Instantaneous Flux Detector

Digital Twin Specification Sheet | Version 1.0 | DF-IFLX01

Specification identity

Twin Code:	`DF-IFLX01`
Twin Name:	Instantaneous Flux Detector
Twin Family:	Pulse and Time-Domain Detectors
Family Role:	Integrates instantaneous electromagnetic power flow over a rectangular detector area
Category:	Detector
Type:	Function-Based
Package:	Platform

1 Purpose

The **Instantaneous Flux Detector** evaluates the time-dependent optical power passing through a rectangular detector region. It combines time-domain pulse reconstruction with spatial integration of the normal component of the Poynting vector.

Its output is a temporal power curve $\Phi(t)$, making it the natural bridge between local instantaneous irradiance and total pulse energy.

2 Geometric Support

The flux is evaluated over a rectangular region defined by Start Point and End Point and sampled according to Number of Evaluations.

3 Supported Quantity

The detector outputs instantaneous flux

$$\Phi(t) = \iint_A \mathbf{S}(\boldsymbol{\rho}, t) \cdot \hat{\mathbf{n}}\, d^2\rho, \tag{1}$$

where $\mathbf{S} = \mathbf{E} \times \mathbf{H}$ is the instantaneous Poynting vector and $\hat{\mathbf{n}}$ is the detector-surface normal. The result has the interpretation of instantaneous optical power through the selected area.

4 Simulation Model

The detector reconstructs the time-domain electric and magnetic fields from their spectral representation, evaluates the instantaneous Poynting vector, and integrates its normal component spatially. The relationship to pulse energy is

$$E_{\text{pulse}} = \int_{-\infty}^{\infty} \Phi(t)\, dt. \tag{2}$$

Thus, the flux curve also provides a direct consistency link to the Pulse Energy Detector.

5 Parameters Where This Sheet Adds Guidance

Start Point / End Point

Role: Define the rectangular integration region.

Spec-sheet insight: The rectangle must cover the relevant beam cross-section. Spatial truncation directly reduces the reported flux.

Number of Evaluations

Role: Sets the spatial sampling of the detector area.

Spec-sheet insight: Increase it until the spatially integrated flux is stable.

Oversampling Factor

Role: Refines the temporal reconstruction.

Spec-sheet insight: Determine it by convergence of the temporal power curve rather than by a fixed universal value.

6 Recommended Usage

Use this twin when the relevant quantity is **instantaneous power through a finite detector area**.

Practical setup

1. Add `DF-IFLX01` at the observation plane.
2. Configure the Pulse Evaluation (Rectangle) region.
3. Make the rectangle large enough to contain the relevant pulse cross-section.
4. Choose spatial sampling and increase it until the integrated result is stable.
5. Increase Oversampling Factor until the temporal power curve converges.
6. Inspect $\Phi(t)$ for pulse shape and peak power.

7 Related Twins

Related twin	Main distinction
Instantaneous Irradiance Detector	Provides local power-flow density instead of area-integrated power.
Pulse Energy Detector	Integrates instantaneous flux over time.
Pulse Detector [Temporal]	Shows the temporal field itself.
Pulse Duration Detector	Reports pulse width rather than the full power curve.
Pulse Detector [Frequency]	Evaluates the spectral representation.

8 Possible Replacement Twins

Possible replacement twin	When it replaces this twin
Instantaneous Irradiance Detector	Use when spatially resolved local irradiance is required.
Pulse Energy Detector	Use when only the total energy of the pulse is needed.
Pulse Duration Detector	Use when only pulse width is needed.

9 Further Reading

- Use Case – Effects of Mirror Coating on Pulse Characteristics
- Use Case – Femtosecond Pulse Propagation through Dispersive Seawater
- Use Case – Pulse Broadening in Dispersive Media
- Use Case – Pulse Focusing with High-NA Lens