Progress on the Investigation of Electron Cloud Buildup in Longitudinal Magnetic Fields

– Comparisons of SPU measurements at 15W with solenoidal windings (Dec/2010) and Helmholtz coils (Nov/2012) –

Bonus: Quantum efficiency history in TiN-coated chamber from Sep/2010 to Nov/2012

Previous work: see Jared's talk at the EC meeting on 25 July 2012

Jim Crittenden for Jared Ginsberg, John Sikora, Yulin Li
Cornell Laboratory for Accelerator-Based Sciences and Education
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May 2010 – June 2011

Preliminary calibration
1000 cu / 25 A / 40 G

August 2012 – now

Preliminary calibration
1000 cu / 25 A / 150 G

Only the two coils on the right are powered
Compare SPU signals 24Dec10 - 19Nov12

5.3 GeV electrons 8 mA/bunch

Compare signals for the same field values according to the preliminary calibration.

Scale the 2010 signals up by arbitrary factors as a visual aid.

The 2010 signals are all EARLIER than the 2012 signals for the same field value.

Since the timing is determined by the cyclotron period (see Jared's talk on 25 July 2012), this means the 2010 field values according to the preliminary calibration must be too low.

Notice that the 2010 16-G signal is timed similarly to the 2012 22-G signal.
Compare SPU signals 24Dec10 - 19Nov12

Check the normalization by comparing the signals with the field off.

A good match is found by increasing the 2010 signals by a factor of 1.9.

Has the quantum efficiency really increased by such a factor?

Check using the familiar witness bunch data with the positron beam (next slide).
A reminder

This TiN-coated chamber was first installed at 15W in August 2010. It was removed in August 2011 and stored for a year wrapped in plastic. It was reinstalled in August 2012.

Comparison of the 24Dec10 and 19Nov12 signals shows the same factor of 1.9 found with the electron data.

The history is interesting:

The chamber when first installed showed a high quantum efficiency, which decreased by a factor of 2 in 3 months. Then it gradually increased until the chamber is removed in July 2011.

It was back to nearly the unconditioned value in August 2012 after re-installation, but no longer decreases with beam conditioning.
Applying the factor 1.9 to the 2010 16-G signal produces a signal strikingly similar to the 22-G 2012 signal.

The field calculation for the well-defined geometry of the Helmholtz coils is presumably more reliable. (see Uniform Magnetic Fields and Double-wrapped Coil Systems, J.L. Kirschwink, Bioelectromagnetics 13 (1992))

Does this remarkable comparison hold up for other field values? (next slide)
The field ratio is $\frac{22}{16} = 1.38$

So the 2010 field value of 22 G is instead $22 \times 1.38 = 30.4$ G.

Indeed the signal arrives slightly earlier than the 30-G 2012 signal.

The 2010 field value of 28 G is instead $28 \times 1.38 = 38.6$ G.

Again the signal arrives slightly earlier than the 37-G 2012 signal, as expected.

Notice in particular how similar the signals are despite the dramatically different coil geometry. This raises confidence that even with the uneven solenoid windings the field was quite uniform.
The simulation studies of last summer already convinced us that the field values were likely too low, since the modeled signals arrived later than observed. The level of error in the field calibration is consistent with the nonlinear failure of the model for differing field values. This convincing improvement in the field calibration will give more confidence in the modeled photoelectron energy distribution, which now must be re-tuned.