Mathematical Method to Simplify In-Situ Temperature Computation during the Splice Process

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2.1 Mathematical Method to Simplify In-Situ Temperature Computation during the Splice Process

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Abstrakt
Komplexe optische Netzwerke fordern eine immer größere Anzahl an permanenten und dämpfungsarmen Glasfaserverbindungen (Spleiße). Eine wichtige Voraussetzung für hochqualitative Spleiße ist eine geeignete Temperaturverteilung. Die Autoren stellen eine In-situ-Methode zur Temperaturkontrolle durch Bildbearbeitung vor.

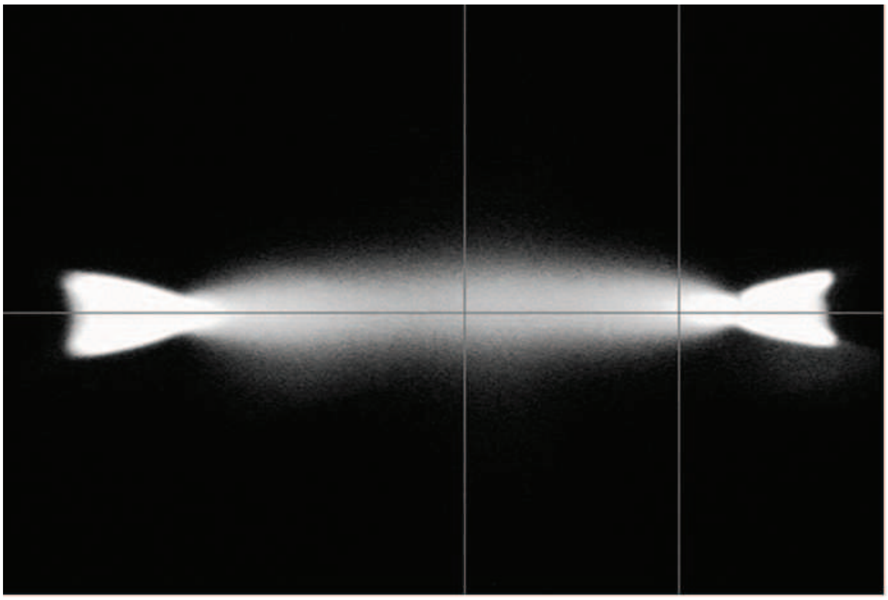

Abb. 2.1-1: *Discharging frame with selected cross sections and transversal section*

Nowadays, metropolitan network users may use internet bandwidths up to 200 MB/s. The old copper wire network is obsolete for these conditions. Instead, this performance is achieved by using optical fibers. One of the most important conditions is to create an optical network between the provider and customers with as few lossy connections as possible. The key solutions to this problem are high quality thermal splice connections. These are complex processes in which the optical fiber ends are cleaned, then molted in a high-frequency discharging arc and then pushed together. At the end of the splice process, the connection has a loss of less than 0.1 dB. One of the important characteristics in the splice process is the temperature distribution in the discharging arc. The highest values are around 2000°C, which is the temperature necessary to melt the glass of the optical fiber.

Like mentioned in a prior presentation [1], one method to compute the temperature is given by using the Abel-, respectively the Inverse Abel Transformation of the recorded arc discharging process [2] – [3]. A similar method is used by the astrophysical scientists to determine the temperature distribution of a star from images of the star.

The splice process is recorded by the alignment cameras in the splicer and extracting a frame for the discharging arc (Fig. 2.1-1), the Inverse Abel Transformation can be applied.

The results of the intensity distributions at the cross sections are presented in Figure 2.1-2, and Figure 2.1-3.

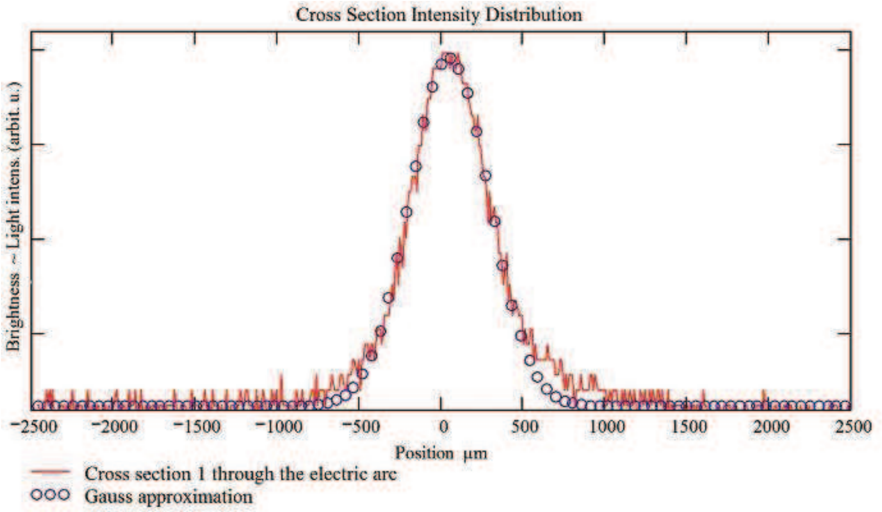

Abb. 2.1-2: *Distribution and Gauss approximation at position 1, where the parameters are*

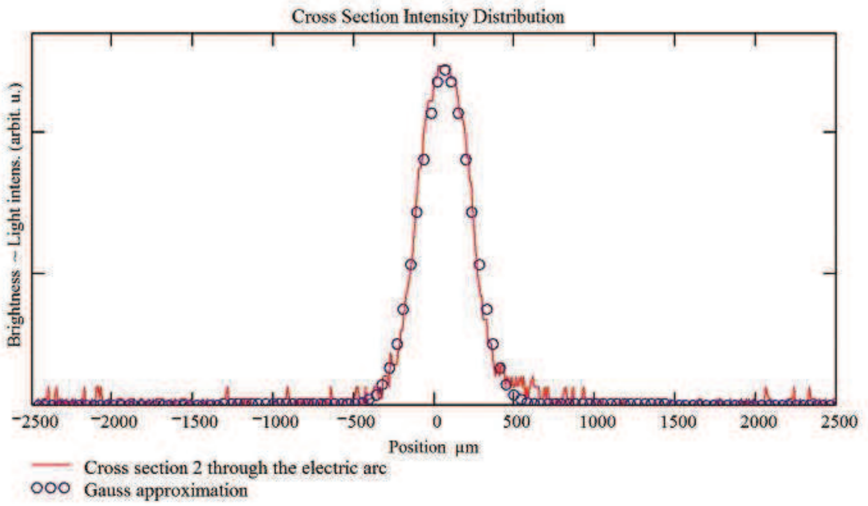

Abb. 2.1-3: *Distribution and Gauss approximation at position 2*

Considering the obtained two profile distributions, it can be concluded that the distributions can be approximated very well by Gaussian distributions:

$$F(x)=A\cdot e^{-\frac{(x-B)^2}{2\cdot C^2}}+D \quad (1)$$

In this formula, the individual parameters represent:
A - Amplitude of the intensity
B - Position shift on the axis
C - Standard deviation (σ)
D - Background level

Considering the Gaussian distribution as the approximation of the cross section distribution, an Inverse Abel Transformation can be done analytically, and sophisticated spline approximations of the distribution are no longer necessary. In particular, the costly numerical computation of the Abel transform is also no longer needed. Considering the obtained results of the cross section and the transversal section, the power distribution in the arc discharging area can be determined. Using an adequate calibration, the temperature distribution is finally obtained.

References

[1] W. Lieber, W. Schröder, D. Curticapean: In-situ Leistungs- und Temperaturverteilung im Spleißprozess, IAF Beiträge aus Forschung und Technik 2011

[2] S. H. Lee Editor: Optical Information Processing, Fundamentals; Springer – Verlag Berlin, Heidelberg, New York, 1981

[3] W. Hackbusch, Integralgleichungen: Theorie und Numerik, Teubner, Stuttgart,1999