

The LST HV for the barrel and rear muon chambers in Zeus and some extrapolations to BaBar. V1.0

The HV system in Zeus is composed by:

- HV power supply CAEN SY127 equipped with A332 (6KV/1mA) modules (similar to the ones currently used in the IFR) providing the regulated HV
- HV distribution crates CAEN SY227 equipped with distribution board A279 that receive the HV from the A332 modules and distribute it to 32 channels providing also current monitoring. The board didn't allow for remote switching of single output channels, but manual disconnection was always possible.

The SY227 is no longer in CAEN catalog, so I'm including an old data sheet that gives an idea of what it is.

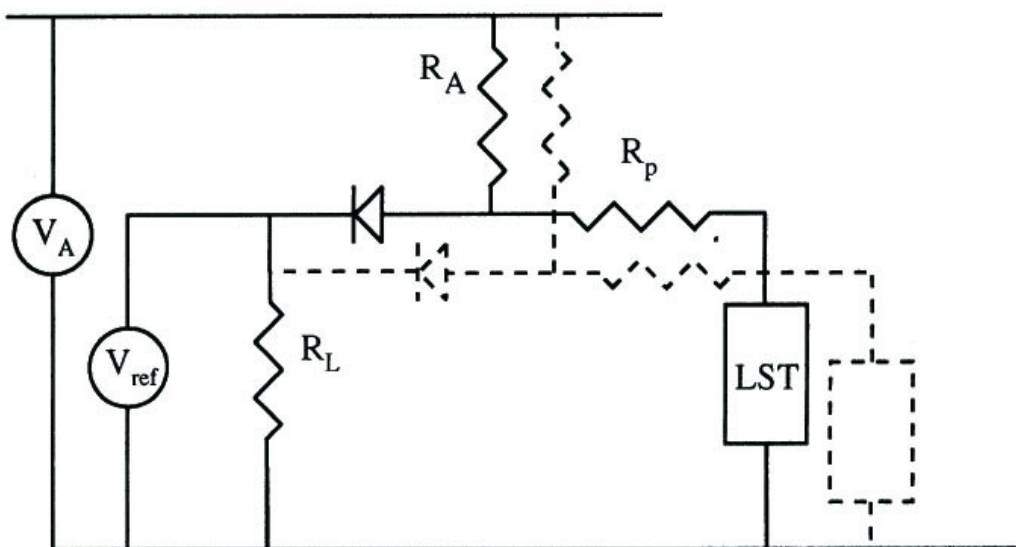
HV multi-conductor cables (~ 50 wires each), ~ 60 m long, connect the LST to the distribution board. One distribution channel serves two 8-cell profile. Connectors on both sides of the cable are simple "banana" like one pin male connectors, soldered to each conductor. The HV system was located on balconies attached to the detector in a region where access was possible at any moment during Hera operation.

One well known problem with LST is that, especially in the very first part of their life, there is a certain probability of having self-sustained discharges.

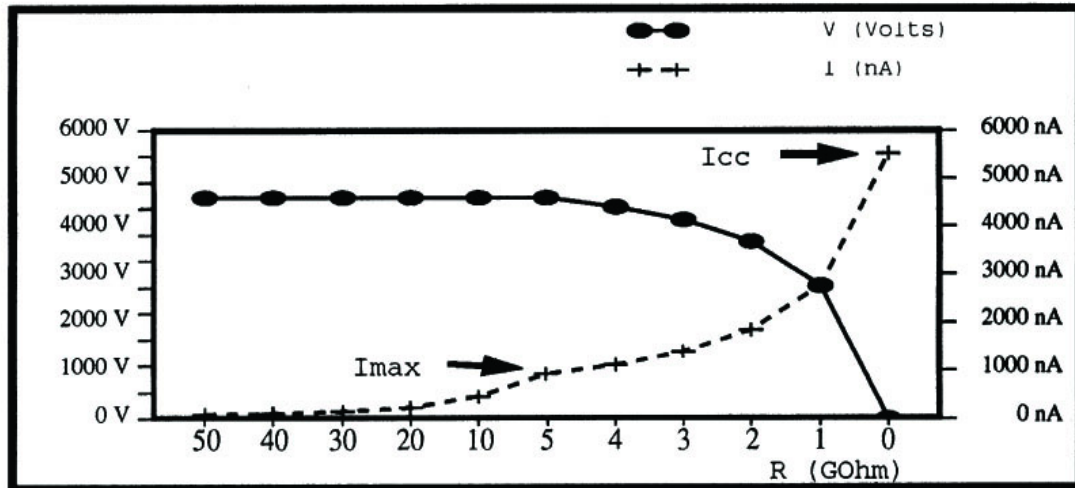
In these cases it was shown that leaving the LST under large currents was, not surprisingly, causing permanent damage.

Therefore it was common practice to "condition" new LST by going through HV cycles since such treatment was shown to recover some of the discharging tubes. After weeks of operations, the amount of LST showing large discharges usually drops significantly, but it does still happen from time to time. This may lead to non negligible detector inefficiencies if HV has to be taken down to inhibit the growth of the discharges.

Therefore for Zeus we modified the SY227 boards by inserting a simple passive current limiting circuit.



Basically when the LST is working normally the voltage seen is V_{ref} , when it draws current above a certain threshold the diode becomes reverse polarized and the current gets limited by R_A . The relationship between current and voltage is represented in the following plot, as a function of the equivalent resistance of the LST:



The result is that the discharge is quenched and the current never goes much beyond the threshold. In this way we could keep the HV on all the time. LST that showed high currents for long periods of time were eventually disconnected from the distribution boards.

It is interesting to know that in Zeus the inner chambers are hit by a continuous flux of photons from the Uranium Calorimeter, while the current of the rear chambers were mostly driven by the proton beam background. So the accumulated charge so far has been much larger than what LST in BaBar can ever see.

Typical current for an 8-fold tube in 2000 ("highest" luminosity) and corresponding rates (normalized to an average signal of 15 pC) were:

	<i>Barrel inner</i>	<i>Barrel outer</i>	<i>Rear inner</i>	<i>Rear outer</i>
current (8-fold tube)	250 nA	40 nA	300–500 nA	500–600 nA
rate	10 Hz/cm	1 Hz/cm	25–40 Hz/cm	35–40 Hz/cm

Costs of the Zeus system (1993 prices):

for 1280 channels:

- 1 SY127 5 KEuro
- 10 A332 10x0.7=7 KEuro
- 10 SY227 1.74x10=17.4 KEuro
- 40 A279 1.0x40= 40 KEuro
- TOTAL 70 KEuro

Cost per channel: 55 Euro/Channel

As one can see, the cost was driven by the distribution boards (82%), due to the high level of granularity. A 30% increase due to inflation should also be added. The SY127 and related modules could be taken from the current RPC system and elsewhere. So my estimate would be $55 \cdot .82 \cdot 1.3 = 58$ Euro/Channel

For estimating the cost of the HV cable I have a quotation recently used by CMS for a 31 pole HV cable: 6.5 ChF/m

Assuming 15 m of cable on average this gives: 2.2 Euro/channel, so the total price with connectors mounted can be less than 5 Euro/channel.

A rough estimate for 2000 HV channels (two 8-fold tubes per channel) projects the total cost of the HV system in the region of $60 \times 2000 = 120$ KEuro.

Mauro Morandin

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