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The Big Bang and the Power Distribution

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As year 2010 and the first decade of the 21st century draw to an end, it is time for reflections. A few weeks ago I was at CERN (the European Organization for Nuclear Research, also the birth-place of the World Wide Web) to do a five-day signal-integrity training. This visit brought up some interesting nice memories from the past.

CERN is a fascinating place to visit. If you do not have the opportunity to be there in person, a lot of material is available on-line at [1] and [2]. My favorite is the video, which shows you in one minute how the giant ATLAS detector was built [3].

CERN was officially founded in 1954 by the first 12 member states. Today the CERN website lists twenty member countries from Europe, with many more cooperating institutions from all over the world. CERN may be mostly known to the public by the Large Hadron Collider (LHC) experiment, where scientists attempt to recreate the conditions that happened very soon after the Big Bang, some 13.7 billion years ago. If you are looking for a refresher on this part of your physics knowledge, you can start at [4]. To recreate the conditions, which occurred just a fraction of a second after the Big Bang, two particle beams are made to collide at specific points along the 27-km (17 miles) long underground tunnel.

Figure 1: *A cross section view of the LHC experiment, where two particle beams are kept on counter-rotating paths by a network of superconducting magnets.*

To keep the particle beams on a circular path, the magnetic field is created in a gigantic super-cooled pipe, using many thousands of amperes of current in a set of superconducting magnets. The photo in *Figure 1* was taken at the Microcosm exhibition of CERN, showing a portion of the underground pipe.

I did not know how lucky I really was in the summer of 1976, and later in the mid 90s, when I had a chance to visit the CERN tunnels underground. In 1976 CERN had the 'small' tunnel just completed, which was 7km in length. In the mid 90s I visited the large 27-km new tunnel, which runs 100 meter deep under France and Switzerland.

During the design and construction of the LHC experiment, I had the privilege to be part of a small and enthusiastic team of researchers, university staff members, graduate and post-graduate students, working on various slices of this huge project. The task was to create a data acquisition system to bring out the vast amount of data from the detectors. In the early 90s we used FibreChannel 1.0625 Gbps optical links. *In Figure 2* you can see one of the prototype units for a 1Gbps link front end. These printed circuit boards were among the firsts in Europe using the (then new) ZBC2000 50-um power-ground laminate, also known as buried capacitance. The board size was 9x3.5 cm (3.5x1.4”).

***Figure 2:** An early prototype of the 1.0625 Gbps FibreChannel media-interface board.*

Figure 3 shows the stack-up, together with the noise measured on a system running random data. The noise was measured with direct coaxial connection providing 10 GHz bandwidth. You can see that the thin laminate kept the power distribution noise very low.

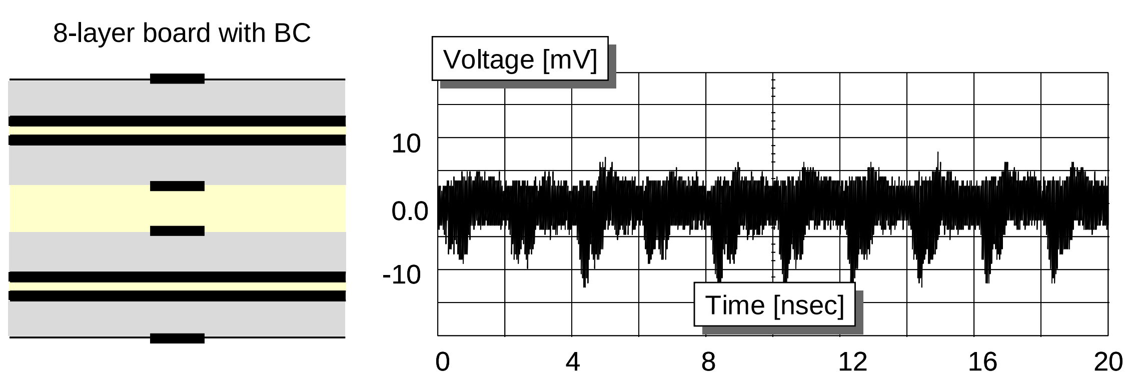

***Figure 3:** Stack-up and measured noise on the supply rail.*

To illustrate the progress of technology, *Figure 4* shows a prototype high-speed data-acquisition front-end board today. You can compare the size of the board on the photo to the size of the hand of my friend, who held the board while I took the picture.

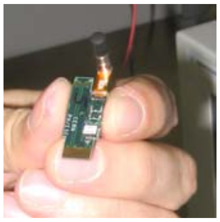

Figure 4: *Prototype of a new 5-10 Gbps media interface board today.*

In future columns we will speak about some of the misconceptions and about the true benefits of thin laminates.

References:

[1] http://public.web.cern.ch/public/
[2] http://www.boston.com/bigpicture/2008/08/the_large_hadron_collider.html
[3] http://www.atlas.ch/multimedia/html-nc/atlas-built-in-one-minute.html
[4] http://www.big-bang-theory.com/