AbstractID: 11451 Title: Reliability Growth of a Fully Automated Robotic IGBT System

Purpose: To evaluate the reliability growth in seed delivery by TJU's EUCLIDIAN, a fully automated robotic system, developed for image-guided brachytherapy (IGBT).

Method and Materials: Important steps in reliability growth analysis are: identification and isolation of failures, classification of failures, and trend analysis. For any one-of-a-kind product, like EUCLIDIAN, reliability enhancement is accomplished through test-fix-test cycles of the product. Failure Mode, Effect and Criticality Analysis (FMECA) were used for collection and analysis of reliability data by identifying and categorizing the failure modes. Failures were classified according to severity. Failures that occurred in EUCLIDIAN operations were considered as Non-Homogenous Poisson Process (NHPP), and the trend was analyzed using Laplace test. For analyzing and predicting reliability growth, commonly used and widely accepted models, Duane's model and Crow's model, were applied. Mean Time Before Failure (MTBF) was used as an important measure for assessing reliability.

Results: During pre-clinical testing, 360 seeds (in 10 cases) were deposited automatically and 6 critical failures were encountered. The majority (5 failures) of which occurred during the first three cases. The Laplace test index was -1.134 (<0), indicating significant trend in failure data, and the failure interval values were gradually becoming larger. Since the failure occurrence interval was increasing, the system reliability exhibited an increasing trend. System's failures distribution followed both the Duane's and Crow's postulations of reliability growth. MTBF was 129.4 seeds, which meant that a full brachytherapy case could be performed without any critical failure. The shape parameter for MTBF was 0.4638 (<1), suggesting positive reliability growth of the EUCLIDIAN. At 0.95 confidence, the lower and upper bounds of the MTBF were 42.8 and 612.9, respectively.

Conclusion: Analyses of failure mode strongly indicated a gradual improvement in EUCLIDIAN's reliability. For better consistency in MTBF and reliability prediction, more data are being collected.