Super-B:
RF and HOMs absorbers.

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SLAC National Accelerator Laboratory

XIV Super B General Meeting

September 27– October 1, 2010

INFN-LNF, Frascati, Italy

Super-B parameters. March 3, 2010

Sasha Novokhatski "RF and HOMs absorbers"

(Bold: computed values)		Base Line		Low Emittance		High Current		Tau/Charm (prelim.)	
Parameter	Units	HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)
Energy	GeV	6.7	4.18	6.7	4.18	6.7	4.18	2.58	1.61
Circumference	m	1258.4		1258.4		1258.4		1258.4	
Bunch length (zero current)	mm	4.69	4.29	4.73	4.34	4.03	3.65	4.75	4.36
Bunch length (full current)	mm	5	5	5	5	4.4	4.4	5	5
Beam current	mA	1892	2447	1460	1888	3094	4000	1365	1766
N. Buckets distance		2	2	2	2	1	1	1	1
Ion gap	%	2	2	2	2	2	2	2	2
RF frequency	Hz	4.76E+08	4.76E+08	4.76E+08	4.76E+08	4.76E+08	4.76E+08	4.76E+08	4.76E+08
Revolution frequency	**Hz**	**2.38E+05**		**2.38E+05**		**2.38E+05**		**2.38E+05**	
Harmonic number	**#**	**1998**		**1998**		**1998**		**1998**	
Number of bunches	**#**	**978**		**978**		**1956**		**1956**	
N. Particle/bunch	**#**	**5.08E+10**	**6.56E+10**	**3.92E+10**	**5.06E+10**	**4.15E+10**	**5.36E+10**	**1.83E+10**	**2.37E+10**
Bunch current	**mA**	**1.935**	**2.502**	**1.493**	**1.930**	**1.582**	**2.045**	**0.698**	**0.903**
Energy Loss/turn	**MeV**	2.11	0.865	2.11	0.865	2.11	0.865	0.4	0.166
Momentum compaction		4.36E-04	4.05E-04	4.36E-04	4.05E-04	4.36E-04	4.05E-04	*4.36E-04*	*4.05E-04*
Energy spread (zero current)	**dE/E**	6.31E-04	6.68E-04	6.31E-04	6.68E-04	6.31E-04	6.68E-04	*6.31E-04*	*6.68E-04*
Energy spread (full current)	**dE/E**	6.43E-04	7.34E-04	6.43E-04	7.34E-04	6.43E-04	7.34E-04	*6.94E-04*	*7.34E-04*
CM energy spread	**dE/E**	**5.00E-04**		**5.00E-04**		**5.00E-04**		**5.26E-04**	
Energy acceptance		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Synchrotron frequency	**kHz**	3.01	2.8	2.97	2.77	3.54	3.26	2.96	2.77
Synchrotron tune		0.0126	0.0118	0.0125	0.0116	0.0148	0.0137	0.0124	0.0116
SR power loss	**MW**	**3.99**	**2.12**	**3.08**	**1.63**	**6.53**	**3.46**	**0.55**	**0.29**
RF Wall Plug Power (SR only)	**MW**	**12.22**		**9.43**		**19.98**		**1.68**	
Total RF Wall Plug Power	**MW**	17.08		12.72		30.48		3.11	
Number of cavities		12	8	12	8	20	12	6	4
Number of Klystrons		6	4	6	4	10	6	3	2
Total Number of klystrons		10		10		16		5	
RF Voltage	MV	7.01	5.25	6.88	5.13	9.3	7.2	2.54	1.94
R_s	MΩ								
Q_0									
β									

Super-B RF plug power. Base Line.

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HER	HER	HER	HER	HER	HER	HER	HER	HER	HER	HER	HER	HER+
Total	Zero I		Max	Number			Total	Total	Total	forward	reflected	LER
RF	Bunch	Bunch	voltage	of	S.R.	HOMs	cavity	reflected	forward	to one	from	Total
voltage	length	spacing	per cavity	cavities	power	power	loss	power	power	cavity	one	forward
MV	mm	ns	MV	klystrons	MW	MW	MW	MW	MW	MW	MW	MW
	4.69											
7.01	4.78	4.20	0.58	12.00	3.99	0.27	0.54	0.36	5.16	0.43	0.03	8.19
	5.00			6.00								
												HER+
LER	LER	LER	LER	LER	LER	LER	LER	LER	LER	LER	LER	LER
Total	Zero I		Max	Number			Total	Total	Total	forward	reflected	Plug
RF	Bunch	Bunch	voltage	of	S.R.	HOMs	cavity	reflected	forward	to one	from	Power
voltage	length	spacing	per cavity	cavities	power	power	loss	power	power	cavity	one	eff.~50%
MV	mm	nsec	MV	klystrons	MW	MW	MW	MW	MW	MW	MW	MW
	4.29											
5.25	4.71	4.20	0.66	8.00	2.12	0.41	0.45	0.05	3.03	0.38	0.01	16.38
	5.00			4.00								

Power absorption

- All power in the rings (5.2 MW + 3 MW) should be absorbed by the water cooling system directly without causing any unpleasant beam problem like emittance growth or instability due to high intensity of the generated wake fields, vacuum pressure rise or electron multipactoring.

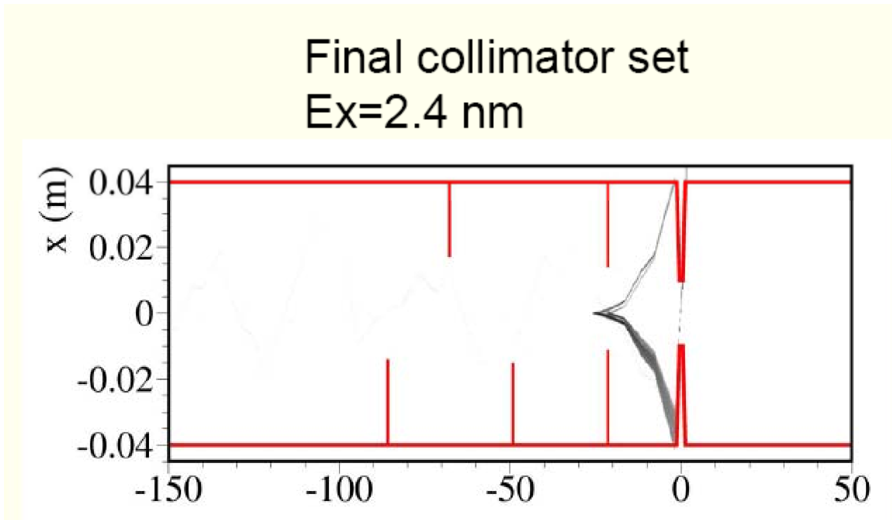
- Same amount of power (8.2 MW) will be dissipated in the klystron beam collectors.

Transverse wake fields

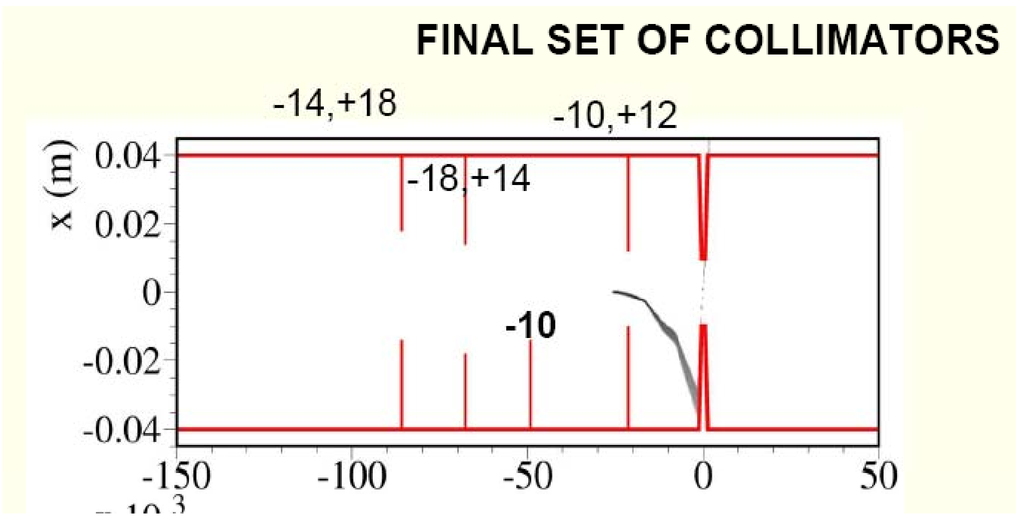
- Transverse wake fields are generated in the asymmetrical parts of the beam pipe.
- Transverse wake fields can penetrate through the small hole in the vacuum chamber or longitudinal slots of shielded bellows, vacuum valves and RF shields.
- Transverse wake fields may propagate long distances.

Collimators in Super-B

Sasha Novokhatski "RF and HOMs absorbers"



LER

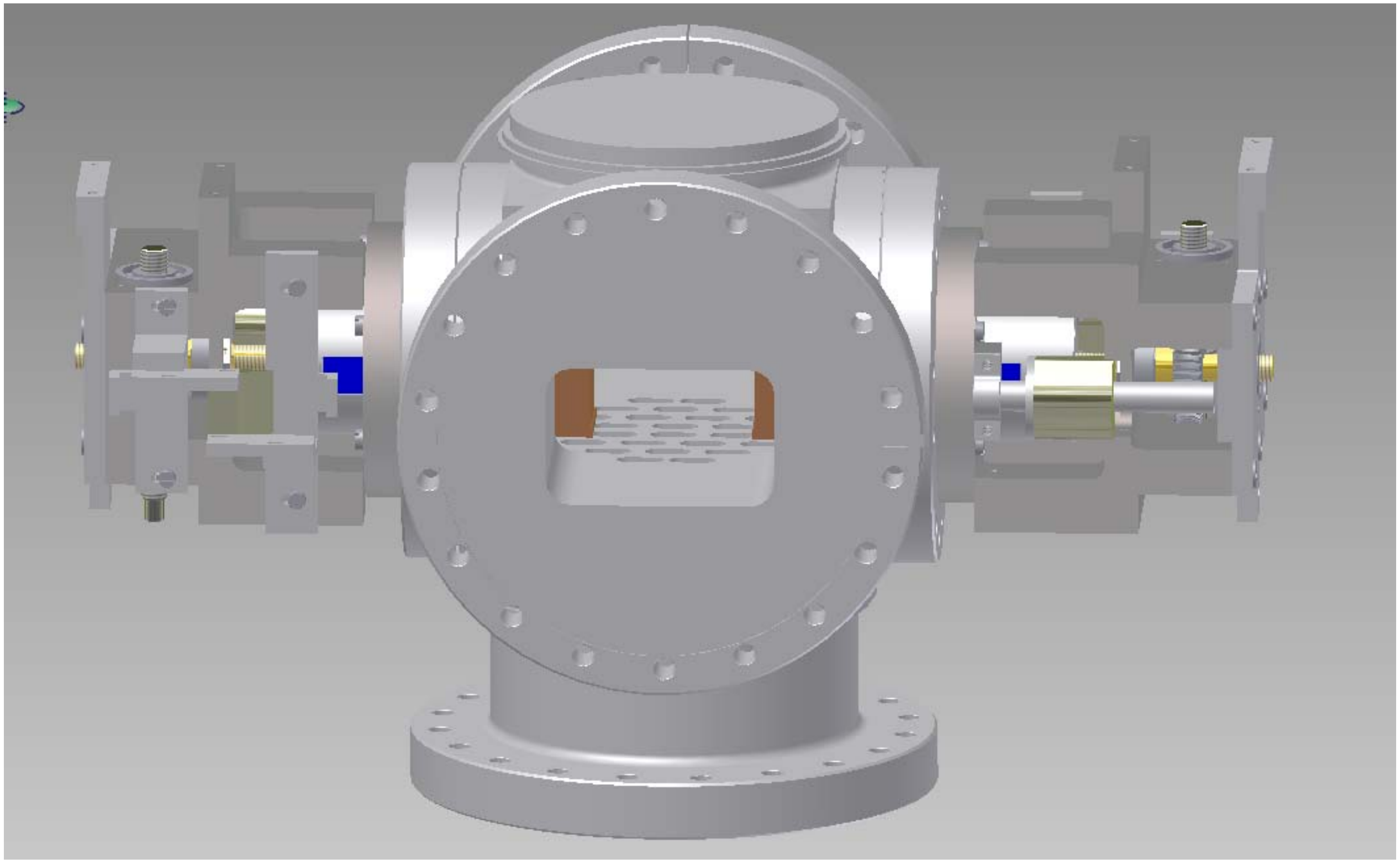


HER

Manuela Boscolo,
April 2010

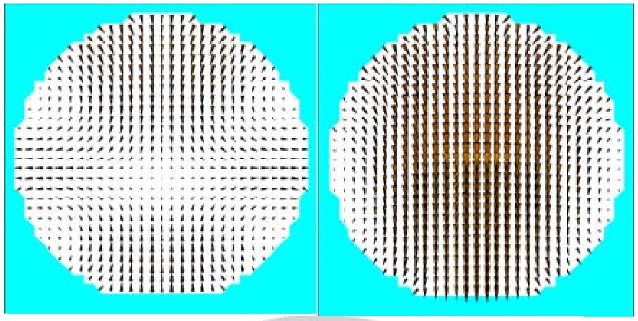
A beam scraper

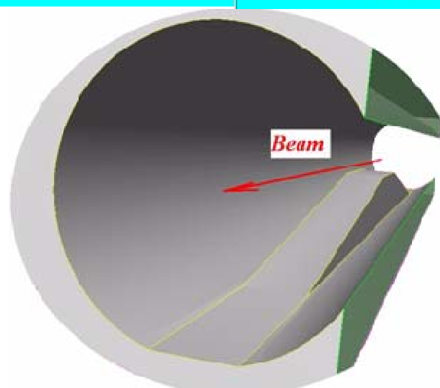
Sasha Novokhatski "RF and HOMs absorbers"

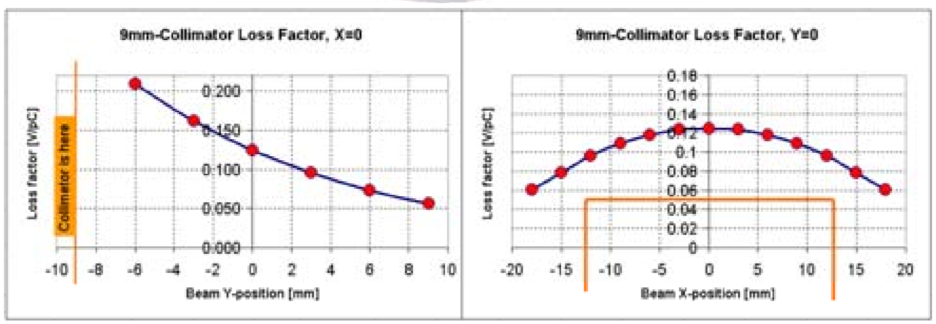


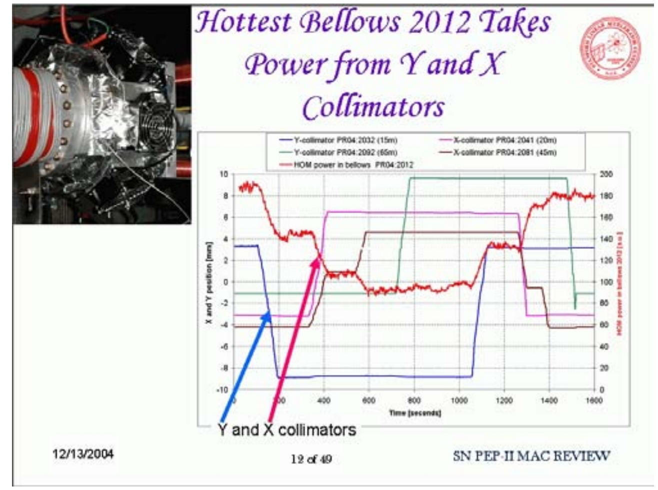
PEP-II collimator is optimized but still produces a lot of transverse fields

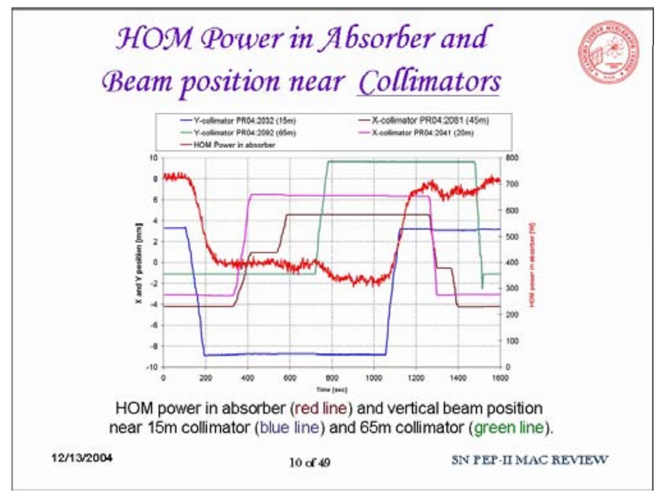
Sasha Novokhatski "RF and HOMs absorbers"





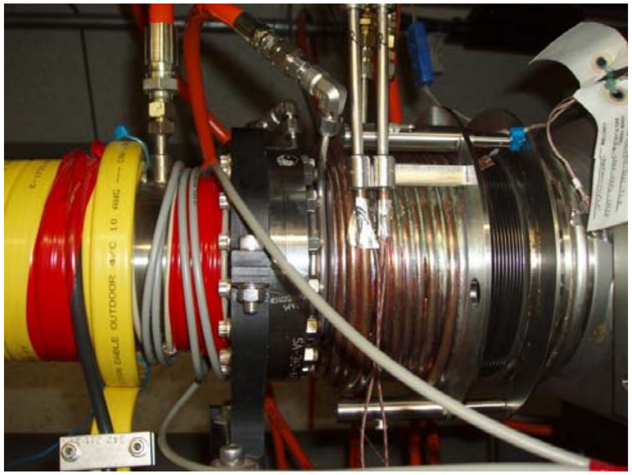


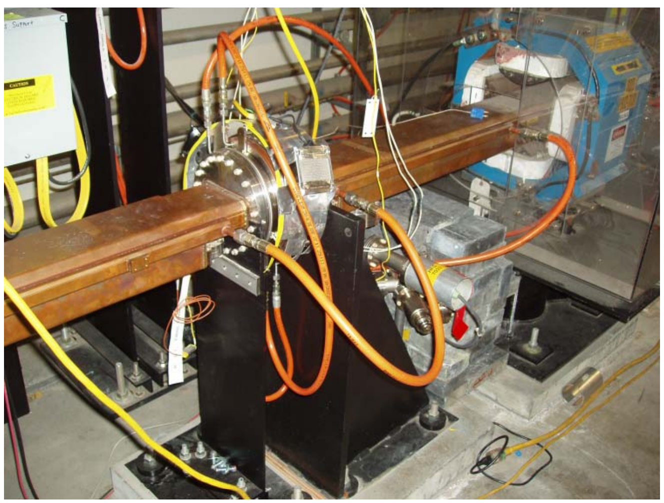


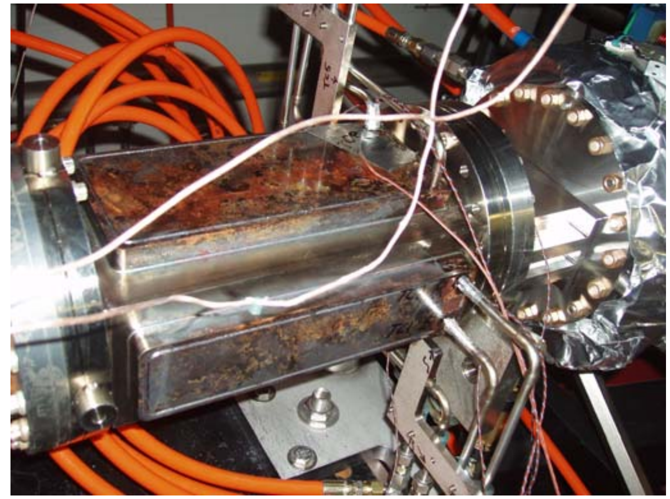


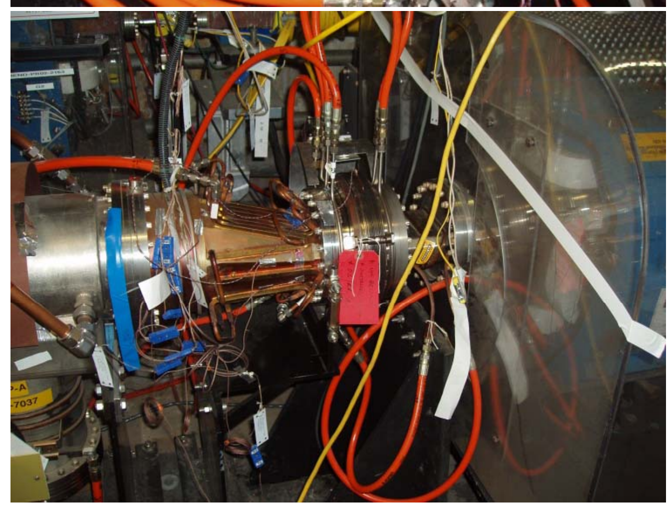
SLAC has developed high efficiency HOMs absorbers for different cross-sections

Sasha Novokhatski "RF and HOMs absorbers"



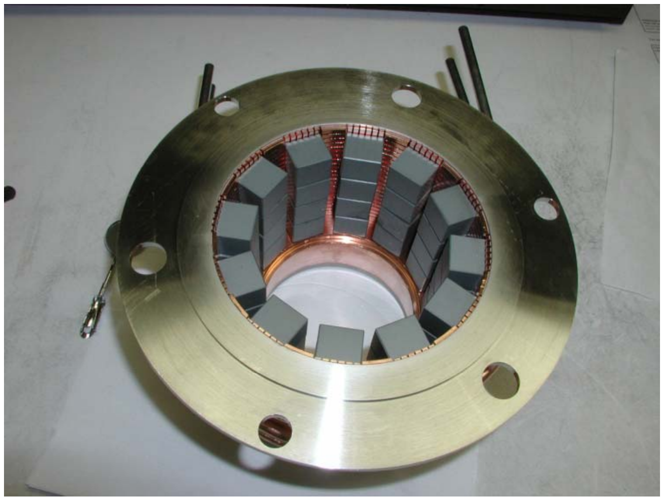


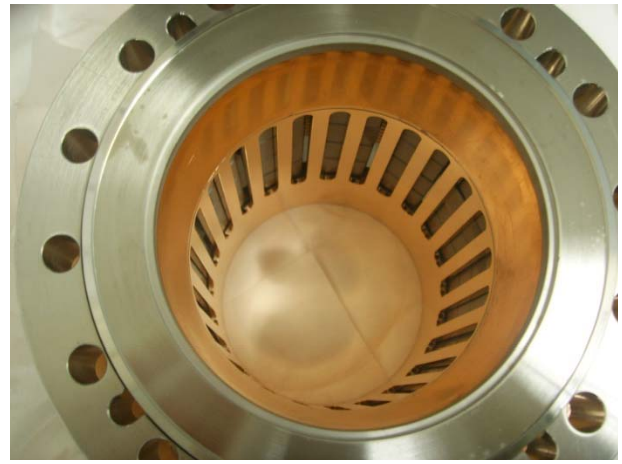


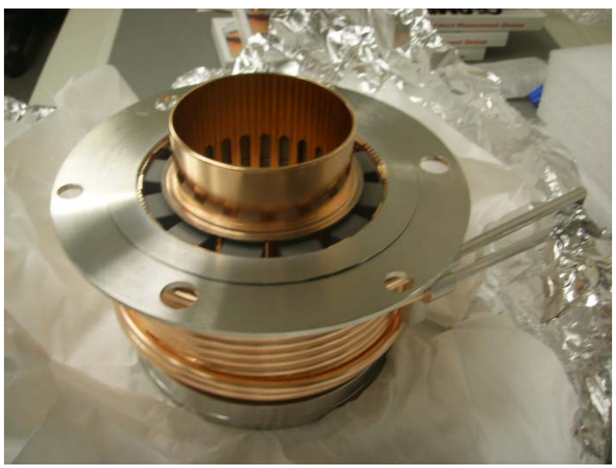


State of art technology

Sasha Novokhatski "RF and HOMs absorbers"



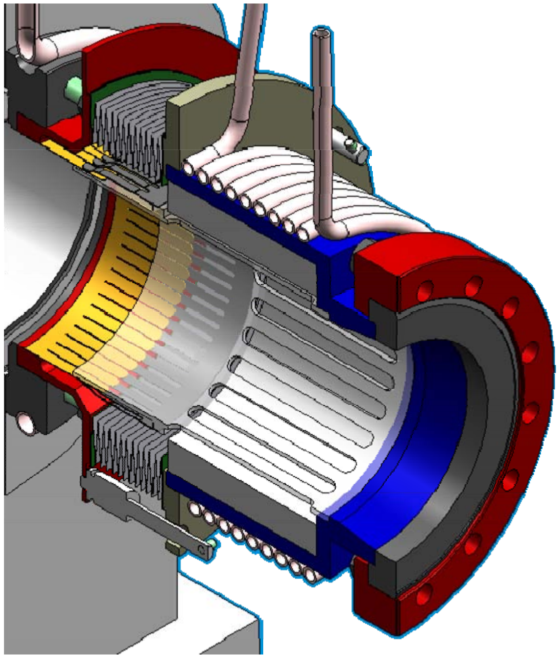




Absorbers for a round chamber

Sasha Novokhatski "RF and HOMs absorbers"

- Flange dimensions:
  3.5" (diameter) x 4'' (length)
- 40% efficiency
- Installed 5



Installed absorbers after each LER collimator

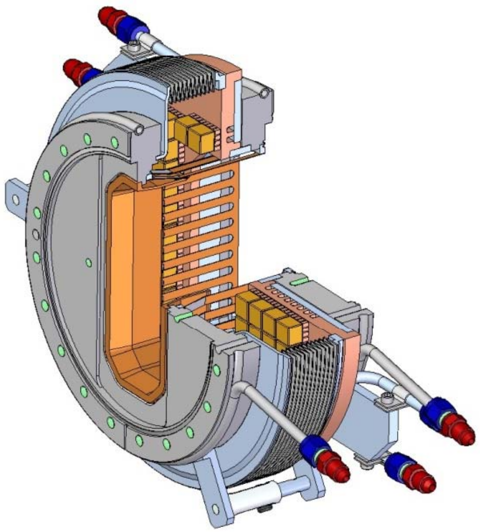
SLAC PEP-II LER absorbers

- Flange dimensions:

  3.543" x 1.969" x 4'' (length)

  J-style RF seals

  – Produced:10, installed 8



SLAC PEP-II HER absorbers

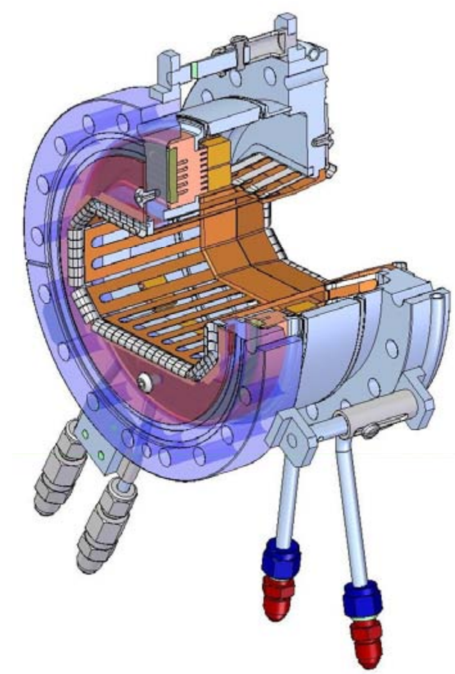
Sasha Novokhatski "RF and HOMs absorbers"

- Aperture dimensions:

  4.920" x 1.969" x 4'' (length)

  Ω -style RF seals

  – Produced:6, installed 5



Other PEP-II absorbers

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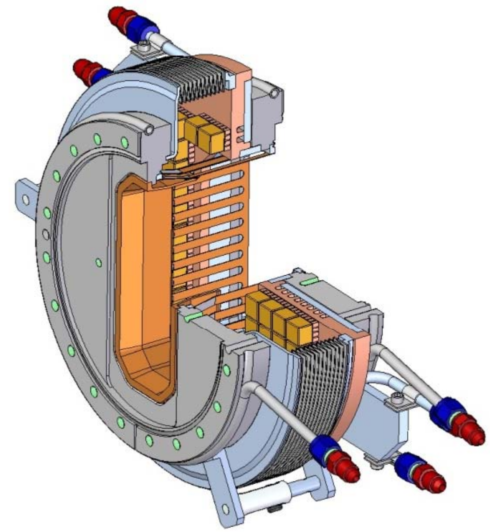
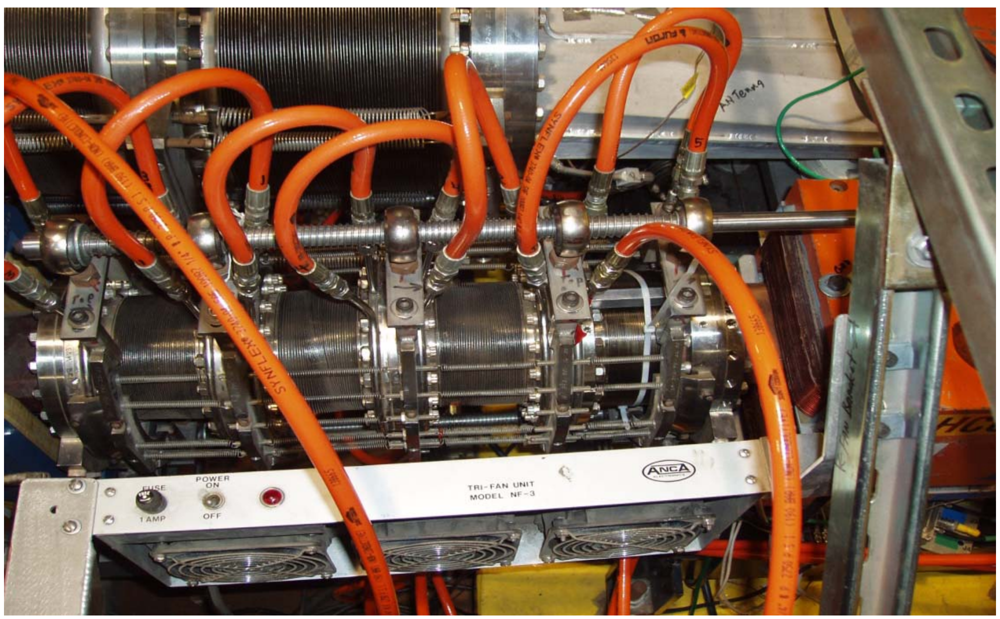
- LER Frangible Link HOM absorbing bellows
  - install 2, one spare





30 kW absorber

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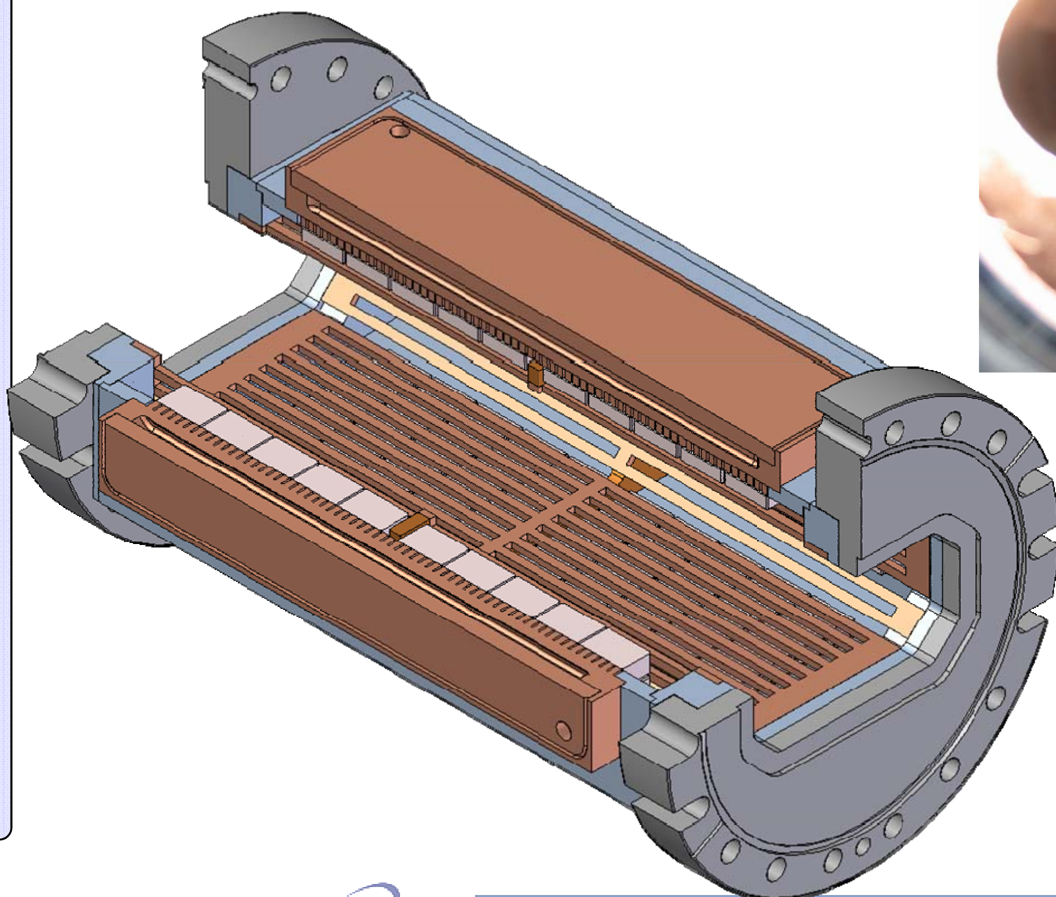

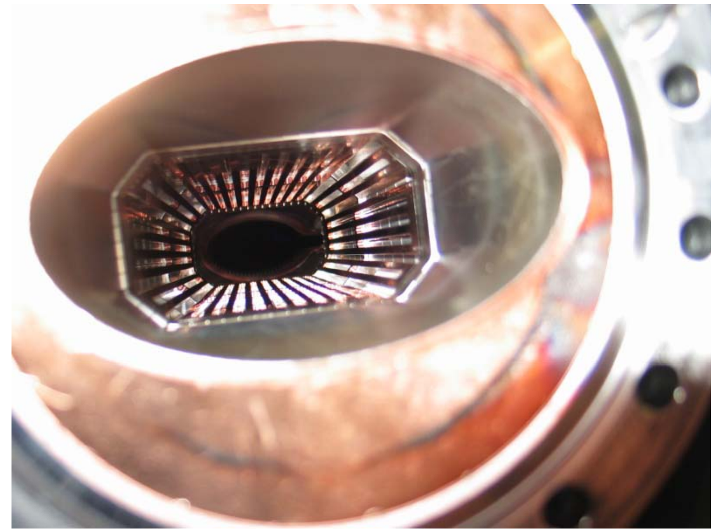

Q4/Q5 Bellows with Absorber

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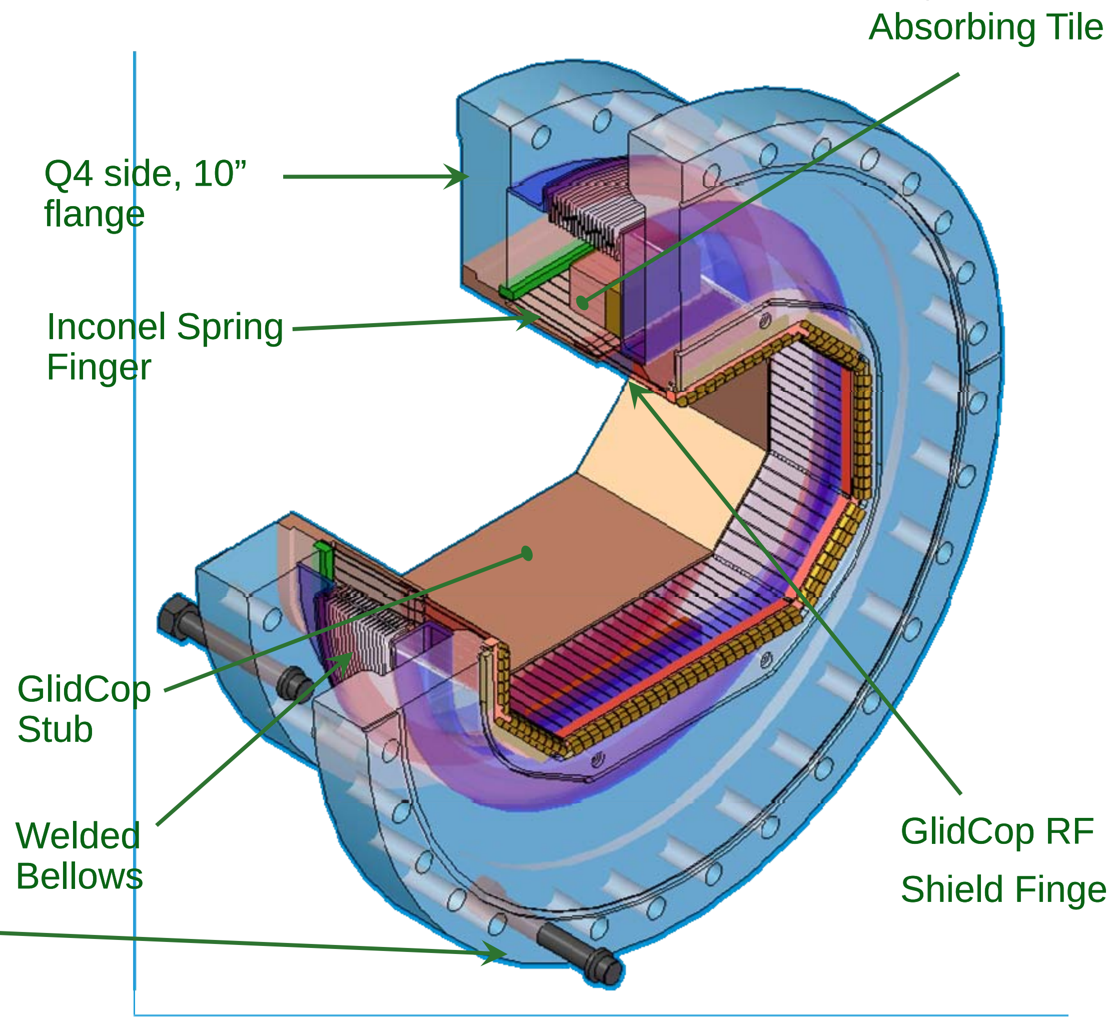
- Mechanically decouples Q4 & Q5 vacuum chambers
- Absorbing tiles above and below beam orbit

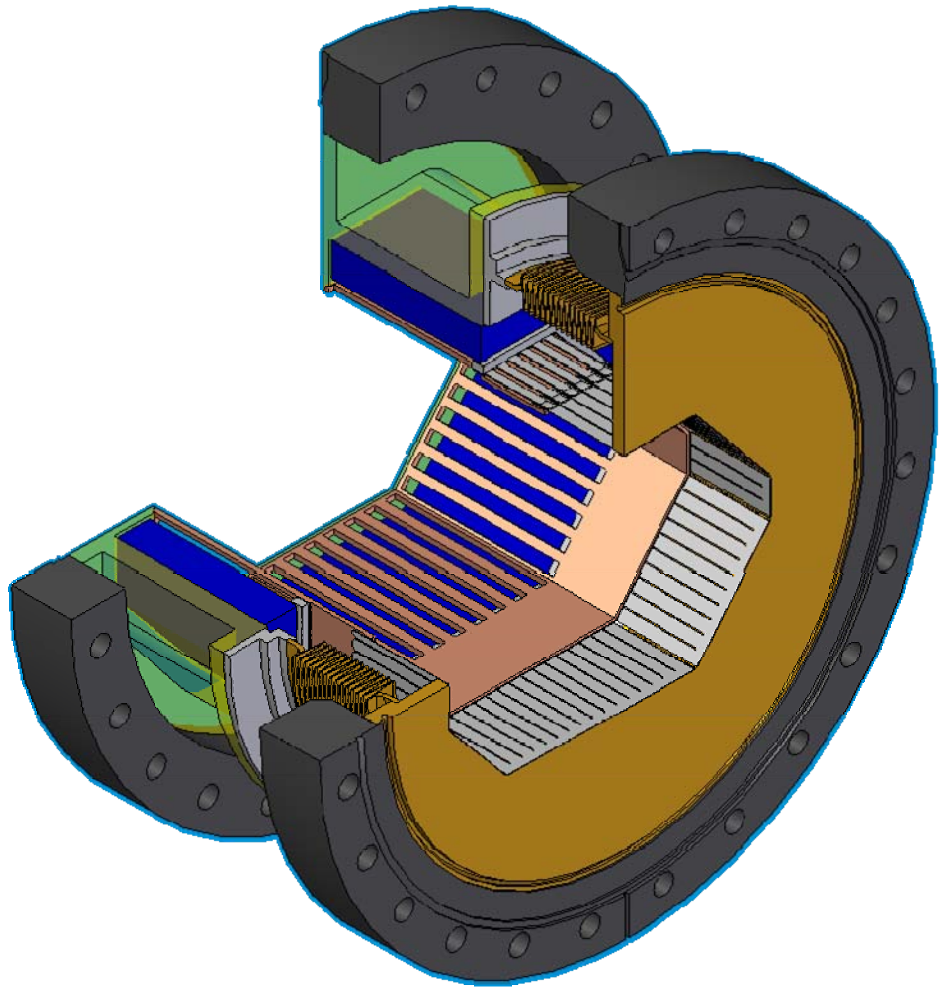
Cooling – not shown



Q1/Q2 HOM Bellows

Sasha Novokhatski "RF and HOMs absorbers"

- Technically very challenging
  - Limited space available
  - Anticipated high power loads
- Design compromises travel during installation to accommodate new HOM absorption arrangement
- 61 mm maximum tile/slot length
- Absorbing tiles are open to the convolutions
  - No additional tile set needed in bellows cavity
- HER Arc Bellows features
  - Spring, Stub, RF shield



Absorbers in the Super-B

Sasha Novokhatski "RF and HOMs absorbers"

1) After IR collimators (4+4)
2) After energy collimator (1+1)
3) After injector kickers (1+1)
4) After abort kickers (1+1)
5) After electron cloud cleaning electrodes.
6) In any place with a complicated vacuum chamber transition

Possible distribution of HOM absorbers in Super-B

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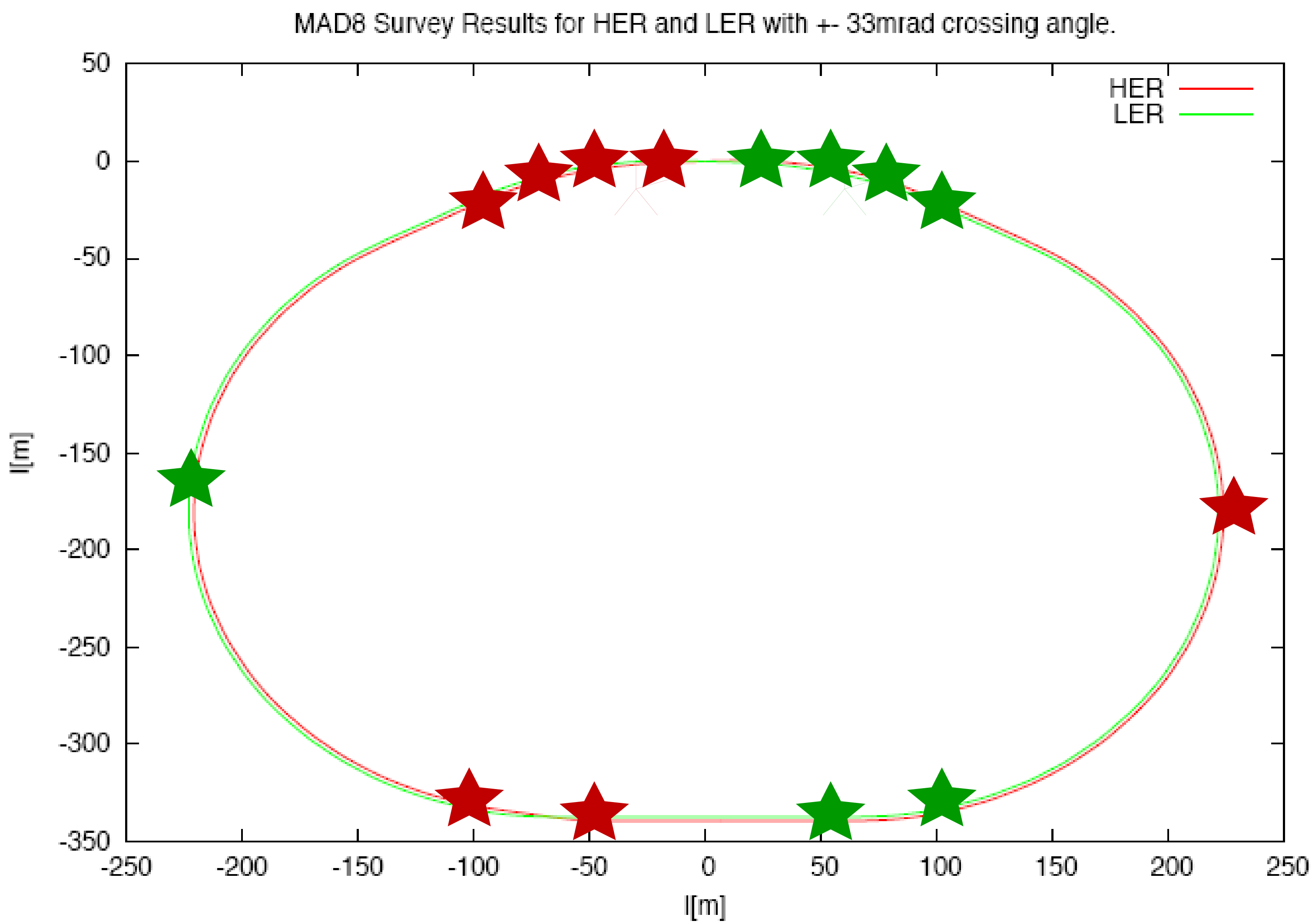

XIV SuperB General Meeting @ INFN-LNF

from 27 September 2010 to 01 October 2010 (Europe/Rome)