Energy Control of ASML EUV Source

Max Crisafulli | Craig Weiner | Sean Tseng | Bryan Chung | Armura Tang

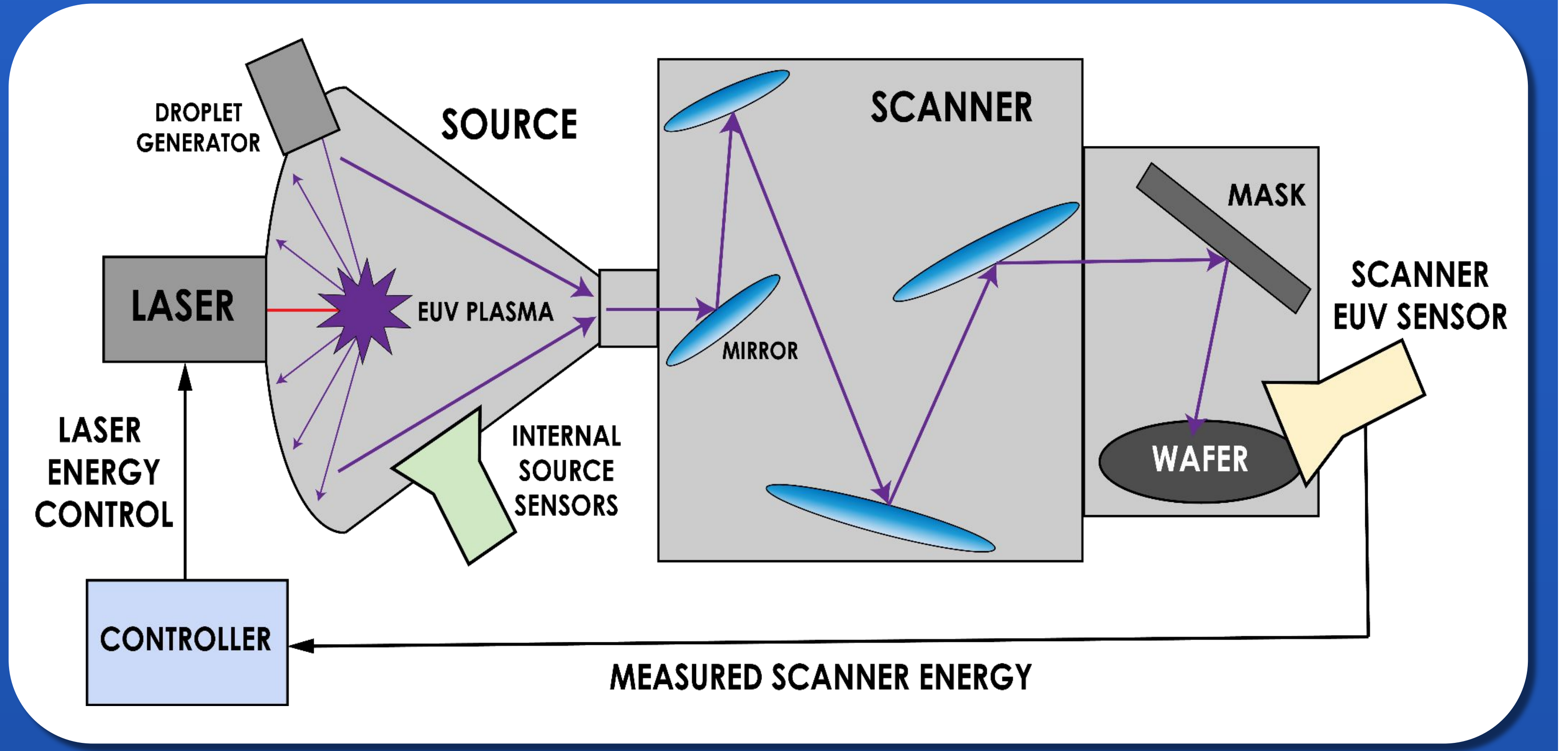
Twice the Speed, Twice the Power

ASML EUV SOURCE

ASML's Extreme UltraViolet (EUV) photolithography process is essential for the production of almost all modern-day chips in high-tech devices.

Photolithography is a key process in chip fabrication; circuit features are produced by exposing a photosensitive material deposited on the chip to high-energy EUV light.

ASML's machine requires high-speed and high-tolerance control over the EUV light produced. ASML intends to increase the speed of these machines; however, sensor delays inherent to the system mean that increasing the speed degrades the quality of the EUV light received by the wafer.

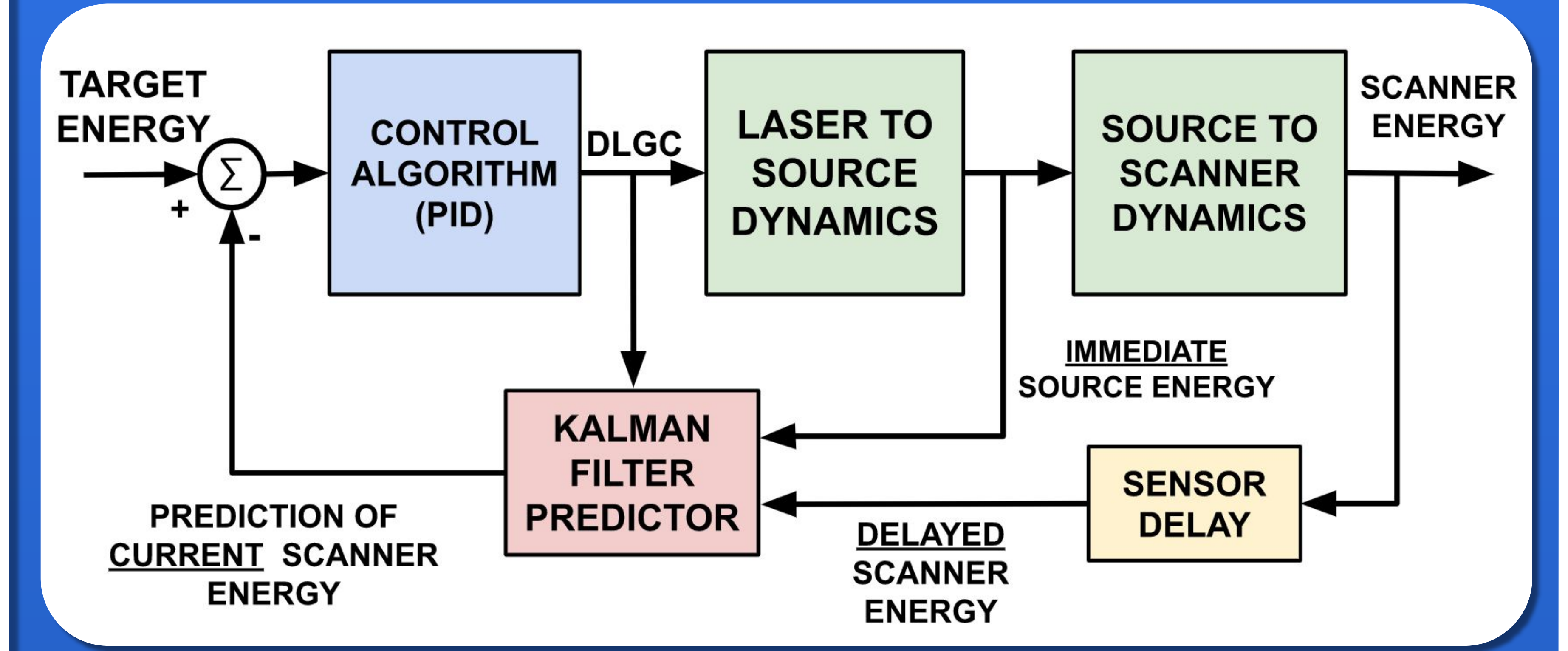


PERFORMANCE SPECIFICATIONS

Our project minimizes the effect of the feedback delay by implementing a Kalman-Filter based prediction algorithm and PID controller. The controller and predictor were tuned by developing metrics to evaluate the simulated system's performance.

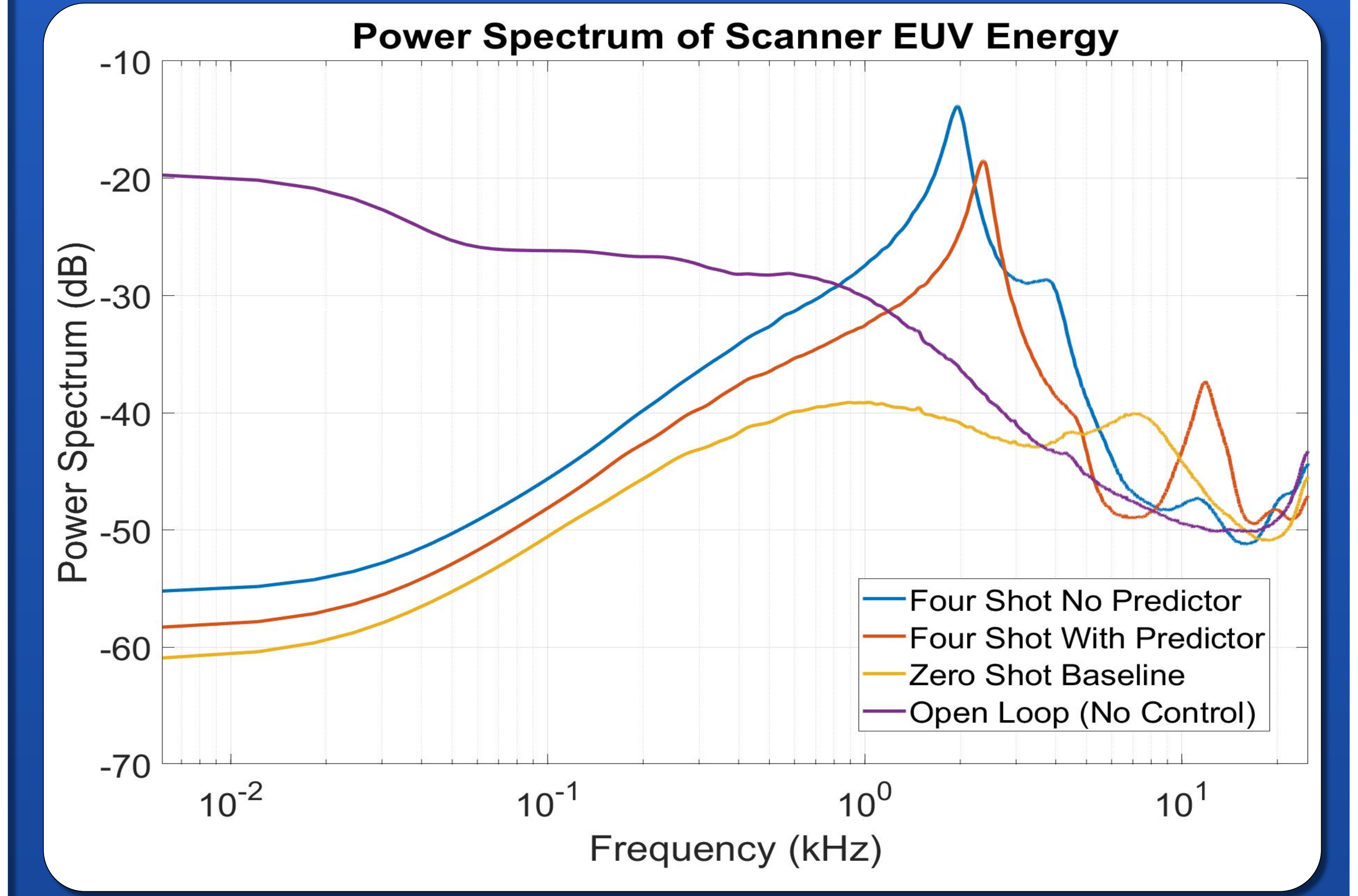
The main metric by which the system's performance was evaluated is called *dose error*: a measure of the difference between the wafer's desired EUV light exposure versus how much light it actually received.

CONTROL DIAGRAM



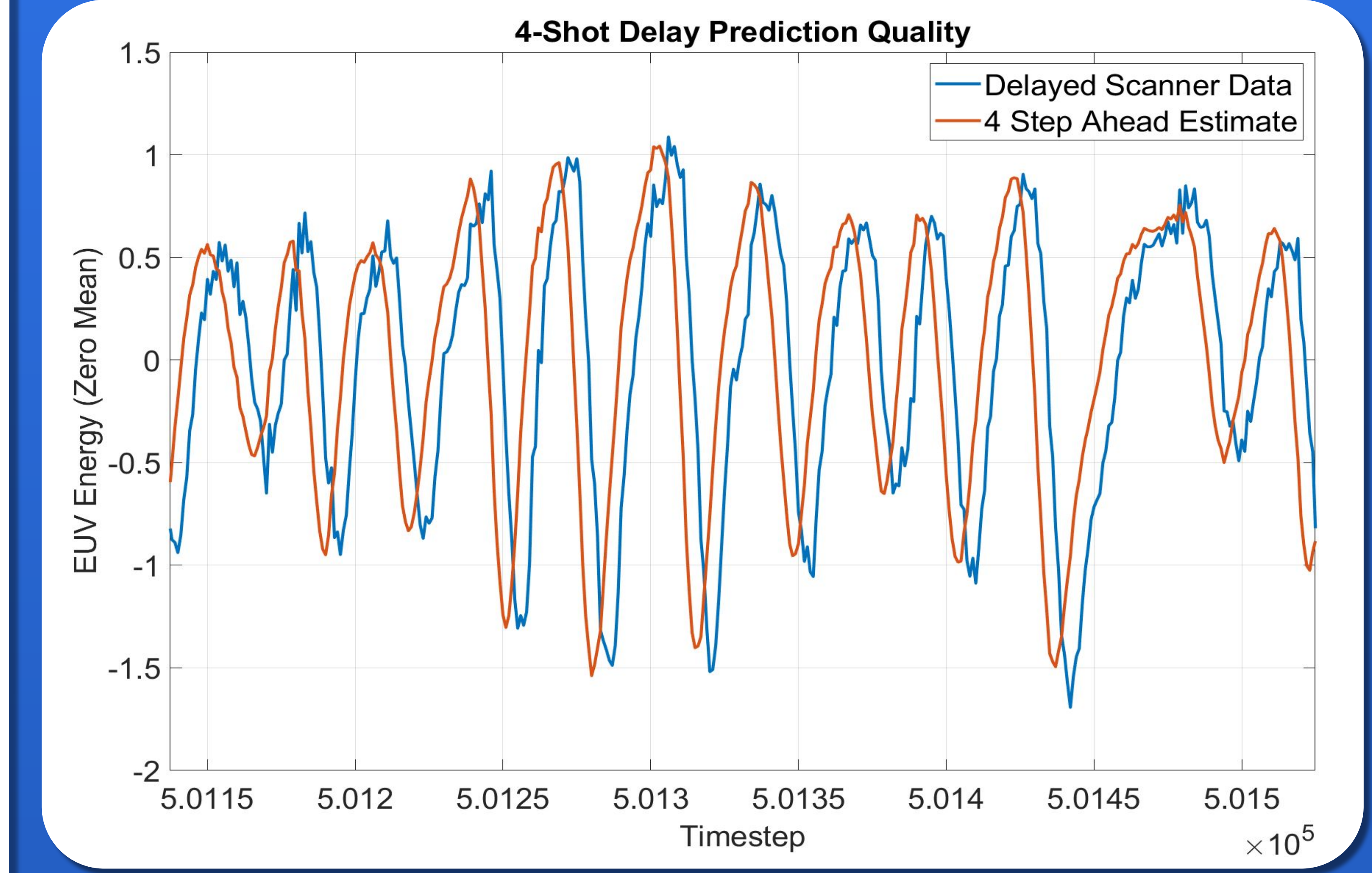
- PID Controller maintains targeted scanner energy.
- Kalman Filter predictor incorporates previously unused source sensor information to bypass the sensor delay.
- Basic system dynamics model the different energies at the source and scanner.

SPECTRAL PERFORMANCE



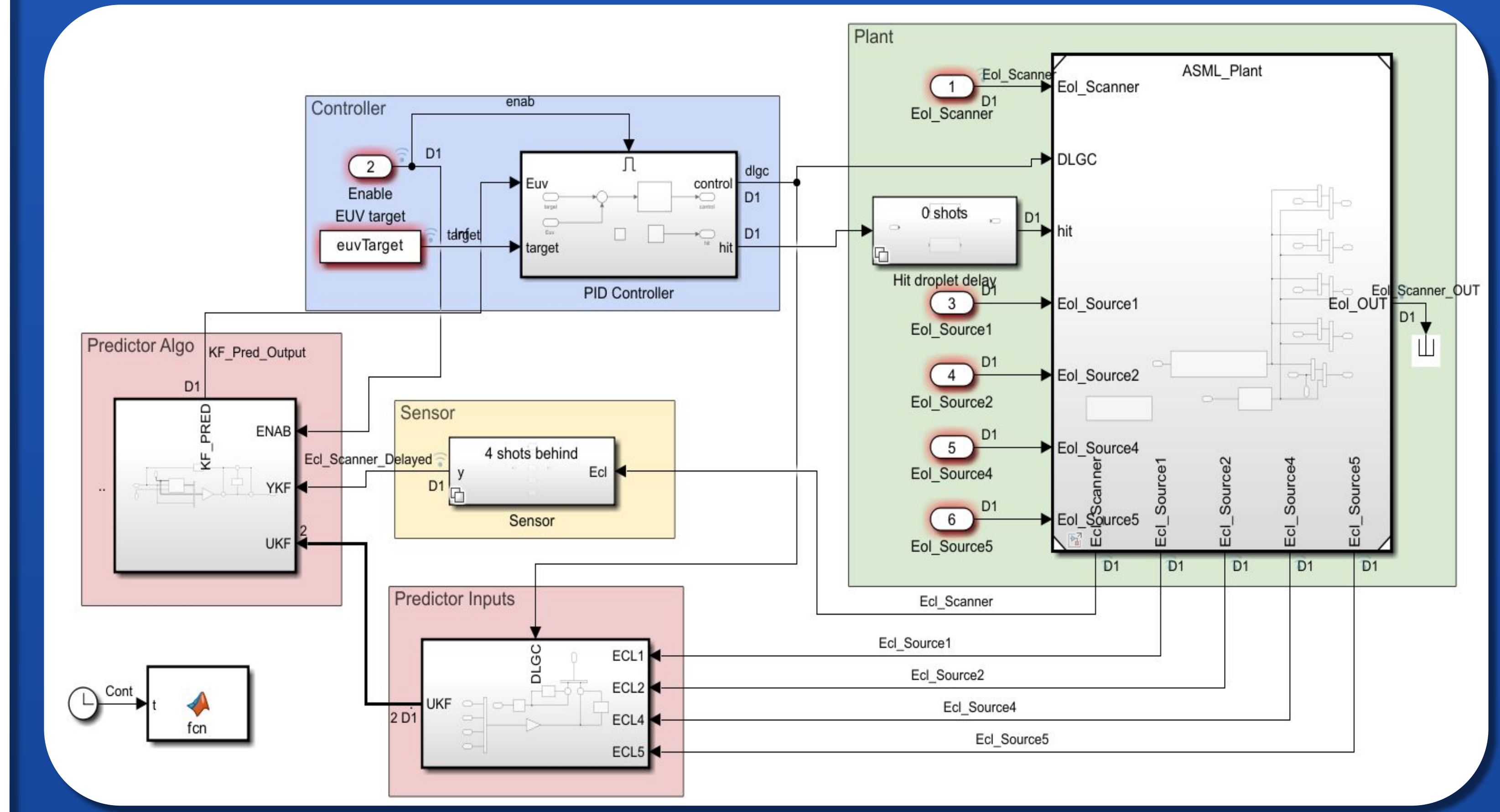
- Predictor algorithm succeeds in making closed-loop performance closer to the ideal case (Zero Shot).
- Disturbances attenuated in critical region (<1kHz) or pushed to higher frequencies.

PREDICTOR QUALITY



- Kalman Filter predictor estimate uses immediate source sensor data and is updated by the delayed scanner sensor data (blue).
- Predictor (orange) estimates current scanner energy before delayed scanner data (blue) is available.
- Our algorithm achieves a theoretical increase in throughput by 95.2%.

SIMULINK DIAGRAM



- SIMULINK process model expanded to include multiple EUV Source sensors, updated PID controller, sensor delay, and predictor algorithm.

Acknowledgements: We would like to thank Dr. Andrew Liu, Prof. Ilan Ben-Yaacov, Prof. Luke Theogarajan, Ray Chang, and ASML for their help and guidance with throughout this project.

UC SANTA BARBARA
College of Engineering