

High-speed data acquisition and optimal filtering based on programmable logic for single-photoelectron (SPE) measurement setup

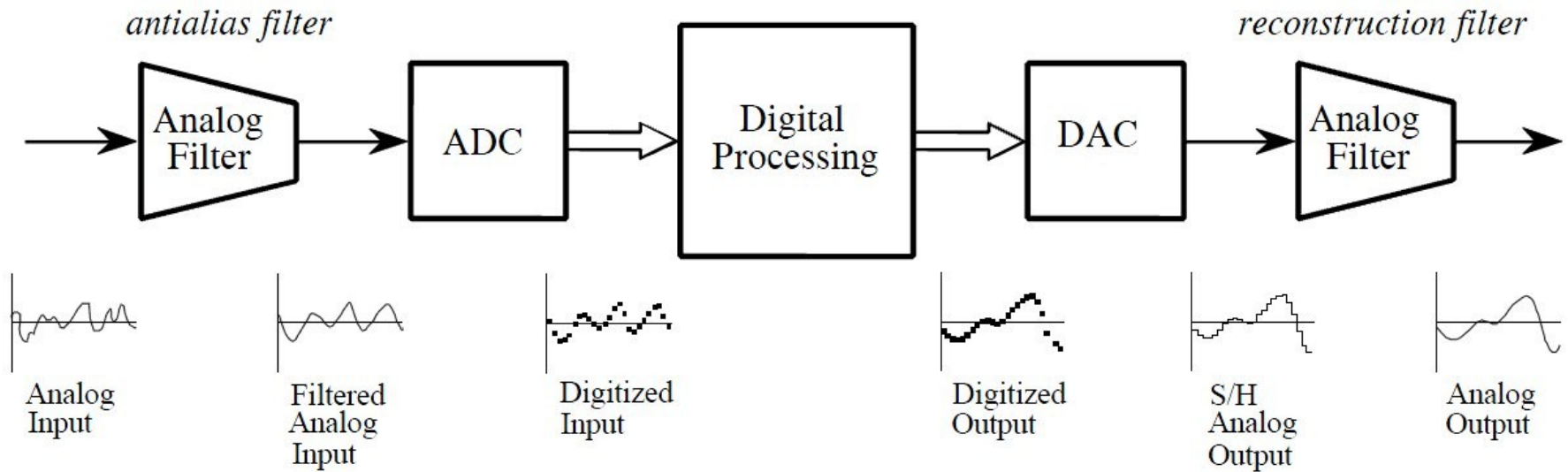
Experiment #7

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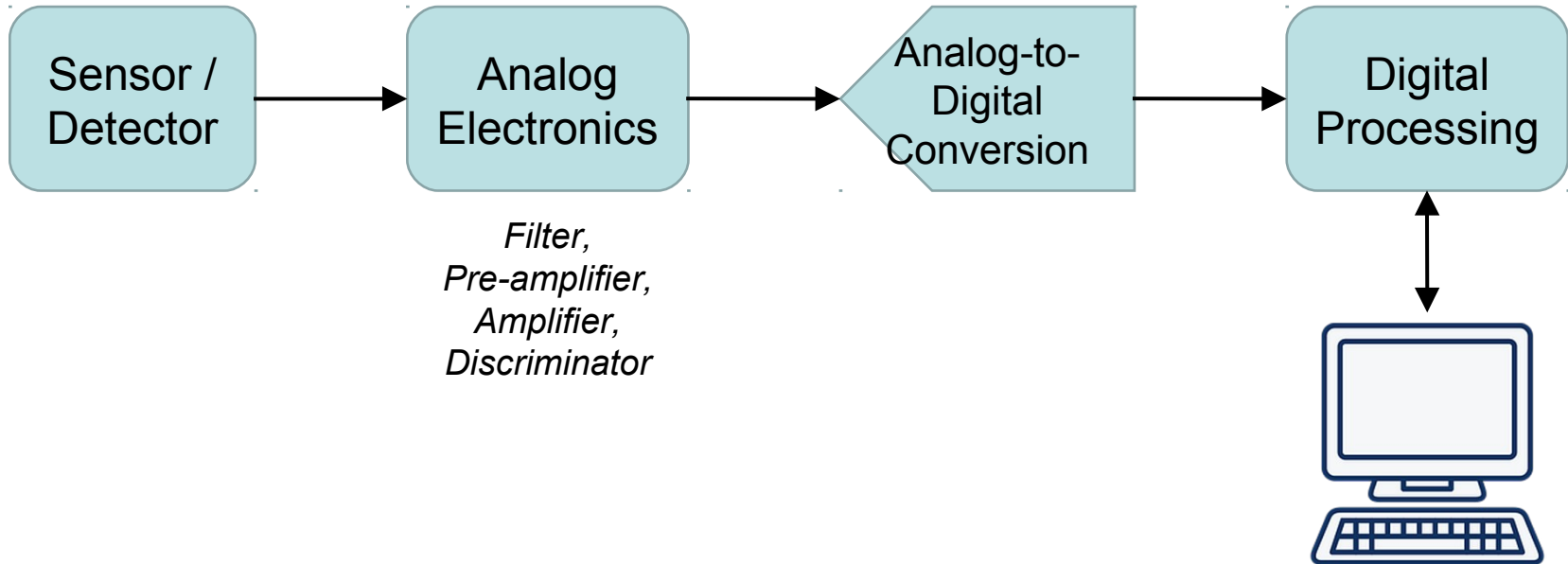
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Digital Signal Processing

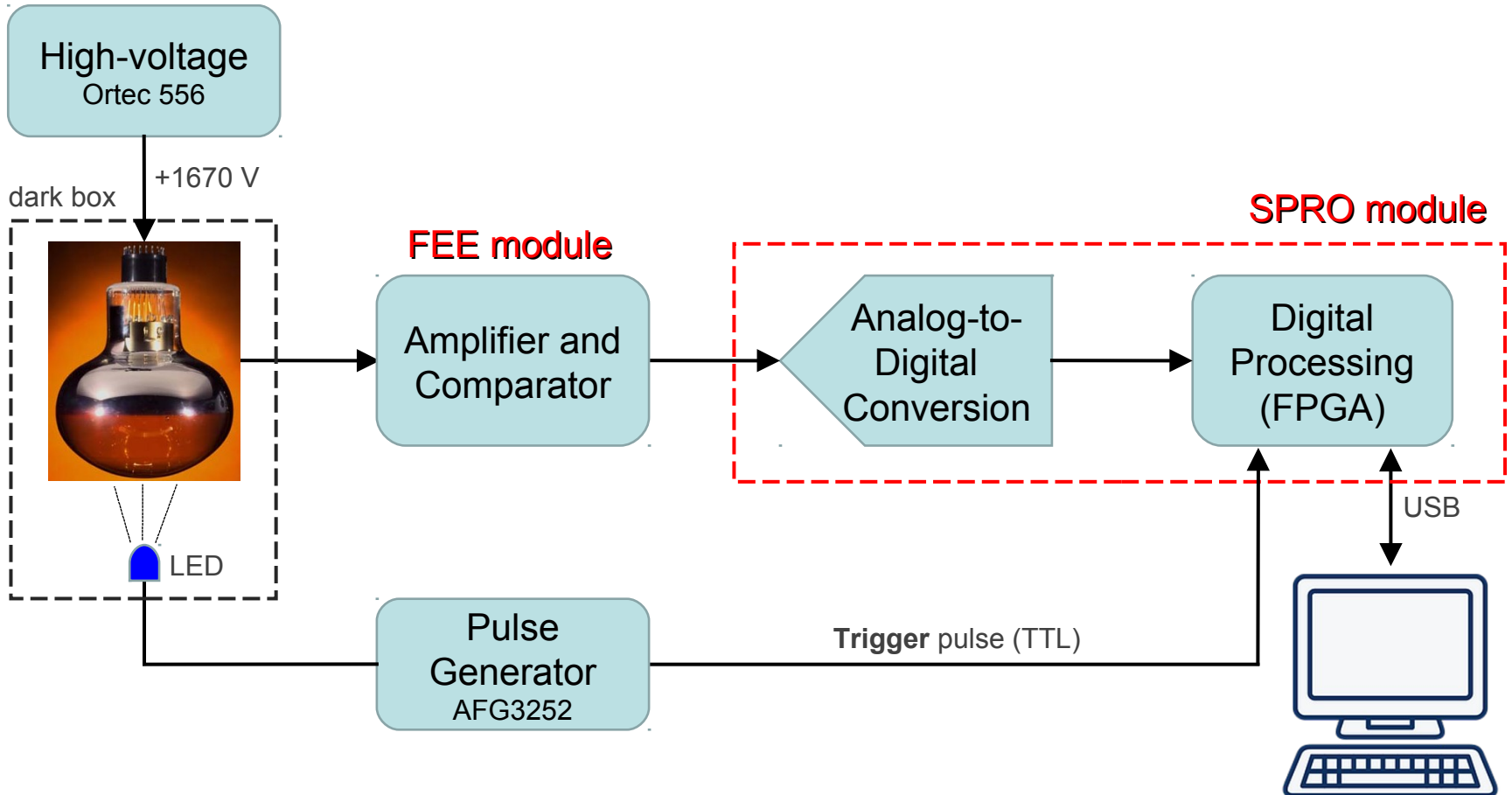


High-Speed Data Acquisition



The SPE measurement setup

SPE = Single Photoelectron



Photomultiplier Tube

Sensor

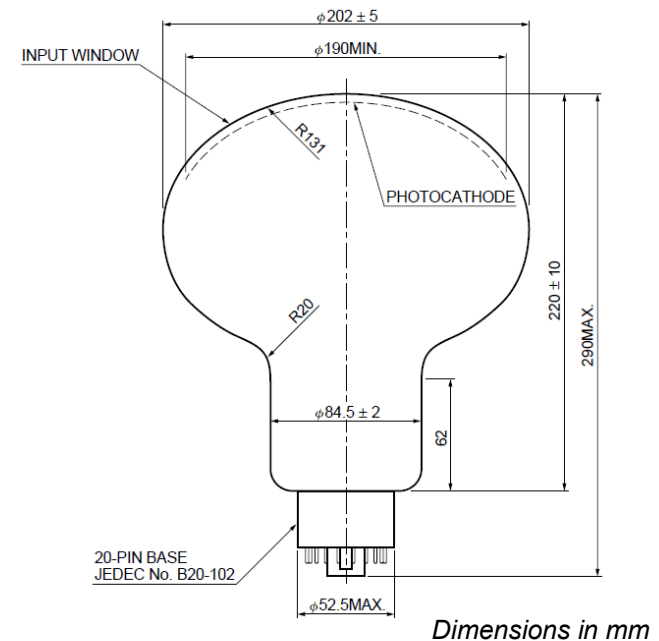
Photomultiplier Tube, model R5912, manufacturer Hamamatsu.

GENERAL

| Parameter | Description/Value | Unit |
|--|---------------------------|----------------|
| Spectral Response | 300 to 650 | nm |
| Wavelength of Maximum Response | 420 | nm |
| Photocathode | Material | Bialkali |
| | Effective Area | 530 (Min. 450) |
| Window Material | Borosilicate glass | — |
| Dynode | Structure | Box and Line |
| | Number of Stages | 10 |
| Direct Interelectrode Capacitances (Approx.) | Anode to Last Dynode | 3 pF |
| | Anode to All Other Dynode | 7 pF |
| Base | 20-pin base JEDEC B20-102 | |
| Weight | Approx. 720 | |
| Suitable Socket | E678-20A (supplied) | |

CHARACTERISTICS (at 25°C)

| Parameter | Min. | Typ. | Max. | Unit |
|---|--|-----------------------|------|---------|
| Cathode Sensitivity | Luminous (2856K) | 70 | — | μA/lm |
| | Radiant at 420nm | 72 | — | mA/W |
| | Blue (CS 5-58 filter) | 9.0 | — | μA/lm-b |
| | Quantum Efficiency at 390nm | 22 | — | % |
| Anode Sensitivity ¹⁾ | Luminous (2856K) | 700 | — | A/lm |
| | Radiant at 420nm | 7.2 × 10 ⁵ | — | A/W |
| Gain ¹⁾ | — | 1.0 × 10 ⁷ | — | — |
| Supply Voltage for Gain of 10 ⁷ | — | 1500 | 1800 | V |
| Anode Dark Current (after 30min. storage in darkness) ¹⁾ | — | 50 | 700 | nA |
| Dark Count (after dark condition for 15 hours) ¹⁾ | — | 4 | 8 | kcps |
| Time Response ¹⁾ | Anode Pulse Rise Time | — | 3.8 | ns |
| | Electron Transit Time | — | 55 | ns |
| | Transit Time Spread (FWHM) ³⁾ | — | 2.4 | ns |
| Pre Pulse ⁴⁾ | 4ns to 20ns before Main pulse | — | 0.5 | % |
| Late Pulse ³⁾ | 8ns to 60ns after Main pulse | — | 1.5 | % |
| After Pulse ³⁾ | 100ns to 16μns after Main pulse | — | 2 | % |
| Single Photoelectron | PHD (Peak to Valley Ratio) | — | 2.5 | — |
| Pulse Linearity ²⁾ | at ±2% Deviation | — | 60 | mA |
| | at ±5% Deviation | — | 80 | mA |
| Magnetic characteristics (at 200mG/20μT) | Sensitivity Degradation | — | 10 | % |

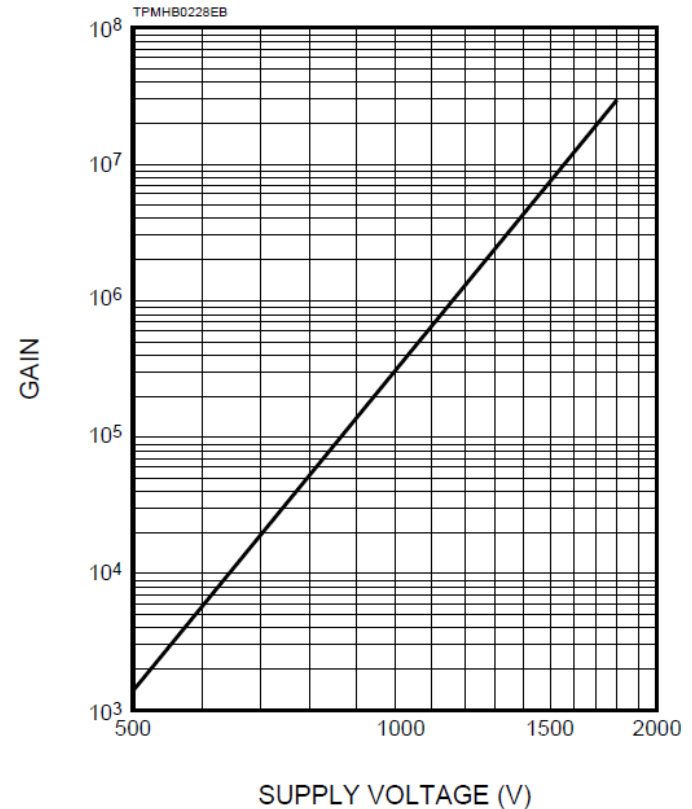
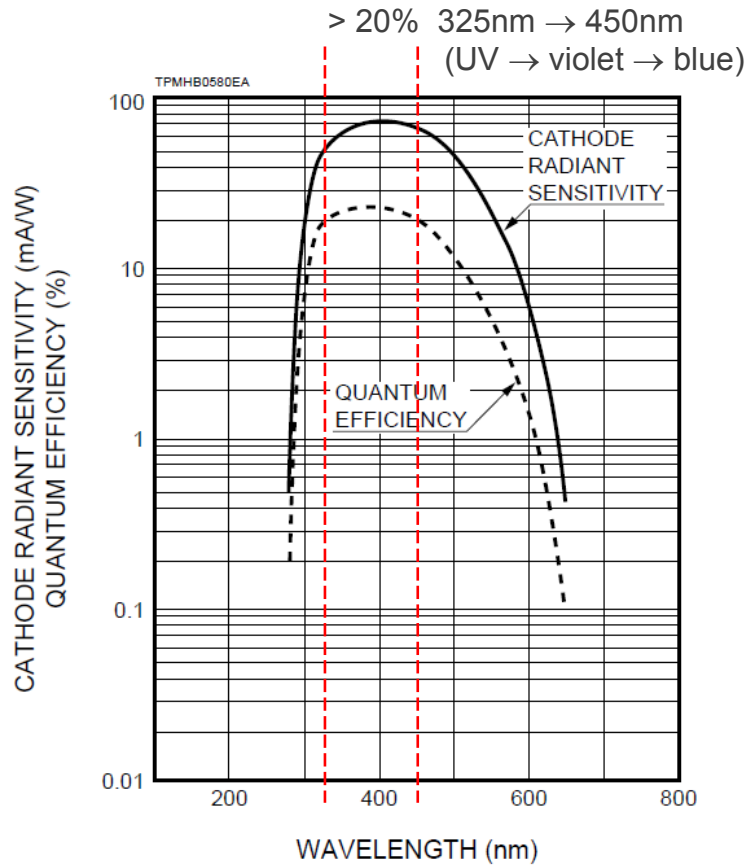


Photomultiplier Tube

Sensor

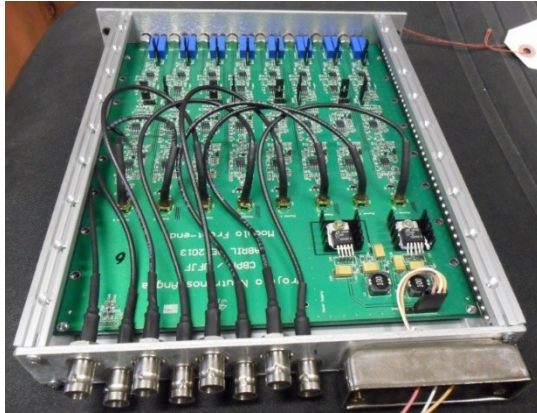
Photomultiplier Tube, model R5912, manufacturer Hamamatsu.

| | | | | |
|---|--------|---------|--------|--------|
| Ultraviolet visible Near Infrared | Violet | 700 THz | 430 nm | 2.9 eV |
| | Blue | 640 THz | 470 nm | 2.7 eV |
| | Green | 580 THz | 520 nm | 2.4 eV |
| | Yellow | 530 THz | 570 nm | 2.2 eV |
| | Orange | 500 THz | 600 nm | 2.1 eV |
| | Red | 460 THz | 650 nm | 1.9 eV |



Custom Electronics

FEE module (amplifier)



- Power Supply: **+/- 6 Vdc**
- Dynamic range: **2.8 Vpp**
- Bandwidth: **10 MHz**
- Gain: **~ 8**

SPRO module (DAQ)



- Power Supply: **+ 6 Vdc**
- Input impedance: **50 Ω**
- Dynamic range: **2.0 Vpp**
- ADC sampling rate: **125 MSPS**
- ADC resolution: **8 bits**
- Intel Cyclone FPGA: **EP2C20Q240C6**
- Communication interface: **USB 1.1**