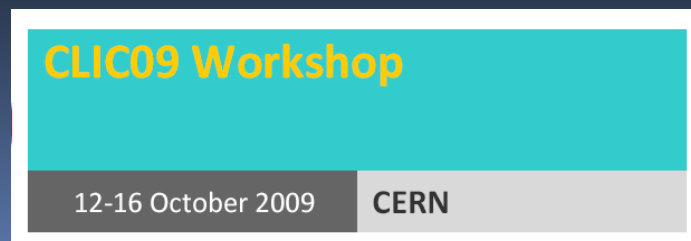


ILC kicker design and experience with the new DAΦNE injection kickers

D. Alesini (LNF, INFN, Frascati)

For the Kicker study group at LNF:

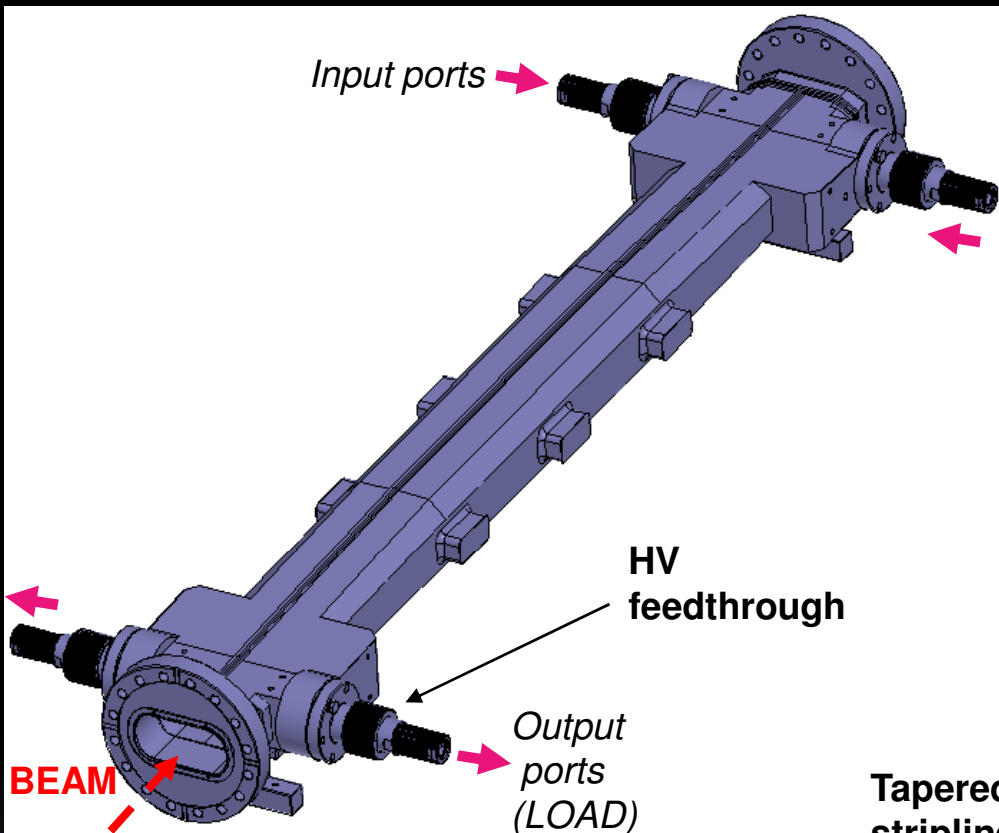
F. Marcellini, S. Guiducci, P. Raimondi



PRESENTATION OUTLINE

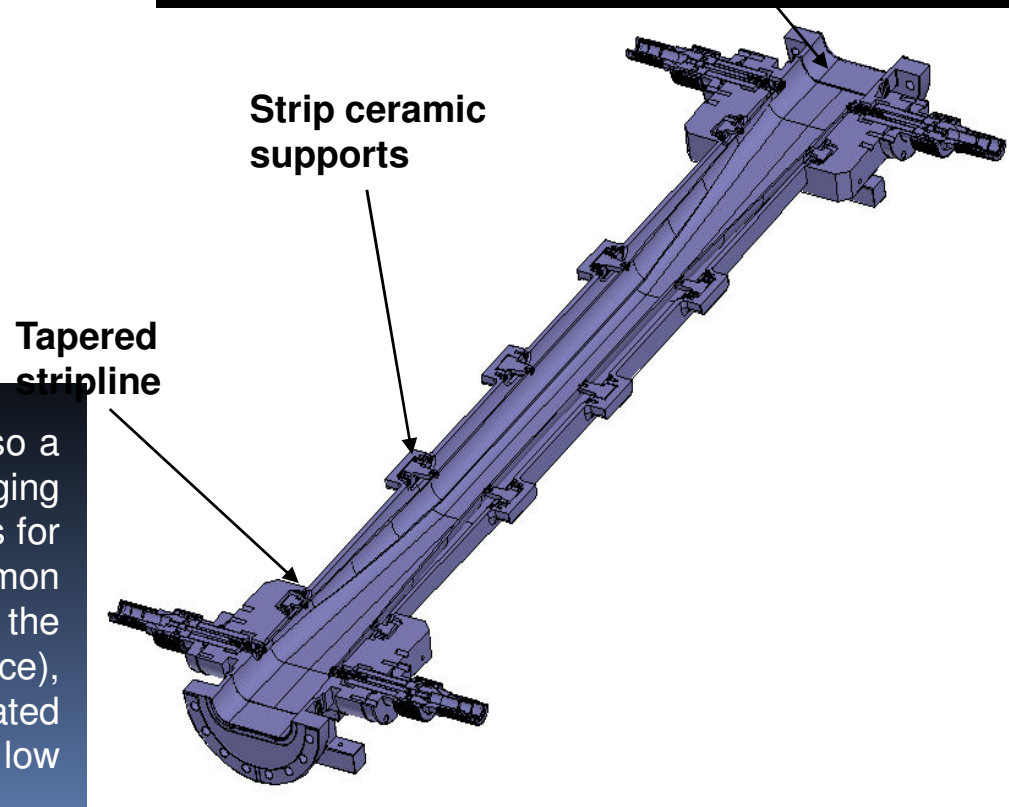
1. Design of a stripline kicker for beam injection in the DAΦNE collider.
2. HV tests and RF measurements of the kicker.
3. DAΦNE operation with the new kickers.
4. ATF Kicker
5. Studies on the stripline injection kicker for ILC damping ring.

THE NEW DAFNE INJECTION KICKER



New kickers have been realized for the injection upgrade of the Φ -factory DAFNE. They have been conceived to operate with new fast pulse generators recently available. Compared to the previous devices, the new system has as main features:

- a) much shorter pulse (≈ 12 ns instead of ≈ 150 ns);
- b) better uniformity of the deflecting field;
- c) lower beam impedance;
- d) higher repetition rate (max. 50 Hz).



The new injection system at DAFNE represents also a test and a R&D activity of one of the most challenging issues of the ILC, i.e. the injection/extraction kickers for the DR. ILC/DR and DAFNE kickers have common requirements: short pulse length (this minimizes the bunch distance and hence the DR circumference), good uniformity and high strength of the integrated deflecting field, and impedances of the structure as low as possible.

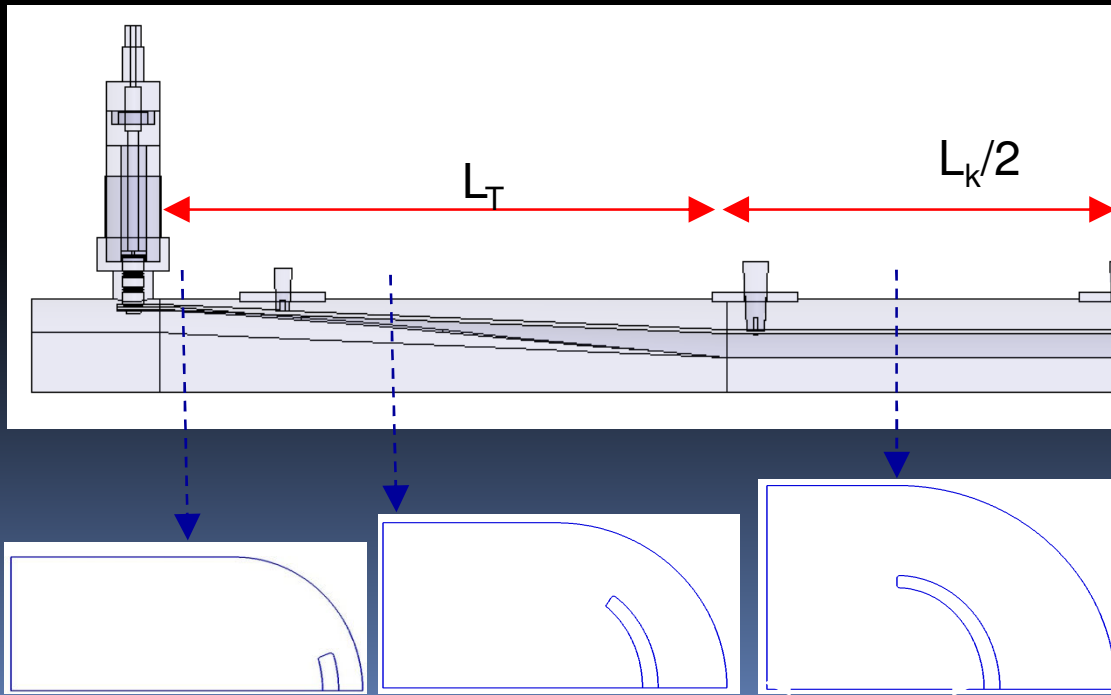
DESIGN CRITERIA OF THE NEW KICKERS

The elliptical cross section:

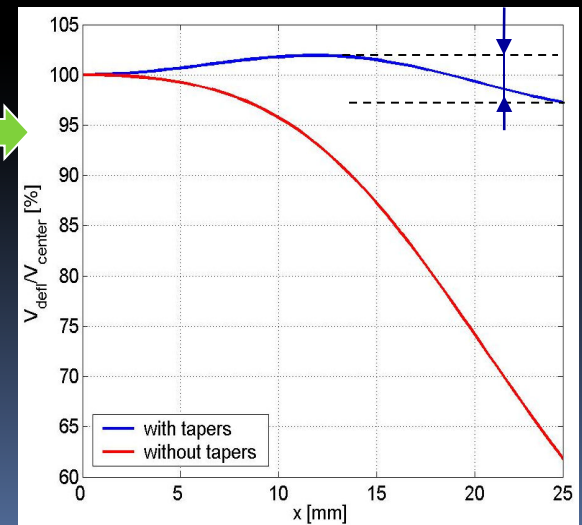
- Minimizes the discontinuity of the beam pipe cross section between the injection region and the adjacent dipole regions
- **Increases the deflection efficiency.**

The tapered stripline:

- Improves the **uniformity** of transverse deflection as a function of the transverse position
- Reduces the contribution of the kicker to the machine **impedance**
- improves the **reflection coefficient** at high frequency (short pulses) because of smoother transition between feedthrough coax line and stripline.

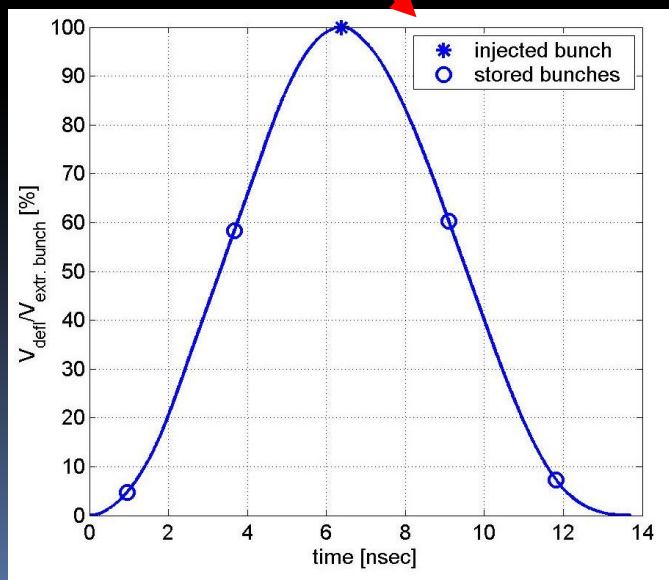
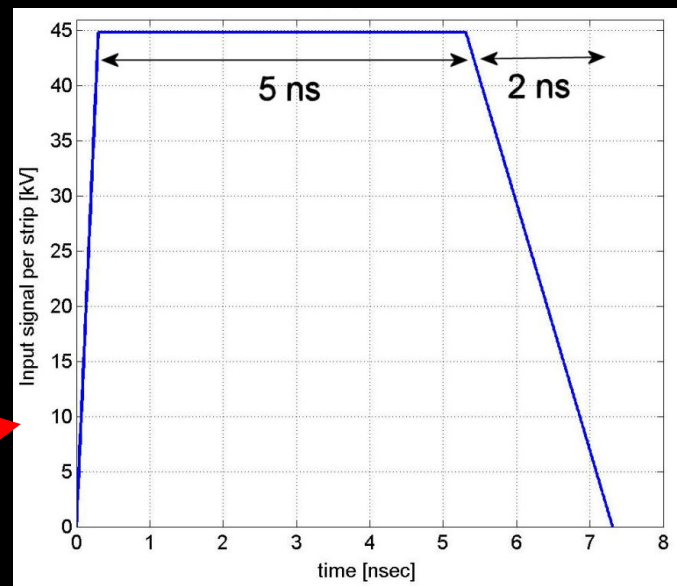


Field flatness by integration

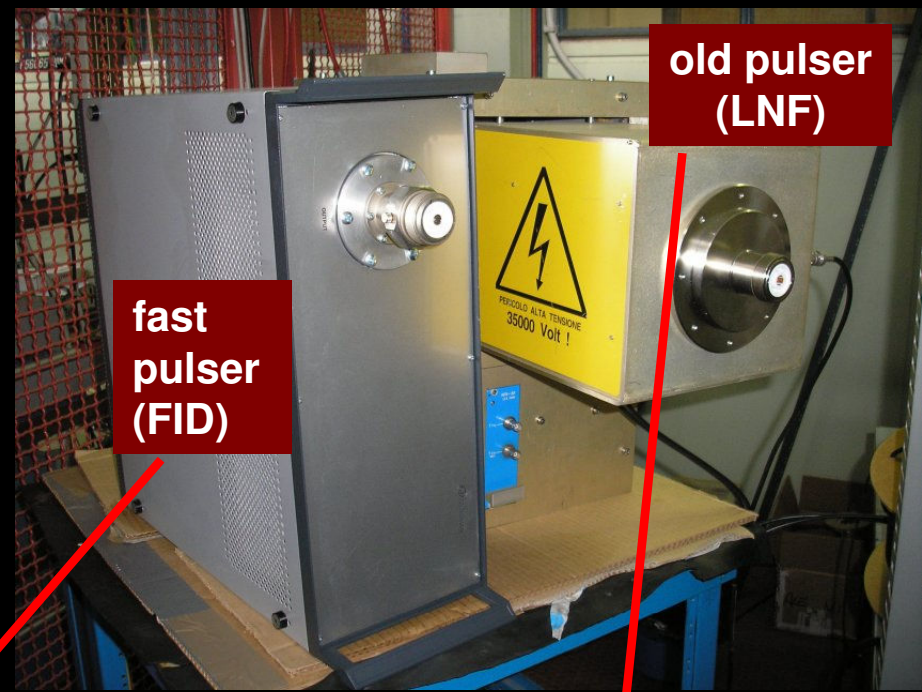
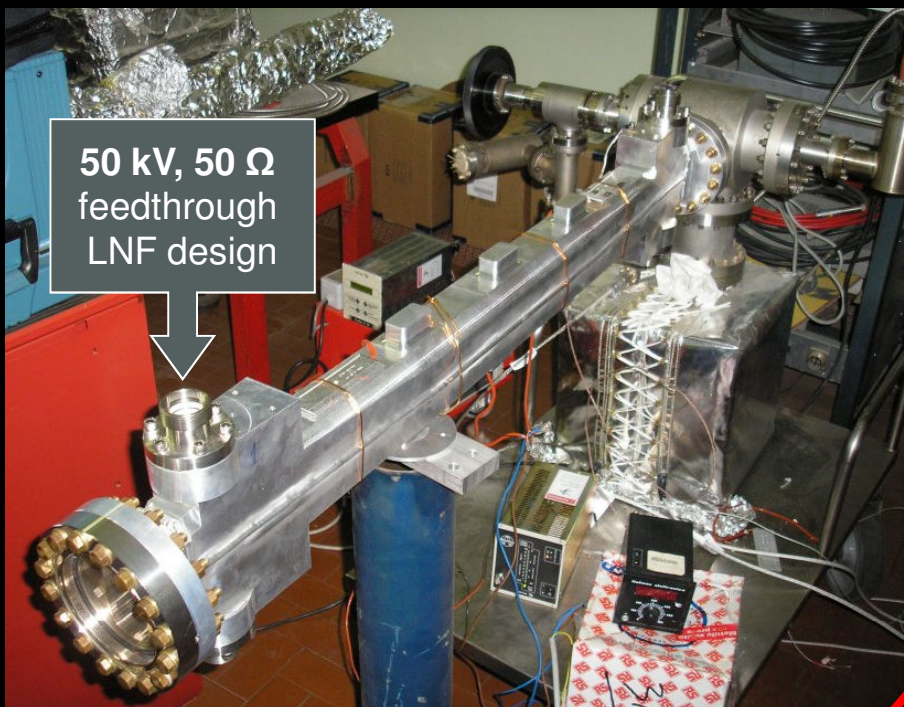


ORIGINAL DESIGN PARAMETERS

PARAMETERS	
Beam Energy E [MeV]	510
Time spacing between bunches [ns]	2.7
Deflection [mrad]	5
Total deflecting voltage VT [MV]	2.5
Total kicker length L [cm]	~90
Voltage per strip [kV]	45
Input pulse length [ns]	~5
Pulse length "seen" by bunches [ns]	~10
Max rep rate [Hz]	10



HV R&D @ LNF



Before installation, the new kicker was tested and measured in laboratory: high voltage tests were performed on the kicker fully equipped with feedthroughs, cables and loads. Both the old 250ns long 25kV pulse generator, already used with the previous DAFNE kicker, and a fast 5ns - 45kV pulse generator produced by FID GmbH have been tried successfully.

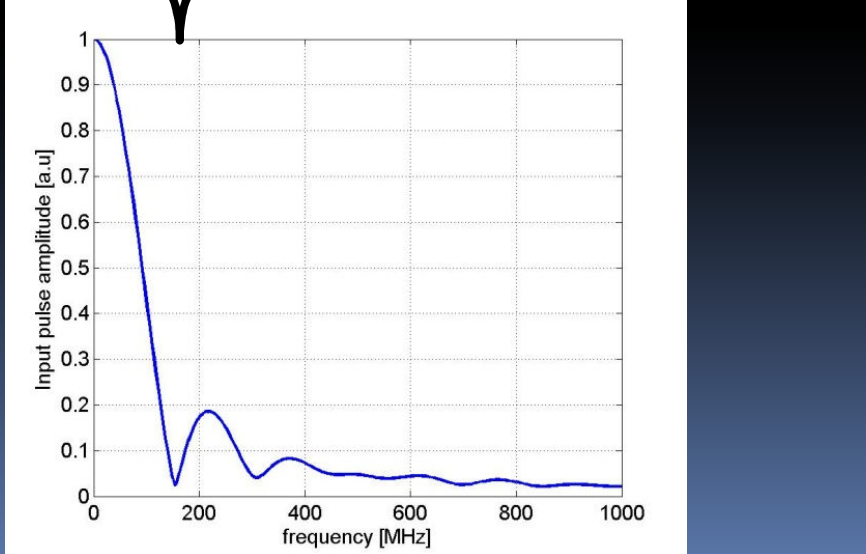
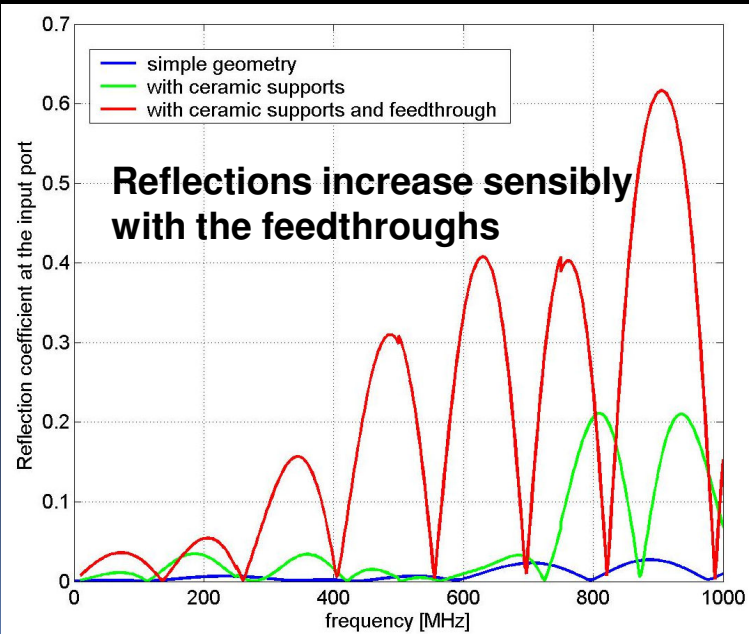
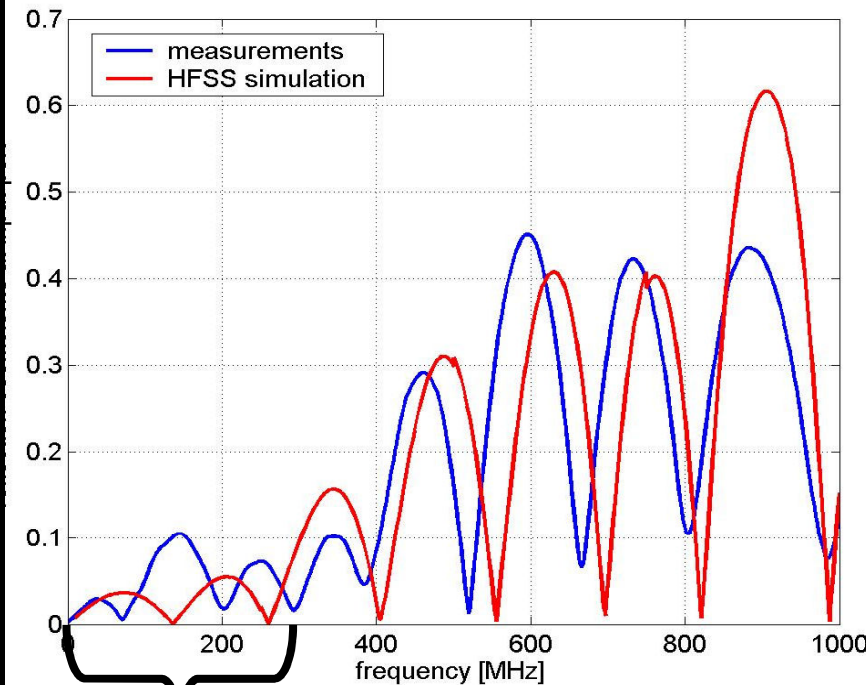


RF MEASUREMENT RESULTS: REFLECTION COEFF.

The kicker frequency response has been measured as reflection coefficient (S_{11}) at the input port of the stripline. S_{11} is quite small up to $\approx 400\text{MHz}$ (the pulse frequency spectrum does not extend beyond), but increases at higher frequencies. The deterioration of S_{11} is mainly due to the feedthroughs contributions.

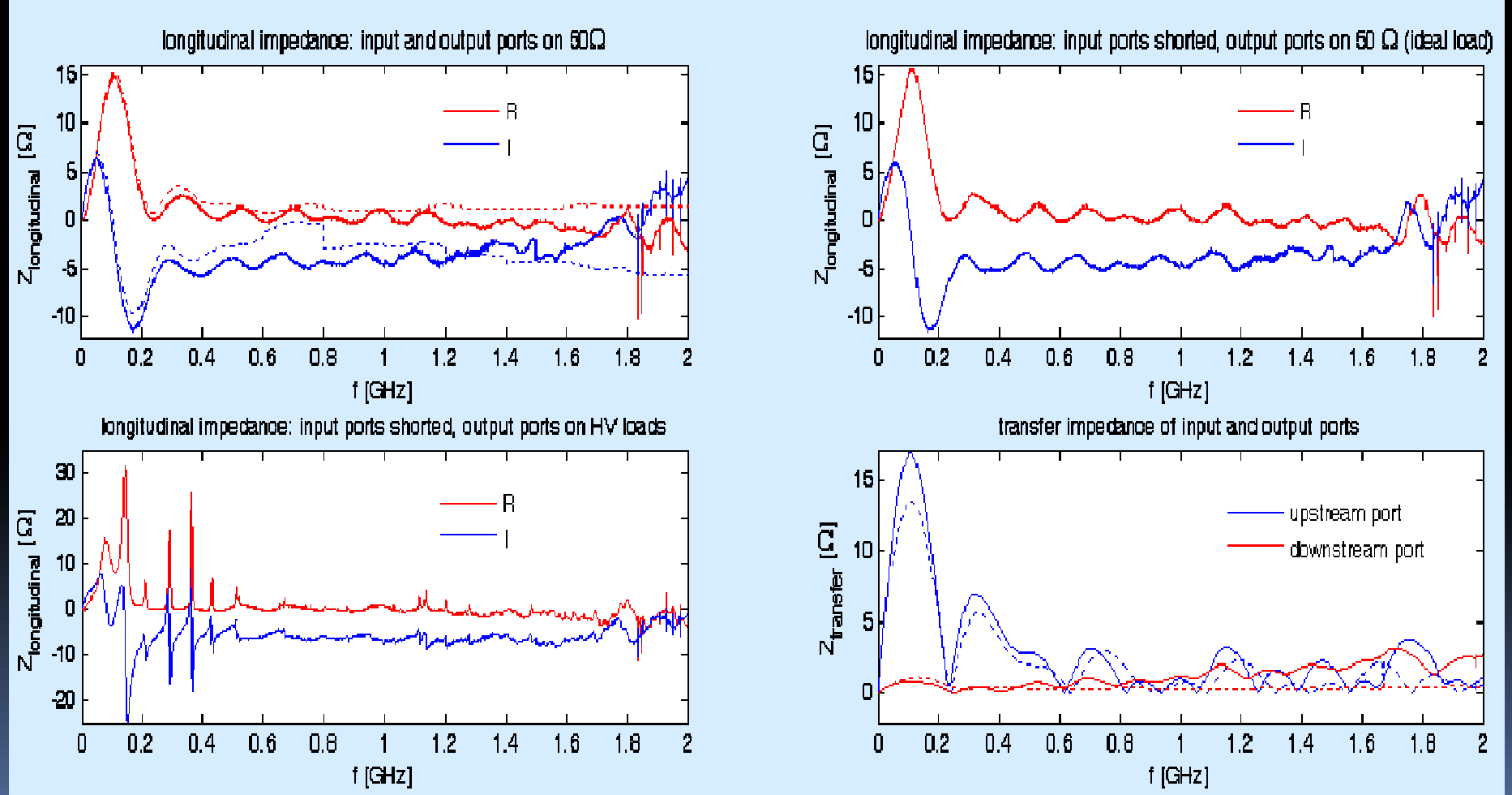


Reflection at the input port



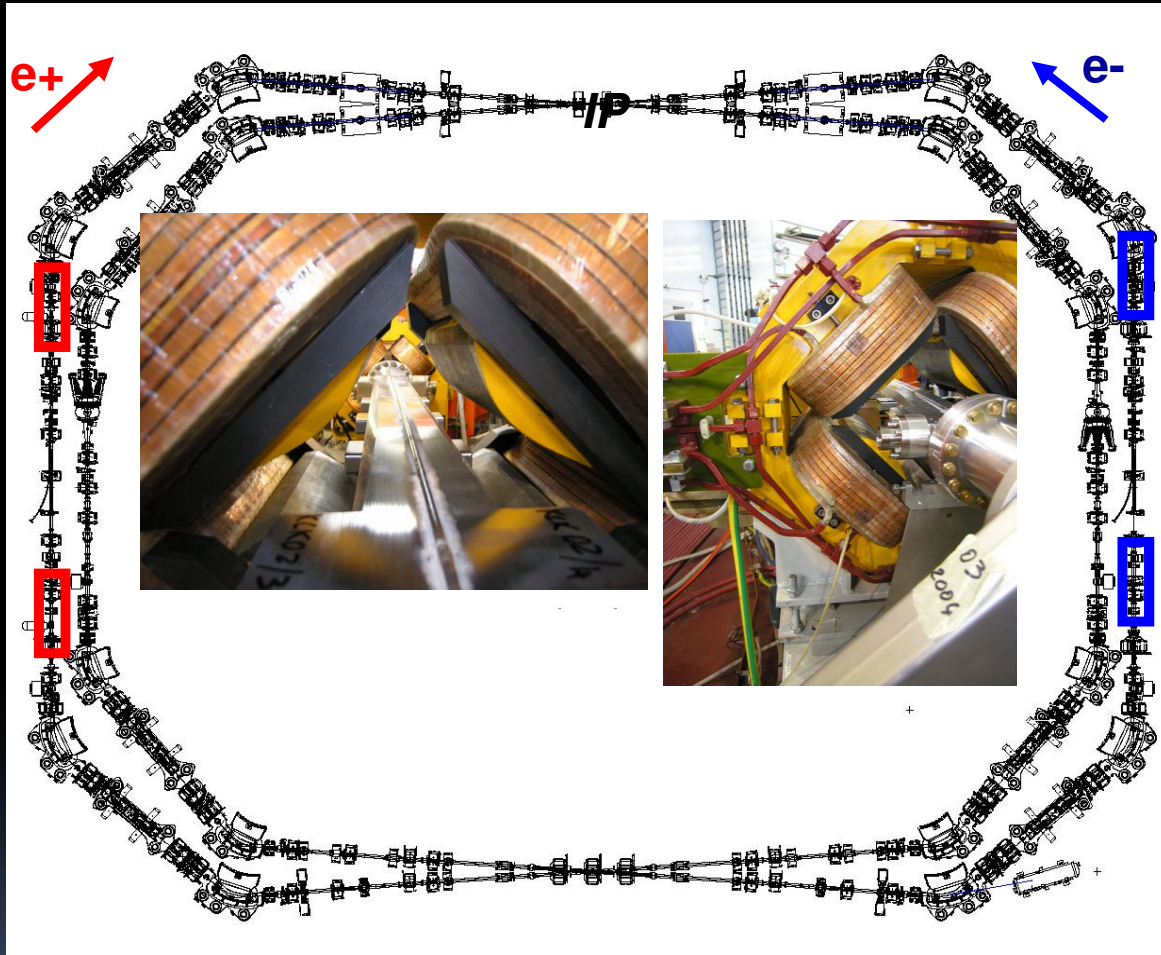
RF MEASUREMENT RESULTS: BEAM IMPEDANCES

The wire method technique of measurement has been used to fully characterize the kicker impedance. The longitudinal coupling impedance has been measured with several different terminations at the 4 kicker ports



DAFNE OPERATION WITH THE NEW KICKERS

New kickers installed in the DAΦNE rings (Nov. 07)



First results of operation with FID fast pulsers have been very promising.

Routine operation with 45kV FIDs not allowed because of their very poor reliability.

For these reasons we decided to decrease the HV from 45 to 25-28 kV re-adjusting the machine parameters.

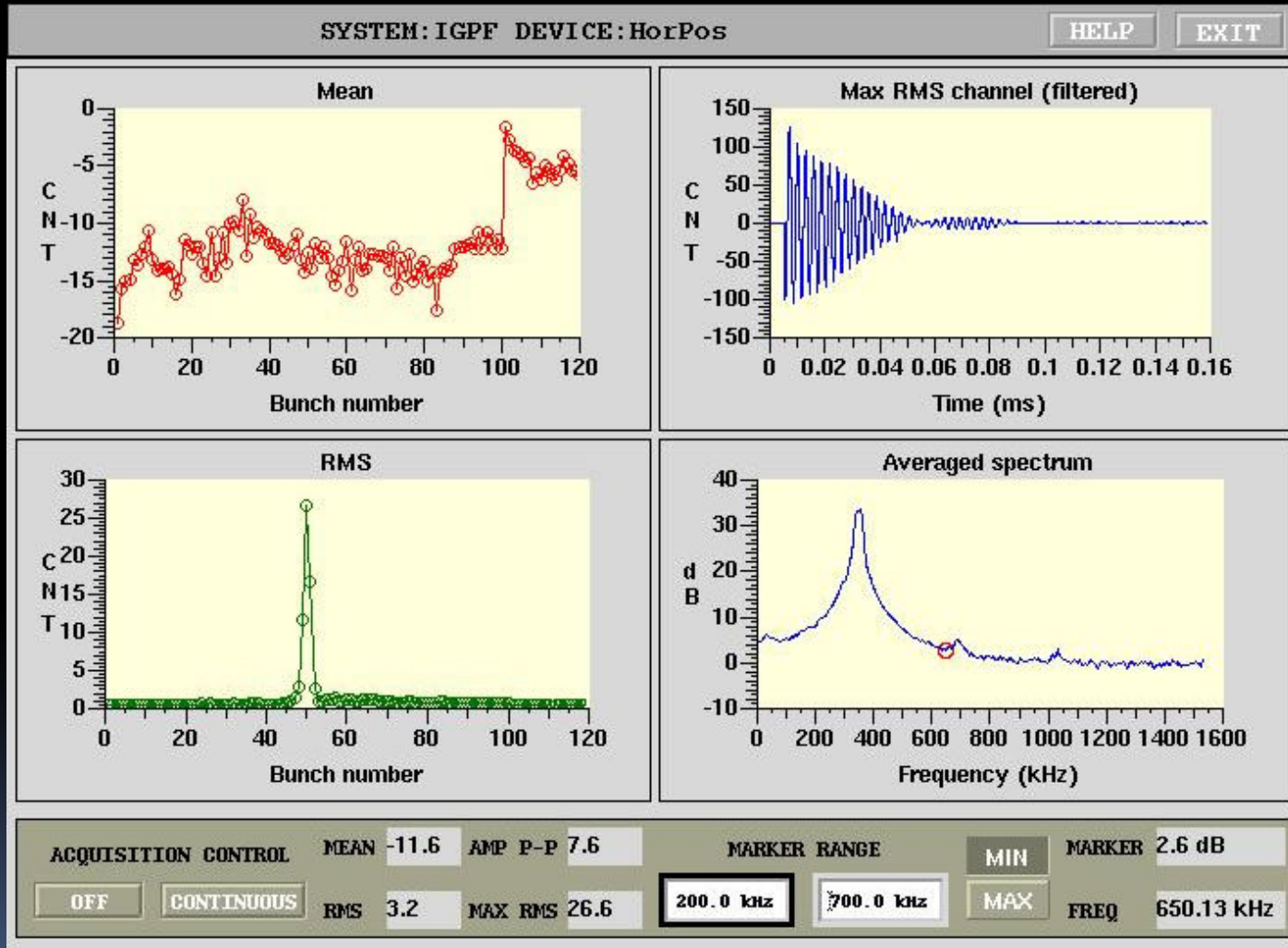
After increasing β function in the kicker region and changing the beam orbit in the septa, we tried successfully injection with a 24kV, 5ns FID.

In the e+ ring one strip is now used by the horizontal fast feedback to fight the e-cloud instability.

In e- ring we have successfully tested injection with a hybrid system: one strip connected to the old long pulser and the other to the short one at 25 kV. It is now in operation.

BEAM OSCILLATIONS WITH FAST KICK

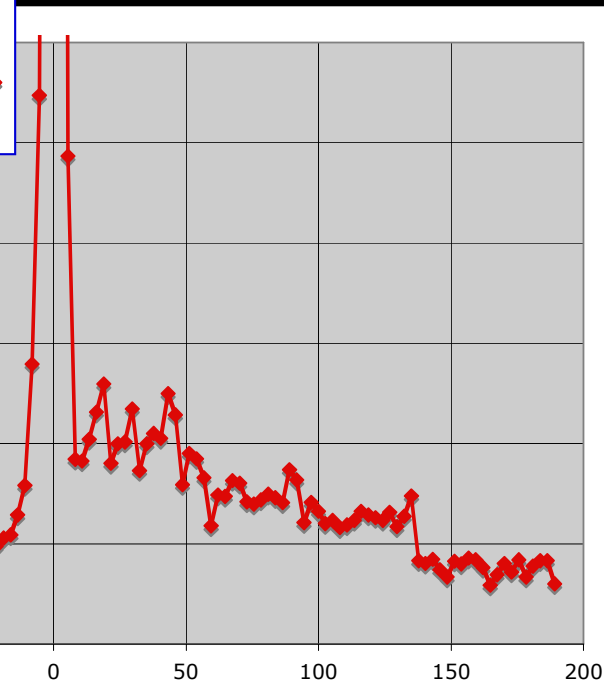
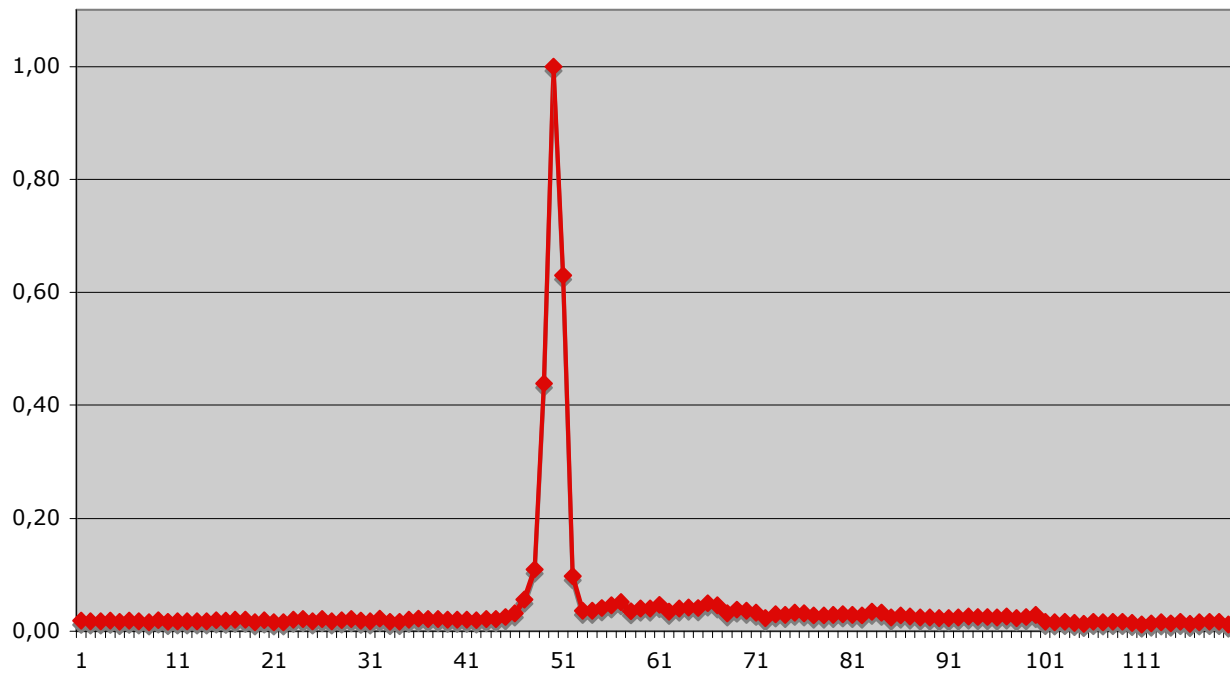
Measured by the horizontal digital feedback system.



100, of 120, stored bunches with kicker pulse centered on bunch 50.
bunch distance 2.7 ns.

BEAM OSCILLATIONS WITH FAST KICK

rms oscillation
amplitude of 100
stored bunches with
kicker pulse centered
on bunch 50



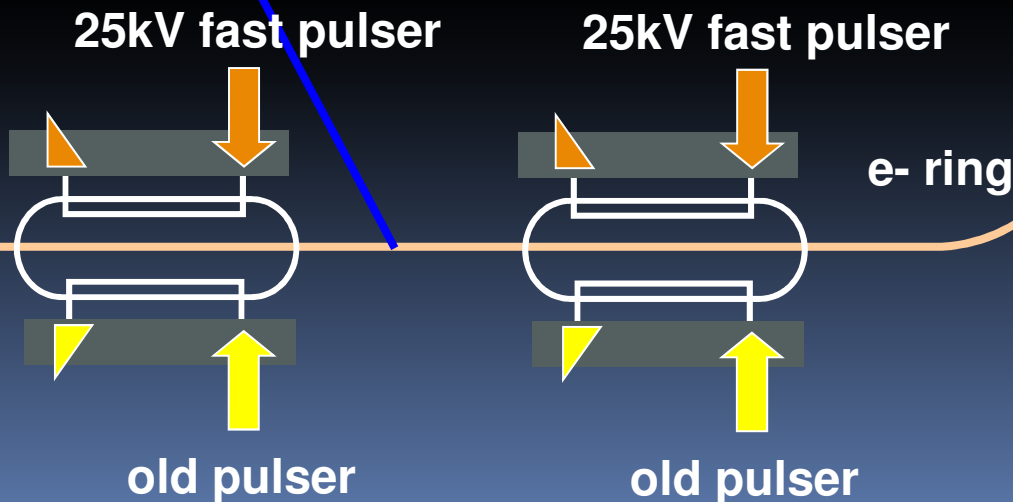
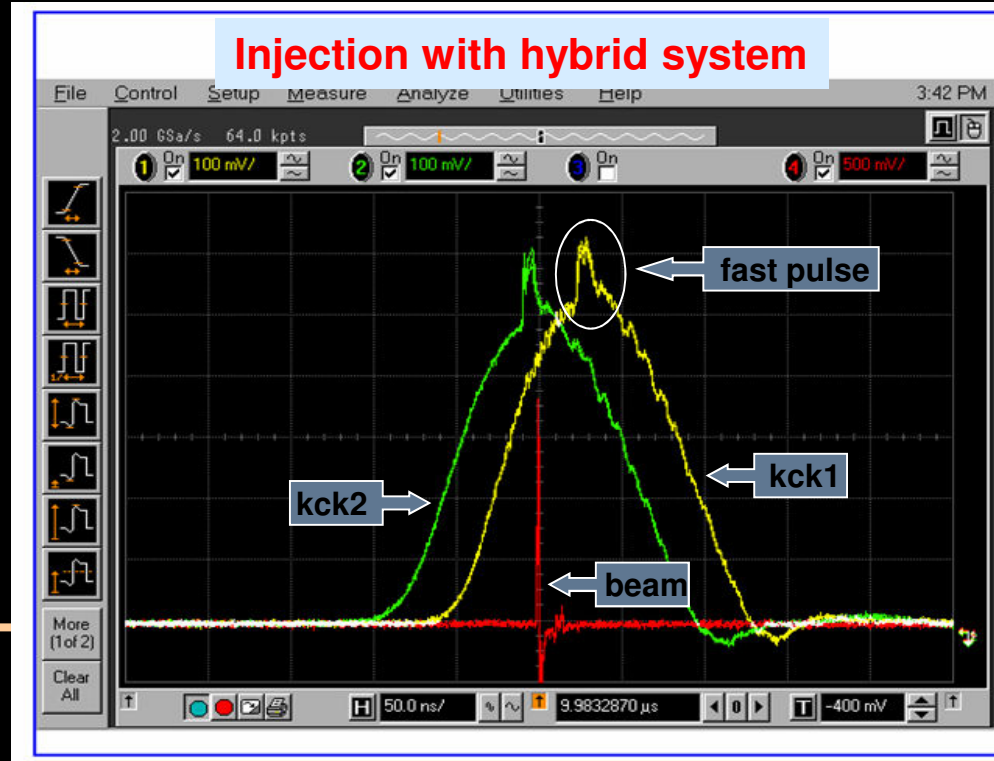
Same plot with a scale in ns
and amplified vertical scale

Shows a tail of ~2% above
noise level

THE HYBRID CONFIGURATION

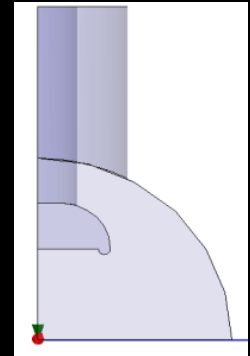
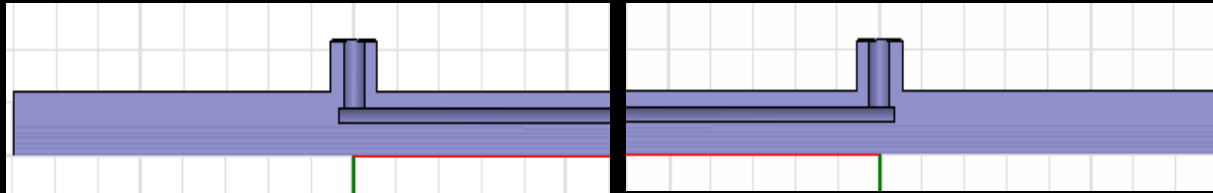
24kV FIDs have been tested in the electron ring kickers (“hybrid” configuration).

They are now in operation

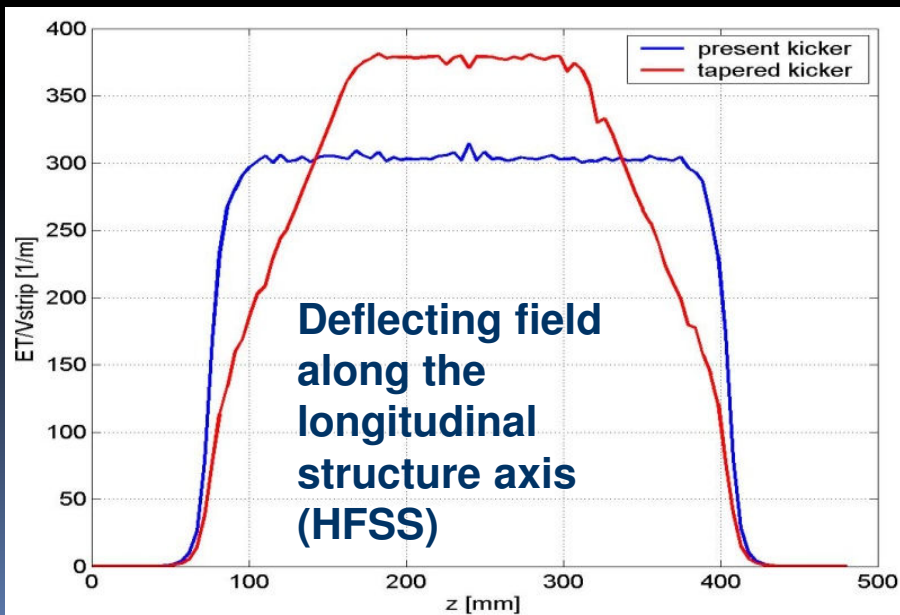
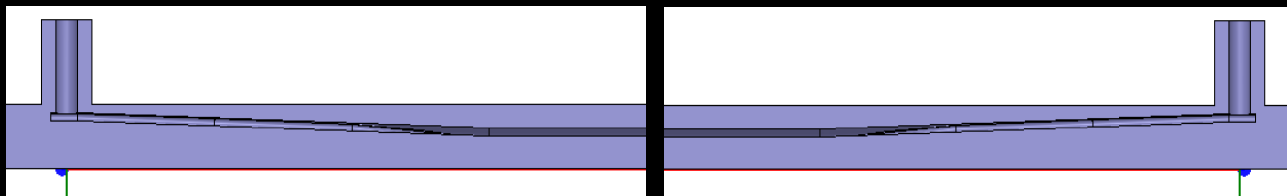


KICKER FOR ATF

ATF PRESENT KICKER

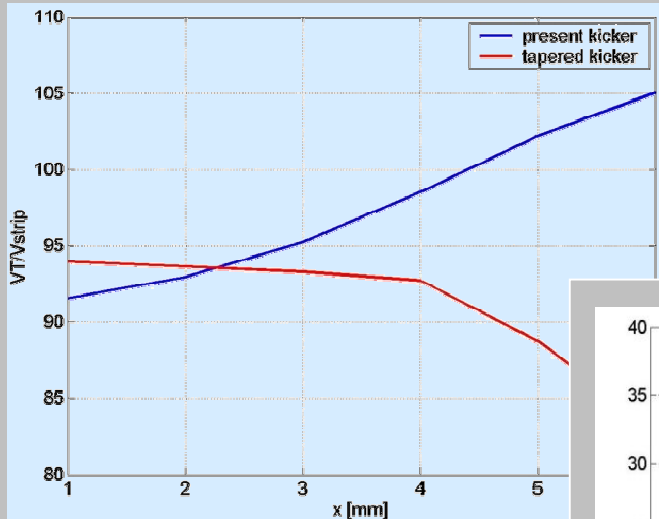


ATF TAPERED STRIPLINE KICKER

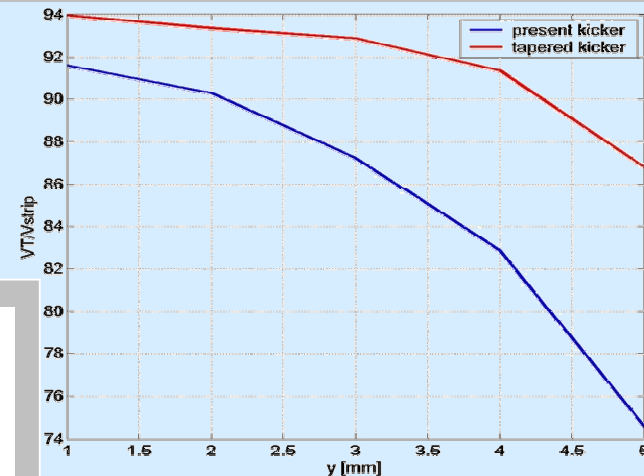


A new tapered stripline kicker has been design for ATF.

COMPARISON RESULTS NEW vs OLD

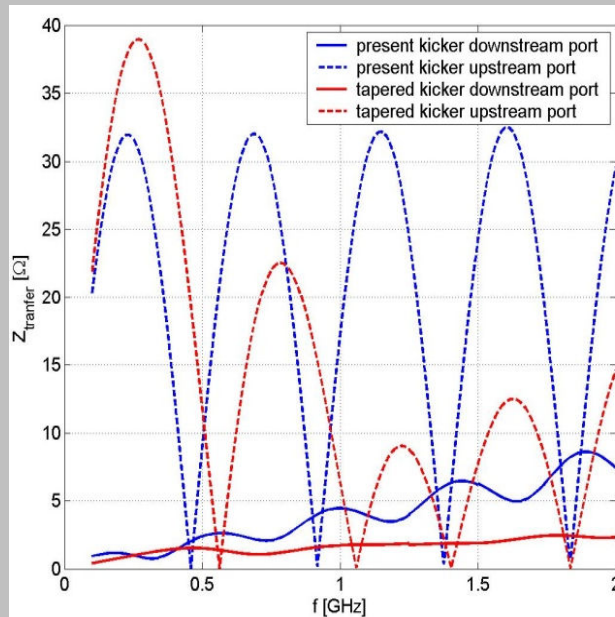
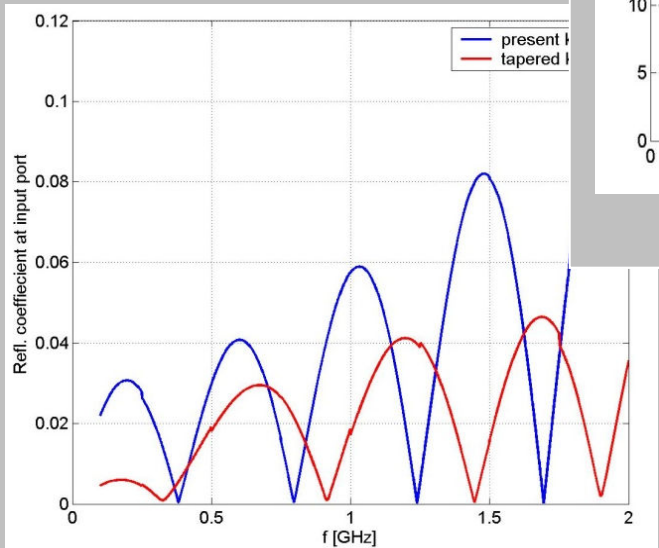


deflecting voltage on the horizontal axis



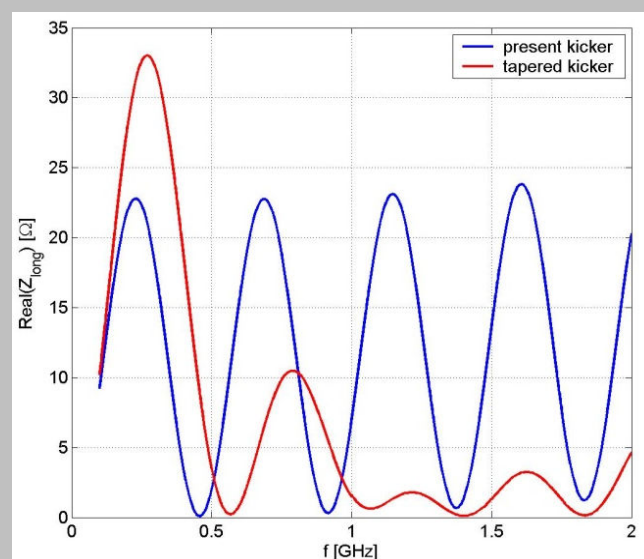
deflecting voltage on the vertical axis

Input port reflections



Transfer impedances

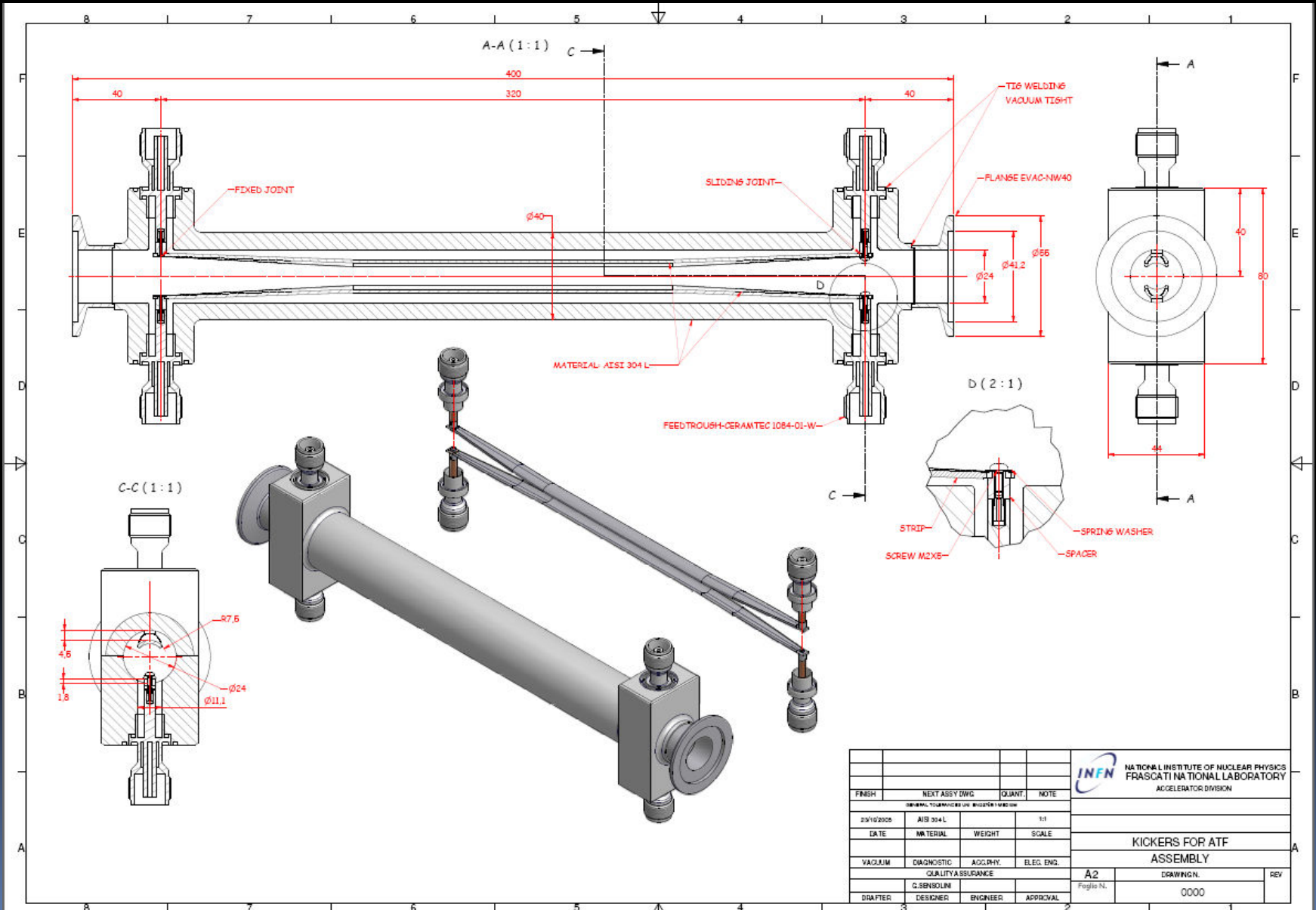
Longitudinal coupling impedance



Kicker ready to be send at KEK

Kicker is made in stainless steel, 320 mm long.

Feedthroughs are commercial available HN-type connectors (CERAMTEC).



				 NATIONAL INSTITUTE OF NUCLEAR PHYSICS FRASCATI NATIONAL LABORATORY ACCELERATOR DIVISION	
FINISH	NEXT ASSY DWG	QUANT.	NOTE		
GENERAL TOLERANCES UNLESS INDICATED OTHERWISE					
23/10/2008	AIS 304 L		1:1		
DATE	MATERIAL	WEIGHT	SCALE		
VACUUM	DIAGNOSTIC	ACQ. INY.	ELEC. ENG.		
	QUALITY ASSURANCE				
DRAWER	DESIGNER	ENGINEER	APPROVAL		
				A2	0000
				Figura N.	REV

ILC kickers: uniformity of the deflecting field

STARTING POINT PARAMETERS

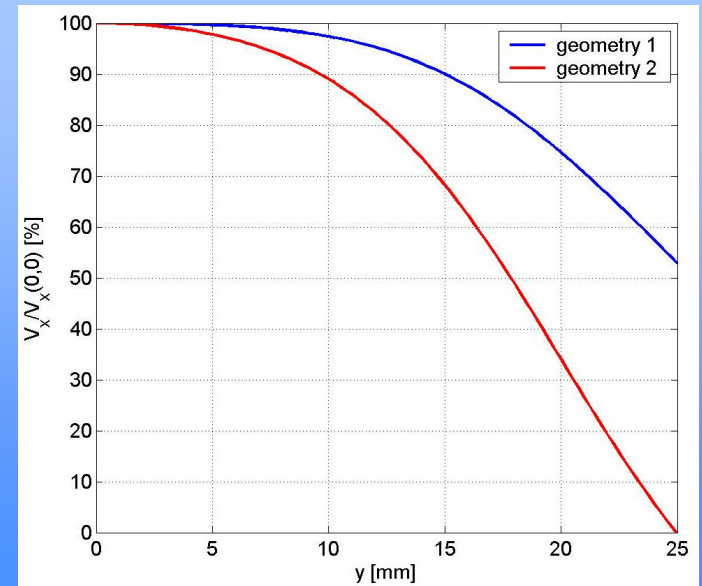
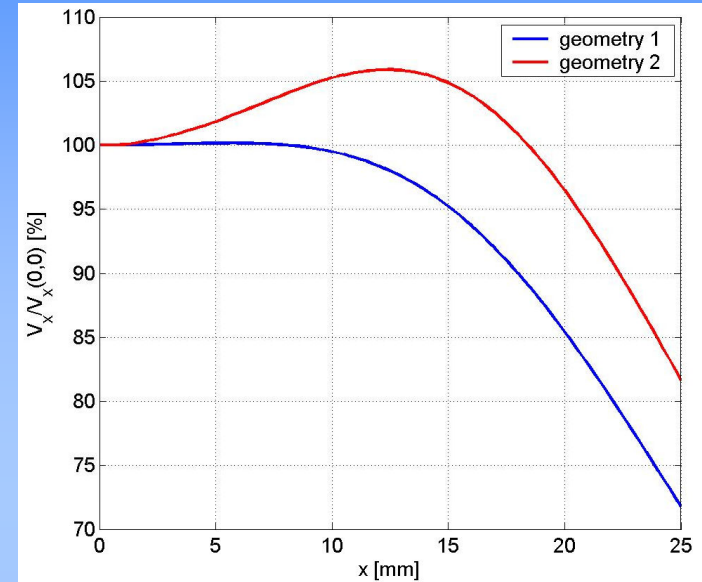
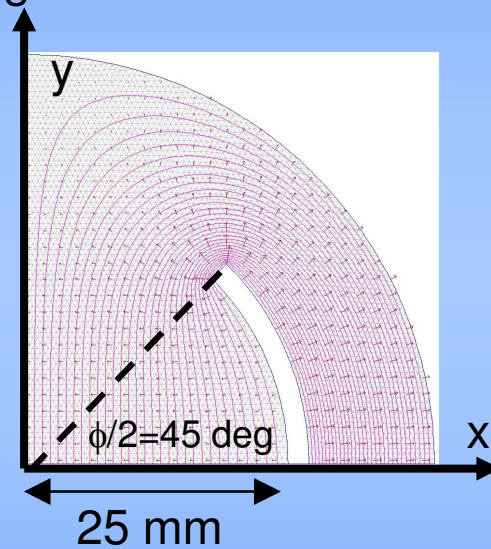
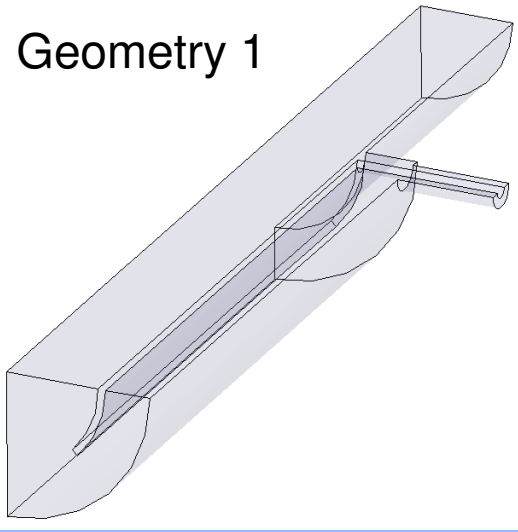
$\beta_{x_KICK}=65$ m; $\beta_{y_KICK}=20$ m

$A_{x_max}=A_{y_max}=0.09$ m·rad (injected)

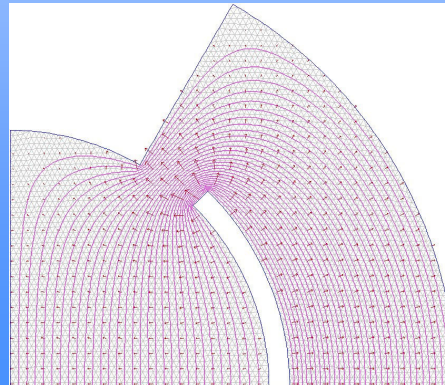
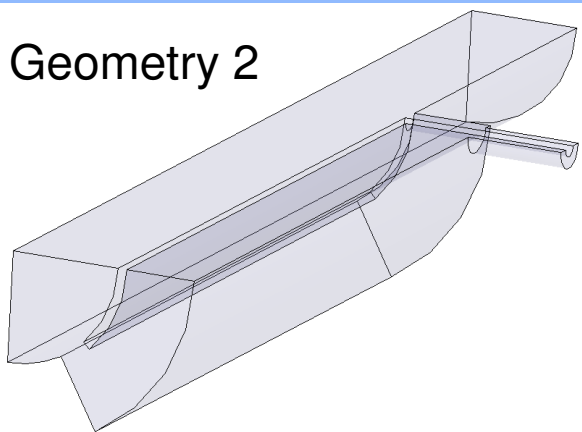
Bunches distance = 3.08 ns

Considered stripline geometries

Geometry 1

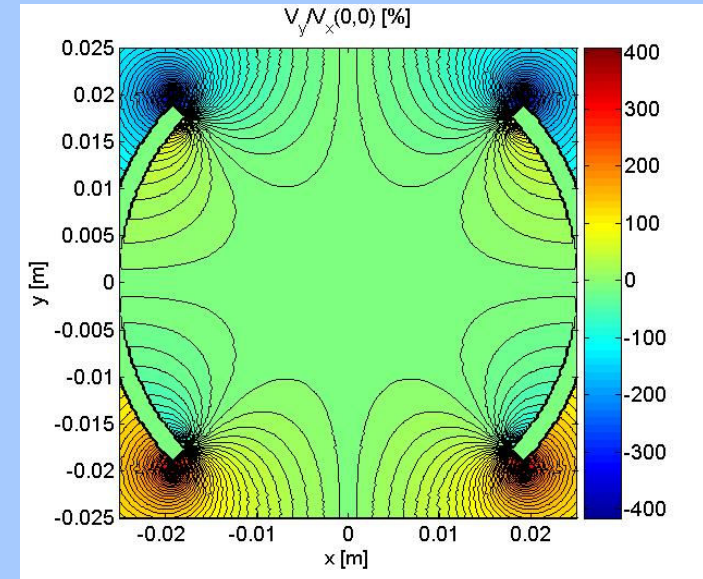
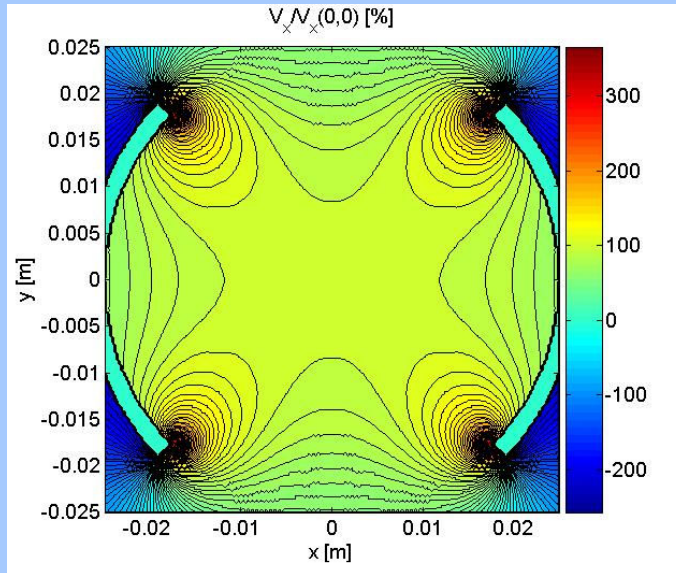
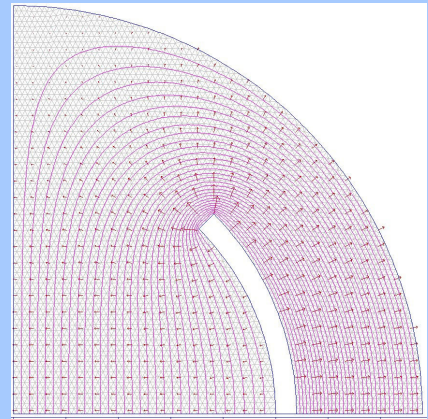


Geometry 2

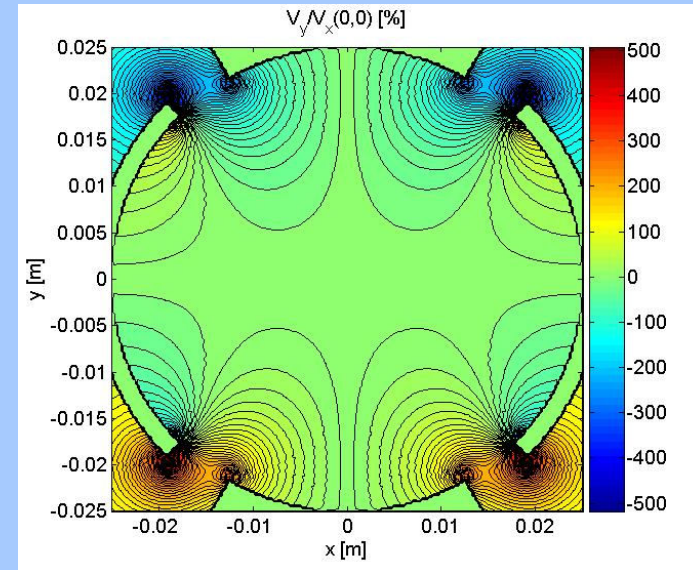
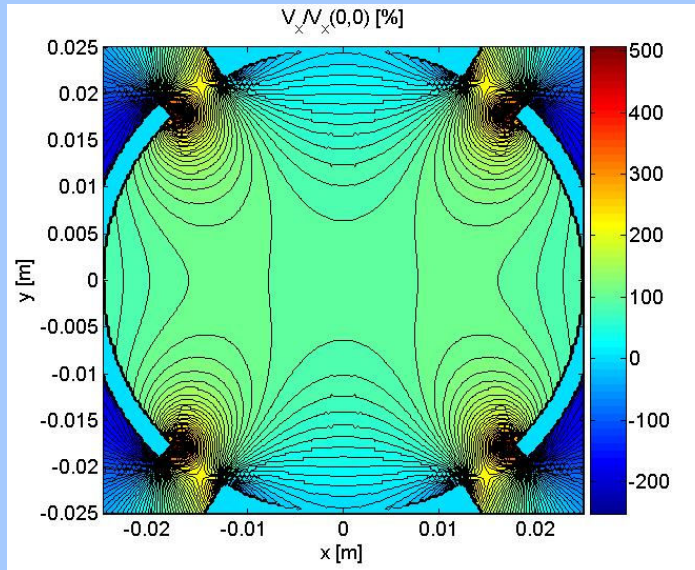
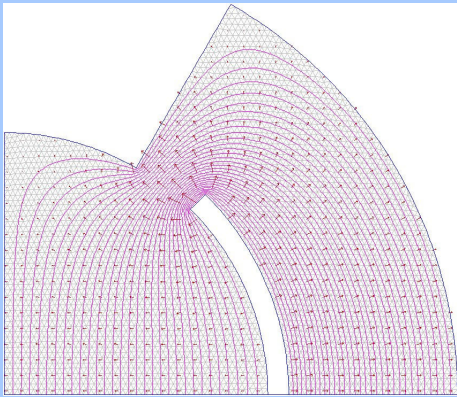


ILC kickers: uniformity of the deflecting field

Geometry 1

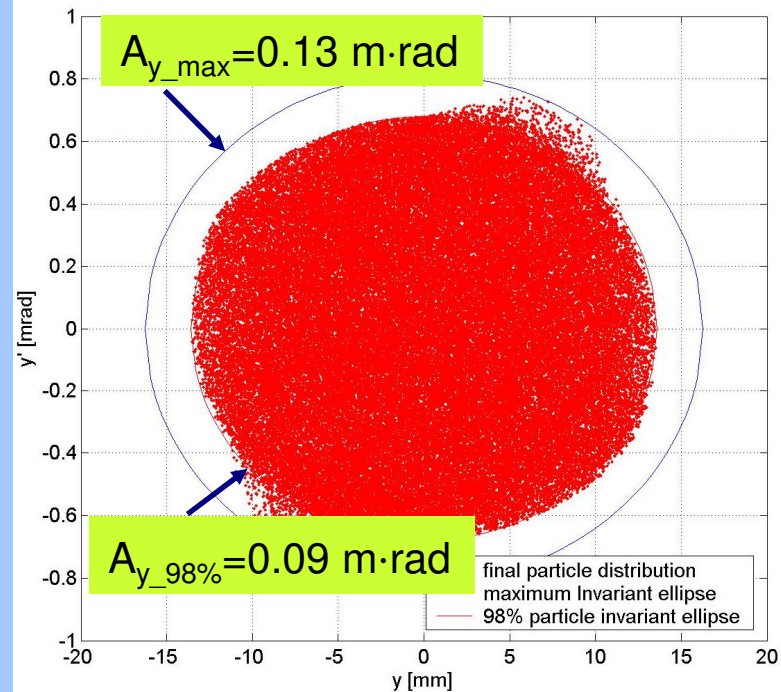
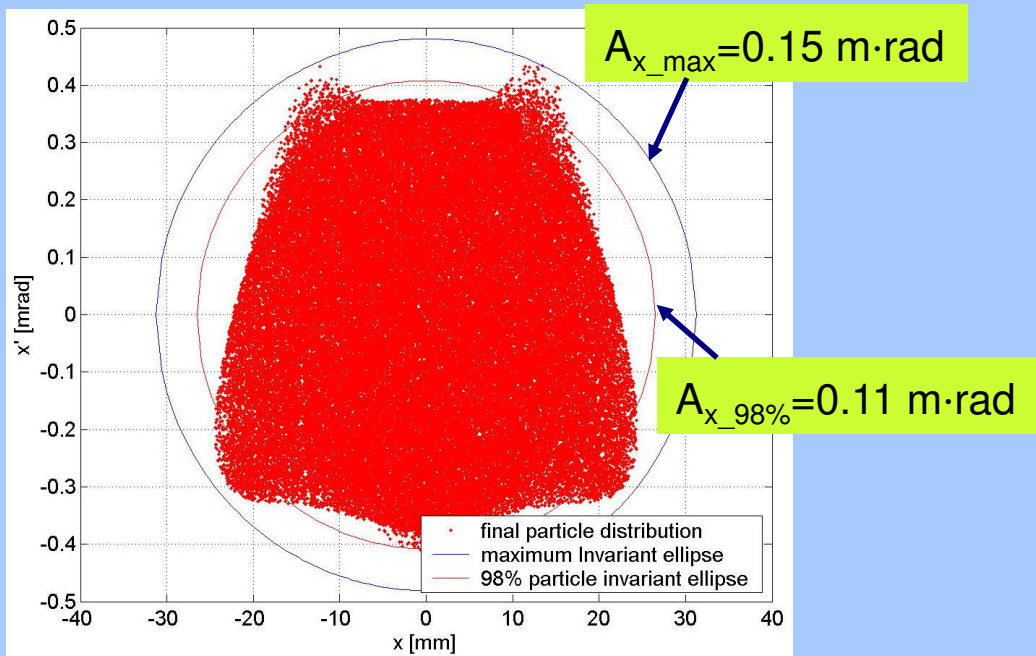
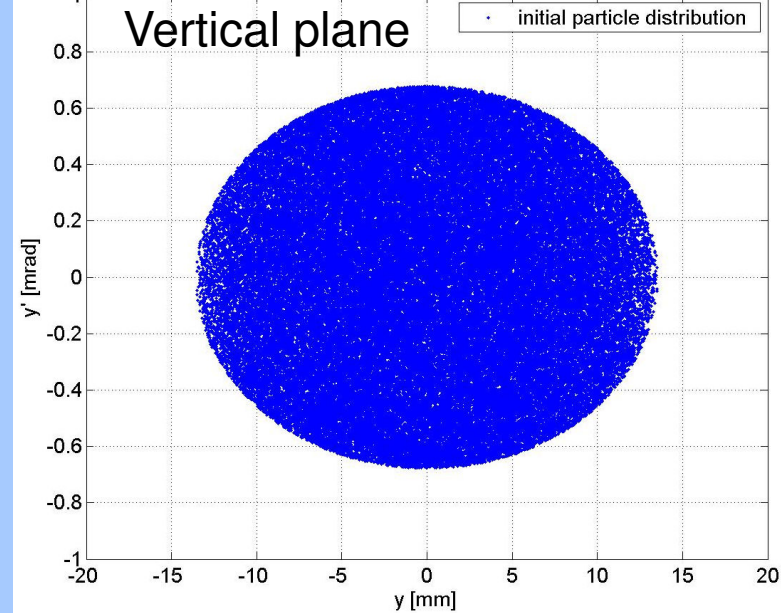
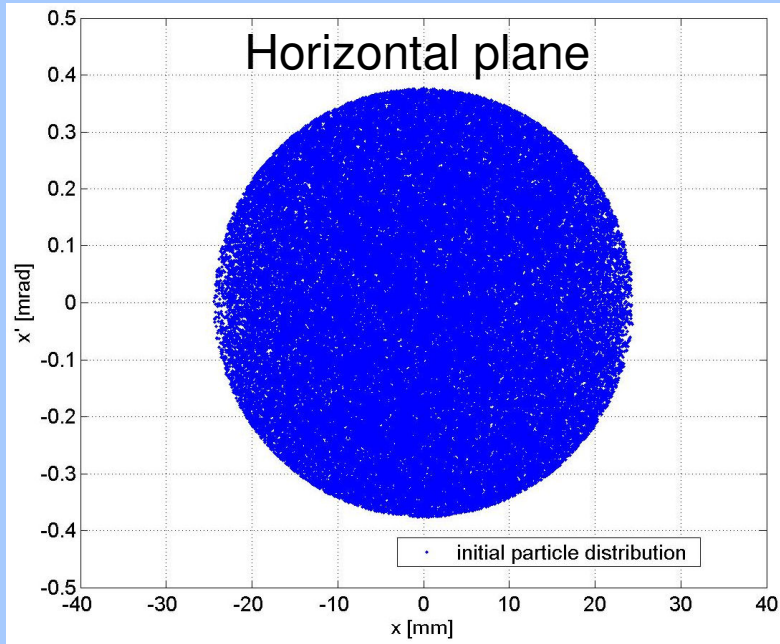


Geometry 2

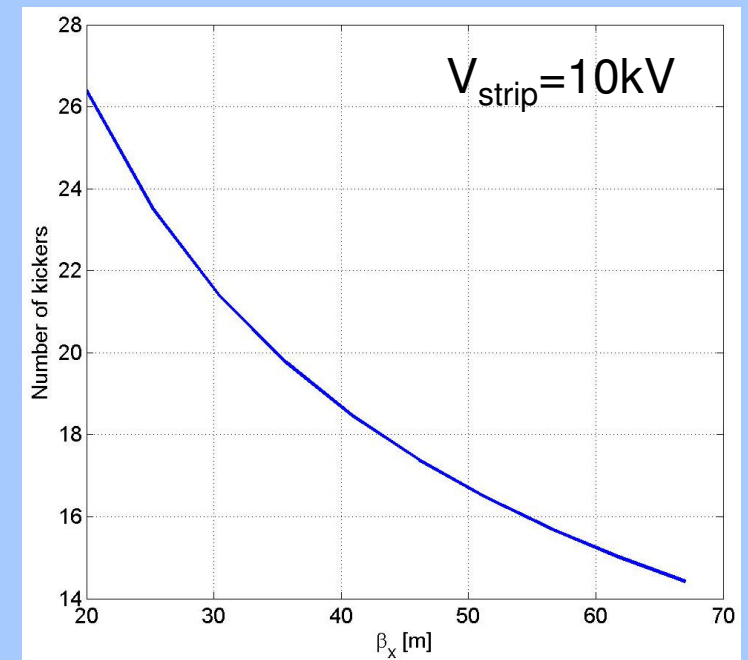
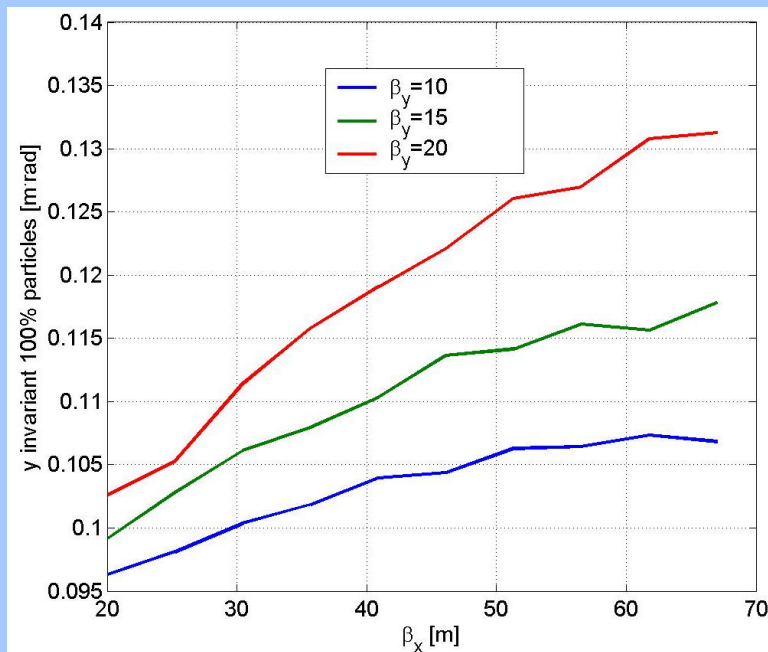
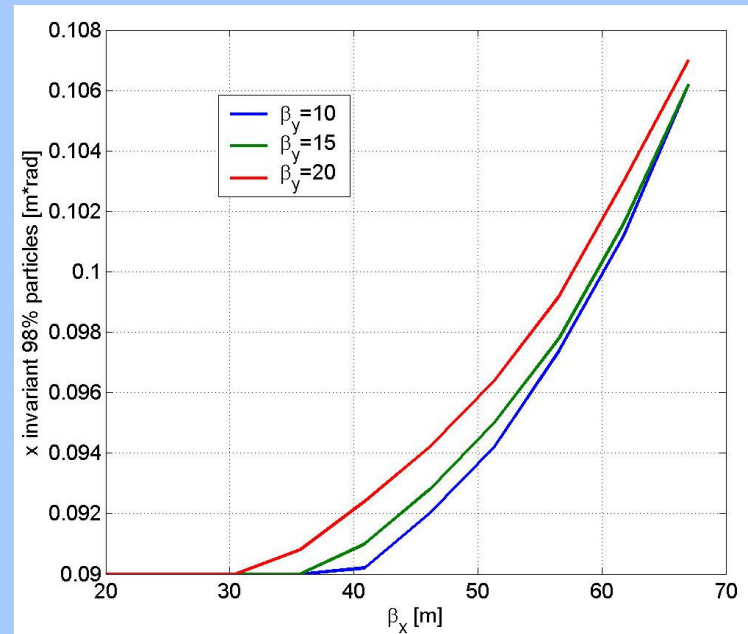
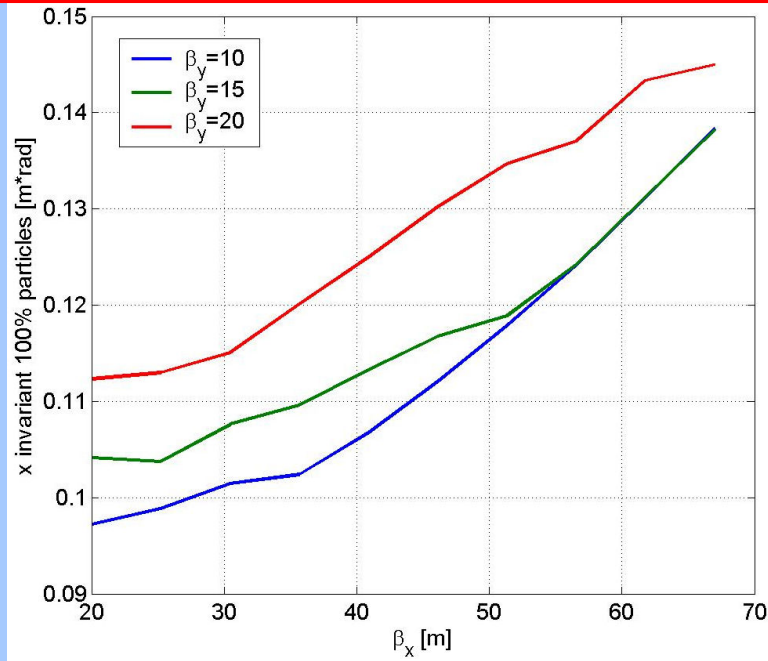


ILC kickers: effect of the uniformity of the deflecting field on beam invariant

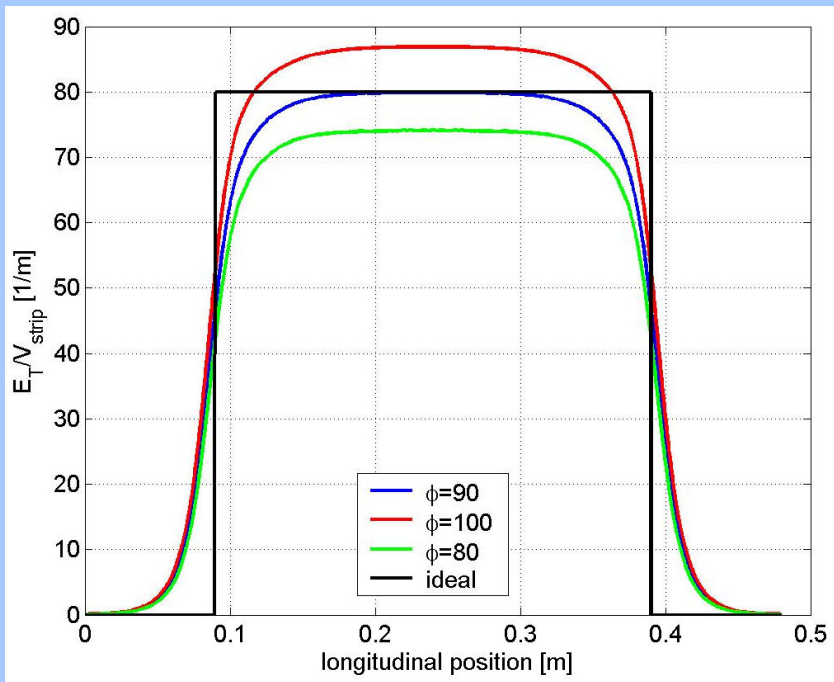
Geometry 1



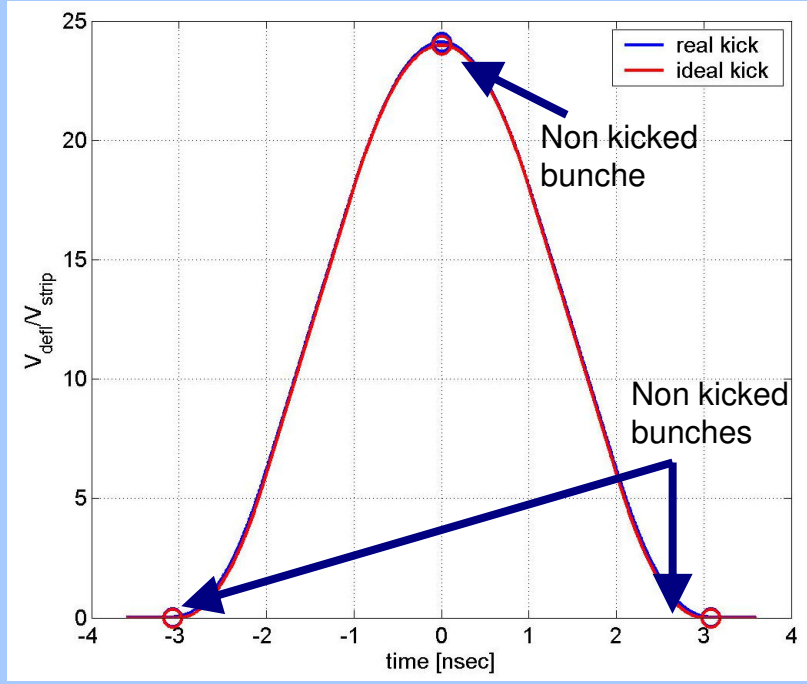
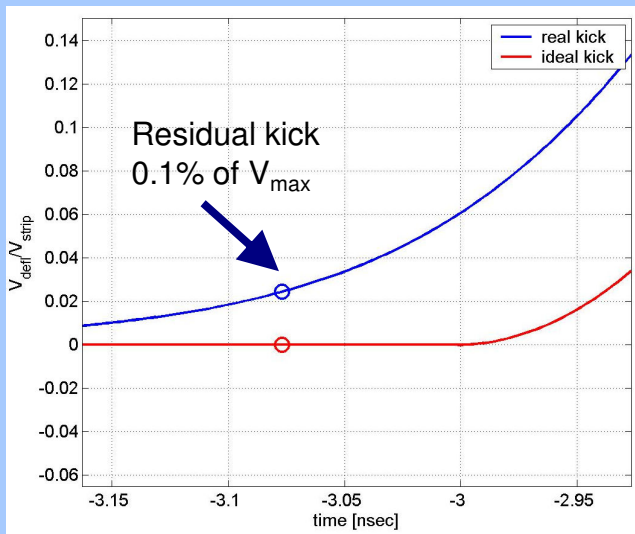
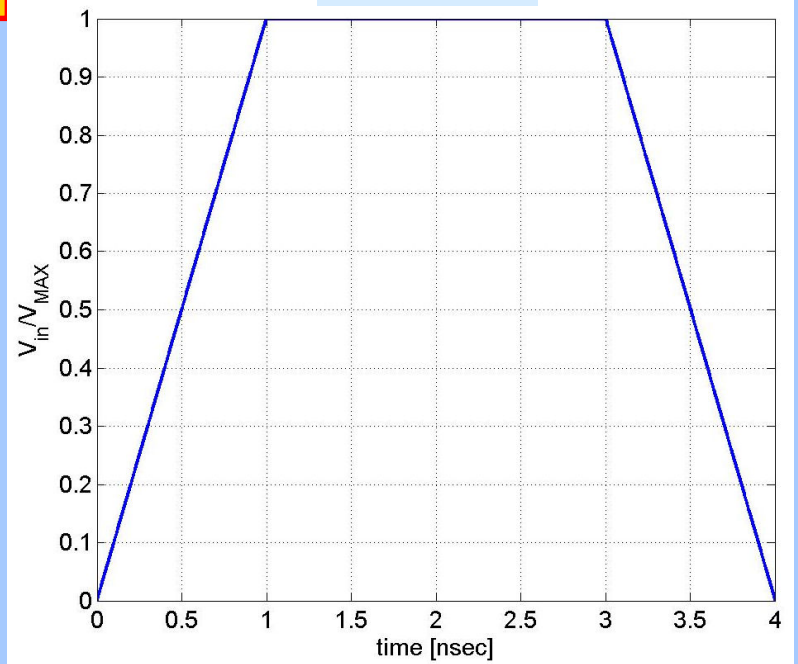
ILC kickers: kicker β -functions effect on invariant increase (geometry 1)



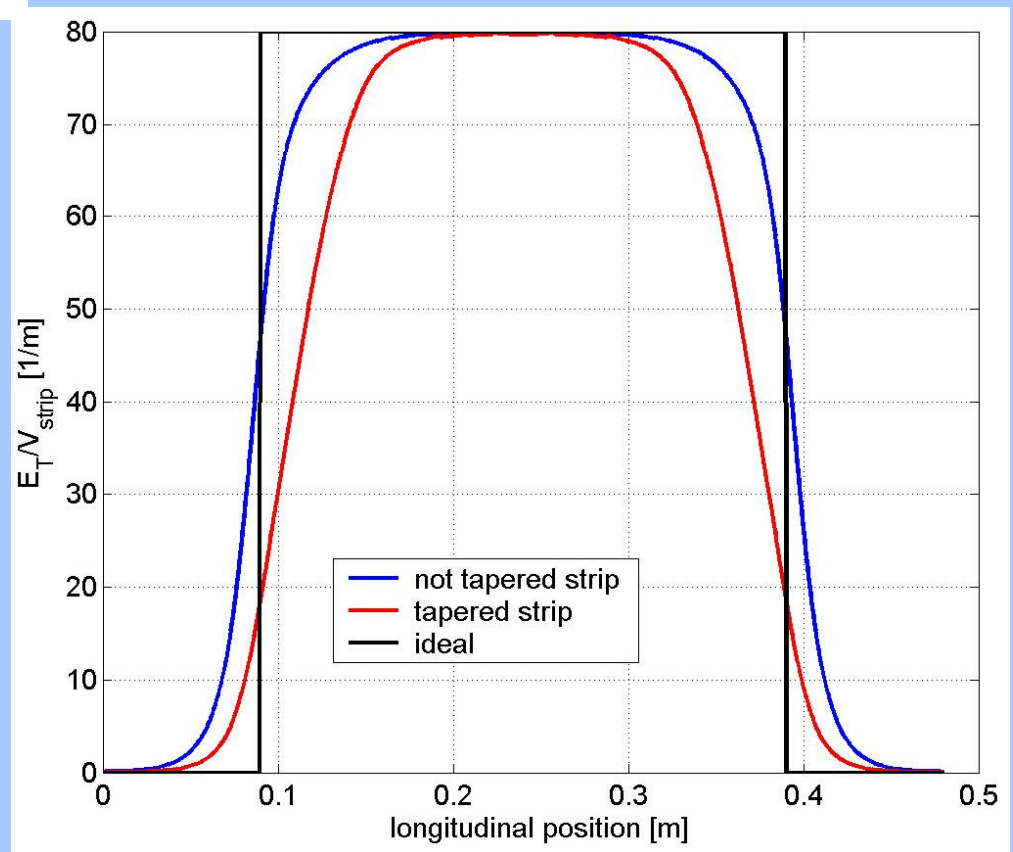
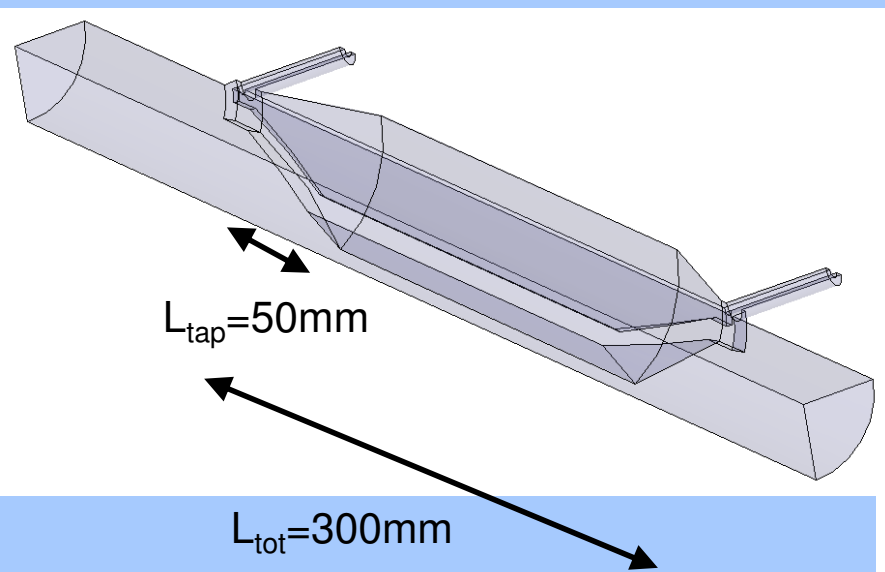
ILC kickers: physical and electrical lengths



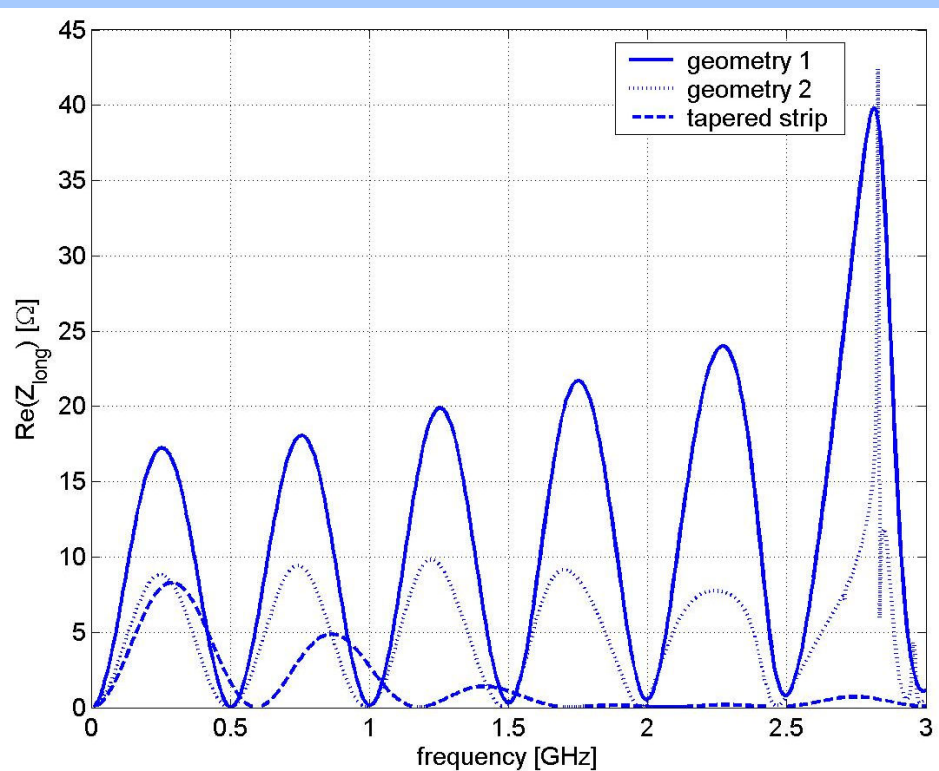
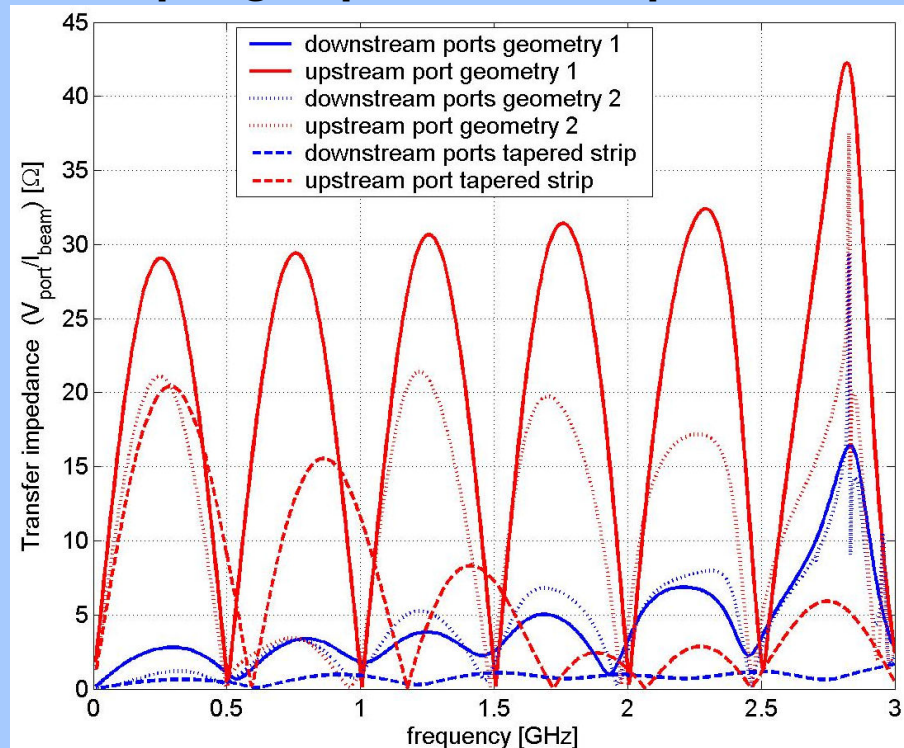
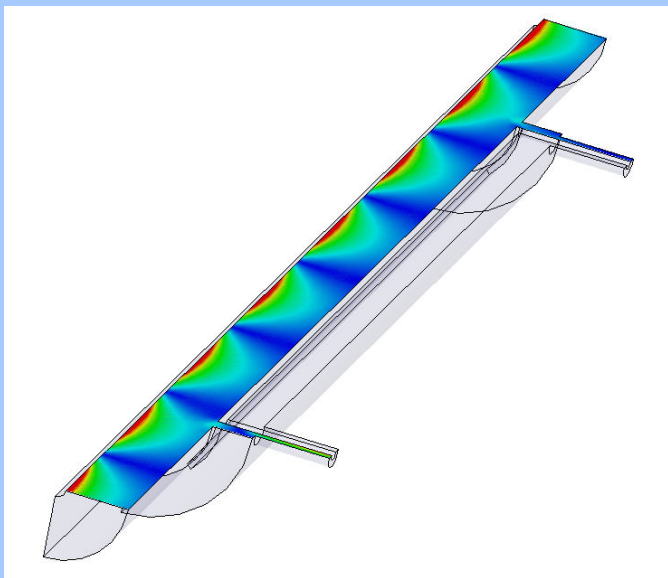
Input pulse



ILC kickers: tapered strip, electrical lengths comparison



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



CONCLUSIONS

- The new DAFNE injection kickers, installed one year ago, work well and are very versatile devices. Used with both FID and old DAFNE pulsers and even as a feedback kicker!
- Reliability problems of the fast pulse generators by FID remain to be solved, we hope with the 24kV units.
- A tapered stripline kicker for ATF has been designed and constructed.
- Some preliminary calculations and design considerations on the ILC kickers have been done