**Monaco 6.0 TPS Template Files Explanation**

**Part1. Introduction**

Monaco TPS is a template-based treatment planning system where for each new treatment plan creation, template files should be selected to load into TPS. Unlike other vendor’s product, Monaco Treatment Plan Template (MTPT) is an integration of all treatment plan information includes beam settings, dosimetric criteria and IMRT constraints i.e. cost functions, sequencing parameters. So it’s convenient and easy to create a new treatment plan via this approach in Monaco TPS.

Another characteristic of Monaco is biological optimization algorithm in fluence map optimization and aperture optimization. Biological cost functions like serial, parallel, quadratic overdose were utilized during the fluence optimization. Traditional trial-and-error process for treatment plan fine-tune in Monaco would be more efficient via bio cost functions (CFs), which could tremendously decrease the number of these hyper-parameters in CFs.

Actually, with more customer’s feedback accumulated, two distinguished issues occur in current manipulations. First one is the management of MTPTs as too many MTPTs of different sites or cases would make it hard to find a suitable template for a new site. Another issue is the template disfunction in the upgrade of Monaco from 5.11 to 5.5 version. Since the functions of shrink margin was totally modified in Monaco 5.5 so most of our customers are uneager to upgrade to lastest version before the issue was solved.

Thus, here we want to explore the Monaco Template files thoroughly from files decode to performance in different TPS version. The following work was illustrated in three parts: Firstly, we would give a detailed explanation of current MTPT files’ structure and its corresponding item in Monaco TPS GUI. Secondly, we would give a detailed elucidation of MTPT variation for different Monaco TPS versions. Finally, the current Auto Template workflow would be showed and potential clinical application would be further explained.

MTPT files Explanation

Here we utilize MTPT 6.0 version as an example for further explanation. Understanding Template files structure and file format would help make more innovation in Automation of Monaco Clinical Workflow.

MTPT files components

MTPT have six files with format xml, hyp, pln and tel respectively as seen in Fig. 1. For inverse IMRT or VMAT plans, the segment sequence including MLC positions, segment weight, gantry angle were all stored in the file with suffix tel. Biological optimization parameters like IMRT constraints, sequencing parameters and beam settings were all saved in hyp file. Please note hyp is the abbreviation of Hyperion which is a former TPS optimization engine acquired by Elekta. Dosenormsettings.xml is a html file contained the DVH statistics evaluation criteria. Isodosesettings.xml is another html file stored the isodose line template settings for display. The remaining two files dvhparam.xml and pln were plan related parts without any specific functions.

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Figure.1. Illustration of MTPT files

MTPT bio-optimization cost functions (hyp)

Hyp, a text file, could be easily read and write. (only for internal). The first part of hyp was IMRT constraints with each structure name and their corresponding cost functions followed. As seen in Fig. 2, Monaco IMRT constraints with each cost function was constructed with a serial of parameters.

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Figure 2. The capture of IMRT constraints in Monaco TPS

Here we would explain each cost function one by one with the reference to training guide. As seen in Fig. 3 the target penalty is set line by line in hyp files corresponding to the cost functions in UI. The name called “qp” is the target penalty function and isoconstraint maps to the prescription dose.

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Figure 3. Cost function of Target Penalty in hyp file and TPS

The cost functions of quadratic overdose and maximum were to constraint the high dose region in dose distribution of targets. The CFs name were “o\_q” and “mxd” in hyp files. The relationship between hyp and GUI was shown in Figure 4.

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Figure 4. Cost function of Quadratic Overdose(left) and Maximum(right) in hyp file and TPS

The biological cost functions of parallel and serial were unique in Monaco TPS and they are devised based on a biological model called equivalent uniform dose (EUD). The CFs name were “pa” and “se” in hyp files. The relationship between hyp and GUI was also shown in Figure 5.

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Figure 5. Cost function of Serial(left), Parallel(right) in hyp file and TPS

MTPT sequencing parameters (hyp)

For different inverse IMRT delivery technologies (Step&Shoot, dMLC, VMAT) in Monaco TPS, the parameters in hyp would differ a lot. Here we would further explain the details in hyp corresponding to different technologies.

MTPT beam settings (hyp)

MTPT file explanation (dosenormsettings.xml)

MTPT file explanation (tel)

MTPT files Variation between different versions

Auto-MTPT Workflow