FAST KICKERS TESTS
AND
BELLOWS IMPEDANCE AT DAFNE

Fabio Marcellini, LNF- INFN

LCWS08 & ILC08
Nov 16-20, 2008 University of Illinois, Chicago

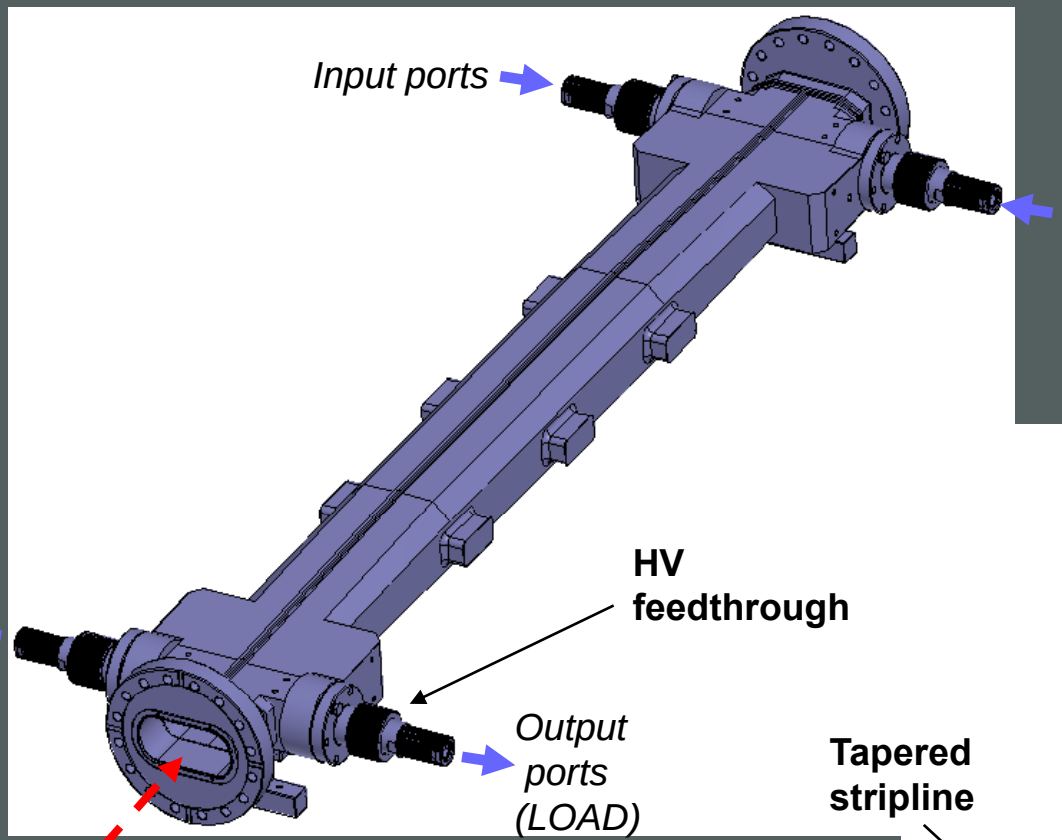
PRESENTATION OUTLINE

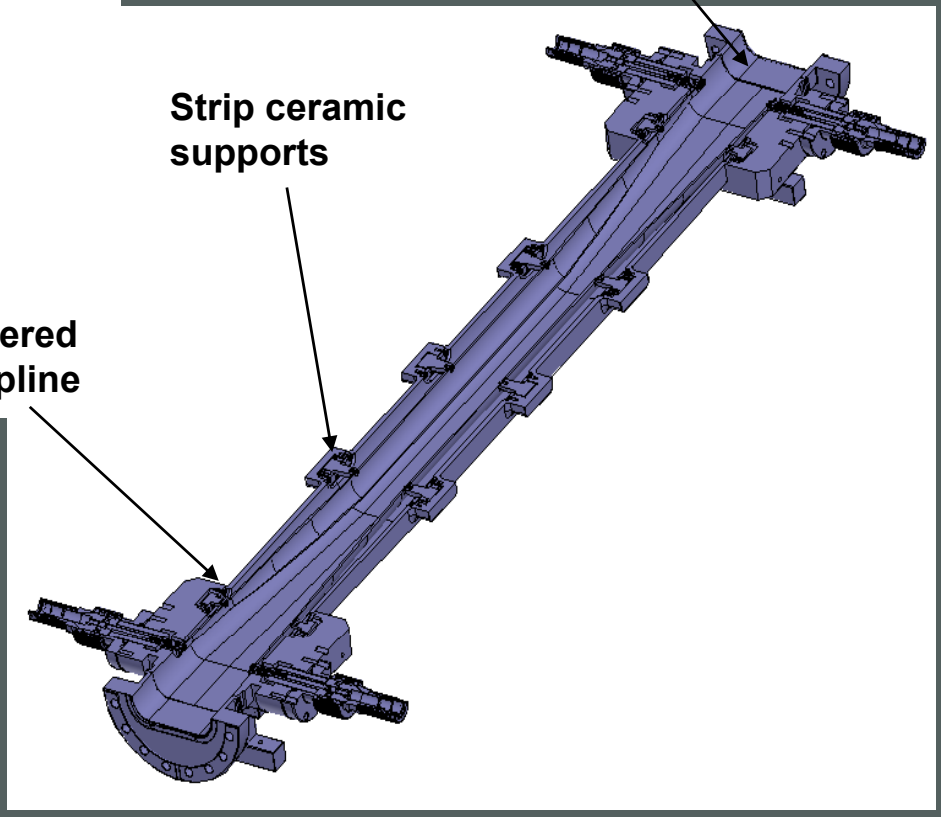
1. Design of a stripline kicker for beam injection in DAFNE storage rings.
2. HV tests and RF measurements of the kicker.
3. DAFNE operation with the new kickers.

4. Realization of a stripline kicker for ILC damping ring.

5. New DAFNE shielded bellows

1. DESIGN OF THE NEW DAFNE INJECTION KICKER



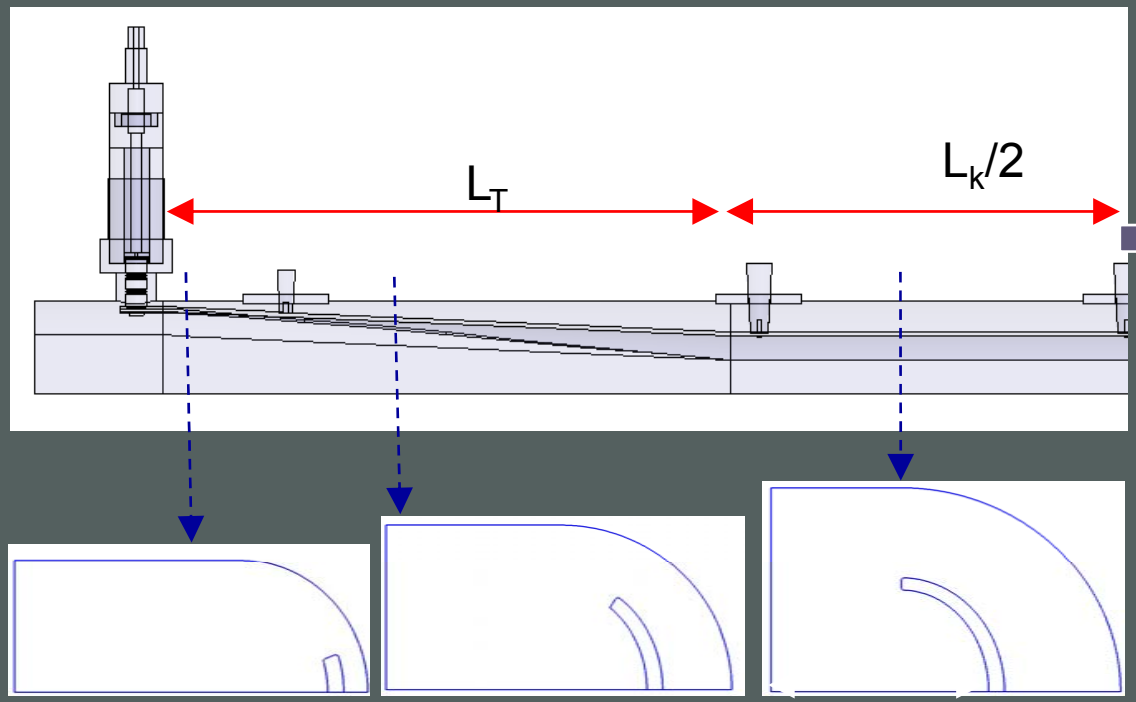


The elliptical cross section:

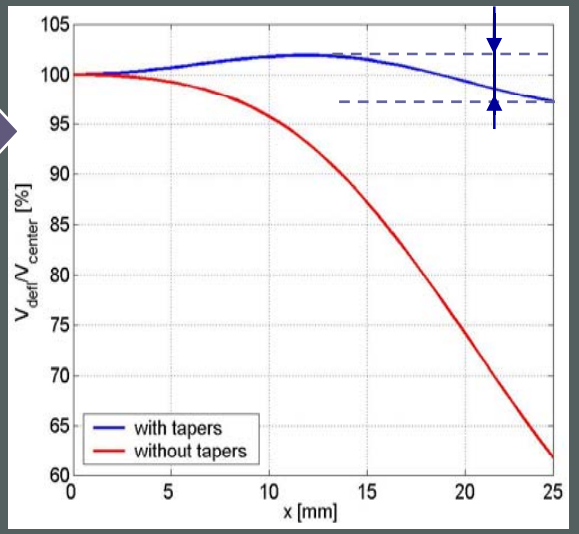
- Minimizes the discontinuity of the beam pipe cross section between the injection region and the adjacent dipole regions
- **Increases the deflection efficiency**.

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.



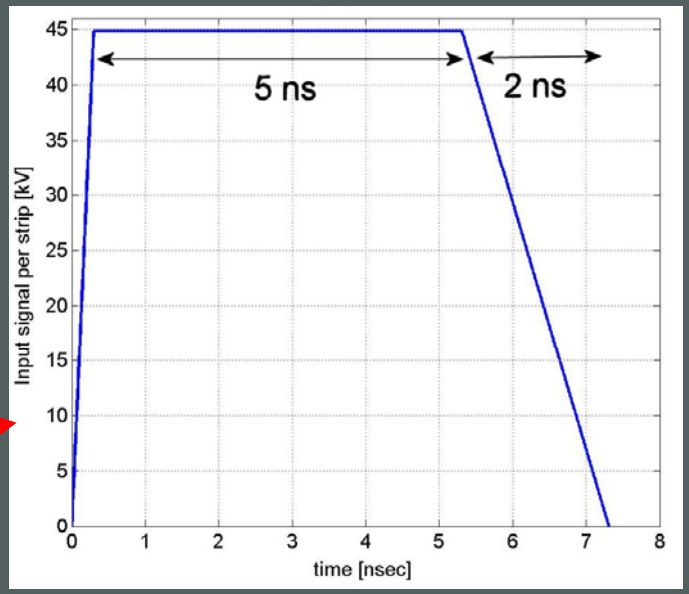
Field flatness by integration

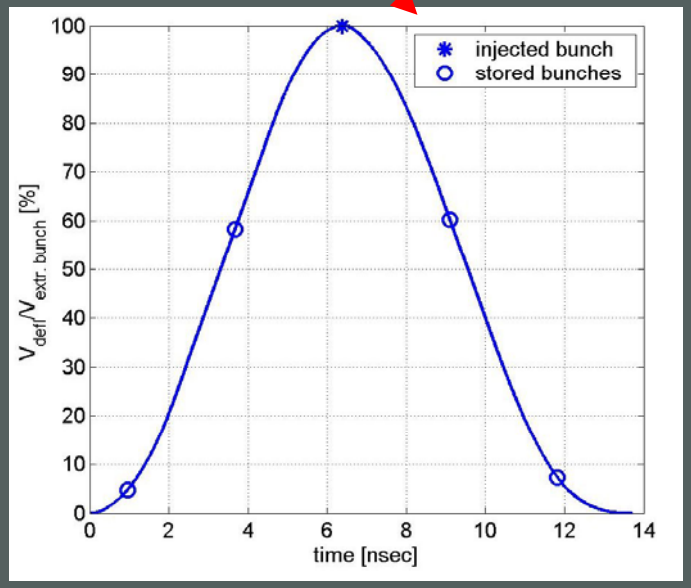


±3%

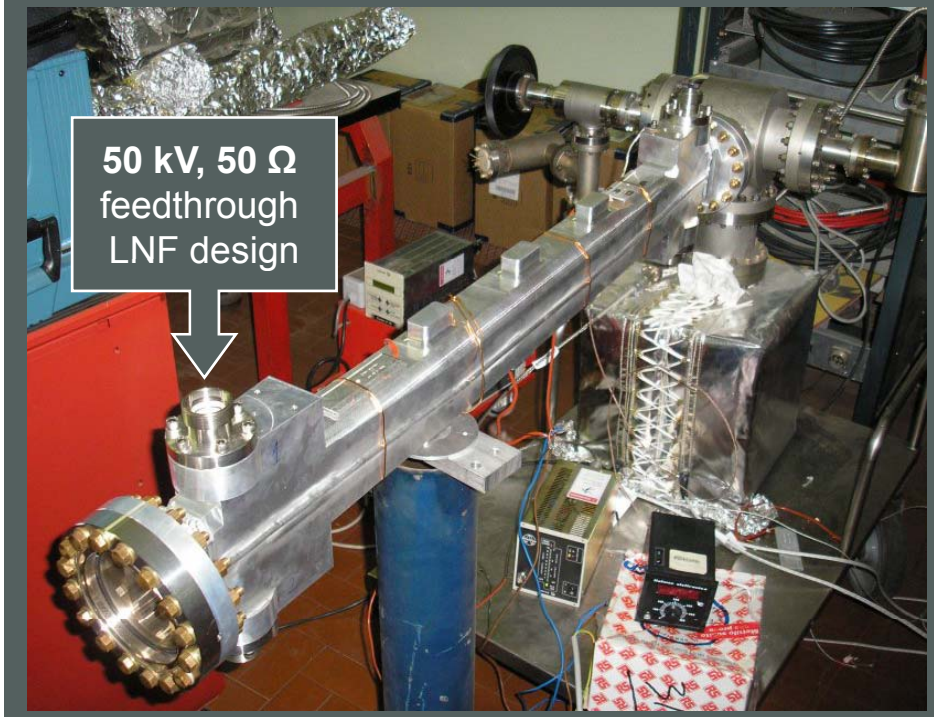
injection kicker design parameters

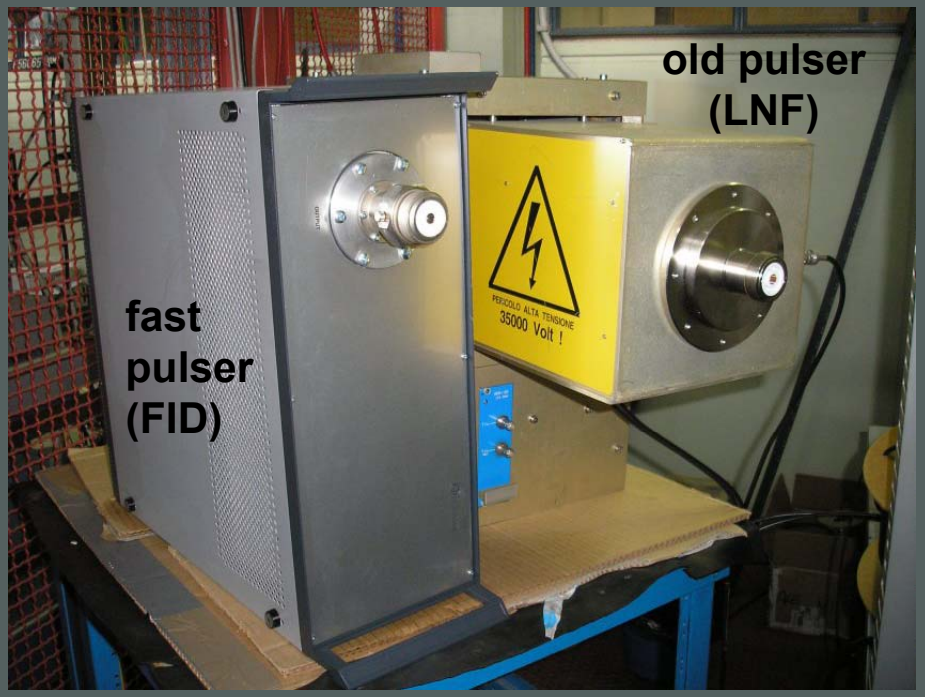
PARAMETERS	
Beam Energy E [MeV]	510
Time spacing between bunches [ns]	2.7
Deflection [mrad]	**5**
Total deflecting voltage VT [MV]	2.5
Total kicker length L [cm]	~90
Voltage per strip [kV]	**45**
Input pulse length [ns]	~ 5
Pulse length “seen” by bunches [ns]	~10
Max rep rate [Hz]	10



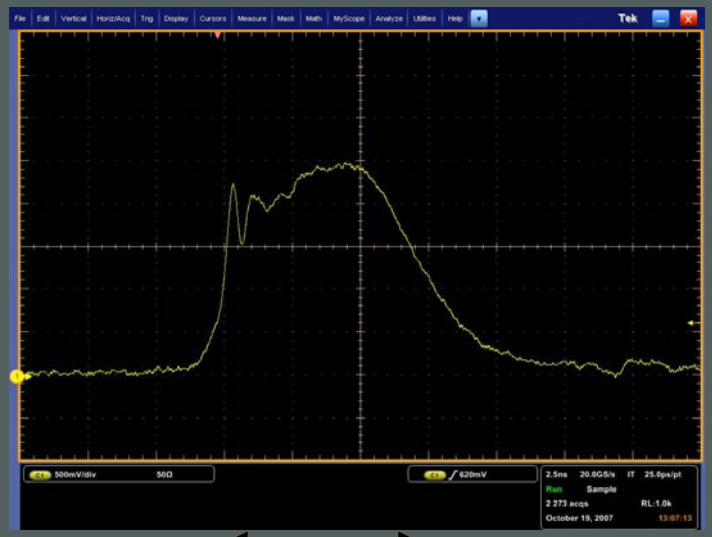


2. HV TESTS



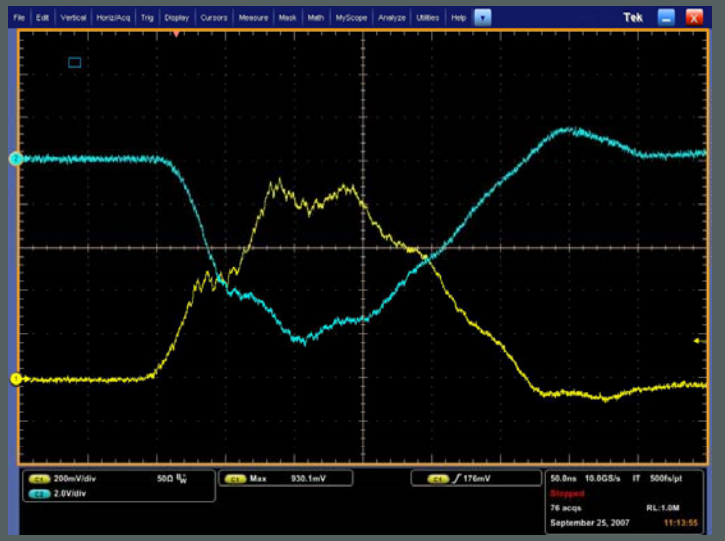


45 kV



5 ns

25 kV

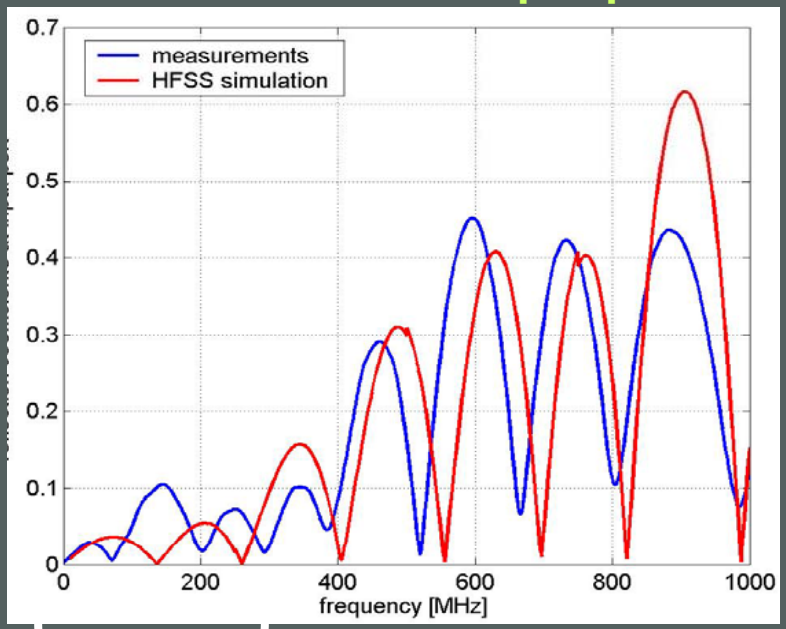


250 ns

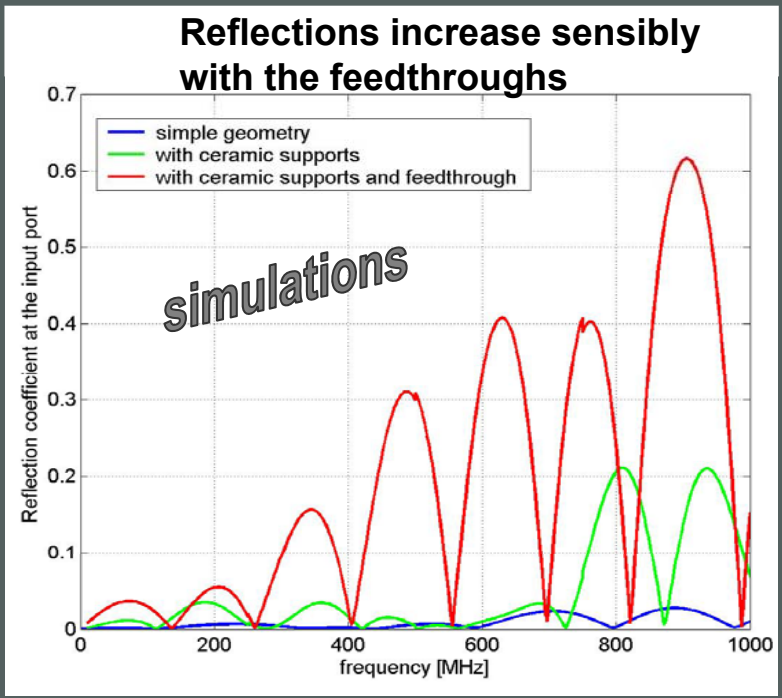
2. RF measurements: frequency response

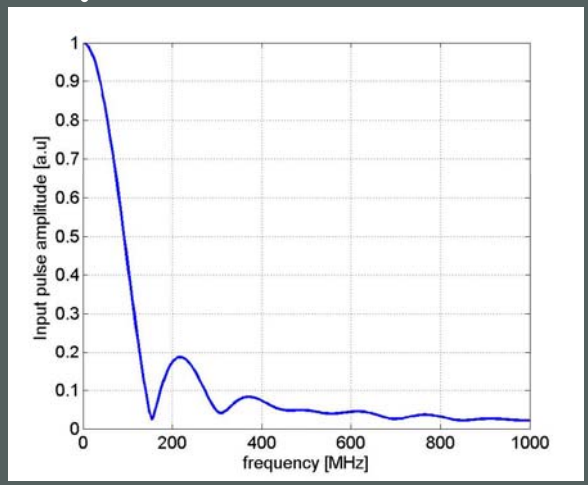
Special connectors needed to adapt HV connector to RF standards

Reflection at the input port

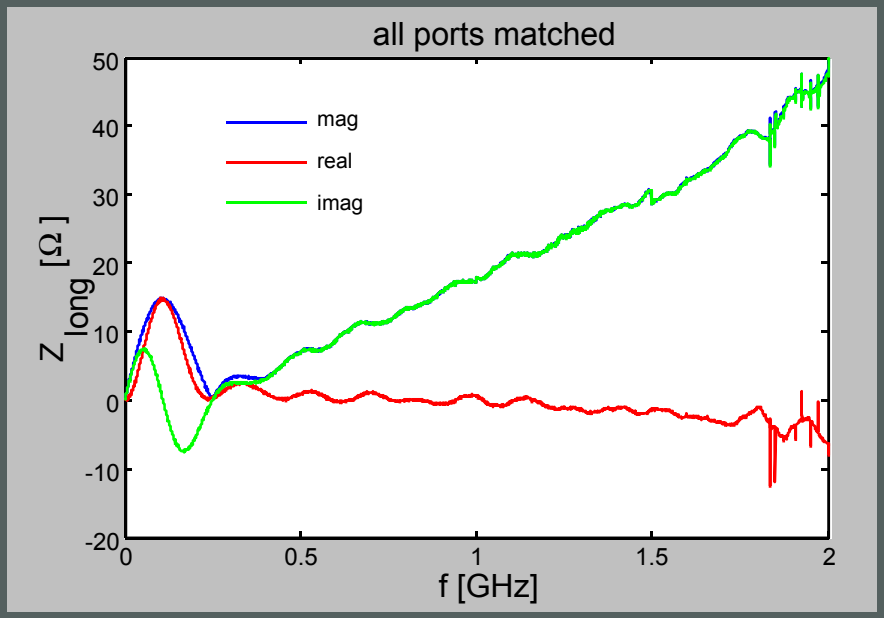


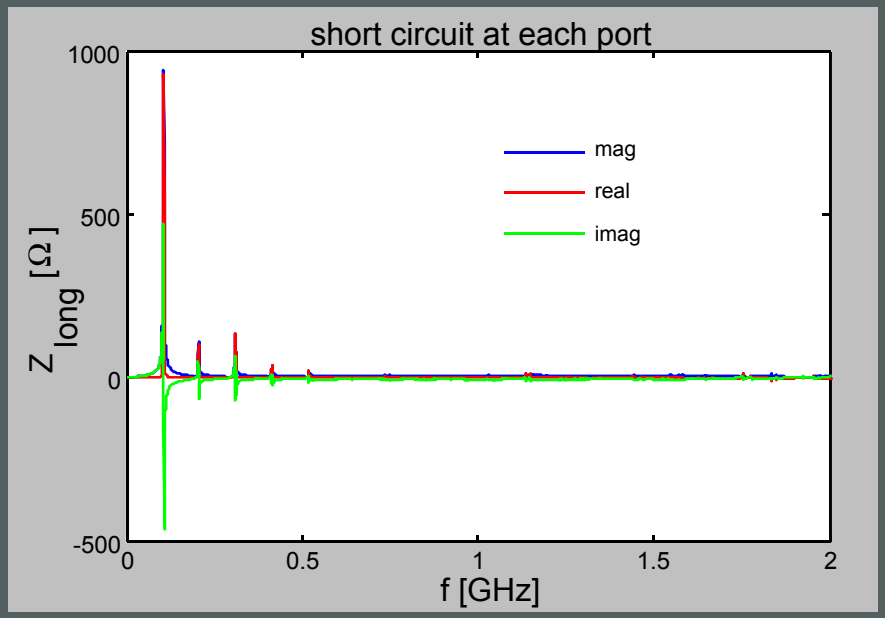
Reflections increase sensibly with the feedthroughs

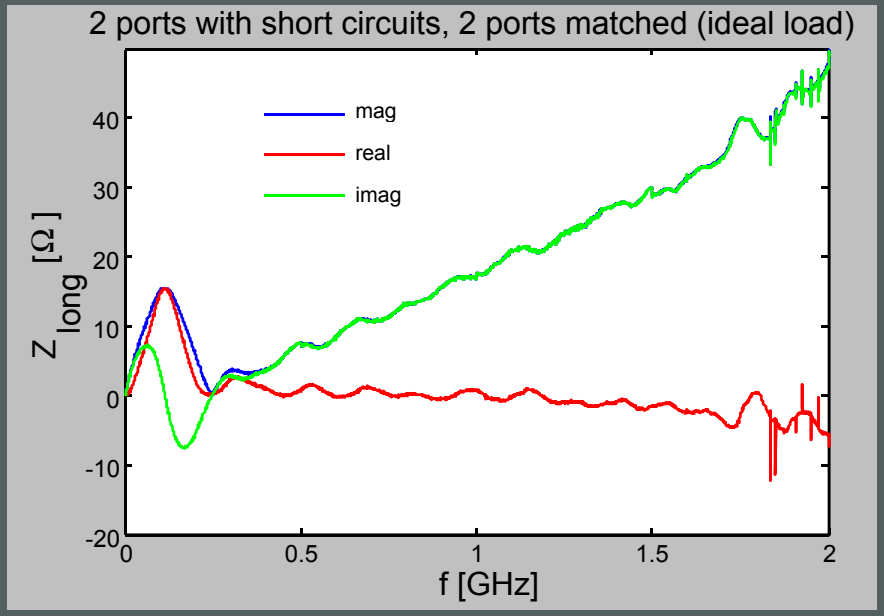


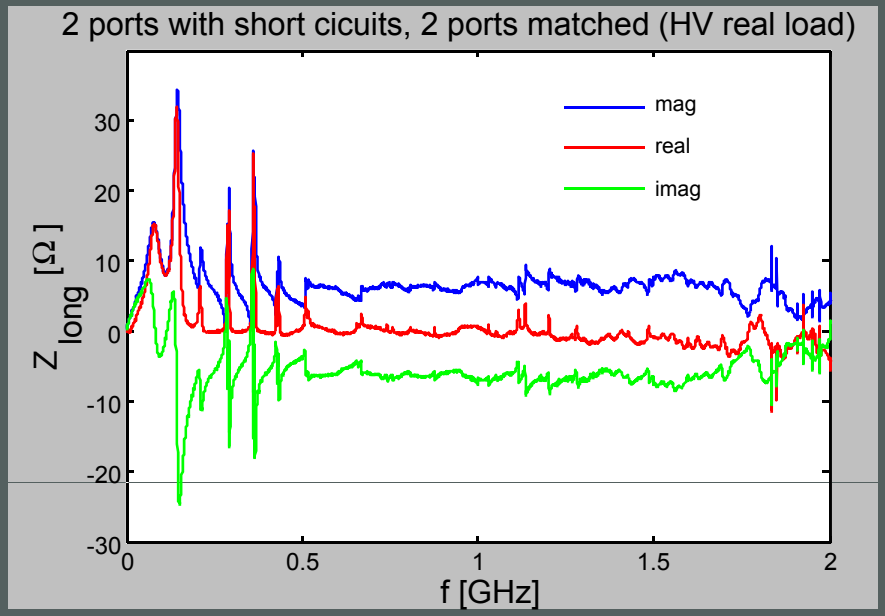


2. RF measurements: longitudinal impedance



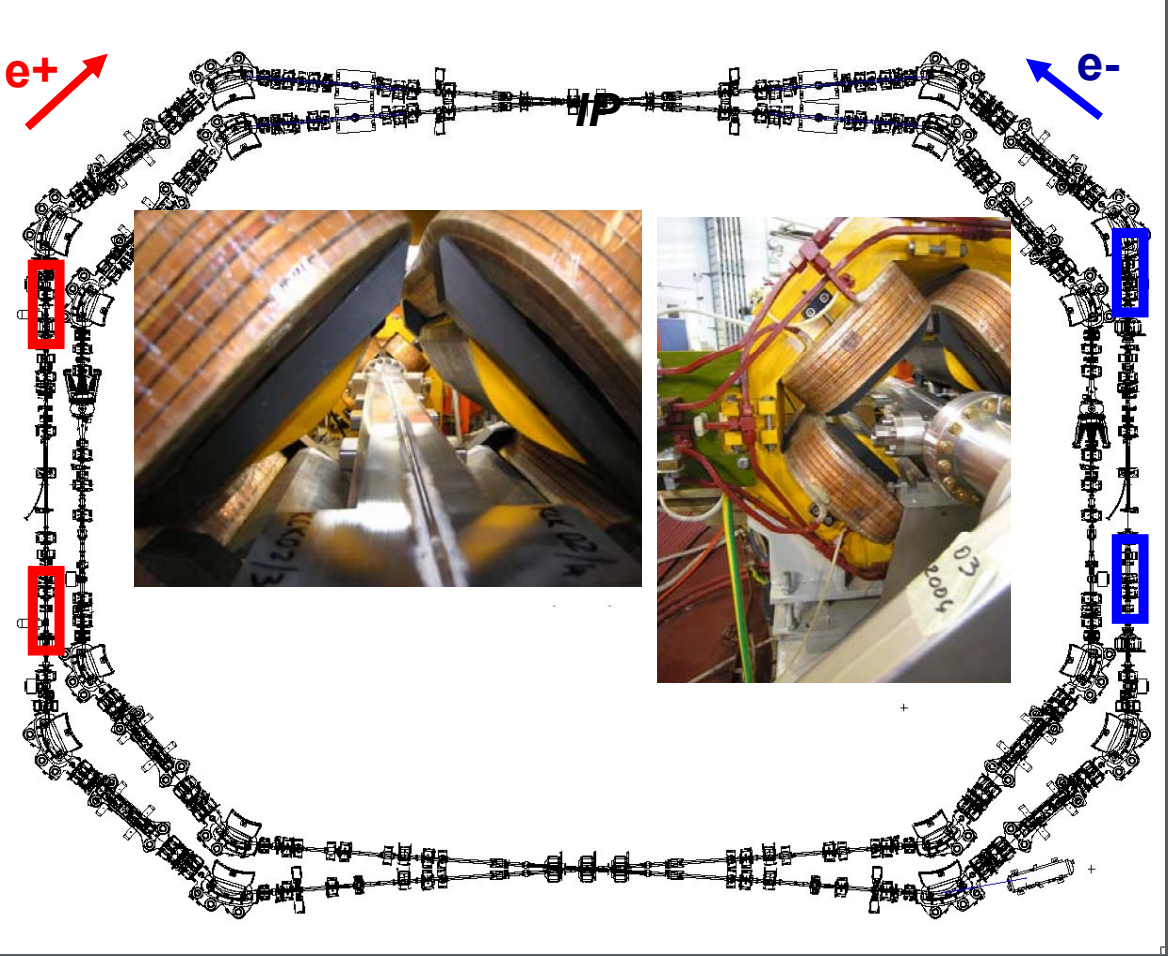






3. DAFNE operation with the new kickers

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



Final version of the 45 kV FID pulsers has shown poor reliability. At present only 1 pulser of 4 is good.

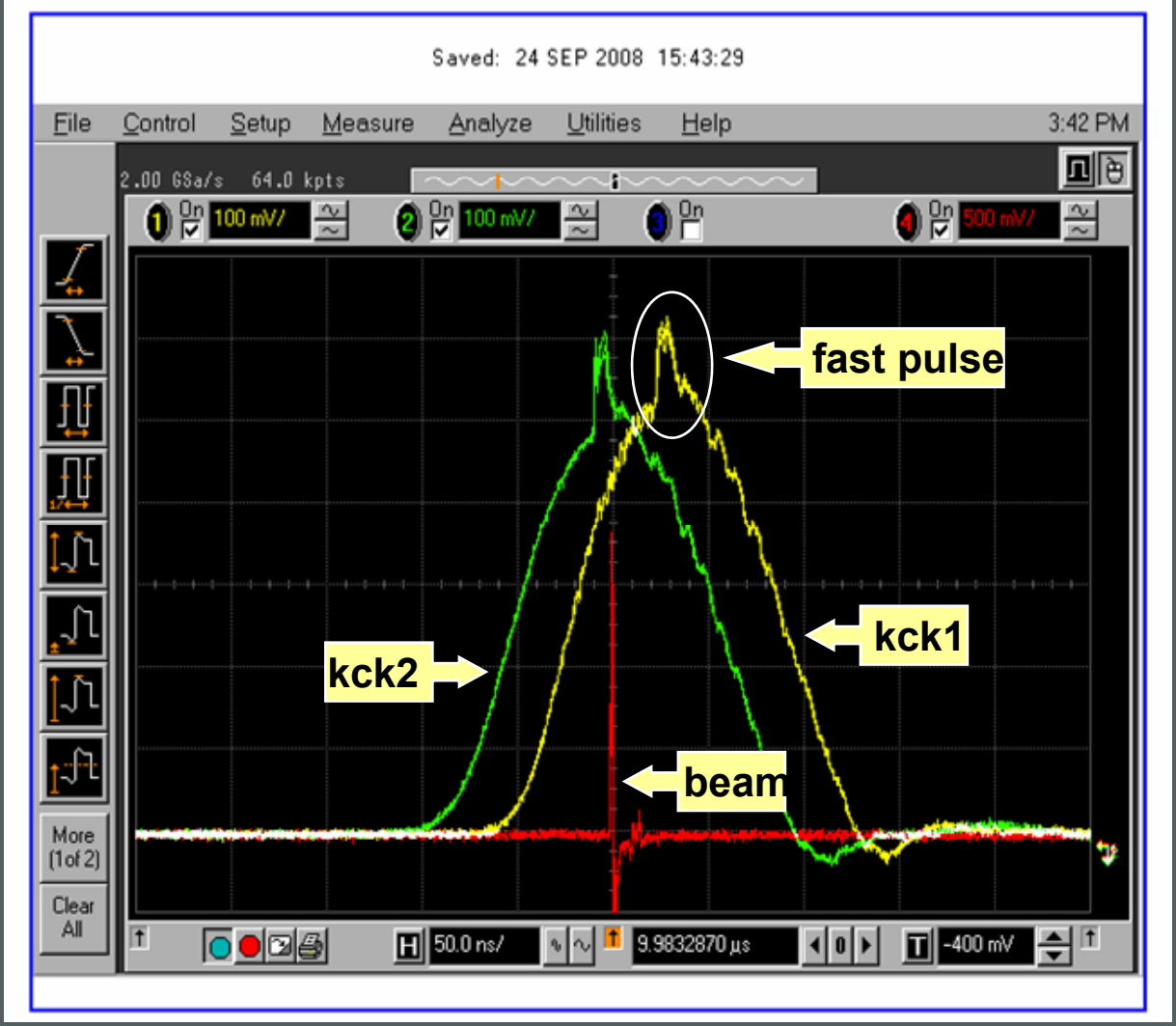
FID GmbH repaired and updated several times the broken components but a reliable solution has not yet been found.

We never had the possibility to operate with the 4 pulsers working together at the same time.

We are now running with the old, long pulse system in both the rings.

In e+ ring we have succesfully tested injection with a hybrid system connecting both the old pulser and the 45kV fast pulser to each kicker.

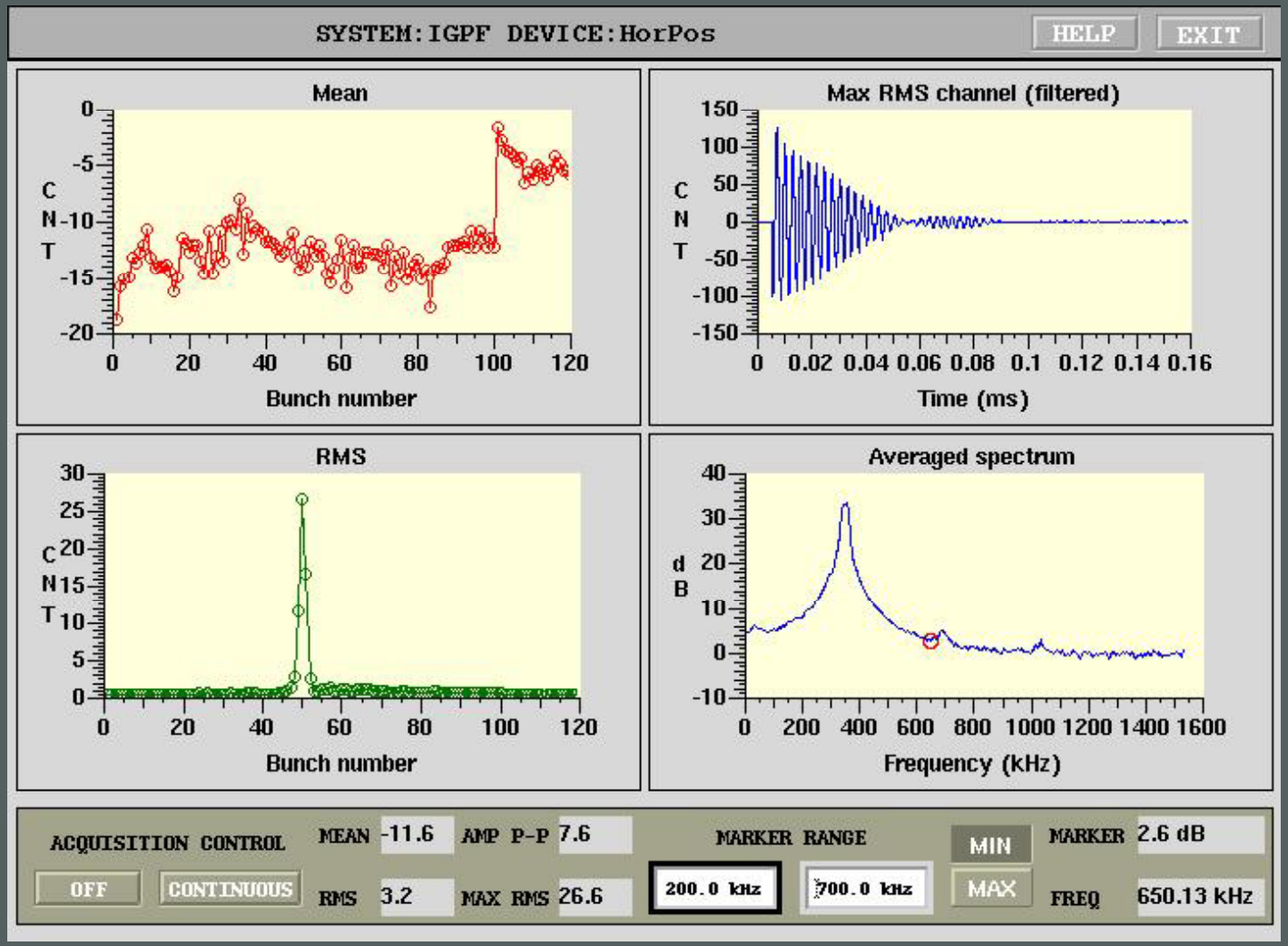
Injection with hybrid system



Long and the fast pulses observed in sum at the scope.
Taken from 2 striplines of the e+ ring kickers.
Different attenuations for signals from the 2 striplines.

DAFNE beam oscillations with fast kick

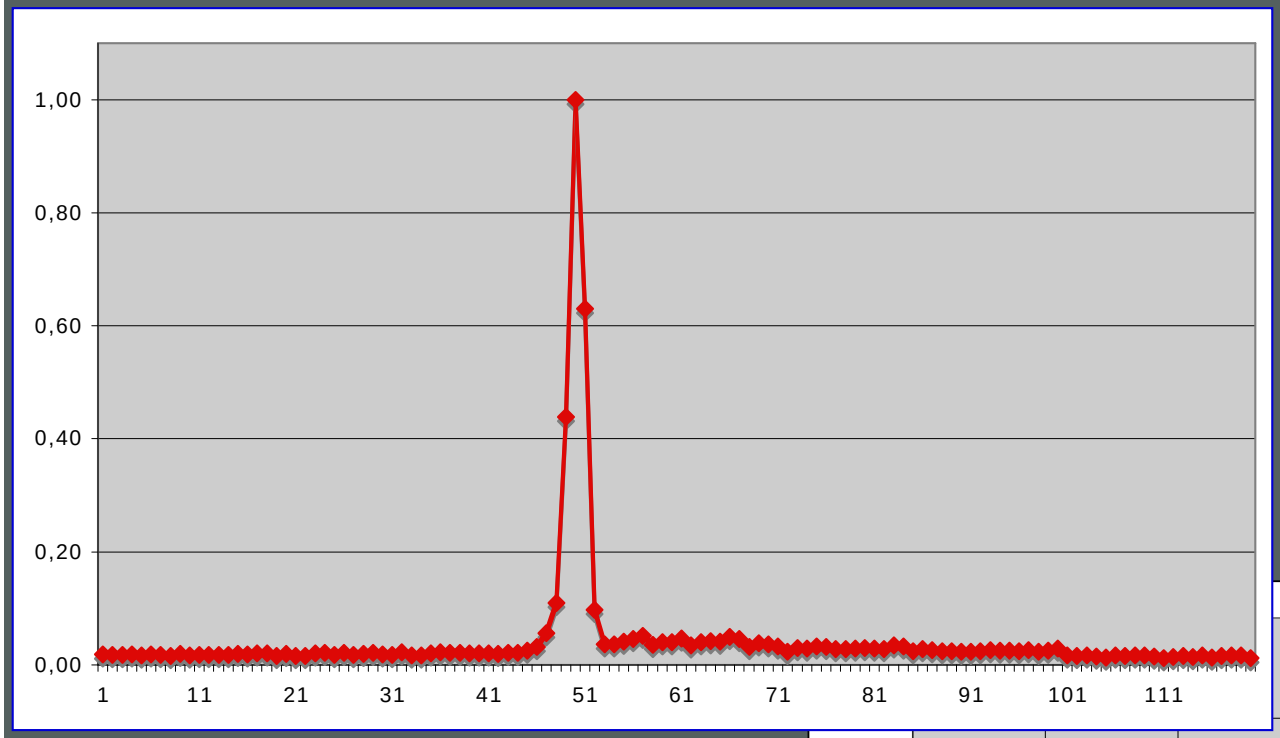
Measured by the horizontal digital feedback system.



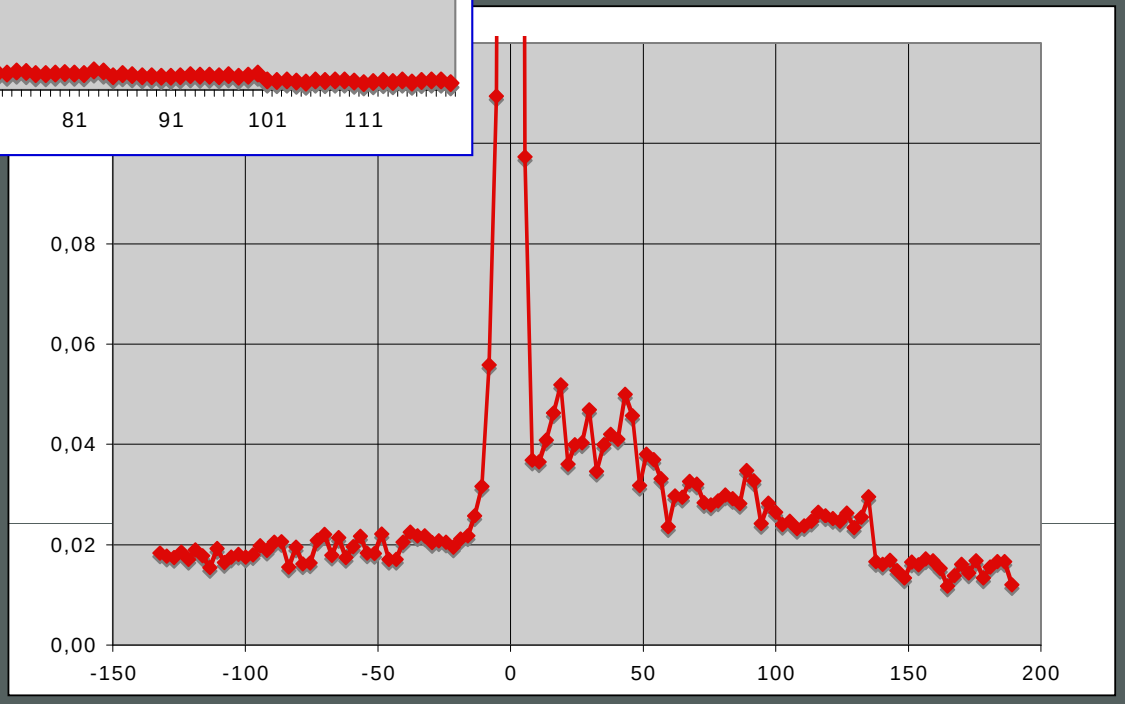
100, of 120, stored bunches with kicker pulse centered on bunch 50.

bunch distance 2.7 ns.

DAFNE 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

Experience with FID pulsers

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.

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

Pulse shape is the same of the 45kV FID, just lower voltage amplitude.

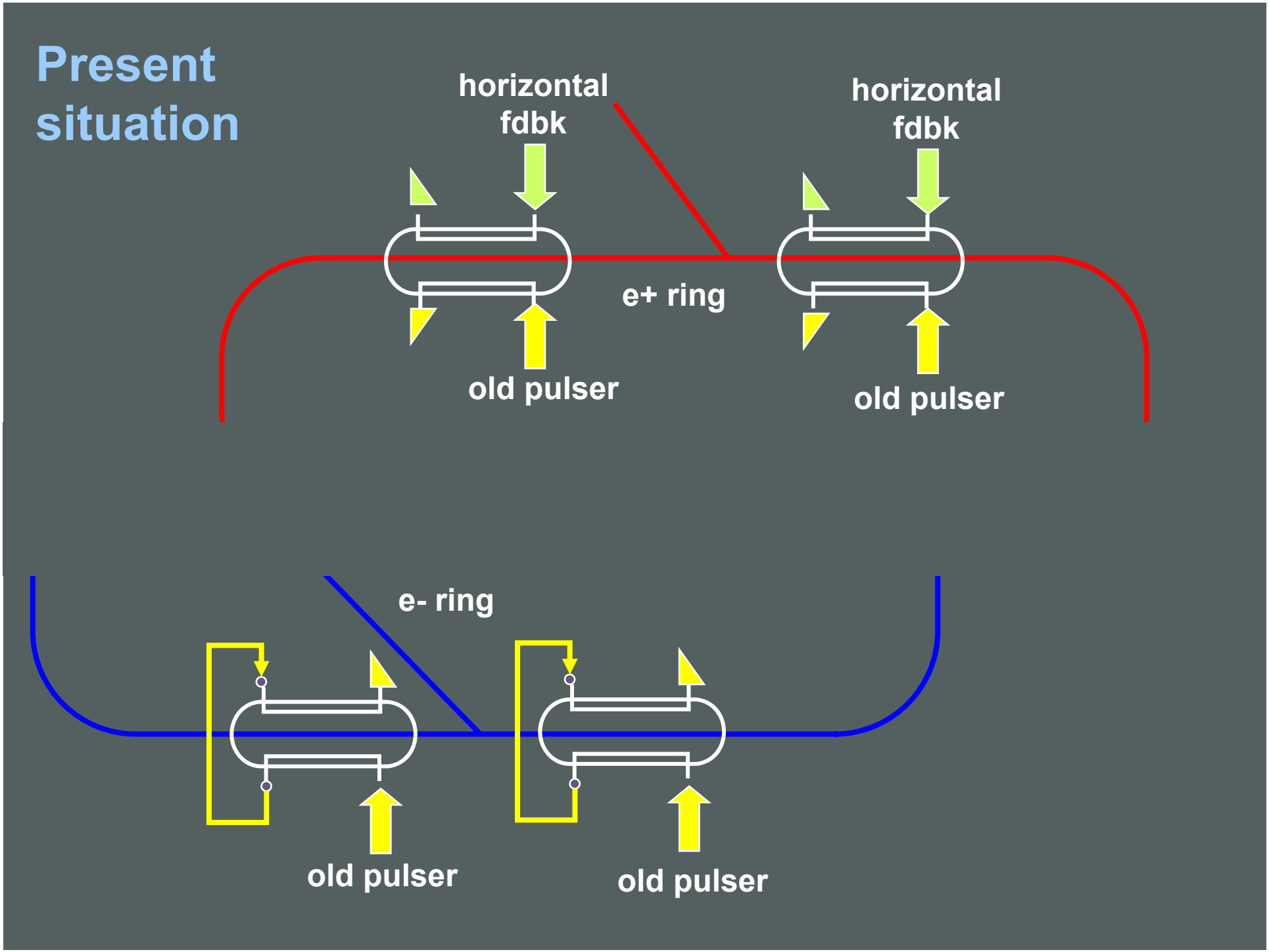
We used this 24 kV FID for lab tests and never had problems up to now.

We decided to give up the 45 kV FIDs and try to go on with the 24 kV units.

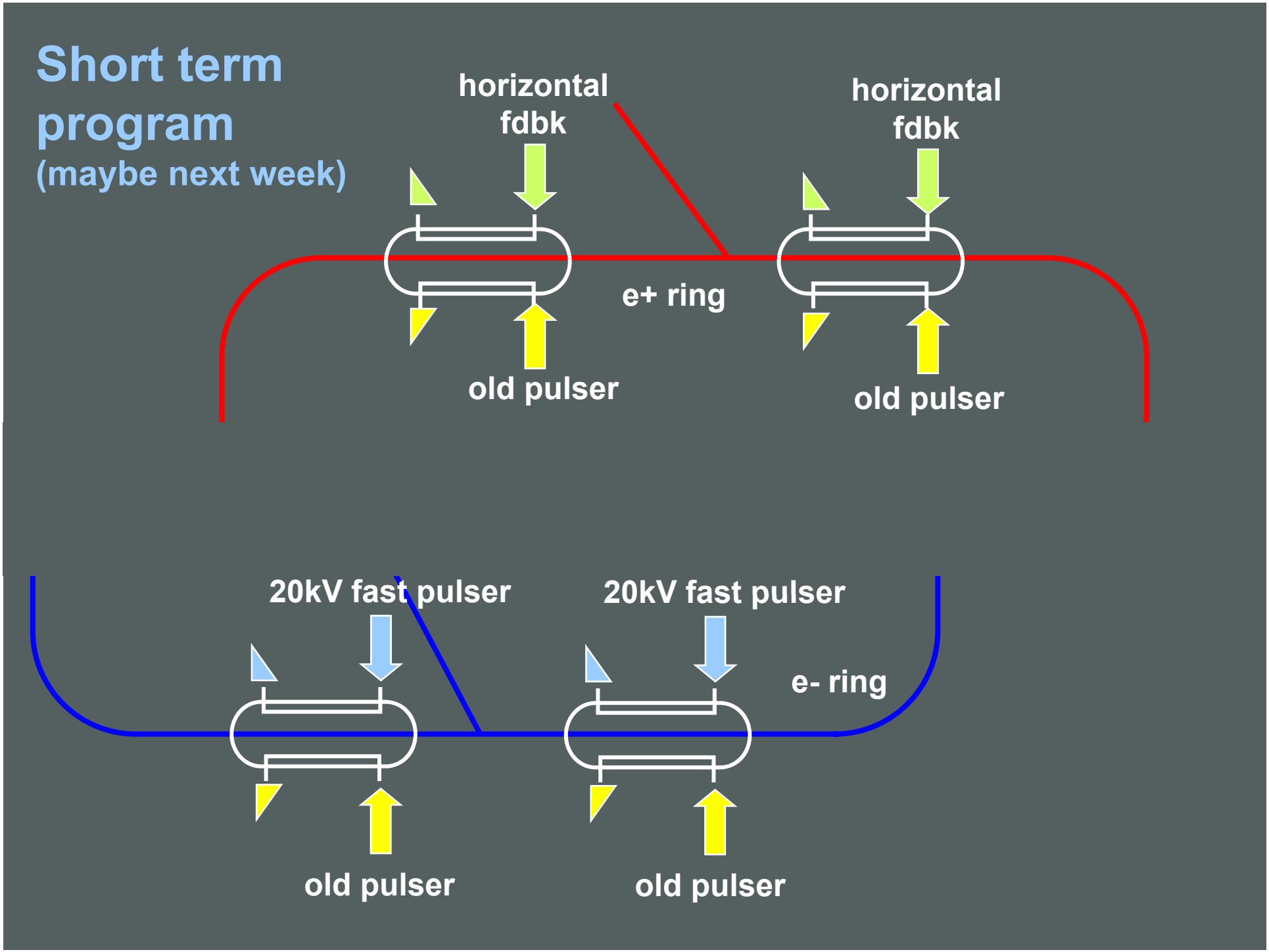
It is possible to have eight 24kV pulsers at the cost of the four 45 kV FIDs. Enough for both the rings.

The 24kV FID used for lab HV tests

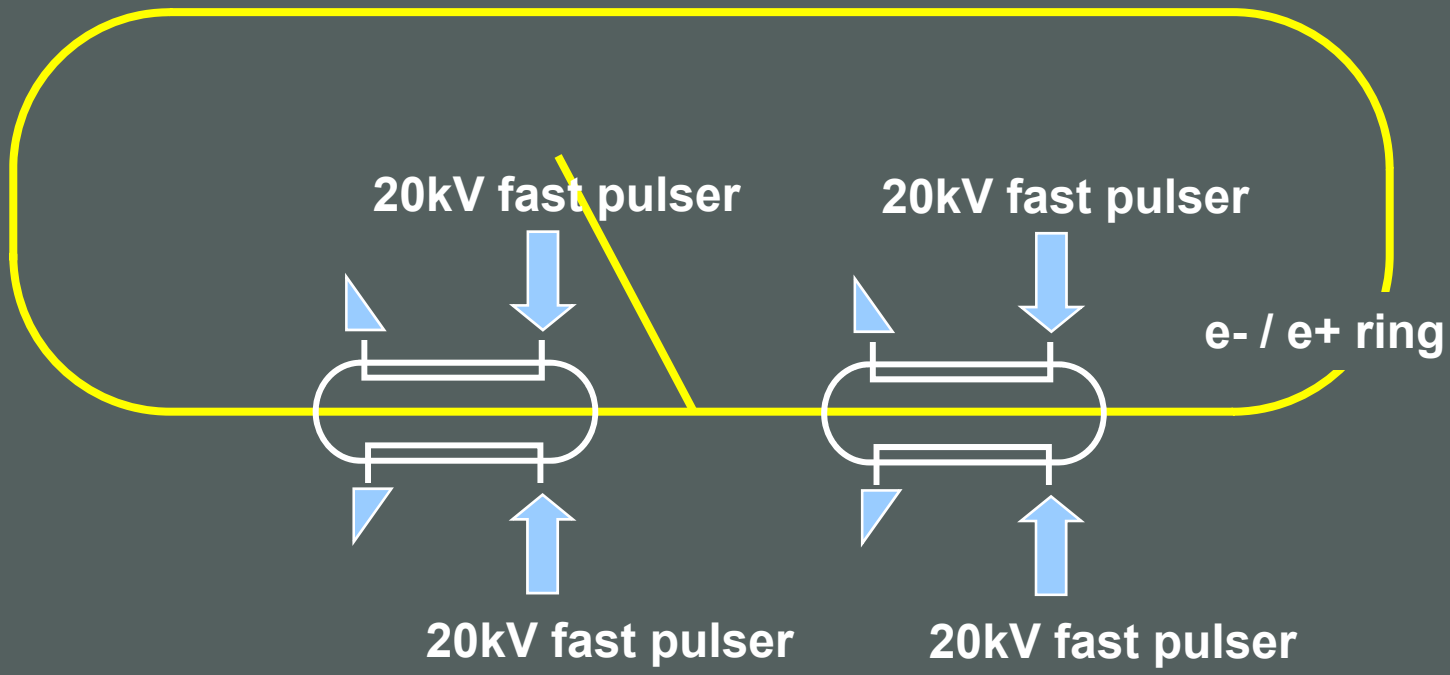
Present situation



Short term program
(maybe next week)



Longer term program

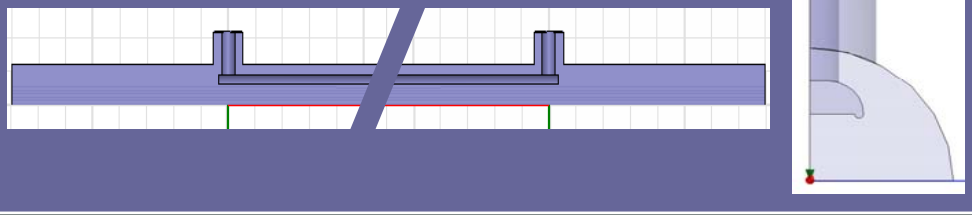


An additional stripline kck will be installed in e+ ring for the horizontal fdbk.

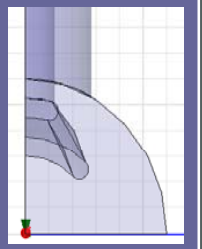
Operation with hybrid solution also possible.
More flexible in case of failure of FID pulsers.

4. A KICKER FOR ATF

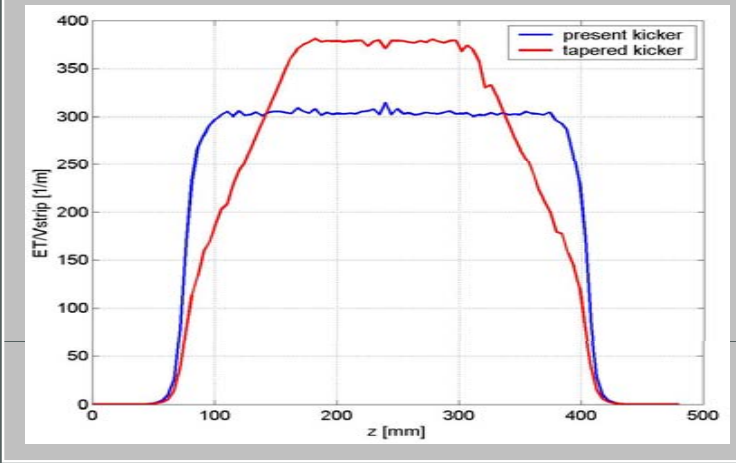
ATF PRESENT KICKER



ATF TAPERED STRIPLINE KICKER



Both the structures have been simulated with HFSS

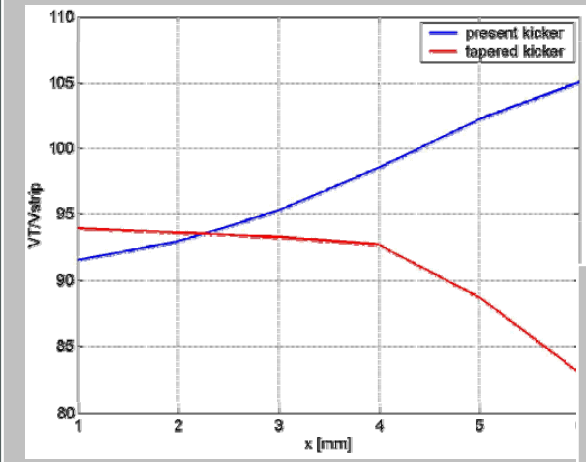


Deflecting field along the longitudinal structure axis

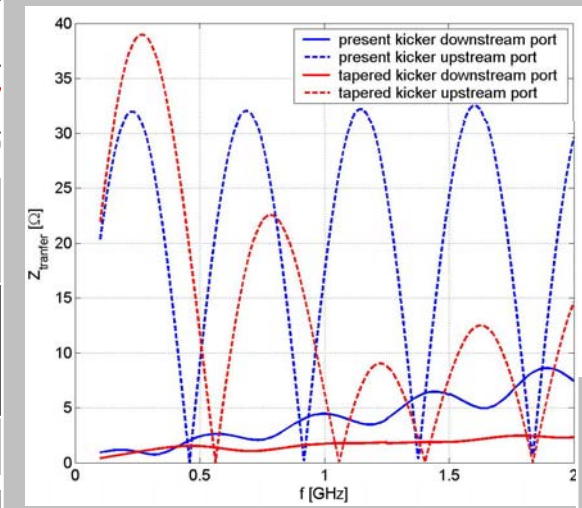
Blue: straight section stripline

Red: tapered stripline

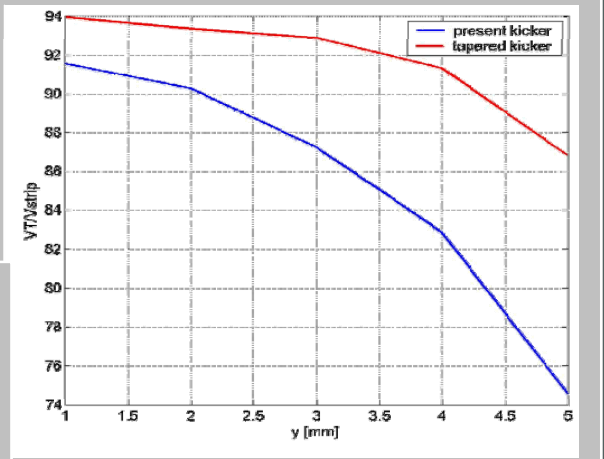
SIMULATION RESULT COMPARISON



deflecting voltage on the horizontal axis

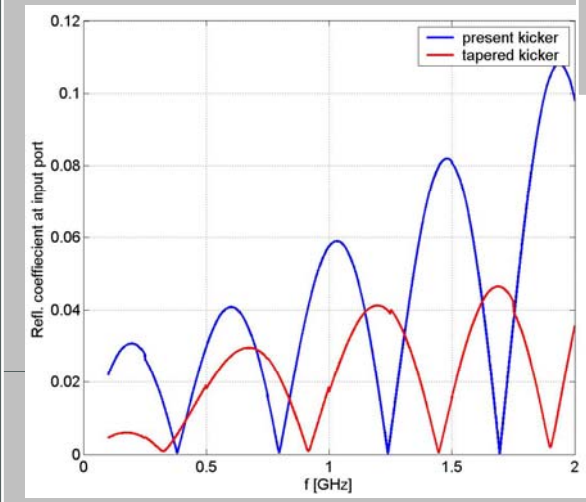


Transfer impedances

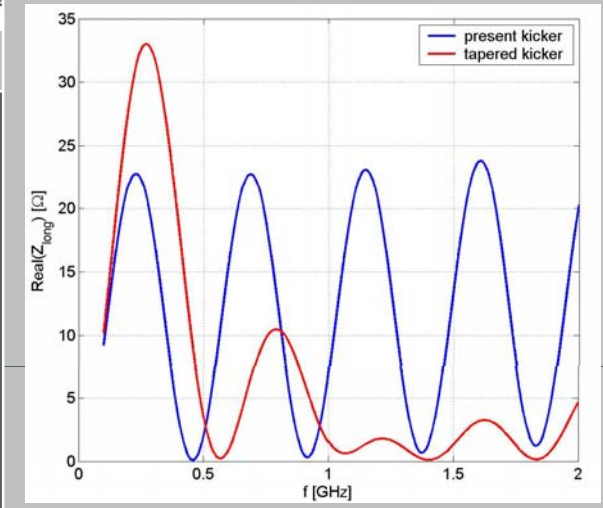


deflecting voltage on the vertical axis

Input port reflections



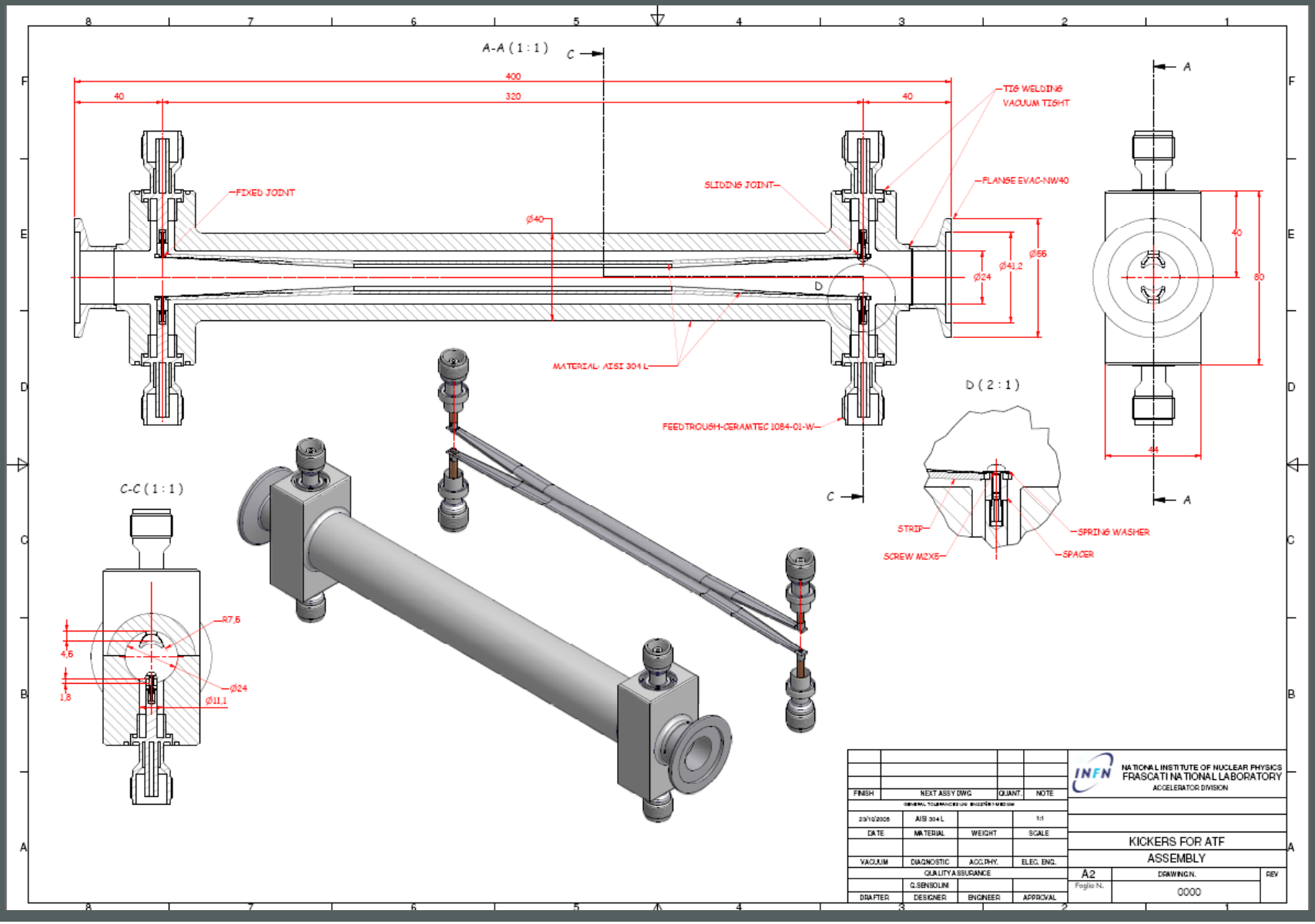
Longitudinal coupling impedance



Mechanical drawing of the kicker ready. Fabrication starting soon.

Kicker is made in stainless steel, 320 mm long.

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

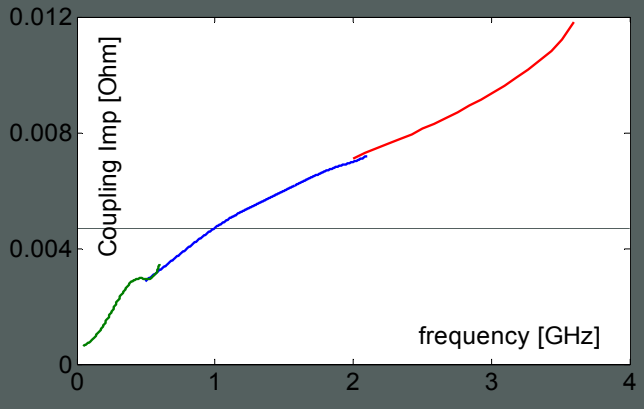


5. The new DAFNE bellows

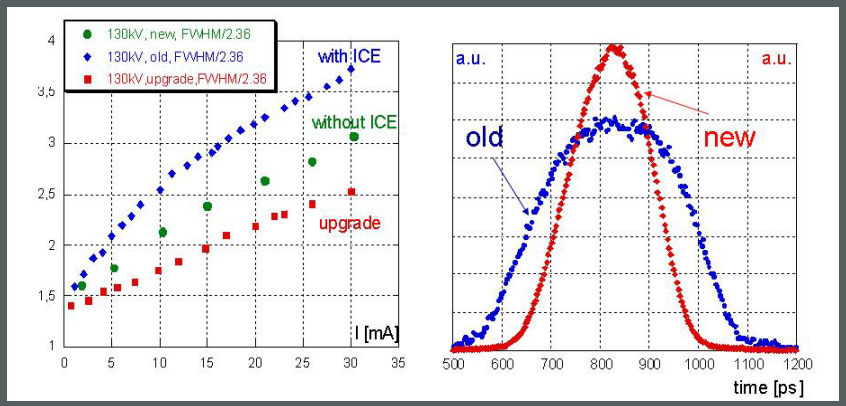
For the DAFNE upgrade, **vacuum chamber modifications have concerned**:

1. new interaction regions,
2. new stripline injection kickers,
3. all ion clearing electrodes removed in the electron ring.
4. new bellows

Low impedance design of the new vacuum chamber components

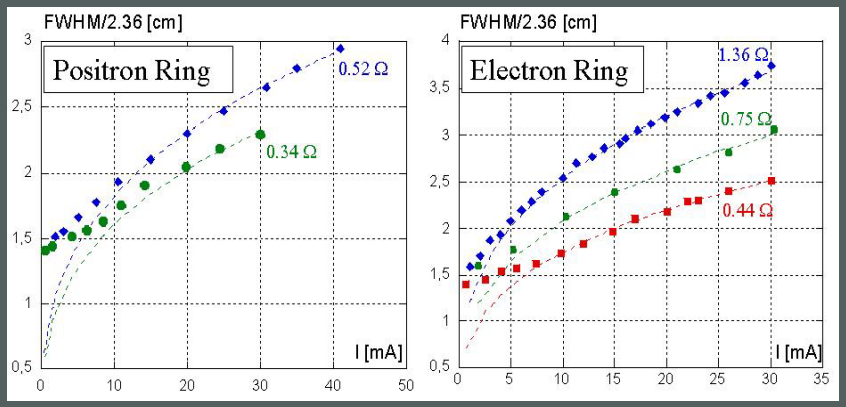


Bellows beam coupling impedance obtained by HFSS



Bunch length as a function of bunch current in the electron ring.
(left)

Bunch charge distribution (@ ~30mA) in the electron ring.
(right)

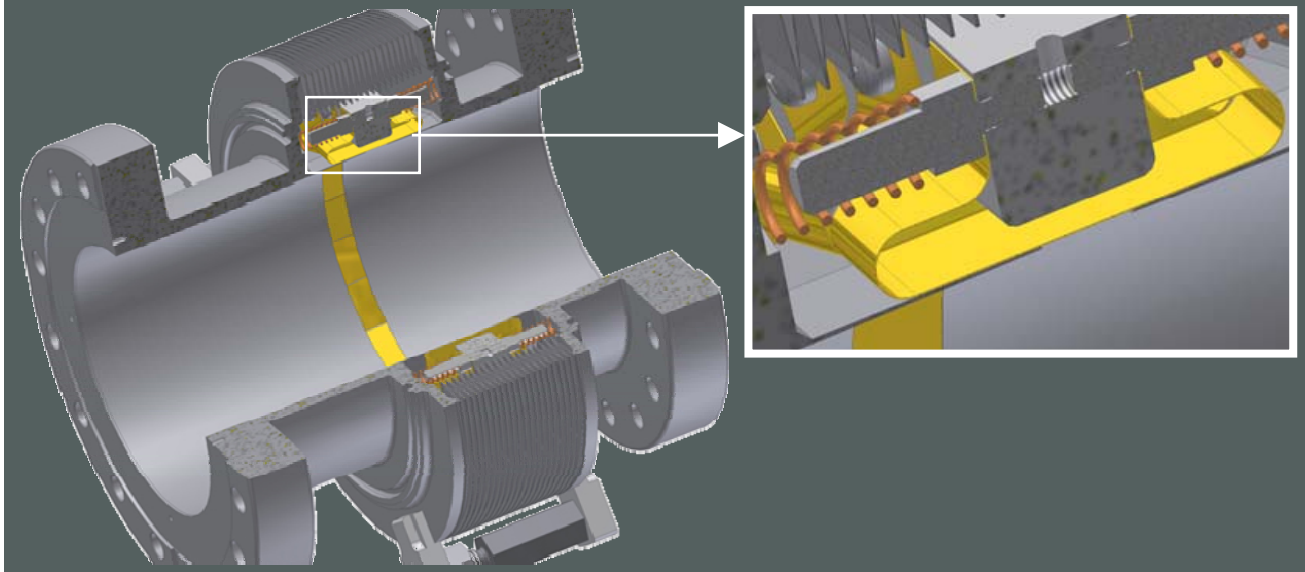


Bunch lengthening in:
positron ring (left)
electron ring (right)

few ion clearing electrodes still remaining in the e- ring.

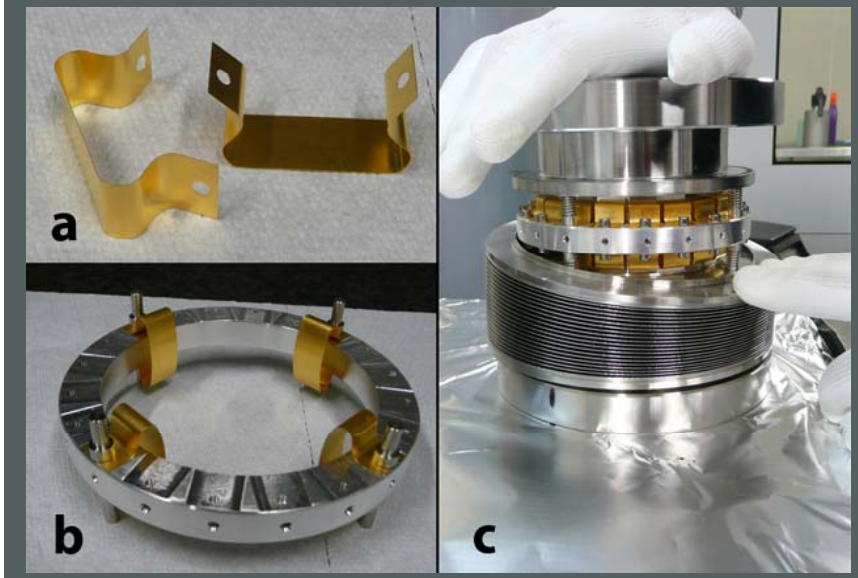
coupling impedance has been decreased by about 50% in the positron ring and 70% in the electron ring.

DRAWING OF THE NEW DAFNE BELLOWS



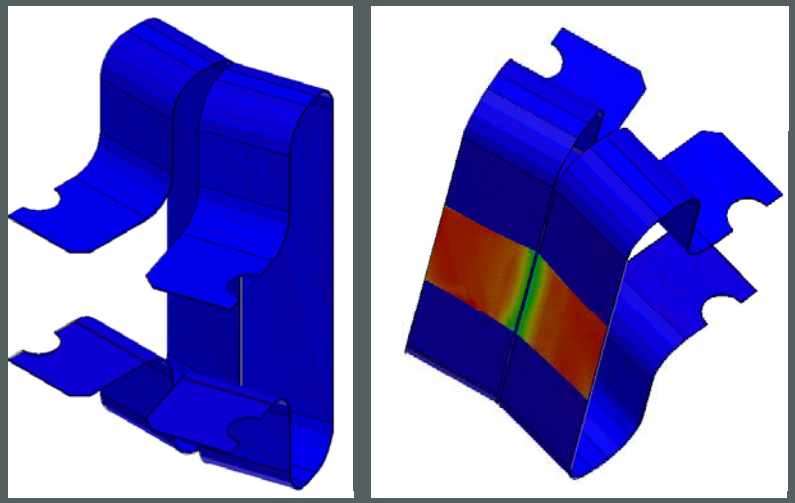
Designed for a circular cross section (ø 88 mm) chamber.
The shield is composed of:

- 2 cylindrical pipes, welded at the bellows ends, give continuity to the beam pipes except for the gap between them.
- 20 Ω shaped, gold-coated, Be-Cu strips, shielding this gap.
- A floating thick aluminium ring where the 20 strips are bolted.



gold coated strip (a),
supporting Al ring (b),
bellows assembly (c).

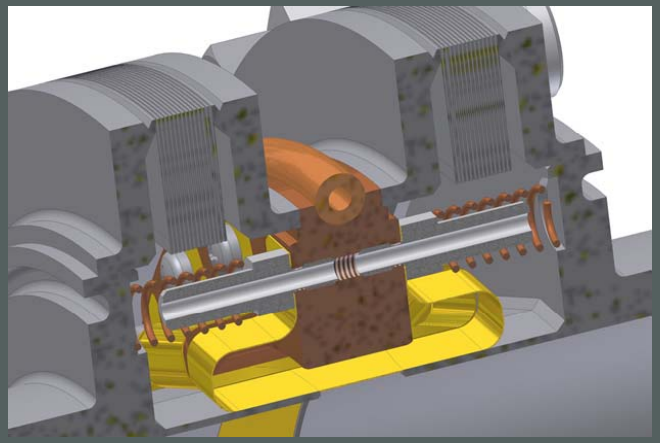
THE RF SHIELD CAN FIT DIFFERENT BEAM PIPE CROSS SECTIONS



Tangential magnetic field (current distribution) on the strip surfaces.

Due to the high thermal capacity of the supporting ring, the RF shield has a high thermal strength.

No specific devices to dissipate the power released by the DAFNE beam on the structure.



A cooled version of the bellows has been also considered for possible application on different machines.

The bellows convolutions were split in two and an external cooling serpentine is brazed around the supporting ring.

See also: EPAC ’08 proceedings TUPP051 and TUPP074

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 has been designed for ATF, mechanical drawings already done. Ready to be realized.

- A new shielded bellows designed for the DAFNE upgrade as well. It could be easily readapted to different chamber cross sections and a version with cooling is also available.
- Together with the new injection kicker, it contributed to lower the machine impedance, as bunch length measurements have shown.