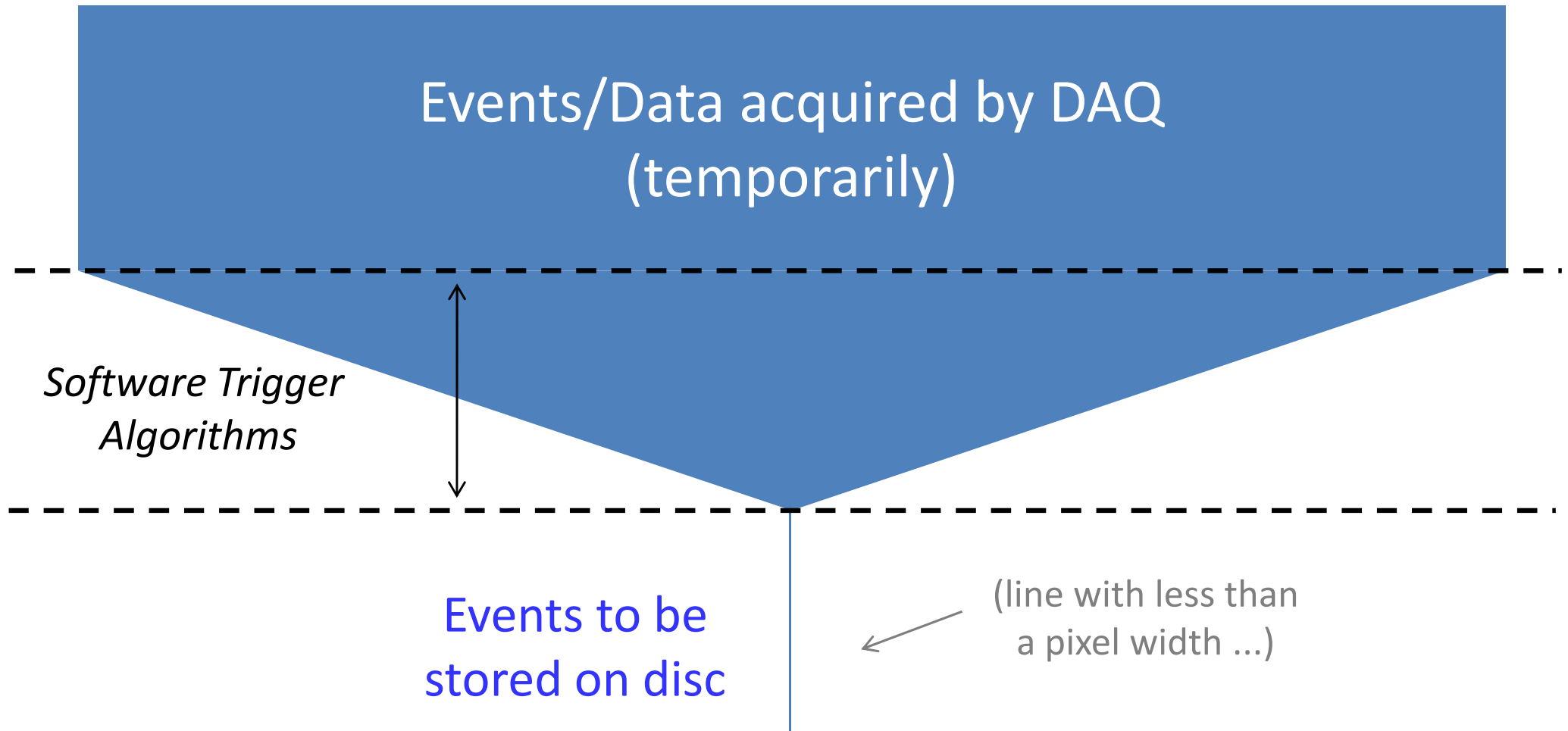# PANDA Software Trigger

K. Götzen
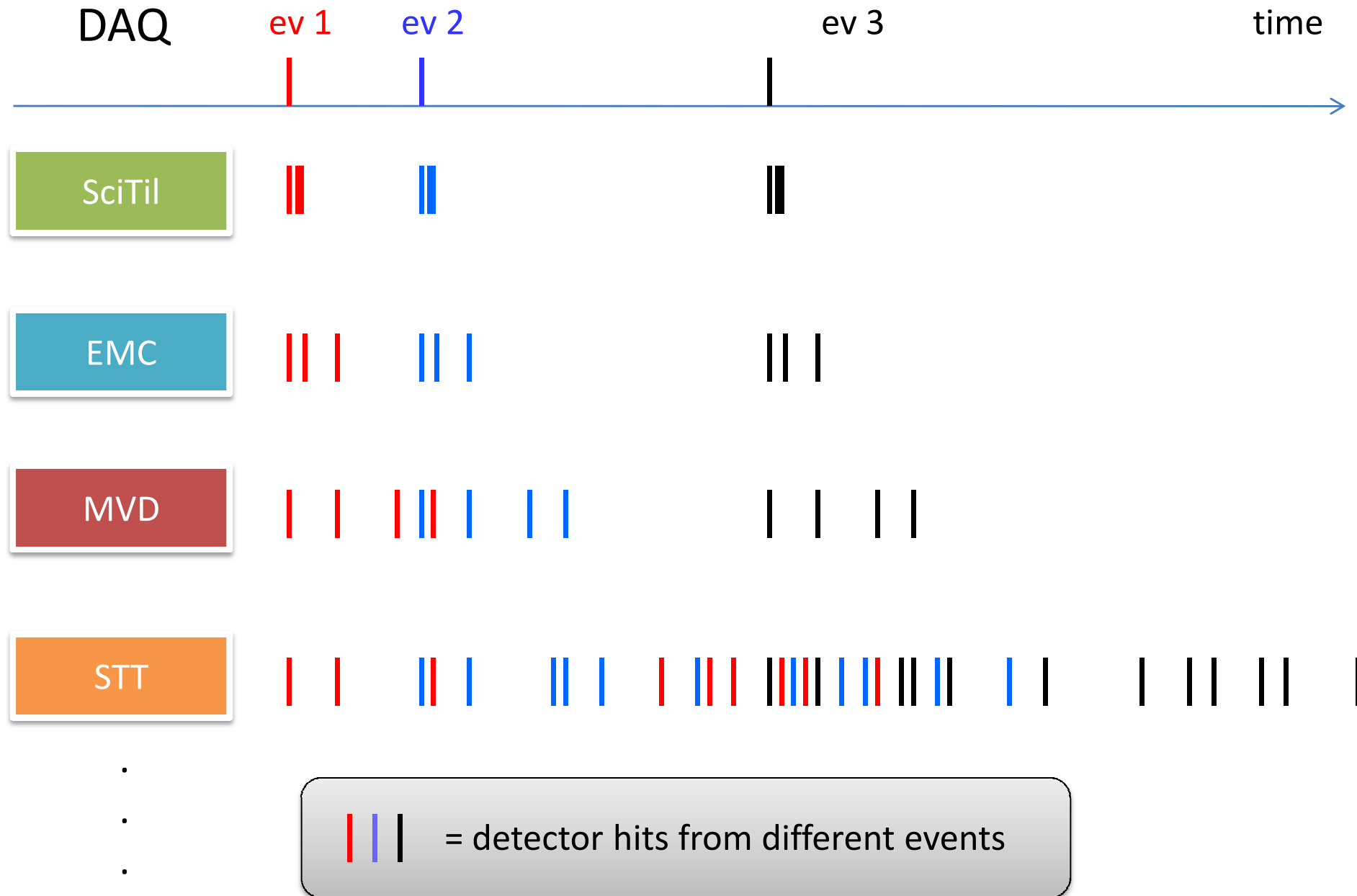
Oct. 2011

Why Software Trigger at all?

- Many benchmark channels (no ‚golden' channel)

- Channels consist purely/predominantly of hadrons

- Signal and background events look quite similar in terms of
  - Multiplicity tracks/neutrals
  - kinematic distributions
  - event shape, ...

- *Many, many, many* more background events ($\times 10^6$)

- No ‚simple' hardware trigger can cope with that situation

- Need sophisticated algorithms with high selectivity

- Only possible with online reco + a lot computing power

Challenge

Events/Data acquired by DAQ
(temporarily)

*Software Trigger
Algorithms*

Events to be
stored on disc

(line with less than
a pixel width ...)
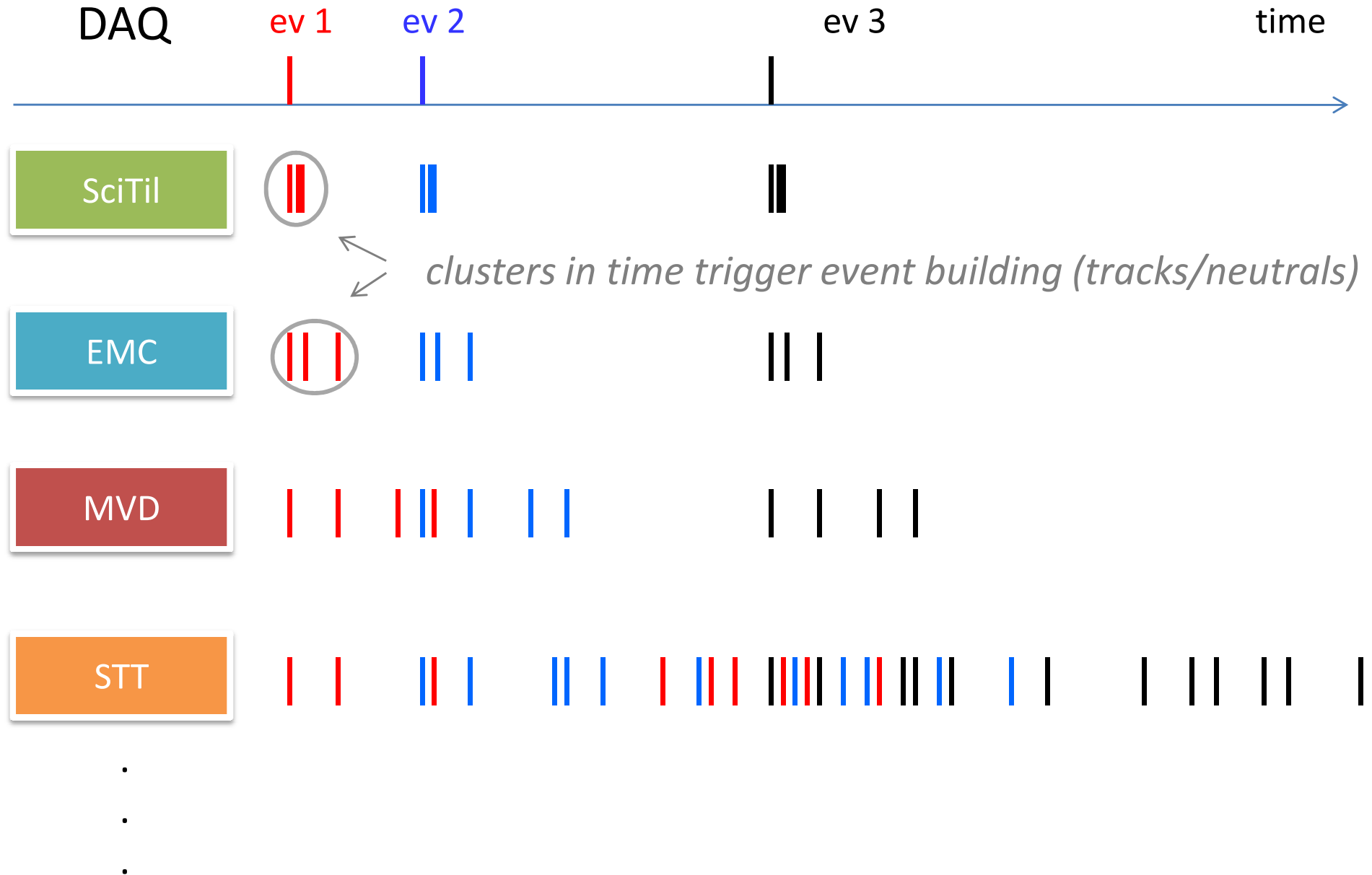
- Required reduction factor: 1/1000 (all triggers in total)
- e.g. 50 algorithms → factor 1/50000 in average

Online reco scenario

Online reco scenario

Online reco scenario

DAQ   ev 1   ev 2   ev 3   time

SciTil

0.5 ns

EMC

3 ns

MVD

20 ns

STT

200 ns

read buffers according to detector speed/delay/latency (numbers arbitrary)

Online reco scenario

DAQ   ev 1   ev 2   ev 3   time

SciTil

0.5 ns

EMC

3 ns

MVD

20 ns

STT

200 ns

Start online reco (event 1):
- pattern recognition
- track reconstruction
- EMC cluster reconstruction
- track/EMC match
- PID stuff

…
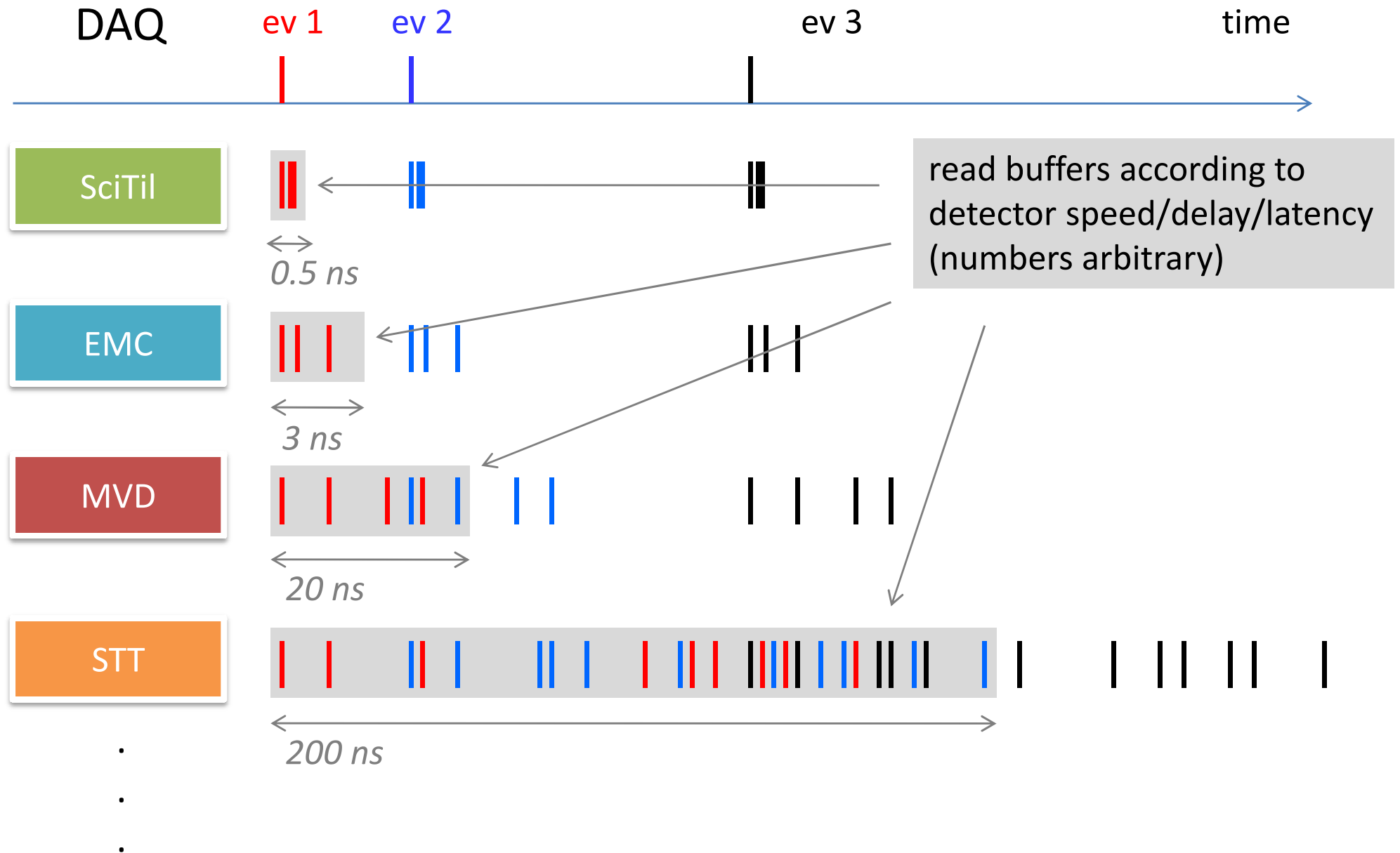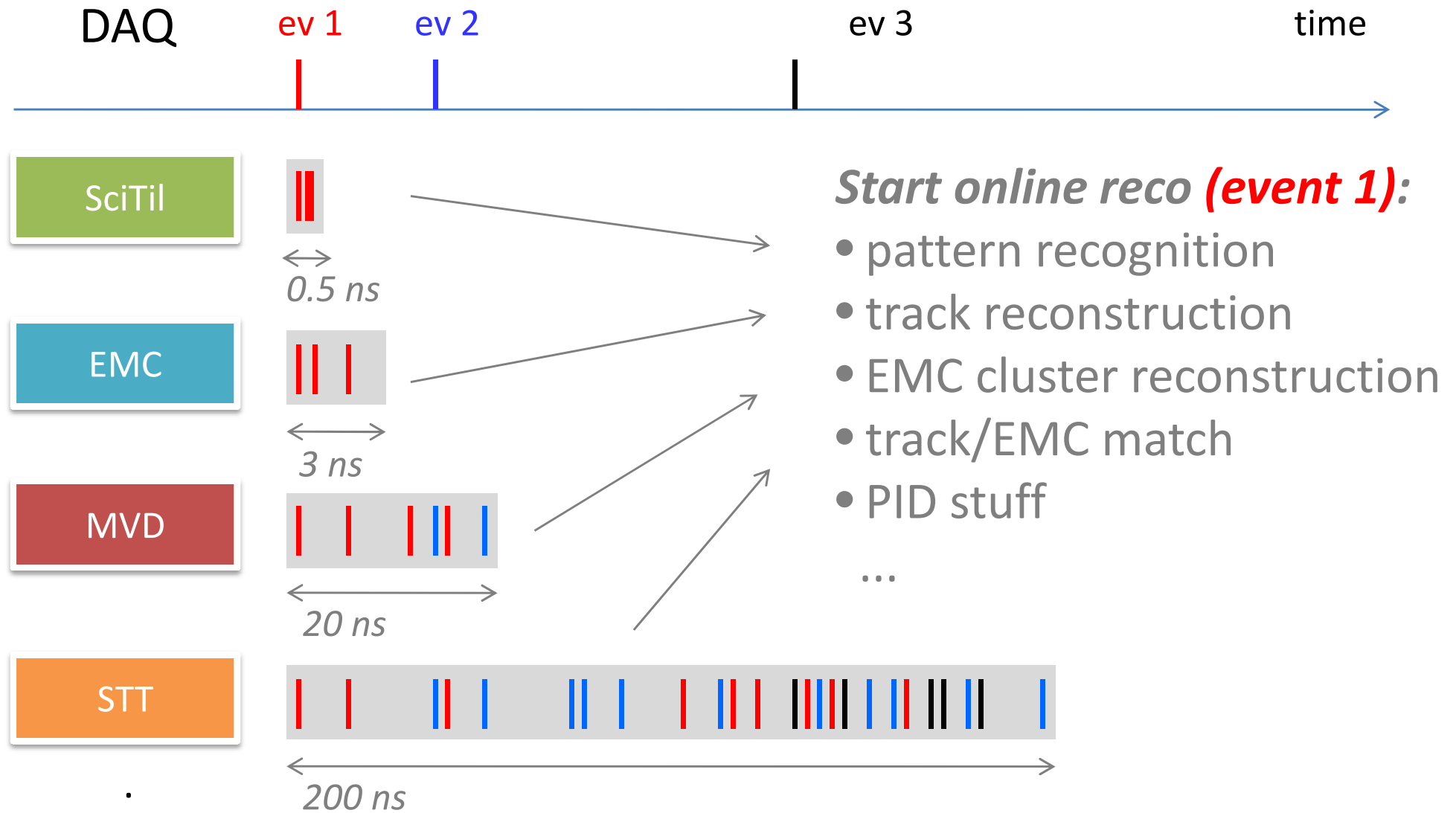
Trigger Algorithms

- Information for the trigger can be
  - direct hit information (perhaps SciTil hits, EMC hits)
  - higher reconstructed information (tracks, clusters, inv. mass, angles, ...)

- Two scenarios:
  - Inclusive trigger before event building
    - e.g. 2 electron cand. (J/psi)
      → start event building on selected buffered data

  - Exclusive trigger with reco'd events
    - reconstruct every event (candidate)
    - run event based trigger algorithm

Ingredients for Algorithms

Studying the *Physics Book* (offline scenario) gives idea about necessary information, e.g.

- J/psi (→ base for many charmonia)
    - Invariant Mass: Tracking/Momentum
    - Electron ID: Tracking, cluster energy, track/cluster match
    - Muon ID: Tracking, Muon detector information
    - Vertex: Tracking

- D/Ds Mesons
    - Pi0s: EMC clusters
    - Inv. Mass: Tracking
    - Kaon, Pion ID: dE/dx, DIRC info (w/ track match), ToF (track match)
    - Vertex: Tracking

- Baryons
    - Inv. Mass: Tracking
    - proton, pion ID: DIRC info (w/ track match)
    - Vertex: Tracking

- Full events: 4C fitting

Track and momentum reconstruction is key ingredient for almost everything!

Some comments to Physics Book results

- Some of the benchmark channels reported in Physics Book seemed to be at the limit concerning
  - signal/noise ratio
  - signal statistics (due to low cross section and/or limited integrated luminosity/beam time)

- For proper efficiency determination
  - trigger efficiency
  - event building efficiency
    have to be taken into account (was not the case I guess)

which makes the situation even more challenging...

Quality of Online Reco

- Will there be different algorithms for online/offline reco?

- Will there be a quality difference?

- If yes, I assume online quality will be worse, i.e.

    - worse track finding/reco. efficiency
    - worse momentum resolution (→ inv. mass resolution)
    - worse EMC energy resolution (→ mass res. of pi0, eta, ...)
    - less precise PID information (→ worse PID efficiency)
    - no fitting (4C, vertex, mass) available

Approach for Trigger

- Two possible directions:

- „Top down"
  – Online experts tell, what can be reconstructed in time
  – Analysis experts determine resulting limitations to the planned physics program

- „Bottom up"
  – Analysis experts tell, what it required to study all channels
  – Online experts provide the required information

- I'd prefer to start with bottom up approach

To be investigated

- Which information are mandatory for full physics program?

- What is required precision for

    - momentum resolution
    - energy resolution
    - track finding efficiency (maybe momentum dependent)
    - event building efficiency
    - PID information

    to achieve the required trigger efficiencies & purities?

Next steps to be done

- Implementation of time based simulation, pattern recognition and reconstruction for all detectors

- Determination of selectivity of various selection criteria (full MC)

- Resolution/efficiency dependence of trigger algo's (perhaps sufficient with toy MC)

- Event building efficiency as function of event rate (+ impact of possible event bursts from pellet target)