NGLS Third Harmonic Cavity

Daniel Bowring

Lawrence Berkeley National Laboratory

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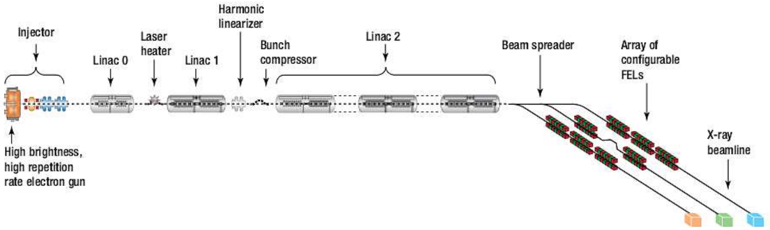
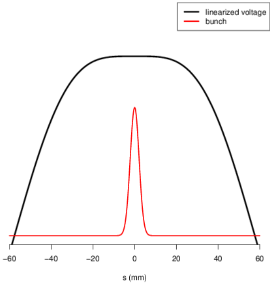
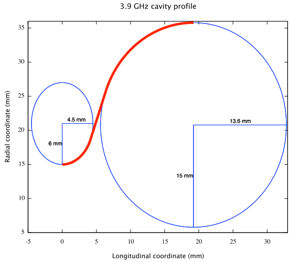
Overview


Injector
Linac 0
Laser heater
Linac 1
Harmonic linearizer
Bunch compressor
Linac 2
Beam spreader
Array of configurable FELs
X-ray beamline
High brightness, high repetition rate electron gun

Overview





	FLASH	NGLS
Frequency (MHz)	3900	3900
Design gradient (MV/m)	14	14
# Cavities	4	4?
Total Voltage (MV)	20	20?

Longitudinal Phase Space

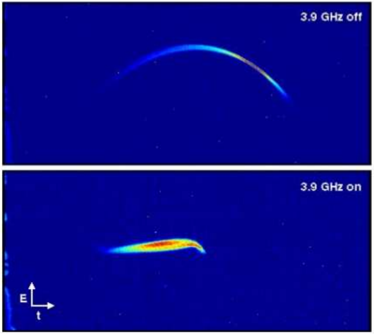


Figure 3: The first linearization of the longitudinal phase space measured with a TDS. Without and with applying 16 MV 3.9 GHz voltage and a BC2 energy near 150 MeV.

Figure: Transverse deflecting structure measurement of longitudinal phase space, before and after applying 3rd harmonic cavity voltage. (E. Vogel et al., IPAC 2010.)

FNAL Experience

- We're using FNAL's 3.9 GHz cavity as the basis for our design. Some of this material will look familiar.
- Lots of good input already from E. Harms, H. Edwards, M. Foley, and others on FNAL institutional experience.

NGLS Challenges

- Short bunches $\rightarrow$ more HOM concerns (c.f. J. Byrd's talk).
- CW operation requires high-performance input, HOM coupling solutions.

Input Coupler

- Small beampipe → coupler kicks. See Figure.
- Tight squeeze in the FLASH cryomodules means they had some difficulty in resolving this problem.
- FNAL's institutional experience with industry-fabricated couplers is useful here.
- Recent interest in waveguide alternatives to coaxial coupling.

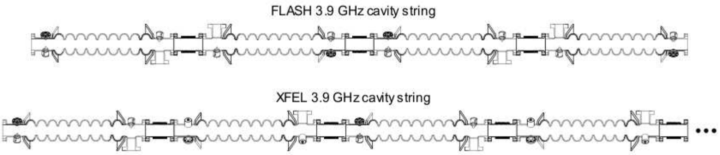
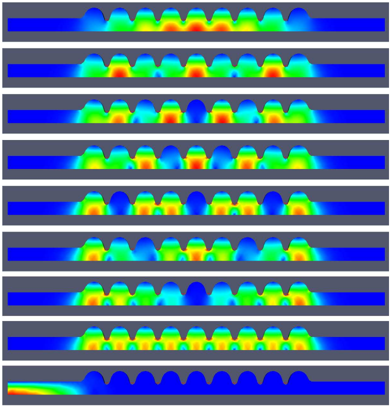


Figure: E. Vogel et al., SRF 2007.

Higher-Order modes

- The HOM spectrum is being studied using the ACE3P code package (Omega3P, T3P).
- We estimate $\sim$ 10% of HOM power dissipated **above 100 GHz**.
- How to model accurately at $>$ THz frequencies? Code + broadband impedance estimates.



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ACE3P Capabilities

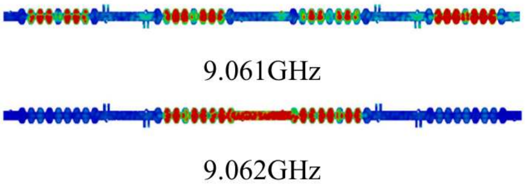

Figure 6: Magnitude of electric field from OMEGA3P simulations for the 5th dipole band. The 9.061 GHz mode is a trapped mode and that at 9.062 GHz is an inter-cavity mode.

Figure: I.R.R. Shinton et al., IPAC 2011: Eigenmode simulation of third harmonic cavity string.

HOM Coupler Issues

- FLASH relied on preexisting coaxial coupler design. No opportunity for waveguide coupler R&D.
- Two-leg formteil design very difficult to weld. (Stress fractures, see next slide.) FNAL recommends a 1-leg design.

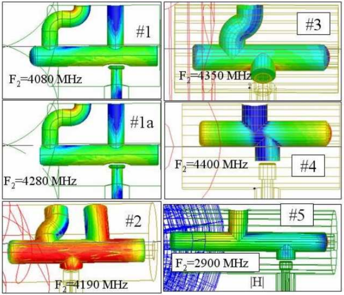

Figure 4: Different HOM coupler designs. Calculated fields on the F-probe surface are shown.

Figure: T. Khabibouline et al., PAC 2007.

FNAL: Lessons Learned

Valuable input from FNAL on technical challenges:

- E-beam welding from various labs, vendors
- Nb, sapphire material quality control
- ES&H coordination during cryomodule assembly