Cesr TA

July 10, 2012
Linear Electron/Positron Collider

Electrons

Undulator

Detectors

Electron source

Beam delivery system

Main Linac

Damping Rings

Main Linac

31 km
To minimize the emittance (temperature) of the beams in CESR

- Operate at 2GeV (vs 5.3)
- Relocate superconducting wigglers to L0 straight to
  - increase radiation damping rate
  - and reduce emittance
Increase damping rate and reduce emittance

Wiggler with RFAs and TiN-coated VC

Wiggler with RFAs and uncoated Cu VC
Xray beam size monitor – beam height
Visible light beam size monitor (L3) – beam length and width
Detector box

Helium or Vacuum

DownStream

Source to Optics Box = 4.29 m,
Optics box to detector = 10.5 m
m = 2.45
Xray beam size monitor

32 channel photodiode array
50µm pitch

Single pass pin hole image
σ ~ 20µm
Visible light beam size monitor

(a) Schematic diagram of the visible light beam size monitor. The system includes a B48W/E Be mirror, an Iris, Lens 1 (f=5 m), Double slits, Lens 2 (f=1 m), Polarizer, Filter (500+/−3 mm), and a CCD camera and Streak camera.

(b) Physical layout of the visible light beam size monitor.
Horizontal beam size

\[ \sigma_x = 275 \ \mu m \]
What is the electron cloud?

- Synchrotron radiation from the circulating positrons, strikes the walls of the vacuum chamber and photoelectrons are emitted.
- Photo electrons traverse the chamber, strike the opposite wall and emit secondary electrons.
- Secondary electrons are accelerated by subsequent bunches, hit the wall and emit . . .
- Evolution of the cloud depends on chamber geometry and local magnetic field.

schematic of e- cloud build up in the arc beam pipe, due to photoemission and secondary emission [Courtesy F. Ruggiero]
Measures the time average cloud density and energy spectrum

View of from outside vacuum chamber of dipole style RFA with 9 independent collectors. The fine mesh wire grid is in place (but transparent)
Dipole RFA data with characteristic central peak

Run #2983 (1x45x1.25mA e+, 5.3 GeV, 14ns): SLAC4 (Al) Col Curs

Aluminum chamber
45 bunches, 1.25mA/bunch
14ns spacing, 5.3GeV
Mitigation in a dipole field
Electron cloud mitigations

Dipole chamber with antechamber and grooves

Wiggler chamber with clearing electrode

Cu

TiN

A little more improvement is required.

Bend section

- Two test beam pipes with grooves were manufactured
- Different manufacturer

Type 2

Type 1

Electron cloud mitigations

DRAFT

2.2. Vacuum System Modifications

3840511-249

3840511-250

Figure iemnr The grooves of the SCW RF beam pipe were inspected optically before TiN coating and after TiN coating.

smaller the impedance to minimize HOML induced by the electrode the ends of the electrode are tapered at a \( \theta \) angle down to a \( \epsilon \) mm radius at its tip. The HV connection is made by a coaxial line coming through a port located underneath one of the tapered ends of the electrode. The electrical connection to the electrode is made via a convex button washer with a \( \phi \) mm diameter. The effects of the low profile of the discontinuity, the tapered ends of the electrode and the hidden HV connection have not been calculated in detail, they are expected to produce a HOML parameter of less than a few \( \epsilon \)\( \times \)\( \epsilon \) \( \times \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( \epsilon \) \( 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Figure photos here show the key steps of the RFA installation on a wiggler beam pipe:

A. Three grids installed and individually wired to the connection port.
B. Flexible circuit collector installed and located with ceramic headpins.
C. With the circuit through the 'duckunder' tunnel, all signal wires were attached in the connector port.
D. After making the final RFA connection, a vacuum pump down and leak check was performed and a final RFA electrical check out was performed under vacuum before certification as being ready for welding of the RFA cover.

Before integrating the RFA beam pipe into the SCW, the temporary flanged end bend away from the RFAs must be machined off using a clean milling machine with clean cutting tools. Extreme care was taken in this final machining step, which included blocking metallic debris from entering the RFA section of the beam pipe and constant purging of the chamber with N\textsubscript{2}.

The RFA beam pipe was inserted into the wiggler warm bore and precisely positioned with respect to the wiggler magnet by optical survey. Extreme care was also taken in the final welding stages, including final beam pipe flange and seals to the wiggler insulation vacuum vessel, to prevent overheating of the RFA components.

Finally, the completed SCWs with RFA beam pipes were 'baked' at 90\degree C for 2 days by circulating hot water through the beam pipe cooling channels in an effort to degas the vacuum components after the prolonged air exposure during the final RFA beam pipe insertion and welding. The first two SCWs with RFA beam pipe were successfully installed in the west side of the Lk Experimental region in CESR in October.

RFAs located at B-field max, min, and mid.
Electron cloud mitigations in damping wiggler

Wiggler Center Pole Comparison: 1x45 e+, 2.1 GeV, 14ns

- Wig1W 5/2/10 (Cu)
- Wig2B 1/31/09 (TiN)
- Wig2B 12/5/09 (Grooved)
- Wig2B 5/2/10 (Electrode)
Solenoids suppress ecloud
Bunch by bunch and turn by turn vertical emittance is measured with xray beam size monitor

Emittance dilution begins in bunch 10
Vertical and horizontal tune shift vs bunch number
22 bunches/train - 14ns spacing
$\Delta Q \sim$ cloud density
- Install time resolving RFAs in L3 chicane grooved chamber
- Replace Q15W a-Carbon coated chamber with TiN chamber
- Replace Q15E diamond-like carbon coated chamber with bare aluminum
- All vacuum D-line for xray beam size monitor
- Upgrade visible light monitor with fast readout
END