RF Power Systems and Optimized RF structures for electron beam acceleration

- Make it vacuum sealed as a single block - no vacuum pumps
- Consider alternative RF cavity manufacturing technology
- Consider Aluminium as an alternative material
- Make a suggestion for operating frequency
- Make it compatible with permanent magnet focusing system
- Make a suggestion for energy and current

RF power drivers

Conclusion/Suggestion:

Short term (2-3 years) Solid State RF oscillator + Klystron Amplifire

- Broad frequency range availability
- Compactness of SSO and robustness of Klystron

Long term (over 5 years): Monitor SSO/A development at GHz frequency range

RF cavity manufacturing techniques

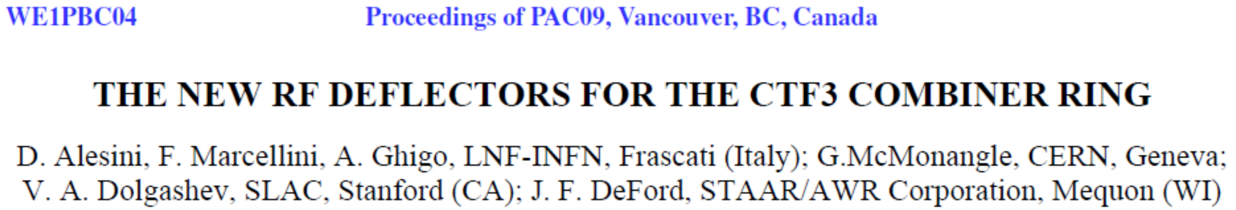
Solutions/suggestions

1/ Manufacture from bulk material using CNC lathe

2/ Use additive technology (if cheaper and more reliable) to manufacture components outside vacuum envelop

Use of Aluminium

RF deflector for the CTF3 combiner Ring (Frascati, SLAC, CERN)



WE1PBC04 Proceedings of PAC09, Vancouver, BC, Canada

THE NEW RF DEFLECTORS FOR THE CTF3 COMBINER RING

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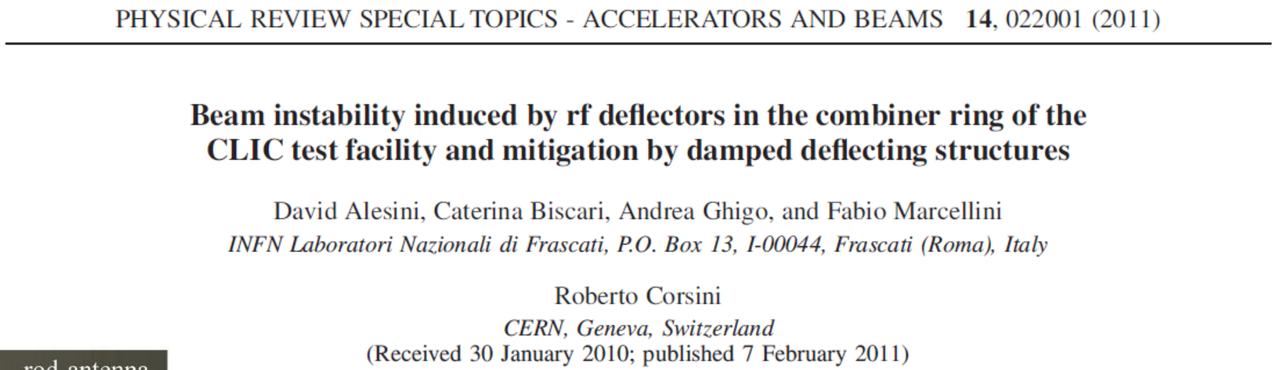

PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS **14**, 022001 (2011)

Beam instability induced by rf deflectors in the combiner ring of the CLIC test facility and mitigation by damped deflecting structures

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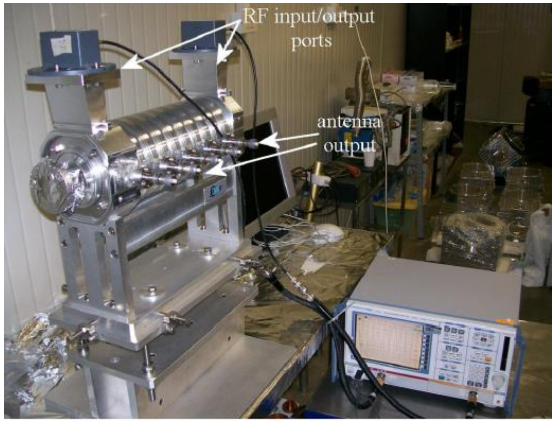
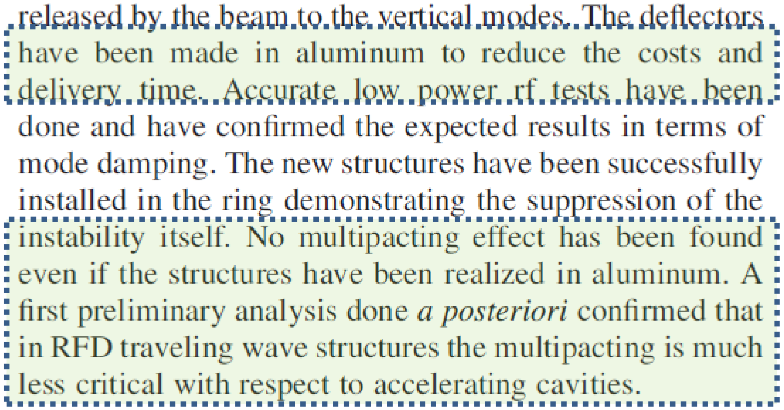
(Received 30 January 2010; published 7 February 2011)





released by the beam to the vertical modes. The deflectors have been made in aluminum to reduce the costs and delivery time. Accurate low power rf tests have been done and have confirmed the expected results in terms of mode damping. The new structures have been successfully installed in the ring demonstrating the suppression of the instability itself. No multipacting effect has been found even if the structures have been realized in aluminum. A first preliminary analysis done *a posteriori* confirmed that in RFD traveling wave structures the multipacting is much less critical with respect to accelerating cavities.

Conclusion/suggestions

1/ The physical properties of copper is superior to aluminium.

2/ Aluminium advantage: cost, weight and simple to machine

3/ At high frequencies the advantages of aluminium are less clear and copper is competitive

4/ Multipacting can be issue in case of aluminium

Operating frequency:
1.3GHz, 3GHz, 6GHz, 9GHz, 12GHz

- Solid State RF oscillator + Klystron Amplifire
- Shifting to high frequency reduces the aluminium advantages and makes copper price competitive and more attractive
- Manufacturing using CNC lathe machining
- Decreasing dimensions (high operating frequency) makes design of permanent magnets electron –beam optical system less complex

Conclusion/suggestions

1/ If schema SSOsc + Klystron is used to drive Linac we can consider high frequency option 9GHz. The price of klystron and SSOsc will be the defining

2/ High frequency Linac will be more compact

3/ Availability of 9GHZ test equipment at CERN

4/ At high frequency design of permanent magnets seems to be less challenging due to small transverse dimentions

Standing wave vs travelling wave

- At high frequency to avoid multipacting and use technology available TW Linac seems to be appropriate.
- At frequencies 1.3GH and below standing wave system can be considered.

Servicing, maintenance, cost

- Vacuum sealed (no external pump)
- Cathode incorporated with Linac and changed with the Linac.
- Modular design: change parts without service

	Option 1	Option 2			
f (GHz)					
RF driver					
Energy					
Focusing					

Thank you

Material to manufacture the RF cavity
Copper Vs Aluminium

Property	**Copper(Cu-ETP)**	**Aluminium(1350)**	**Units**
Electrical resistivity (annealed)	**1.72**	**2.83**	**mOhm-cm**
Thermal conductivity at 20°C	**397**	**230**	**W/mK**
Coefficient of expansion	17 x 10-6	23 x 10-6	/°C
Tensile strength (annealed)	200-250	50-60	N/mm2
Tensile strength (half-hard)	260-300	85-100	N/mm2
0.2% proof strength (annealed)	50-55	20-30	N/mm2
0.2% proof strength (half-hard)	170-200	60-65	N/mm2
Elastic modulus	116-130	70	N/mm2
Fatigue Strength (annealed)	62	35	N/mm2
Fatigue Strength (half hard)	117	50	N/mm2
Specific heat	385	900	J/kgK
Density	**8.91**	**2.70**	**g/cm3**
Melting Point	**1083**	**660**	**°C**

Copper (MT)	**$6923**	**Aluminium (MT)**	**$2069**

RF cavity manufacturing techniques

1/

Oxford, UH-FLUX project

2/

A 3D Printed Superconducting Aluminium Microwave Cavity

arXiv:1604.04301v2 [physics.ins-det] 1 Jun 2016

[1] *School of Physics, University of Melbourne, Parkville, Victoria 3010, Australia*

3a/

Oxford, UH-FLUX project

3b/

CERN, CLIC