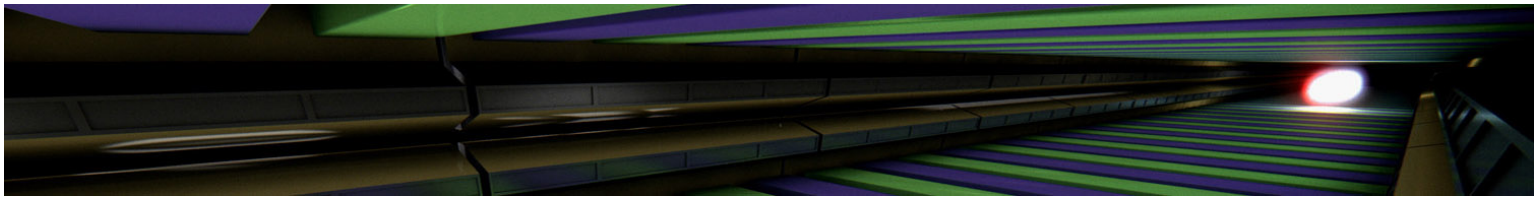
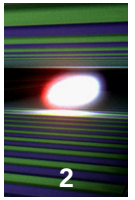


# The Veto System

Alexander Kaukher

European XFEL, WP-75

# Motivation

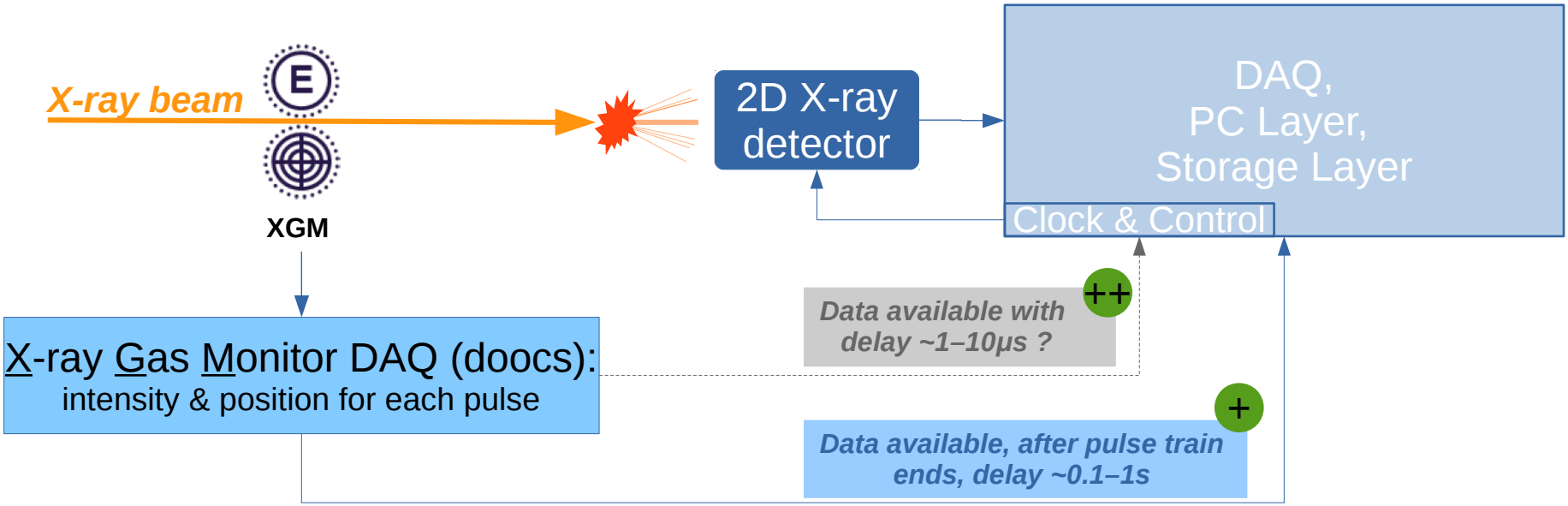


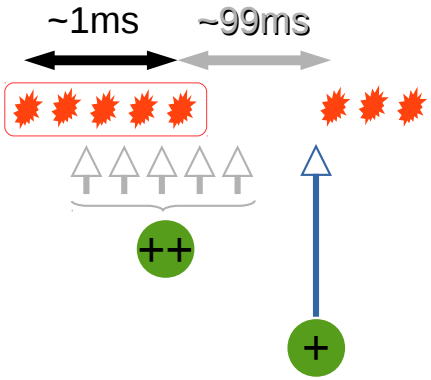

- Record data if experimental conditions fulfilled
  - X-ray beam has proper intensity, position, ...
  - Sample in place, ...
    - ➔ Provides *additional* mechanism to discard „garbage“ data

- Number of images acquired by fast 2D x-ray detectors:
  - AGIPD → 352 images, DSSC → 800, LPD → 510
    Some XFEL experiments would profit from larger number of acquired images

# Example: X-ray Beam Intensity






+ = Potential to discard unnecessary" data

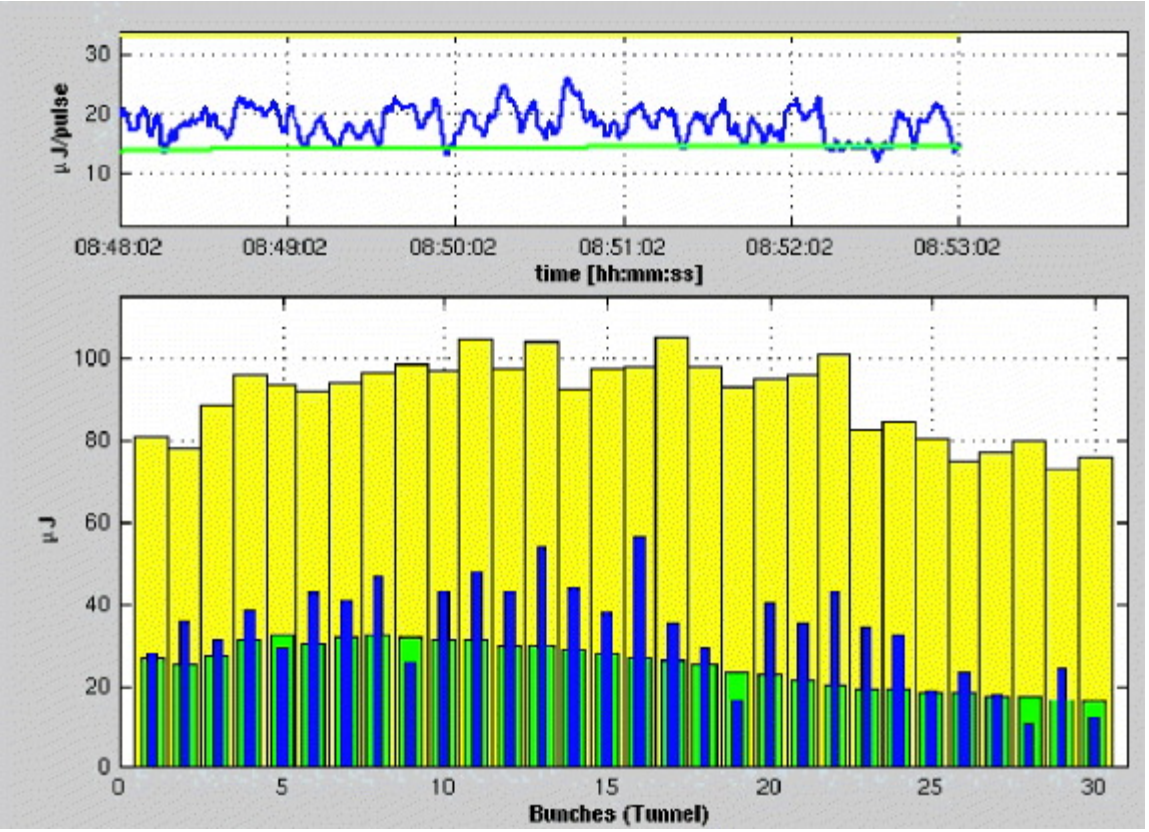
++ = Potential to discard unnecessary" data **and** reuse some detector's memory

# Example: X-ray Beam Intensity



- In the case X-ray intensity drops below a predefined threshold – discard data (... for the rest of the pulse train ?)

  User defines the threshold in advance




Data from Gas Monitor Detector (*FLASH*)
New J. Phys. 11 (2009) 023029

"... the blue bars represent the pulse energy (in µJ) of each bunch of the actual bunch train

(yellow bar =maximum value, and

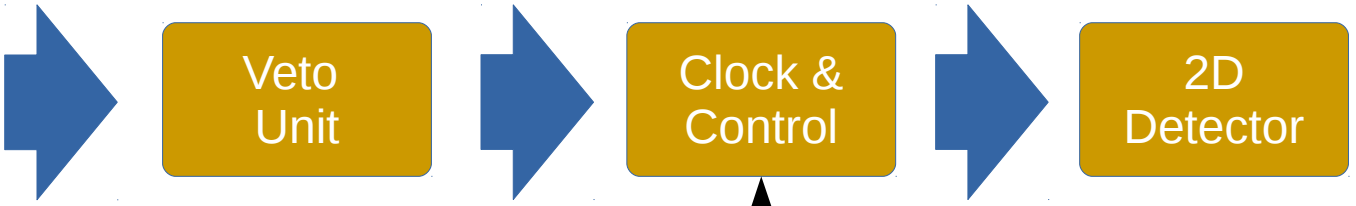
green bar = averaged for the respective bunch since start of averaging)."

# Candidates for veto sources



**XGM**
**PES**
**HIREX (Gotthard2)**
**e-TOF**
**i-TOF**
**MCP detector**
**...**

DAQ with a digitizer + FPGA (peak finding, etc.)




*if $I_0$ < ? ,*
*and if*
*i-TOF[protons] = false*
*and*
*...*
*then → reject data*

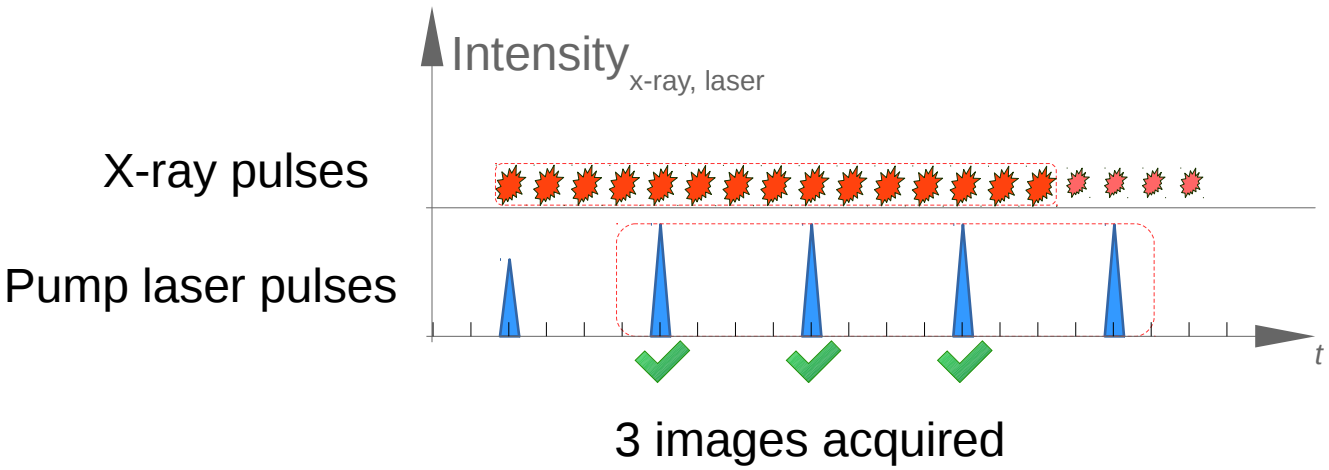
XFEL timing

- User defines a threshold on $I_0$, ...

# Example: Select X-ray Pulses of Interest



- User defines a pattern of x-ray pulses of interest

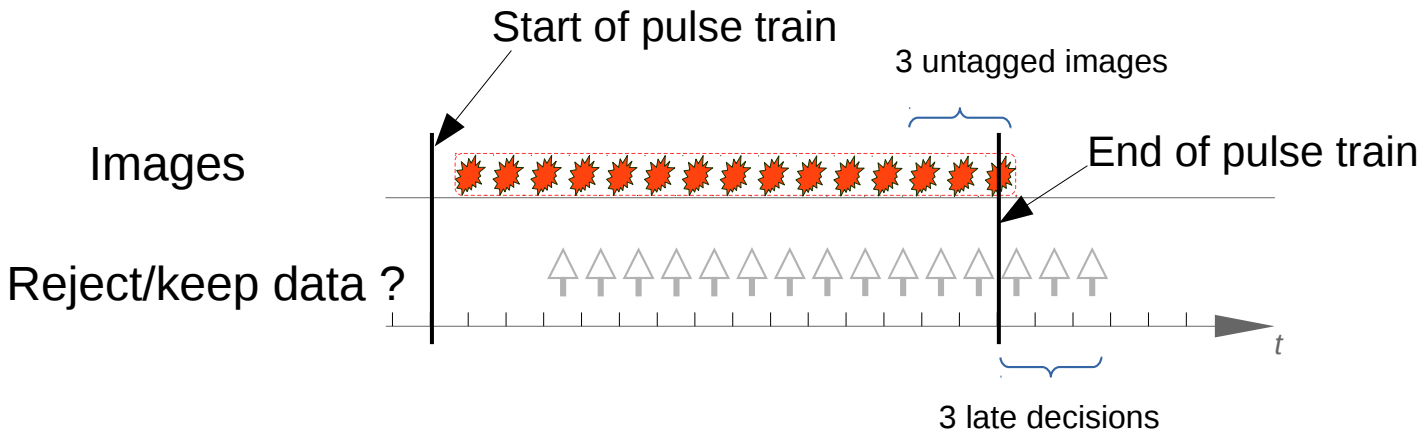



  - The pulse selection pattern can be stored in Clock&Control Module
    - ➔ “decisions” of lowest latency

# Clock&Control → Detector Interface

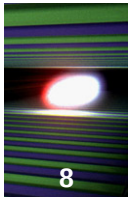


- Late arriving decisions do not contribute to reuse of detector's memory



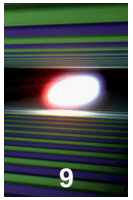

- Latency should be as low as possible

# Summary




- *The Veto System* has a potential to increase amount of data acceptable by users
- Requires input from users
- The latency should be kept as low as possible to increase effective number of images acquired with a 2D detector
- XGM is expected to be the first example for data rejection

# Spare slides



# Acquisition Rate Reduction at SPB/SFX



- Estimated acquisition rates (L. Chavas, CFEL):
  - 22-125 kHz (20 µm Rayleigh jet)
  - 500-670 kHz(6 µm Gas-dynamic jet)

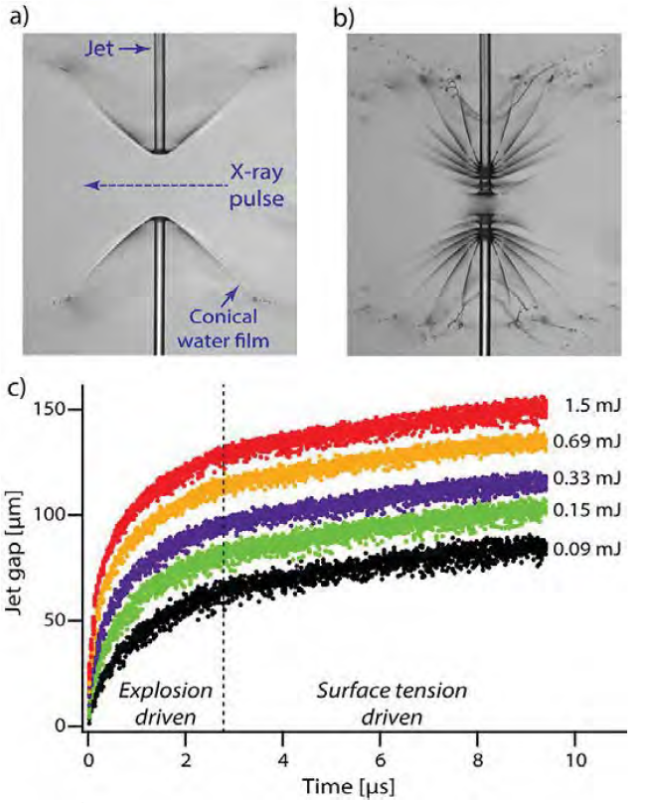



Fig. 3 a) A 20-µm water jet, 3 µs after absorption of a X-ray pulse focused to 1 µm. The gas from the explosion pushes the liquid from the jet into a thin film. b) Overlaid images of the jet at 75 ns, 235 ns, and 1, 2, 3, 4 and 5 µs. c) Jet gap growth. During the explosion-driven phase the gap grows logarithmically with time, and the gap size at the end of this phase scales logarithmically with the pulse energy. These dependencies show that the expansion of water vaporized by the X-ray pulse is approximately self-similar.

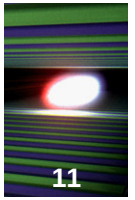
**NPI: Non-Periodic Imaging**

Claudiu A. Stan et al.

*Atomic, Molecular, and Optical Sciences Research Meeting, Bolger Conference Center Potomac, Maryland October 26–29, 2014*

http://science.energy.gov/~/media/bes/csgb/pdf/docs/Atomic Molecular and Optical Services/Atomic_Molecular_and_Optical_Sciences_Research_Meeting_2014.pdf

# Other Thoughts




## Vetoing Events for FEL Experiments Can Be Tricky

SLAC

- **Very hard to implement effective trigger/veto system**
  - Not strictly a technical issue: the ability to veto events is already implemented in the system
  - Vetoing based on beam parameters not effective (most pulses are good)
  - Hard to get help from users in setting veto parameters which define event quality
    - Users themselves often don't know what these parameters or their thresholds should be
    - Users are usually very suspicious of anything which can filter data on-the-fly
    - Things may get better as algorithms mature
- **Benefit of vetoing events based on the event data is potentially very large for some experiments**
  - Factor 10-100 for some CXI imaging experiments
  - Many experiments, though, have hit rates close to 100%

Amedeo Perazzo
SLAC