

TOF-PET Brain Imager : Estimate of the Trigger and DAQ Rates

P. Murat

November 5, 2012

Trigger Counting Rates: Single Photons

- typical PET injection: $15\text{mCi} = 400\text{MBq} = 4 \cdot 10^8$ decays per second
- after injection radioactive tracer gets distributed over the whole body
- assume 100% acceptance for a full body imager of 1m,
- brain imager ring of 4cm would detect 4/100 of the total counting rate

$$r = 16 \cdot 10^6 \simeq 20\text{MHz}$$

- Current design has 36 boards \rightarrow 500 KHz per board
- only about half ($1 - (2/3)^2$) of all decays have at least one photon out of the patient's body \rightarrow additional reduction by a factor of about 2.
- 250 KHz per board. On average, $4\mu\text{sec}$ between the 2 trigger signals coming from the single board. **This rate determines the trigger requirements**
- 30 kHz per DRS4 channel \rightarrow $30\mu\text{sec}$ between the events
- the time is roughly the same as the DRS4 readout time for 1024 channels at 33MHz

Trigger Counting Rates: coincidence events, or “doubles”

- about $4/100 * 4 \cdot 10^8 \simeq 2 \cdot 10^7$ decays per second can result in coincidences
- 1/9 of them have both photons out of the body
- the two photons go back-to-back, so for $D=25\text{cm}$, the brain imager acceptance $A \simeq 4\text{cm}/(12.5\pi \text{ cm}) \simeq 0.1$
- resulting rate of the coincidence events or “doubles”:

$$r = 2 \cdot 10^7 / 10 / 10 \simeq 2 \cdot 10^5 = 200 \text{ KHz}$$

- for the fully efficient trigger this would be the acquisition rate
- this is 5 KHz per board and about 0.6kHz per channel

DAQ Rates

- DRS4: 12bit / cell
- assume that read only 2 signal channels and two trigger channels
- readout: 100 ns window is enough, at 5 GHz sampling rate it is 500 cells
- event size: $4 \cdot 500 \cdot 1.5 \text{ bytes} = 3 \text{ KBytes}$
- DAQ data rate: $3 \text{ KBytes} * 2 \cdot 10^5 \text{ events/sec} \sim 600 \text{ MBytes/sec}$
- 2 GHz sampling rate: 200 cells, 1.2 KBytes / event, DAQ rate - 240 MBytes/sec
- 1 GBit ethernet line saturates at about 60 MBytes/sec, need at least 4 lines