EuroFEL Support Laboratory: Spettroscopia Laser Ultra-Veloce: Ricerca Fondamentale e Applicata

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Laser System: **CNR: Area della Ricerca Tor Vergata**

1 Vitara-T mode-locked oscillator with integrated Verdi pump laser

2. Legend Elite USP HE+ 1k-II Ti:Sa laser Regenerative Amplifier with integrated Evolution 30 pump laser

3. OPerA-Solo OPA with integrated UV-VIS extension wavelength option

1) **Mode-locked Ti:Sa oscillator** with integrated solid-state pump laser

Pulse Duration 20 fs (uncompressed)

Tuning Range (@ 30 nm of bandwidth) 755-860 nm

2) **Ultrafast Regenerative Ti:Sa Amplifier**

Pulse Duration (FWHM) ≤35 fs

Energy/Pulse (mJ) ≥4 mJ at 1 kHz

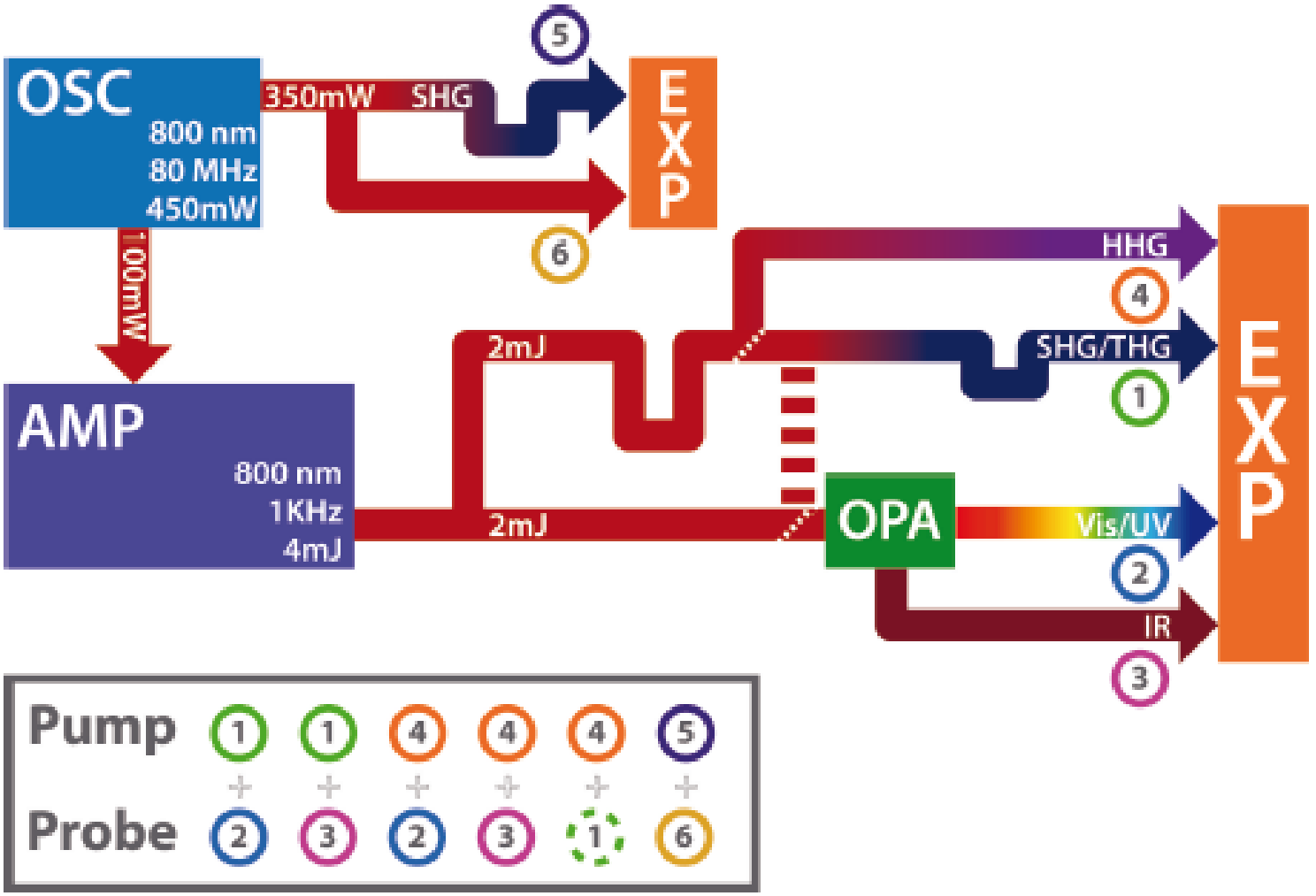
Energy Stability (RMS, over 24 hours) < 0.5%

3) **Optical Parametric Amplifier (OPA) System**

240nm to 20000nm.

Output power: ≥380uJ (signal + idler, at peak) with 2.0mJ input @ nominal 35fs.

Conceptual Layout of Laboratory



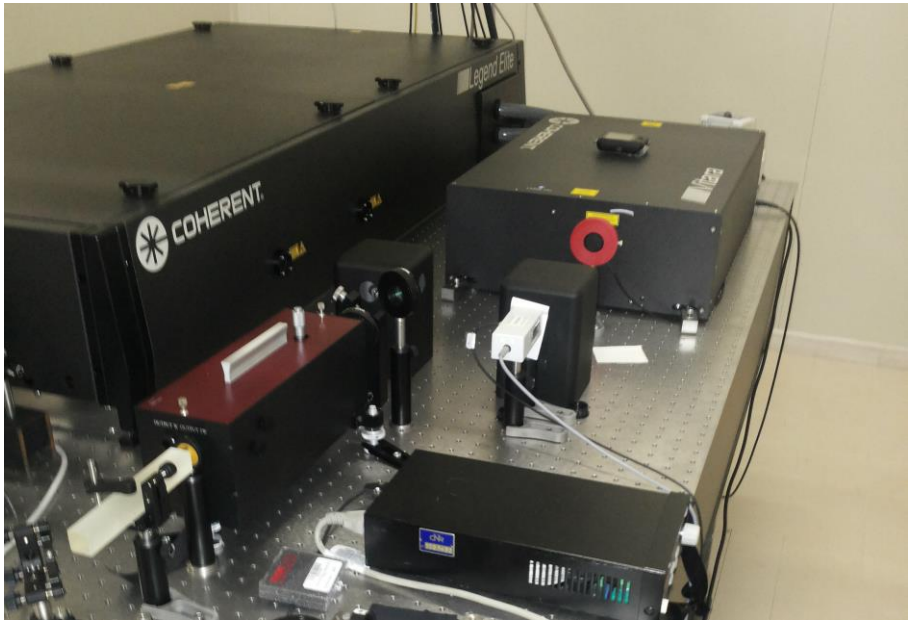
Characteristics of the Laboratory Sources
Part 1: Oscillator

800 nm c. 400 mW of power at 80 MHz

Laser a Diodi
Continuo – 10 W
@532 nm

→

Oscillatore Ti:Zaffiro
80 MHz
@800 nm
20 fs
500-600 mW

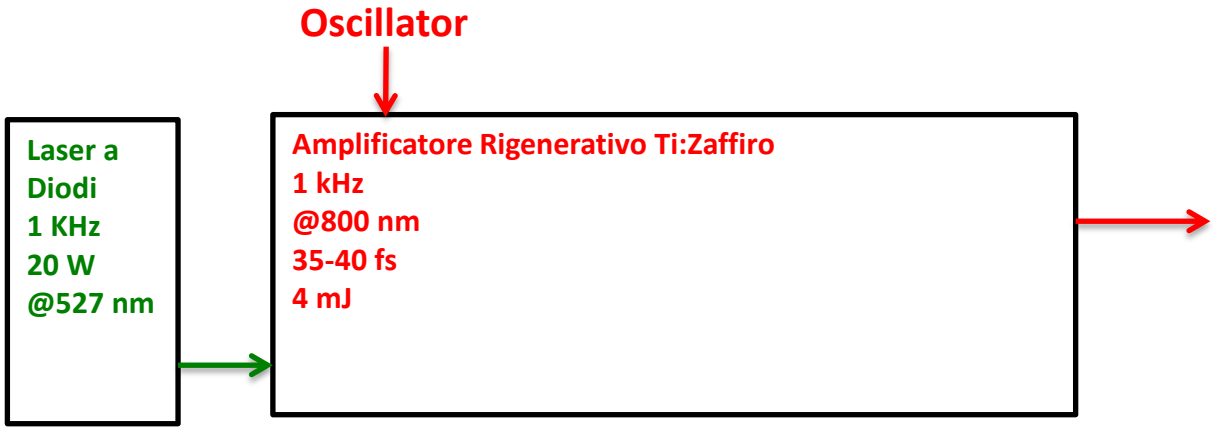


Possible uses:

Time resolved luminescence (already installed, Fausto Martelli – IMM- CNR)
Fixed wavelength pump-probe
Treatment of Materials
Characterisation of materials

Part 2: Amplifier and OPA

Amplifier

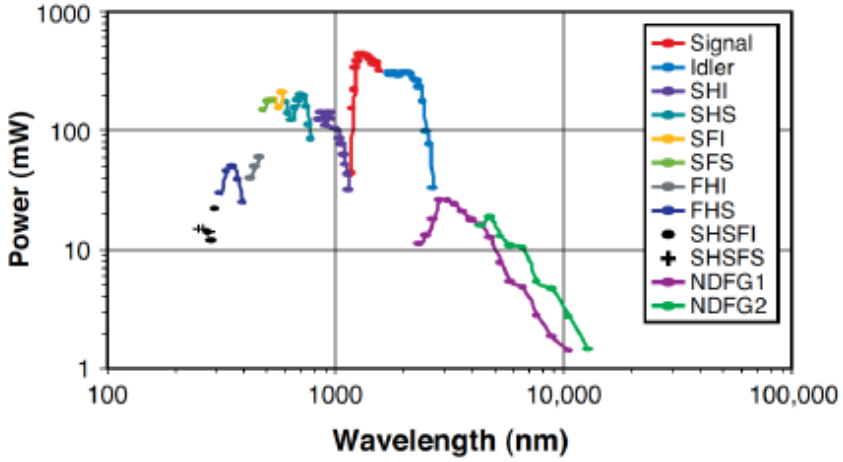


Second harmonic generation in crystal (efficiency 30 – 40%) : 100s uJ/pulse (35fs)
Third Harmonic generation wave mixing : 2 – 8 % : 10s – 150 uJ/pulse (35 – 50 fs)

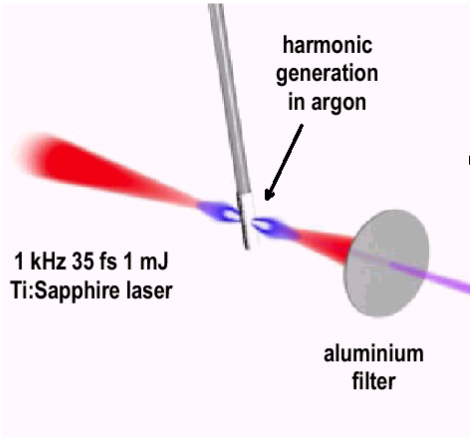
Optical Parametric Amplifier

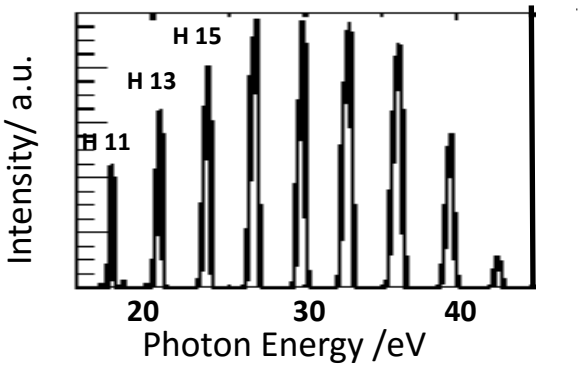
≥380uJ signal at 1300 nm
≥280uJ idler at 2100 nm

Overall tunability: 240 nm – 20000 nm



Part 3: HHG (in design and contruction stage)





Argon

13a – 25a armonica (fino a 40eV)

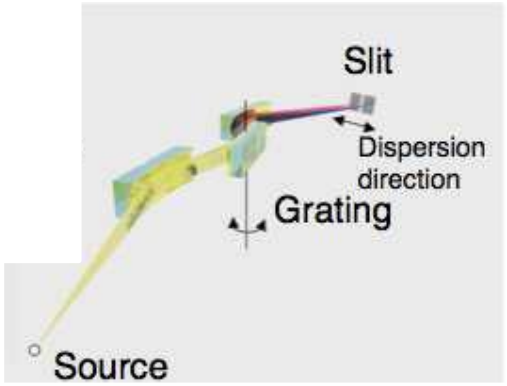
10^7 – 10^8 fotoni/impulso/armonica

Neon

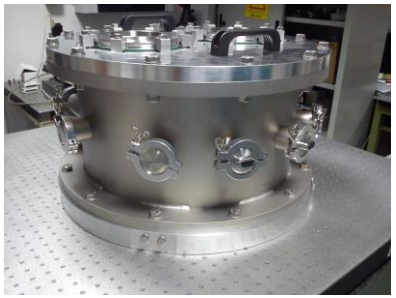
13a – 61a armonica (fino a 90eV)

10^5 – 10^6 fotoni/impulso/armonica

Harmonic separation developed in collaboration with Luca Poletto (CNR-IFN, Padova)



Present state of monchromator



Projected Completion Date: Early 2016

Auxillary Lab Equipment

Equipment for the characterisation and manipulation of light

Power meters

Spectrometer

Monochromators

Femtosecond Transient absorption spectrometer (installed July 2015)

FROG (Frequency resolved Optical Grating) – developed with ENEA

Precision delay lines

Signal display/manipulation (oscilloscope, lock-in, etc)

Applications: ultrafast lasers

Conventional laser applications	Benefits by using femtosecond lasers
ablation	• more controllable • less damage
spectroscopy	• Femtosecond temporal resolution • wide spectral range • coherent control
imaging	• nonlinear imaging (e.g. TPA, THG) ->3D optical sectioning -> contrast in transparent samples

Example: Materials processing
Femtosecond vs. Picosecond ablation

Laser pulse width: 80 fs

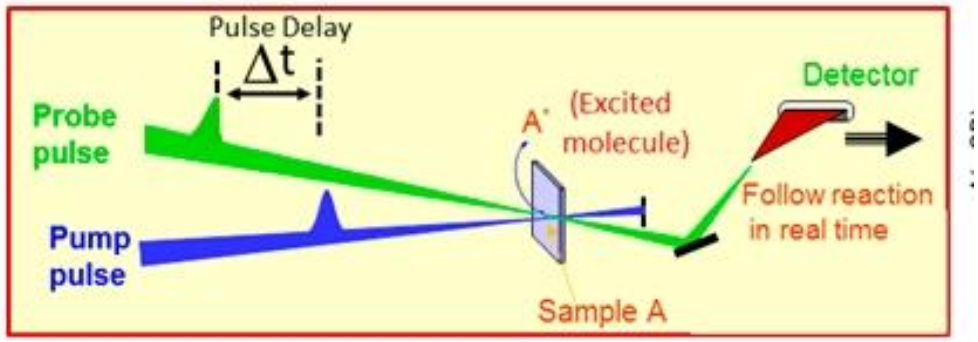
deterministic -> predictable ablation

Laser pulse width: 200 ps

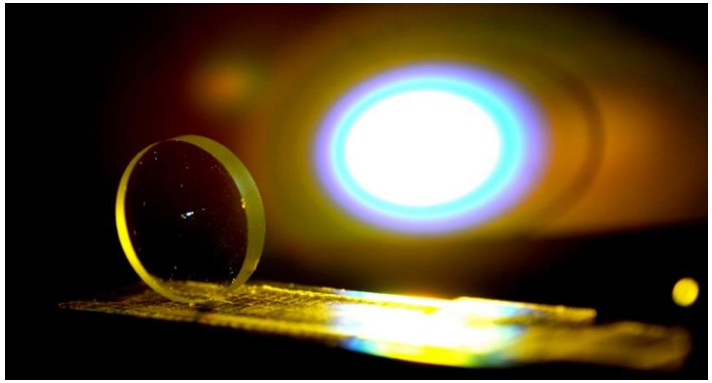
stochastic -> uncontrolled ablation

Example 2: Pump-probe characterisation

Investigation of the dynamics of molecules and materials at the femtosecond timescale



White light generation



Femtosecond transient absorption spectroscopy

Non-radiative transitions and excited state dynamics of organic molecules
Plasmon resonance of metal nanoparticles
Dynamics due to interaction of molecules with nanoparticles (col. Prof. La Russo)
Dynamics of silicon nanowires

People involved

Daniele Catone
Lorenzo Avaldi
Stefano Turchini
Stefano Colonna
Fausto Martelli (IMM)

Antonio Cricenti
Alessandra Paladini
Claudio Quaresima
Julietta Rau
Francesco Toschi
Nicola Zema