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THE NEW RF DEFLECTORS OF THE CTF3 COMBINER RING

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on behalf of the team

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OUTLINE

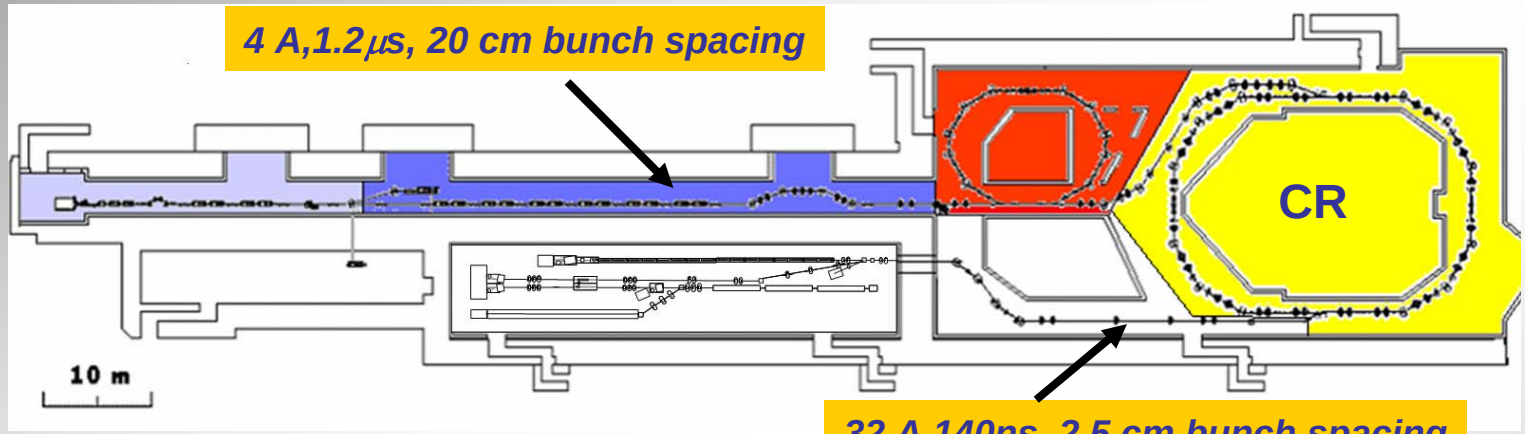
1) VERTICAL BEAM INSTABILITY IN CTF3 DUE TO THE VERTICAL TRAPPED MODES IN RF DEFLECTORS

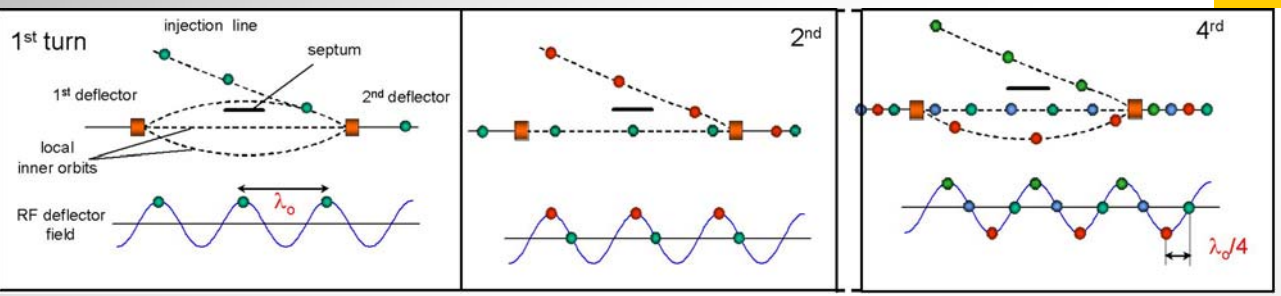
2) NEW RF DEFLECTORS:

-design
-construction
-tests and results
-multipacting analysis

VERTICAL INSTABILITY IN THE CR

The second stage of the bunch train compression in CTF3 is realized in the 84 m circumference CR. This is achieved by means of two TW RF deflectors working at fRF=2.99855 GHz.

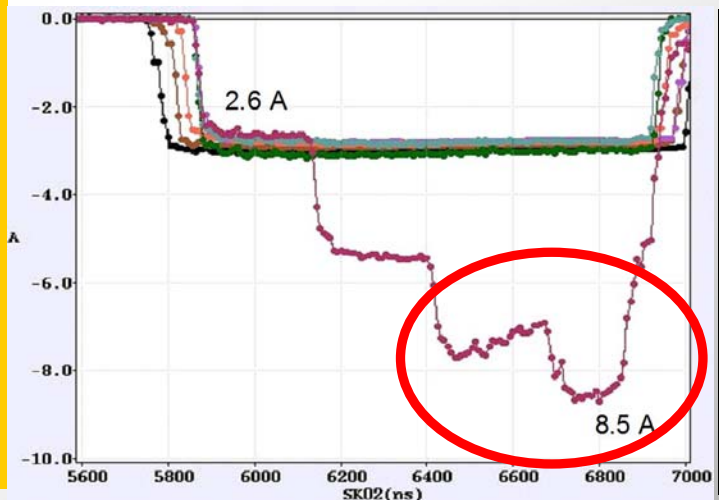




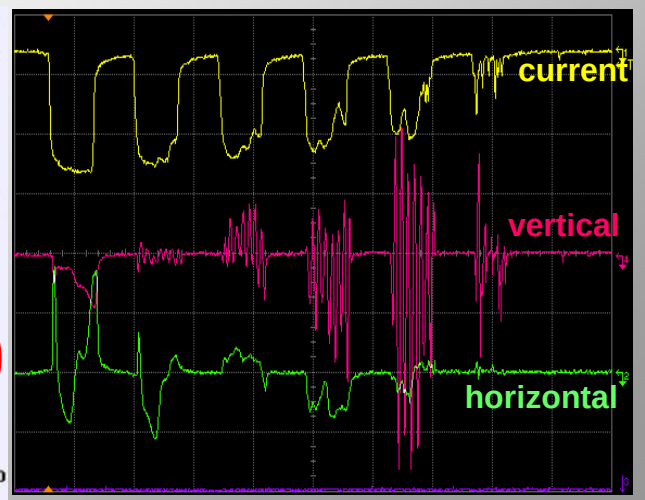
In the run of November 2007 a vertical beam instability has been observed during operation

A detailed analysis [D. Alesini, EPAC '08] has identified in the RFDs vertical trapped modes the source of such instability.

Limit in the max. current



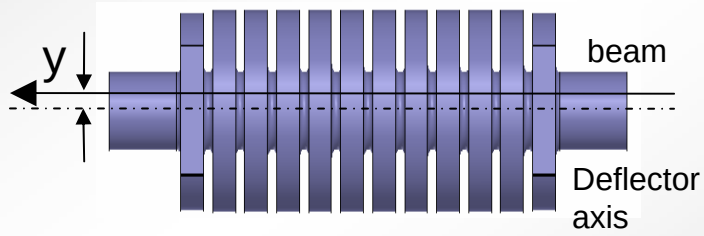
BPM signals showing vertical instability

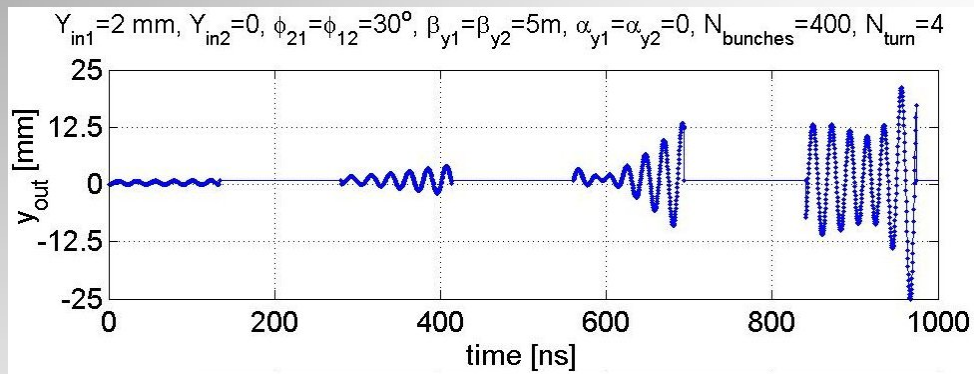


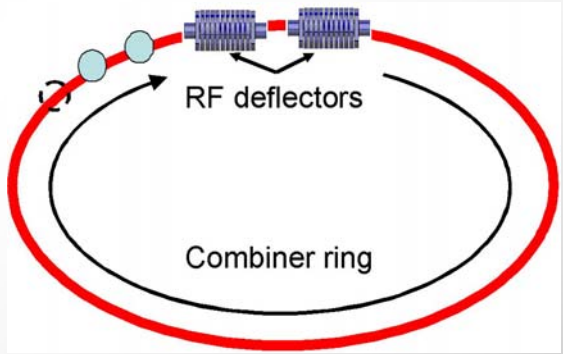
WAKEFIELD INDUCED BY THE VERTICAL MODES

-The ***SW vertical modes*** are excited by an ***off axis passage*** of the beam inside the RFDs.

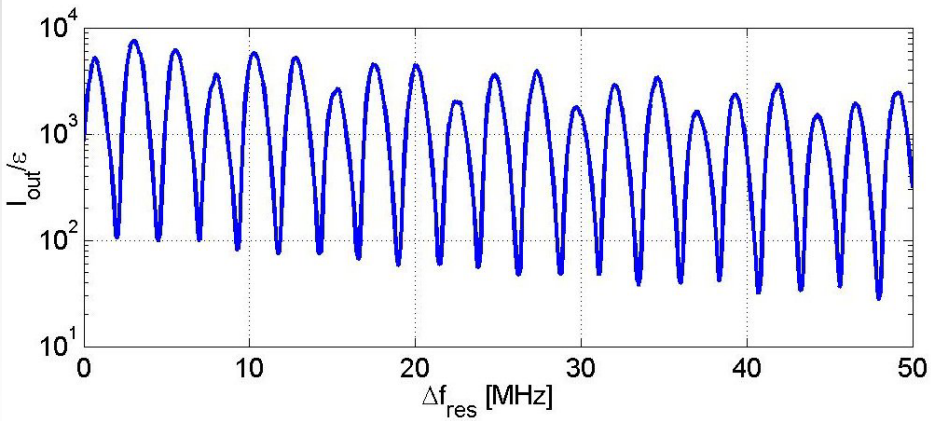
-A ***dedicated tracking*** code has been written to study the multi-bunch multi-passage effects and the dependence of such instability on the resonant mode properties and ring optical functions.

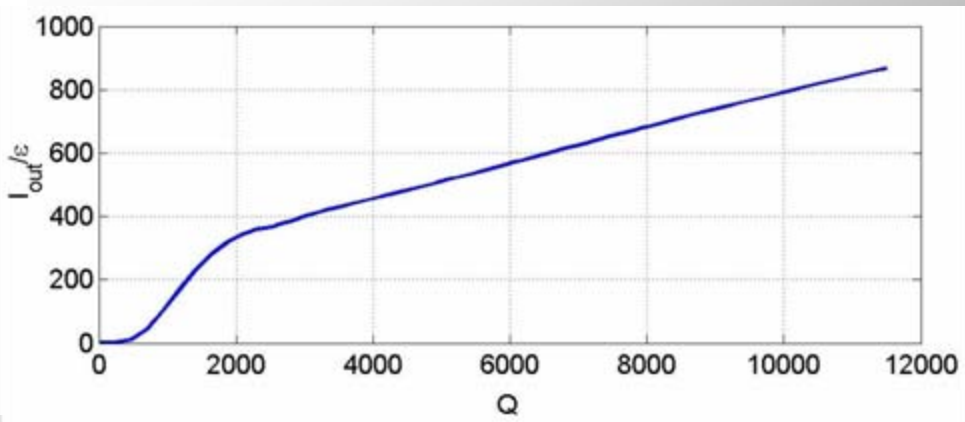






Instability dependence on ***resonant frequency*** and ***quality factor*** of the vertical modes





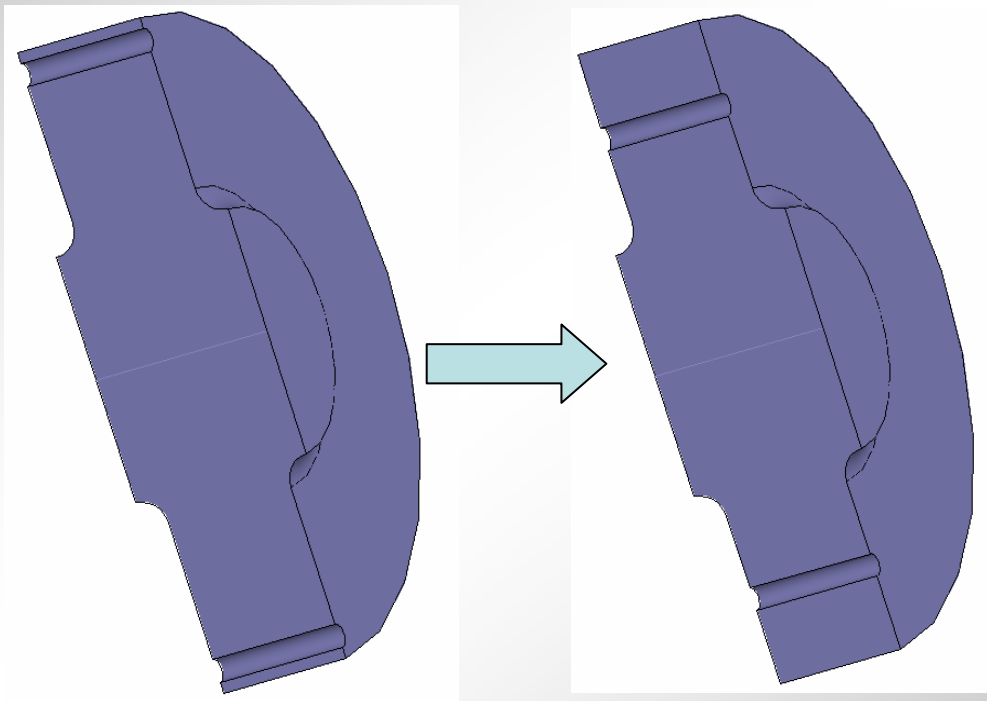
They suggested ***to strongly shift the resonant frequencies*** of the vertical modes (Δf>300 MHz) or/and ***to strongly reduce their quality factors (Q<100)***.

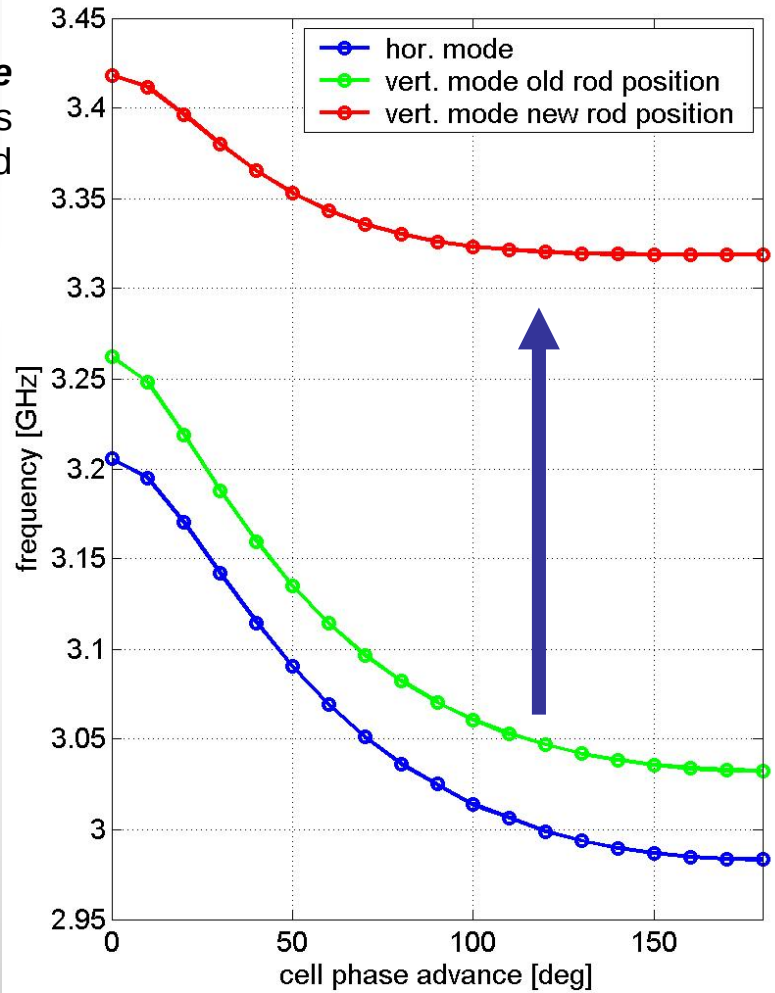
NEW RF DEFLECTOR DESIGN: increase of vertical modes frequency shift

In the original design ***metallic rods*** have been inserted to split in frequency the deflecting mode with vertical polarity.

The dimensions and position of the rods have been chosen to avoid the excitation of the vertical modes from the beam power spectrum line at 2.99855GHz and RF generator.

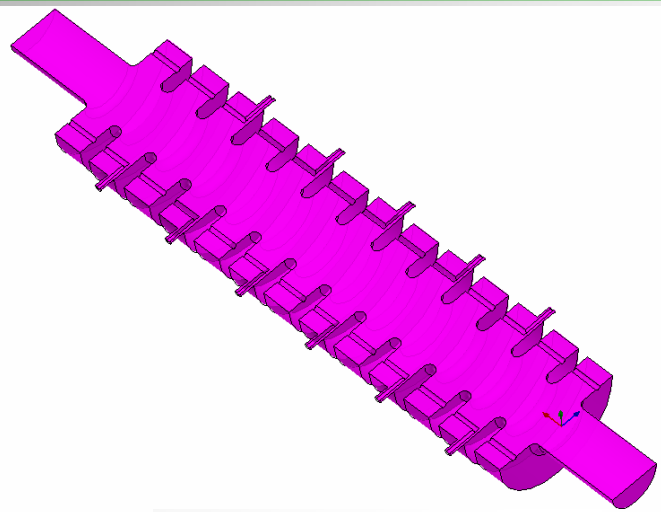
To increase the frequency shift of the vertical mode polarity we changed the position of the rods towards the axis of the structure. In this way the vertical modes are shifted more than 300 MHz away from the horizonthal ones.

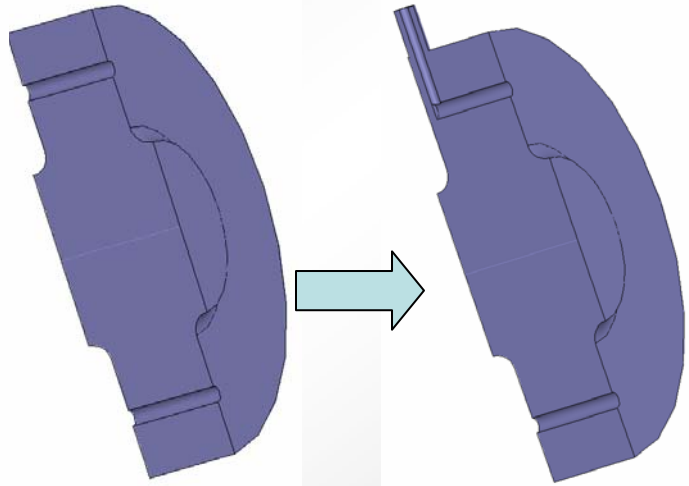


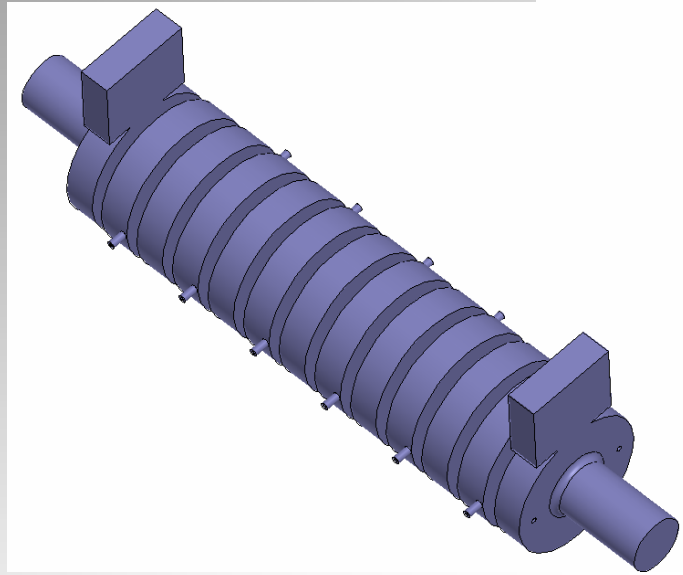


NEW RF DEFLECTOR DESIGN: damping of the vertical modes

To damp the vertical modes excited by the beam the ***rods*** in the cell have been modified in order to be ***damping antennas***.

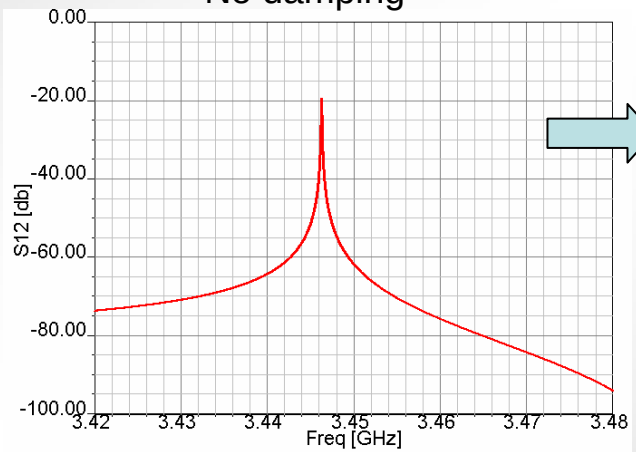




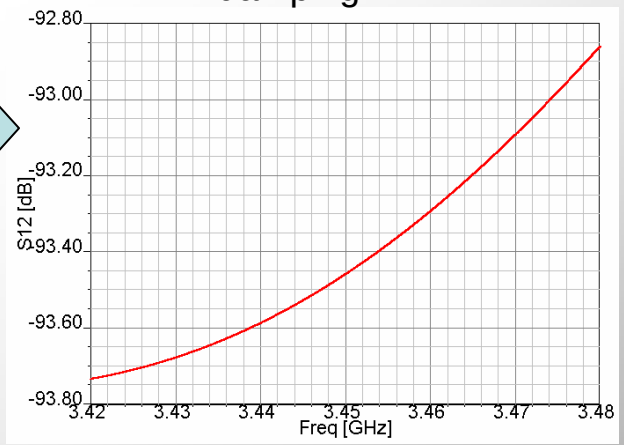


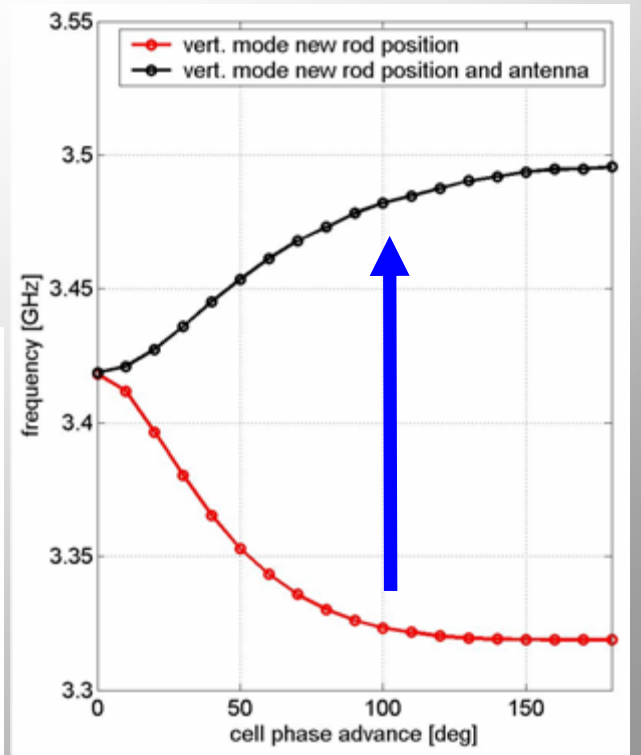
The result is a strong damping of the vertical modes and a further shift of their resonant frequencies.
Example: Mode 0

No damping



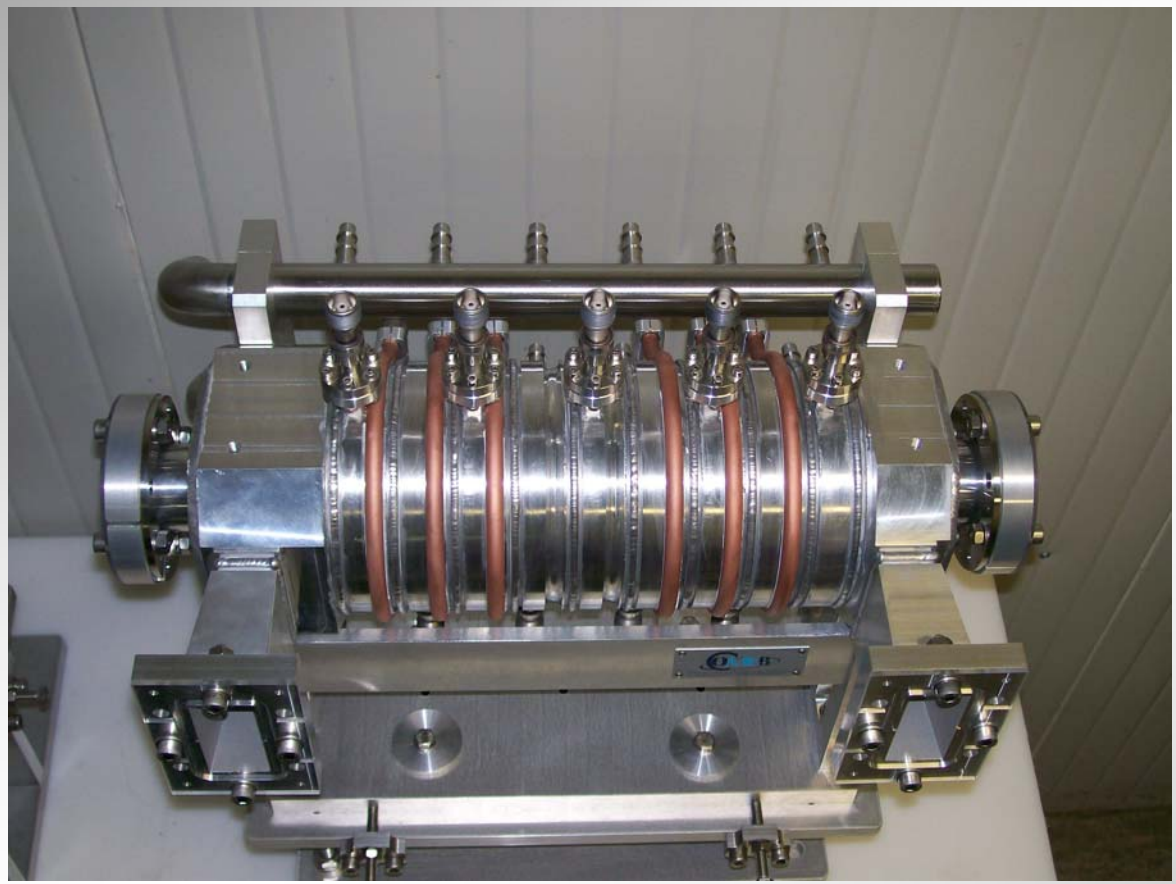
damping

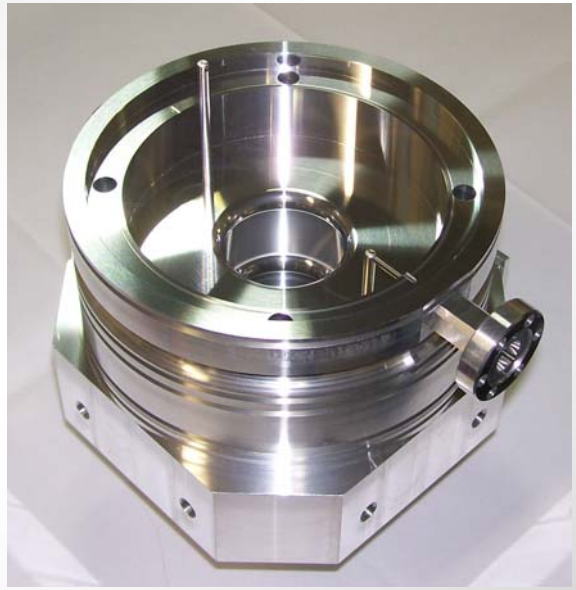




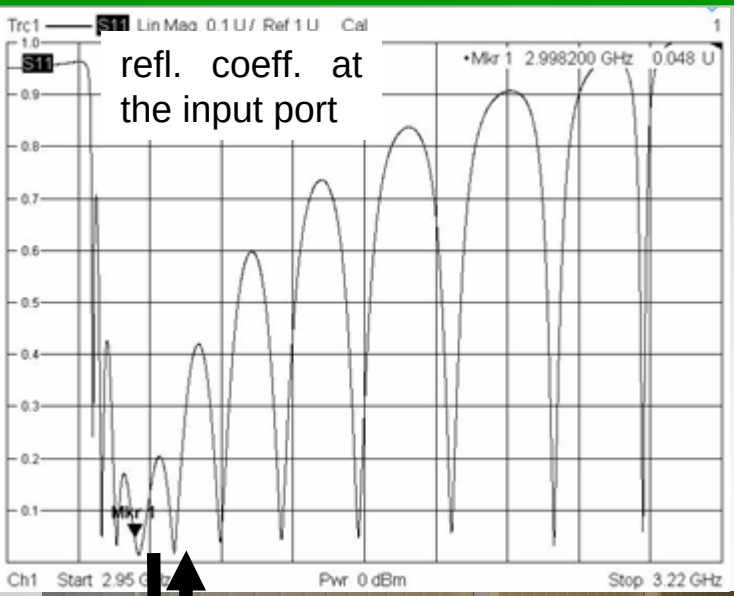
DEFLECTOR REALIZATION

To reduce the cost and the delivery time of the device we decided to built the new RFDs in ***aluminium***. The cells have been machined, clamped together with tie rod to guarantee the RF contacts and welded.

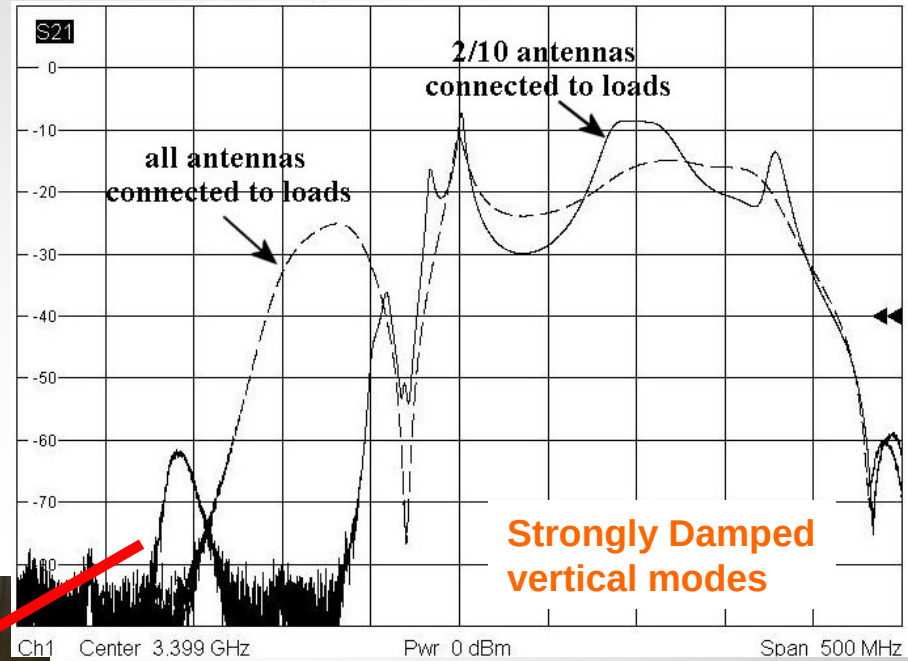


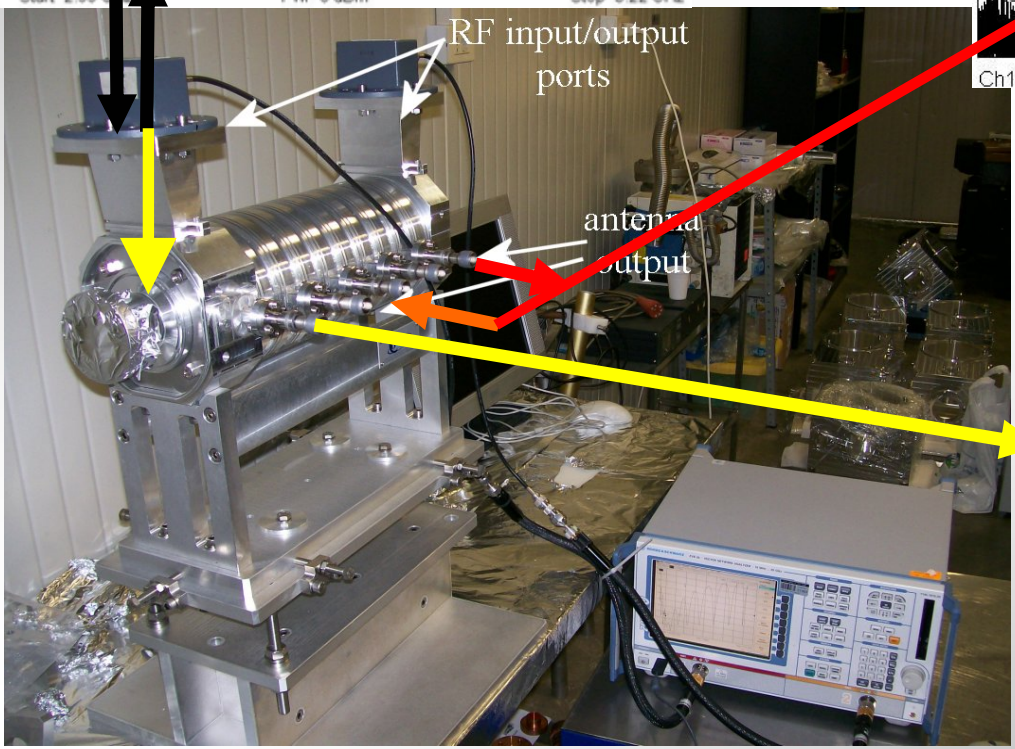


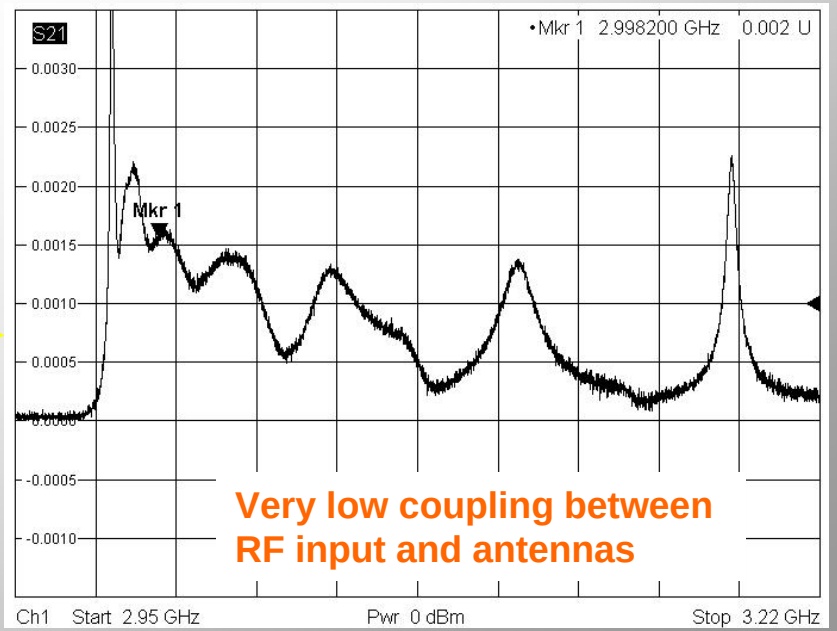
DEFLECTOR RF MEASUREMENTS



RF measurements have been done before and after welding

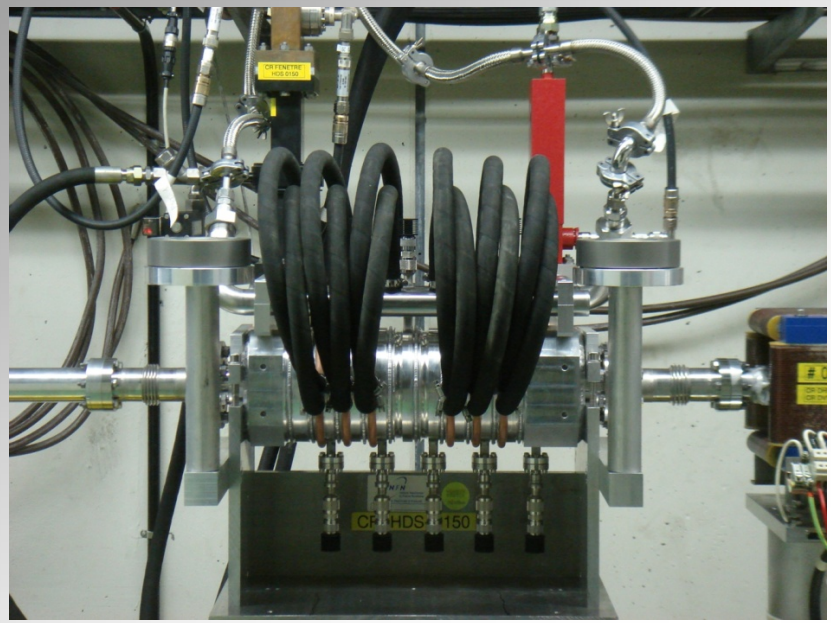






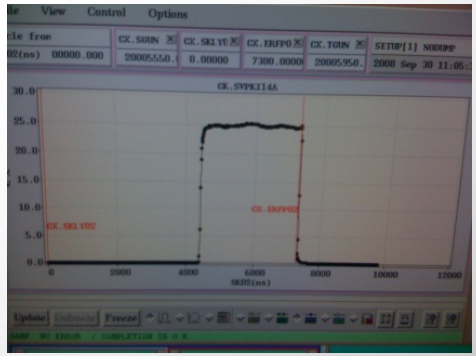
HIGH POWER TESTS

The ***cavities have been installed in the CR and RF power conditioning needed less than 1 hour***. More than 10 MW have been fed in each cavity (nominal working power 7 MW) and ***no multi-pacting effect have been observed*** (except in one cavity at 200 kW for 5-6 minutes…)

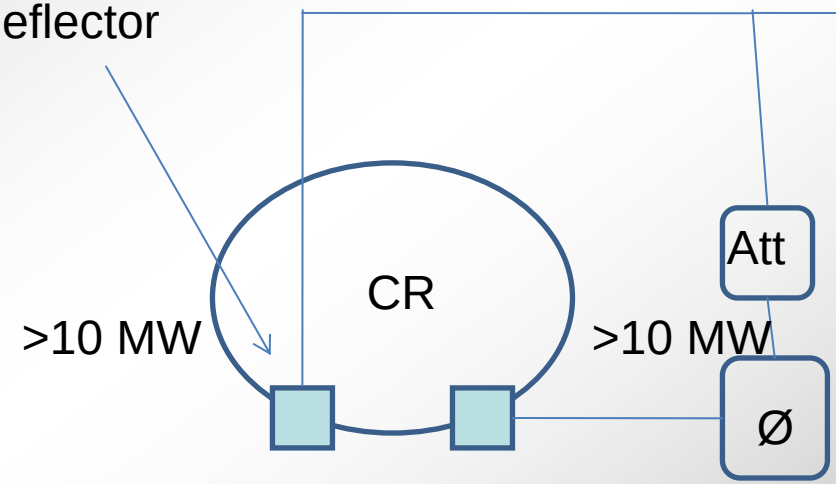


MKS 14

25 MW



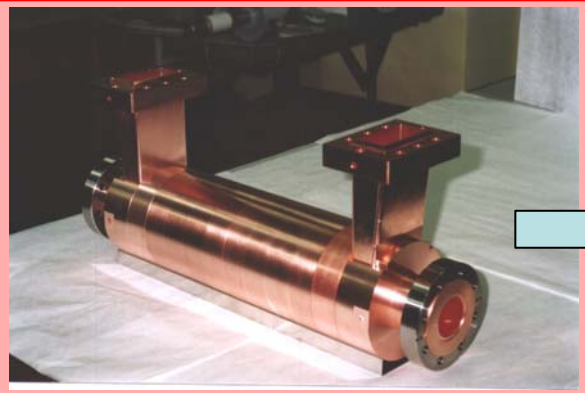
RF Deflector

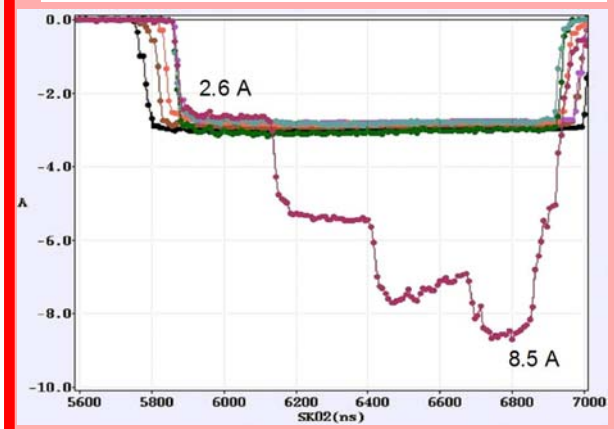


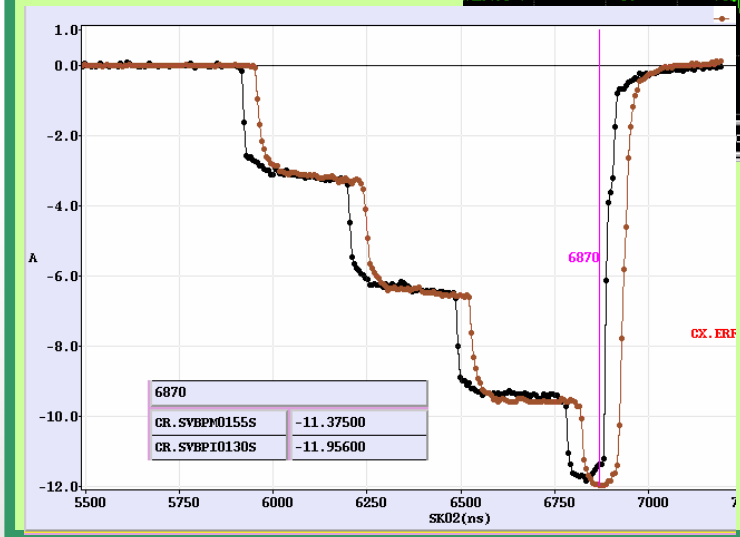
Reflected power

TEST WITH BEAM

Beam recombination in the CR has been achieved very soon without evidence of vertical instabilities !







See S. Bettoni talk FR1RAC04

MULTIPACTING ANALYSIS

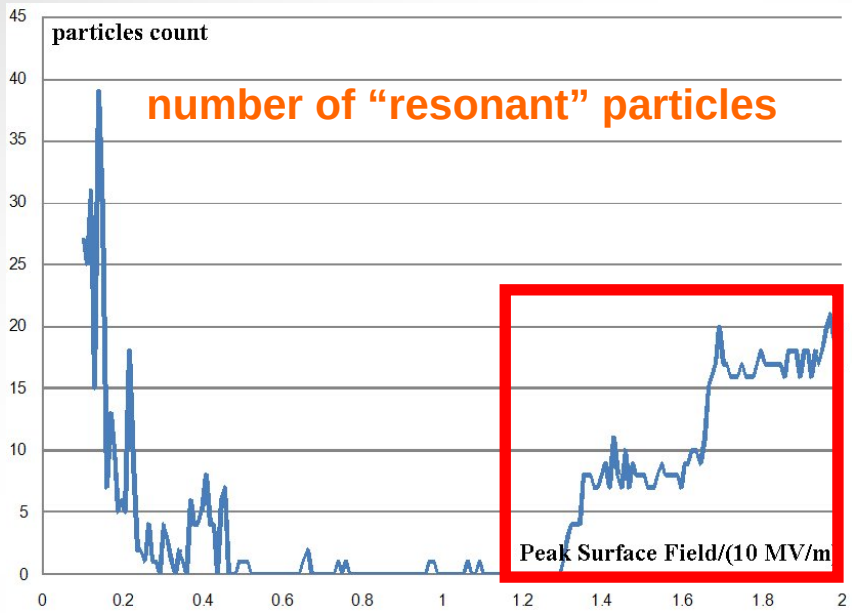
⇒ From the MP point of view, ***the aluminium*** is worse with respect to copper because of its ***higher SEY***.

⇒***The choice of the aluminium has been still maintained*** even if, at the beginning, no MP simulations were available

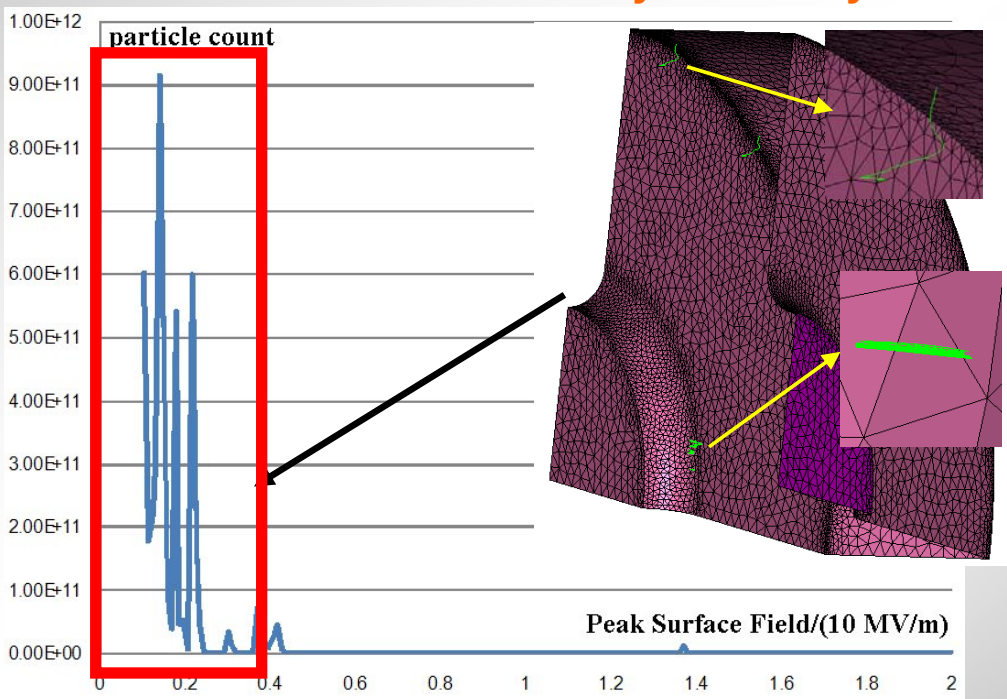
⇒we were encouraged from:

- ⇒ ***no evidence of MP*** in copper deflectors
- ⇒ ***the dynamics*** of the SE strongly perturbed by H
- ⇒ ***a backup*** solution could be Ti-coating

⇒ All these intuitive arguments have been validated by simulations “a posteriori” by the ***code Analyst***.



total count of secondary electron yield



RESULTS

⇒***The bulk of the action is at low field strengths*** (<about 3 MV/m peak field)

⇒***Small numbers of multipactors*** at any given field level.

⇒Typically 2 RF periods per impact (some 3 periods).

⇒***Geometric resonances are found at higher field levels*** (> 15 MV/m), but per-impact yield is generally less than 1 in this field range.

SUMMARY

1) The mechanism of the observed ***strong vertical instability*** in the CTF3 CR has been ***understood and modeled***. By simulation ***key parameters*** to reduce the instability strength have been found.

2) The ***new RF deflectors*** have been designed according to the beam dynamics simulation results. They suggested ***to strongly shift the resonant frequencies*** of the vertical modes and ***to strongly reduce their quality factors***.

3) The deflectors have been realized in ***aluminum*** to reduce the costs. A dedicated fabrication/assembling technique has been developed to guarantee the RF contact and ultra high vacuum operation.

4) ***RF test have been successfully done*** without observing multi-pacting phenomena.

5) Injection and recombination in the CR showed that the ***instability has been suppressed***.

6) The MP analysis (done “a posteriori”) has found interesting results and suggests that **aluminum can be used without big problems** (from this point of view) **to built RFD structures**.

Thanks to: C. Biscari, G. Geschonke, R. Corsini, G. Fontana and I. Syratchev