

FERMI FEL Linac Achievements and Upgrade

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FERMI is the Italian externally seeded free electron laser in the UV and soft x-rays, driven by a high brightness electron beam S-band plus X-band linac. In recent times, the linac has been upgraded, leading the final beam energy from the design value of 1.2 GeV to 1.5 GeV. Together with proper management of the electron beam quality, fundamental wavelengths down to 4 nm become therefore accessible to users. Additional upgrades concerning laser systems, diagnostics and RF structures are on the path. We present the FERMI FEL linac status, and provide an overview of running and future capabilities of the facility.

Hz rep rate.

FEL UPGRADES AND ACHIEVEMENTS



INJECTOR UPGRADE

Two 3-m long, dual-feed accelerating structures replaced old single-feed ones*



One more RAD in FEL2 for higher energy from 1st stage, and relaxed Seed laser performance.



LINAC ENERGY UPGRADE

Older structures were moved to the high energy part of the Linac.

Maximum Linac energy is now 1629 MeV. The maximum operating energy at 700 A of nominal current, is 1550 MeV at 10



REFURBISHMENT OF RF STRUCTURES – DESIGN STAGE

Limitations to the attainable energy at 50 Hz come from the BTW

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|-------|---------|---------|---------|---------|--------|
| nac 0 | Linac 1 | Linac 2 | Linac 3 | Linac 4 | |
| 1 170 | | | | | TZ 1 / |



LASERS UPGRADES

SEED LASER ROOM



Layout of the FERMI Seed Laser setup after recent upgrade

PIL and Laser Heater

2-bunch operation with separation 0.33-2.33 ns.

Laser Heater double pulse (beating); pulse shaping under testing.

Seed Laser

New amplifier for shorter pulse FEL2 seeding.

OPA-like tunability in the 260-270 nm range.

Higher pulse energy and shorter pulse duration for pumpprobe experiments.

e-BEAM DIAGNOSTICS UPGRADE



3-D drawing of the new multi functional device for transverse profile measurement: screen (translation stage visible in *backgrond)* + *wire* scanner (in forefront).

- A routine operation at 1.55 GeV (after compression) and 50 Hz will require an operting gradient of **24 MV/m** on Linac3 and Linac4.
- Longitudinal and transverse wakefields effects shall be mitigated with respect to the actual BTW structures.



The new accelerating module will be comprised of two 3.1-m long accelerating structures.

- Each structure will be of the constant-gradient type.
- RF couplers will be of the electriccoupled type*.

SHORT-RANGE WAKEFIELDS

| 00 | Long | gitudinal | Wake | functions | |
|----|------|-----------|------|-----------|--|
| 00 | | | | | |

| Transverse | Wake | functions | |
|------------|------|-----------|--|
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The new structures will mitigate wakefields effects, ensuring a final beam energy > 1.5 GeV at 50 Hz

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