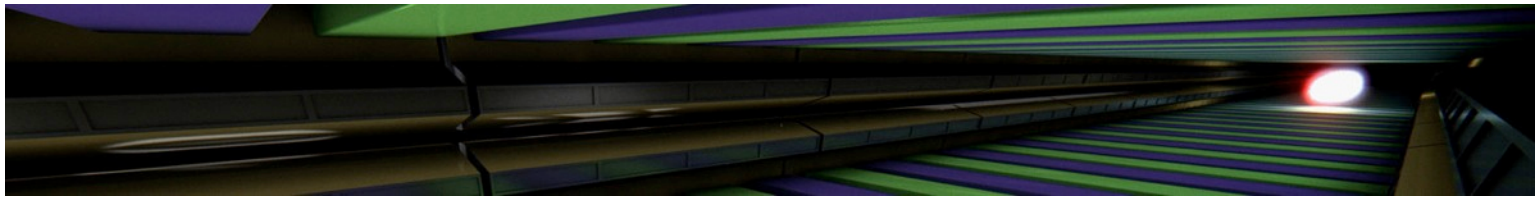
European XFEL



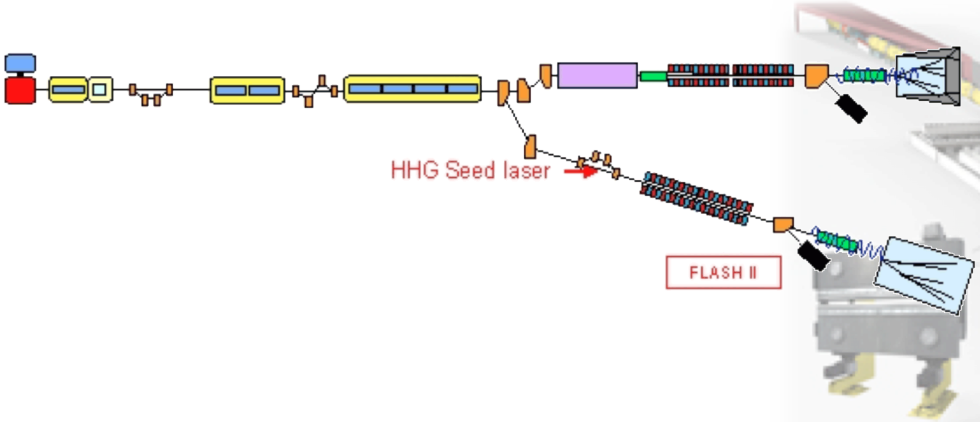
XFEL-MPS

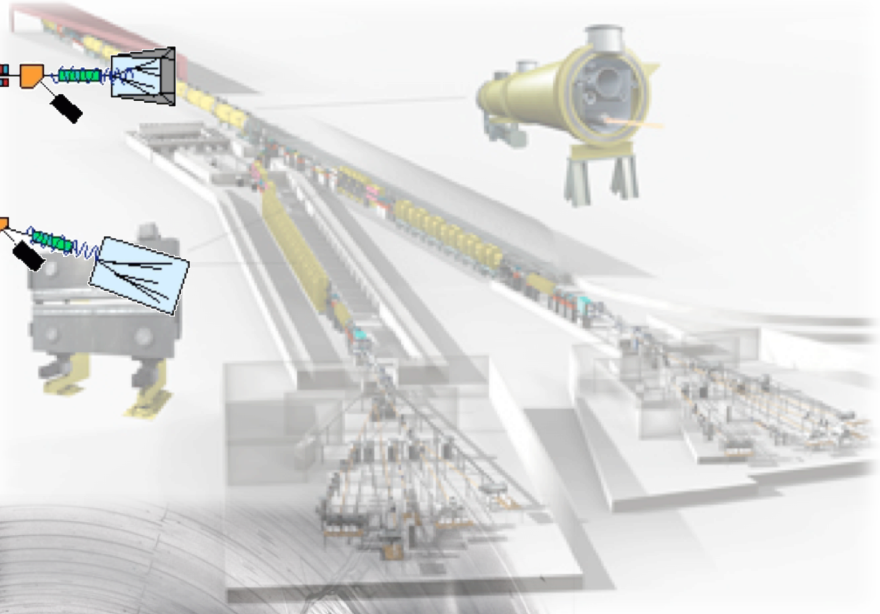
Machine Protection for XFEL and FLASH II

PLC Workshop Lund, 29.-30.08.2013

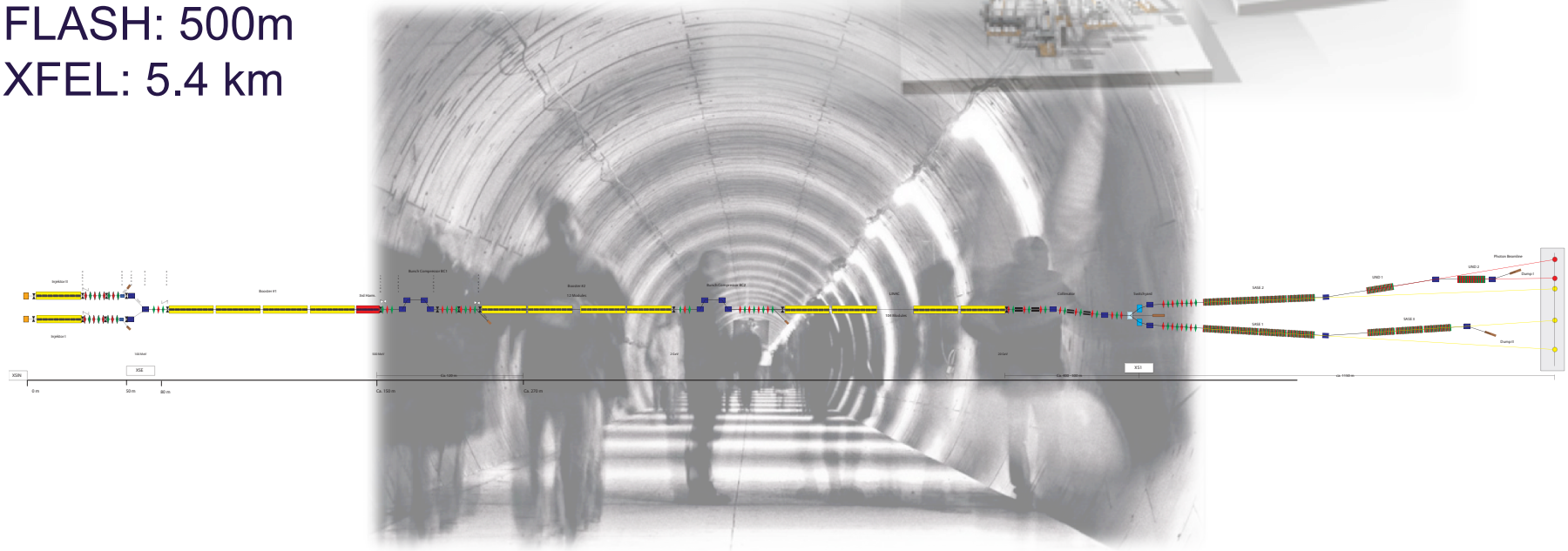
European XFEL

FLASH 2 and XFEL accelerators





Overall length
FLASH: 500m
XFEL: 5.4 km



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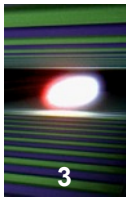
Why no PLC for MPS in XFEL and FLASH2?



- Speed
- Same technology everywhere in XFEL
- Same Hardware
- Homogenous general concept
- µTCA technology
- Maintenance must be easy (µTCA advantages)
- No distinction between fast and slow inputs, same priority for all
- Remote FPGA maintenance via IPMI bus (I^2C) or PCIe

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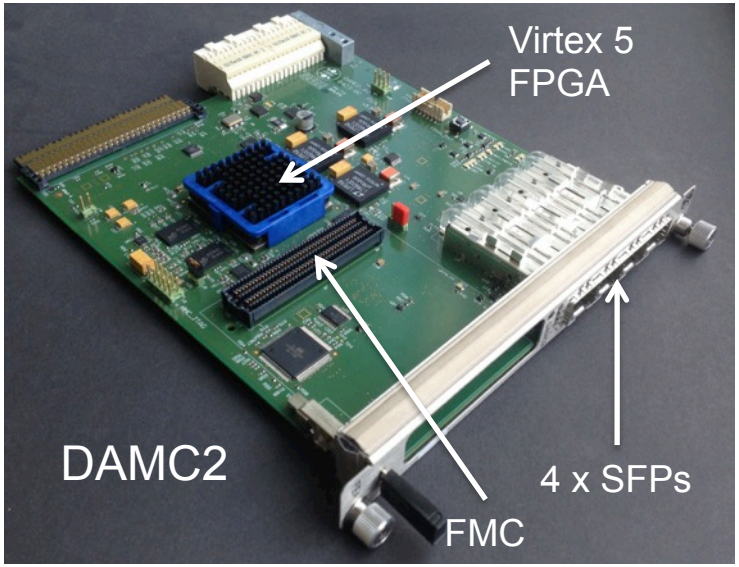
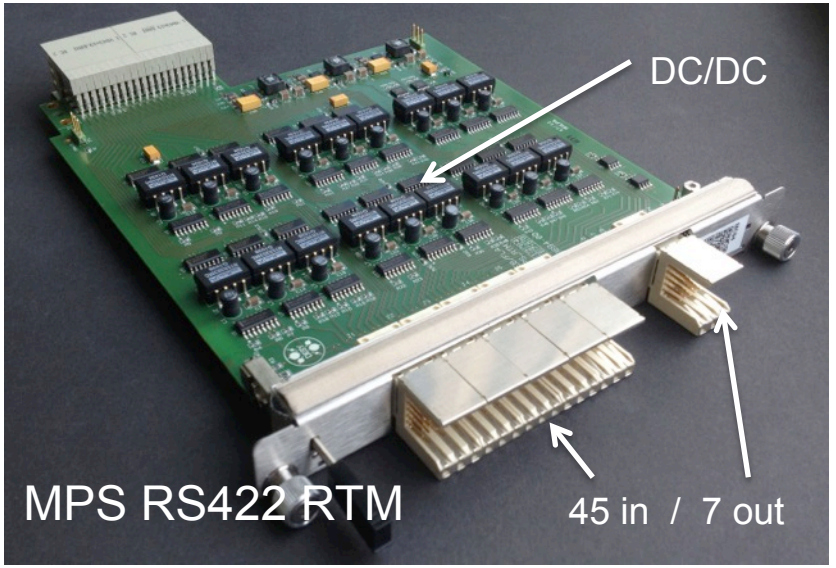
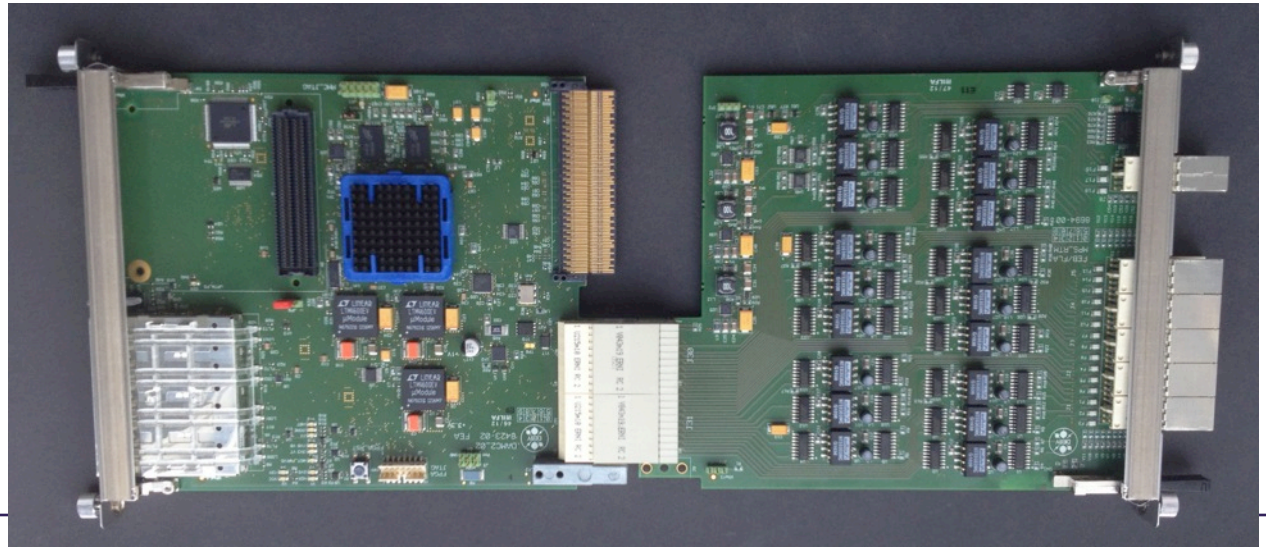
µTCA components







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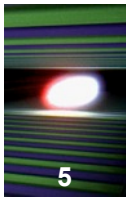
Global MPS features at DAMC2



- Scalable
- same firmware in every DAMC2
- Every DAMC2 slave holds all information of all prior connected slaves (debugging)
- Every slave can be connected to the timing system
- Configurable – NOT programmable
- Every slave can be hold one I2C driven FMC Dosimetry board
- Stand alone system, independent from control system
- Calculation of thresholds (analog / digital) are done outside MPS in connected systems

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General MPS features at DAMC2

- 45 RS422 external input channels, 100 ns min. alarm signal length
- 3 internal input channels for FMC and Backplane alarms
- 7 RS422 output channels
- I2C support to FMC
- 4 SFP I/O fiber optic lines (0-4 Inputs, 0-4 outputs)
- Addressable up to 64 Sections, each equipped with 64 DAMC2 MPS modules
- Fast internal RS422 link from in- to outputs
- Debug Register
- LED status indicator (heart beat, server connection, initialization)
- Settings checked by DOOCS server

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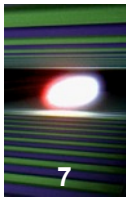
Input Channel MPS features



- Options for each input channel:
  - Enable / disable inputs
  - Test input
  - Check functionality of connected systems between Macro Pulses
  - Pulse counter within a given time, both configurable
  - Beam Mode generation
  - Section Pattern generation
  - Alarm Type generation
  - Save each Alarm into DOOCS history

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Output Channel MPS features

- Options for each output channel:
  - Enable / disable
  - Test output
  - Fast output line configuration on same DAMC2 board
  - Save each action into DOOCS history

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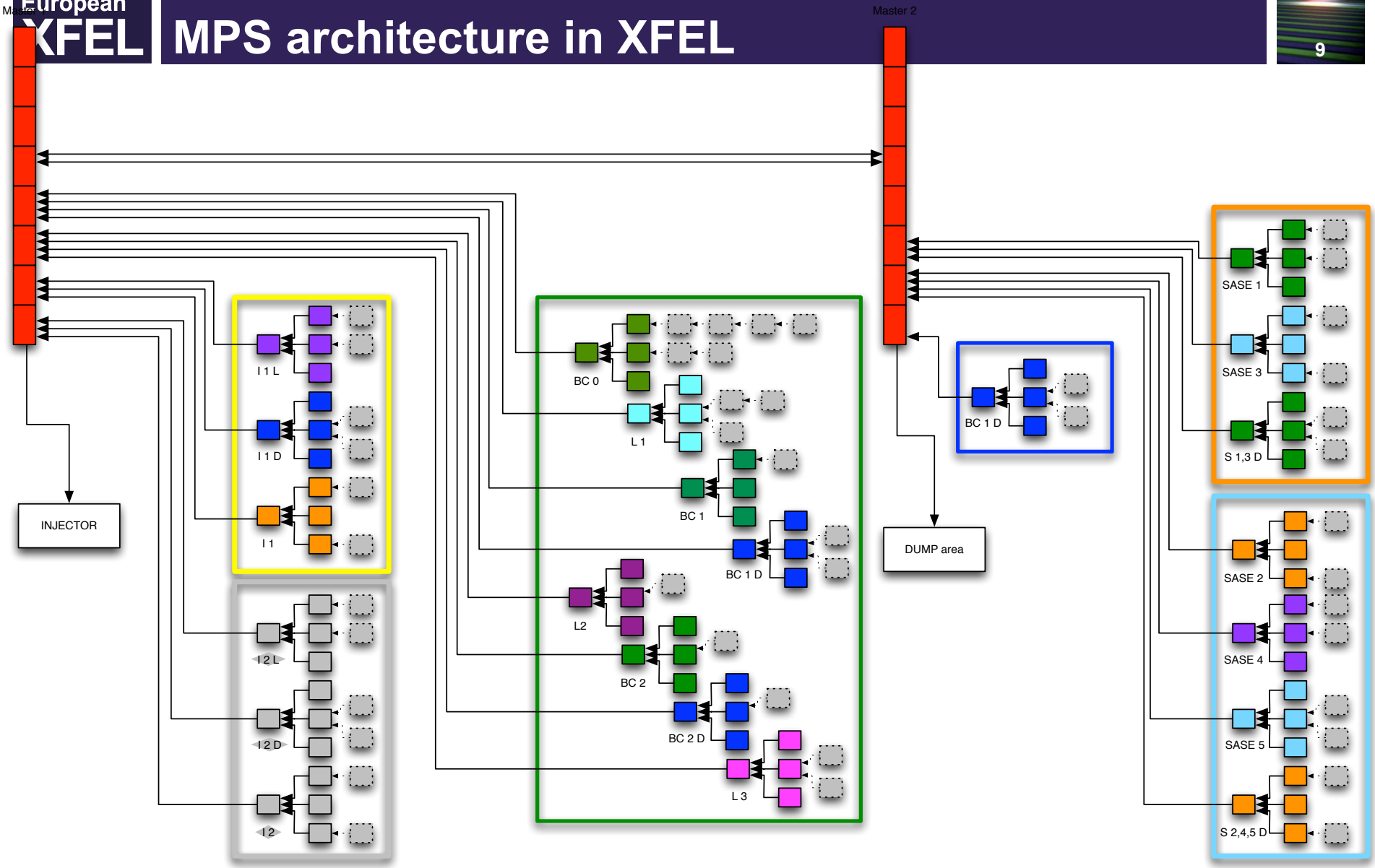
MPS architecture in XFEL



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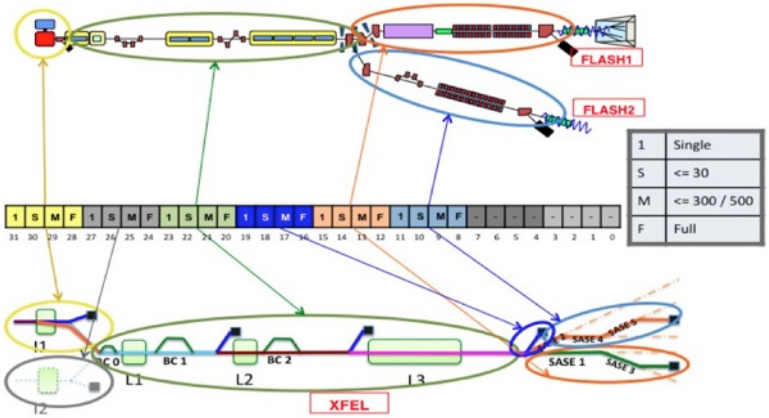
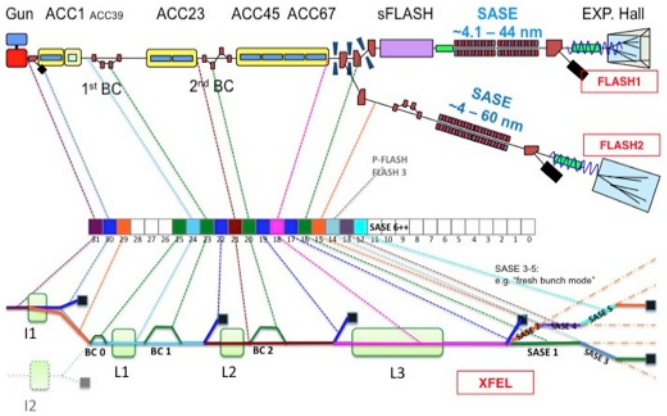
Information structures, protocol priority, pre-processing





Beam Modes

63-52						
Sec 63-58	Addr 57-52	51	50-48	47-40	39-32	31-0
FFF 12 (6+6)		P 1	CNT 3	spare 8 bit	ALARM Type 8 bit	BEAM Modes 32 bit

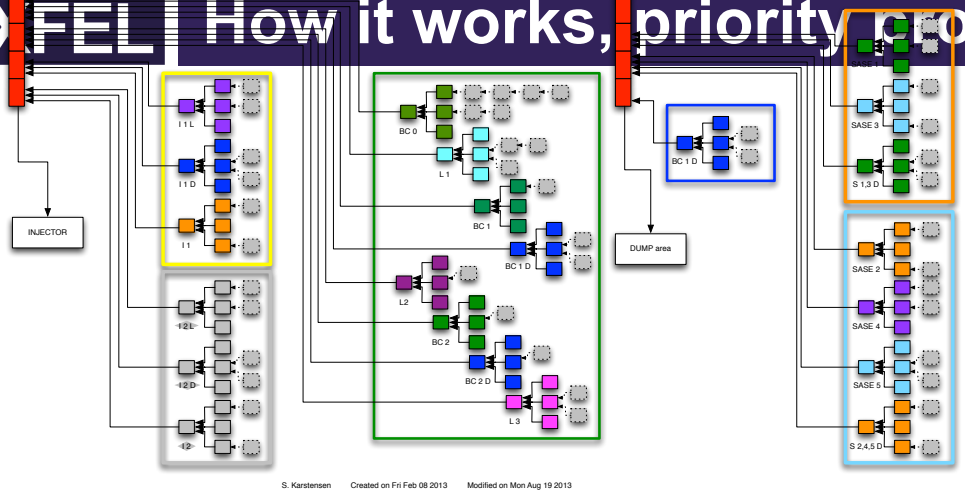
Section Pattern

63-52						
63-58	57-52	51	50-48	47-40	39-32	31-0
FFE 12 (6+6)		P 1	CNT 3	spare 8 bit	spare 8 bit	SECTION PATTERN 32 bit

Slave Info

63-52				
63-58	57-52	51	50-48	47-0
000 - FFD 12 (6+6)		P 1	CNT 3	single SLAVE information 48 bit

European XFEL How it works, priority protocols

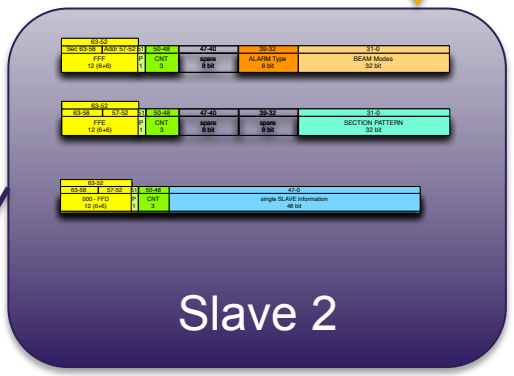


1.) Beam Modes **very high**

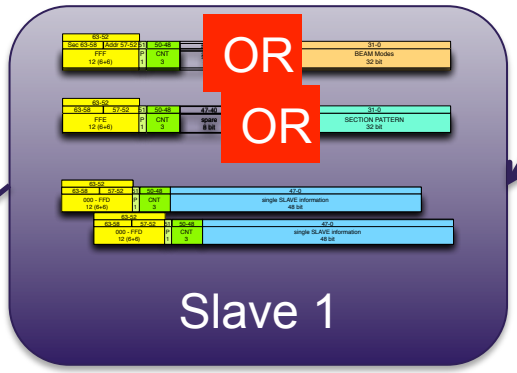
2.) Section Pattern **high**

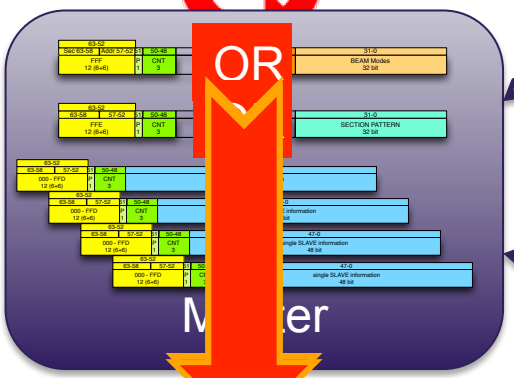
3.) Slave info **low**

Alarm

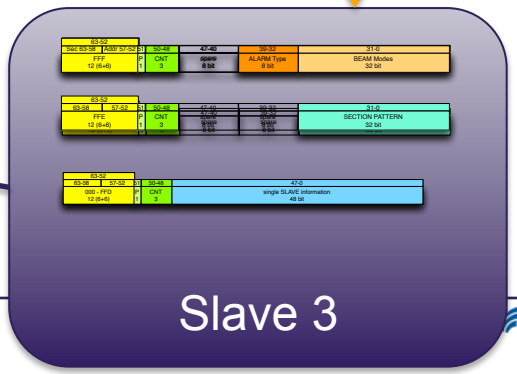


timing





Alarm



ALARM out

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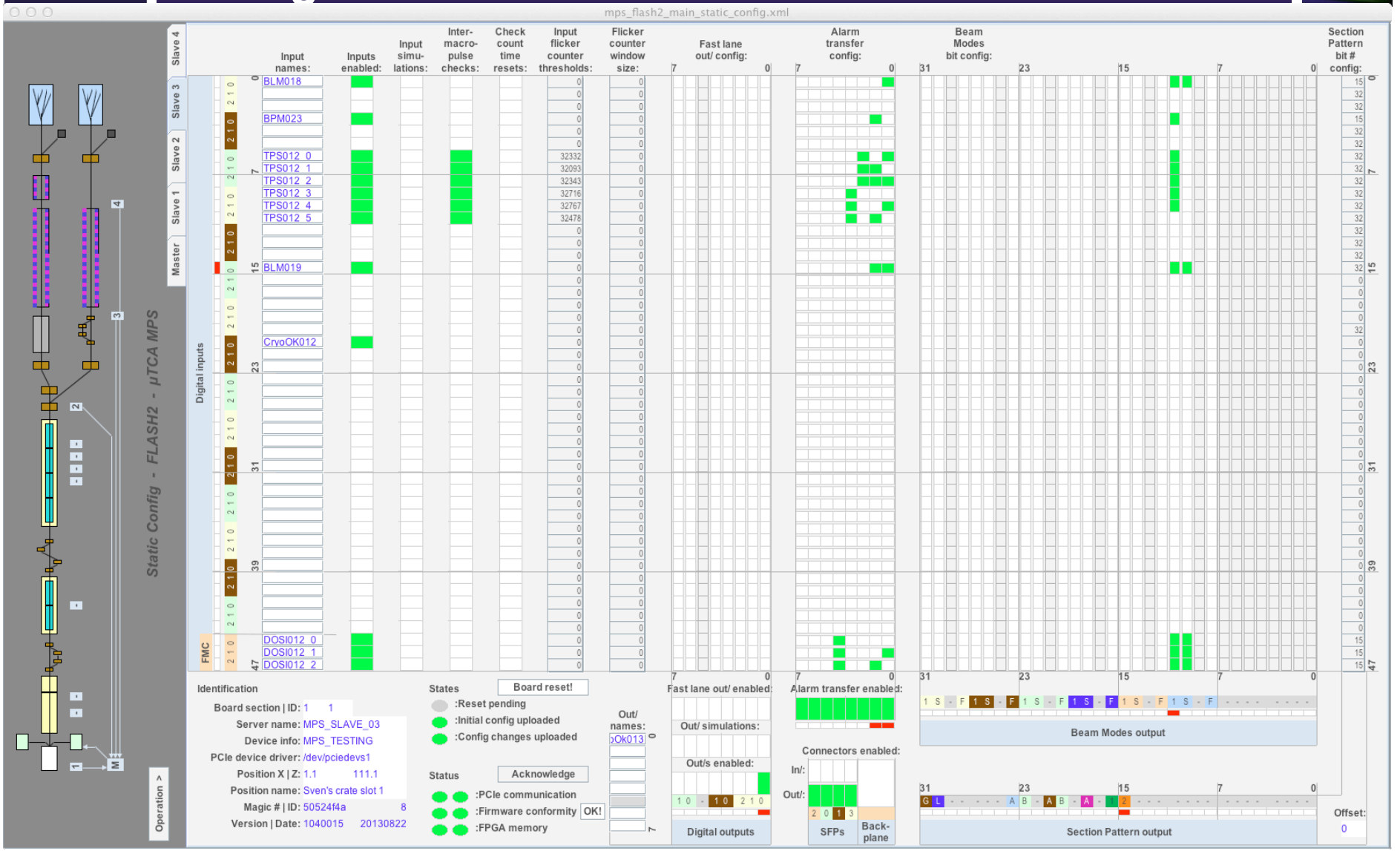
Configuration Panel for FLASH 2



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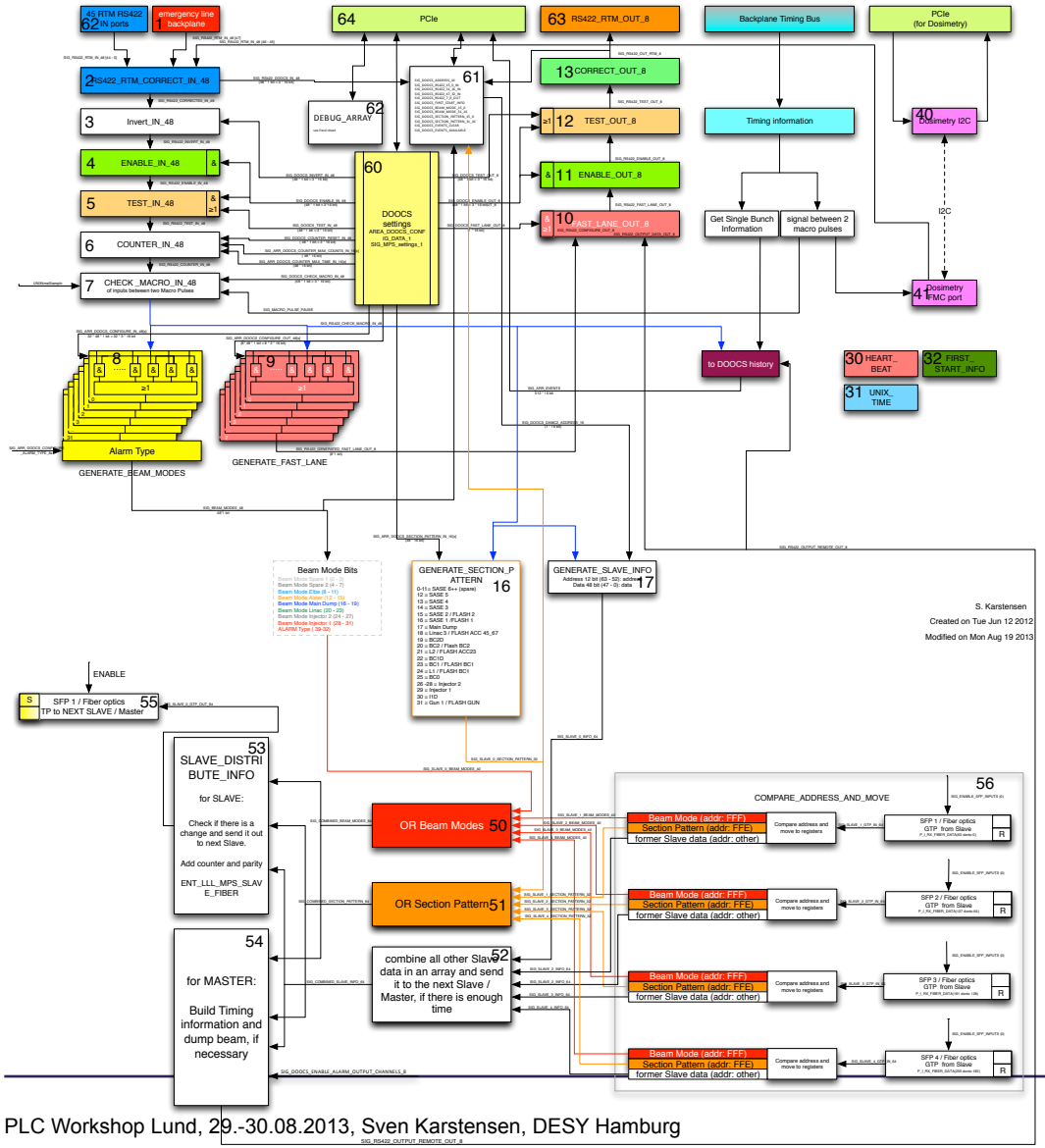
MPS program architecture

MPS SLAVE structure

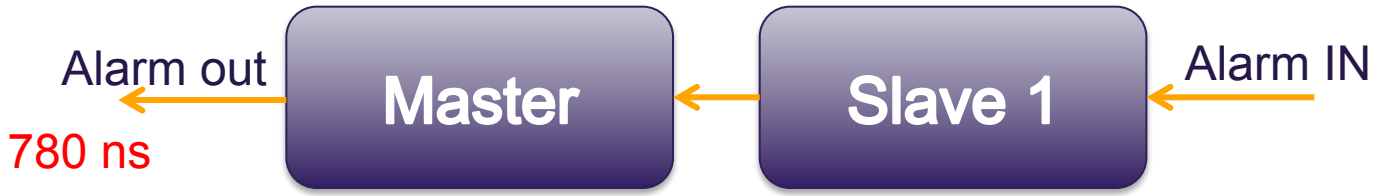


- Numbers in drawing corresponding to chapters in FPGA code
- Excel Sheet includes all addresses

Latency (August 2013)

Fiber optics: unattended (5 ns/m)
Speed: 1.25 GBps

Latency between Master and Slaves will be improved.
Factor 3 is aspired.



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Reaction Times in XFEL

Beam loss location	Distance from injector	Distance from dump	# of lost bunches
Injector	0 m	-1970 m	0
BC1	160 m	-1810 m	7
BC2	360 m	-1640 m	15
Linac center	1040 m	-930 m	44
Linac end	1650 m	-320 m	69
Beam distribution	2010 m	40 m	2
Last undulator	3010 m	1040 m	44

- ~ 50 bunches are inside accelerator
- Signal transport from dump to injector 20 µs (2000m)
- ~ 50 bunches generated before laser is blocked
- Using beam dump kicker reduces the number of lost bunches inside SASE undulator sections.

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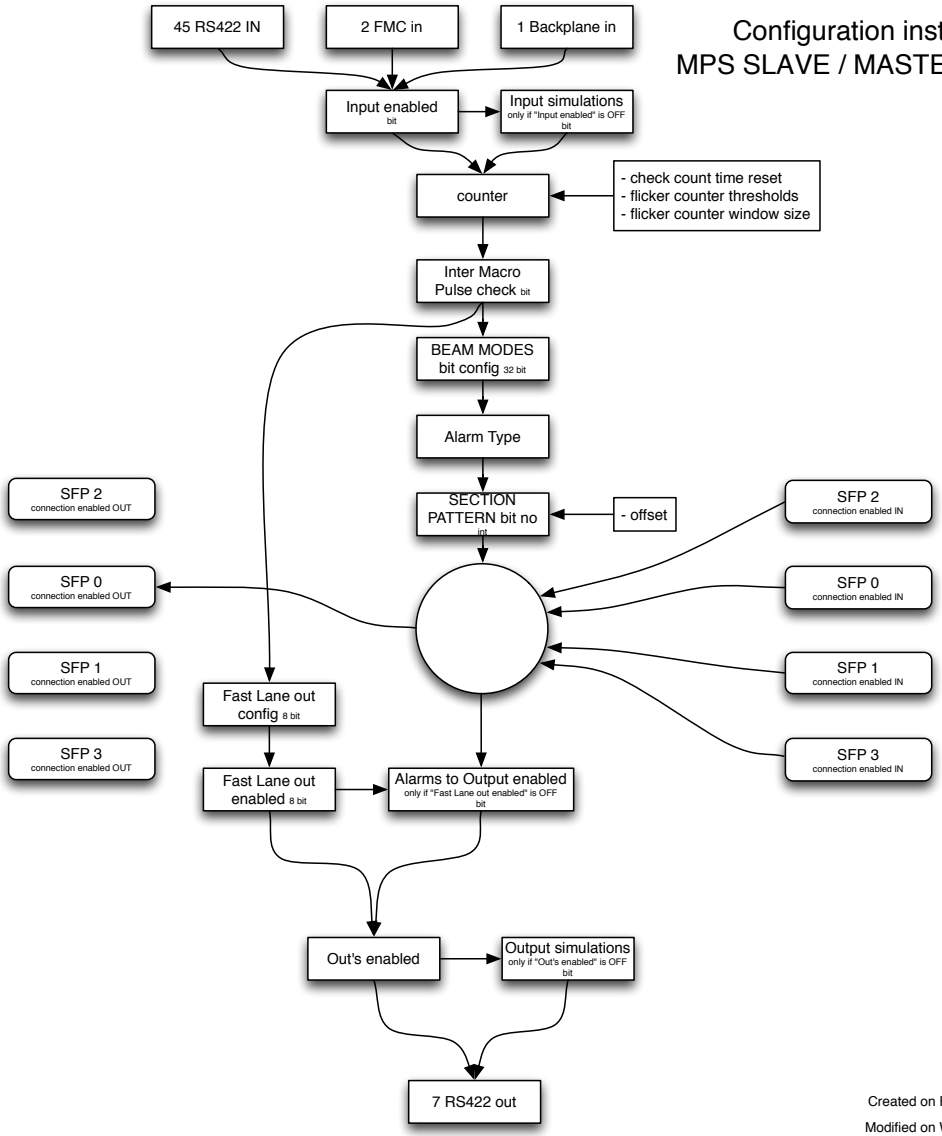
Configuration Instruction

Configuration instruction
MPS SLAVE / MASTER flowchart



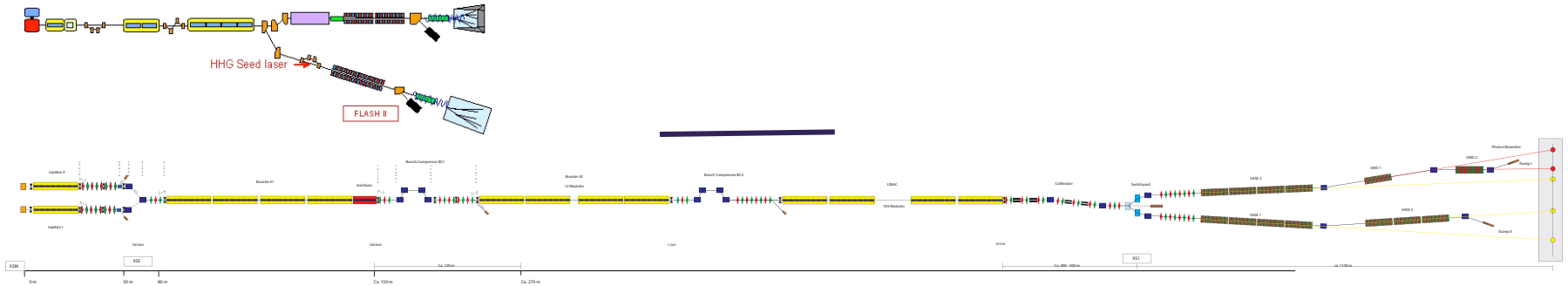
S. Karstensen
Created on Fri Aug 23 2013
Modified on Wed Aug 28 2013

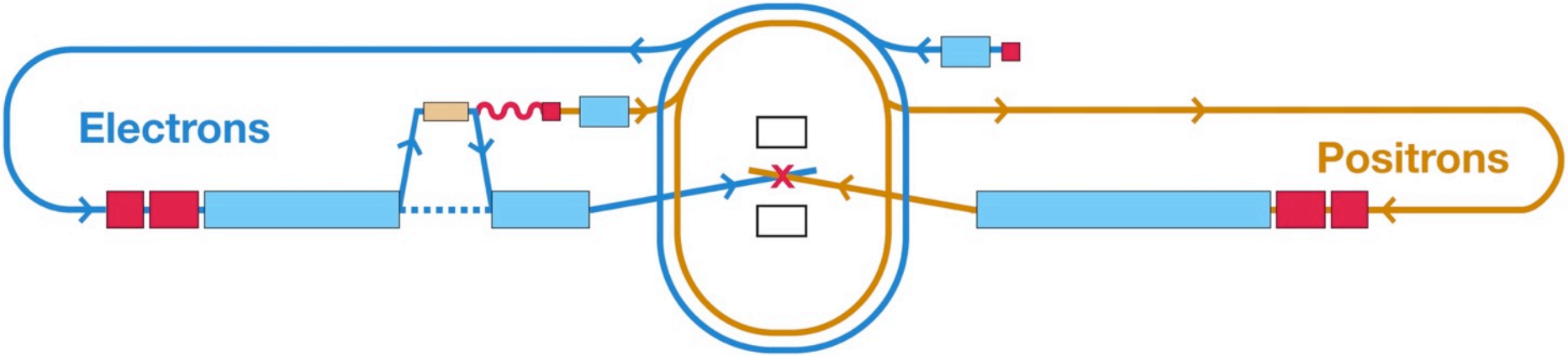
DESY HELMHOLTZ ASSOCIATION

European XFEL

FLASH II, XFEL, ILC

- scalability





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Thank you