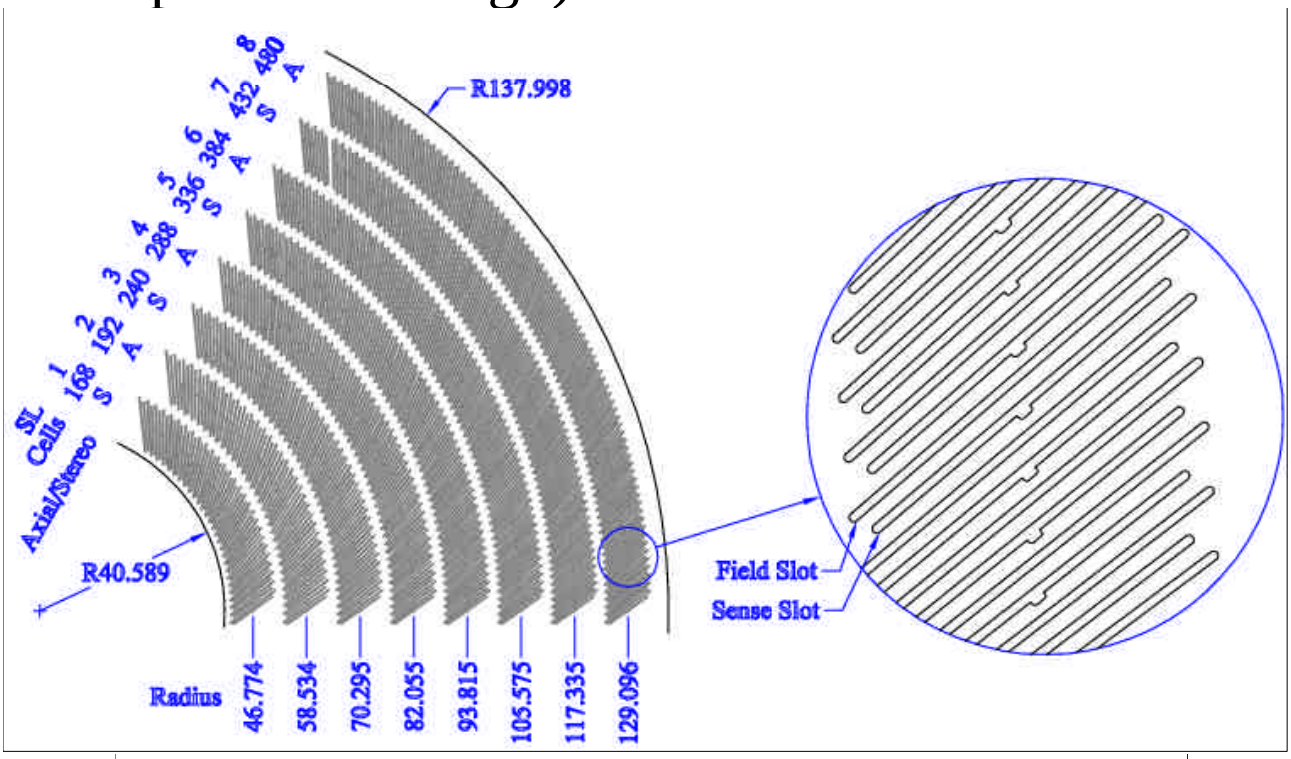
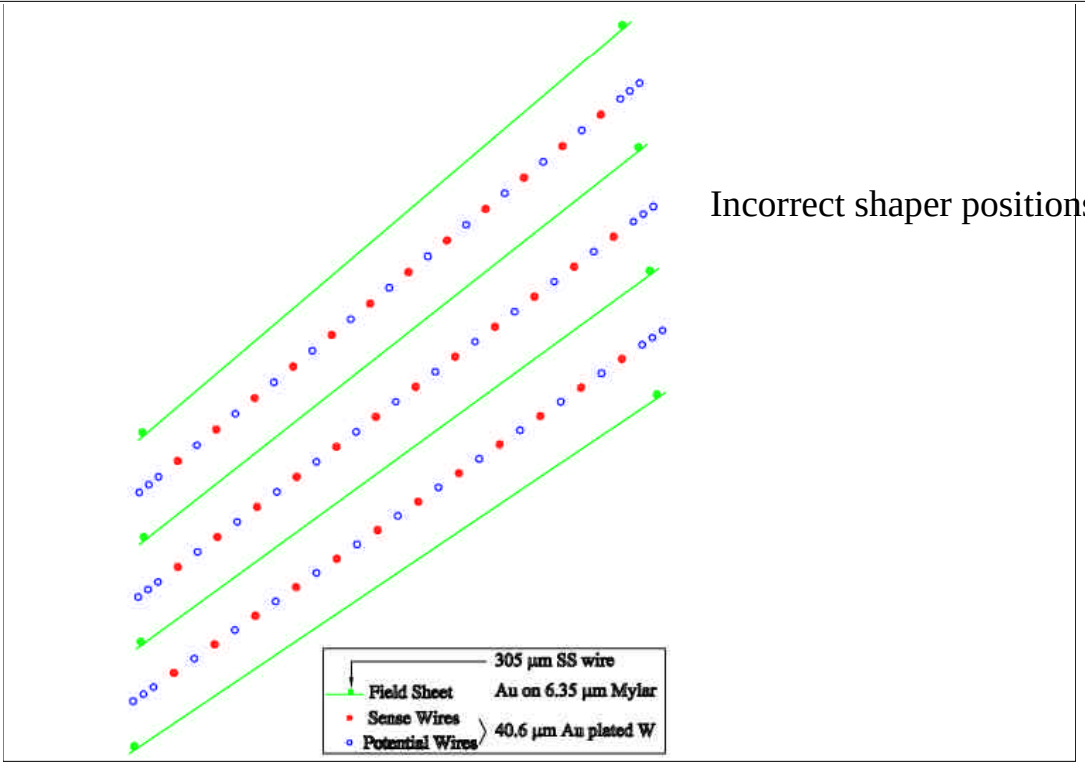
Gain drop due to wire aging in the COT

- Evidence for gain drop with time in data.
  - Quite consistent picture from cosmic rays and collisions (gjet, minimum bias)
  - Greater drop with increasing integrated current (SL2 most, SL8 least)
  - ϕ dependence: Largest on the bottom
  - z dependence: Increases from West (-z) to East.
- Here show the high statistics studies of Kevin Burkett using the gjet sample
  - Tracks from this data set have very stable η and pT distributions over time.
  - Uses pedestal-subtracted pulse width, which is proportional to pulseheight, for width .vs. time plots.
  - dG/G ~ 6 dT/T ~ 6 dP/P, where G is gain, T is absolute temperature and P is absolute pressure. Kevin's data is corrected for absolute pressure (although not perfectly).
  - Looked for and did not find a significant dependence on instantaneous luminosity

Reminder of basic design and geometry

- 1/6 Section of COT End Plate (Super Layer / Super Cell Design)

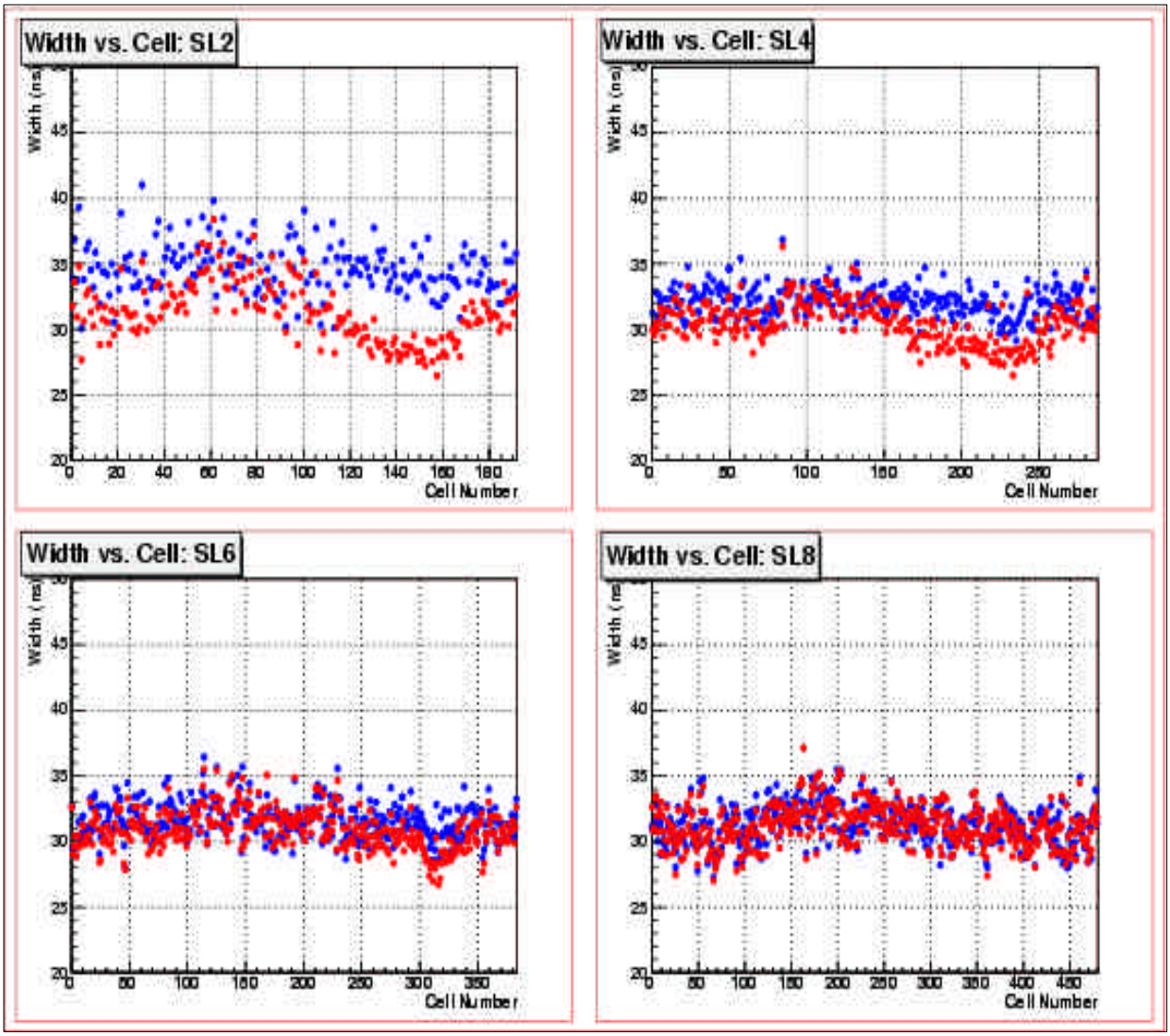




Incorrect shaper positions

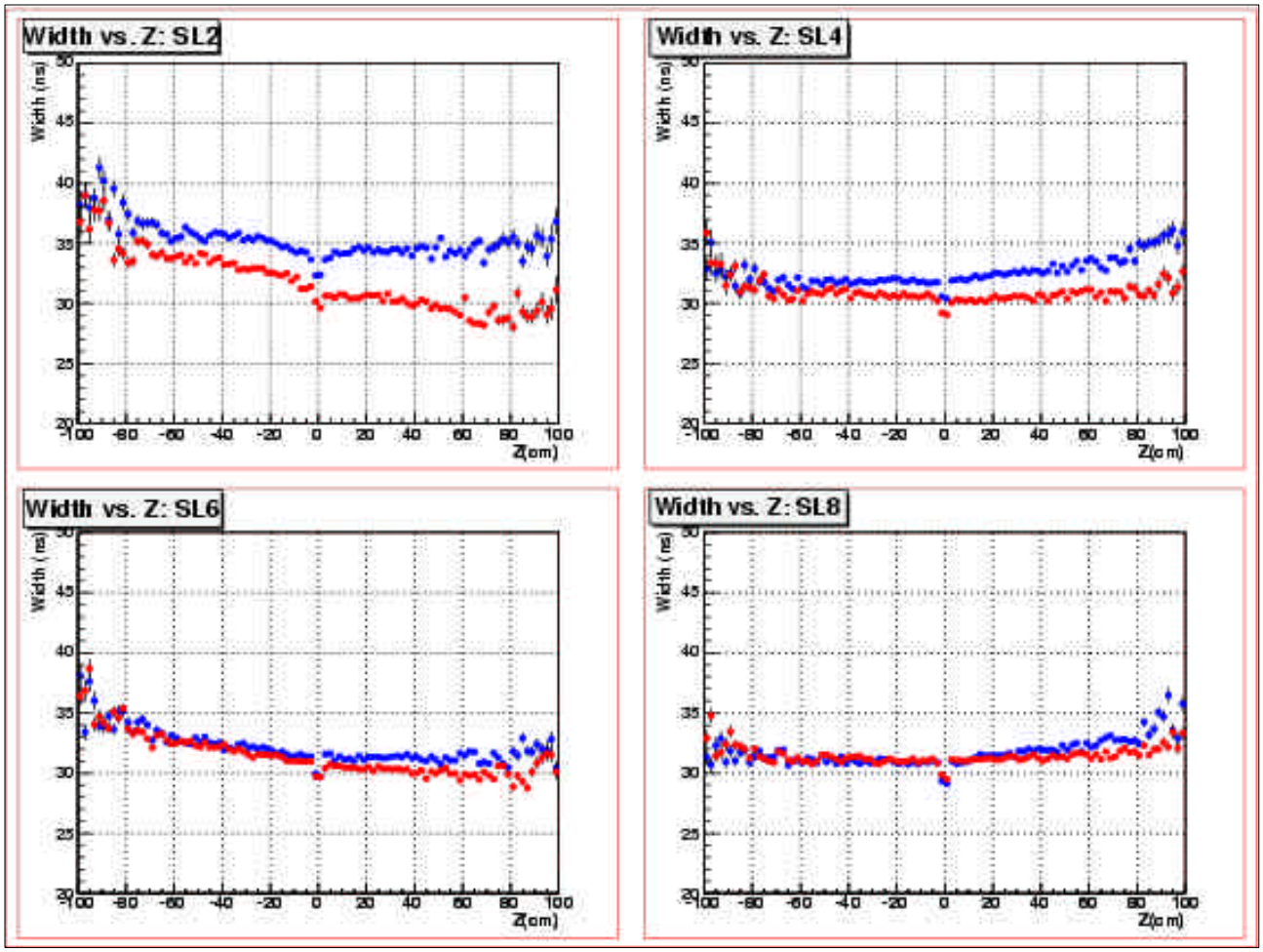
Width versus cell (ϕ) (Axial Layers)

- Run 149663 (very early run)
- Run 168820 (just before Fall '03 shutdown)



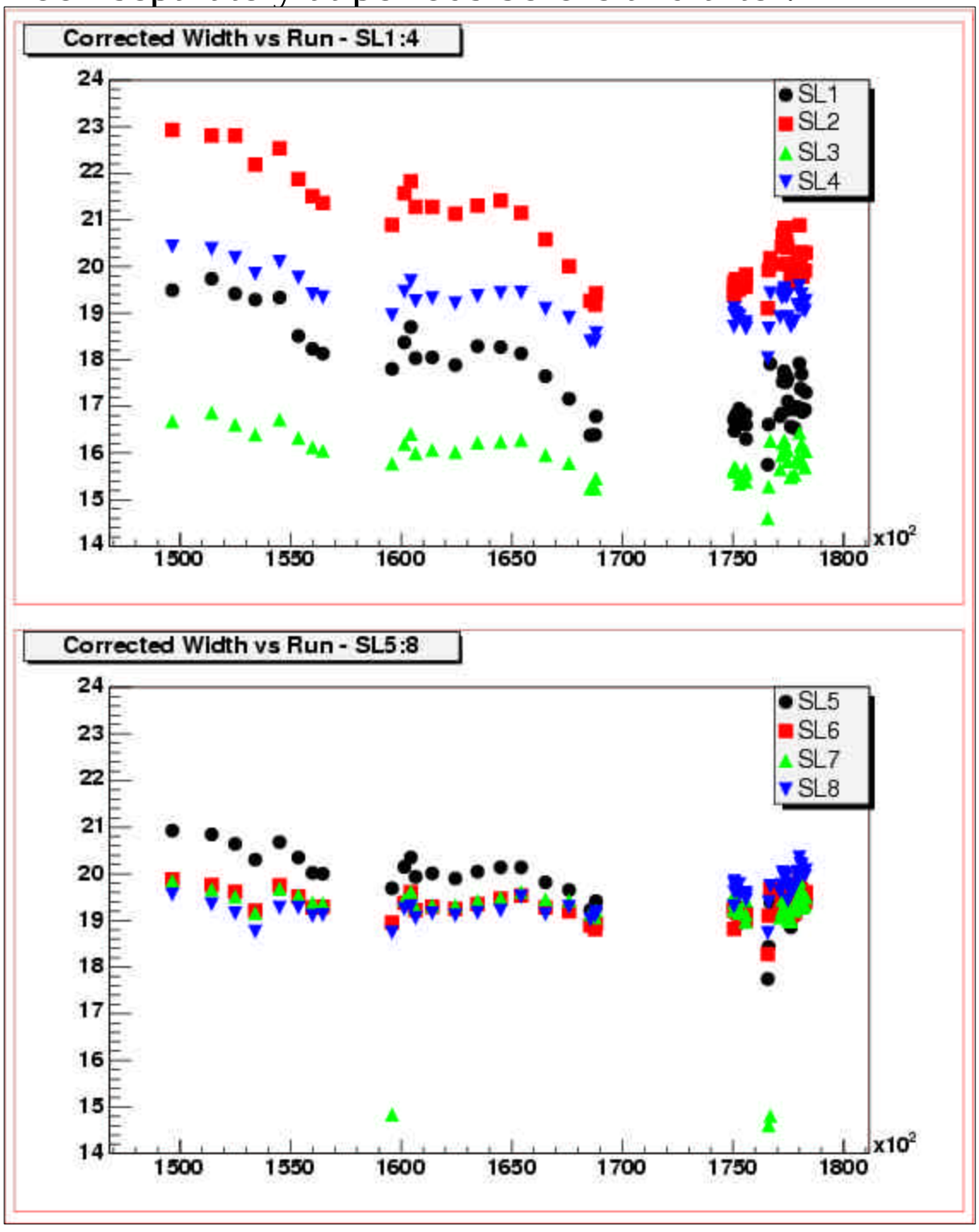
Width versus z (Axial Layers)

- Run 149663 (very early run)
- Run 168820 (just before Fall ’03 shutdown)



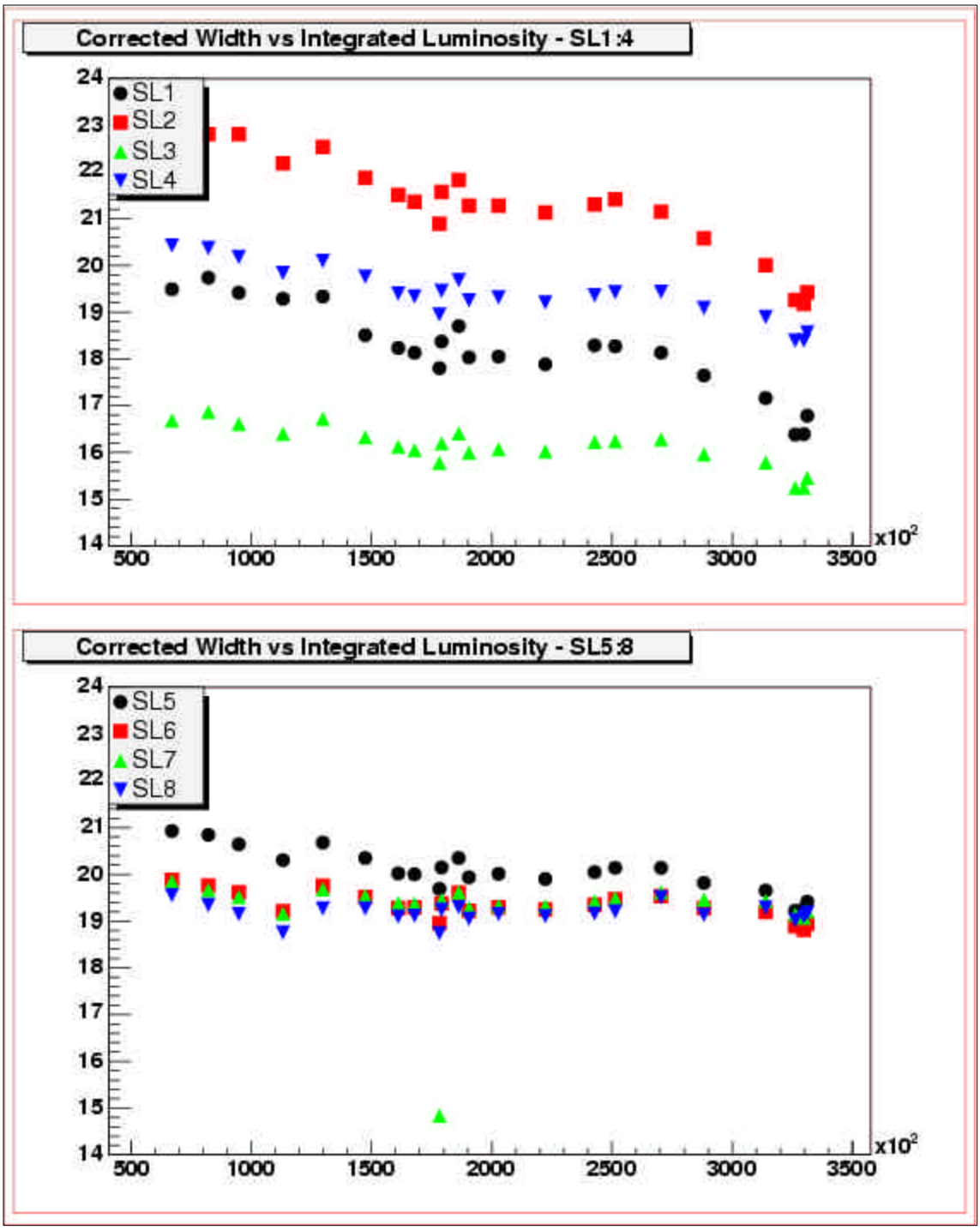
Width .vs. Run Number

- Note that there is little change immediately before and after the Fall ’03 shutdown.
- Look separately at periods before and after.



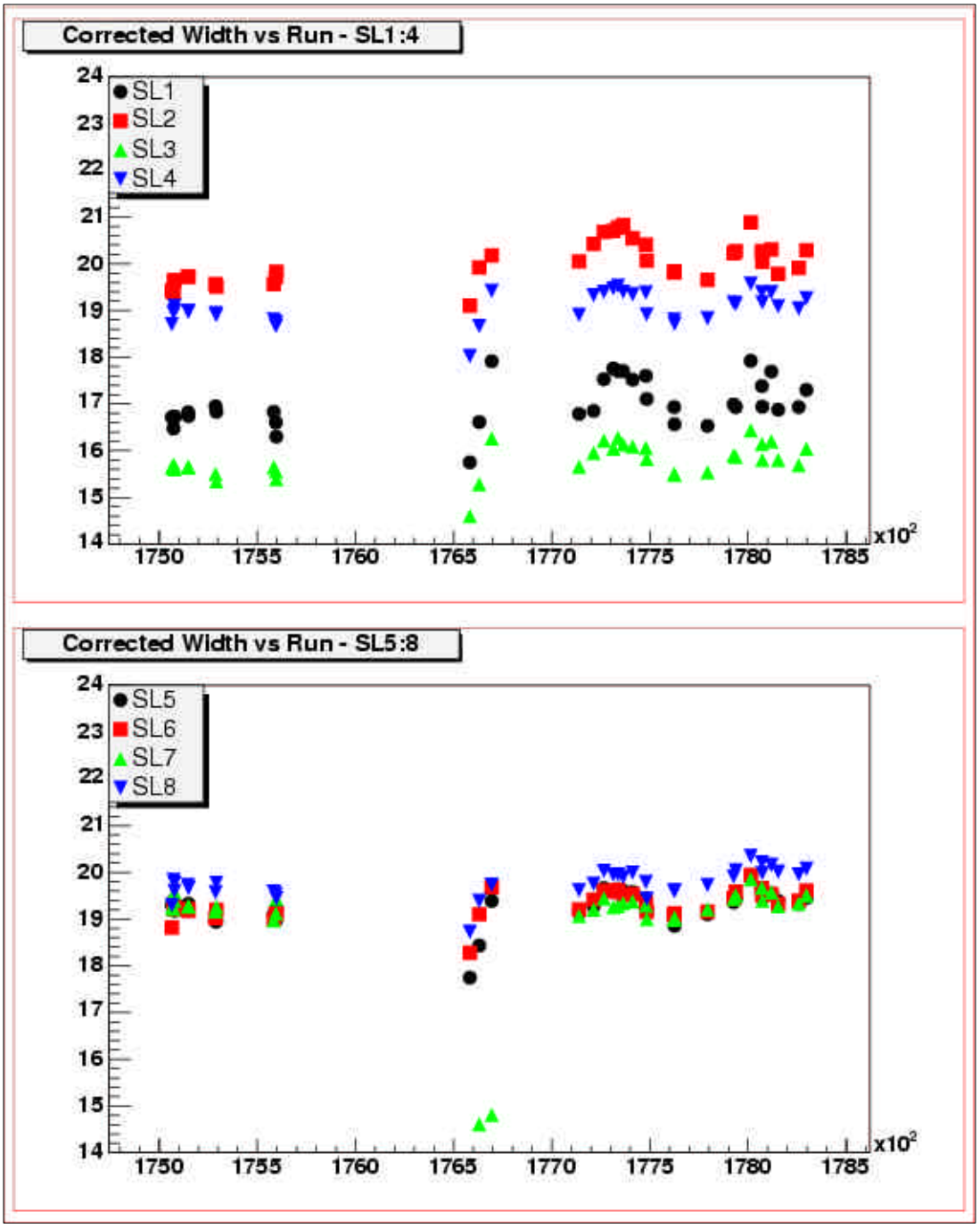
Width .vs. Integra. L (before shutdown)

- Significant drops 11/02-01/03 and 06/03-09/03.



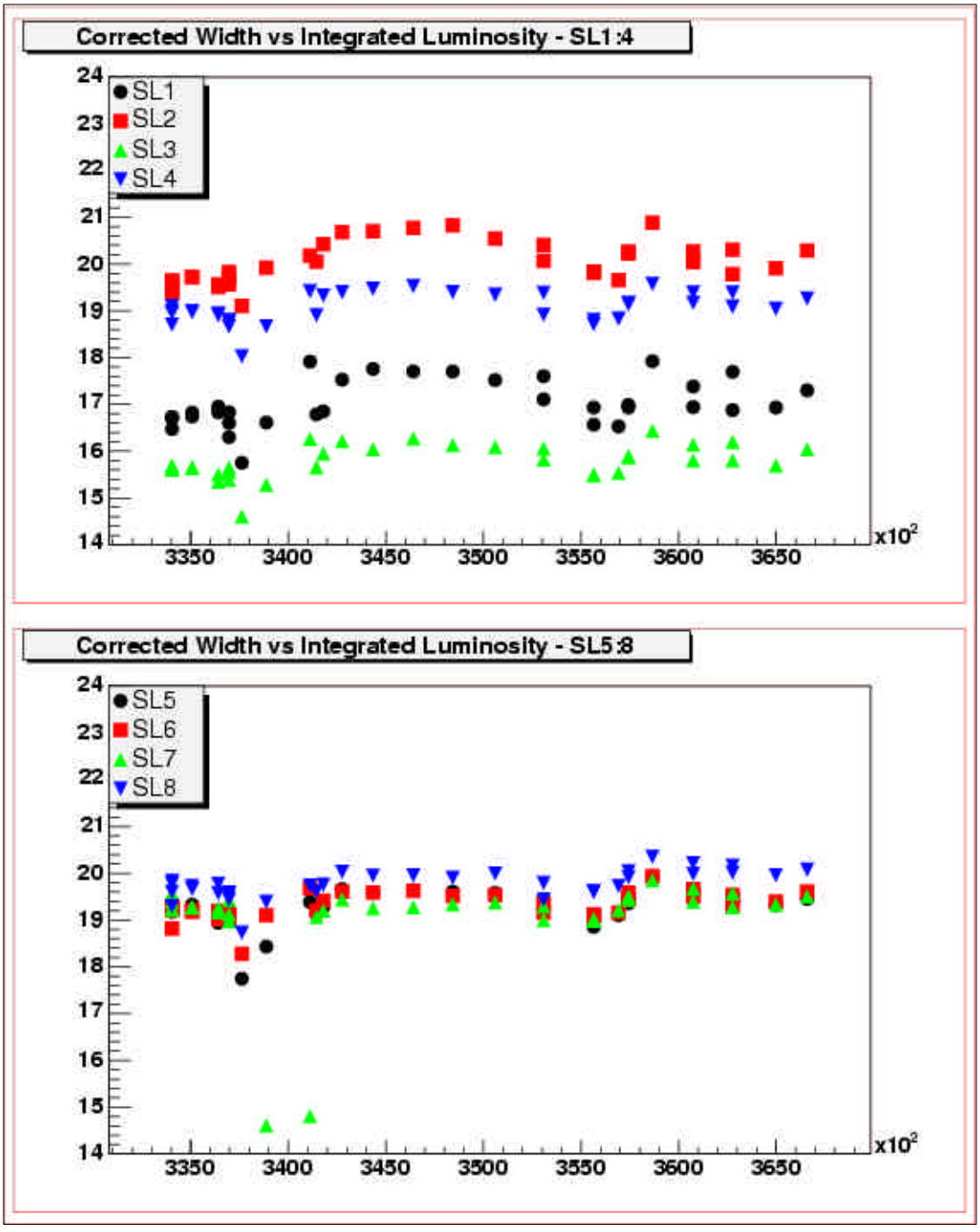
Width .vs. Run (after shutdown)

- Runs 176600+: Recovering from N2 test.
- Runs 177400+: Mistake in gas mixture and recovery.

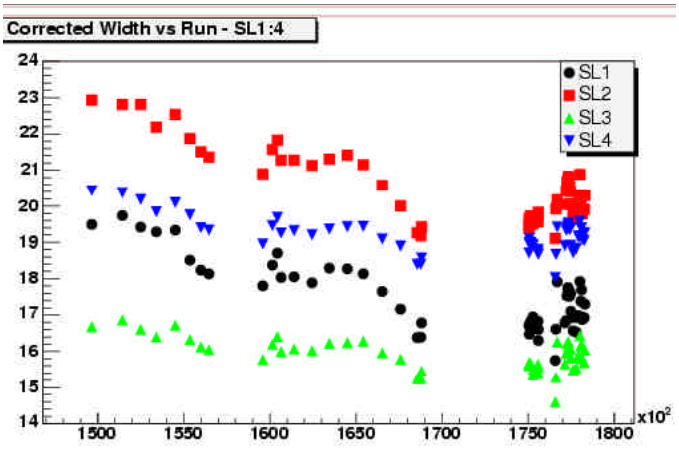


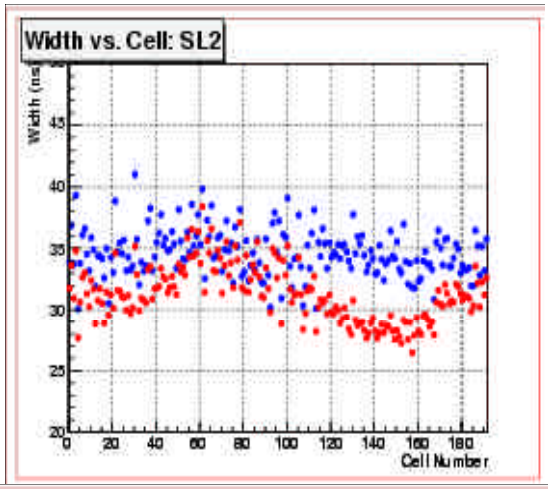
Width .vs. Integra. L (after shutdown)

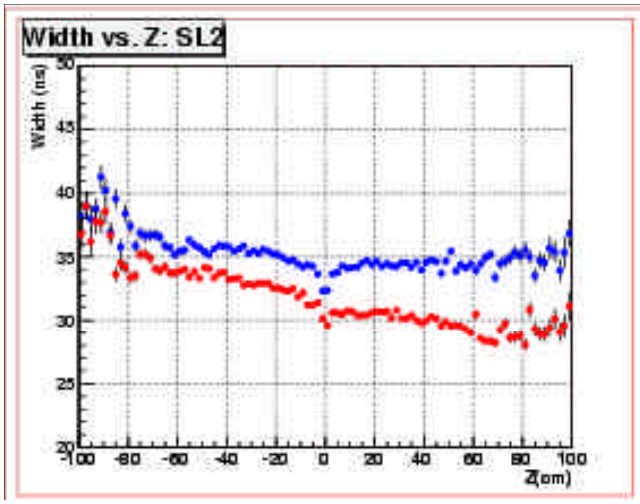
- No indication of gain decrease for ~1 month after the Fall ’03 shutdown.

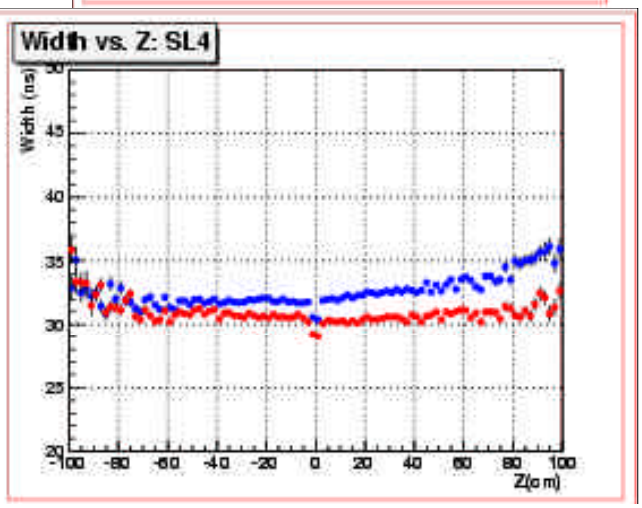


Questions





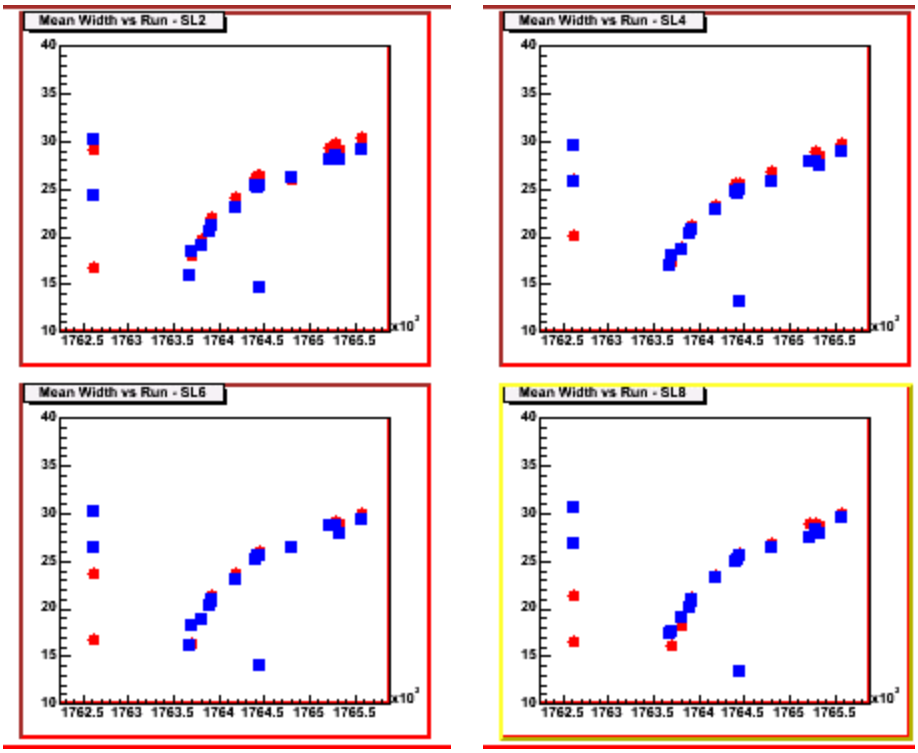




- Time dependence: Why the sharp falls and why the apparent “bump up” after long shutdowns?
- z dependence: Gas input at z = -150 cm. Is the flow rate too small? “Contaminants” from the chamber materials or interactions?
- ϕ dependence: What is the temperature and flow variation with ϕ? Is there more radiation on the bottom?
- What about the Gas Monitor Chambers and HV currents?

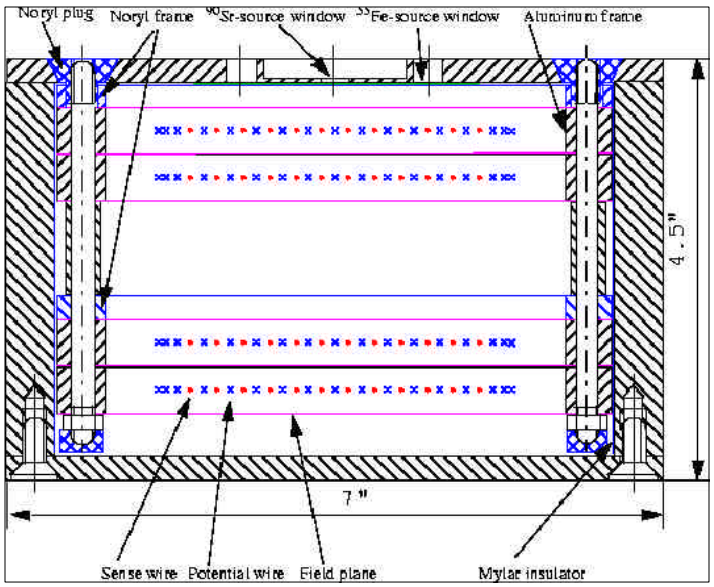
f dependence: HV currents, Gas flow

- For a test, installed separate HV supplies for SL2-S5 top and bottom.
- Fit current versus instant. L with losses ~constant.
  - I(Lost P=5000) ≈ I(L = 5E29): Losses are a small contribution to total current.
  - Bottom current ~10% less than top: About what you would expect from measured gain drops.
- Flow N2 for 9 hrs. then switch back to argon/ethane. Monitor top and bottom widths from cosmic runs:
  - In “recovery”, densities of input gas and chamber gas within a few percent.
  - No big difference between top and bottom and radius: Flow of new gas quite uniform.



Gas Monitor Chambers

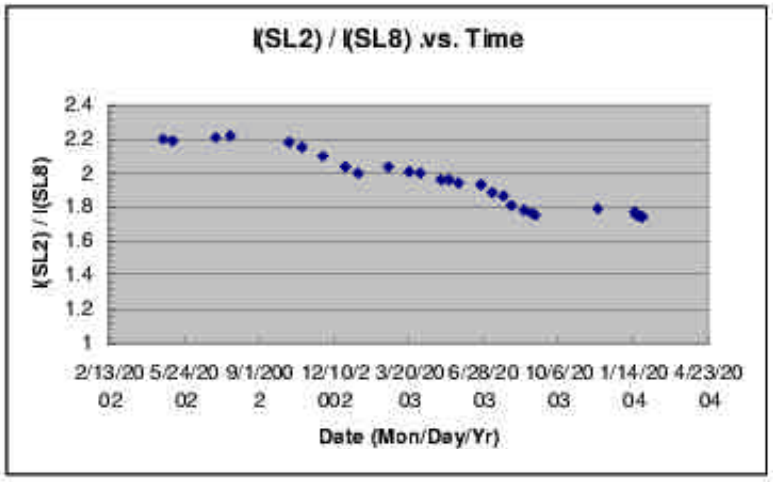
- Gas Monitor Chambers (GMCs) are located just downstream of the alcohol bubbler (GMC3) and in the Collision Hall at the input donut (GMC1) and output donut (GMC2).



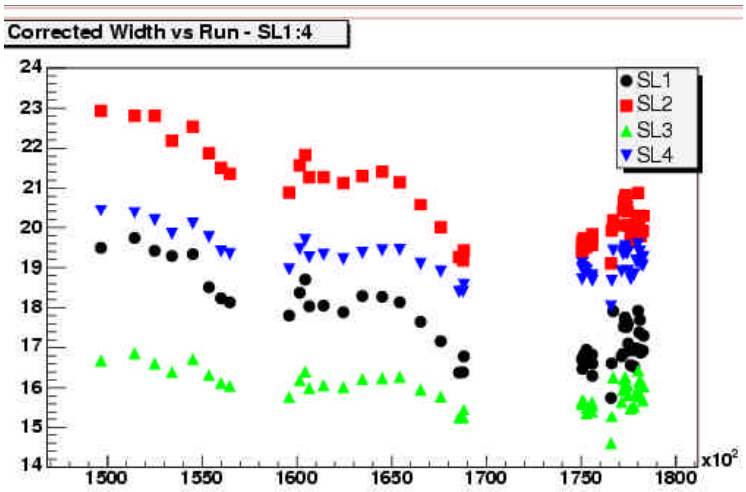
- Continuous measurements during Run 2: Current ratios of 3 top planes to bottom plane with Sr90: Gain drop in all planes in all GMCs < 2% /coul/cm.
- In December ’03, we checked this result for GMC3 and GMC2 using Fe55. The top plane in GMC3 saw a gain drop < 0.15% /coul /cm and the top plane in GMC2 saw a gain drop of (0.6 ± 0.15)% /coul/cm.
- The average gain drop in SL2 of ~20% corresponds to ~400-500%/coul/cm. What causes the difference, particularly compared to GMC2 at the output donut?

Time dependence using HV current

- Use the ratio of the HV current in SL2 to that in SL8 to track the time dependence of SL2 gain loss.



- Compare to corrected width versus run number (time)



- Similar slight “bump up” after January ’03 and Fall ’03 shutdowns.
- However, current indicates a steady decrease (although at reduced rate) immediately afterward.

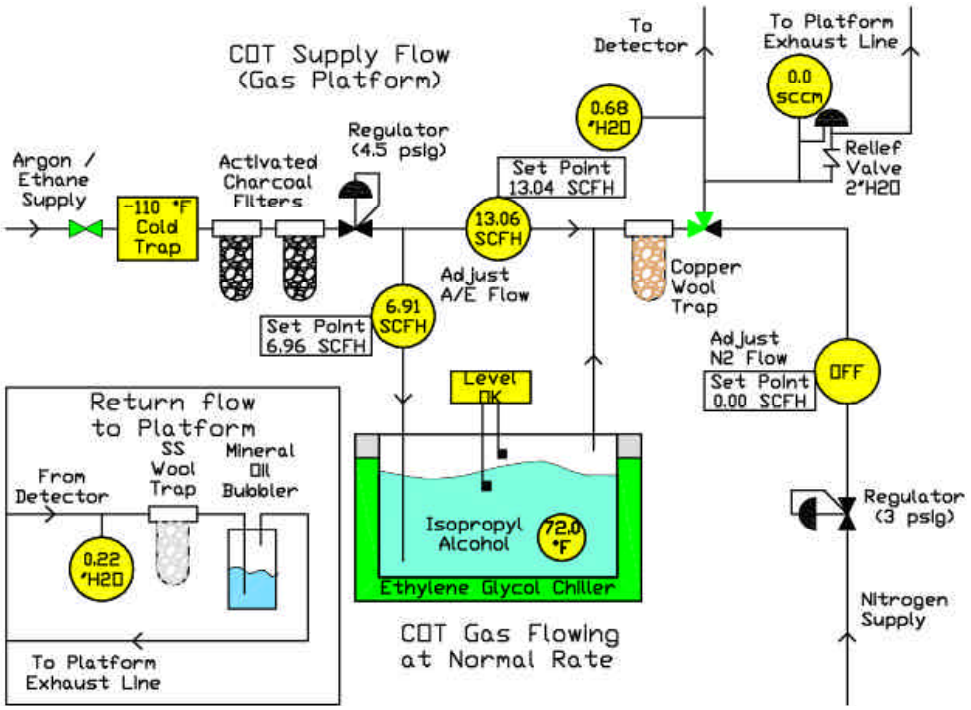
Discussion

- z dependence + lack of aging in output GMC
  - **Assume something harmful is accumulating in the gas as it flows through the chamber. For any type of contamination, increasing the flow rate should help. (Likely not true if alcohol aerosols being produced in colder areas of chamber).**
  - **Aging meetings: Groups report aging problems with too little flow. Groups report increased aging "downstream" when the wire is irradiated along it's length.**
  - **Morris suggests that it may be negatively charged radicals produced in avalanches that stay near the sense wires. The gas mixes in the output donut before reaching GMC2. The GMCs have a much larger volume exchange rate than the COT.**
- Time dependence
  - **No significant drop (width or current) until ~ Nov '02. Is there a luminosity threshold? What is the dependence on instantaneous luminosity?**
  - **Some indication of temporary improvement after the long January and Fall '03 shutdowns.**
  - **Not much done during shutdowns: Time off, Run in nitrogen, Exchanged alcohol in bubbler.**
  - **Aging meetings: There are reports of slight recovery after time off.**
  - **More "gas system maintenance" (eg, replace alcohol, filters) can't hurt if done carefully.**

Discussion

- f dependence
  - There is more aging on the bottom than on the top. There is also a lesser hot spot for aging at 45°.
  - So far, measurements indicate that the radiation dose and flow rates are uniform. Flow rate needs more study.
  - There is a temperature gradient (colder on the bottom and warmer on the top), but the last significant decrease in Silicon cooling temperature was in August ’02, before any gain decrease is seen.
  - Possible “indirect” effect of lower temperature: a) aging rate increases as the gas temperature decreases? b) Problem with alcohol condensation in colder areas (ie, near Silicon cooling lines and near bottom of detector?)
  - Some heavy contaminant migrating toward the bottom of the chamber? (GMC2 taps off the donut nearer the top).
  - Dave checked that there is no ϕ dependent change in the ASDQ response.

What are we doing?



- Increased flow rate from 20 to 40 SCFH
- Working on increase to 60 SCFH (ASAP).
  - **Cold trap modification (hopefully just replace one line)**
  - **Raise temperature of alcohol bath and add thermal insulation to lines.**
  - **Replace passive pressure relief with APACs controlled valves.**
- Have procedure for replacing alcohol while COT in argon/ethane (can do between stores). Done on 1/26/04.
- Soon replace charcoal filter and inspect copper wool

What are we doing?

- Ran some SL2 sense wires at +100v between stores to see if negative radicals would move away. This had no effect on the rate of gain drop.
- Set all layers off instead of at 40% HV between stores so that polarizable molecules would tend to drift away from the sense wires. This had no effect on the rate of gain drop.
- Difficult to pin down dependence of aging on wire current (i , i^2 ..?). Morris and Aseet can discuss this in more detail.
- Increasing the flow from 20 to 40 SCFH at best had a small effect on the rate of gain drop.
- Del sent samples of our gas to be analyzed by specialists in mass spectrometry. He will start with the input gas, but will eventually take a sample of the output. Samples from all ethane trailers look very clean. No striking correlation between changing trailers and changing aging rates. Rob can comment.
- Taking some stores with Silicon warm to investigate temperature effects: in progress.
- Taking some stores with 1-2% nitrogen in the gas (~9% gain drop) to investigate “bumps”: in progress.

What are we planning?

- Beyond 60 SCFH, we must reuse the gas. We have a design for re-circulating the gas at 200 SCFH with 40 SCFH makeup.
- Make direct measurements of flow and temperature of gas in lines through 30º crack.
- Reverse flow to test interpretation of z-dependence.
- A JHA is ready for an access to swap out a wire plane on the bottom of SL2 (4-5 days in Hall, 7-9 days until COT ready for data).
  - Analysis of wire growth with Scanning Electron Microscope (elements) and Fourier Transform Infrared Spectroscopy (molecules).
  - Run wires in test chamber and try to reverse aging (Start with ~5% mixture of CF_4 in Ar/Et)
- Swap out GMC2 (output donut) and analyze the limited growth on its wires.
- Run a GMC cold (better simulate COT temperatures).
- Use Garfield and Magboltz to find possible mixtures with CO2 (no hydrocarbons).
- Setting up radiation damage test on pre-production prototype. Start with Ar/Et/CF_4(50/35/15). Did not see problems with this mixture in small, less realistic, prototypes.