Modified Allard Method (MAM)

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Overview

- Introduction
- Definitions
- Methods of determining effective intensity
- Convolution method
- Examples

Introduction

As soon as AtoN lights at sea were flashed, the question was raised,

"how well can we see a flash of light compared to a continuous light?"

The term "effective intensity" was conceived and various models were applied to data from flash measurements.

Definition - Effective Intensity

IALA 1977

Effective Intensity is defined by the equivalence of fixed and flashing lights at threshold levels. Levels above threshold are not considered.

CIE

The **effective intensity** (of a flashing light) is the luminous intensity of a fixed (steady) light, of the same relative spectral distribution as the flashing light, which would have the same luminous range as the flashing light under identical conditions of observation.

Definition - Range

IALA E-200

In the case of a light that appears as a point source, the **luminous range D** is defined as the maximum distance at which a light can be seen, as determined by the luminous intensity I of the light, the meteorological visibility V and the threshold of illuminance E_t at the eye of the observer. At this distance, the illuminance E at the observer's eye is reduced to the threshold value E_t.

CIE (proposed)

Luminous range is the maximum distance at which a point source of light can be detected achromatically.

Definition - Visibility

IALA 1977

Meteorological visibility is the greatest distance at which a black object of suitable dimensions can be seen and recognized by day against the horizon sky, or, in the case of night observations, could be seen and recognized if the general illumination were raised to daylight level.

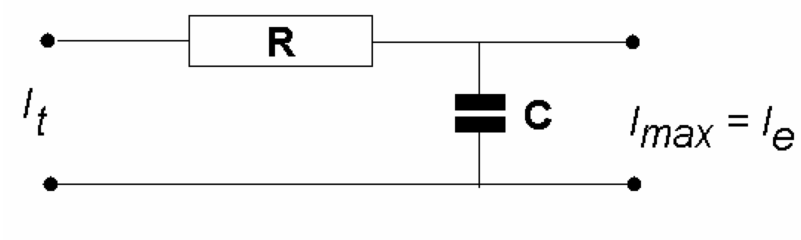
Methods of Determining Effective Intensity

- Allard 1876
- Blondel and Rey 1912
- Blondel-Rey-Douglas 1957
- Schmidt-Clausen 1967
- Convolution (modified Allard) 1960 - 2007

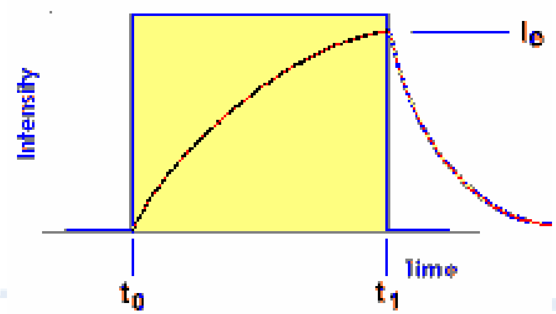
Allard 1876

$$I_e = \max_{t_0 < t \le t_1} \left(\int_{t_0}^{t} I(u) \frac{\exp((u - t)/a)}{a} du \right)$$

Where *a* is the visual time constant (0.2 seconds)



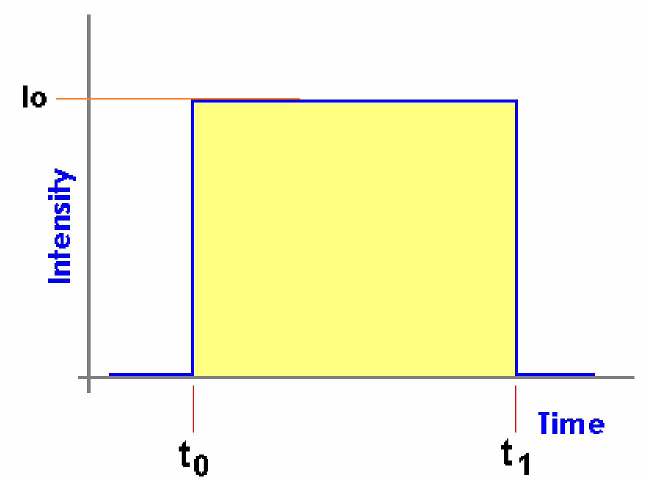
Where *RC* is the time constant = *a* (0.2 seconds)



Blondel-Rey 1912

$$I_e = \frac{I_0 \left(t_1 - t_0\right)}{a + \left(t_1 - t_0\right)}$$

Where *a* is the visual time constant (0.21 seconds for dark conditions)

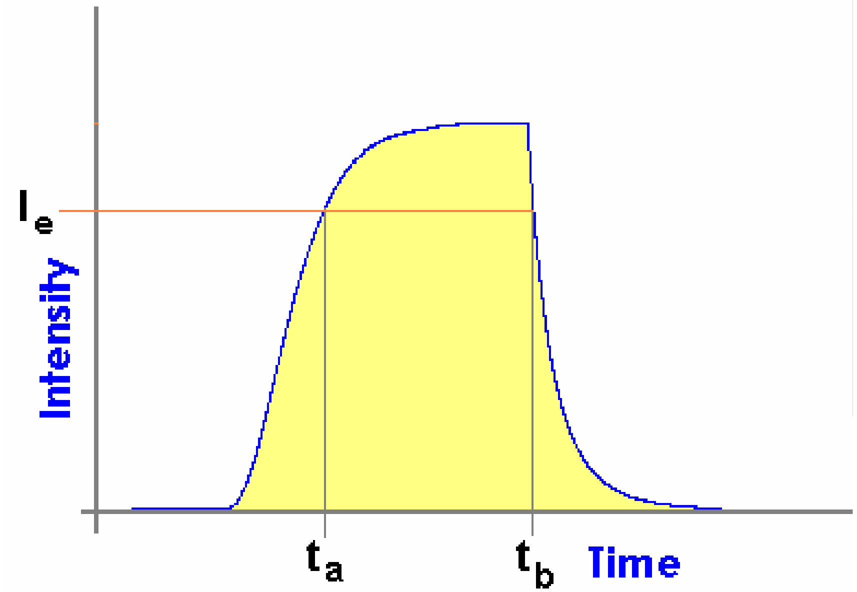


Blondel-Rey-Douglas 1957

$$I_e = \max_{t_a, t_b} \left(\frac{\int_{t_a}^{t_b} I(u)\, du}{a + (t_b - t_a)} \right)$$

Where *a* is the visual time constant (0.2 seconds for dark conditions)

with t_a and t_b such that $I(t_a) = I(t_b) = I_e$

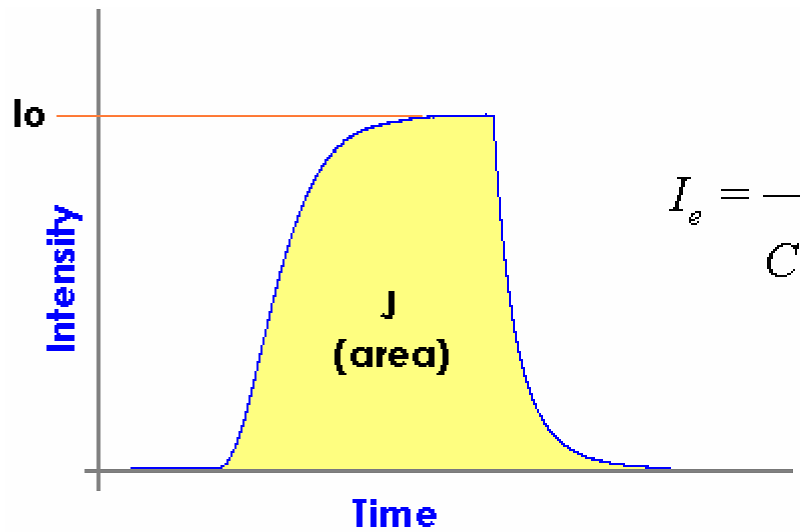


Schmidt-Clausen 1967

$$I_e = \frac{\int_{t_0}^{t_1} I(u)\,du}{\left(a + \frac{\int_{t_0}^{t_1} I(u)\,du}{\max\limits_{t_0 \le t \le t_1}(I(t))} \right)}$$

t_0 and t_1 encompass the whole flash, as measured

Where *C* is the visual time constant (0.2 seconds for dark conditions)



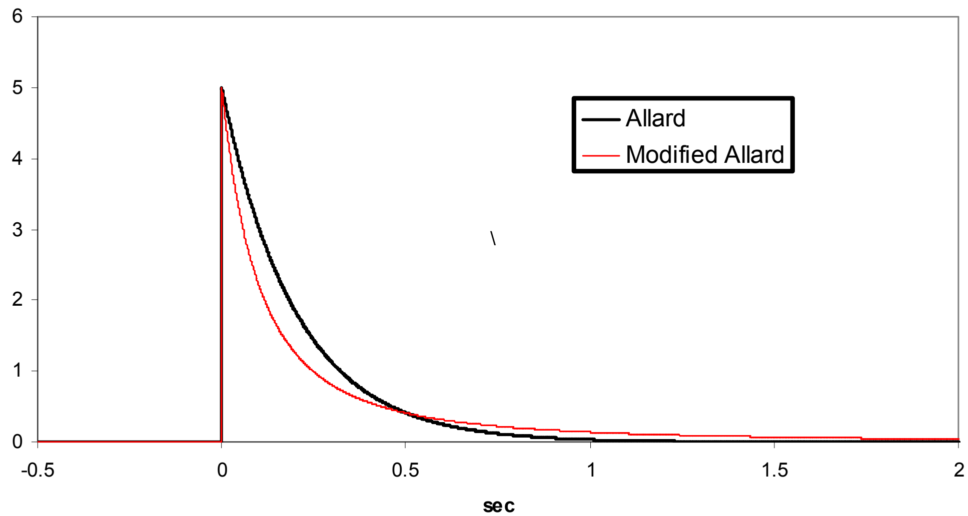
$$I_e = \frac{J}{C + \frac{J}{I_0}}$$

Convolution (modified Allard)

$$I_e = \max_{t_0 < t \le t_1} \left(\int_{t_0}^{t} I(u) \frac{a}{(a + t - u)^2} du \right)$$

Where *a* is the visual time constant (0.2 seconds for dark conditions)

Allard's $\frac{e^{-t/a}}{a}$ function replaced with $\frac{a}{(a + t)^2}$

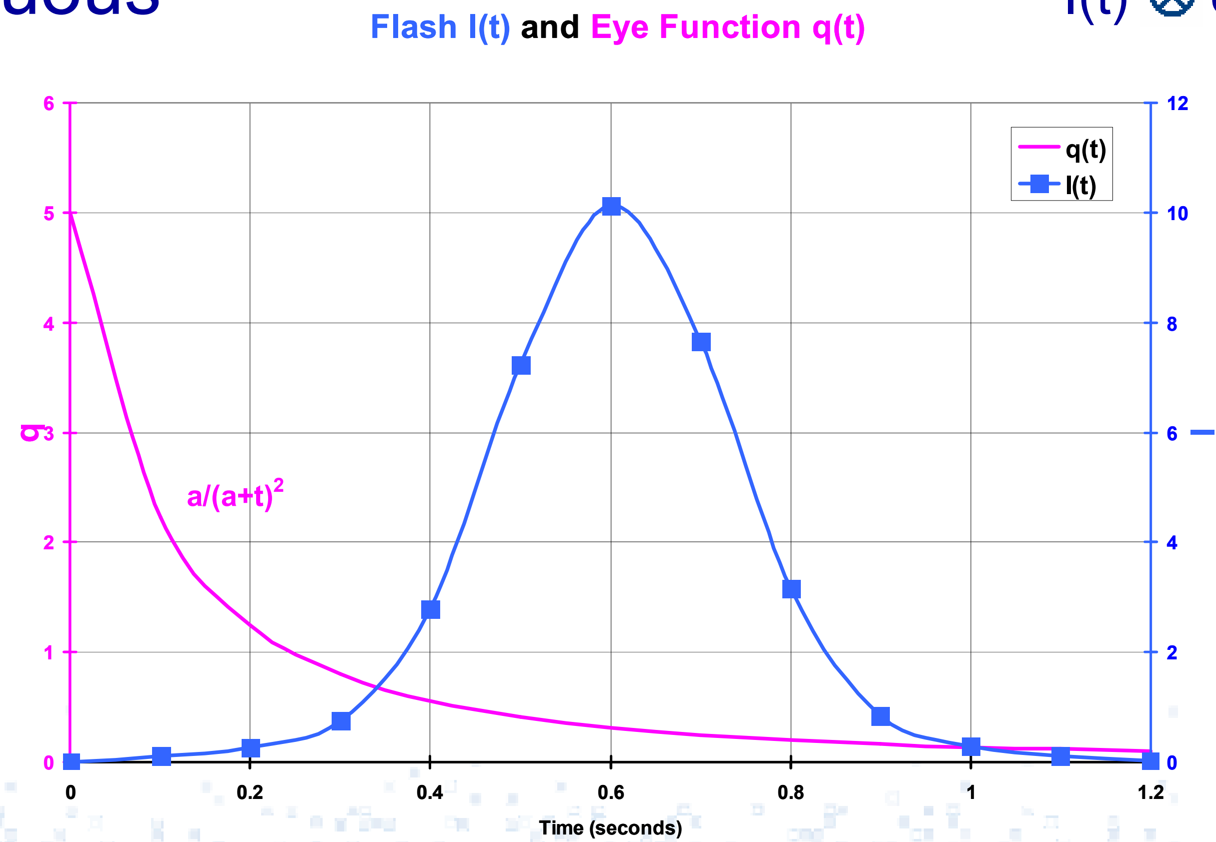


For a = 0.2 seconds

Convolution

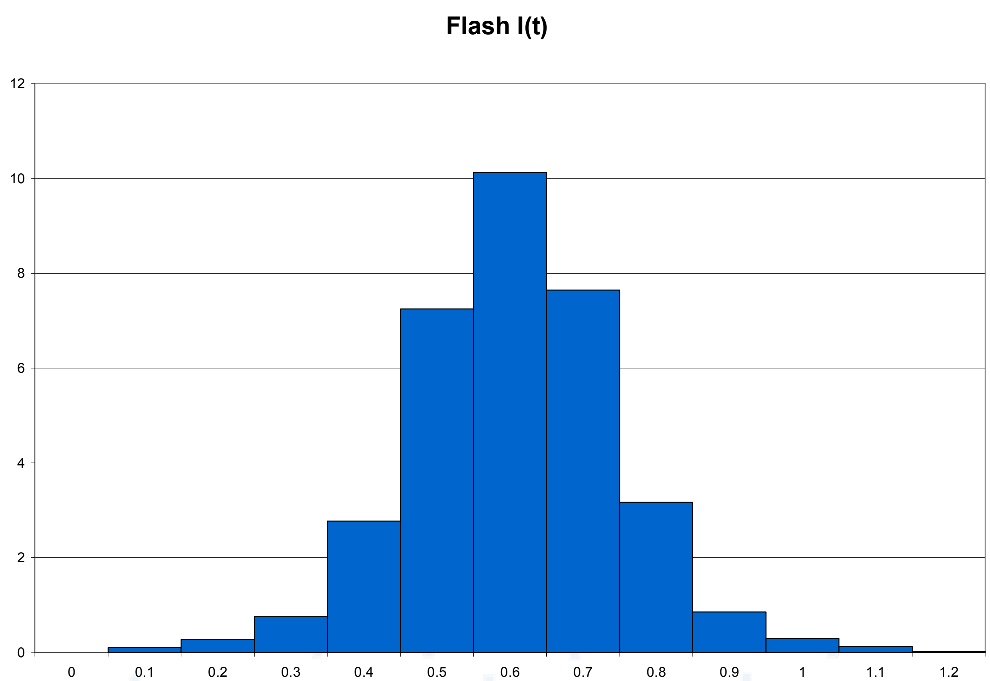
Continuous

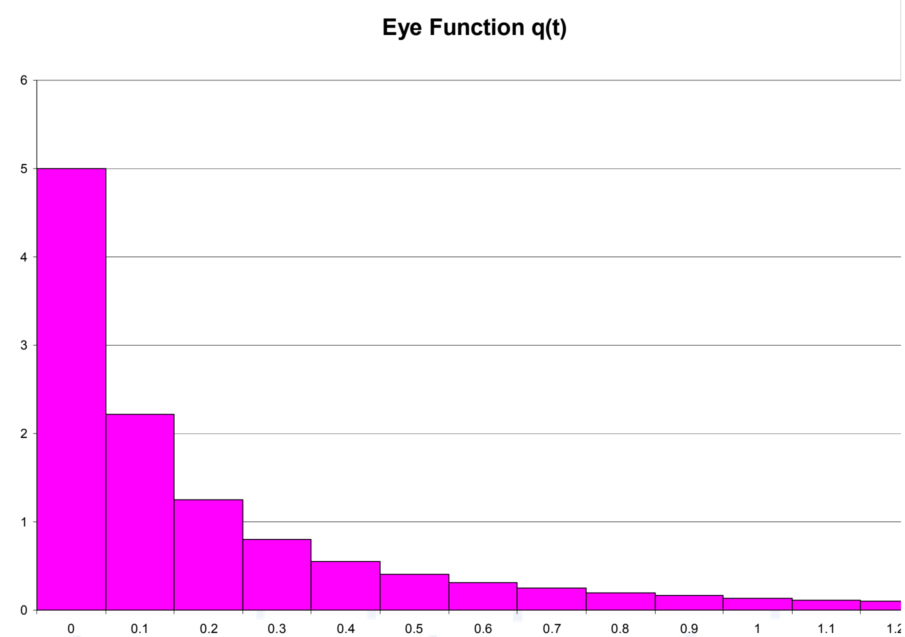
$I(t) \otimes q(t)$



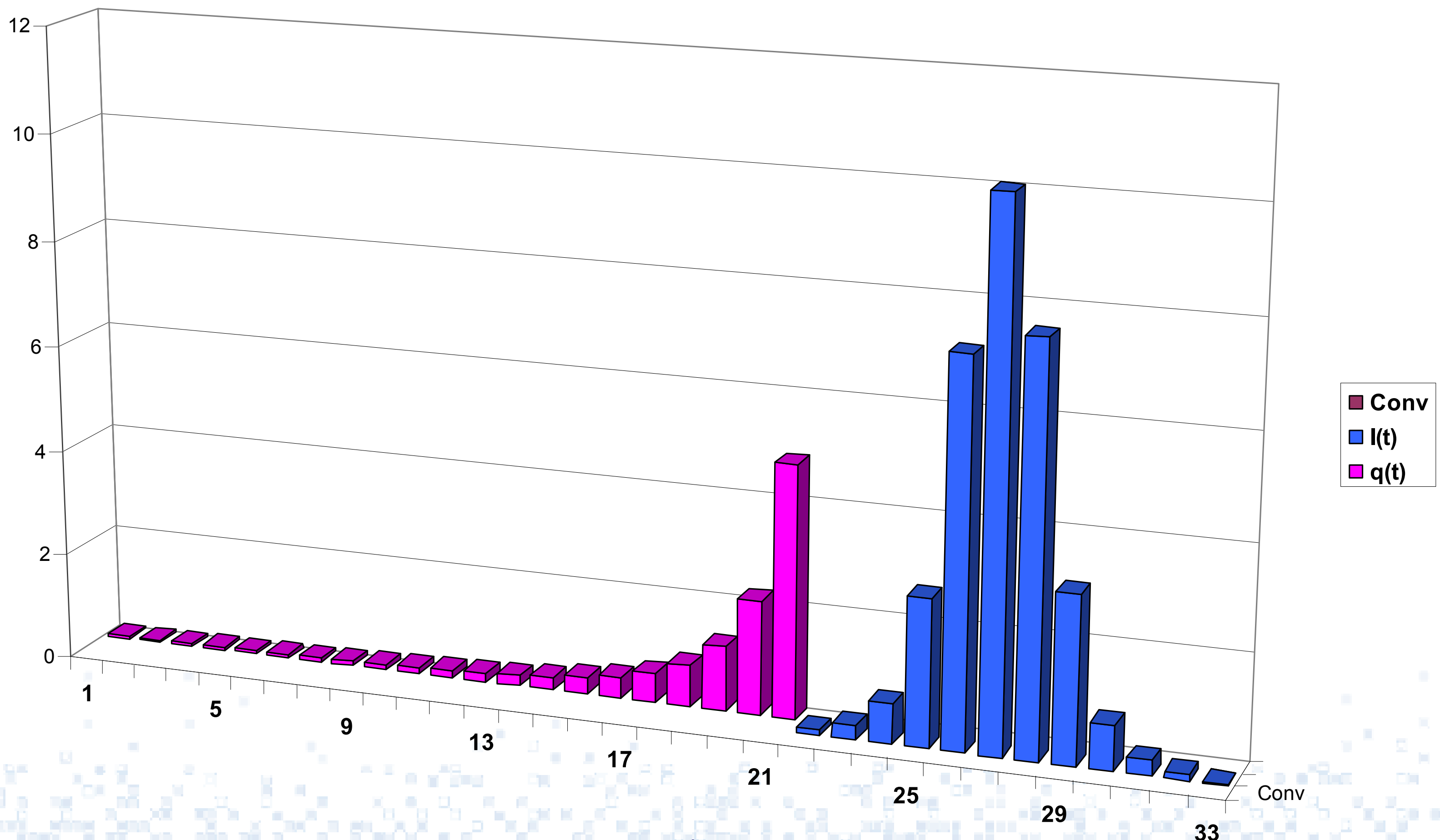
Convolution

Discrete

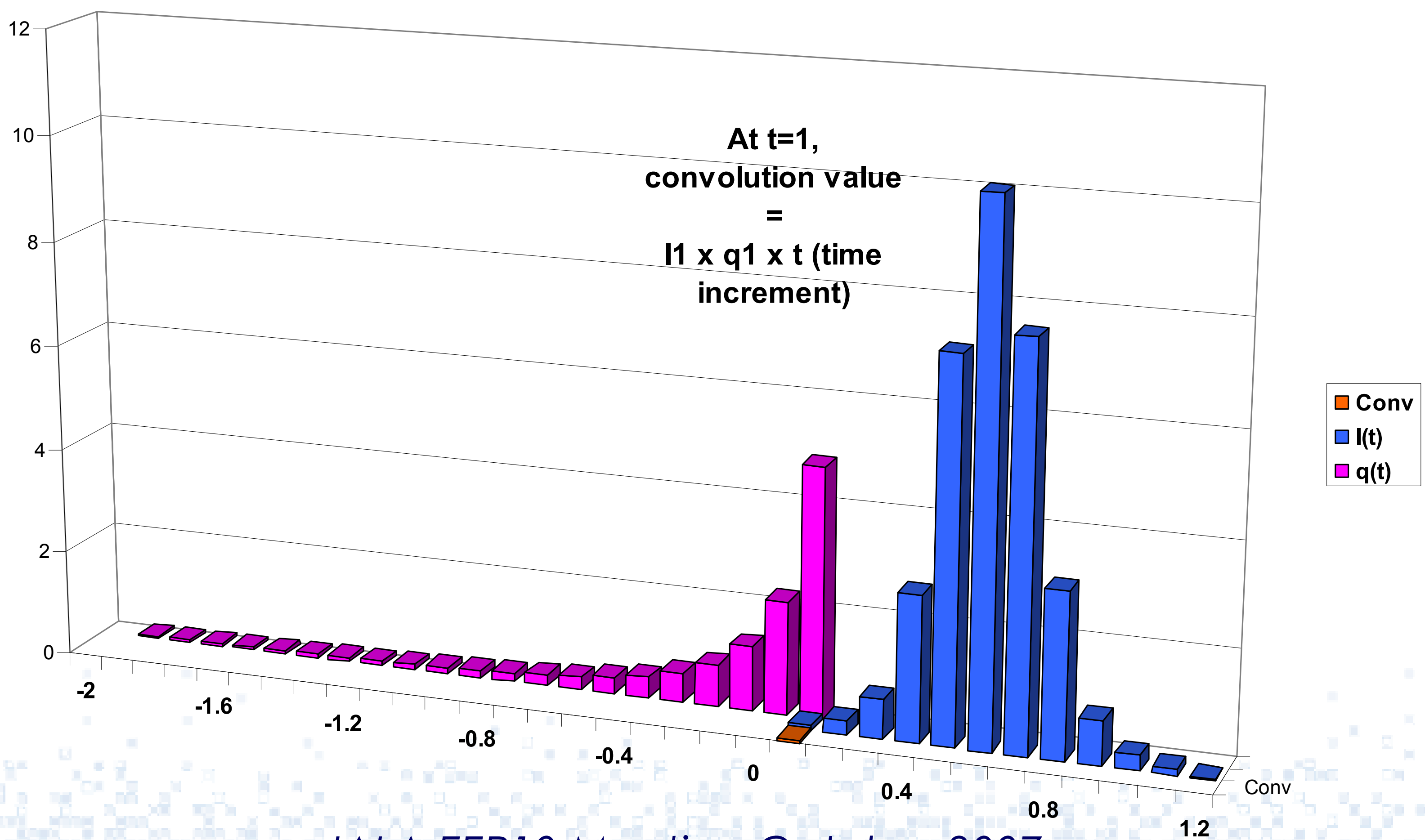




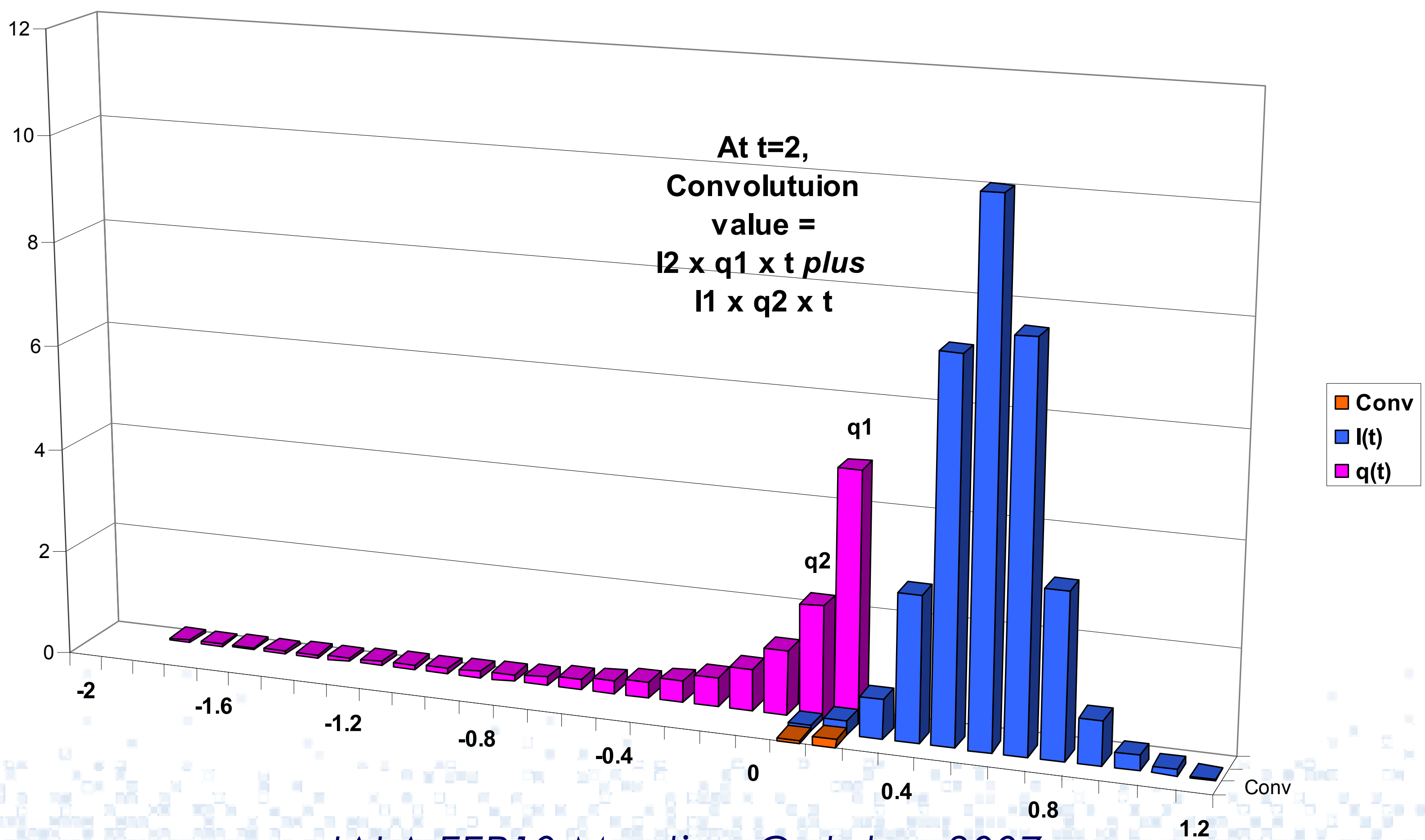
Convolution at t = 0



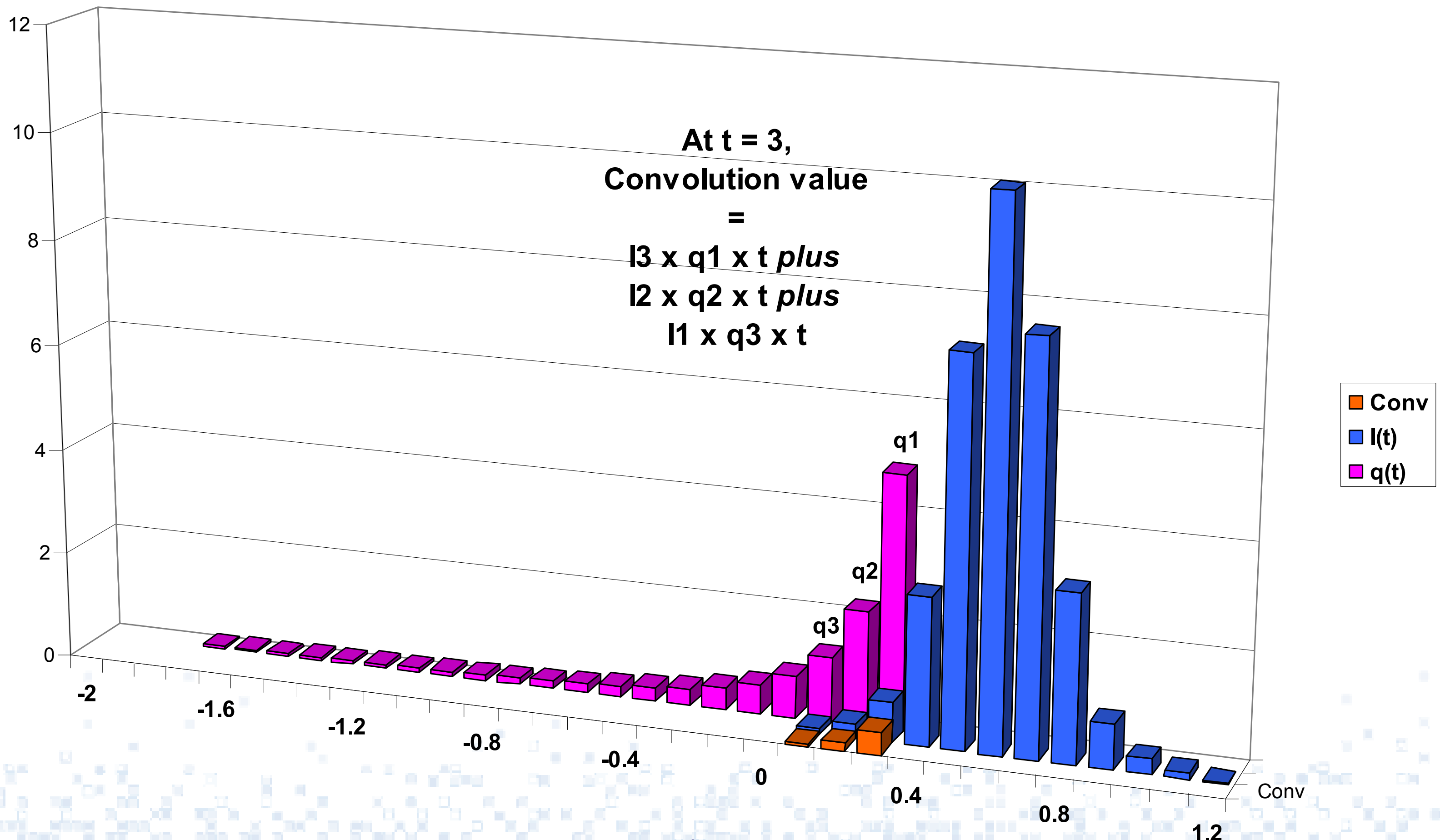
Convolution at t = 1



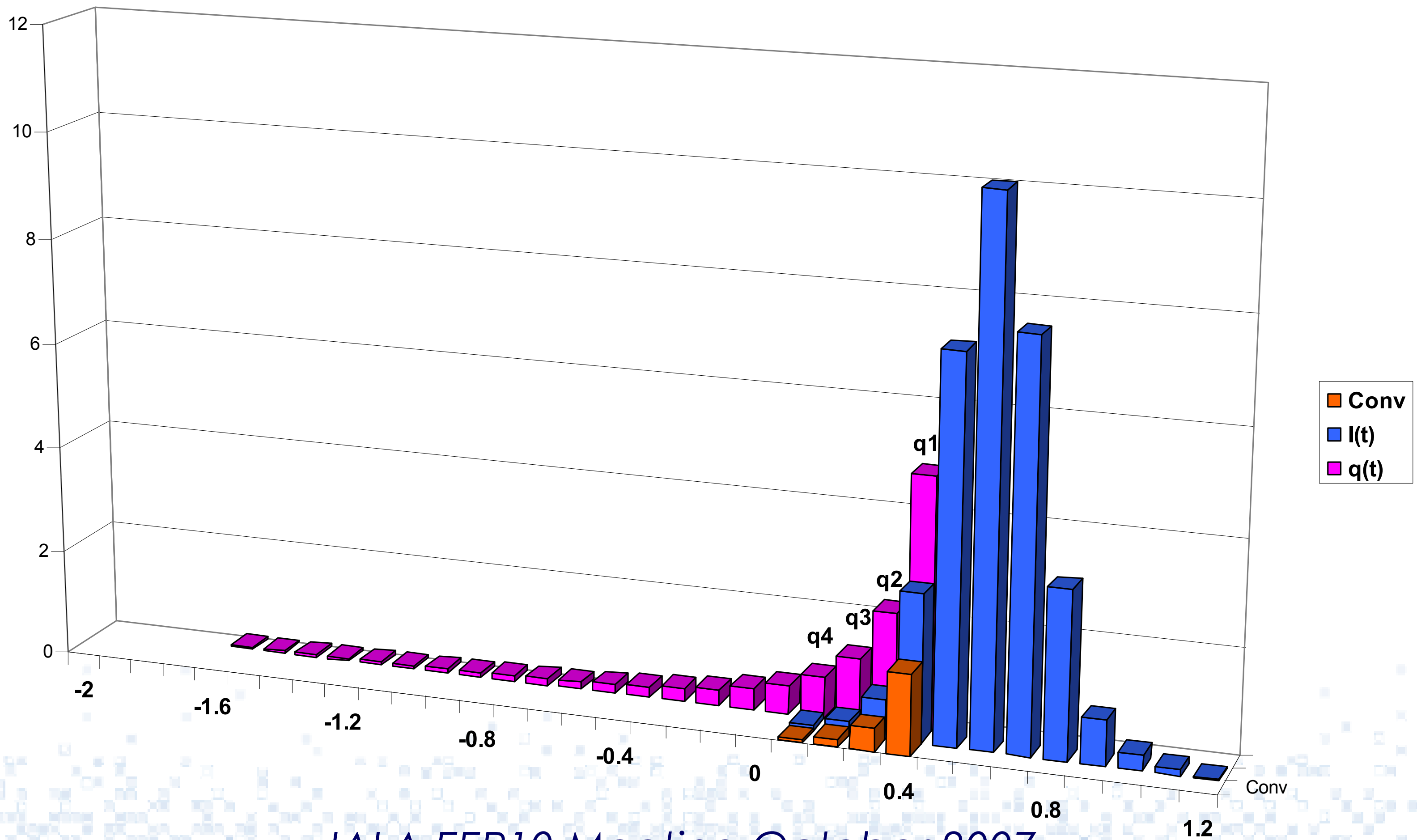
Convolution at t = 2



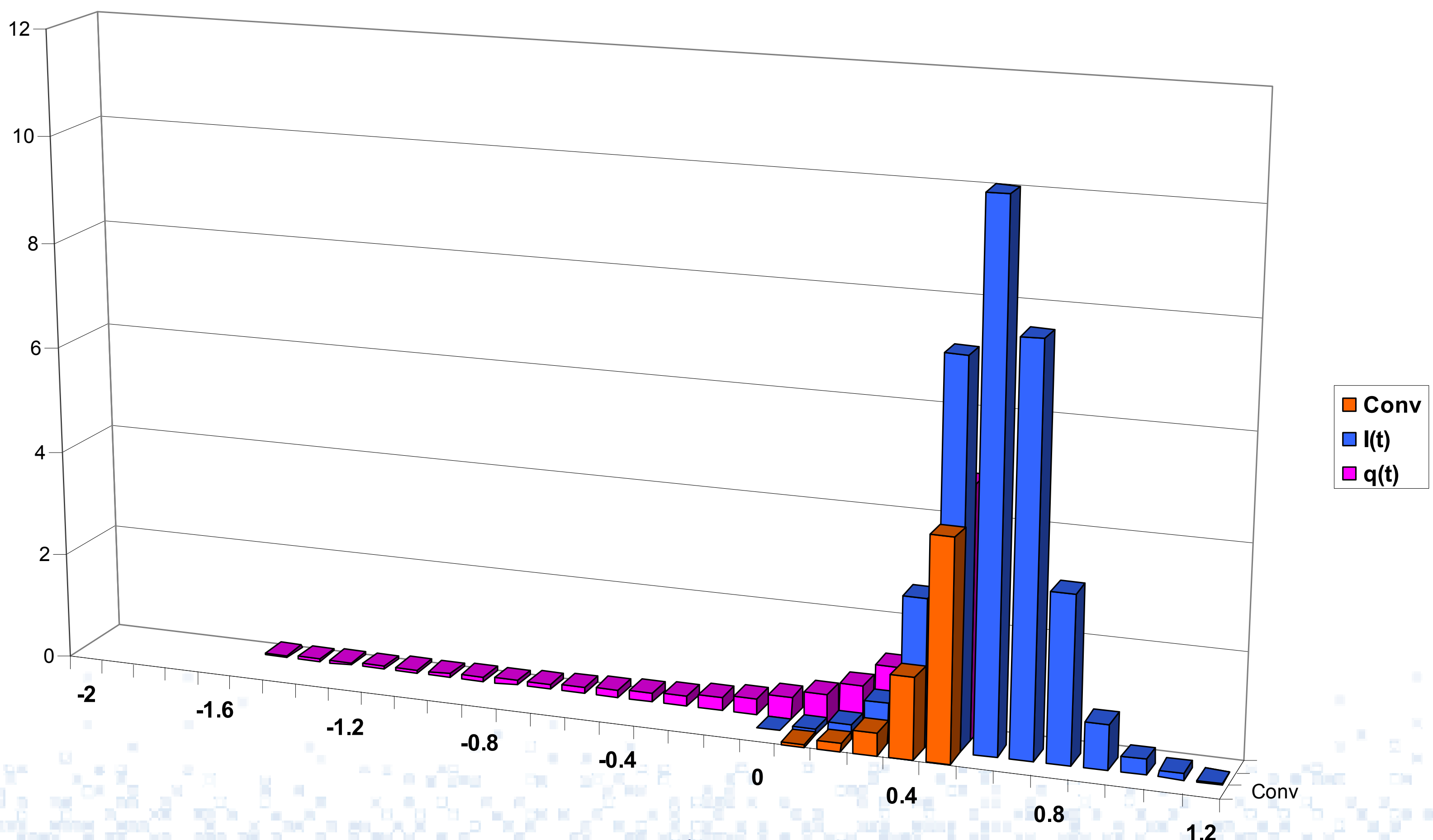
Convolution at t = 3



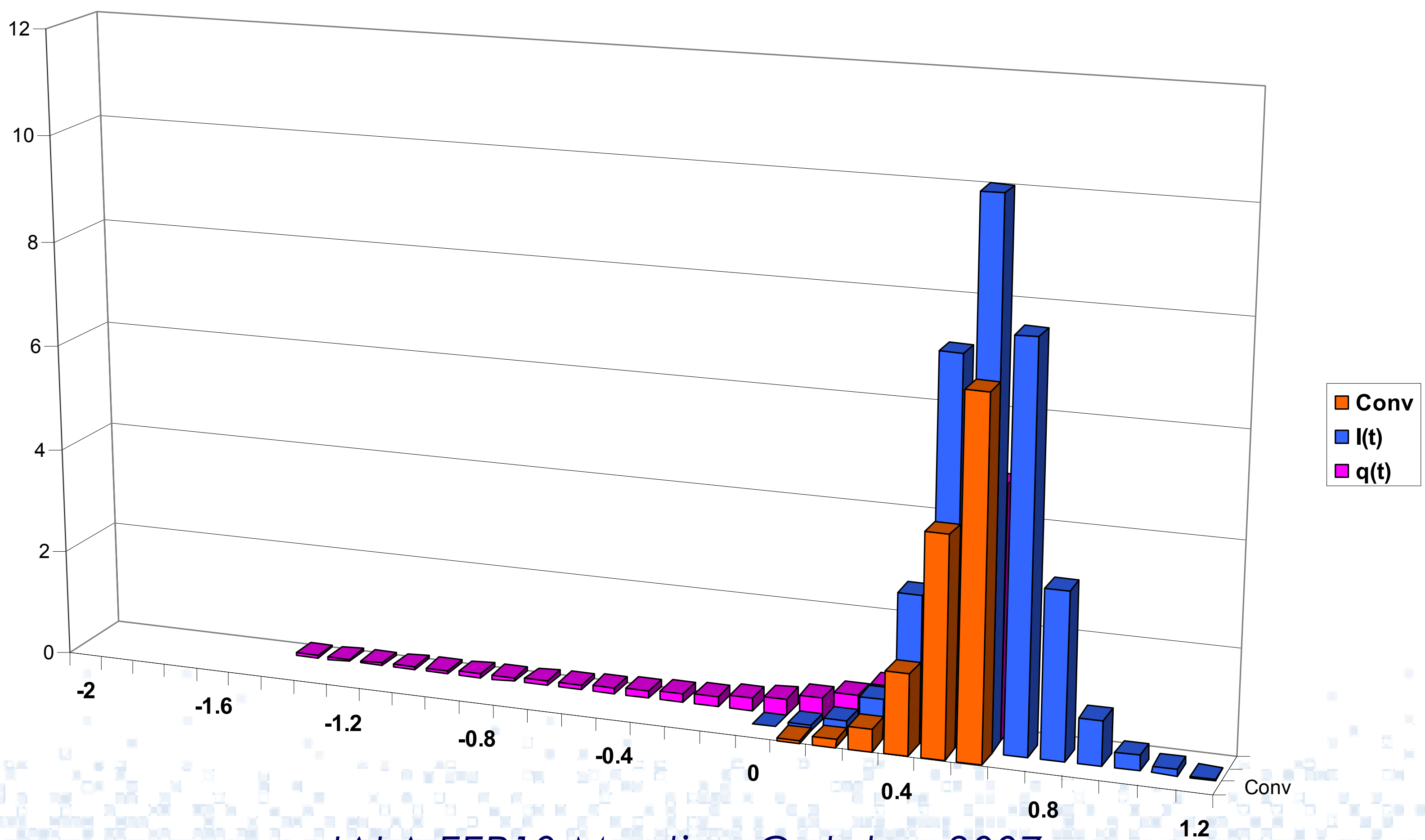
Convolution at t = 4



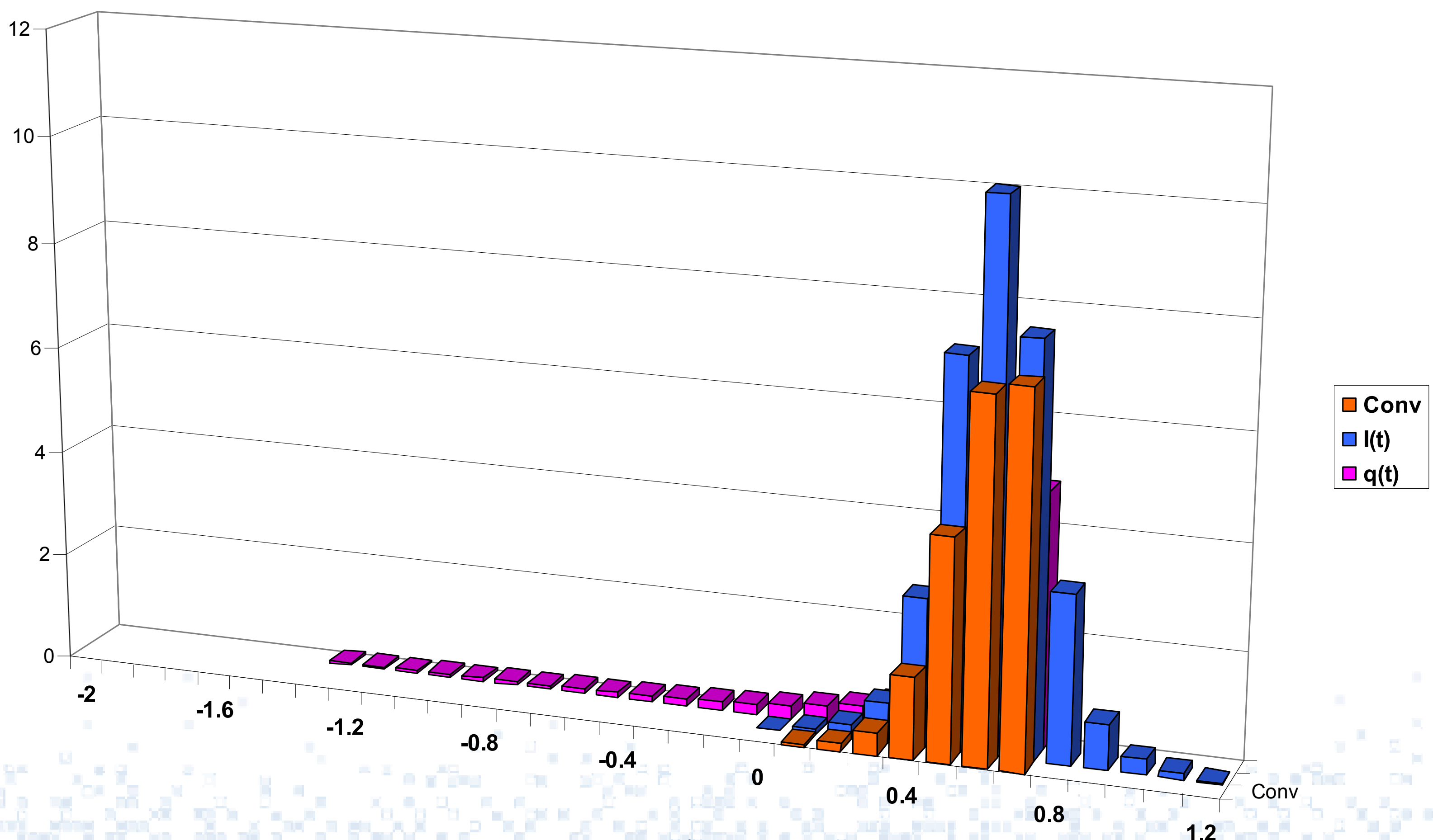
Convolution at t = 5



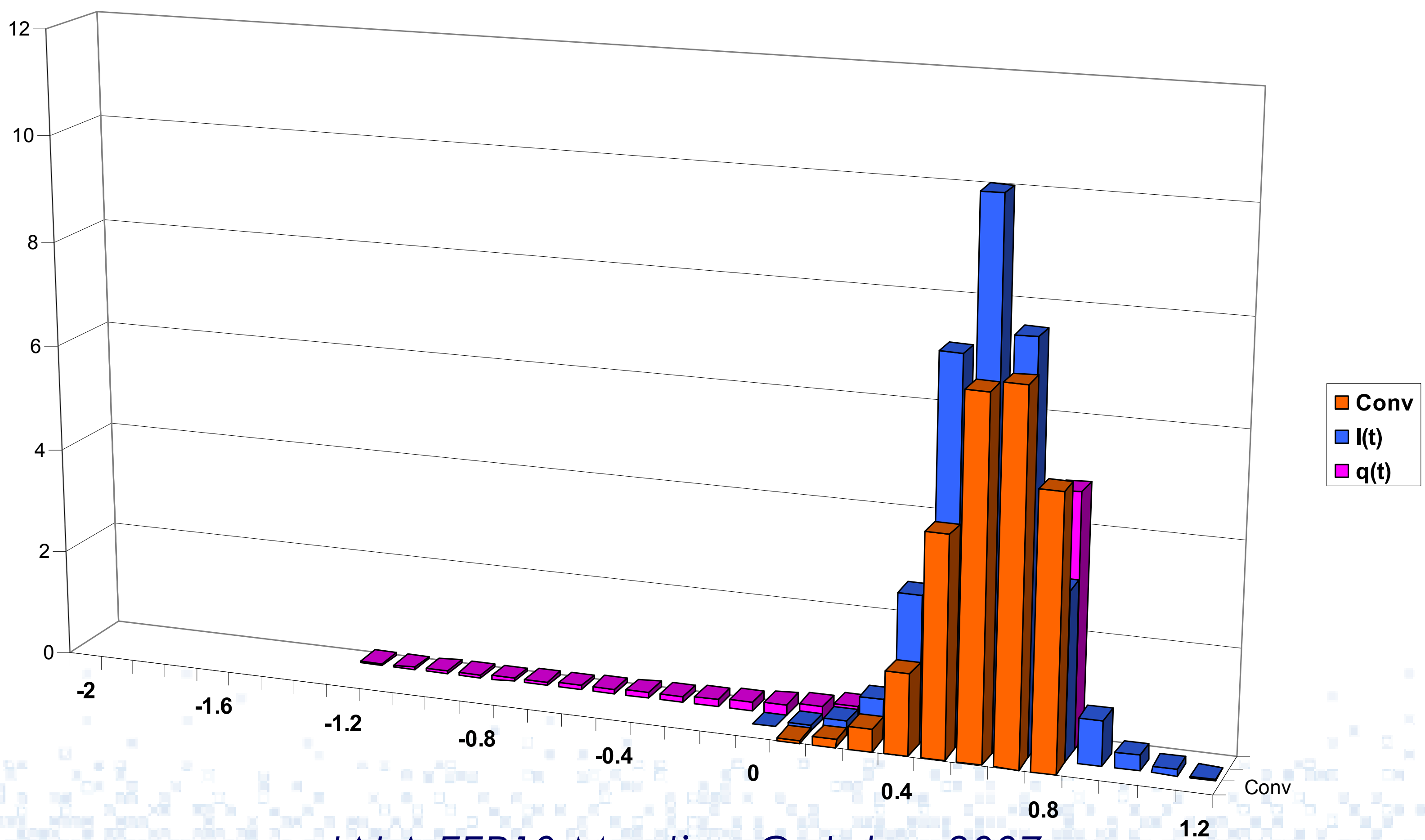
Convolution at t = 6



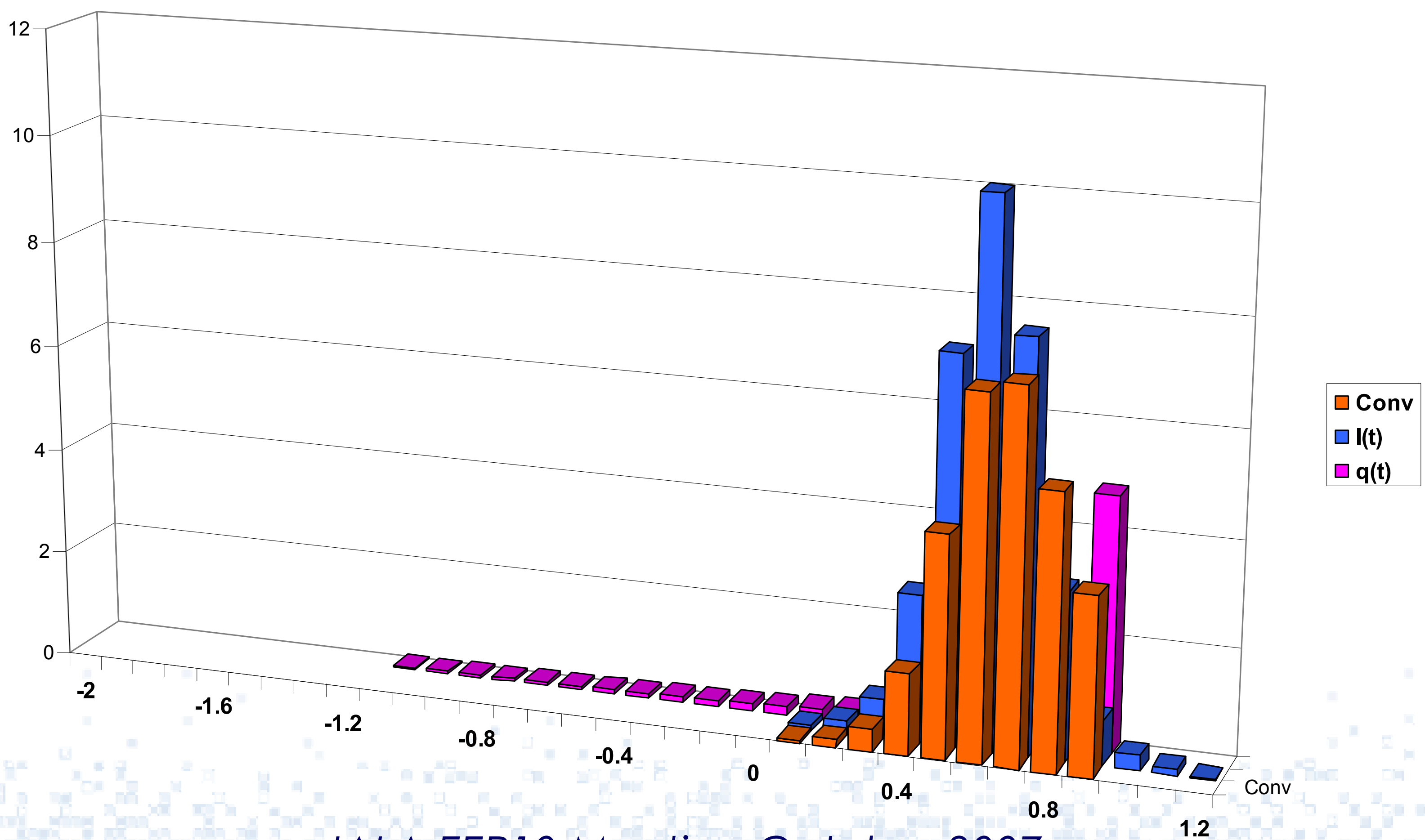
Convolution at t = 7



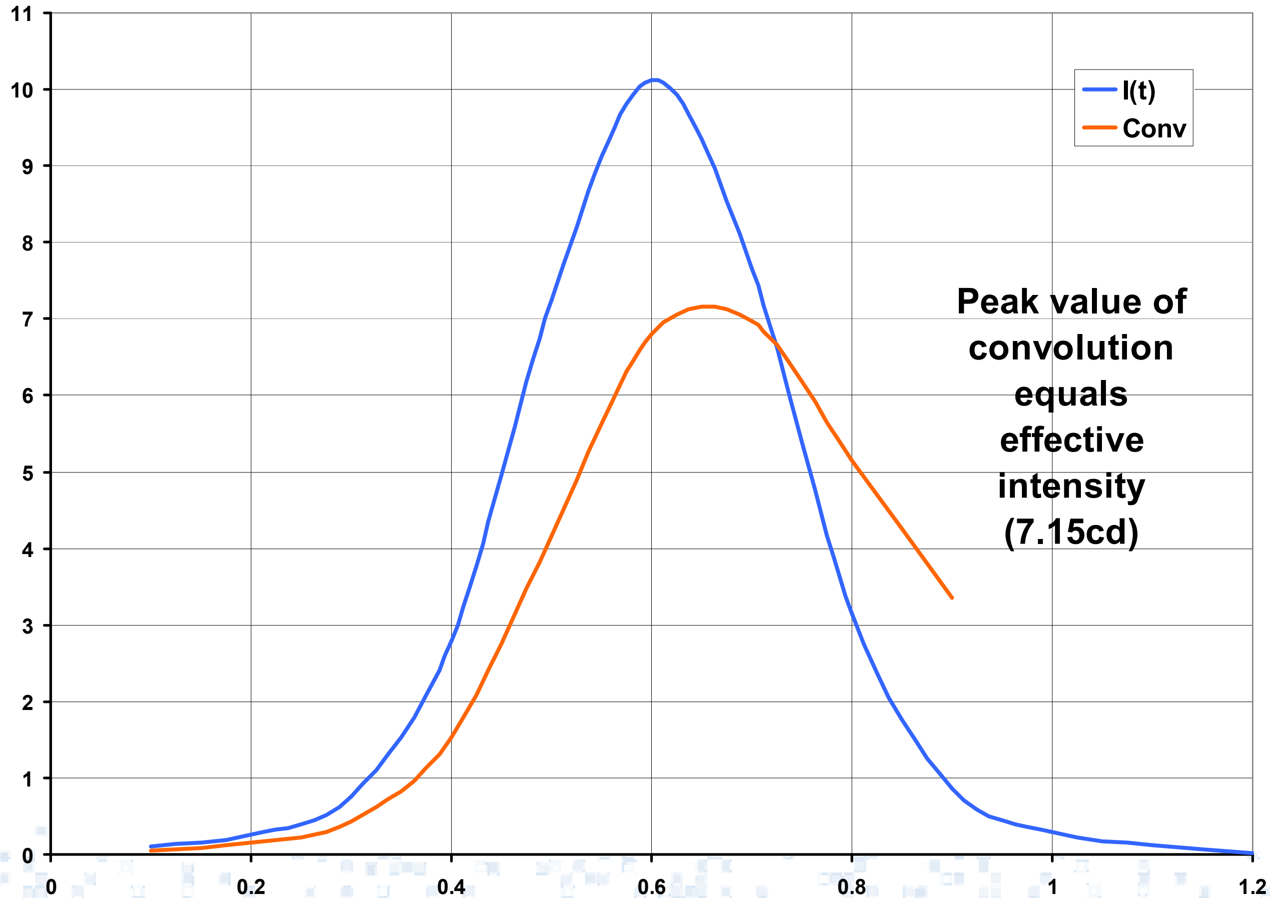
Convolution at t = 8



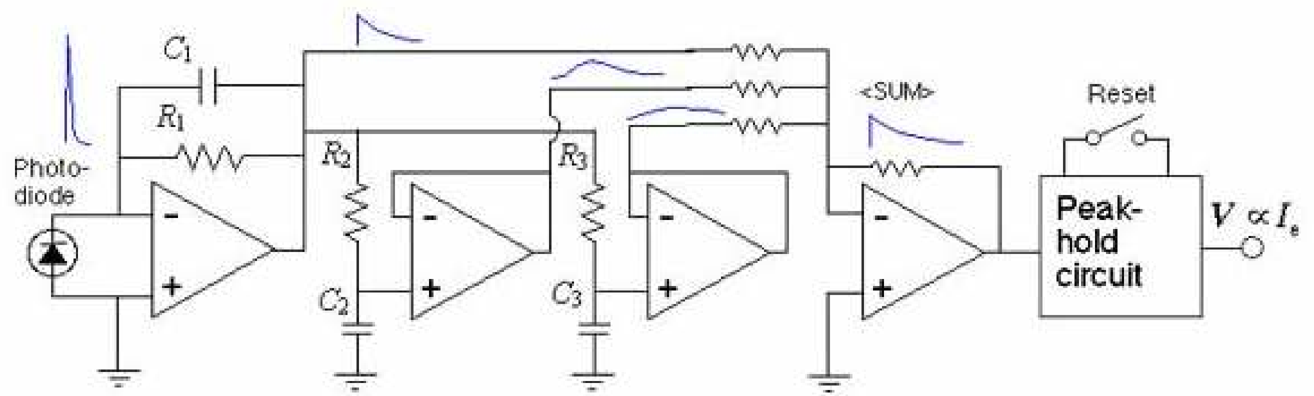
Convolution at t = 9



Convolution



Modified Allard Hardware Model



$$q(t) = \frac{w_1}{a_1} e^{-\frac{t}{a_1}} + \left\{ \frac{w_1}{a_1} e^{-\frac{t}{a_1}} \right\} * \left\{ \frac{w_2}{a_2} e^{-\frac{t}{a_2}} \right\} + \left\{ \frac{w_1}{a_1} e^{-\frac{t}{a_1}} \right\} * \left\{ \frac{w_3}{a_3} e^{-\frac{t}{a_3}} \right\}$$

with $w_1 + w_2 + w_3 = 1$,

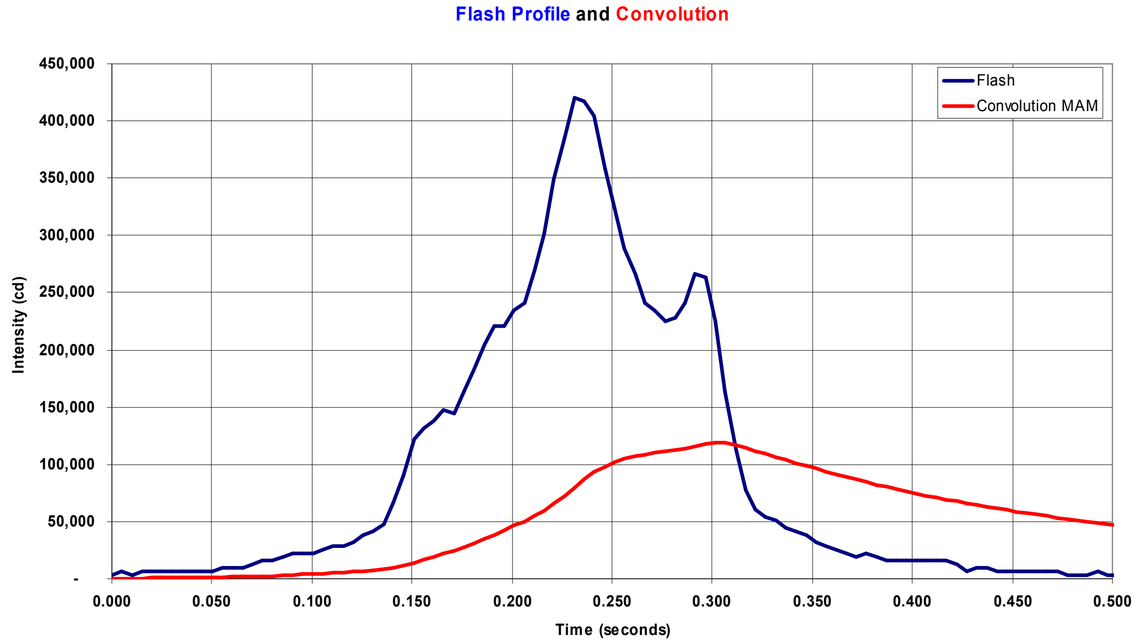
Total time constant $a = a_1 / w_1 = 0.2$ s, $*$: convolution

$a_1 = C_1 R_1$

$a_2 = C_2 R_2$

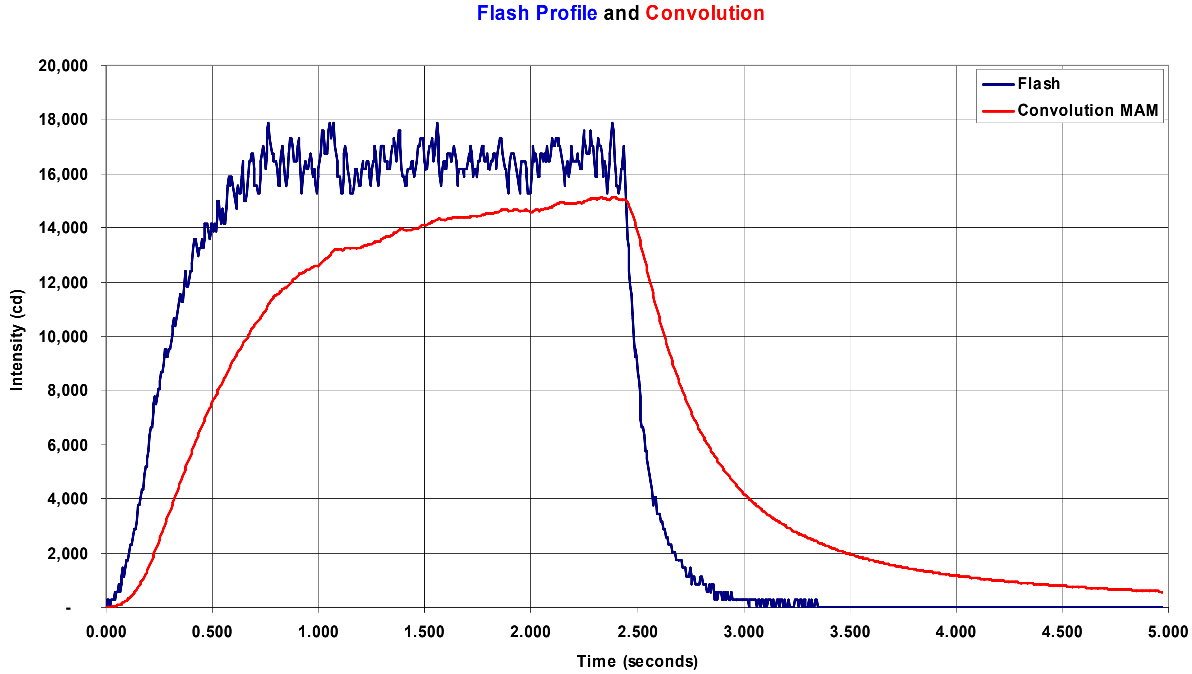
$a_3 = C_3 R_3$

Example 1 - Bardsey Island L/H



Io (cd)	J (cd.secs)	**MAM Ie (cd)**	**SC Ie (cd)**	SC eff t	t50% of peak	t10% of peak
420,000	48,500	**119,000**	**154,000**	0.115	0.110	0.201

Example 2 – Chaine Tower



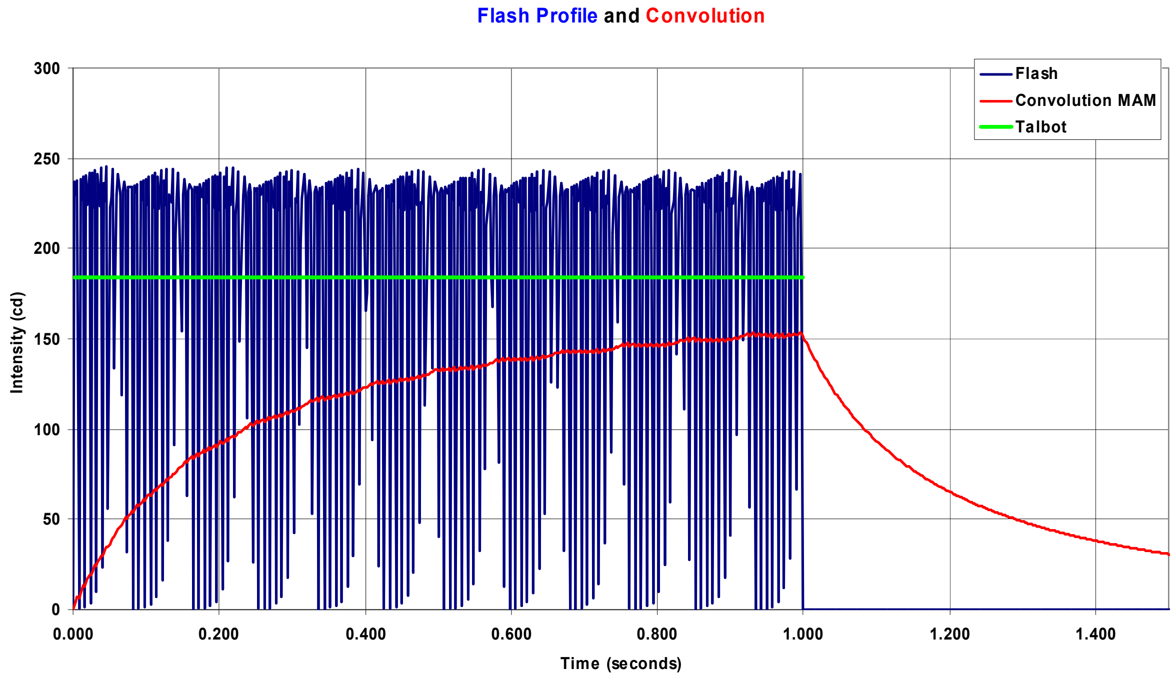
Noisy

Io (cd)	J (cd.secs)	**MAM Ie (cd)**	**SC Ie (cd)**	SC eff t	t50% of peak	t10% of peak
17,900	37,200	**15,000**	**16,000**	2.081	2.228	2.568

Smoothed Io

Io (cd)	J (cd.secs)	**MAM Ie (cd)**	**SC Ie (cd)**	SC eff t	t50% of peak	t10% of peak
16,500	37,200	**15,000**	**15,000**	2.263	2.253	2.613

Example 3 – LED Buoy Light



PWM

Io (cd)	J (cd.secs)	**MAM Ie (cd)**	**SC Ie (cd)**	SC eff t	t50% of peak	t10% of peak
246	184	**153**	**194**	0.748	0.996	0.996

Smoothed Io

Io (cd)	J (cd.secs)	**MAM Ie (cd)**	**SC Ie (cd)**	SC eff t	t50% of peak	t10% of peak
184	184	**153**	**153**	1.000	0.996	0.996

Conclusions

- Modified Allard is a suitable tool for flash photometry in determining the effective intensity of any flash shape or pulse train.
- A hardware add-on can be made for a photometer to give a direct read-out of effective intensity.
- The convolution method can be amended if a more appropriate q(t) is found (currently $a/(a+t)^2$).
- Effective intensity is only relevant at achromatic threshold in darkness.

Thank You

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