Broadband Frequency Conversion of Spectrally Incoherent Pulses and Initial Laser-Plasma Instabilities Mitigation Experiments

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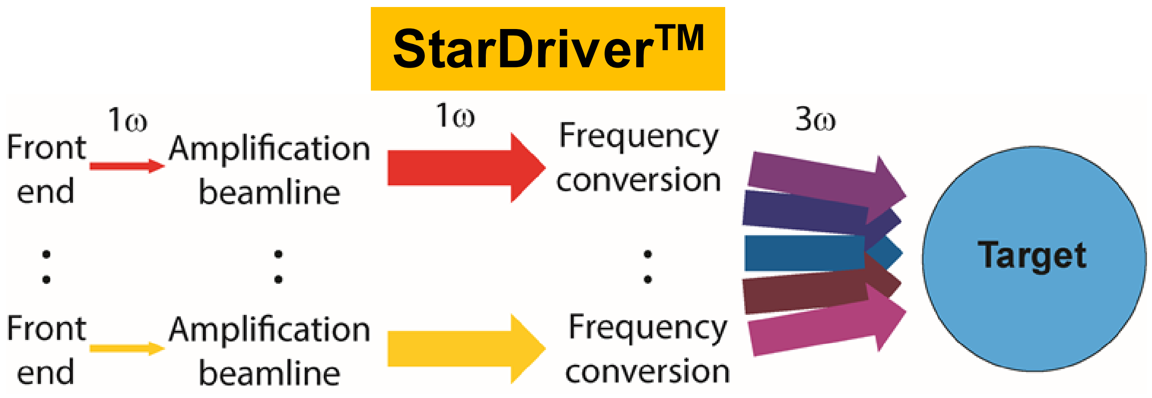
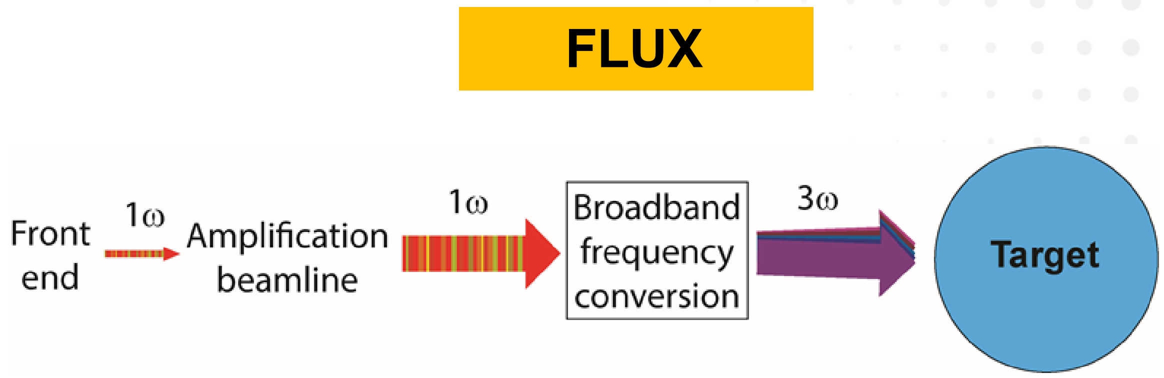
Team members and roles

- **Christophe Dorrer (PI)**
  - Responsible for developing all scientific aspects of the proposed novel sum-frequency generation scheme for the Fourth-generation Laser for Ultrabroadband eXperiments (FLUX)
- **David Turnbull (co-PI)**
  - Responsible for developing all scientific aspects of the FLUX experiments on OMEGA, will lead the efforts to design, build and characterize the electron-plasma waves platform
- **Elizabeth Hill (PM)**
  - Responsible for the engineering and deployment of the proposed technology, will also define and coordinate sub-tasks across the team and enlist support from other LLE groups

The FLUX system will produce on-target spectrally incoherent UV pulses with fractional bandwidth $\Delta\omega/\omega > 1.5$ %

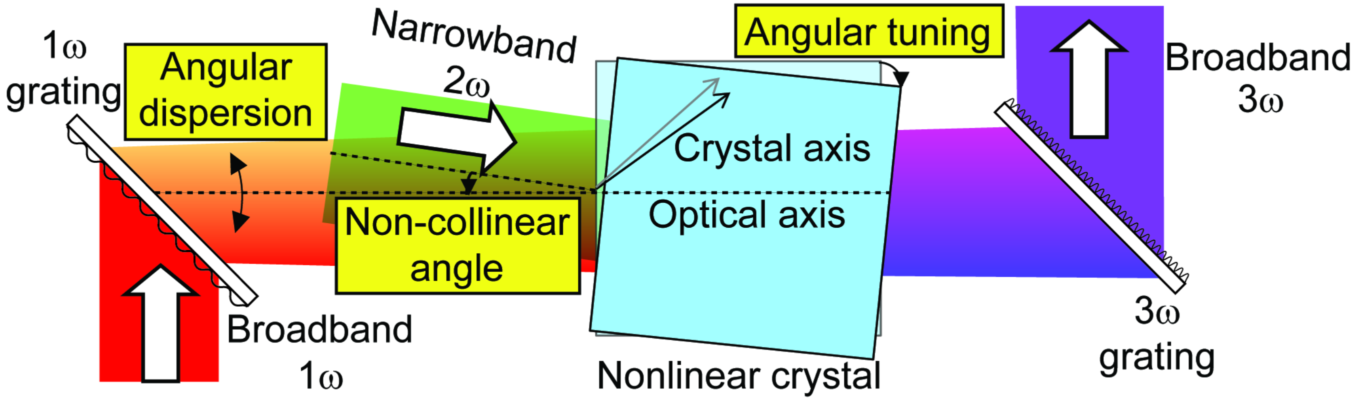




- **Simulations show that laser-plasma instabilities (LPI) detrimental to laser-target interaction can be mitigated by broadband spectral incoherent pulses ($\Delta\omega/\omega$>1.5%):**
  - **StarDriver™ concept: large number of relatively narrowband laser drivers spanning a large fractional bandwidth**
  - **FLUX concept: broadband single-driver**
- **This project will enable the first experimental verification of LPI mitigation at large fractional bandwidth by:**
  - **Accelerating the implementation of a novel, high-efficiency, frequency-conversion scheme for broadband, spectrally incoherent pulses on FLUX**
  - **Demonstrating the mitigation of electron plasma wave instabilities using FLUX on the 60-beam Omega facility**

The project will allow for ICF/IFE-relevant LPI-mitigation studies using broadband spectrally incoherent UV pulses

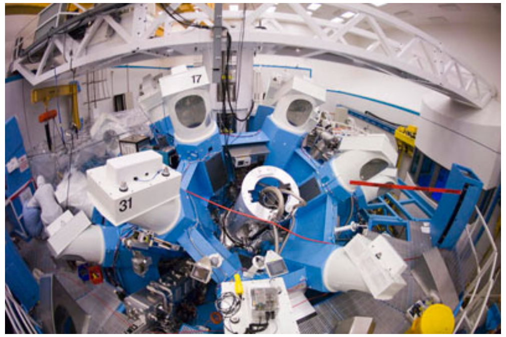
Deployment of broadband sum-frequency generation stage

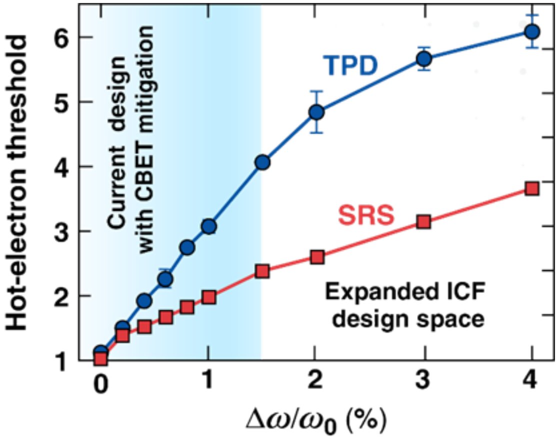


- **Tasks:**
  - Design/procurement/fabrication
  - Testing of individual components
  - Construction/operation/optimization
- **Technical risks:**
  - Laser damage of optical components
  - Ability to phase-match the nonlinear process
  - Commercial availability of diffraction gratings and nonlinear crystal
- **Outcome: Generation of 150-J 1.5-ns UV spectrally incoherent pulses with fractional bandwidth $\Delta\omega/\omega > 1.5$ %**

The project will allow for ICF/IFE-relevant LPI-mitigation studies using broadband spectrally incoherent UV pulses

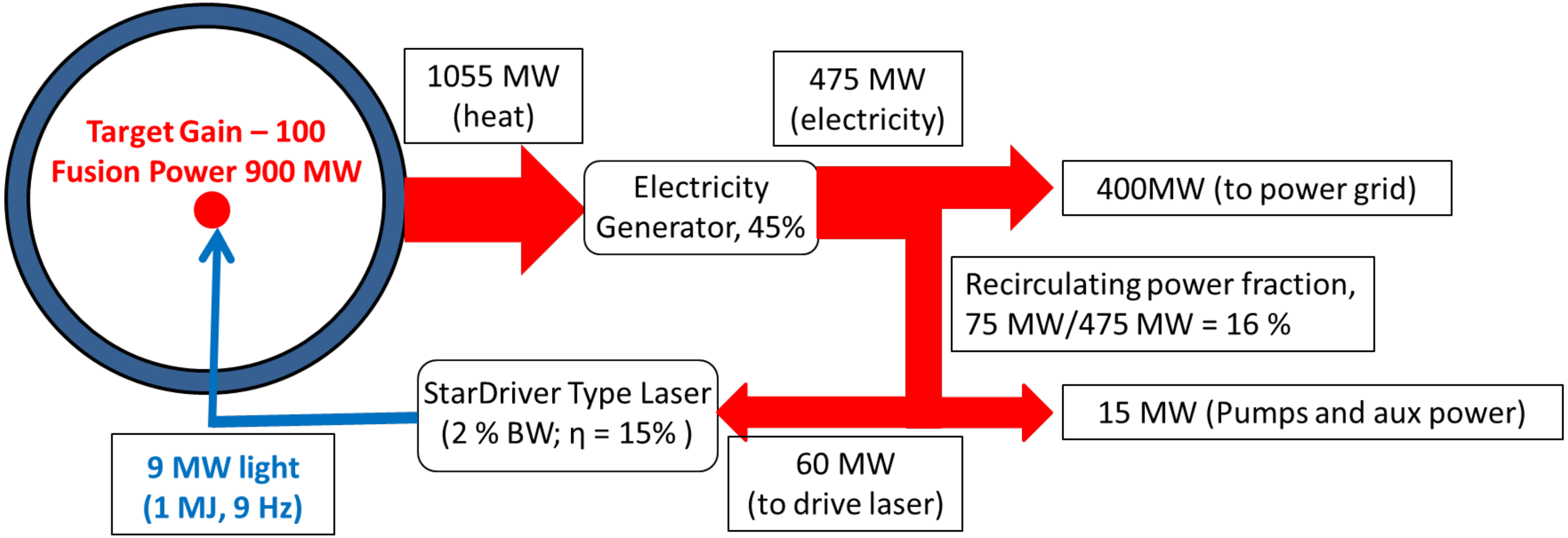
Demonstration of stimulated Raman scattering (SRS) mitigation (three shot days with OMEGA)





- **Tasks:**
  - Commissioning and characterization
  - Narrowband SRS campaign
  - Broadband SRS campaign
- **Risks:**
  - Ability to tailor the gas jet to generate only SRS and generate SRS in a regime relevant to ICF/IFE plasmas (e.g., a narrow SRS spectrum)
- **Outcome: First UV large bandwidth SRS studies in regimes relevant to ICF/IFE, used to benchmark simulation codes**

A diode-pumped broadband StarDriver^{TM} ($\Delta\omega/\omega > 2\%$) is expected to support a 400-MW power plant with cost<$2B



Total direct costs	$1,123M
Laser system	$300M
Reactor plant	$203M
Balance of plant	$620M
Indirect costs	**$674M**

- **First demonstration of broadband spectrally-Incoherent, high-peak-power UV radiation, sufficient to enable the experimental validation of critical LPI suppression in IFE target designs suitable for commercial fusion power.**
- **Current estimate for diode-pumped broadband StarDriver^{TM}-based 400-MW power plant (based on LIFE cost analysis):**
  - **overnight capital cost: $1.8B**
  - **capital cost of electric power: 4.5 $/W**
- **Will require more in-depth cost studies for various IFE approaches**