Operational Experience with the TESLA Test Facility
TESLA Test Facility (TTF)

- Cavity Treatment and Assembly
- Cavity Testing  (RF System / He Plant)
- Cryomodule Assembly
- TTF Linac and Free Electron Laser

Hans Weise / DESY
Snowmass 2001
TESLA Test Facility Linac
Beam Diagnostics at the TTF Linac
TTF RF Gun - DESY Design

- \( N_0 \) / bunch: > 10\(^{10}\)
- \( Q \) / bunch: 1 - 10 nC
- bunches / pulse train: 800 - 9600
- pulse train length: 800 \( \mu \)s
- bunch spacing: 1 \( \mu \)s - 111 ns
- bunch length: 5 ps
- RF power: 3 MW
- laser energy / pulse: typ. 30 - 50 \( \mu \)J
RF Gun at the TTF Linac - FNAL Version
RF Gun Test Setup PITZ - DESY Zeuthen
TESLA Accelerator Module

He gas return pipe

beam position monitor

quadrupole package

module length 12.2 m

input coupler
Gradients of 9-cell TESLA Cavities

Excitation curves of cavities of the third production series

$E_{\text{acc}}$ [MV/m] vs. $Q_0$ [10^9 - 10^{11}]

(b) $E_{\text{acc}}$ [MV/m] for different modules.

Hans Weise / DESY

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Bunch Compression

- Tail particle, more momentum
- Head particle, less momentum

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Bunch Compression

coherent OTR

tomography
SASE Free-Electron Laser at TTF

Electron Beam:
- $I_{\text{peak}} = 2.5 \text{ kA}$
- $\varepsilon_n = 2 \pi \text{ mm mrad}$
- $\sigma_z = 0.05 \text{ mm}$
- $\sigma_r / \gamma = 1.0 \%$
- $\gamma = 2000$

Undulator:
- $\lambda_u = 27.3 \text{ mm}$
- $B_{\text{max}} = 0.497 \text{ T}$
- $N \approx 1000$
- gap = 12 mm

Photon Beam:
- $\lambda_{\text{ph}} = 6.4 \text{ nm (193 eV)}$
- $P_{\text{sat}} = 3 \text{ GW}$
- av. brill. $> 10^{21}$ photons (mm mrad)$^{-2}$ (0.1% bw)
- pk. brill. $> 10^{29}$ photons (mm mrad)$^{-2}$ (0.1% bw)
- m.p. length $= 800 \mu\text{s}$
- nbr. of bunches $\leq 7200$
- rep. rate $\leq 10 \text{ Hz}$

Hans Weise / DESY  
Snowmass 2001
SASE FEL at TTF - the Undulator
Operation of the SASE FEL @ TTF

SASE operation at different wavelengths

Electron Beam Energy: 181 - 272 MeV
FEL Wavelength: 80 - 181 nm
Photon Energy: 7 - 15 eV

only spontaneous emission observed
TTF Operation

- acceleration of 800 μs long pulse trains
- full beam loading
- gradients up to 23 MV/m with beam
- approx. 9000 hours of operation
- FEL operation

TESLA

500 GeV c.m.
TTF2 Program – Commissioning in 2003

spectrometer
monochromator section
seeding undulator
collimator section
linac modules 4-6
bunch compressor
undulator (6 modules)
temporary beamline
electron beam bypass line
17 m long TDR TESLA module