Redesign of the End Group in the 3.9 GHz LCLS-II Cavity*
A. Lunin, I. Gonin, T. Khabiboulline, N. Solyak, Fermi National Accelerator Laboratory, Batavia, USA

Introduction
A continuous operation regime of the 3.9 GHz LCLS-II accelerating structure at the maximum gradient of 14.9 MV/m sets an extra caution on possible overheating of HOM couplers feedthroughs. The HOM feedthrough coupler antenna is made of a solid Niobium, which does not produce significant amount of RF losses until its temperature is kept below critical, but it may initiate a thermal runaway process and end up by a cavity quench due to a leak of an operating mode or a resonant excitation of the cavity HOM spectrum. In order to avoid such a scenario, one has to minimize the antenna RF heating by using smaller antenna tip and increasing the size of the f-part snag.

Signals transmission in the 3.9 GHz cavity
The redesign of the 3.9 GHz cavity End Group is completed. Reduced beam pipe aperture simplifies the HOM coupler notch filter tuning, while modifications of the HOM coupler f-part and the antenna reduce RF losses in the HOM feedthrough making it suitable for CW operation of the LCLS-II linac.

Conclusions

• Detuning of few MHz is observed for the notch filter central frequency in the XFEL 3.9 GHz cryomodule
• Up to 1 W average rf power might leak through the single HOM port at 14.9 MV/m gradient.
• The HOM port signal (S24) normalized to the cavity transmission signal (S14) reveals the notch filter central frequency

Dipole HOMs Spectrum in the End Group

• In the tuned HOM coupler, the feedthrough antenna with new tip has a higher local G-factor of 1.7x10^9, comparing to the 3.2x10^8 G-factor of the original design.
• It is equivalent to a reduction by a factor of five of associated surface RF losses, which makes new HOM coupler suitable for the CW operation.

• It is difficult to tune the notch filter in a close proximity of dipole HOMs
• Number of nearby dipole HOMs is reduced to four in the LCLS-II 3.9 GHz cavity
• The frequency of the closest dipole mode is shifted up by 100 MHz comparing to the original XFEL design.

Notch filter passbands.

Dipole HOMs Spectrum in the End Group

• The LCLS-II design with a reduced beam pipe aperture has a less influence of nearby dipole modes and, thus, ensures an easy tuning of the sensitive HOM coupler notch filter.

Conclusions
The redesign of the 3.9 GHz cavity End Group is completed. Reduced beam pipe aperture simplifies the HOM coupler notch filter tuning, while modifications of the HOM coupler f-part and the antenna reduce RF losses in the HOM feedthrough making it suitable for CW operation of the LCLS-II linac.