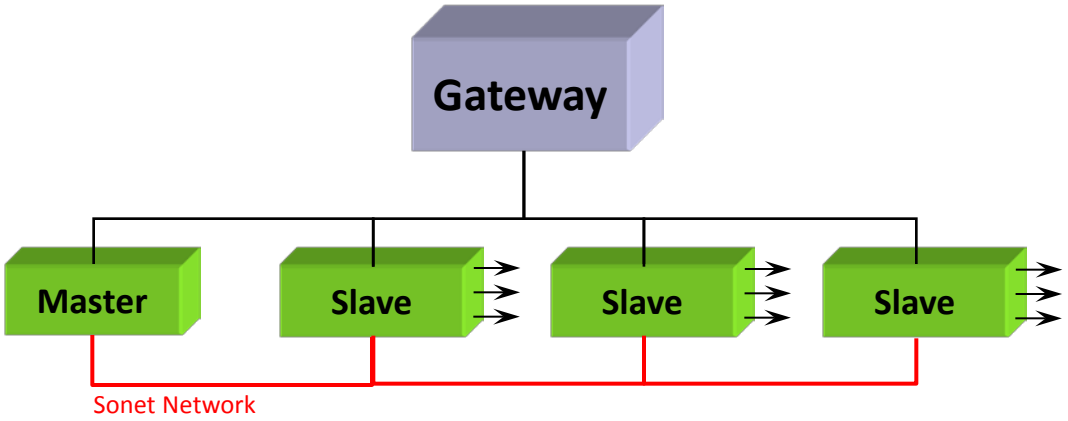

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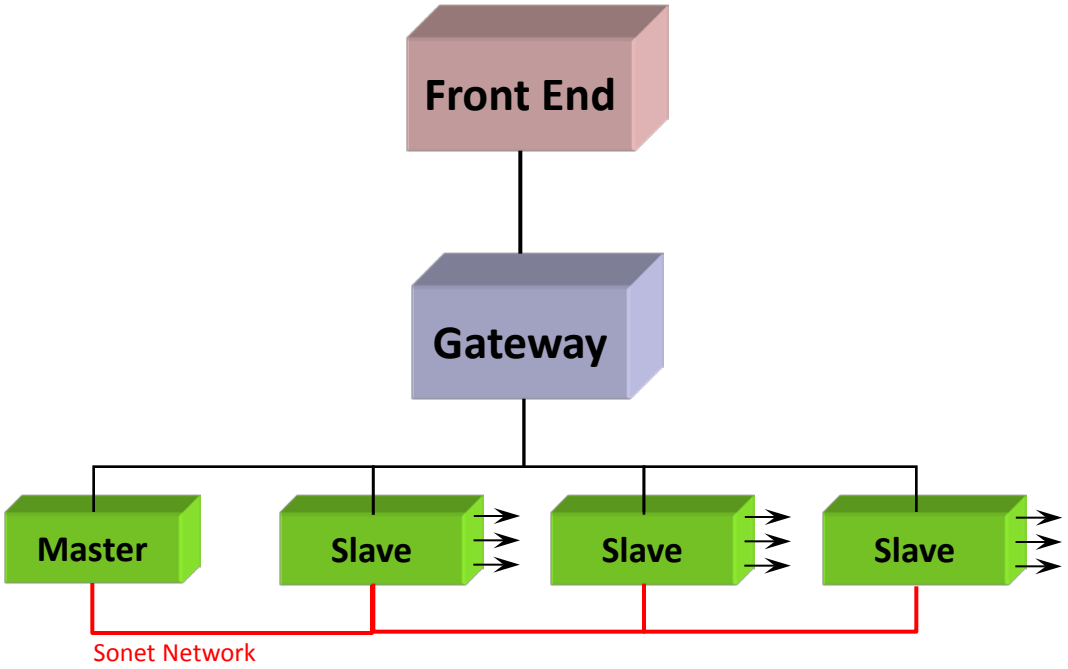

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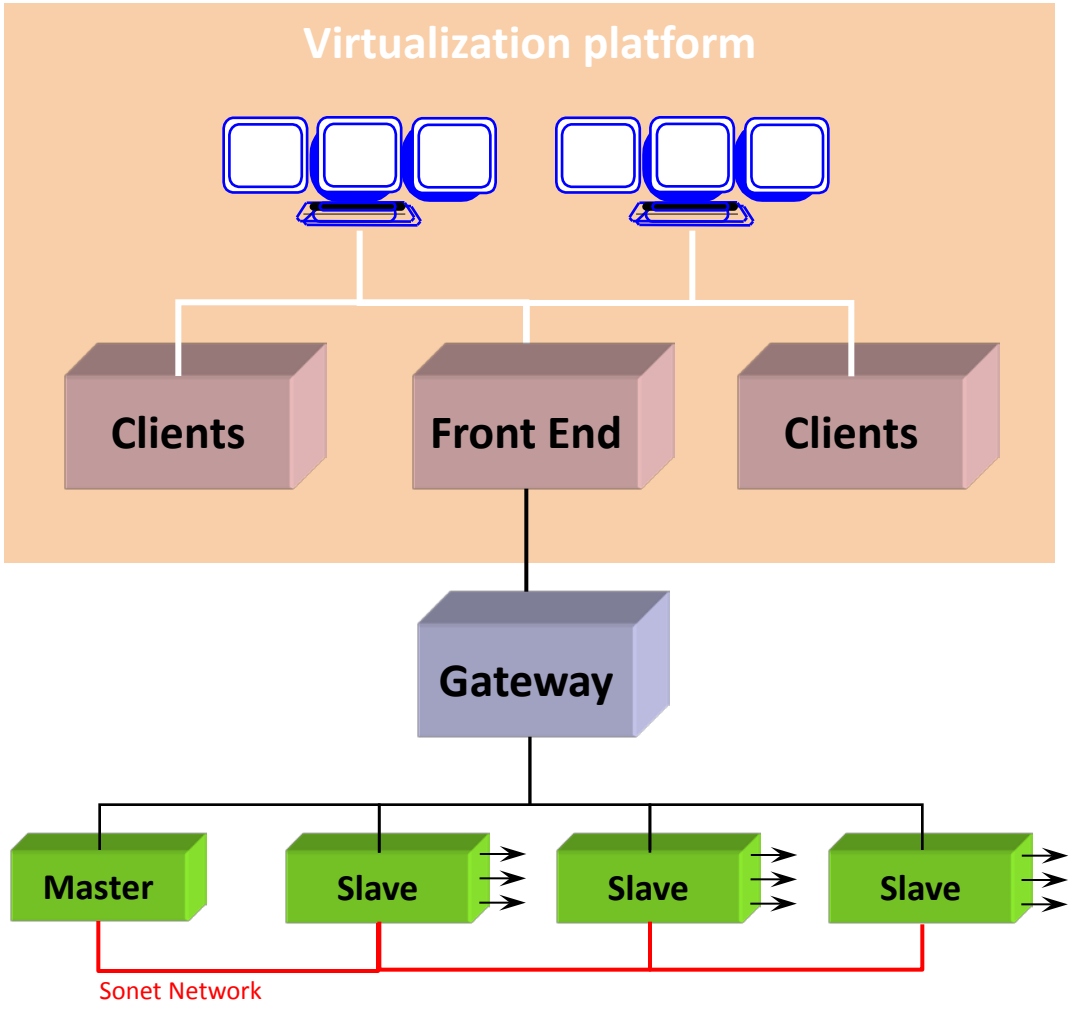

Supervisory components
The Timing System Gateway

A PC under Windows 7 with 2 roles:

- Acts as a communication gateway between Timing System devices and the Supervisory Front End
  - Masks protocol heterogeneity between different kinds of Timing System devices used: LIL master/slaves, LMJ master/slaves, UPTS devices, Greenfield GFT series devices
  - Polls devices to maintain a table of device status made available to the front end
  - Communicates with the Supervisory Front End using a TCP/IP socket protocol
  - The Supervisory Front End can load/read gateway configuration files, read results, start/stop devices, configure device channels (triggers or fiducials) and read device status
- Translates the user delays to raw values entered to delay generators
  - User clients give delays in ps from Target T0 to the output of the delay generator
  - The Timing System Gateway translates these values into raw values for delay generators using the content of a configuration database giving propagation delays into the components of the timing system : master, slaves, fiber optic cables
  - Slaves temparature is taken into account in this calculation

Supervisory components
The Timing System Front End

- A set of virtual machines under Windows 7 running a supervisory application that interacts with the operators and other LMJ Subsystems Clients
- This application is made with the framework used by all other LMJ Subsystems and and based on the PANORAMA industrial SCADA (CODRA)
- Other LMJ Subsystems Clients are typically Sequence Programs that need to trigger synchronously a set of channels (triggers or fiducials)
- Sequence Programs could be the Master Shot Sequence or Subsystems Sequences of the Power Conditioning, Alignment, Laser Diagnostics, Target Diagnostics Subsystems
- Multiple Sequence Programs using the Timing System Front End can be run simultaneously
- Clients interacts with the Timing System Front End using an API called Timing System Services

Supervisory components
The Timing System Services

- Timing System Services are offered by the Timing System Front End as a WCF API
- Timing System Services are based on the concept of Group : a Group is a set of channels that are trigged synchronously
- Inside a group, channels can be configured to be triggered on command or repetitively at 0.1 Hz, 1 Hz, 10 Hz, 100 Hz
- Using the Timing System Services API a client can :
  - Create groups
  - Add or remove channels to/from a group
  - Configure channels delay and recurrence
  - Activate or deactivate groups, making them available for being triggered or not,
  - Trigger groups

Conclusion

- The Timing System under development on the LMJ will be able to synchronize laser quadruplets on the target within the requested 40 ps rms

- It is based on three subsystems able to manage:
  - 2000 triggers ranging from 150 ps rms jitter to 15 ps rms jitter,
  - 100 ultra-high precision triggers with 5 ps rms jitter
  - 200 fiducials with 5 ps rms jitter

- The supervisory subsystem will allow multiple clients to simultaneously create, configure and trigger set of channels synchronously in a concurrent environment.


Photo : Eric Journet
Thank you for your attention…