# Flagging and treatment of anomalous channels

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for the working group

CEA-Saclay/IRFU SPP

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- Identification of anomalous channels
- Reconstruction of saturated channels
- Recovery of (isolated) dead channels
- Recovery of dead Trigger Towers

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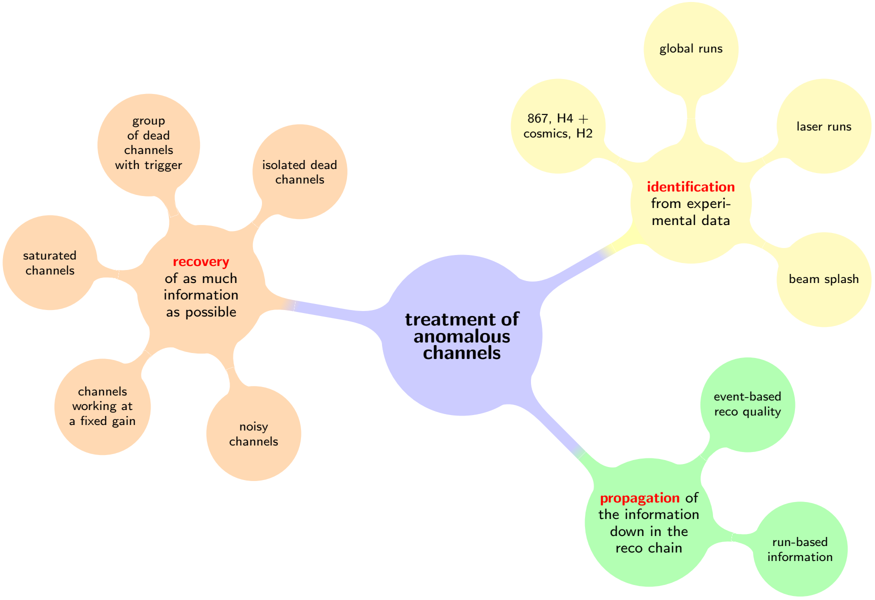
# Introduction



# Classification of problematic channels

| | problematic channels | problematic trigger towers |
|---|---|---|
| Barrel | 69 (41 dead) | 10 (9 with trigger) |
| Endcap | - | 5 (1 with trigger) |

Problems identified so far (information that will go in the DB):

1 really dead channels: no signal in any kind of runs

2 DAC settings problems

3.1 channels always at fixed gain (gain 12 not working)

3.2 channels always at fixed gain (gain 12 and gain 6 not working)

3.3 channels always at fixed gain 0

4 channels with no laser, ok elsewhere

5 problematic VFEs

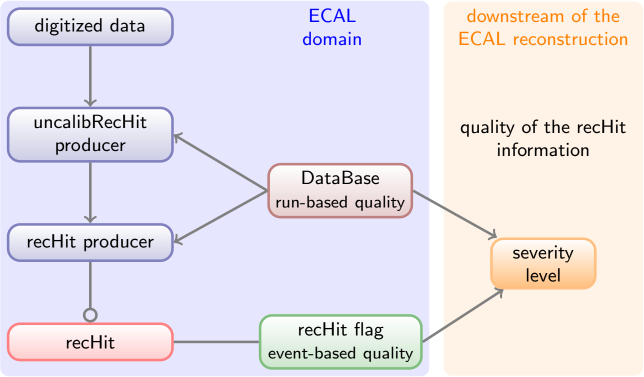
6 problematic isolated trigger towers

7 noisy channels - 'hot' channels and large pedestal rms

- Possibility to add more flags to the classification (hope not. . . )

$\Rightarrow$ the treatment of the different flags has to be flexible and easily configurable (i.e. what to do with each flag should be specified via cfg file)

# Reconstruction schema




- The DB has a run-based channel quality information and also the parameters for the reconstruction algorithms: it is accessible to both UncalibRecHitProducer and RecHitProducer
- The RecHit holds a flag summarizing the event-based reconstruction quality
- RecHit flag + DB info = severity level ≡ how reliably can I use the channel (be it reconstructed or not)?

# Reconstruction strategy for anomalous channels

**At the UncalibRecHit level:**

| | | |
|---|---|---|
| saturated | $\longrightarrow$ | leading edge method |
| fixed gain | $\longrightarrow$ | might profit from special weight method with 3+5 (to be investigated) |
| noisy | $\longrightarrow$ | to be defined |

**At the RecHit level:**

isolated dead channel:

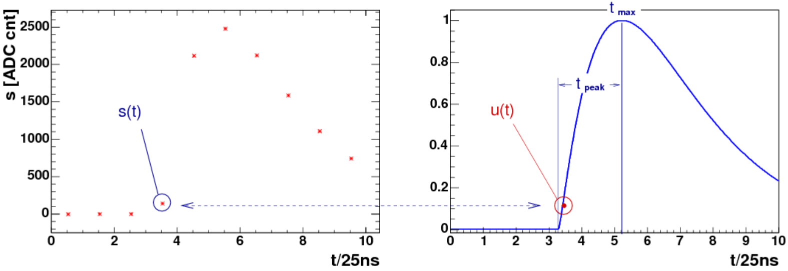
- **if** in an interesting region according to Selective Readout Process (SRP)
- **if** in a $3 \times 3$ matrix around the crystal with the highest energy deposit
- **if** $\sum E_i$ in $3 \times 3 >$ threshold
- ▶ consider neighbouring crystals, estimate the missing energy and assign it to the RecHit

  for practical purposes, as the energy will anyway be (re-)clustered in a subsequent step

in dead Trigger Tower with trigger information:

- **if** TP energy $>$ threshold
- ▶ use the Trigger Primitive (TP) information
- ▶ share the TP energy among the TT recHits - in a first step "democratically" i.e. $E_{\text{hit}} = E_{\text{TP}}/25$

# Reconstruction of saturated channels



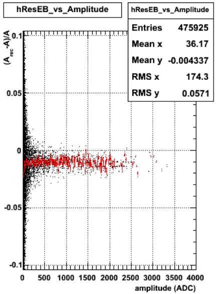

- Pulse shape $u(t)$ assumed to be known (e.g. empirically)
- Amplitude from the last unsaturated sample $s(t)$:

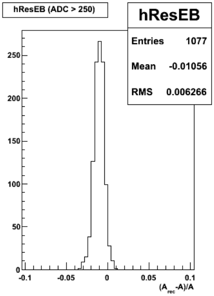
$$\boxed{\mathcal{A} = \frac{s(t)}{u(t)}}$$

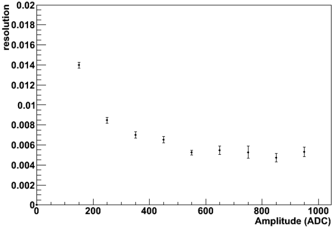
- The resolution basically depends only on the jitter of the signal
- A precise time-calibration can make the biases negligible

# Reconstruction of saturated channels

The method has been included in CMSSW: preliminary results




- There is still a 1% bias under investigation and very likely due to a not yet identified time-shift between the reconstruction and the digitazion step

**N.B** The approach is independent from other methods based on the crystals adjacent to the saturated one $\Rightarrow$ can be combined (at the RecHit level)

# Recovery of (isolated) dead channels

Requirements:

- criteria to determine where the dead crystal is w.r.t. the electromagnetic shower
- criteria to decide whether or not it is significant to recover the dead channel
- algorithm to recover the energy

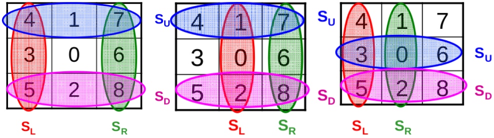
Algorithm currently investigated:

- Neural Network approach
- parametrization as a function of the impact point on the crystal with the maximum energy
- recovery based on neighbouring crystals à la "saturated case"

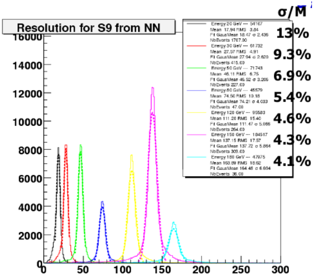
# Recovery of (isolated) dead channels

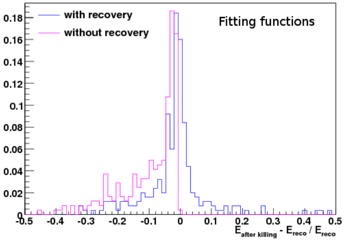
Algorithm example: Neural Networks

- One NN to select which case we are facing
  (i.e. where is the dead crystal w.r.t. the shower)
- One NN per case to recover the energy




Example of results: recovery and physics impact (preliminary!)



# Recovery of (isolated) dead channels

**New inputs for the recovery procedure**

- Given the energy and the impact point on a crystal, we can predict the energy deposits in a matrix of crystals (e.g. $5 \times 5$)

$\Rightarrow$ from the deposit of the energy in the matrix we can fit the shower energy (and the impact point) and predict the energy deposited in the missing crystal(s)

**Advantages**

- should be easy, fast and general (few parameters)
- could work even for $> 1$ missing crystals ($\Rightarrow$ missing VFE)
- optimistic approach: can even be used for missing crystals in a region with overlapping showers?

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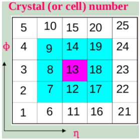
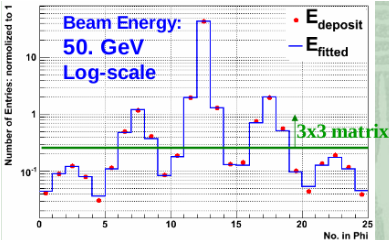
From J. Tao's talk, e/$\gamma$ POG, January 19th




Longitudinal profile: $$\frac{dE}{dt} = E_0 b \frac{(bt)^{a-1} e^{-bt}}{\Gamma(a)}$$

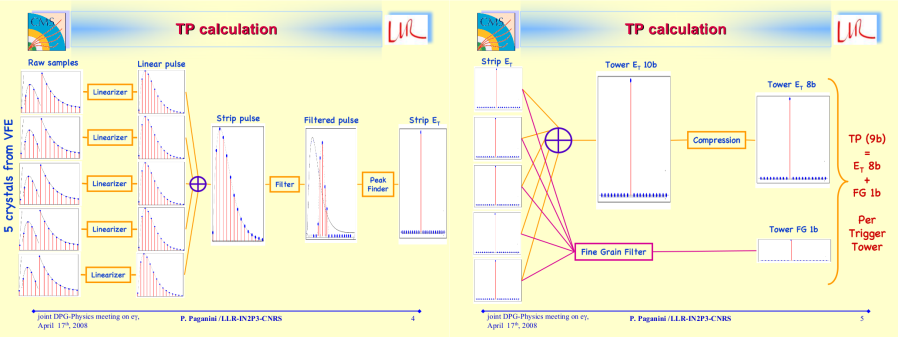
Lateral profile: $$f(r) = \frac{6R^2 r}{(r+R)^4}$$

**validation of the parametrization (TB2006)**



# Recovery of dead Trigger Towers

Reminder from one of Pascal's talks:




**Handles to recover the energy information:**

- TPG linearizer: fixes the saturation scale (i.e. the dynamic range) for the ET of a tower (10 bit information)
- TPG compressor pass from 10 bit information to 8 bit information: fix the dynamic range and the Look-Up Table (LUT) mapping 10 bit to 8 bit (which can be nonlinear)

# Recovery of dead Trigger Towers

## Present status

- current status of the detector reproduced
- started to look at the physics impact on fully simulated events
- started to look at the trigger emulator (scale/LUT optimization)

## Near future

- Optimize the TP saturation scale and the LUT to have the best possible resolution on the most useful range
  - study on physics channels are needed
  - be careful as the optimization goes in the opposite direction the trigger would like (extend the scale)
- Decide how to re-assign energy to the recHits
  (can affect further reconstruction steps)
- Handle the cases in which we exceed the saturation scale
  (look at neighbouring crystals/trigger towers?)

# Conclusions

- Flags for the DB ready to be deployed
- An initial reconstruction schema will be adopted to handle all anomalous channels
- Further steps:
  - saturated channels:
    - adopt the leading edge method (with ad-hoc bias correction)
    - check the digitization sequence to understand the observed 1% bias
  - isolated dead channels:
    - finalize studies on the physics impact
    - investigate the parametric shower method
    - converge on the easiest and best performing method
  - dead Trigger Towers:
    - recover using the current LUT and share the energy among the hits "democratically"
    - start the studies on the physics impact
    - optimize the choice of saturation energy and LUT (a study also relevant for the trigger itself $\Rightarrow$ profit from collaboration)
    - optimize the energy sharing among the channels