High Initial Luminosities at D0

Bill Lee

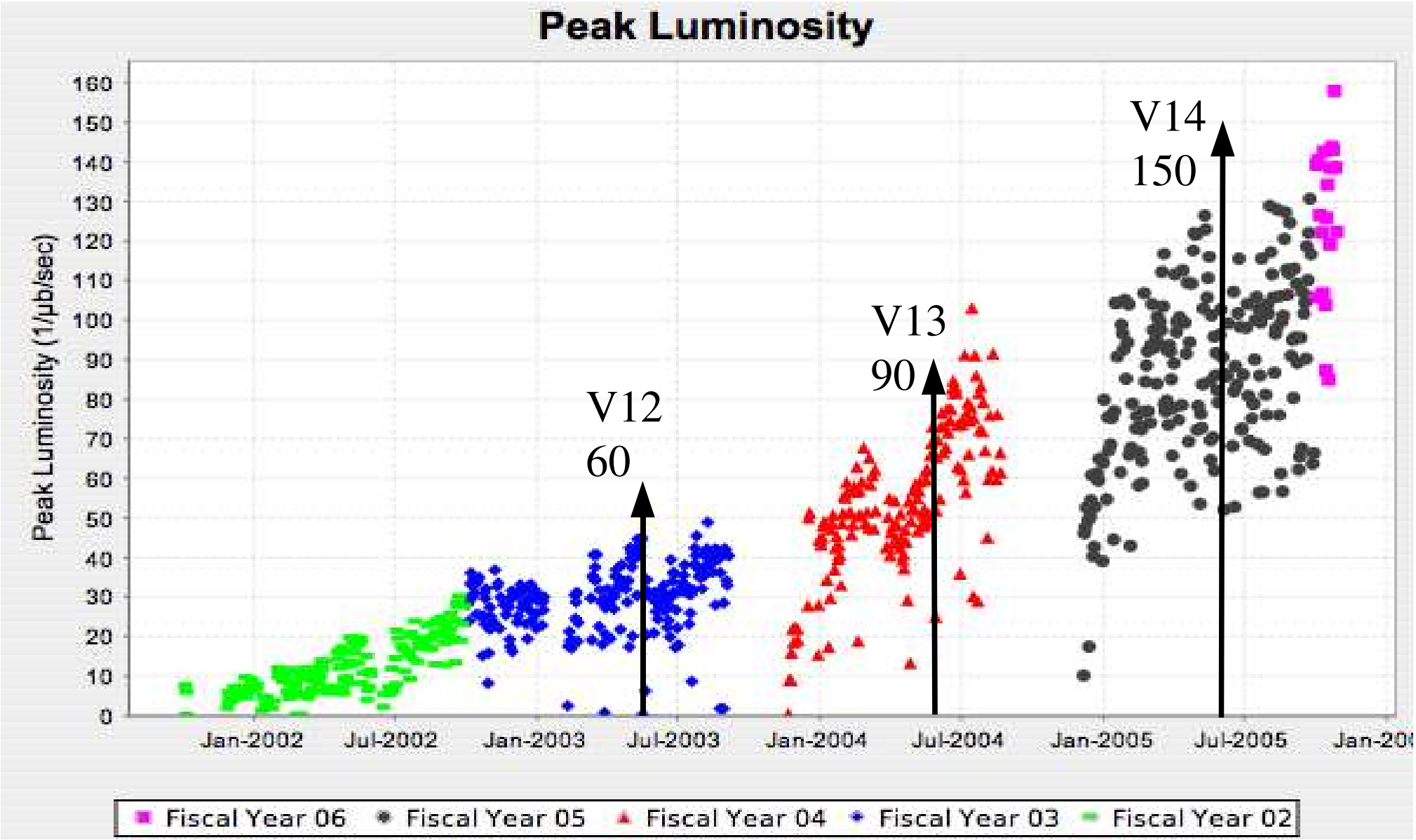
Joint Luminosity Meeting
1 November 2005

Progression of Initial Luminosity

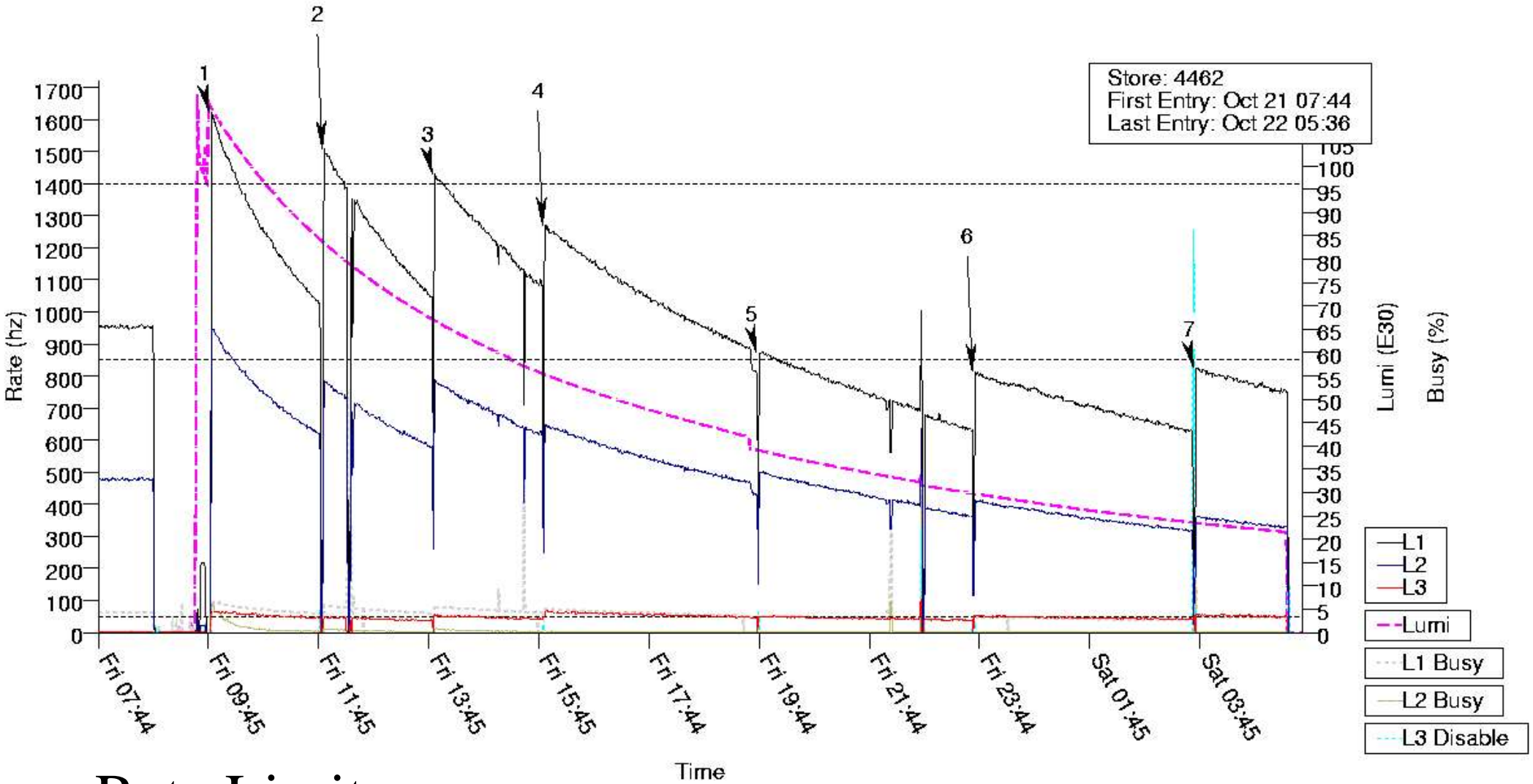
Initial Luminosity (E30)	Store	Start Time
157.99	4477	2005 Oct 31 09:25
149.91	4473	2005 Oct 27 02:53
136.69	4468	2005 Oct 25 03:29
136.40	4465	2005 Oct 23 19:20
123.83	4401	2005 Sep 25 11:19
119.12	4318	2005 Aug 04 17:18
117.57	4138	2005 May 12 17:42
115.24	4118	2005 Apr 29 09:49
111.48	4116	2005 Apr 27 18:51
109.17	4053	2005 Mar 21 10:26
105.99	4048	2005 Mar 18 13:17
96.09	4002	2005 Feb 23 19:03
93.85	3952	2005 Jan 29 20:07

Initial Luminosity (E30)	Store	Start Time
93.57	3657	2004 Jul 16 11:53
84.32	3621	2004 Jul 6 23:21
77.20	3588	2004 Jun 22 11:36
75.46	3586	2004 Jun 21 00:58
71.88	3574	2004 Jun 14 15:16
70.98	3562	2004 Jun 7 15:18
68.21	3534	2004 May 26 18:09
65.70	3532	2004 May 25 07:54
64.06	3261	2004 Feb 27 16:42
59.47	3245	2004 Feb 18 22:06
56.04	3219	2004 Feb 5 15:56
52.65	3217	2004 Feb 4 04:16
52.46	3214	2004 Feb 2 11:28

Trigger Lists and Target Lumi



DAQ Rates



- Rate Limits
  - L1 – 1400 Hz L2 – 1000 Hz L3 – 50 Hz

L1 Rate

- Rate Limit of 1400 Hz
  - L1 busy (deadtime) is proportional to L1 rate.
  - 1400 Hz keeps our L1 busy to below 5%.
- L1 issues
  - L1 trigger rates are non-linear.
  - As we go to higher luminosity, we tend to violate the 1400 Hz limit choosing to run at a higher FEB
    - This keeps more physics triggers running, but all triggers experience a higher deadtime.

L2 and L3 Rate

- L2
  - Rate Limit 1000 Hz
    - Design limit
    - This limit is mainly due to the amount of time it takes the calorimeter to digitize its data to send to L3.
  - L2 Issues
    - L2 rates can be limited by L3's ability to process data.
- L3
  - Rate Limit 50 Hz (design), but can actually write much faster.
  - L3 Issues
    - Processing time
    - Event size (increases with higher Luminosity)
      - If L2 rate and event size get too large, can reach ethernet limit.

High Luminosity Running

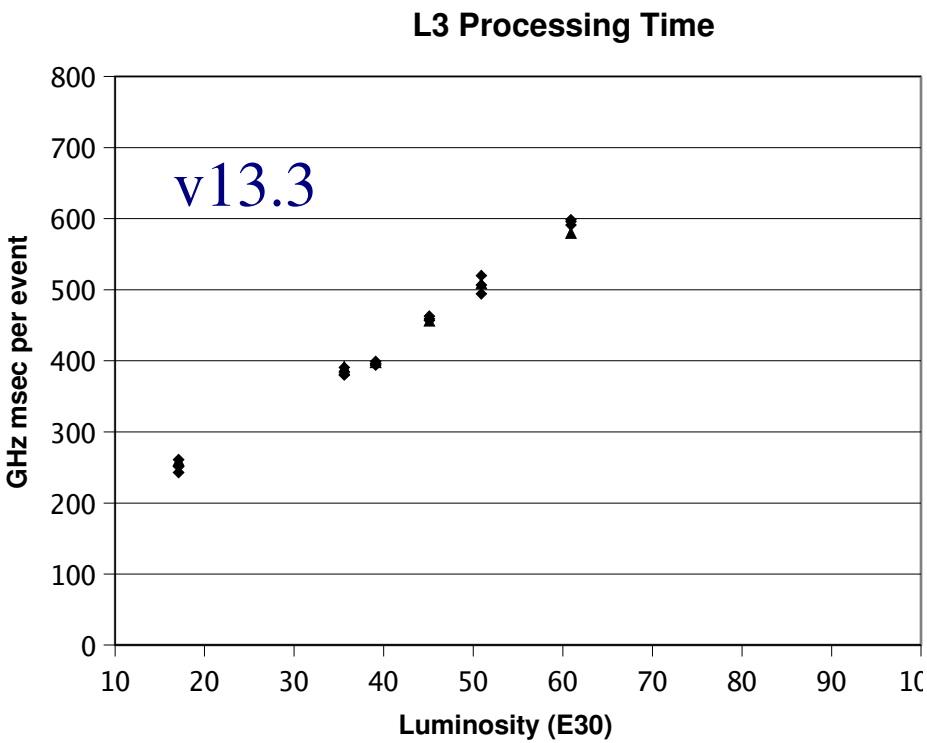
- For most of Run II, D0's ability to run at higher Luminosity has been a function of the quality of the trigger list being used.
  - In order to run at a given luminosity, a new set of triggers needs to be created to keep the rates within the allowed limits.
    - This will require the development of new tools to increase rejection without losing efficiency.
  - Another method of keeping a high efficiency is to use multiple triggers to cover a larger phase space.
- So far, D0 has been able to develop trigger lists to keep up with the higher luminosity.

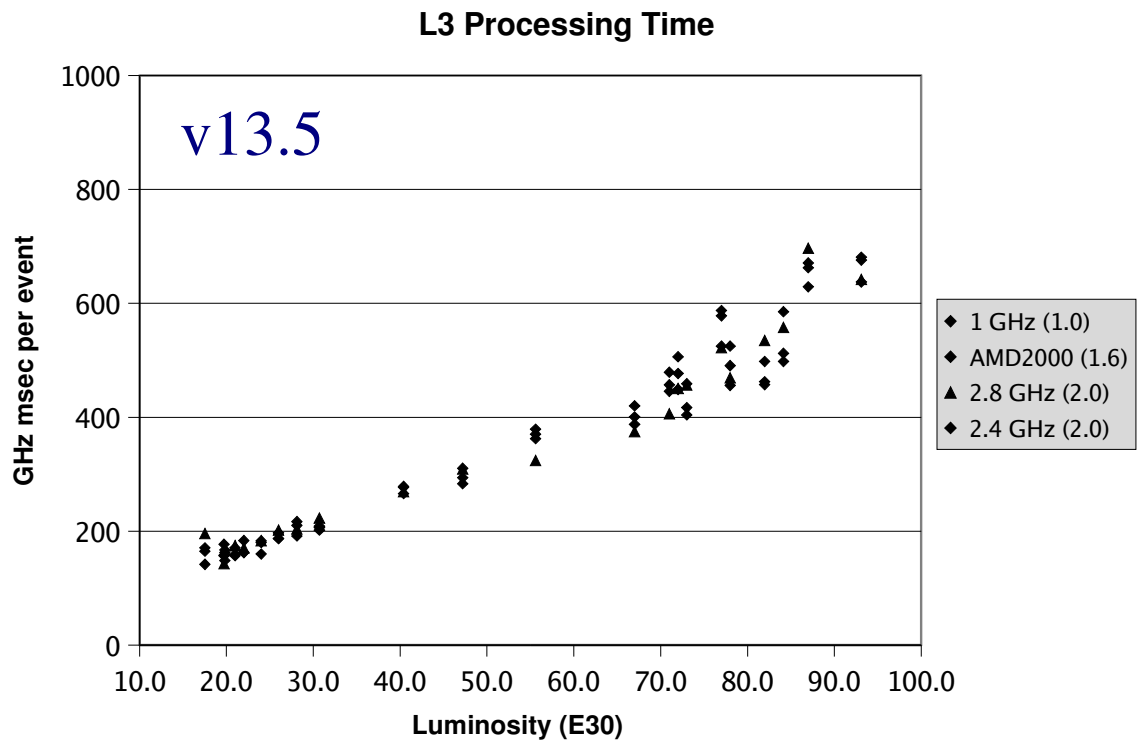
Ethernet Troubles

- In 2004, as luminosities grew, we began to see that the event size was increasing as the events grew more complicated.
  - This caused us to reach the 100 Mb ethernet bandwidth for sending events to L3.
  - The solution has been to switch to gigabit ethernet cards for those detectors that have large event sizes.

L3 Processing Time

Coming out of the 04-05 shutdown, disables occurred because L3 could not process the data fast enough to keep up with the L2 rate.





Times reduced by:

- Improving L3 algorithms, triggers
- Reordering triggers to run faster triggers first

In addition we have increased the capacity of our L3 Farm.

L2CTT Crate

- When the luminosity began to go above 120 E30, we found that the L2 busy rate for one of our L2 crates was becoming high as well as it was losing sync. This was actually two separate problems.
  - A logic flaw was quickly discovered which solved the sync problem.
  - It was discovered that the L2 system was not reading efficiently across the VME backplane. There were also some timing issues located in the event loop.
    - While this situation has been greatly improved by modifications to the readout mode, it is not entirely resolved and still being investigated.

Advantages of Leveling

- Bunch to bunch leveling is most important to D0.
  - It has been seen during stores with wide variations in bunch population that out prescale sets no longer apply to the given luminosity. This is because of the nonlinearity of our trigger rates.
- Leveling during a store
  - Reduces the need to change prescale sets.
  - Reduces the number of high multiple interaction events.
  - High instantaneous luminosity impacts our efficiency in detecting many physics processes.
    - Muon isolation
    - Track multiplicity

Summary

- So far D0 has been able to cope with the rising luminosity.
  - Higher luminosities have pointed out limitations of our detector, but we have so far been able to solve them.
    - We hope that even higher luminosities will continue to help us find and address detector issues.
- It is mainly choosing a good set of triggers that will allow D0 to run at high luminosity.
- Leveling will be useful, but since we will be going to higher luminosity, it is helpful to illuminate our limitations early.
  - It is, of course, integrated luminosity that we want to maximize.