BRAINLAB

- Global leader in the development and manufacturing of software driven medical technology
- Integrated Neurosciences Portfolio
- 100 Novalis Systems
- 100 Novalis Tx Systems
- 300 high-resolution mMLC Systems
- 770 Radiosurgery customers
- 450 ExacTrac Systems

BrainLAB Headquarters, Munich, Germany
Neurosurgery & Radiosurgery Integration
University Hospital Erlangen, Germany

- Surgical procedure with intraoperative MRI
- Follow up treatment with SRS to treat residual tumour
- One intuitive iPlan software and iPlan Net
- Tumour board decisions can include all options
Neurosurgery & Radiosurgery Integration
Digital Lightbox
Neurosurgery
Image Guidance, zTouch and Universal Instrument Calibration
Neurosurgery
Intra-Operative Imaging – BrainSUITE ® iMRI
Novalis Tx Radiosurgery
Powerful Treatment Delivery
Varian Radiosurgery Platform

- Trilogy or True Beam technology
- 1000 MU/min dose delivery
- Multiple Photon and Electron Energies
- 0.5mm gantry isocenter at installation
- 6D Robotic Couch
- Multiple imaging possibilities
Frame-Based and Frameless SRS
Stereotactic Hardware
HD120 High Definition micro-MLC
Beam shaping for superior dose conformality

- Finest resolution beam shaper
- 120 individually-motorized tungsten leaves
- 32 central pairs of 2.5 mm
- Large 22 X 40 cm² fixed field size
- Maximum leaf speed 2.5 cm/sec
- Sharp penumbra <3 mm for SRS
RapidArc™
VMAT for precise dose delivery in a single rotation
Novalis Image Guidance
Complementary Technologies

Volumetric Linac-Based Imaging - OBI
- Radiographic IGRT: 2D – 2D Matching
- Cone-Beam CT IGRT: 3D – 3D Matching
- kV fluoroscopy

Room Based X-Ray Imaging – ExacTrac
- X-Ray IGRT: 2x2D – 3D Matching
- Frameless IGS/IGRT with automated 6D positioning
- Intra-fraction motion detection with Snap Verification
- Adaptive Gating for tumor motion management

Portal Imaging - PortalVision
- Treatment verification during dose delivery
- “See what you treat while you treat.”
- Dosimetry Quality Assurance
ExacTrac
Image Guidance for Stereotactic Frameless treatments and moving targets

Frameless SRS/SRT
Non-Invasive IR Monitoring
Snap Verification
Adaptive Gating
Biometric Automation
6D Robotic Correction
**ExacTrac 6D Robotics**
Correction of rotational misalignments

- Robotic rotation of Imaging Couch Top
- Automated & integrated to ExacTrac
- Compensates for rotational uncertainties
- 6 degrees of freedom
Frameless Radiosurgery
Clinical Applications
Targeting the simple and the complex
Frameless Radiosurgery


“Novalis IGRS (...) is well suited for the treatment of intracranial lesions with regard to patient setup and treatment accuracy.” [2]

“The system can detect movements accurately within 0.1 mm and rotational changes within 0.2°.” [3]

ExacTrac Snap Verification
Positional verification with fast monoscopic x-ray snapshot imaging
Spine Radiosurgery

“Since 2001, Novalis technology has enabled us to confidently treat over 750 spine patients.”

Samuel Ryu, MD
Henry Ford Hospital

High-definition beam shaping offers the capability to treat a variety of spine indications, including inoperable tumors.

- Localization without implanted fiducials
- Precise multi-modality image fusion for selected target region
- Complementary 2D-stereo X-Ray and Cone Beam CT imaging for high-precision patient positioning
Spine Radiosurgery
Step 1: Initial x-ray setup

Initial Patient Verification
Bony Anatomy Fusion

<table>
<thead>
<tr>
<th>Shifts</th>
<th>Translational Deviations (mm)</th>
<th>Rotational Deviations (°)</th>
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Courtesy of:

David Geffen School of Medicine
At UCLA
Spine Radiosurgery
Step 2: Verification x-ray sequence

Initial Patient Verification
Bony Anatomy Fusion

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</table>

Courtesy of: [David Geffen School of Medicine at UCLA]
Spine Radiosurgery
Intrafractional shift

Patient movements and correctional shifts after initial x-ray localization and positioning for cervical treatments.

Conclusions:

- Vertebral anatomy movement of up to 3 mm within 5 min intervals
- Need for intra-fraction patient monitoring and correction for SRS
Lung SBRT

"The intelligent design of this system is ideal for tracking moving targets in any position, at any time, enabling quick and effective SBRT."

Reinhard Wurm, MD
Klinikum Frankfurt, Oder

SBRT for early-stage lung cancer.

• 4DCT data integration with advanced elastic morphing for automatic ITV contouring
• Precise Monte Carlo dose calculations
• Daily internal adaptation of patient breathing cycle
• Real-time detection and compensation of tumor motion
Lung SBRT
4D CT/PET Lung ITV Outlining

- Gated PET to CT fusion (correlation)
- Metabolic imaging outlining based on Standard Uptake Values (SUVs)
- 4D-series regeneration inside iPlan
- 4D morphing for automatic tumor contouring in multiple phase CTs

Automatic ITV Generation through Elastic Morphing in all Phases of a 4D CT Dataset
Lung SBRT
Realistic Dose Calculations with Monte Carlo Algorithm

• Rx adjustments from Pencil Beam generated clinical knowledge

• Re-definition of SBRT prescription

• Improved tumor control

SBRT Prescription Adjustments Based on Monte Carlo Dose Calculation
Lung SBRT
Gated vs. Non-Gated Treatments

- Significant lung dose reduction with gated delivery
ExacTrac Adaptive Gating
Precise Respiration-Related Tumor Motion Management
ExacTrac Adaptive Gating
Principles and Workflow

1. Respiration cycle recording with IR
2. Stereoscopic x-ray imaging, triggered by respiration cycle
3. Automatic detection of implanted marker
4. Calculation of patient position offset and robotic couch movement
5. Definition of gating window (beam on)
6. Start of gating continued x-ray verification
7. Continued x-ray verification adapting for intra-fraction motion
iPlan Net internet-based planning
Improving accessibility

- Access to treatment planning from any existing network PC through the hospital’s VPN or over internet
- Connecting satellite facilities & remote users
- Multiple-licenses simultaneously
- Session Sharing: Real-time access to any iPlan® from different client computers in parallel offers work sharing or approval
- Load Balancing: Resource optimization for multiple iPlan® Net servers with automatic selection of the best suitable server for any application
iPlan AVM Segmentation
3D Rotational Angiography

- 3D RA to CT correlation
- Threshold segmentation for AVM nidus
- 55 degrees/s acquisition time

Vessel and AVM Nidus Definition on 3D RA Imaging
AVM Radiosurgery
Single fraction, 16Gy, delivery with 5 Dynamic Conformal Arcs

- 90% IDL prescription definition
- DSA or 3D-RA AVM nidus definition
- Frameless Mask Fixation
- Pencil Beam calculations

Patient courtesy of T. Solberg Ph.D.
Adaptive Radiotherapy
On-Line Analysis Tools

- iPlan Original Treatment Plan
- CBCT Import and IGRT Registration
- Elastic Deformation of Treatment Planning CT to Daily CBCTs
- Target Response to Radiation and Display of Daily Treatment Position Fluctuation
- Decision Support for Re-Planning Based on Volumetric Comparisons
- Physician Evaluation View for Adaptive Re-Planning Decision Making
HybridArc Planning
Combining Dynamic Conformal Arc with fixed IMRT fields

- Coplanar and non-coplanar HybridArc planning
HybridArc for Cranial Radiosurgery
Non-Coplanar HybridArcs for Meningiomas

- Non-Coplanar radiosurgery planning for adequate OAR sparing
- Normal Tissue dose reduction compared to IMRT
- Improved Brainstem and Chiasm dose sparing compared to Dynamic Conformal Arc

Rx: 3 Non-Coplanar HybridArcs with Highly Conformal Dose Coverage
HybridArc for Cranial Radiosurgery
Comparison to IMRT

- Homogeneous target dose coverage
- Reduced dose into normal tissue
- Improved OAR sparing
- Faster delivery
- Simplified QA
HybridArc for Cranial Radiosurgery
Comparison to IMRT

HybridArc = Solid
IMRT = Dashed
HybridArc for Spine Radiosurgery
1 HybridArc with 4 IMRT fields

- Reduced dose to normal tissue with IMRT grade spine sparing
- Seamless planning for PTV + Boost requirements
- Short treatment times
- Full treatment plan generation under 5 min