



## ABSTRACT

In the framework of an applied course on metallurgy we have studied different alloy systems using approximate open databases that were specifically created for Pandat use.

We are considering here the numerical derivative of the Scheil solidification curve, with a straightforward built-in function that allows to calculate the numerical derivative of the temperature with the solid fraction. It is now well known that some of these parameters are key for solidification cracking as it has been introduced by prof. Sindo Kou, for the value of the solid fraction  $f_s$  close to 1.

We are transforming by using simple mathematics this function, as long as the limit for  $f_s$  tending to 0 of this numerical derivative is useful for the estimation of grain size/ columnar length during solidification in different processes.

Finally we have considered the reciprocal of this value, which is important for semi-solid processing and for the behaviour of steel in the mushy zone in ingot or continuous casting solidification.

We have obtained general trends using an open – simplified database – and we have considered specific trends using a suite of numerical tools for peak fitting available at the site of prof. O' Haver.

We have used Lorentzian fitting for the peaks on the final stages of solidification, logistic curves for the intermediate ranges ( $0.3 < f_s < 0.7$ ) and finally logistic or linear curves for the initial stages of solidification.

We will compare our results with an R&D Department of a Special Steel Company, ACM, located in France, and with their mother company ABS Acciai, located in Italy

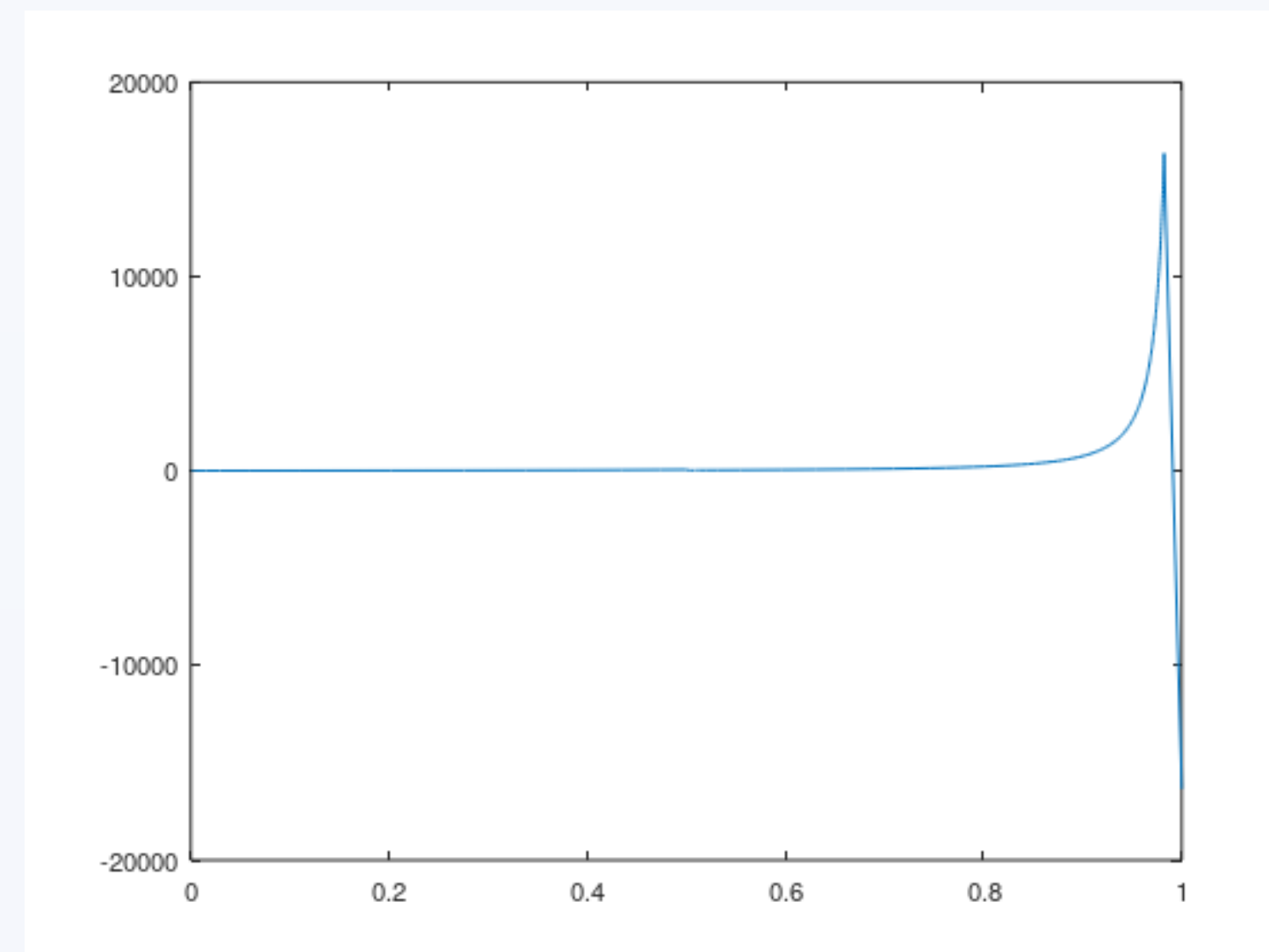
## Main objectives

We are producing preliminary results which will be compared by ACM- the R&D branch of ABS. ACM will verify if the modelling results could be useful for process simulation in the case of ingot casting and continuous casting.

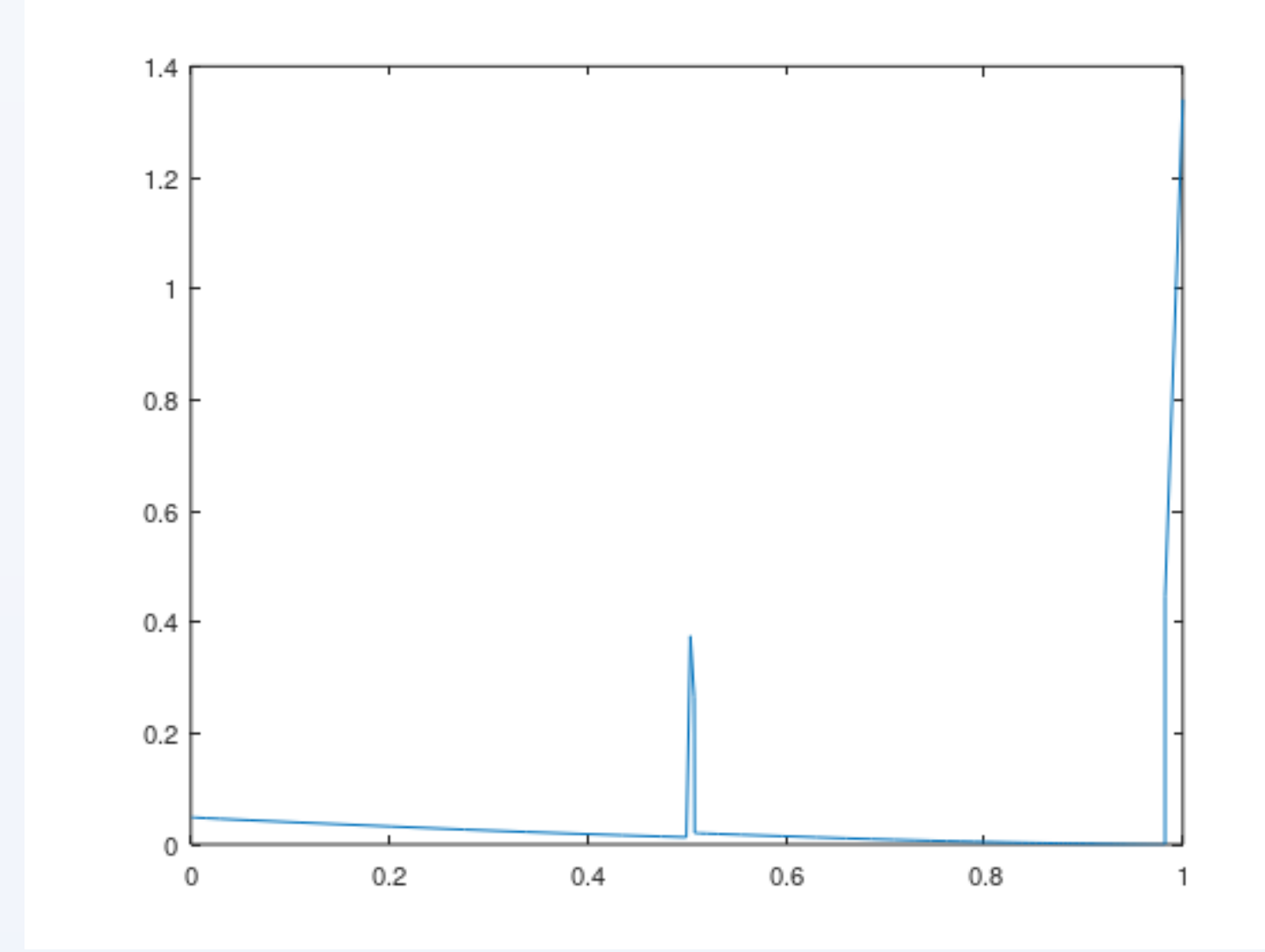
We have already had some technical discussions on carbon steels and it seems that this approach is promising.

## First results

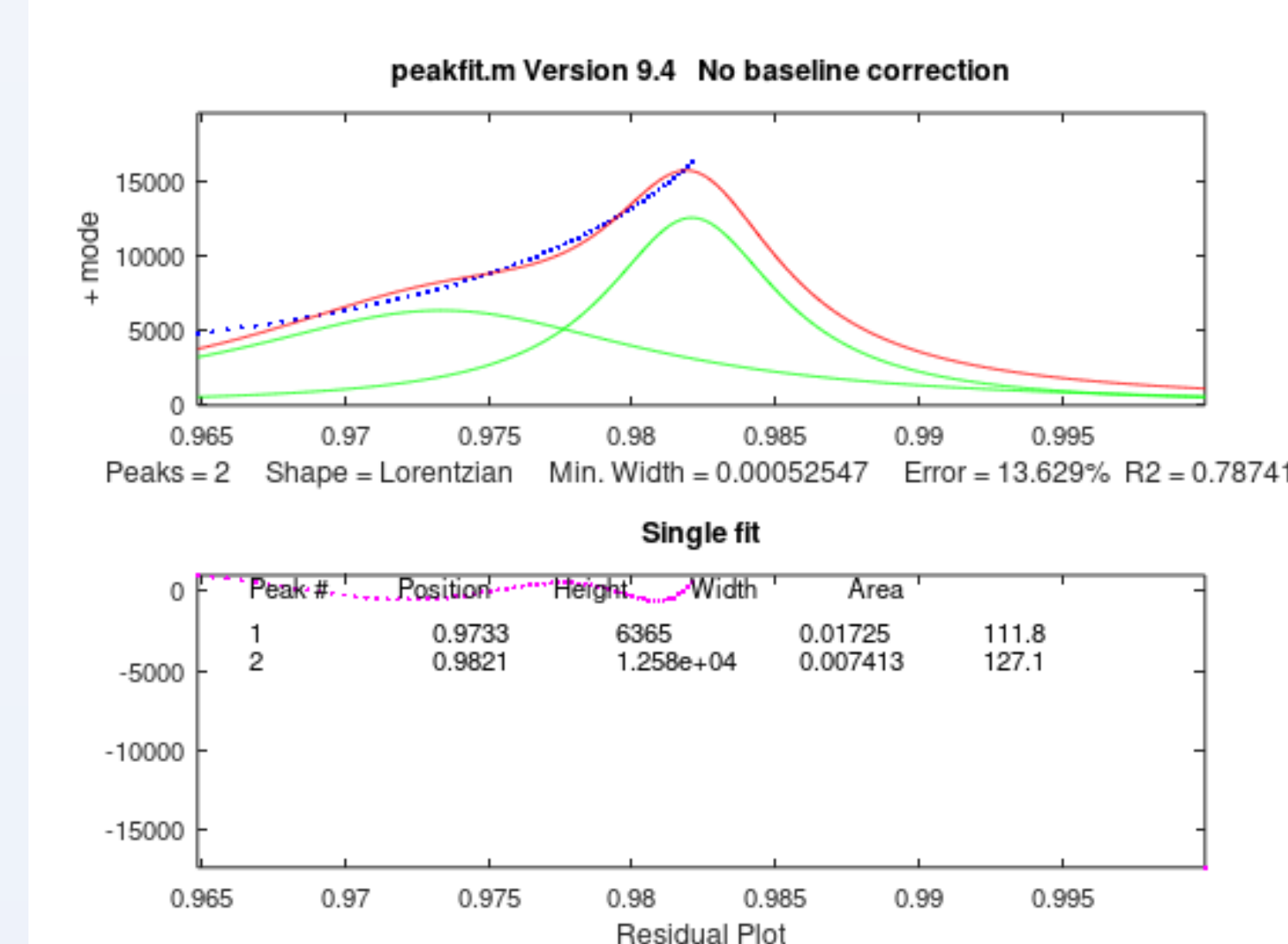
Curve -T//fs



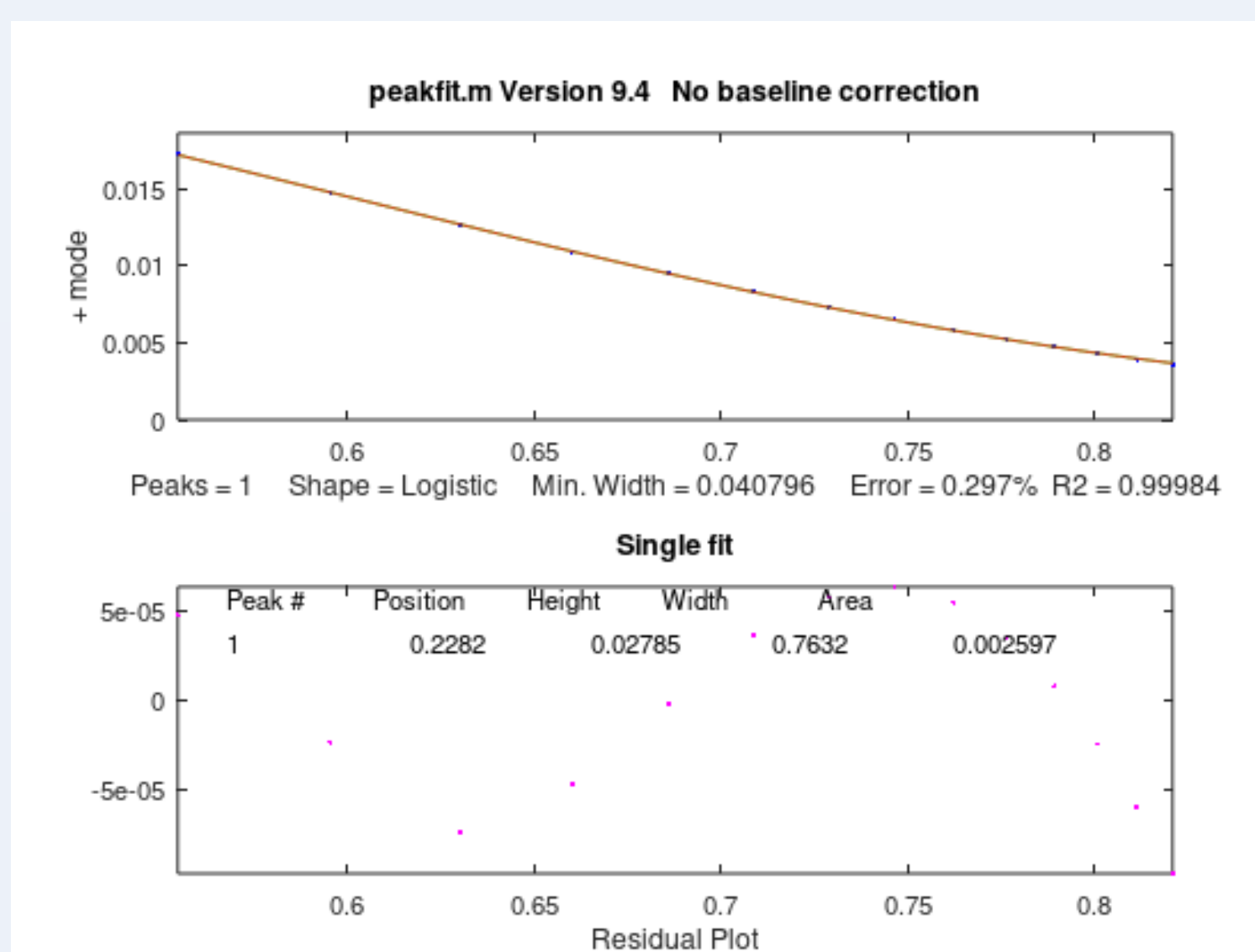
Curve -fs//T (Kapranos/ Zoqui)



Kou peak: two Lorentzians on -T//fs

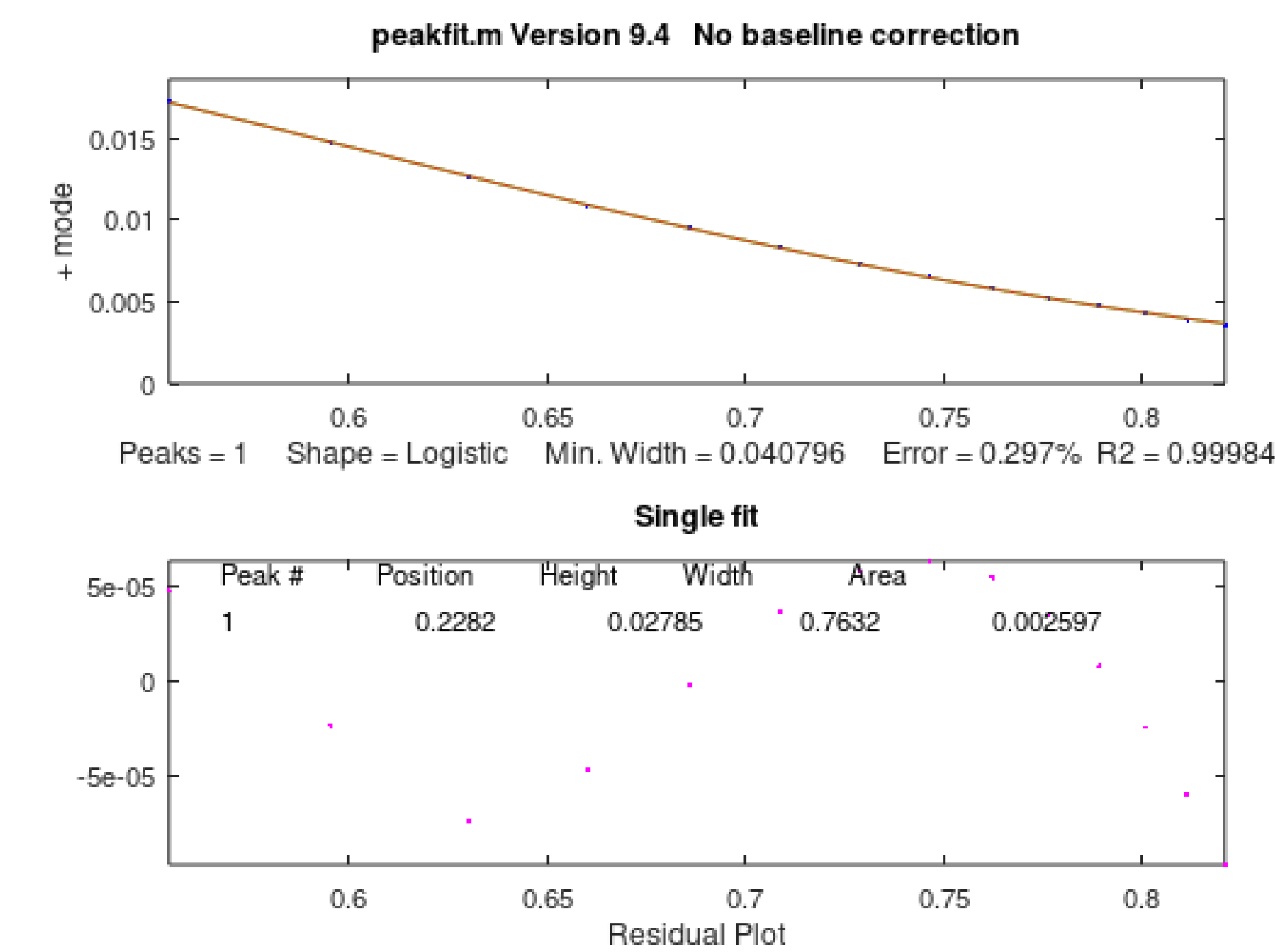


Zoqui Kapranos peak at approx. 0.7 → suitable for semisolid Tixo (logistic curve)

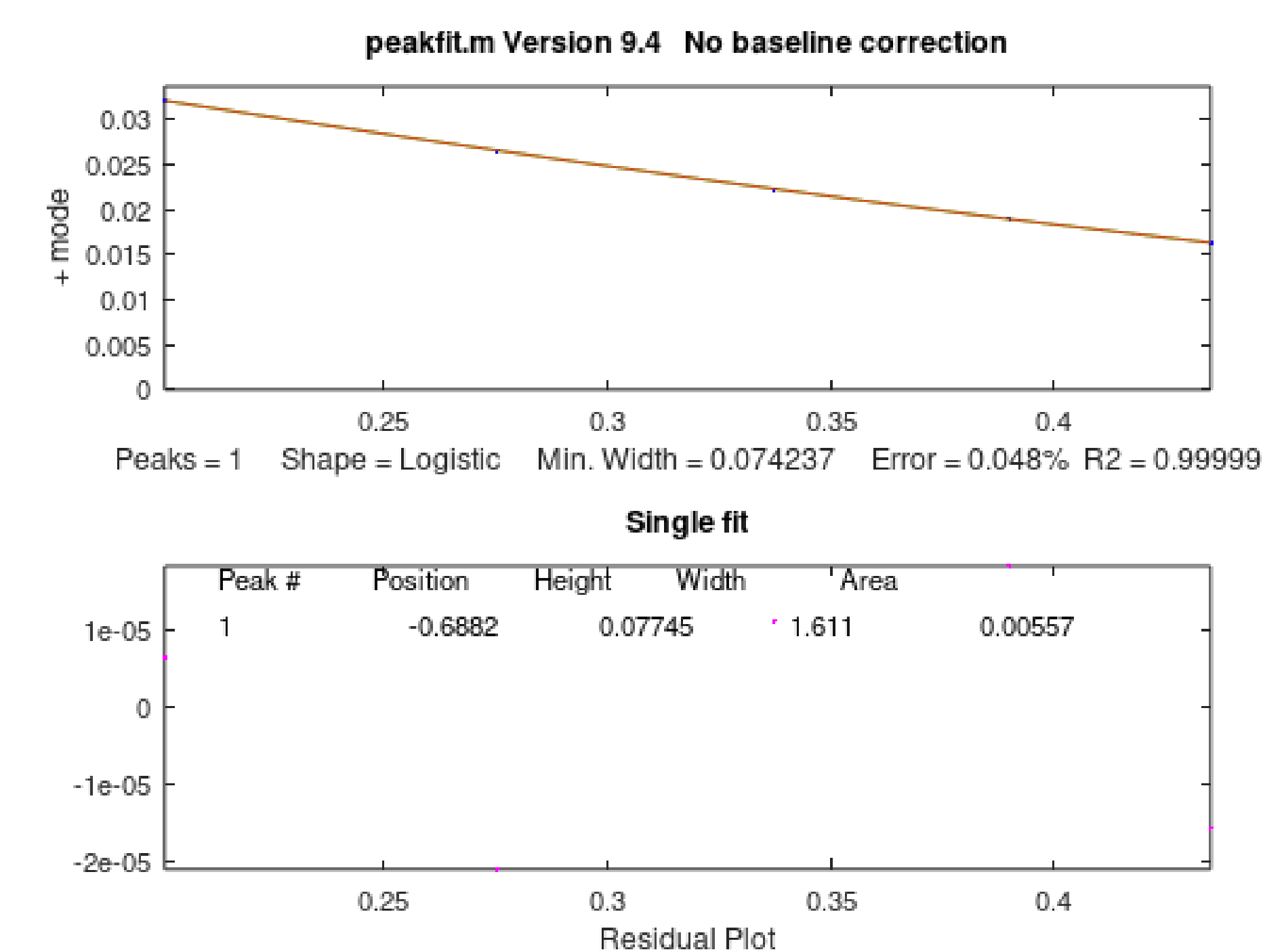


## Results

Zoqui Kapranos peak at approx. 0.3 → suitable for semisolid Tixo (logistic curve)

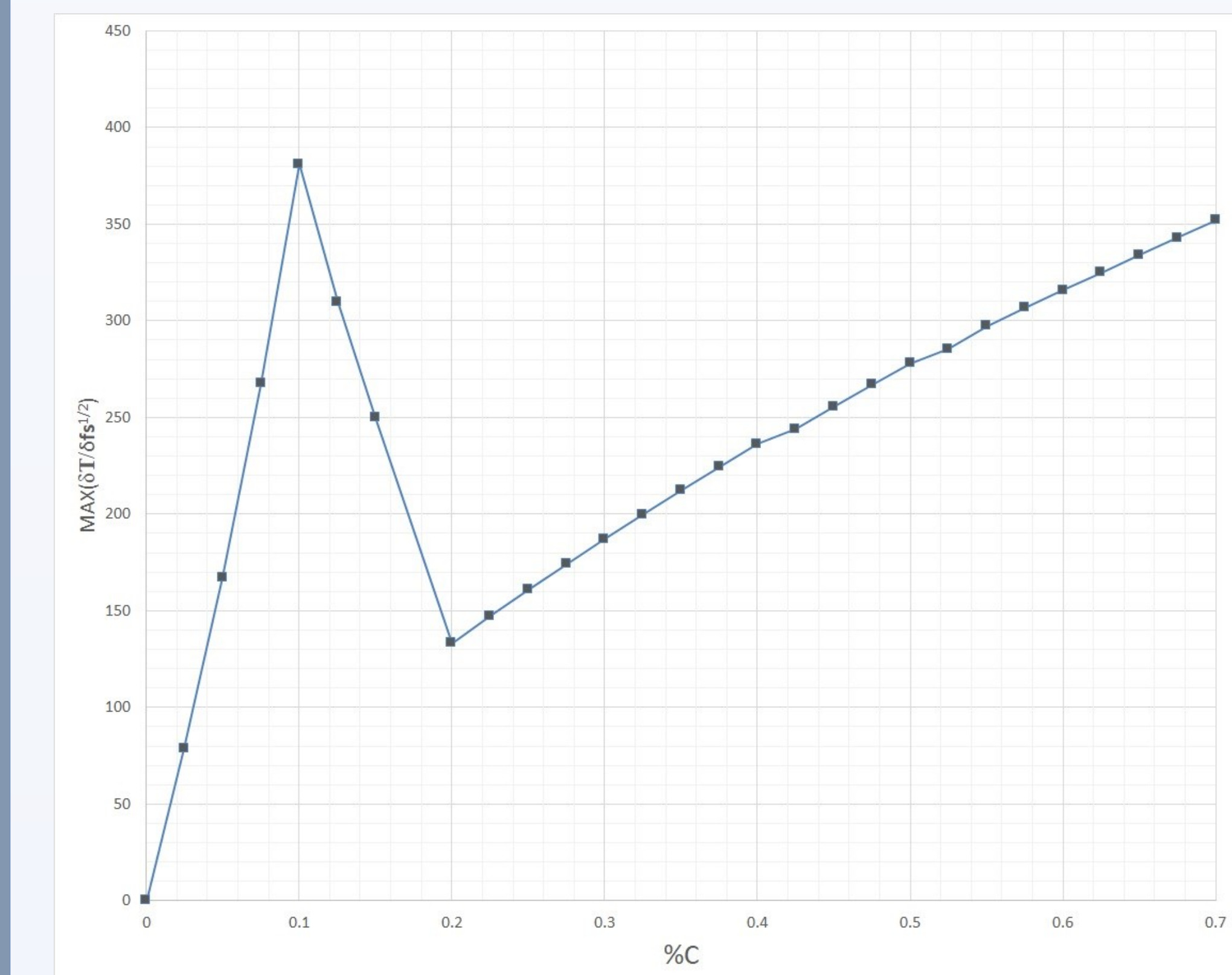


Schmidt Fetzer Limit for  $f_s \rightarrow 0$  on -T//fs



## Conclusions

From the results we obtained, we were able to produce a series of diagrams that represents the behavior of the various criteria with regard to the variation of chemical composition of the alloys and evaluate the results of these variation.



## References

- [1] Sindo Kou, A criterion for cracking during solidification
- [2] Zoqui, E.J. Alloys for semisolid processing
- [3] Artem Kozlov, R Schmid-Fetzer, Growth restriction factor in Al-Si-Mg-Cu alloys
- [4] F. Miaini, Calphad Tools for the Metallurgy of Solidification
- [5] <https://terpconnect.umd.edu/~toh/spectrum/>

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