Offline vs Online selection

- *When taking data, we cut on online variables, reconstructed with worse reco than offline*

- *This results in a turn-on curve*

- *We usually ask flat trigger efficiency -> we cut away a large fraction of the events we collect*

- *With online = offline, whatever we take can be used in analyses*

- *We need a way to speed up reco*

  - *what about "guessing" reco result rather than running reco?*

Analyses start where trigger is efficient

These events are collected (at CPU/disk cost) and never used

Offline Energy

Trigger efficiency

Analyses start where trigger is efficient

All collected events are used offline

Trigger efficiency

Offline Energy
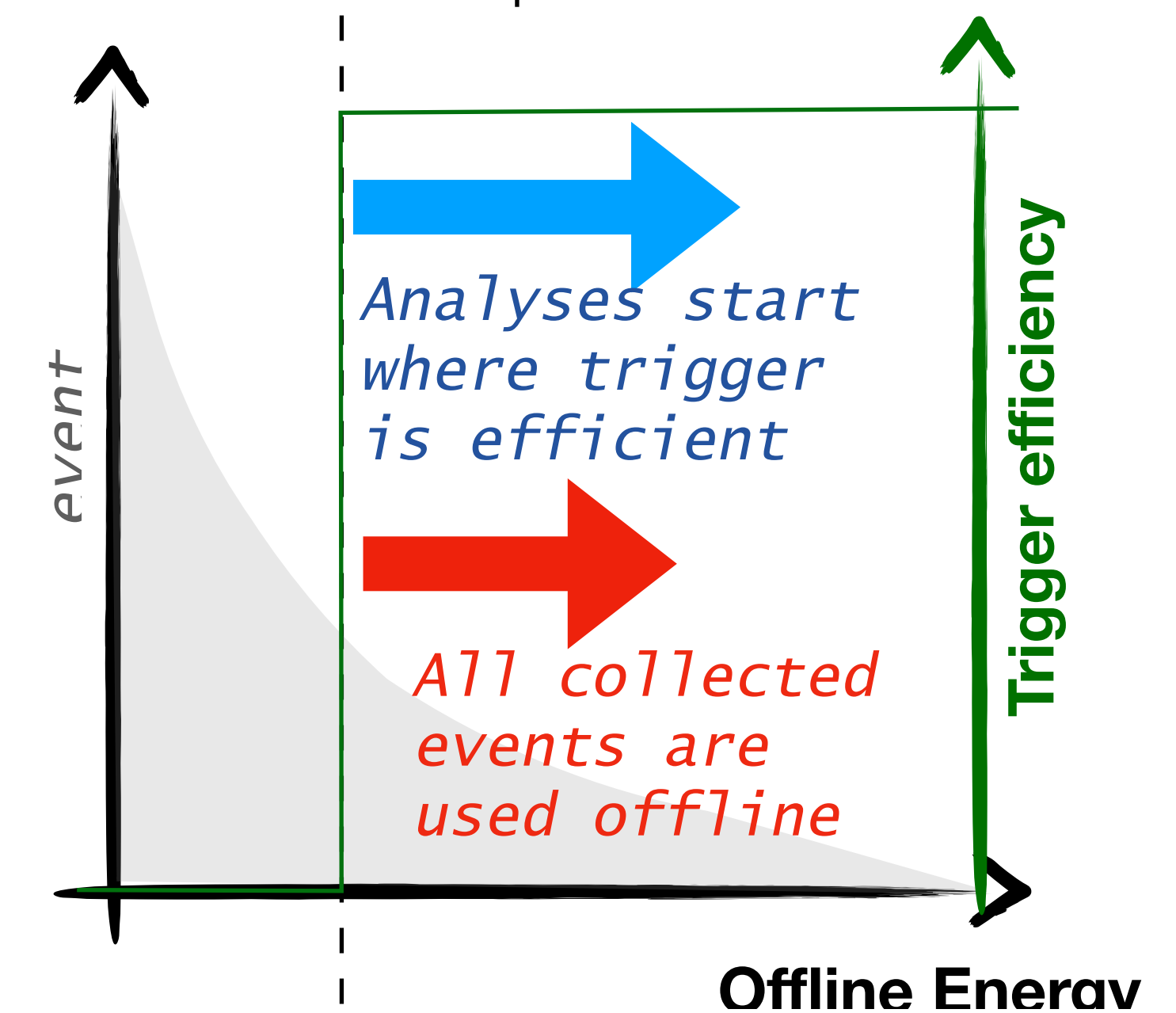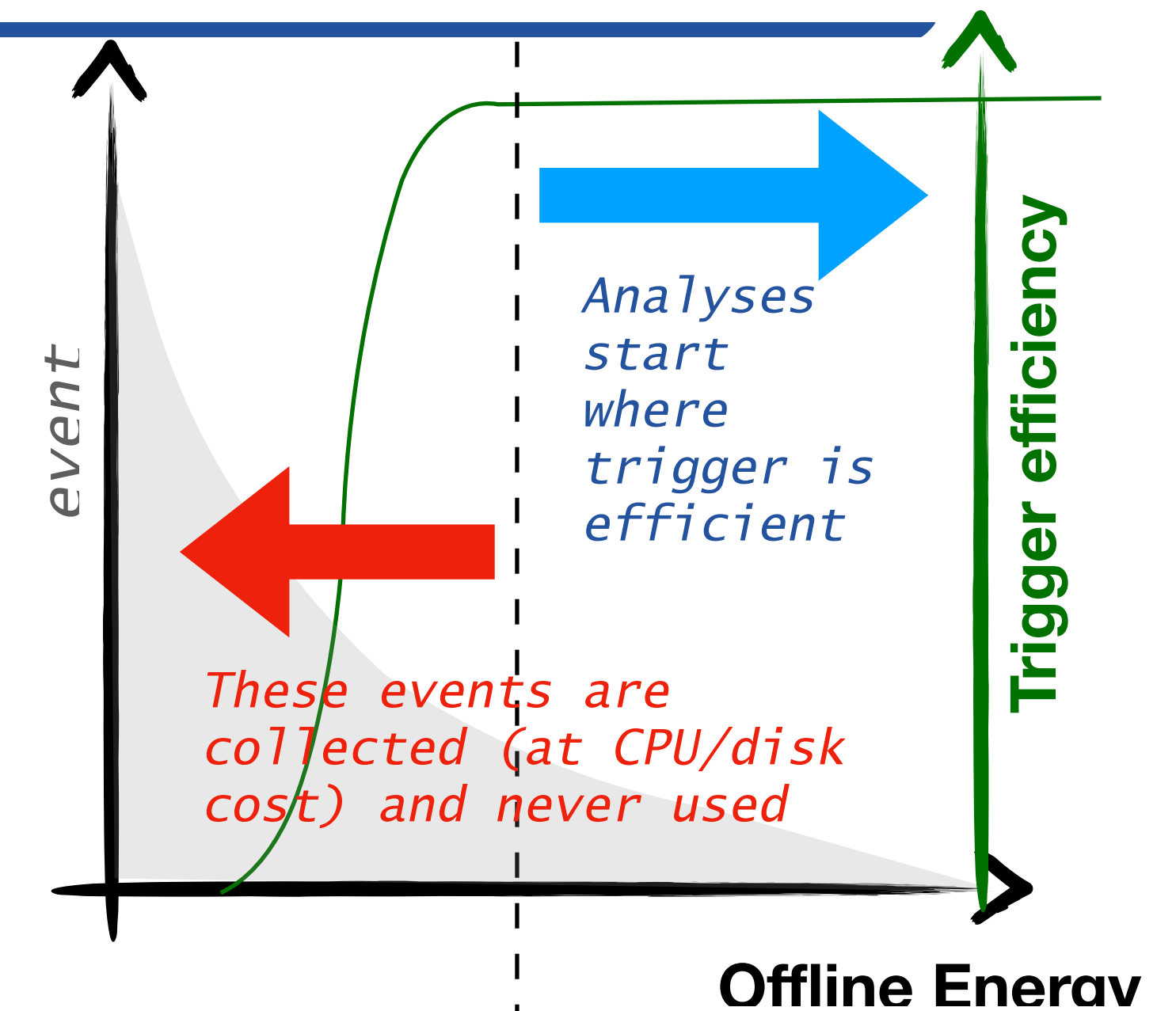
Why Deep Learning

◉ *Neural network can model non linear functions*

   ◉ *the more complex is the network, the more functions it can approximate*

◉ *Neural network are faster to evaluate (inference) than typical reco algorithm.*

   ◉ *This is the speed up we need*

◉ *Neural Networks (unlike other kind of ML algorithms) are very good with raw (non-preprocessed) data (the recorded hits in the event)*

$$(\text{pT}, \eta, \phi, \text{E})_{\text{OFFLINE}} = f((\text{pT}, \eta, \phi, \text{E})_{\text{ONLINE}})$$

   ◉ *could use them directly on the detector inputs*

$$(\text{pT}, \eta, \phi, \text{E})_{\text{OFFLINE}} = g(\text{Event hits})$$

One would have to learn f and g to evaluate them at trigger. Online processing is replaced by offline training

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TO DO LIST

- *Develop models that learn f and g (is this possible at all?)*

  - *now building datasets based on CMS open data, to be as realistic as possible*

  - *intend to release these datasets and allow people to work out efficient procedures to guess the functions*

- *Develop technology for fast inference*

  - *Online: Library to synthesise DL models for HEP from TensorFlow to FPGAs. Ongoing CERN/FNAL effort, first results at CTD2018.*

  - *Offline: see Vincenzo's talk next time*

Needed ingredients

◉ *Expertise: need to bring DL experts at CERN to go beyond master-student-level applications*

◉ *Resources: this lab is starving of GPU hours.*

  ◉ *Having to go through project requests at any time is time consuming*

  ◉ *If we don't want to invest on local resources, we need a place where this could be outsourced, in a training-on-demand way*