# Image analysis capabilities and methodologies of $Nb_3Sn$ Rutherford cables

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Abstract:

The unique Rutherford cabling facility at the Berkeley Center for Magnet Technology, LBNL, has been leading the production of a number of Nb3Sn cables ranging from 11 to 44 strands for a variety of magnet projects. Cable fabrication is a critical step in accelerator magnet production and, to ensure the cables can be used in a magnet, fine tolerances must be kept on the cable width, thickness, keystone angle [1]. In addition to these dimensional measurements, we implemented an in-line image acquisition system that can monitor for critical defects such as cross-overs as well as track the extent of strand deformation at the cable edges. At LBNL, we have associated the cable edge facet dimension with the cross-sectional subelement damages. We thus can use image analysis on the facet as an integral and critical quick turn-around-time quality control monitor. Although such measurements are not direct and require a baseline for a given conductor and cable geometry combination, they are non-destructive. They can be measured across the length of the cable, which contrasts with critical current or residual resistivity ratio measurements, which are only made at the point and tail of the cable and require a lengthy heat-treatment.

Moreover, the high frequency of image acquisition coupled with Fast Fourier Transform analysis can give us insights into the key components of the cabling machine as they tend to produce periodic variations within the cable. Such analysis can help find potential faults and inform maintenance planning. This work describes our setup of in-line imaging of Rutherford cables during manufacture, the subsequent image analysis, and data processing. Several case studies illustrate typical usage of the system and lessons learned.

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References

[1] Cooley, L.D., Ghosh, A.K., Dietderich, D.R. and Pong, I., 2017. Conductor specification and validation for high-luminosity LHC quadrupole magnets. IEEE Transactions on Applied Superconductivity, 27(4), article no. 6000505.