BRAINLAB

BALANCING STANDARDIZATION WITH PERSONALIZATION

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SCRIPTING RESERVATIONS

Thou shalt not delegate

Scripting permits automation of treatment planning processes and has the potential to lessen manual interventions and human labor with the ambition to standardize workflows and patient treatments. Some **reservations**:

- Scripting is shifting the responsibilities of vendors to end-users
- Scripting is segregating users rathers than leveraging the field
- Scripting is biased and relies on experience and expert knowledge
- Scripting does not guarantee improved quality of care

Medical device companies should warrant improved clinical outcomes for patients. However, experience dictates outcomes. It is no longer ethical for medtech companies to push liability solely on its customers.

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NETFLIX

TRIBECA FILM FESTIVAL 2018 OFFICIAL SELECTION

THE BLEEDING EDGE

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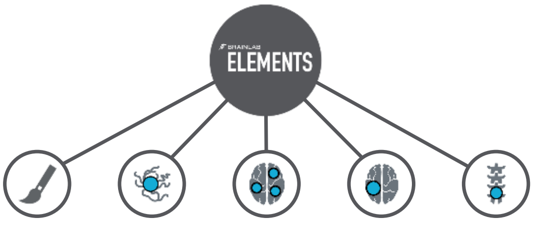
INTRODUCING BRAINLAB ELEMENTS

A series of dedicated software modules serving multiple clinical specialties



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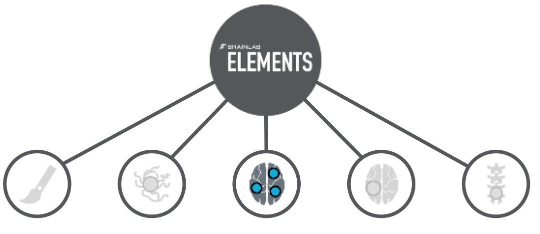
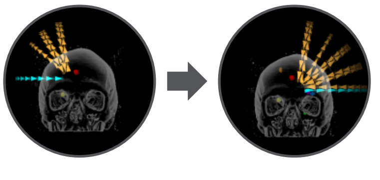


IMPLEMENTED PLAN AUTOMATION

Mirroring algorithm for minimizing radiological depth

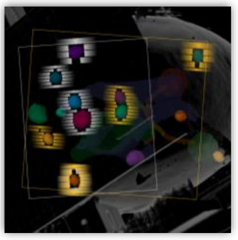
- The software calculates the average radiological depths for all treated metastases for the arc geometry loaded and for the arc geometry mirrored across the sagittal plane
- The software will determine whether the original setup or the mirrored version gives the shortest average radiological depths for all treated metastases
- The geometry with the shortest average radiological depths is selected and used for further plan optimization



IMPLEMENTED PLAN AUTOMATION

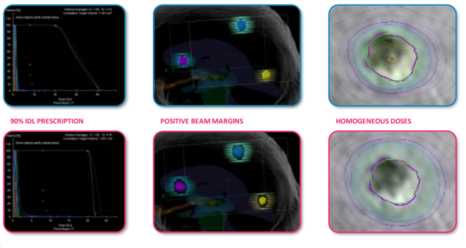
Packing algorithm – Intelligently assigning targets to arcs

- A brute-force by random numbers algorithm searches the most optimal distribution of targets among arcs in order to treat as many targets by as many arcs as possible
- If two targets share a leaf pair, the targets are assigned to different arcs at the same table angle. Else, both targets are assigned to the same arc
- Exceptions are made for situations in which two targets share a leaf pair for a few control points at the extremities of an arc´s gantry span. These situations will be ignored and the fields will be closed during the subsequent plan optimization



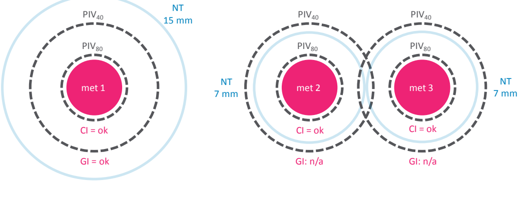
IMPLEMENTED PLAN AUTOMATION

Beam margin optimization for controlled dose heterogeneity



IMPLEMENTED PLAN AUTOMATION

Automatic creation of invisible tuning structures



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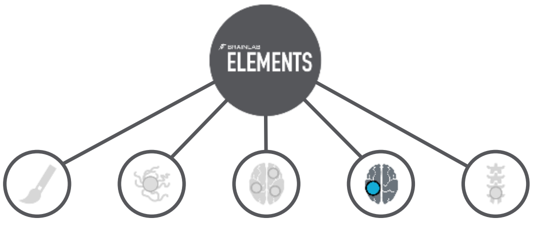

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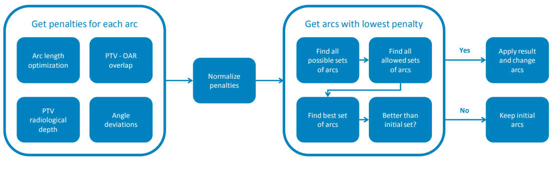
IMPLEMENTED PLAN AUTOMATION

4Pi arc setup optimization



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IMPLEMENTED PLAN AUTOMATION

Halo algorithm for critical organ sparen

- A Halo is an invisible virtual planning object that is automatically created by expanding the Most Important OAR uniformly into all directions.
- The size of the Halo is related to the Tolerated Coverage Volume of the target. A Halo is created in such a way that the overlapping volume between the Halo and the target exactly matches the difference between the Desired and the Tolerated Coverage Volumes.
- The target voxels covered by the halo will then be marked as "to be sacrificed" for the optimization. These voxels do not have to fulfill the desired target dose

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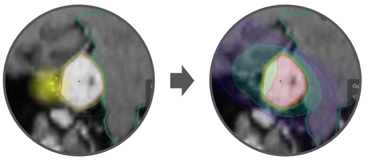
IMPLEMENTED PLAN AUTOMATION
Dose shaper for intuitive plan optimization

- The Dose Shaper allows local shaping of the isodose lines to achieve improved organ at risk protection by straightforward "drag and drop" manipulation of the isodose lines.
- Only one isodose line can be manipulated. As the impact of the dose shaper on the target coverage can be dramatic, it is recommended to use small modifications.
- For a certain treatment plan only one isodose line can be shaped. To start shaping an isodose line when another isodose line has already been shaped all previous shaping steps have to be undone.



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Works in progress, currently not available.

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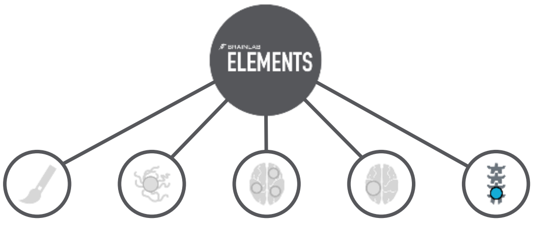

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IMPLEMENTED PLAN AUTOMATION
SmartBrush Spine for automated clinical target volume generation

CERVICAL

THORACIC

LUMBAR

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Further reading: Cox et al. International Spine Radiosurgery Consortium Consensus Guidelines for Target Volume Definition in Spinal Stereotactic Radiosurgery. International Journal of Radiation Oncology • Biology • Physics. 2012;83(5):597-605

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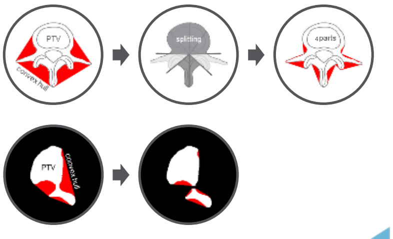
IMPLEMENTED PLAN AUTOMATION

Target splitting

- For complete vertebrae, the PTV is divided into 8 parts. The parts are subsequently merged until 4 parts are left. At each merging step, two parts are chosen so that the sum of the convex hull volumes of all the parts left after merging is minimal
- For partial vertebrae, The PTV is divided into 2 parts by trial-and-error. At each voxel on the skeleton of the PTV, a plane is determined that minimizes the intersection area of the plane and the PTV. The planes are parallel to the craniocaudal axis. If the summed convex hull volumes of the 2 parts is smaller than the convex hull volume of the original PTV, one of the parts may be split again if allowed by the "Maximum number of arcs" parameter.



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IMPLEMENTED PLAN AUTOMATION

Arc duplication

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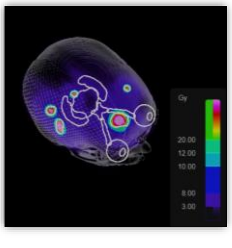
PROKNOW TREATMENT PLANNING CHALLENGE

Five brain metastases radiosurgery treatment planning



#	Metric	Min/Max	Ideal
1	Volume of each GTV covered by 20 Gy	95	99
2	Maximum dose to the outer contour	< 40	
3	Dose (Gy) covering 0.3 cc of the Brainstem	12	5
4	Volume (cc) of the Normal Brain covered by 10 Gy	30	12
5	Volume (cc) of the Normal Brain covered by 12 Gy	20	8
6	Volume (cc) of the Optic Chiasm covered by 8 Gy	0.2	0
7	Maximum dose (Gy) to the Optic Chiasm	8	2.5
8	Volume (cc) of the Optic Nerves covered by 8 Gy	0.2	0
9	Mean dose (Gy) to the Hippocampus	3	1
10	Maximum dose (Gy) to the Lenses	< 2	
11	Maximum dose (Gy) to the Eyes	< 8	

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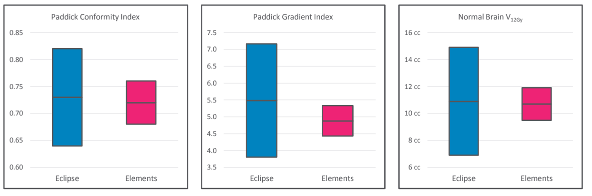
Works in progress, research project under guidance of Mark Chan from University of Essen, Germany

TREATMENT PLANNING STANDARDIZATION

Intermediate results from the global plan comparison study



So far ten Elements customers from united kingdom, Europe and Latin America participated in planning a five brain metastases case. The results were compared against a database of sixty-one Eclipse plans. The radiosurgery treatment planning experience of the Elements planners ranged from one to ten years but the quality of all their individual plans didn´t vary much and was consistently high without any outliers. This is in contrast with the Eclipse plans where a large variation in plan quality can be observed. The estimated planning time in minutes was 75.6 ± 63.0 for Elements versus 676.1 ± 760.3 for all other treatment planning systems.

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