

# The Correlation of Modulation, QA Pass Rate and Delivery Time for SBRT Treatments, Dosimetry and Physics Perspectives

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**Introduction:** Quality assurance of TPS-generated patient plans is critically important to ensure safe, deliverable, high-quality treatment, especially plans with high dose per fraction (i.e. SBRT). Due to the high fractional dose, the desired dose fall-off (i.e. gradient) outside the target area, and necessary conformality, a relatively high modulation (Monitor Units/Fractional Dose) is common.

**Background:** Our previous study, presented virtually at AAMD in 2023, investigated the correlation between QA pass rates and specific beam number/collimator angle combinations. We hypothesized lower OAR doses correlate to higher modulation, and modulation correlated to QA pass rate. This was shown to be not valid. With additional considerations for SBRT treatments, our team created a new project that attempted to correlate QA pass rate with estimated delivery time, MU efficiency and modulation for 20 clinical SBRT patients of various clinics, prescriptions, and physicians.

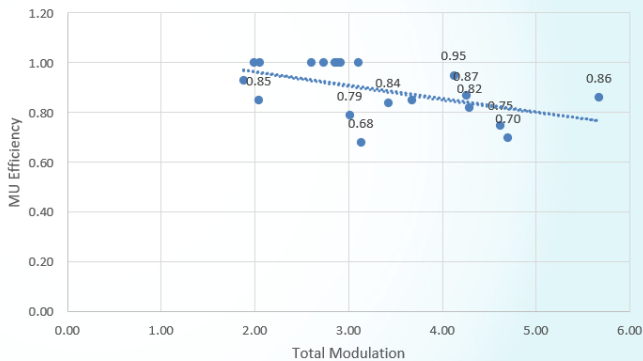
**Methods and Materials:** MU efficiency values were obtained from Elekta's Monaco treatment planning optimization console and plotted against the modulation of each plan. Acceptable QA pass rate was defined as >95% of points passing at 3%/3mm gamma. Finally, estimated delivery time was obtained similarly to MU efficiency and compared to total modulation.

Elekta's definition of estimated MU efficiency

<b>Estimated MU efficiency</b>	The estimated monitor unit efficiency shows how Monaco compares the efficient plan's actual monitor units to the monitor units for the ideal delivery. Therefore, the higher the efficiency the lower the total monitor units for the plan. To increase the MU efficiency of the plan, lower the <b>Minimum Dose Rate Segment Shape</b> property. Efficiency ↑ Total MU ↓ Min Dose Rate ↓
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**Results:** For the comparison of MU efficiency vs. total modulation, we found a minor statistical correlation across all treatment sites.

MU Efficiency vs. Total Modulation

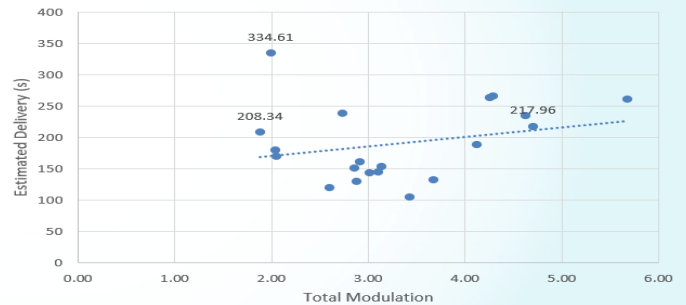


For comparison of QA pass rate vs. total modulation, we found no statistical correlation between the total modulation and the defined QA pass rate  
QA pass rates and total modulation values

Patient	Energy	Disease Site	Field	Total Modulation	3%3mm
1	6FFF	L4 paraspinal	B1	5.67	100.00
2	6FFF	T7	A1	1.88	99.60
3	6FFF	Prostate	A1	4.12	98.60
4	6X	L Lung	A1	3.10	99.10
5	6FFF	Iliac Node	A1	2.05	97.80
6	6FFF	Prostate	A1	4.29	95.90
7	6FFF	Prostate & Rt. Iliac	A1	4.25	99.10
8	6FFF	Mediastinum	B1	3.13	99.70
9	6FFF	Prostate	A1	3.01	99.60
10	6FFF	Lung	A1	2.04	99.60
11	6FFF	Prostate & SV	A1	2.60	99.20
12	6FFF	Paraspinal	C1	2.73	98.40
13	6FFF	Right Upper Lung	A1	1.99	98.90
14	6FFF	Left Posterior Rib	A1	3.67	98.70
15	6FFF	Left Posterior Rib	B1	2.88	94.20
16	6FFF	Prostate	A1	2.91	100.00
17	6FFF	Pancreas	A1	3.42	99.50
18	6FFF	Prostate	A1	4.70	99.20
19	6FFF	RUL	B1	2.85	99.70
20	6FFF	LUL	C1	4.62	97.70

Generally, the estimated delivery time was shown to roughly correlate with total modulation.

Estimated delivery time (s) vs. Total Modulation



**Conclusion:** The results of this study confirm the original hypothesis that higher modulation does not have a significant impact on plan quality or QA pass rate in a SBRT setting. The data seemed to confirm prior observations correlating higher modulation with longer delivery times. This project changed our institutional approach to SBRT planning by prioritizing optimization parameters which yield high quality plans while decreasing patient time on the table. Ultimately, our study reinforces the importance of understanding optimization parameters impact on plan quality and patient specific QA.

