DAQ for Oxygen operation

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Discussion points

- Self trigger mode (Op2022) / Fast clear mode (Op2015) ?
  - Depending the noise

- DAQ Speed-up

- FC modification as Arm1 new FC

Event Rate Estimation

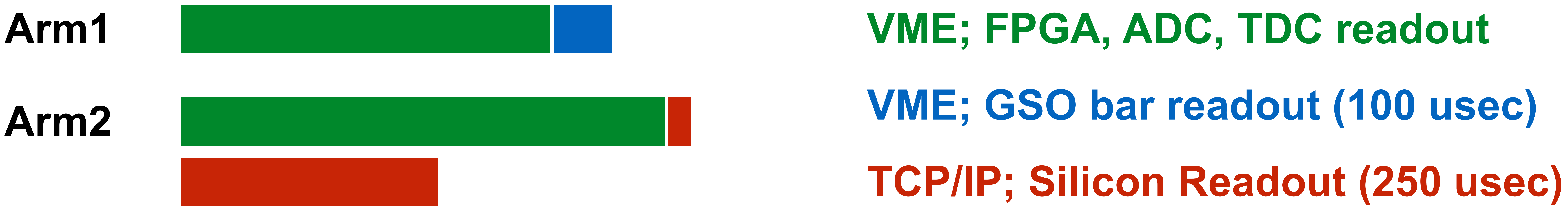
- Operation Condition
  - Beam condition : 1 bunch per train, the number of trains is 50 ?
  - Collision per bunch crossing μ = 0.01 (2015 operation), 0.03 (2022 operation)
  - Acceptance (particle in LHCf per collisions) : ~ 0.2
- Event rate R,
  - Assuming μ = 0.01 and Nb = 50,
    R = 0.01 x 50 x 0.2 x 11.3 kHz = 1.13 kHz
  - Assuming μ = 0.03 and Nb = 50
    R = 0.03 x 50 x 0.2 x 11.3 kHz = 3.4 kHz

Self trigger mode or Fast clear mode ?

- If bunch spacing is more than 2 usec, we can use fast clear method like Op2015.
  - ADC gate opens every bunch-crossing, if no trigger, ADCs are fast-cleared
- The choice affects whether we need a signal delay or not.
  - clearly the signal delay increase the noise (pedestal fluctuation).
  - delay chip might be a source of 10% gain difference between Op2015 and 2022.
- Trigger logic for fast clear method is more complex than that for the self-trigger method.

DAQ performance at 2022 operation

- Readout of modules via VME and Silicon via TCP/IP was performed by a single process (frontend) in a computer.
- Maximum DAQ rate
  - Arm1 : 1.9 kHz (for pedestal trigger) → Readout time per event: 520 μs
  - Arm2 : 1.6 kHz (for pedestal trigger) → Readout time per event: 630 μs
- Readout time



Arm2 VME readout was slower than than of Arm1.
The reason could not be understood yet.
Maybe compatibility between the computer and the VME controller.

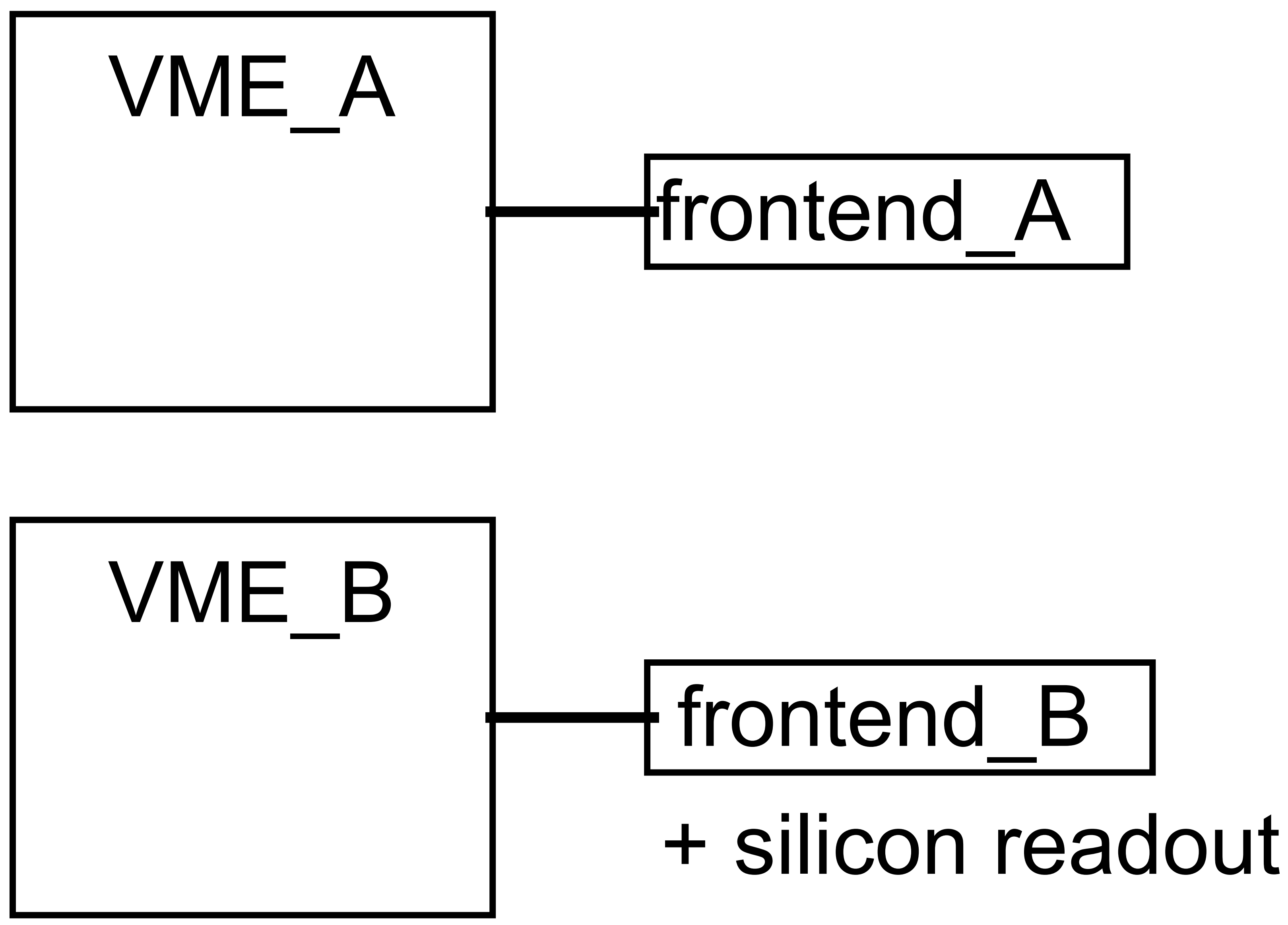
Three proposals of DAQ for pO

- Method used in Op2022
  - Maximum DAQ rate : 1.6 kHz → Operational rate **0.8** kHz
  - Robust.
- New method A) using parallel readout of two VME crate
  - Use the Arm1 VME crate and computer for parallel VME readout (two frontend)
  - Expected maximum DAQ rate : 3 kHz → Operational rate **1.5** kHz

- New method B) using event buffer in each module
  - Data store in the event buffer of each module and readout some events togethers
  - The dead time (only conversion time) per event can be reduced dramatically.
    - ADC module : conversion time, 10 μs ↔ readout time 100 μs
    - How about silicon ?
  - Expected maximum DAQ rate : 3 kHz → Operational rate **3** kHz (assuming two VME readouts)
  - Big technical challenge
    - Event ID in each module, readout control, busy control, etc

New Method A)

- Use the Arm1 VME crate and computer for parallel VME readout (two frontend)
- Expected DAQ rate
  - maximum DAQ rate : 3 kHz → Operational rate **1.5** kHz
- Feasibility
  - No big technical difficulty
  - Concern
    - Event matching between data from the two frontends (performed offline)

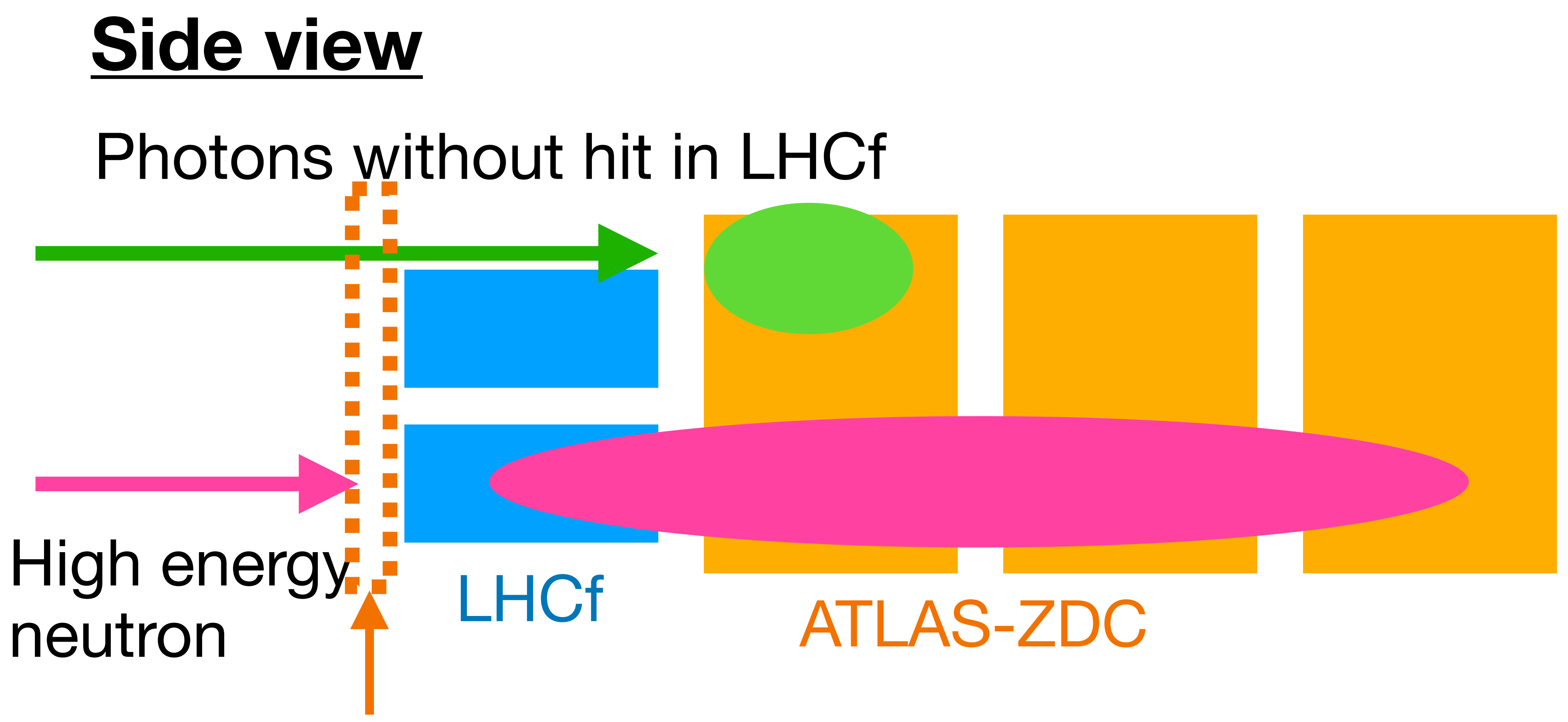


New Method B)

- Data store in the event buffer of each module and readout some events togethers
- The dead time (only conversion time) per event can be reduced dramatically.
  - ADC module : conversion time, 10 μs ↔ readout time 100 μs
  - How about silicon ?
- Expected DAQ rate
  - Maximum DAQ rate : 3 kHz → Operational rate **3** kHz (assuming two VME readouts)
- Feasibility
  - Big technical challenge
  - Event ID in each “module”, readout control, busy control, etc

New FC for joint operation with ZDC

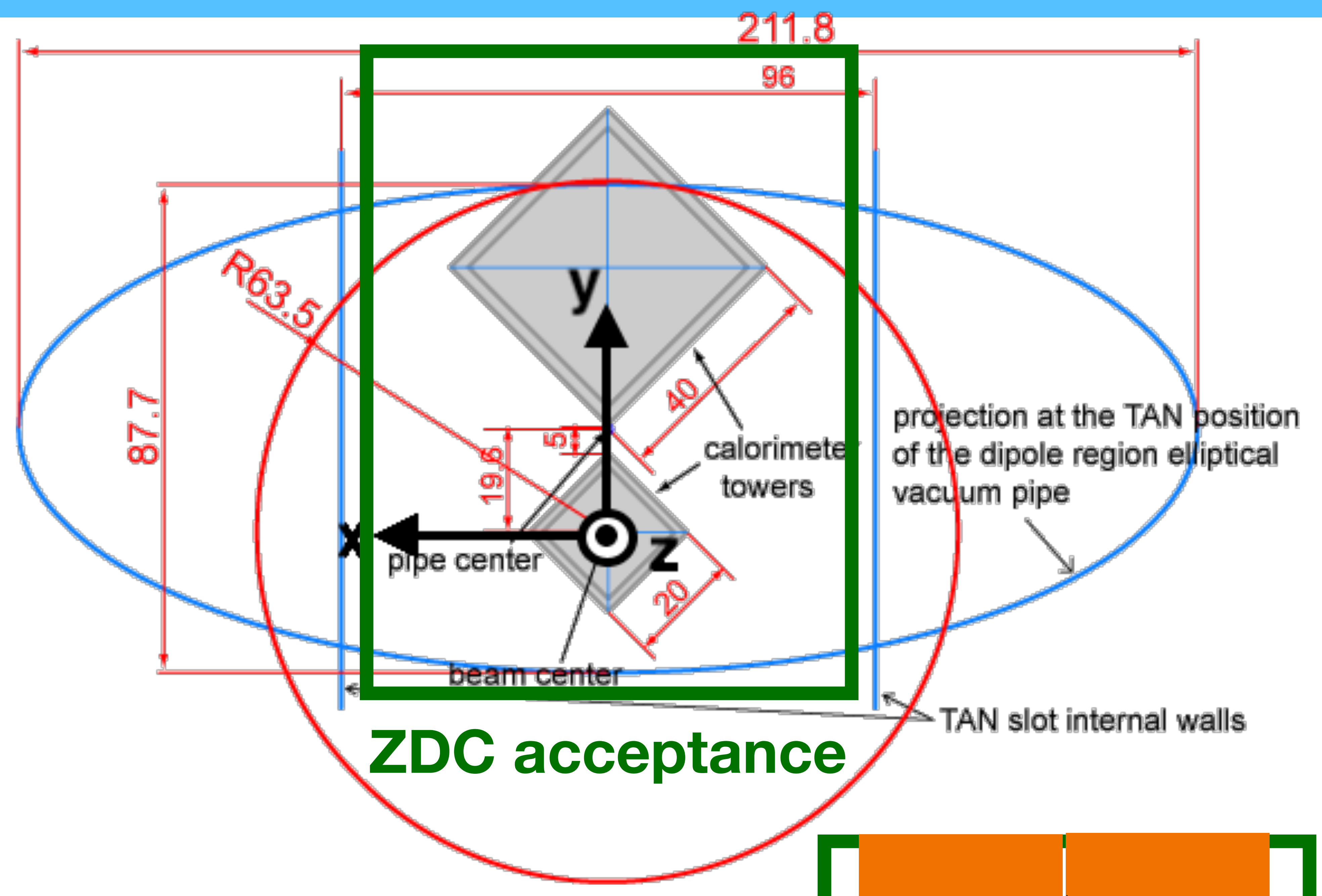
- New FC was introduced in the last operation. It was for better identification of additional particle incidents in ZDC but no hit in LHCf.
  → Important for event reconstruction using LHCf + ZDC
- Tag such addition hit in ZDC using scintillator covering only outer regions of Arm1 calorimeters.
- Install a new Arm2 FC or not
  - Advantage: ~ 30% identification of additional photons in ZDC
  - Disadvantage: loose own beam monitor
  - Concern: impact on the multi-hit identification on silicon



New Front Counter for Arm1

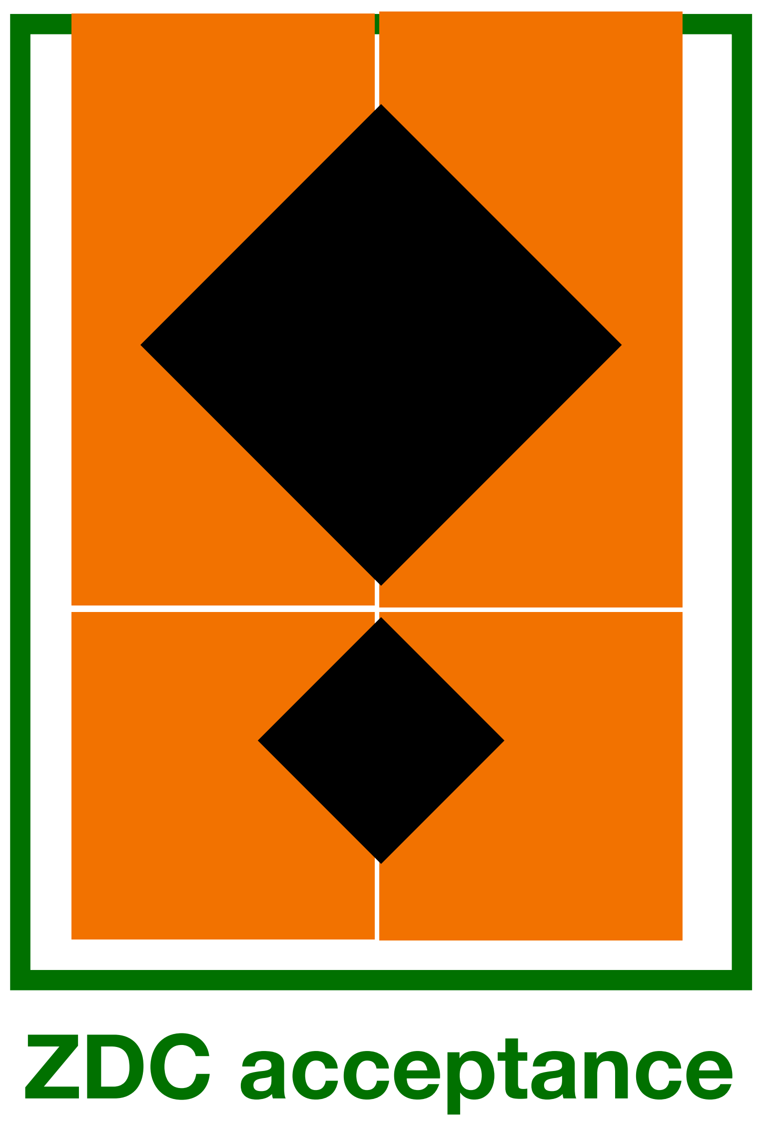
Motivation

- Differences in shape between LHCf detectors and ATLAS-ZDC detectors.
- Some particle without hit in LHCf can make an interaction in ZDC module.
- It is difficult to remove effects of these particles. A MC-driven correction can not be accepted by ATLAS without validation using experimental data.



Concept

- Tagging parts of photons without hit in LHCf but with hit in ZDC.
  - Prepare new front counter with 7mm ($2X_0$) tungsten plate and scintillator.
  - In left plot, orange area is covered by 7mm tungsten + scintillator and black area is covered by plastic plate (NO tungsten)
  - By tungsten plate, parts of high energy photons make an EM shower, and more than 20 MIPs signal is expected.
  - Target of tagging efficiency for photons : ~60% in active area.



Requirements

- Cost : ~ 800 k yen (5 k EUROs), not so much expensive
- Time : ~ 6 months

  Take time to produce the W plates