UPDATE ON KICKERS R&D @ LNF

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PRESENTATION OUTLINE

1) DA Φ NE new injection kickers

considerations on circular and elliptical cross section

advantages of tapered stripline

design

2) R&D activity on HV feedthrough @ LNF and test results on kicker prototypes with pulser (supplied by FID GmbH)

3) ILC kickers

effects of the uniformity of deflecting field and β -function @kicker on beam invariant (injected beam)

electrical/physical length of the kicker

tapered strip advantages on beam coupling and transfer impedance

DA Φ NE new injection kickers: circular and elliptical cross section Efficiency 80 Horizontal component of the 70 electric field (E_T) 60 on the kicker axis [11 ^m ²⁰ 40 ET as a function of the electrode coverage angle. 30 a=25 mm⁺ t⁺ h a=25 mm h 20 - circular * elliptical Field uniformity 10∟ 10 20 30 40 60 70 50 ∲ [deg] Circular/elliptical cases Circular case 220 100 ¢=20 deg 90 200 t=40 deg d=70 deg 80 180 70 160 1% E_T/E_{T center} [%] 140 120 120 100 60 60 40 100 30 80 20 60 circular with ϕ =70 deg 10 elliptical with ϕ =70 deg 40 20 25 5 10 15 01 5 10 15 20 25 transverse position x [mm] transverse position [mm]

DA Φ NE new injection kickers: advantages of tapered stripline

Tapers are usually used to avoid abrupt steps in the vacuum chamber in order to **reduce the intensity of wakefields and HOM** (impedance of the machine).

The *uniformity of deflection* depends on the coverage angle.



<u>Tapering</u> the transition between the kicker structure and the adjacent beam pipe it is possible to <u>minimize</u>:

• the <u>non uniformity of transverse deflection</u> as a function of the transverse position;

• the contribution of the kicker to the <u>machine</u> <u>impedance;</u>

•the <u>reflection coefficient</u> at high frequency (short pulses) because of smoother transition between feedthrough coax line and strip line.



DA Φ NE new injection kickers: design (1/3)



- a) The *elliptical geometry* has been chosen to minimize the variation of the vertical dimension of the beam pipe between the injection region and the adjacent dipole region;
- b) In each section along the structure Dh is a constant and Dv changes;
- c) In each section ϕ has been chosen to have constant characteristic impedance of the line (50 Ω);
- d) The value of a and b are the same for each sections and have been optimized together with the length L_k and L_T in order to contemporary achieve:
 - 1) optimum deflecting field uniformity over the horizontal coordinate;
 - 2) total "effective length" of the kicker compatible with the bunch spacing.



DA Φ NE new injection kickers: design (2/3)





R&D activity on HV feedthrough @LNF and kicker prototype tests (1/3)

When HV is applied the **possibility** of discharges is higher in the endsection of the kicker electrodes, where the electrode itself is closer to the vacuum tube.

HV 50 Ohm (wide band) <u>commercial feedthrough does</u> <u>not exist</u> and an R&D activity has been necessary. The wide band of the feedthroughs is important to <u>keep low the beam impedance</u> of the kicker even well beyond the frequencies content of the input pulse.



A <u>stripline</u> with the same dimension and the same distance from the chamber of the kicker stripline in the end section has been built. <u>Coax</u> <u>ceramic feedthrough</u> have been mounted on this test device and HV tests have been done.



R&D activity on HV feedthrough and kicker prototype tests (2/3)

FEEDTHROUGH

A *commercial feedthrough* (not 50 Ohm) has been initially tested *without success*.





HV PULSER

Several FID HV pulser have been tested up to the final version under specification: 50 kV, 20 Hz flat top 5 ns









R&D activity on HV feedthrough and kicker prototype tests (3/3)

An HV feedthrough at 50 Ohm has been designed, realized and tested at LNF with complete success up to 50 kV with the FID pulser. File Edit Vertical Horiz/Acq Trig Display Cursors Measure Mask Math MyScope Analyze Utilities Help 😱 Tek 📃 😿 (1) High 2.44V (1) Max 2.52V ______ 1.87V

The **new kickers are now in construction** and will be installed in the next shut-down of DA Φ NE (starting from June 2007)



ILC kickers: uniformity of the deflecting field (2/2)







Geometry 2









ILC kickers: kicker β-functions effect on invariant increase (geometry 1)







ILC kickers: kicker β -functions effect on invariant increase (geometry 2)









ILC kickers: physical and electrical lengths



ILC kickers: tapered strip, beam transfer and coupling impedance comparison

3





CONCLUSIONS

1) DA Φ NE new injection kickers design based on tapered strip has been illustrated

2) 50 Ohm HV feedthrough developped @ LNF successfully tested with the FID 50 kV pulser

3) The new kickers are now **in construction** and will be **installed** in the next shut down of DA Φ NE (starting from June 2007)

4) ILC kickers design:

the effect of **non uniformity of the deflecting field has been analyzed showing** an increase of the beam injected invariant

the β -function at the kicker can be reduced mitigating this effect but a large number of kickers is necessary in this case

few **advantages** (reduced beam coupling and transfer impedance) of the **tapered strip** for ILC have been illustrated

FUTURE PLAN

ILC kicker prototype construction and test with HV pulser using the LNF developed feedthrough