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Design of the Short Pulse Petawatt Diagnostics

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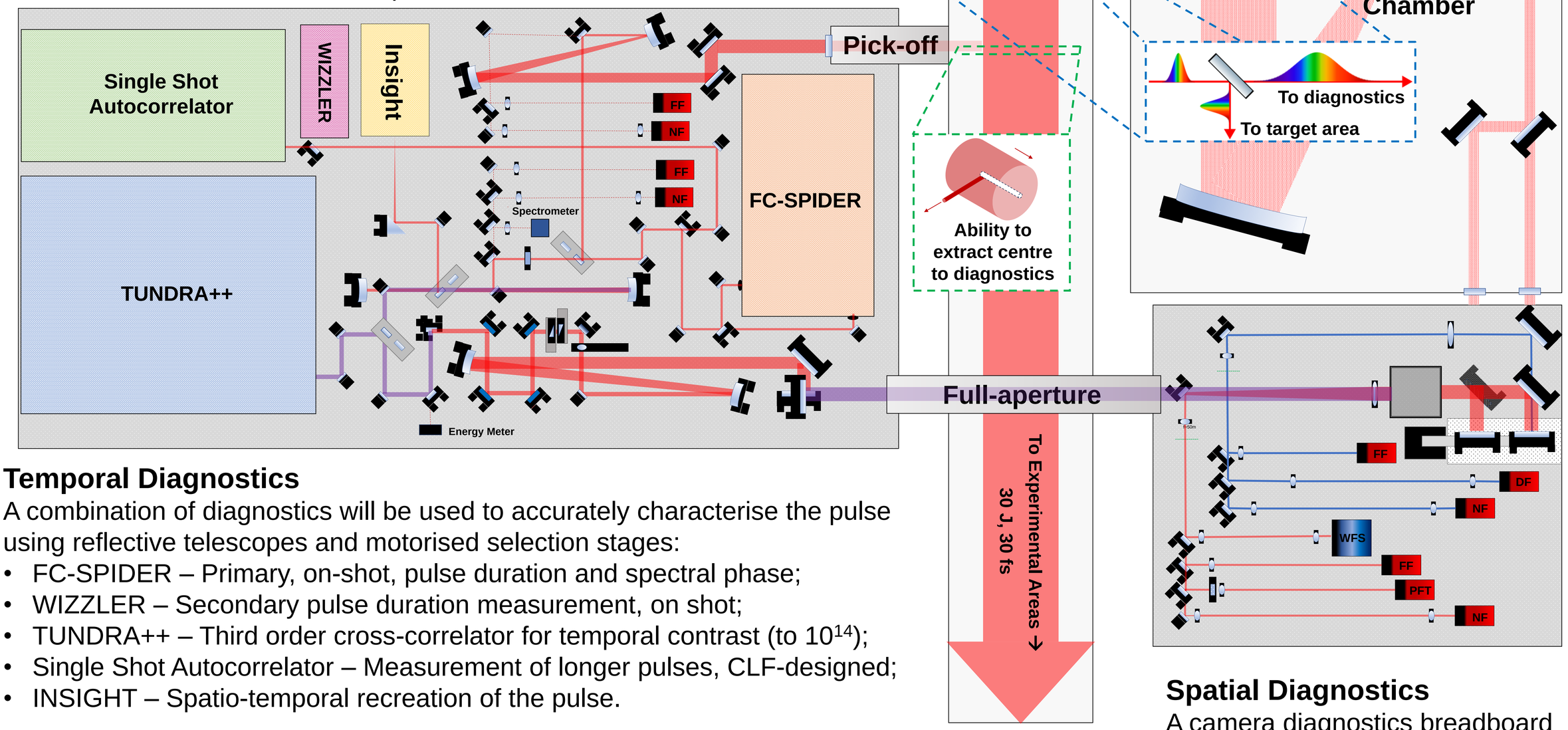
Introduction

One fundamental problem in short pulse, high power laser facilities is the ability to prove the pulse duration of the pulses sent to the experimental is accurate. This is because the realistic attempts to extract the compressed beam, on shot, for measurement destroys the temporal or spatial profile. For EPAC, a design of a dual-measurement method is proposed, with the aim to measure a “pick-off” from the main beam with minimal dispersion, and a full-aperture beampath; a scaled copy of the main pulse. The latter will undergo calibrated re-compression to compensate the dispersion induced in transport.

Diagnostics Layout – Current Concept

The proposed design combine pick-off and full-aperture beamlines to pulse measurement with various devices. The pick-off measures a more accurate temporal duration, however only in a local area, the full-aperture has complete spatial information, but sacrifices the temporal detail.



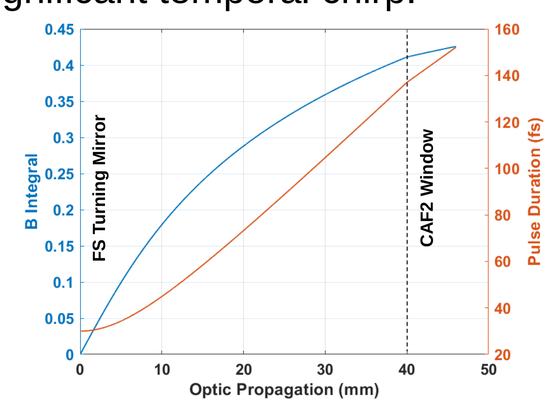
Temporal Diagnostics

A combination of diagnostics will be used to accurately characterise the pulse using reflective telescopes and motorised selection stages:

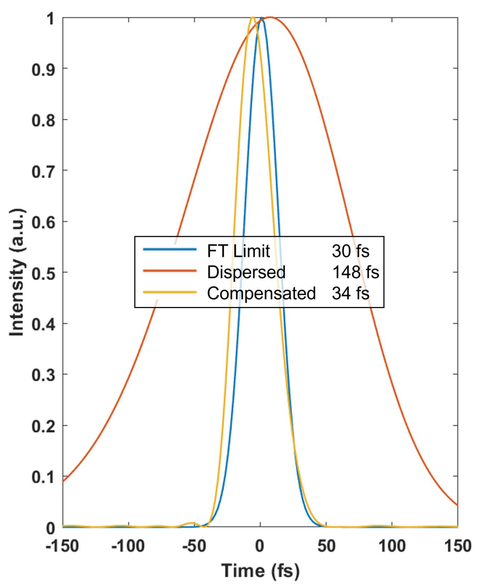
- FC-SPIDER – Primary, on-shot, pulse duration and spectral phase;
- WIZZLER – Secondary pulse duration measurement, on shot;
- TUNDRA++ – Third order cross-correlator for temporal contrast (to 10^{14});
- Single Shot Autocorrelator – Measurement of longer pulses, CLF-designed;
- INSIGHT – Spatio-temporal recreation of the pulse.

Compensation Model

The dispersion from propagation through the large turning mirror and output vacuum window causes significant temporal chirp.



- This stretched pulse duration (~150 fs) is then immeasurable on conventional diagnostics.
- Chirped mirrors will be used to recompress the pulse for measurement.
- This will be calibrated to the pick-off measurement; eventually calibrated to specific target area.



Spatial Diagnostics

A camera diagnostics breadboard will be mounted on a granite block, for stability.

The diagnostics will monitor the compressor output alignment and beam profile, this includes:

- Wavefront Sensor (WFS);
- Near field (NF) – spatial profile;
- Far field (FF) – pointing stability;
- Pulse-front tilt (PFT) – angular dispersion measurement for compensation;
- Dark field (DF) – damage detection on compressor gratings.