Trigger Scheduler, Engines, and Rates

A proposal for flight configuration

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Purpose

- ❑ **Intent: Want to run LAT at SLAC with trigger config as much like flight as possible**
  - – **What is flight trigger config?**
  - – **What rate is acceptable?**

- ❑ **See Confluence page for DC2 source and bkg rates**
  - – http://confluence.slac.stanford.edu/display/SCIGRPS/Resulting+Trigger+and+Filter+Rates
  - – **Steve presented rates for 3 possible trigger configs**
    - • **Example, configuration 2: (TKR && (!ROI || CALLO)) || CALHI**
      - – **Mean rate ~ 2.6 kHz**

- ❑ **See C&A presentation from November**
  - – http://www-glast.slac.stanford.edu/software/AnaGroup/2005Nov28-Grove-FlightTrigEngineConfig.pdf.pdf
  - – **Engine configuration here is revised**
    - • **DC2 background simulation to understand trigger rates**
      - – **Analysis by David Smith and me**

- ❑ **Acceptable rate?**
  - – **From 26.5 us deadtime per evt, deadtime fraction at 10 kHz is >26%**
  - – **Onboard filter processing time, from JJ**
    - • **140 us for HE gamma, less for others**
  - – **Let's keep peak rate < 7 kHz**
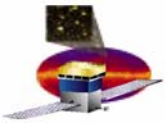   - • **Want mean rate much lower than that**
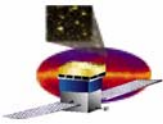
Trigger Logic

❏ **First, need to understand capabilities of Trigger**

  – **Defining document: LAT-TD-01545**

    • **The GLT Electronics Module, Programming ICD Specification**

❏ **Specified in "Trigger Engines" from combinations of "Trigger Conditions"**

  – **8 Trigger Conditions are defined**

    • 2^8 = 256 possible combinations of these Conditions

    • Each can be allowed (or disallowed) to open a trigger window (i.e. start a coincidence)

    • ROI condition is different (see next page)

Condition	Flight setting	Comment
ROI (ACD)	Tower-local veto, ~0.3 MIP	Not allowed to open wdw
TKR		
CAL-LO	100 MeV single log	
CAL-HI	1 GeV single log	
CNO	~20 MIPs single tile	What should flight threshold be?
Periodic	~1 Hz	Gives pedestals
Solicited	Special use	
External	Nothing connected!	Not allowed to open wdw

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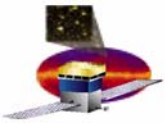
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Detail: ROI Condition

- ❑ **The ROI Trigger Condition is different**
    - – **Can be used as trigger source or veto of TKR**
        - • **Globally applied to all Engines, all Regions of Interest**
        - • **We've selected TKR-veto mode**
            - – **Thus TKR=False and ROI=True should never occur**
                - » **Forbidden by definition of ROI Condition in GEM**
    - – **Up to 16 Regions of Interest may be specified on board**
        - • **Two candidate configs for flight**
            - – **16 "Tower-local" Regions**
                - » **Corresponding to tiles nearest each Tower (sorta)**
            - – **1 "Global" Regions**
                - » **Single region: all top tiles and first 2 layers of side tiles**
            - – **We've selected the Tower-local Regions**

- ❑ **Throughout the remainder of this presentation**
    - – **"ROI" is defined to be the tower-local veto signal**
        - • **ROI = True = 1 means the relevant veto line for the hit TKR is asserted**
   - • **ROI = False = 0 means the relevant veto line for the hit TKR is not asserted**

More Trigger Logic

- ❑ **16 Trigger Engines are available**
  - **For each engine, need to define "Trigger Context"**
    - **Trigger inhibit**
      - **Disables engine, if set**
    - **Data readout mode**
      - **Zero suppression on or off   (for ACD and CAL together)**
      - **4-range or 1-range readout   (for CAL)**
    - **Programmable pre-scale**
      - **Max prescale depth is 256-to-1**
    - **User-defined "marker"**
      - **3-bit numerical value to use, e.g., as a label**
        - » **Note: 8 markers aren't enough for unique map for engines used below**

- ❑ **Scheduler table**
  - **Points each of the 256 combinations of Conditions to a single Engine**
    - **No ambiguity**
  - **But 3 of those 8 Conditions aren't interesting for today's discussion**
    - **External, solicited, periodic**
    - **We're left with 2^5 = 32 to discuss**
      - **8 of these are invalid, i.e. !TKR && ROI && anything else**
      - **1 more is invalid, i.e. all Conditions false**
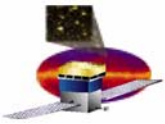 - **Let's specify the final 23…**
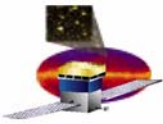
Flight Trigger Engine Mapping

Engine number	Condition Summary								Trigger Context				<Rate> (Hz)	Purpose
	external	solicited	periodic	CNO	CAL-HI	CAL-LO	TKR	ROI	Zero supp	Ranges	Prescale	Marker		
3	0	0	0	1	0	1	1	1	yes	4-rng	0	5	200	GCR calibration
	0	0	0	1	1	1	1	1						
4	0	0	0	1	0	0	0	0	yes	1-rng	255	7	5	Other "CNO" triggers
	0	0	0	1	0	0	1	0						
	0	0	0	1	0	0	1	1						
	0	0	0	1	0	1	0	0						
	0	0	0	1	0	1	1	0						
	0	0	0	1	1	0	0	0						
	0	0	0	1	1	0	1	0						
	0	0	0	1	1	0	1	1						
	0	0	0	1	1	1	0	0						
	0	0	0	1	1	1	1	0						
5	0	0	0	0	1	0	0	0	yes	1-rng	0	2	100	HE gammas
	0	0	0	0	1	0	1	0						
	0	0	0	0	1	0	1	1						
	0	0	0	0	1	1	0	0						
	0	0	0	0	1	1	1	0						
	0	0	0	0	1	1	1	1						
6	0	0	0	0	0	0	1	0	yes	1-rng	0	1	1500	Gammas
	0	0	0	0	0	1	1	0						
7	0	0	0	0	0	1	0	0	yes	1-rng	0	4	400	CAL-only gammas
8	0	0	0	0	0	1	1	1	yes	1-rng	0	3	700	Self-vetoed gammas
9	0	0	0	0	0	0	1	1	yes	1-rng	255	6	20	Leakage of protons

- ❑ **Numbering**
  - – **Engines assigned in bit order of Conditions**
    - · **Engines 0, 1, and 2 for External, Solicited, Periodic, and invalid combinations (i.e. ROI without TKR)**
  - – **Markers assigned in order of photon usefulness, sorta**
- ❑ **Deadtime**
  - – **Minimized rate with 4-range readout to minimize deadtime**
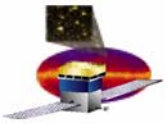 - – **Prescaled the Engines dominated by protons and other "CNO" triggers**

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Total rate for all Engines

❑ **Sum of rate from all Engines**

– **Note**

• **Dropouts in SAA, where triggering is disabled**

• **Peak rates occur away from SAA**

• **Histogram includes only time outside SAA**

– **Mean ~ 3 kHz**

– **Peak ~ 6 kHz**

❑ **Compare to Ritz Configuration 2**

– **(TKR && (!ROI || CALLO)) || CALHI**

• **Mean ~ 2.6 kHz**

– **Here I've added CNO**
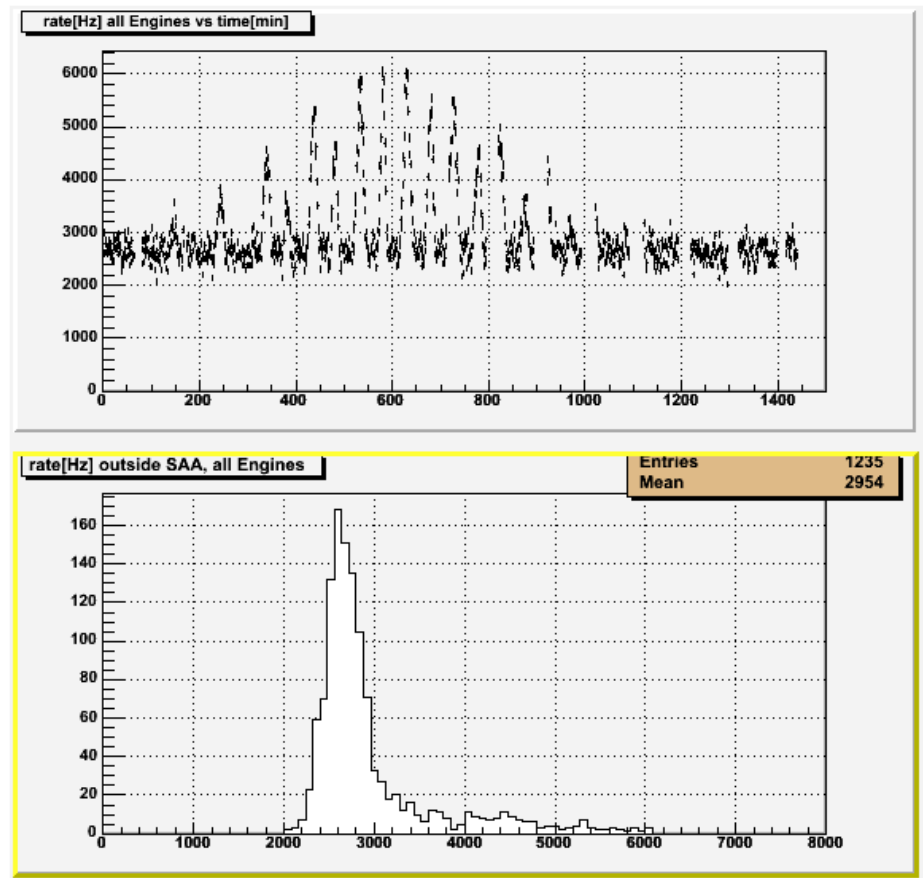
Engine by engine

❑ **Let's now step from engine to engine**

  – **In order of decreasing trigger rate**
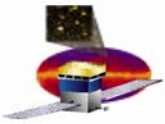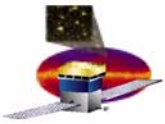
Engine 6 rate

❑ **Content**
- **Gammas**
- **Albedo gammas, LE albedo protons and electrons**

❑ **Condition**
- **TKR && !ROI && !CNO && !CALHI && (CALLO don't care)**
  - **TKR hit with no veto and no really big signals in ACD or CAL**

❑ **Context**
- **1-range, zero-suppressed**
- **Marker = 1**

❑ **Rates**
- **Mean ~ 1500 Hz**
- **Peak ~ 2500 Hz**

❑ **Note:**
- **Primary engine for gammas**
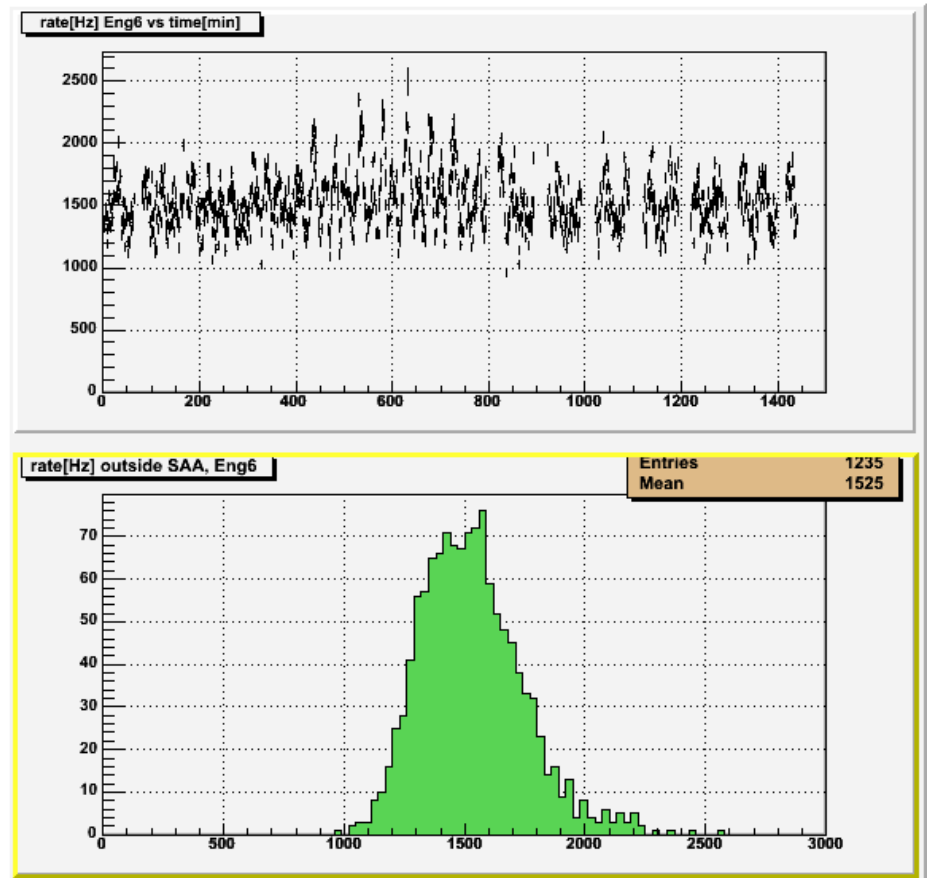
Engine 8 rate

- ❑ **Content**
  - – **Self-vetoed gammas, recovered with CALLO**
  - – **Interacting protons**
- ❑ **Condition**
  - – **TKR && ROI && CALLO && !CNO && !CALHI**
    - • **Local-vetoed TKR hit with max xtal E between 100 MeV and 1 GeV, but no big signals in ACD**
- ❑ **Context**
  - – **1-range, zero-suppressed**
  - – **Marker = 3**
- ❑ **Rates after prescale**
  - – **Mean ~ 700 Hz**
  - – **Peak ~ 2100 Hz**
- ❑ **Note:**
  - – **Candidate for prescaling?**
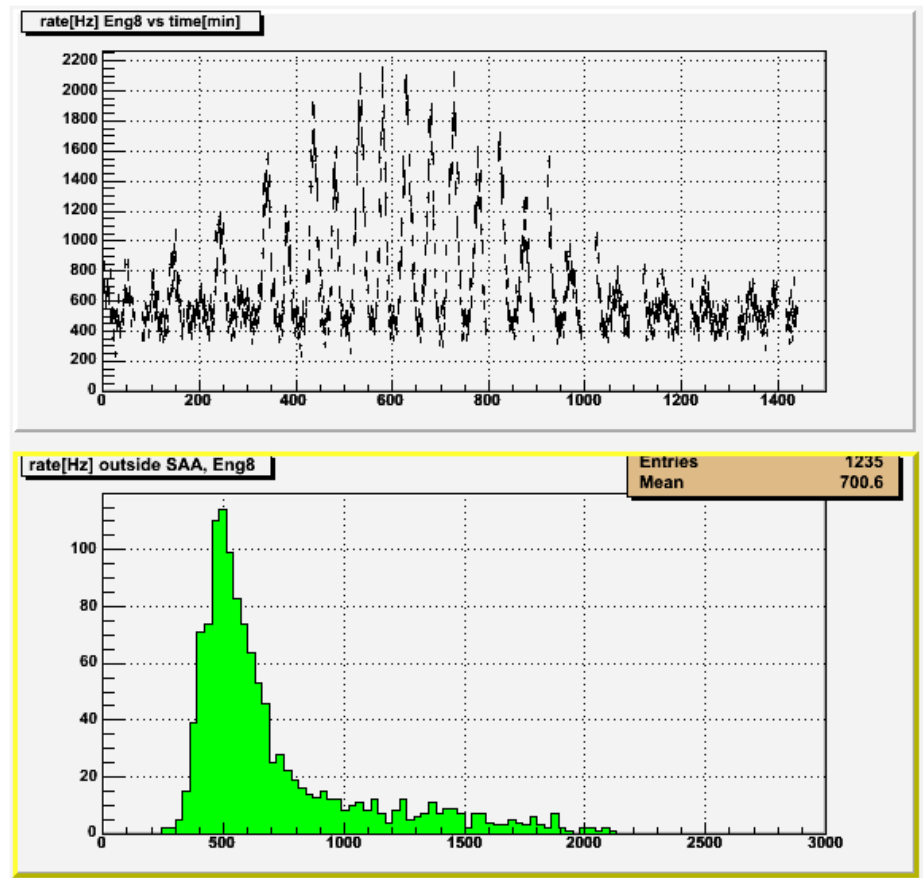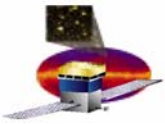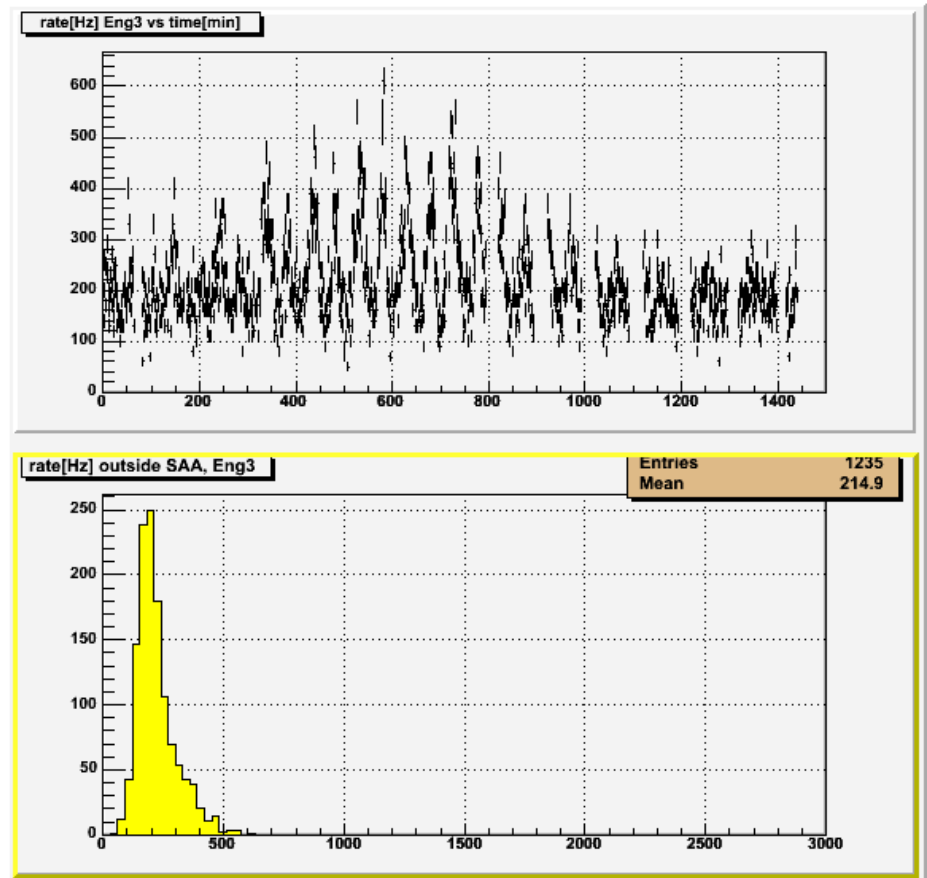
Engine 7 rate

❑ **Content**

– **Gammas that didn't convert in TKR**

– **Interacting sideways protons**

❑ **Condition**

– **CALLO && !TKR && !ROI && !CNO && !CALHI**

• **Big CAL hit with nothing else**

❑ **Context**

– **1-range, zero-suppressed**

– **Marker = 4**

❑ **Rates after prescale**

– **Mean ~ 400 Hz**

– **Peak ~ 1200 Hz**

❑ **Note:**

– **Strong orbital modulation of protons**
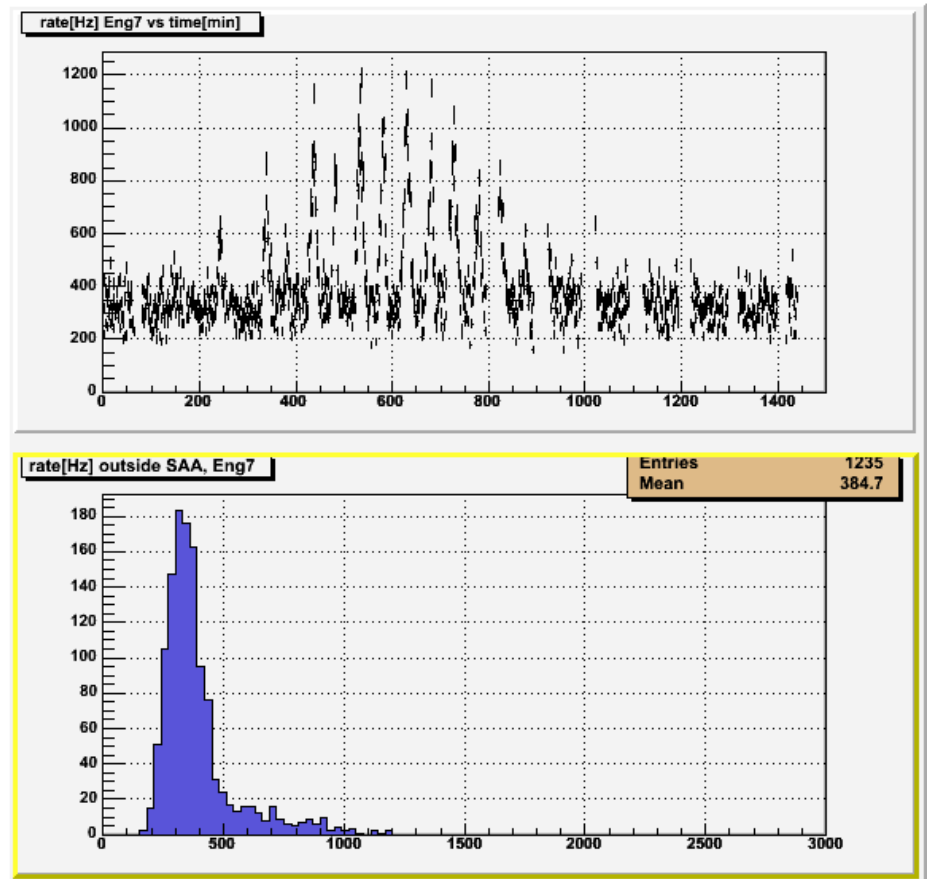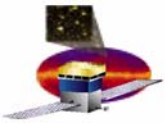
Engine 3 rate

- **Content**
  - **CAL calibration with GCRs**
- **Condition**
  - **CNO && CALLO && TKR && ROI**
    - **Local-vetoed TKR hit with big signal in ACD and CAL**
- **Context**
  - **4-range, unsuppressed readout**
  - **Marker = 5**
- **Rates**
  - **Mean ~ 215 Hz**
  - **Peak ~ 600 Hz**
- **Note: Minimize deadtime fraction**
  - **65 us readout deadtime**
    - **~1.5% deadtime fraction**
  - **Keep CNO threshold high**
    - **Capture 36 MIPs and up**

rate[Hz] Eng3 vs time[min]

rate[Hz] outside SAA, Eng3

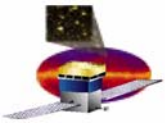| Entries | 1235 |
| Mean | 214.9 |

Engine 5 rate

- **Content**
  - HE gammas
  - Proton splats, …
- **Condition**
  - CALHI && !CNO && (don't care)
    - Big signal in CAL, but no big signal in ACD
- **Context**
  - 1-range, zero-suppressed
  - Marker = 2

- **Rates**
  - Mean ~ 100 Hz
  - Peak ~ 200 Hz
- **Note:**
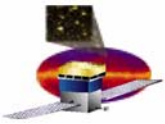 - Rate of single xtal > 1 GeV is modest
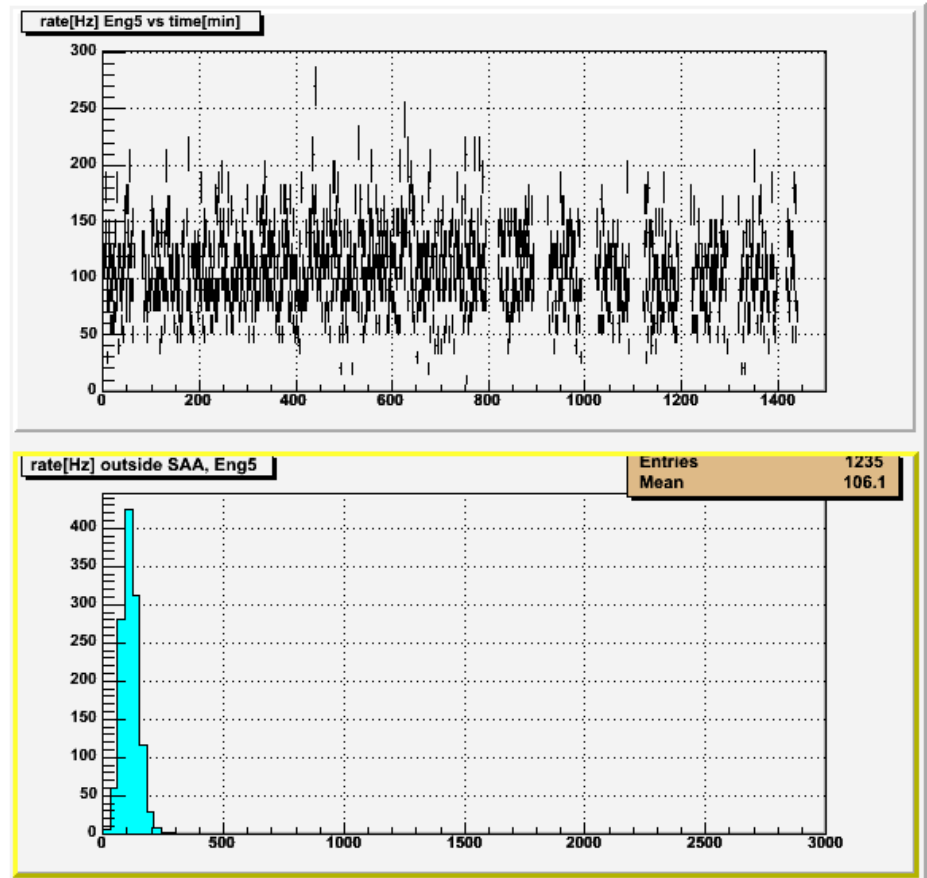
Engine 9 rate

❑ **Content**

– **Pre-scaled leakage of protons**

❑ **Condition**

– **TKR && ROI && !CALLO &&**
!CALHI && !CNO

• **Local-vetoed TKR hit with no big signals in ACD or CAL**

❑ **Context**

– **1-range, zero-suppressed**

– **Prescale 256:1**

• **Max possible in h/w**

– **Marker = 6**

❑ **Rates after prescale**

– **Mean ~ 20 Hz**

– **Peak ~ 35 Hz**

❑ **Note:**

– **Very modest burden on FSW**
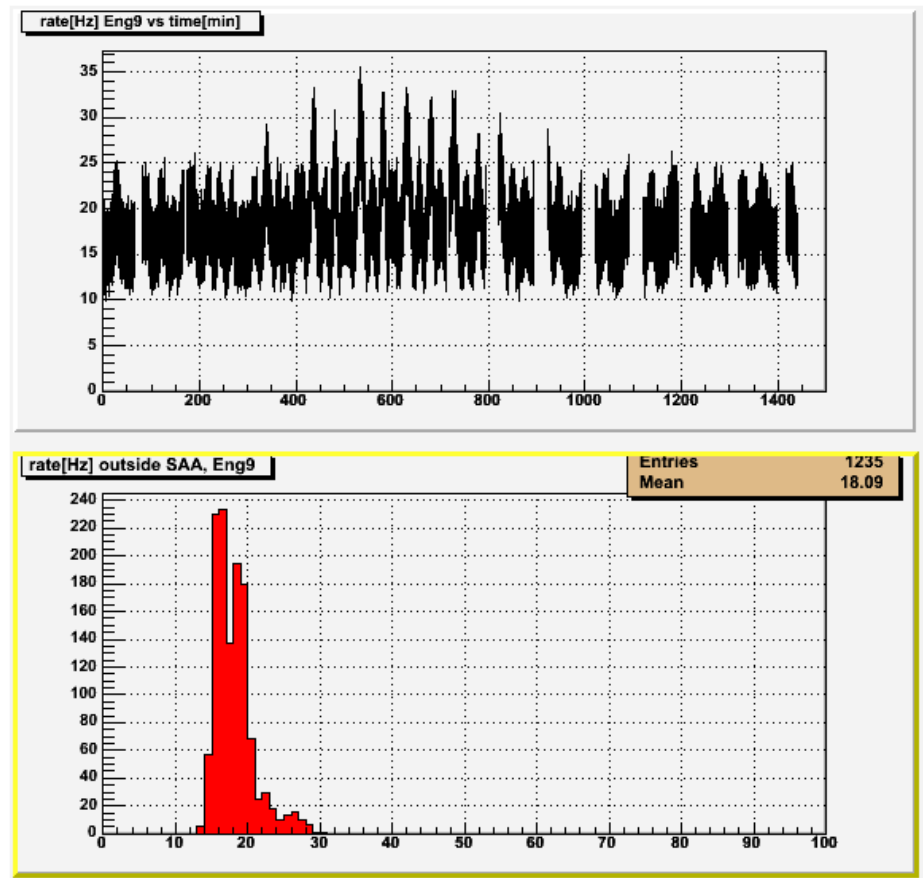
Note: zoomed scale

Engine 4 rate

- ❑ **Content**
  - – **Other "CNO" triggers, garbage**
  - – **LE protons, electrons**
- ❑ **Condition**
  - – **CNO && (don't care)**
  - – **Except eng 3 combination**
- ❑ **Context**
  - – **1-range, zero-suppressed**
  - – **Prescaled by 256**
  - – **Marker = 7**
- ❑ **Rates**
  - – **Mean ~ 5 Hz**
  - – **Peak ~ 14 Hz**
- ❑ **Note: why keep these?**
  - – **Need to study this class further to be sure we're not suppressing gammas**
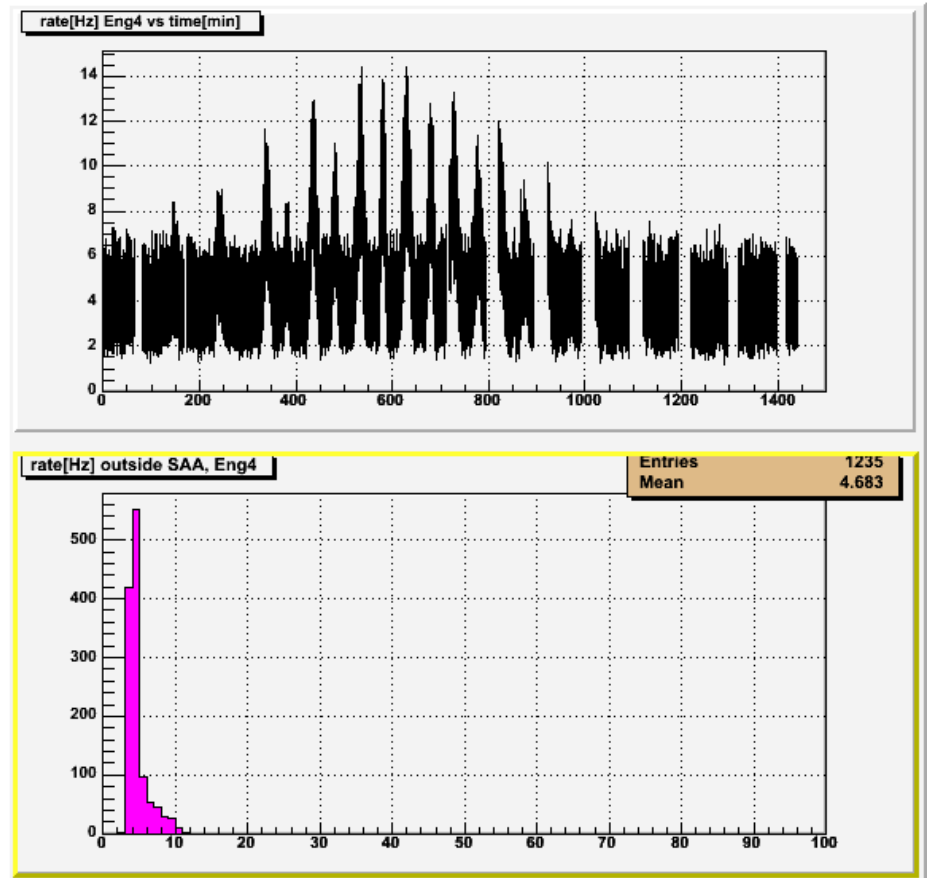
Note: zoomed scale

Conclusions

- ❑ **Proposed Trigger Scheduler and Engine definitions**
  - – **Engines cover all trigger sources**
    - • Gammas, including self-vetoes
    - • Heavy ions for CAL calibrations
    - • Leakage of protons for alignment and calibration
  - – **Rates high but acceptable(?)**
    - • Mean ~ 3 kHz
    - • Peak ~ 6 kHz

- ❑ **SLAC running (e.g. test case LAT701)**
  - – **Use this Scheduler**
    - • Contains all configurations we need, including External
  - – **Change Trigger Context**
    - • Remove prescale of Engine 9, TKR && ROI && !CALLO && !CALHI && !CNO, since it's our primary source of muons
    - • Remove prescale of Engine 4 so we're sure to see one if it occurs