

CONVEGNO DEL GRUPPO REGIONALE PIEMONTE - LIGURIA - VALLE D'AOSTA



Associazione
Italiana
Radioterapia
Oncologica

Radiochirurgia e Radioterapia stereotassica: non solo tecnica



Genova
25 MARZO
2017

E.O. Ospedali Galliera

SBRT e SRS: EVOLUZIONE TECNOLOGICA

FERNANDO MUNOZ

TomoTherapy Center
Ospedale di Aosta

TomoTherapy Center-Aosta



The Past

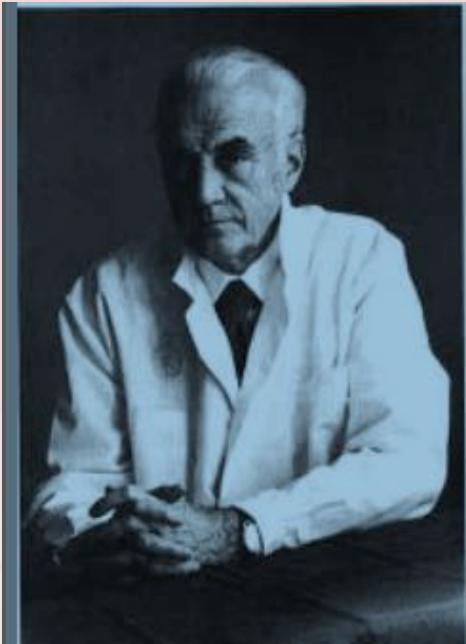
“Rich only in hope, possessing only incomplete information, incapable of offering precise techniques, adapted to diverse forms of cancer, radiotherapy has, however, obtained definite cures in cases incurable by surgery.”

– Henri Coutard (1937)

Historical Landmarks in SBRT

1951-1958

Year	Author	Location	Event
1951	Leksell	Stockolm	Intervention of “Steretoactic Radiosurgery using rotating orthovoltage unit
1954	Lawrence	Berkeley	Use of heavy particle for pituitari for cancer pain
1962	Kiellberg	Boston (Harvard Cyclotron)	Use od proton beam for intracranial radisurgery
1967	Leksell	Stockolm	Intervention of Gammaknife using Co sources
1970	Steiner	Stockolm	Use Gammaknife for AVM's
1980	Fabrikan	Berkeley	Use helium ion for AVM's



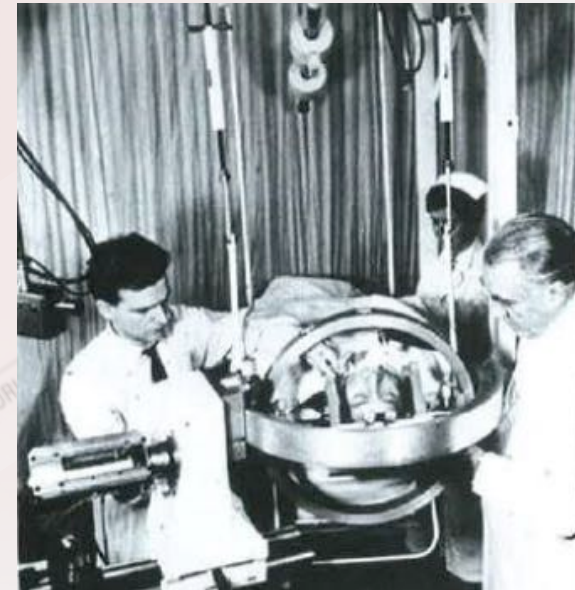
The Past of SBRT

Lars Leksell:

- Coined term of radiosurgery
- First procedure with orthovoltage
- After initially experimenting with particle beam, designed Gammaknife with 179 cobalt -60 source in a hemisphere array



Orthovoltage X ray tube



Particle beam

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The Past of SBRT



John H. Lawrence

- Joined his brother Ernest Lawrence (1939 Nobel Prize for developing cyclotron)
- Explore potential use of cyclotron-produce radioisotopes and nuclear radiation
- By 1954 Lawrence use heavy particle for treating pain in pituitary cancers

Raymond Kjellberg

- Pionered the first treatment of pituitary tumors using proton beam radiosurgery at the Harvard cyclotron

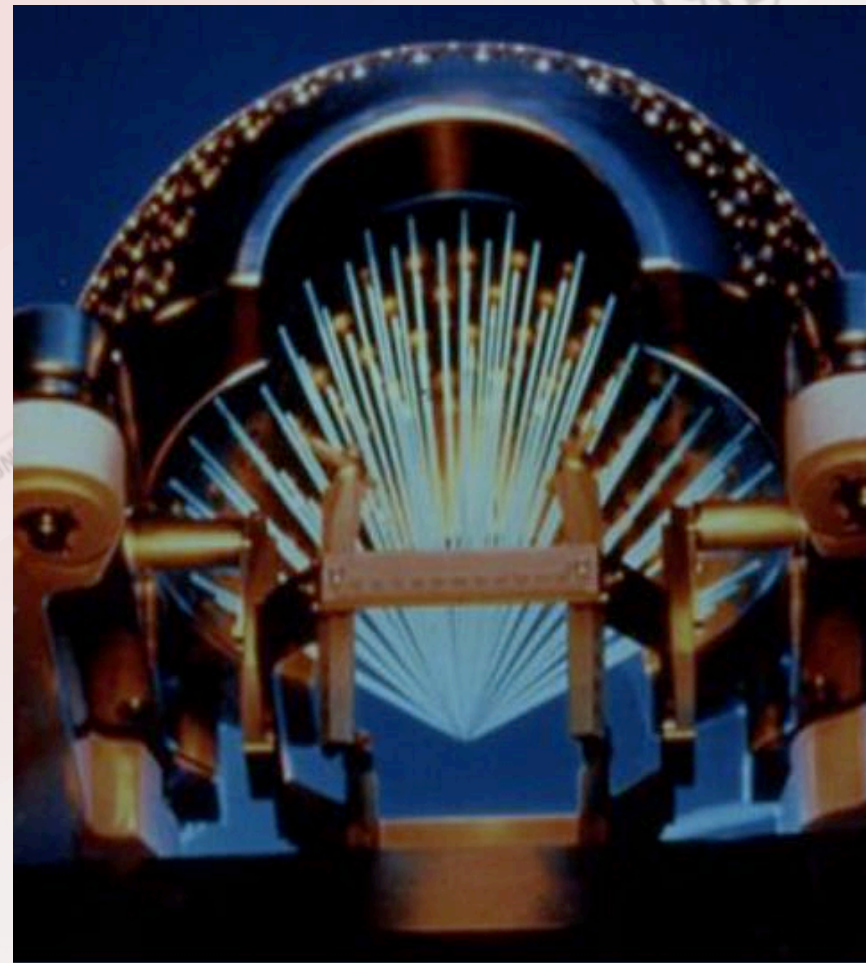


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Gamma Knife



Historical Landmark

1983-1993

Year	Author	Location	Event
1982	Betti Colombo	Buenos Aires Vicenza	Indipendent developments of a system adapting LINAC's for radiosurgery
1986	Winston/Lutz	Harvard	Developments of LINAC based SRS based on common stereotactic frame
1987	Lindsford	Pittsburgh	First Gamma Knife in the USA
1991	Friedman/Bova	Florida	Development od a more reliable technique for highly conformal radiosurgery
1991	LAX/Blomgren	Karolinska	First proposed SBRT
1992	Loeffler/Alexander	Boston	Boston First commercially built dedicated SRS LINAC (Varian- SRS)
1993	Laing	Boston	Gill-Thomas Cosman relocable frame

The Past of SRT



Ladislau Steiner

Worked at Karolinska for over 25 y before spending the remaining career at University of Virginia at Charlottesville since 1987
Pioneer in *radiosurgery for AVM's*

Federico Colombo

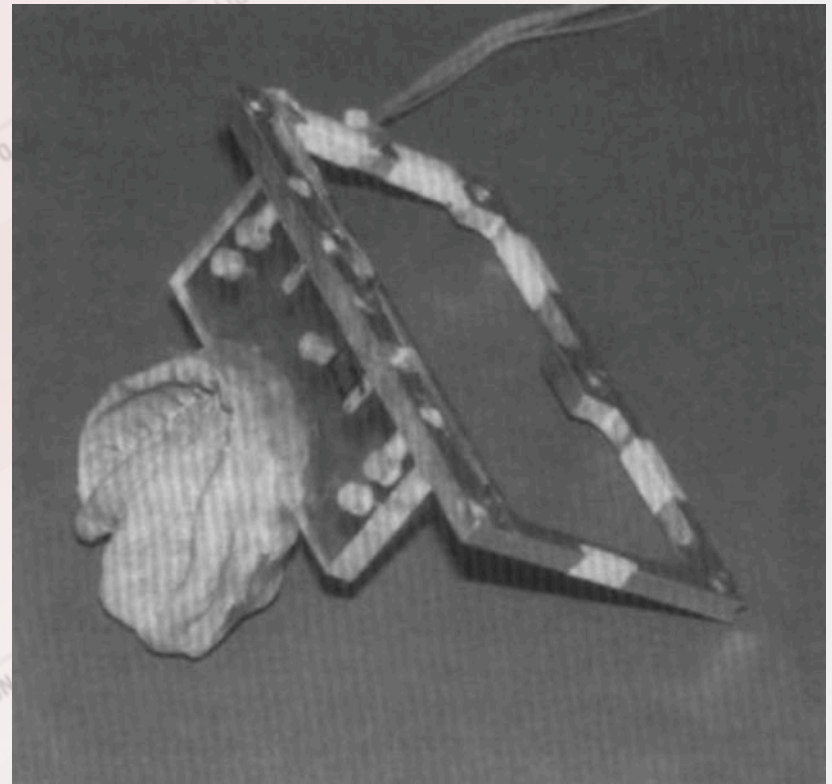
Developed a system for radiosurgery using LINAC for treatment of AVM's



Winston/Lutz

At Boston published the first systematic study of SRT System performance tests that established the localization and treatment delivery accuracies LINAC Radiosurgery treatments

Refining radiosurgery for flexibility with optical tracking



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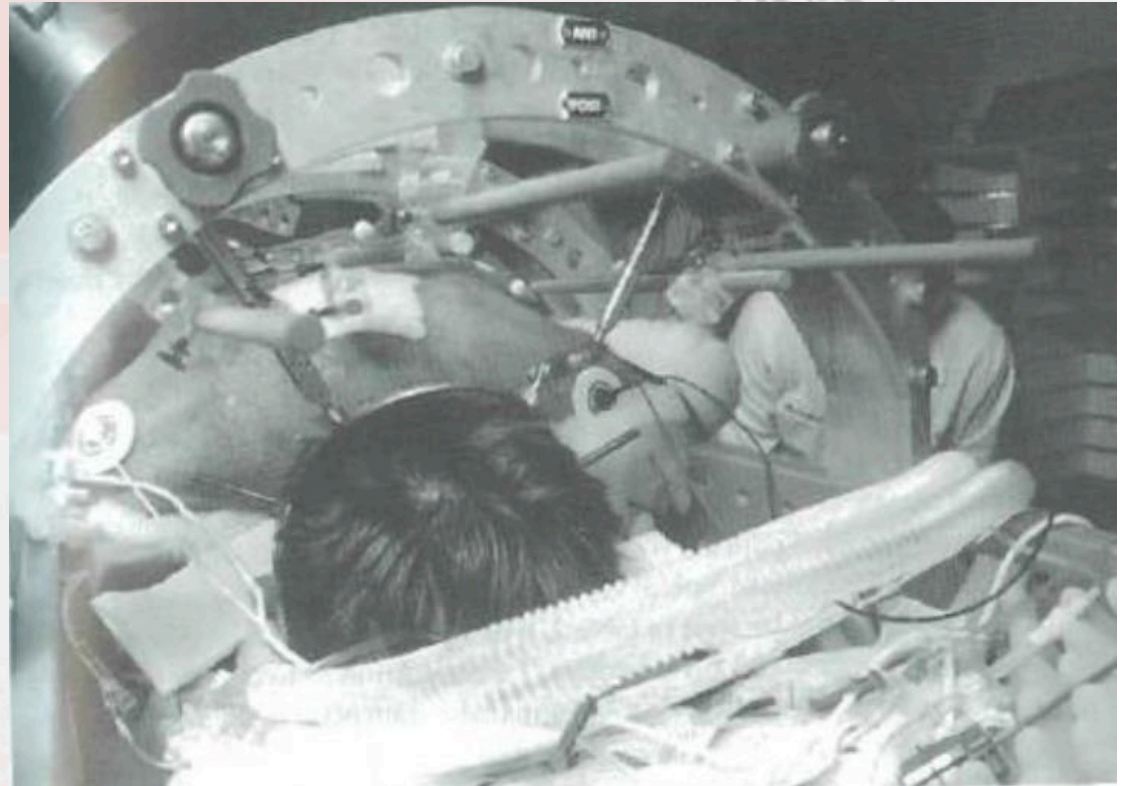
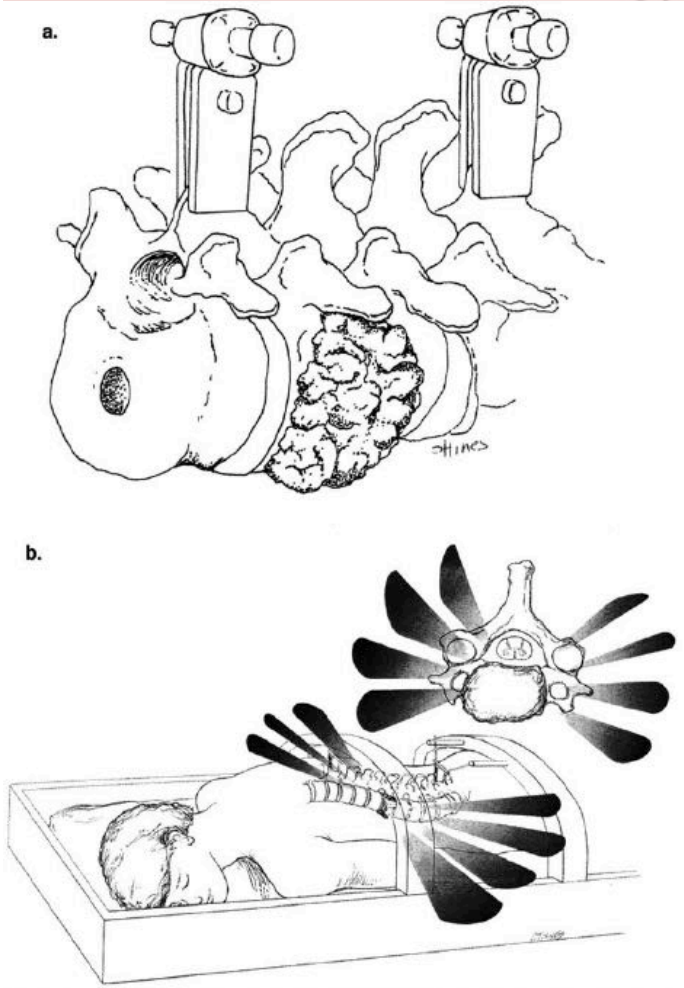
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REGIONE
VALLE D'AOSTA

CONVEGNO DEL GRUPPO

CONVEGNO DEL GRUPPO REGIONALE

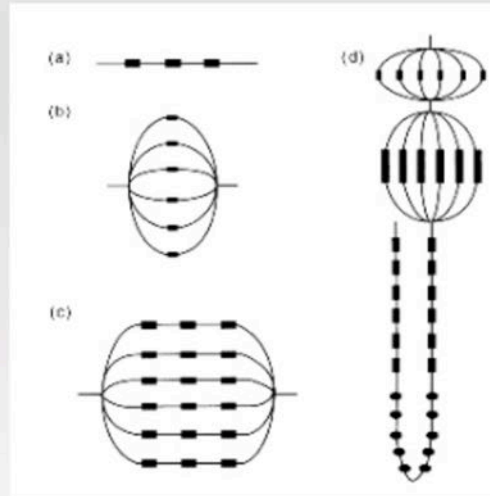
Hamilton rigid stereotactic spine frame



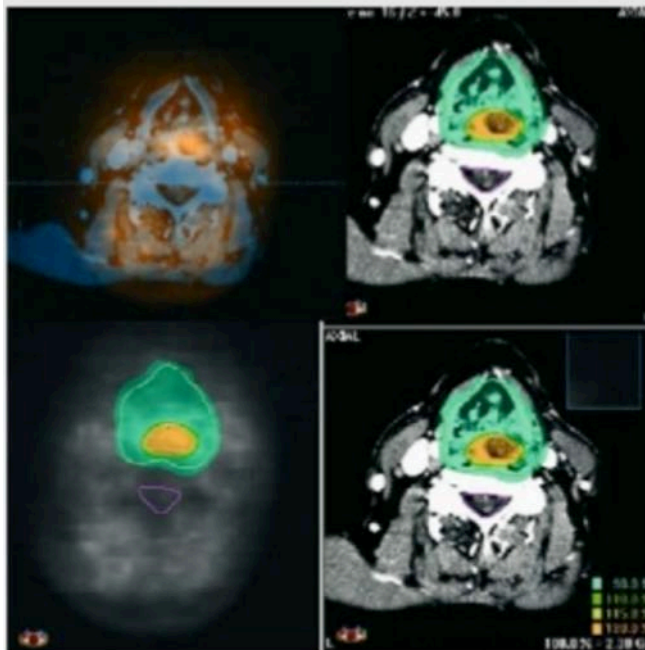
Hamilton et al Neurosurgery 36(29,311-19, 1995
Hamilton et al Stereo Funct NS, 1995

“The greatest difficulty in the world is not for people to accept new ideas, but to make them forget about old ideas.”

- John Maynard Keynes



- Normal critical structures whose radiation sensitivity may **significantly** influence treatment planning and/or prescribed dose.
- A planning organ at risk volume (**PORV**) is added to the contoured organs at risk to account for the same uncertainties in patient setup and treatment as well as organ motion that are used in the delineation of the PTV.
- Each organ is made up of a functional subunit (**FSU**)



- A target volume that incorporated data from molecular imaging techniques
- Target volume drawn incorporates information regarding:
 - Cellular burden
 - Cellular metabolism
 - Tumor hypoxia
 - Tumor proliferation
 - Intrinsic Radioresistance or sensitivity



- **Prostate:**

- Motion max in SI and AP
- SI 1.7 - 4.5 mm
- AP 1.5 - 4.1 mm
- Lateral 0.7 - 1.9 mm
- SV motion > Prostate

- **Uterus:**

- SI: 7 mm
- AP : 4 mm

- **Cervix:**

- SI: 4 mm

- **Rectum:**

- Diameter: 3 - 46 mm
- Volumes: 20 - 40%
- In many studies decrease in volume found

- **Bladder:**

- Max transverse diameter mean 15 mm variation
- SI displacement 15 mm
- Volume variation 20% - 50%

- **Liver:**

- Normal Breathing: 10 - 25 mm
- Deep breathing: 37 - 55 mm

- **Kidney:**

- Normal breathing: 11 -18 mm
- Deep Breathing: 14 -40 mm

- **Pancreas:**

- Average 10 -30 mm

- **Lung:**

- Quiet breathing
 - AP 2.4 ± 1.3 mm
 - Lateral 2.4 ± 1.4 mm
 - SI 3.9 ± 2.6 mm
- 2° to Cardiac motion: 9 ± 6 mm lateral motion
- Tumors located close to the chest wall and in upper lobe show reduced interfraction motion.
- Maximum motion is in tumors close to mediastinum

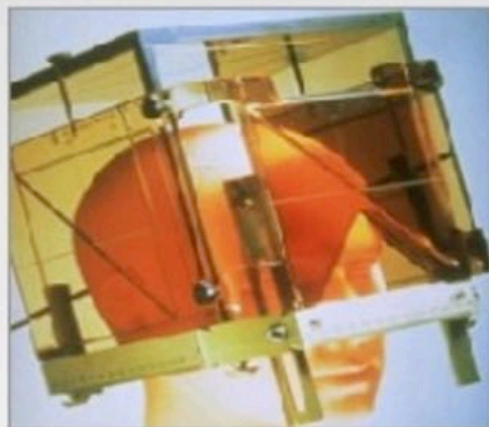




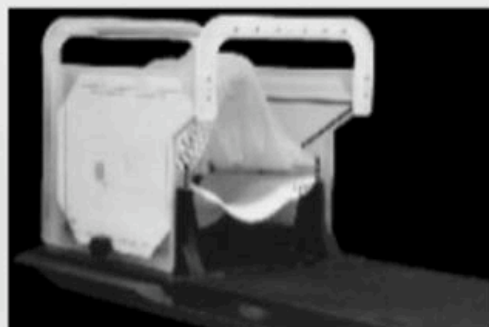
Body Fix system

Elekta Body Frame

System	Technique	Setup Accuracy
Noninvasive Stereotactic frame	Non invasive, mouthpiece	0.7– 0.8 mm (\pm 0.5–0.6 mm)
Latinen Frame	Non invasive, nasion, earplugs	x = 1.0 mm \pm 0.7; y= 0.8 mm \pm 0.8; z = 1.7 mm \pm 1.0
GTC Frame	Non invasive, mouthpiece	X = 0.35 mm \pm 0.06; Y = 0.52 mm \pm 0.09; Z= 0.34 mm \pm 0.09
Stereotactic Body Frame	Non invasive, vaccum based	X = 5 – 7 mm ,Y = 1 cm Z = 1.0 cm (mean)
Heidelberg frame	Non invasive, vaccum based	X = 5 mm,Y = 5 mm, Z = 10 mm (mean)
Body Fix Frame	Non invasive, Vaccum based with plastic foil	X = 0.4 \pm 3.9 mm , Y = 0.1 \pm 1.6 mm Z = 0.3 \pm 3.6 mm. Rotation accuracy of 1.8 \pm 1.6 degrees.



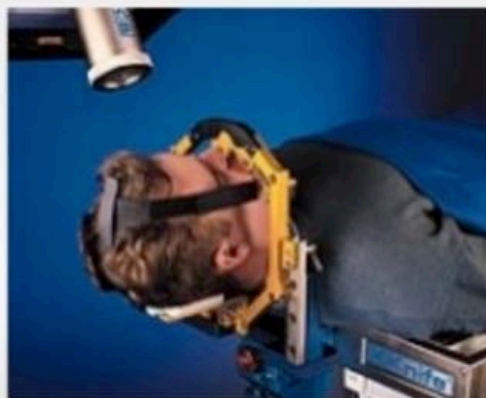
Leksell Frame



BrainLab System



TLC System



Gill Thomas Cosman System

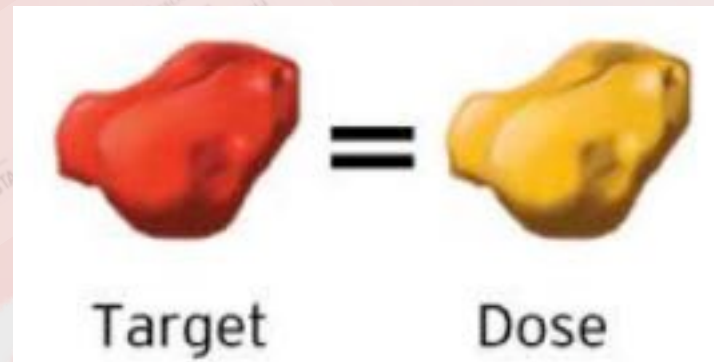
ubuntu

The Present

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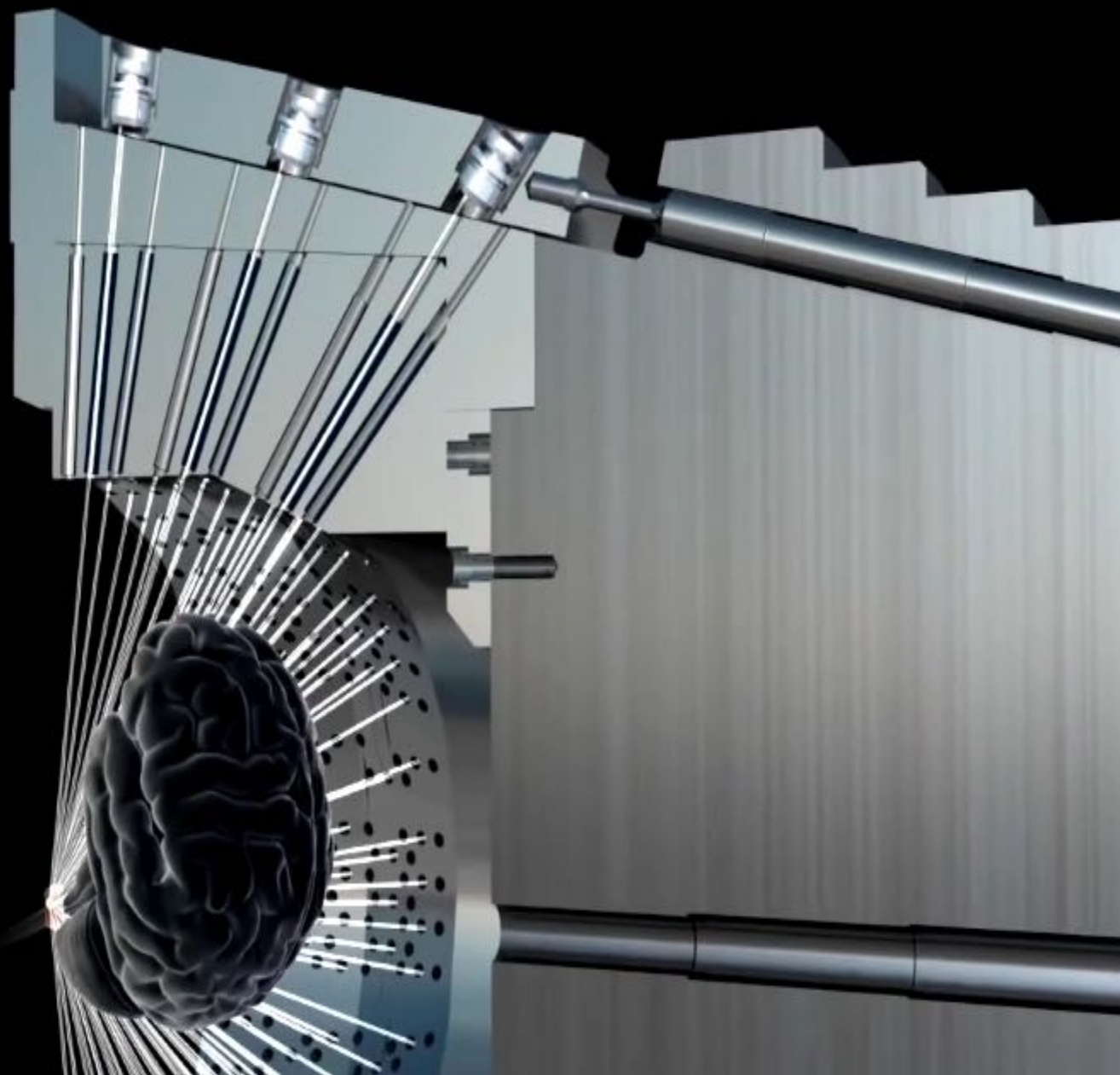


Sterotactic Radiotherapy



- Technique of delivering high dose radiation to a specific target while delivering minimal dose to surrounding tissues
- Derived from Greek word, Stereo=tridimensional space and taxis= to arrange
- Unit used:
GammaKnife, LINAC with special colimators or micro MLC, CiberKnife, Heavy particles, TomoTherapy

Endless abilities for
dose sculpturing



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CONVENTIONAL LINACS



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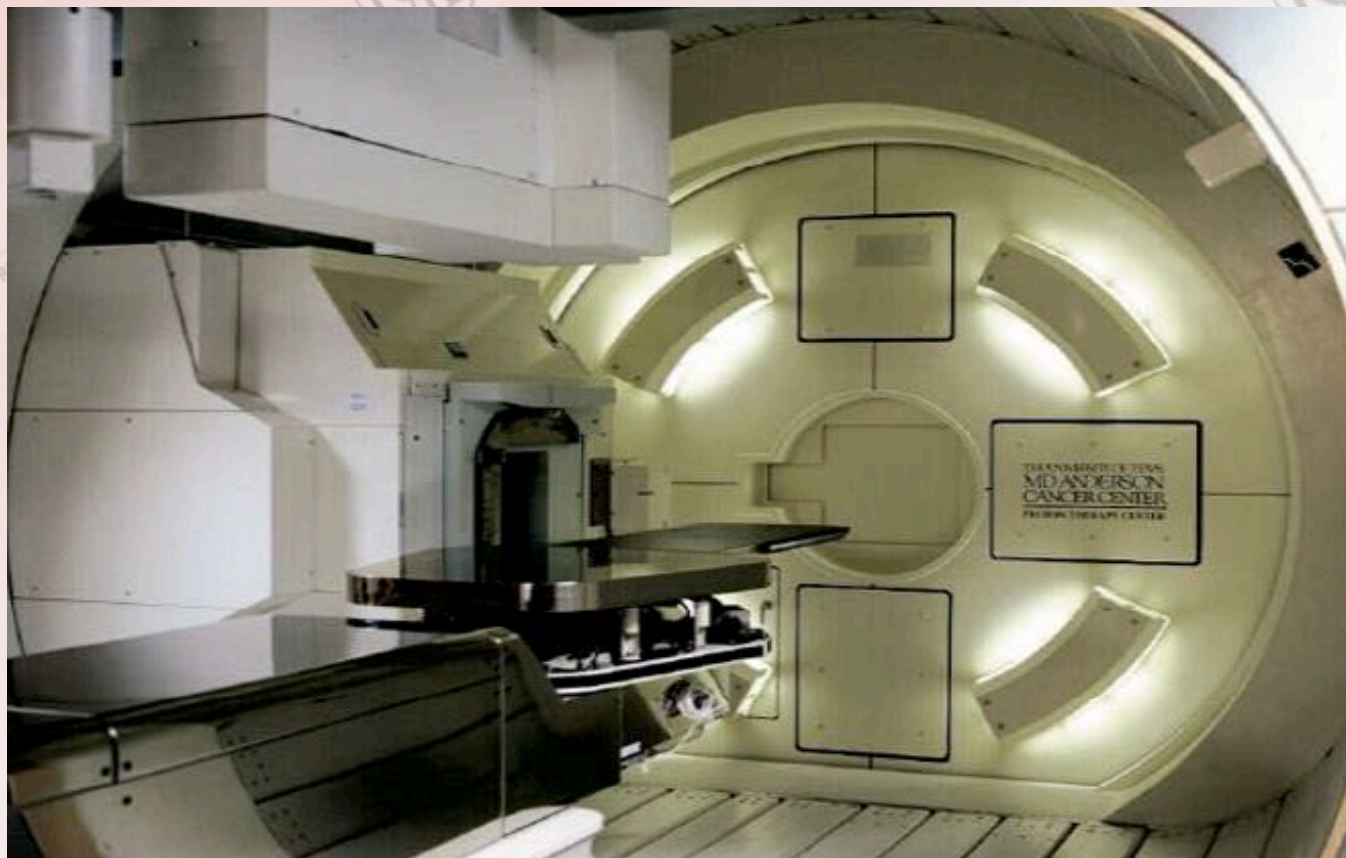


- Conventional LINAC aperture modified by a tertiary collimator.
- Two commercial machines
 - Varian Trilogy
 - Novalis



ubuntu

Proton beam



The Future



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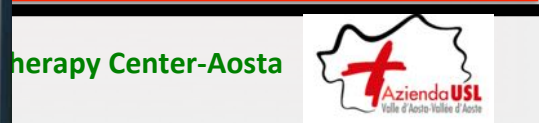
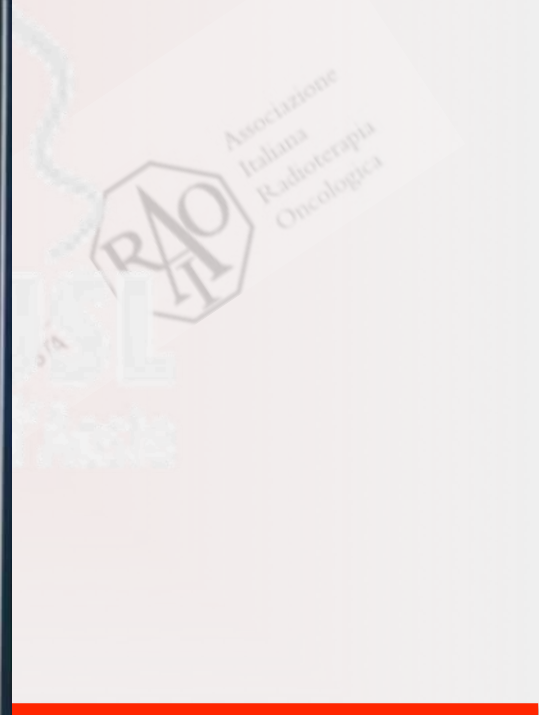
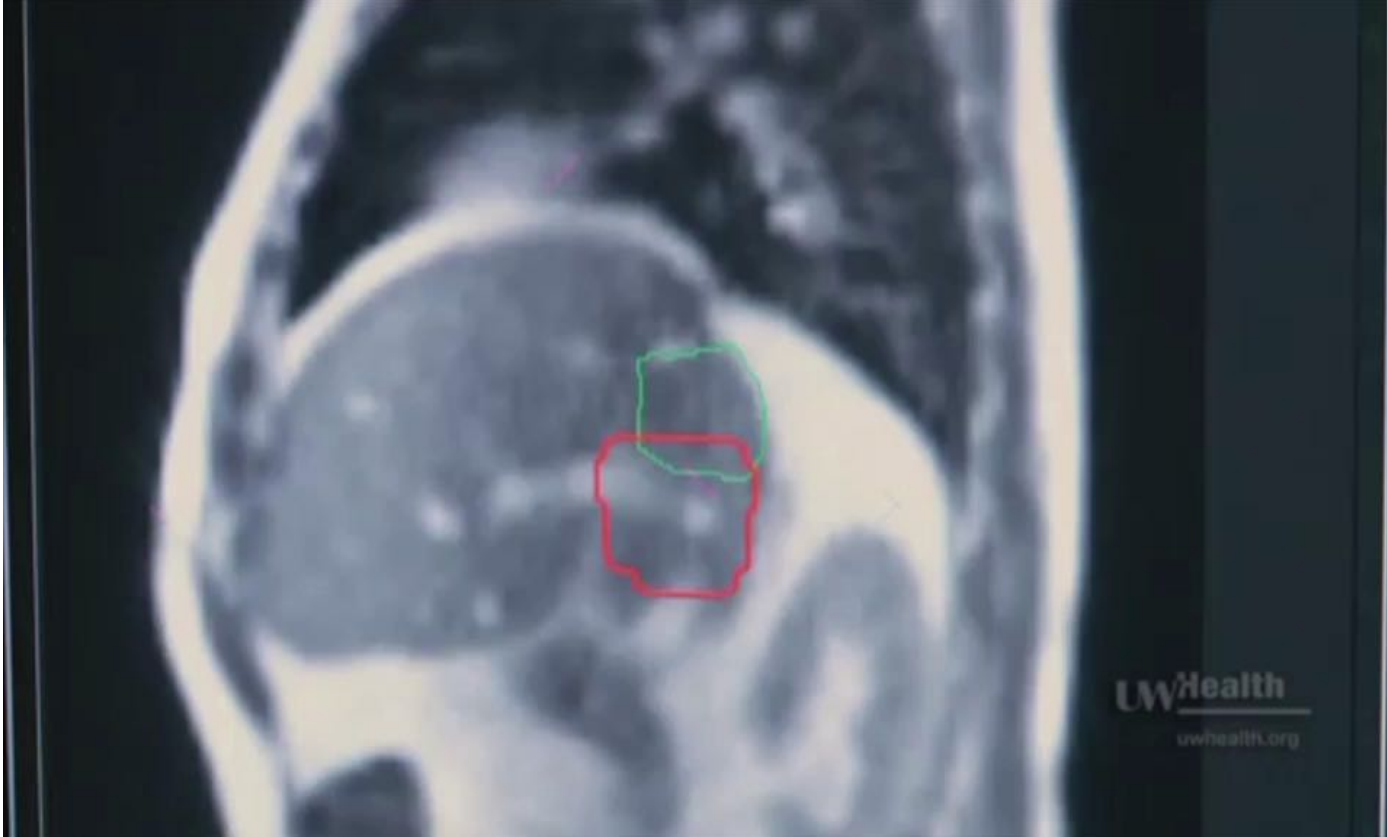
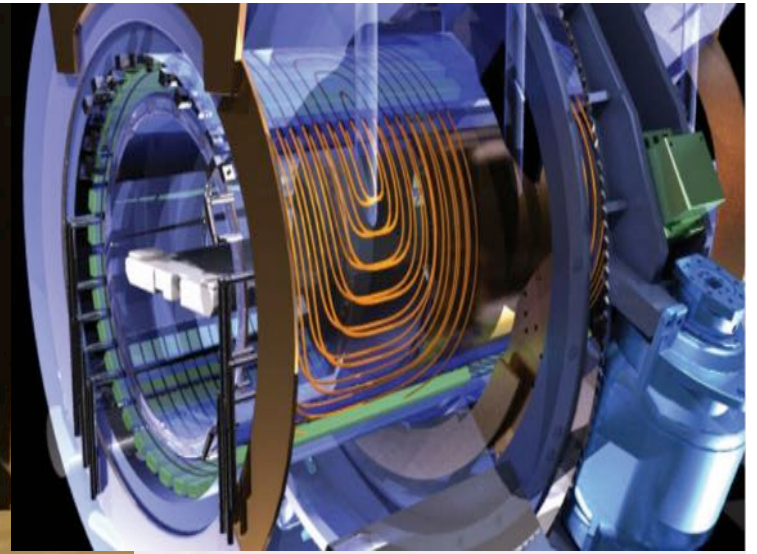


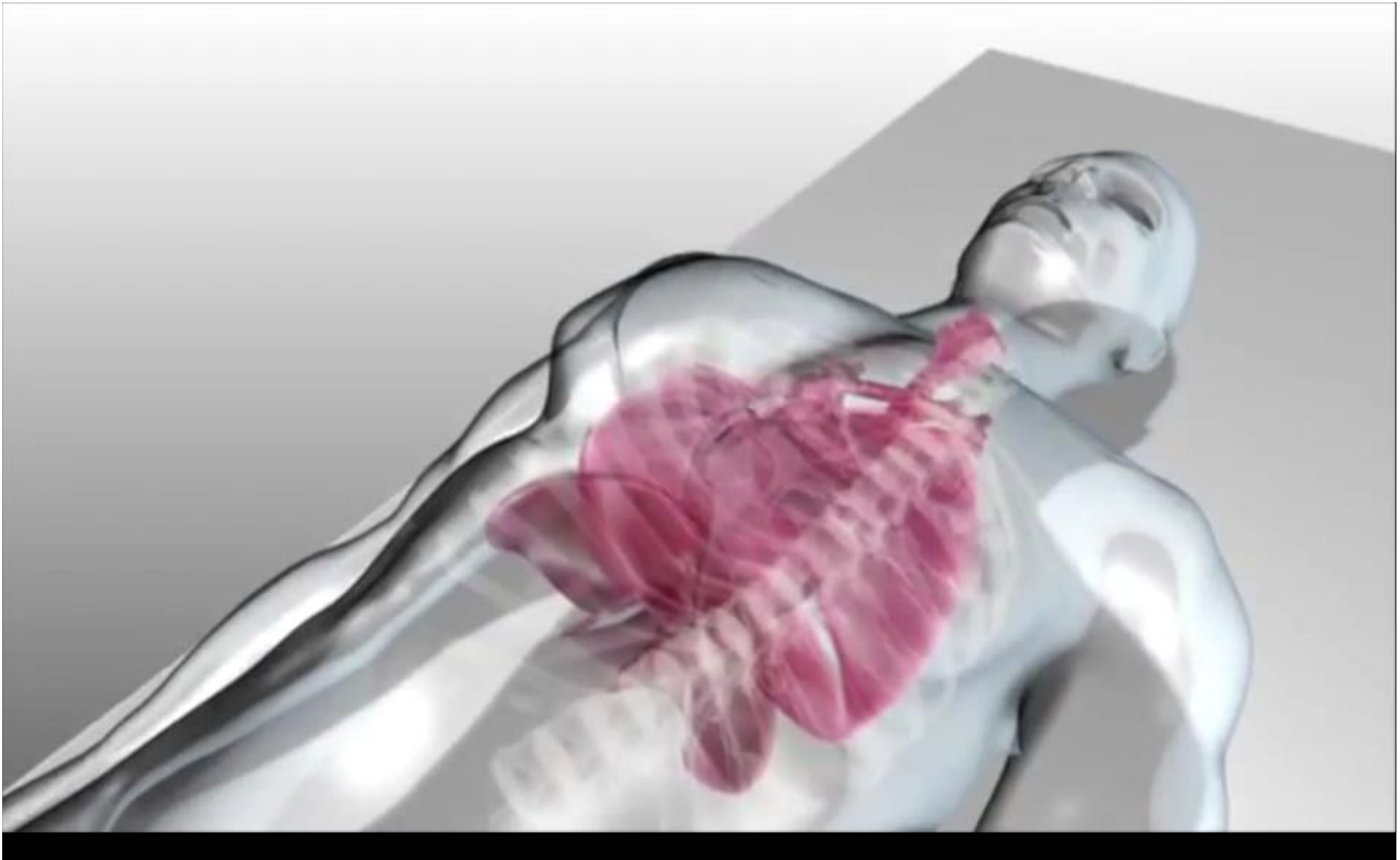
Azienda USL
Valle d'Aosta Valle d'Aoste

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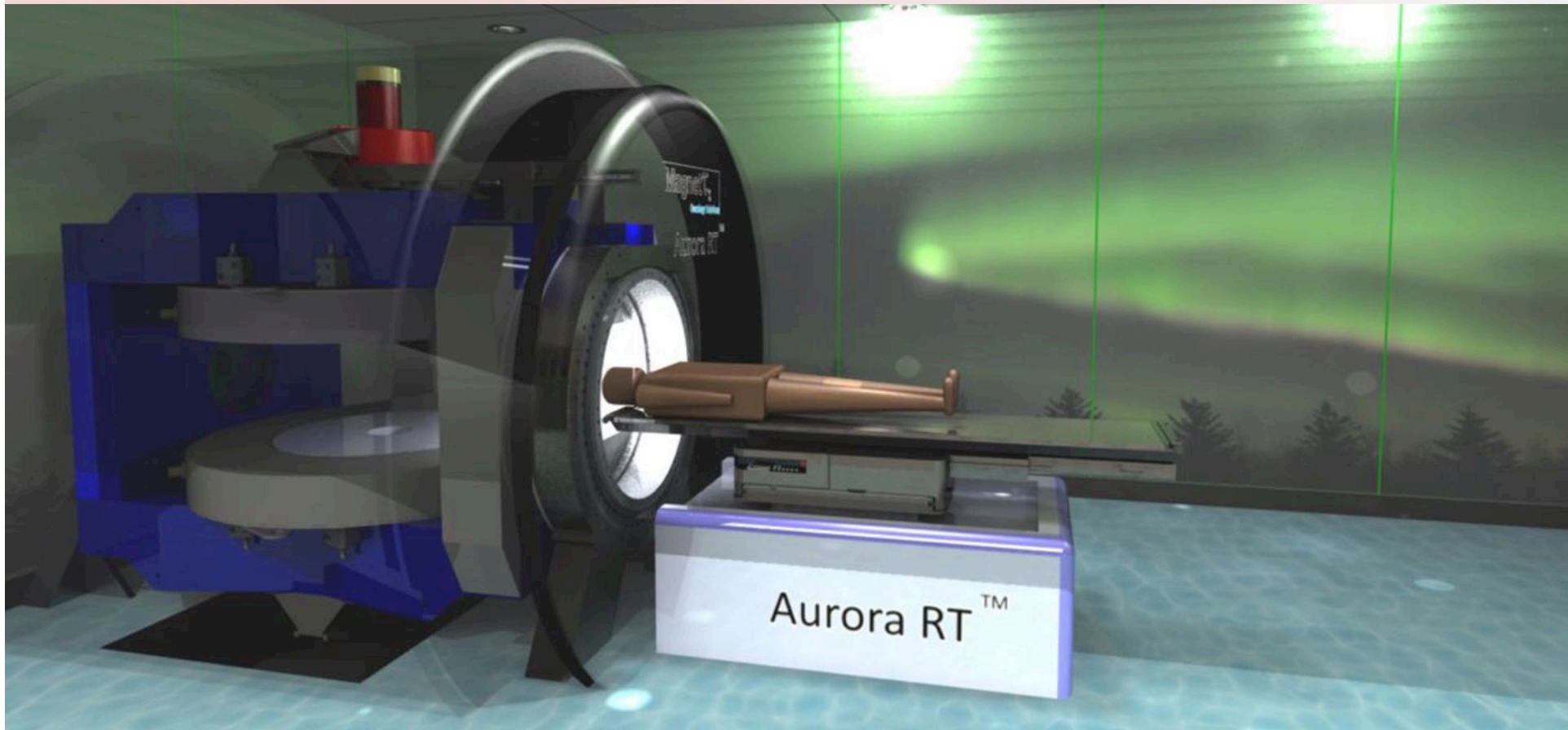




CONTENUTO DEL GRUPPO REGIONALE

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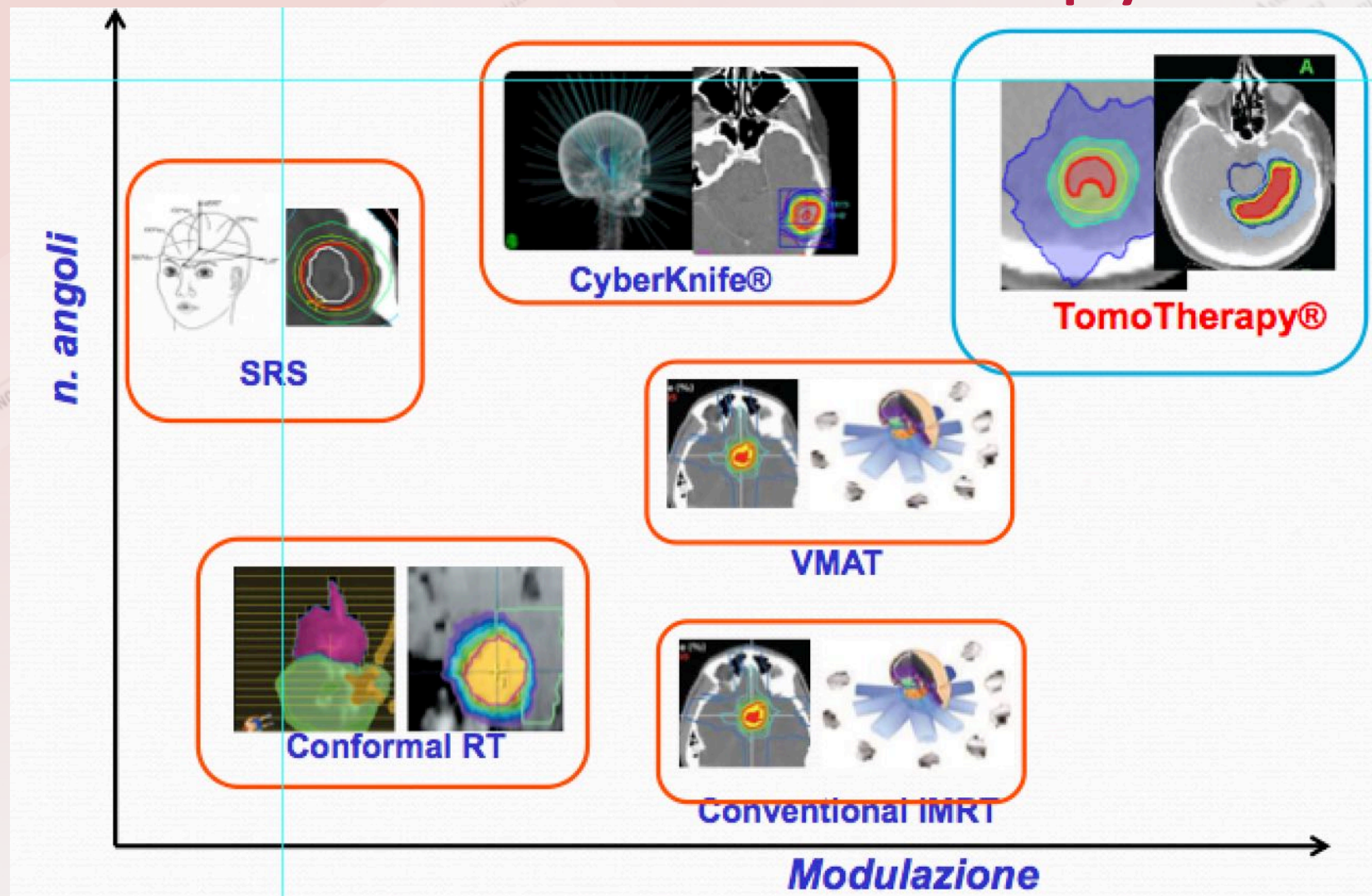


Aurora RT™

TomoTherapy Center-Aosta



Sterotactic Radiotherapy



“Bridging the time since it took its first faltering steps, radiation therapy is today a healthy adult: acclaimed and acknowledged in all intellectual medical centers as a highly specialized integral part of the practice of medicine.”



- Alert Soiland (1944)