

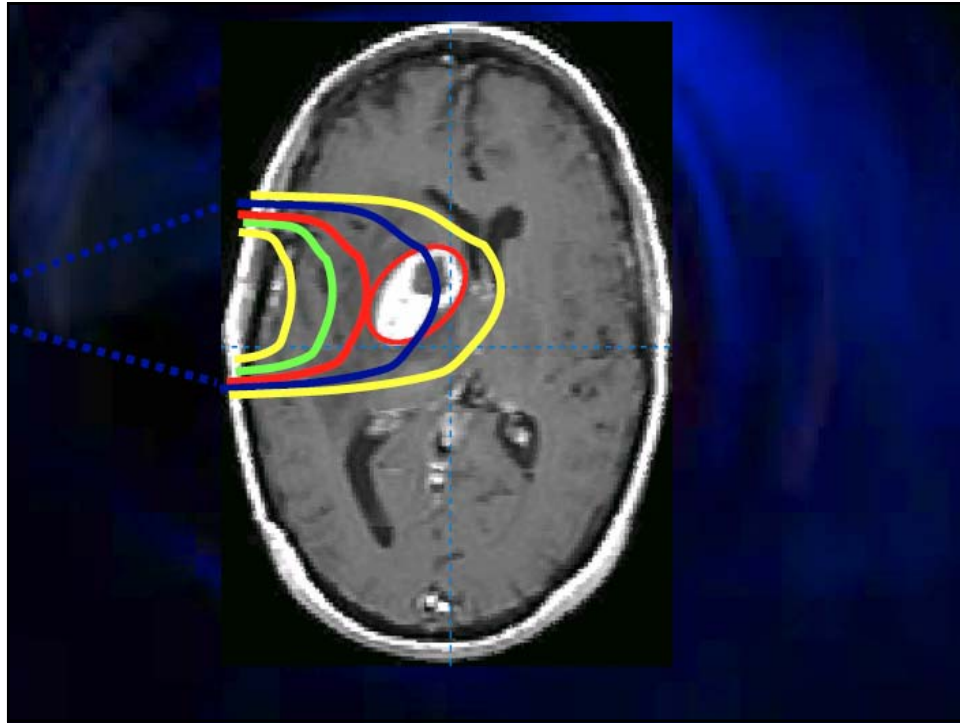
An Introduction to Gamma Knife Radiosurgery



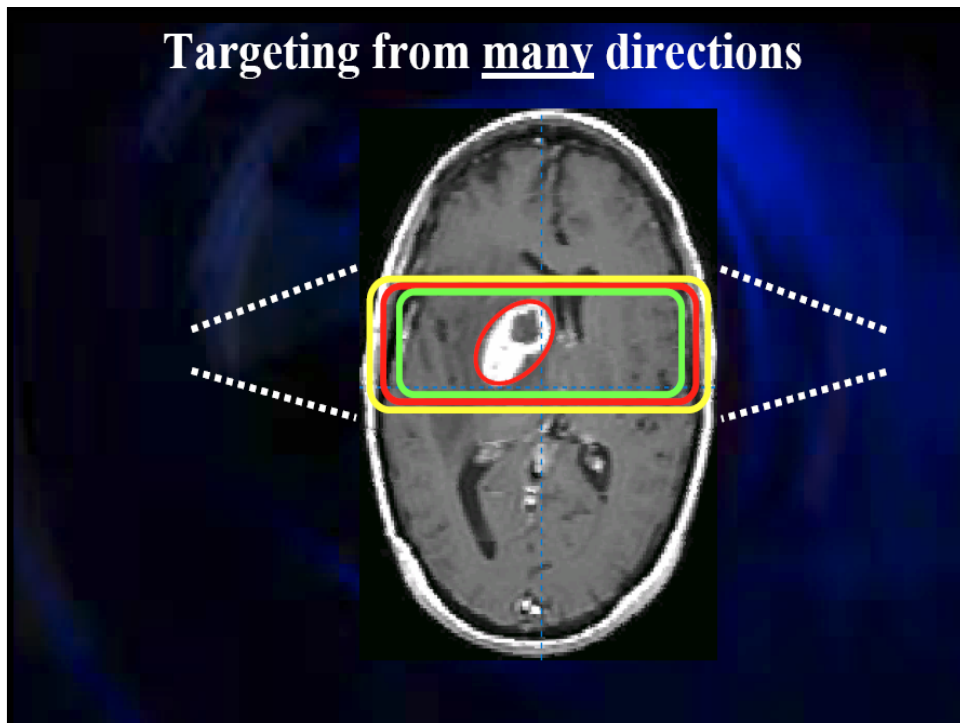
What is Stereotactic Radiosurgery (SRS)?

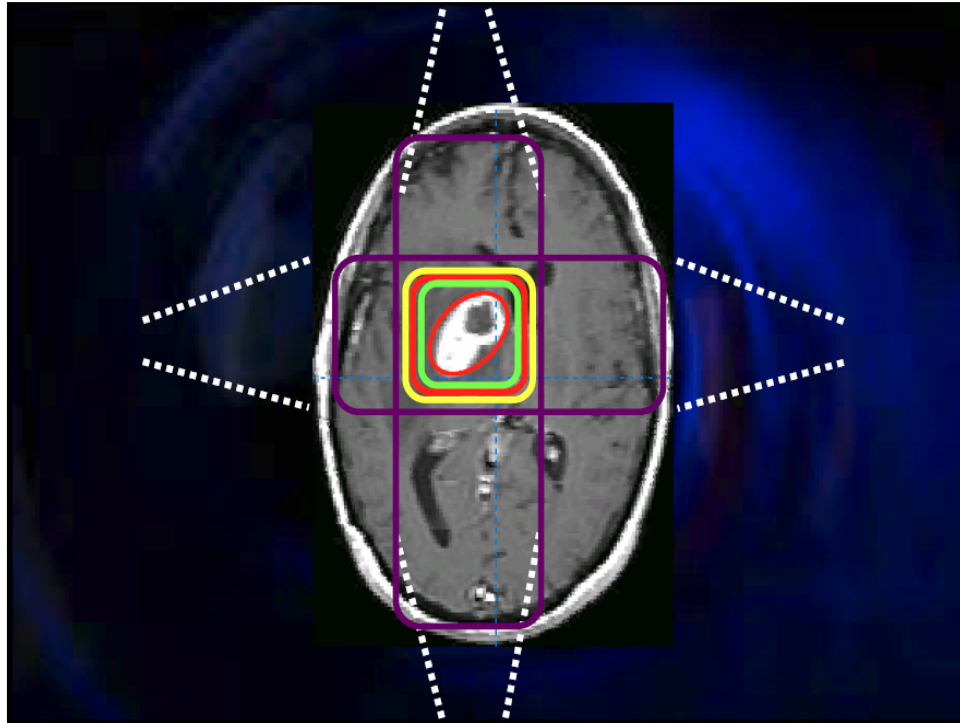
- The delivery of multiple intersecting beams of RT to a radiographically discrete treatment volume using precise localization in order to ablate a target.
- This results in a rapid fall-off of dose at the edge of the target volume and a clinically insignificant dose to adjacent normal tissue.





Targeting from many directions



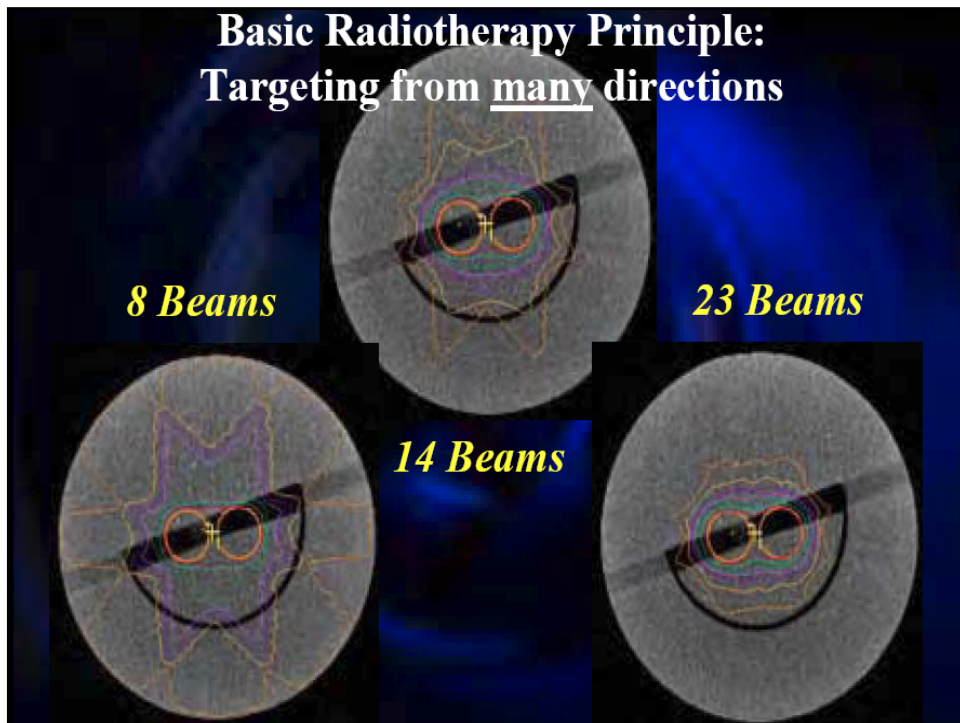


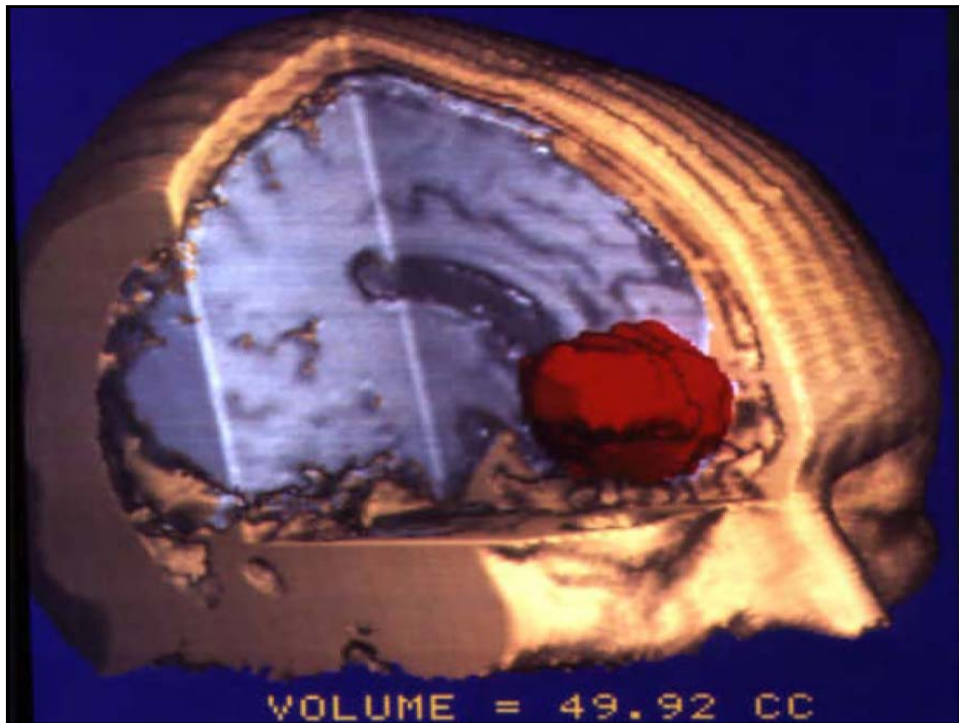
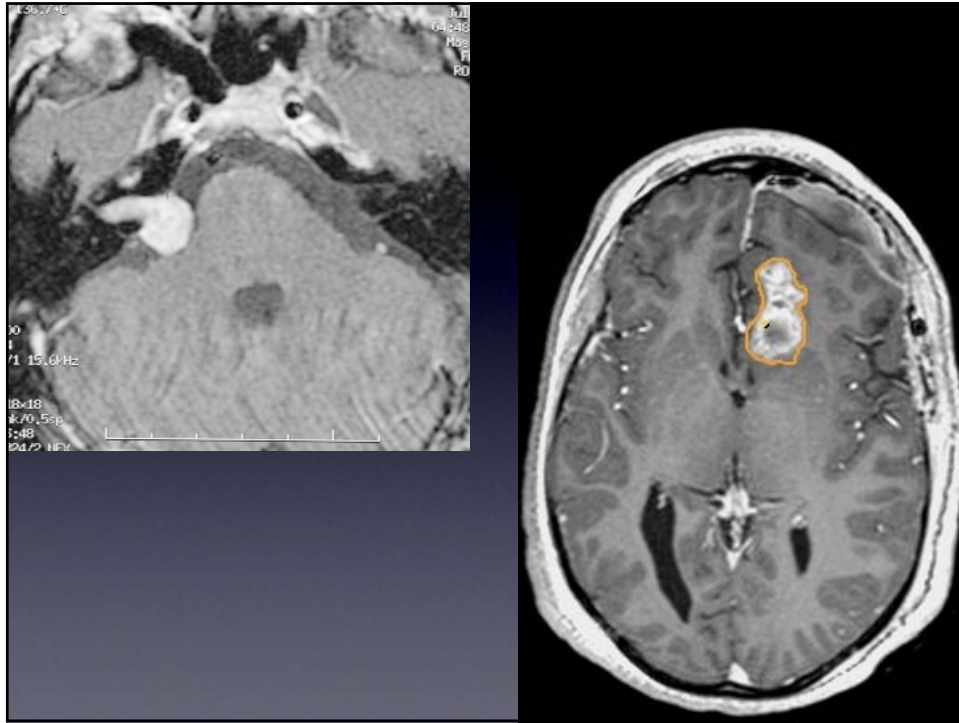
**Basic Radiotherapy Principle:
Targeting from many directions**

8 Beams

23 Beams

14 Beams



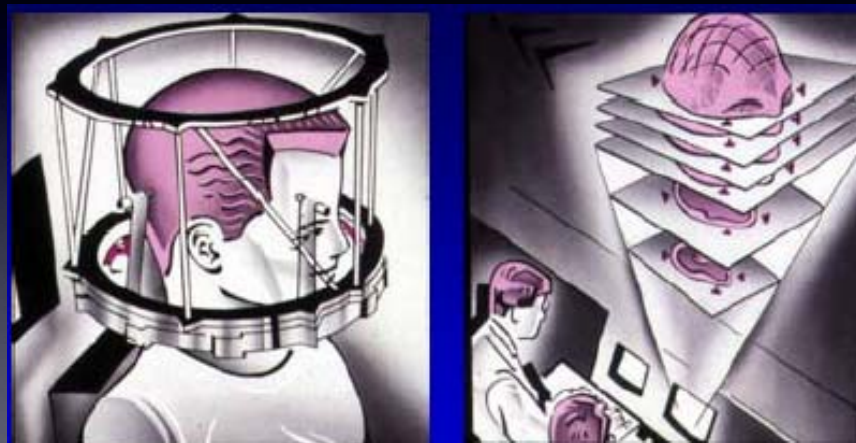


Precise Localization

- The patient's head is immobilized in a stereotactic head frame.
- This ensures that the patient's head position in space is reproducible between treatment planning and the actual treatment.



This is accomplished by placement of a Stereotactic headframe for 3-D localization...

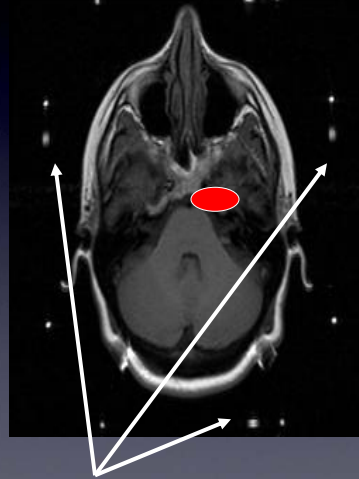


...which allows correlation of
internal anatomy with **external**
markers

- The head frame fiducials are visible on the MRI.

- This allows us to determine the target “coordinates” in an X,Y,Z plane.

- We can therefore orient our beamlets in a conformal fashion



External markers giving 3D localization



Different Ways that RT kills cancer cells...

1. Causes Apoptotic Death (cells detect RT, then die)
Lowest dose
2. Causes Mitotic Death (when cells divide, they die)
Medium dose
3. Causes Necrosis of cells (direct disruption of cell functions)
Highest dose



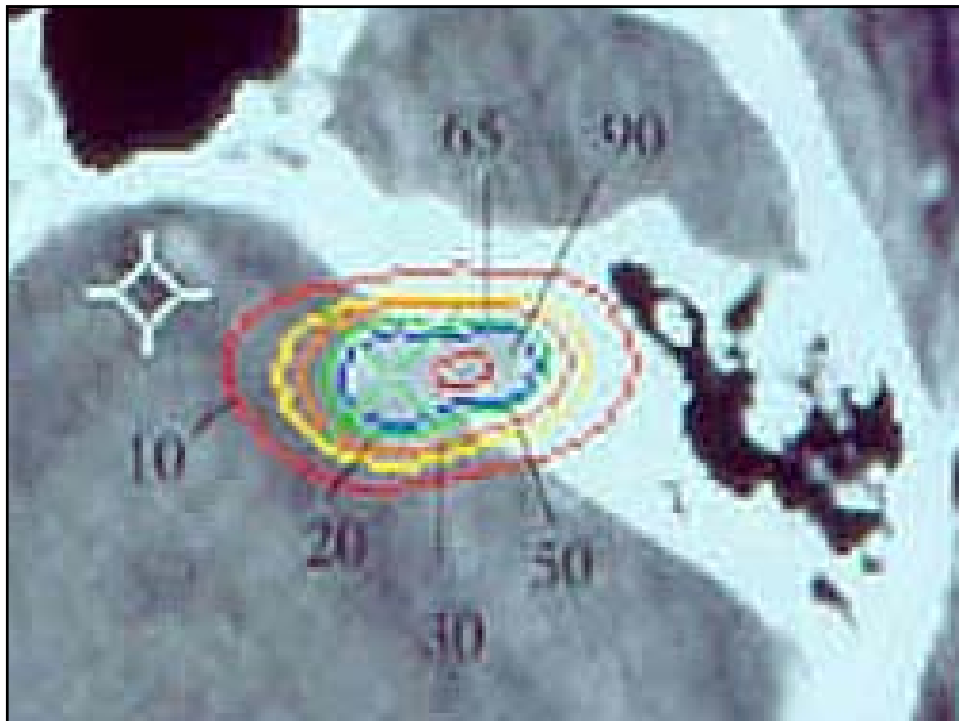
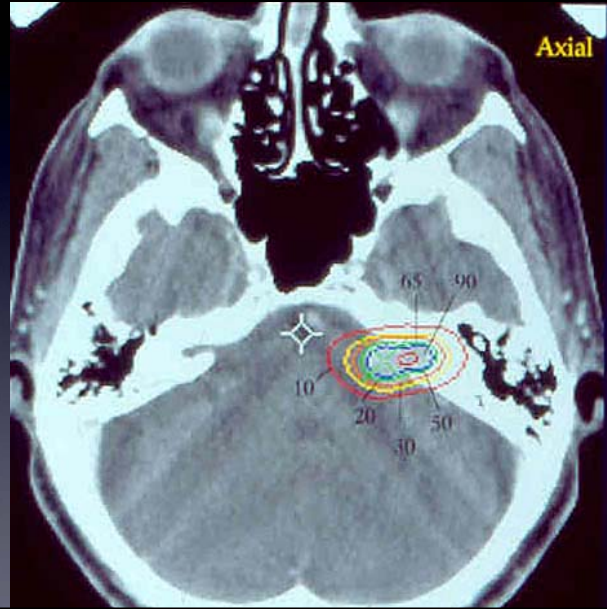
- Conventional RT is delivered over several smaller fractions to take advantage of the biological differences b/w normal and malignant tissue.
- The smaller RT dose allows normal tissue to recover during therapy, but is just high enough to cause a mitotic cell death (or apoptosis) in rapidly dividing cells.



- Radiosurgery is considered ablative. It is capable of killing all cells in its target volume by necrosis or mitotic death, and its dose is above the threshold that would allow normal cells an opportunity to repair.
- It relies on *geometric accuracy* rather than *biology* to elicit its effect and needs a discrete target volume.



Rapid Dose Fall-off



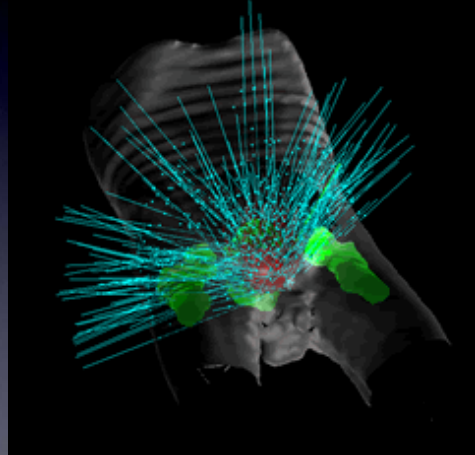
What are the different ways to deliver SRS?



1. X-knife



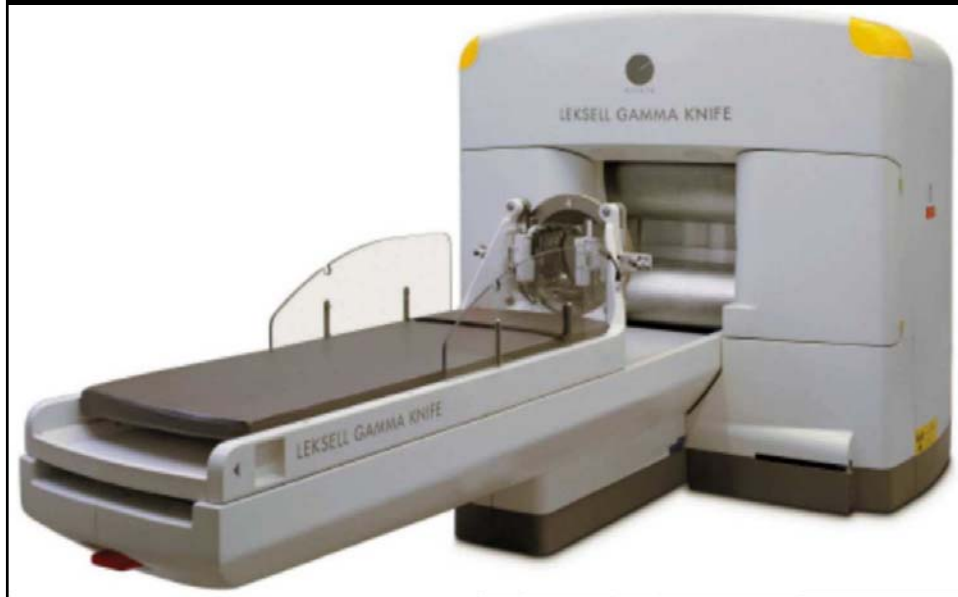
2. Cyberknife



3. Proton Beam



4. Gamma Knife



How does Gamma Knife work?

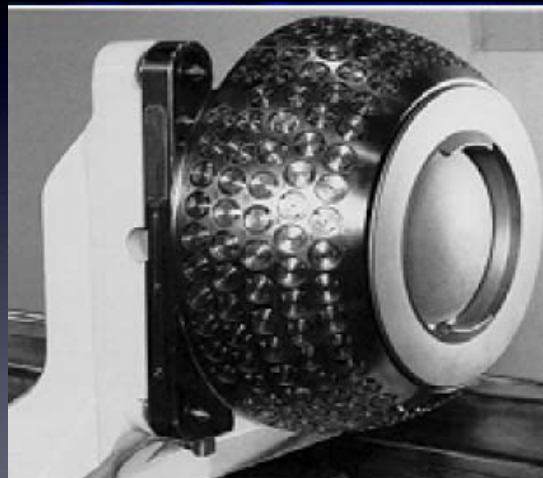
- Utilizes 201 radioactive sources (cobalt-60, which has a half-life of 5 years).



The sources are stored in a very thick lead housing unit...

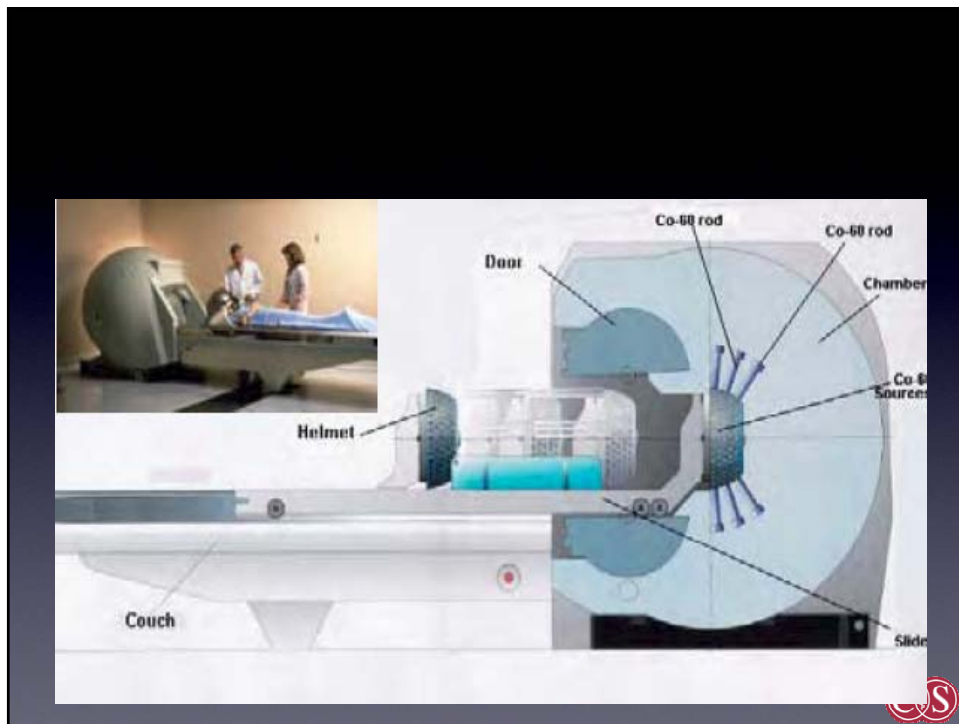


The sources are arranged concentrically around a 'helmet' ...



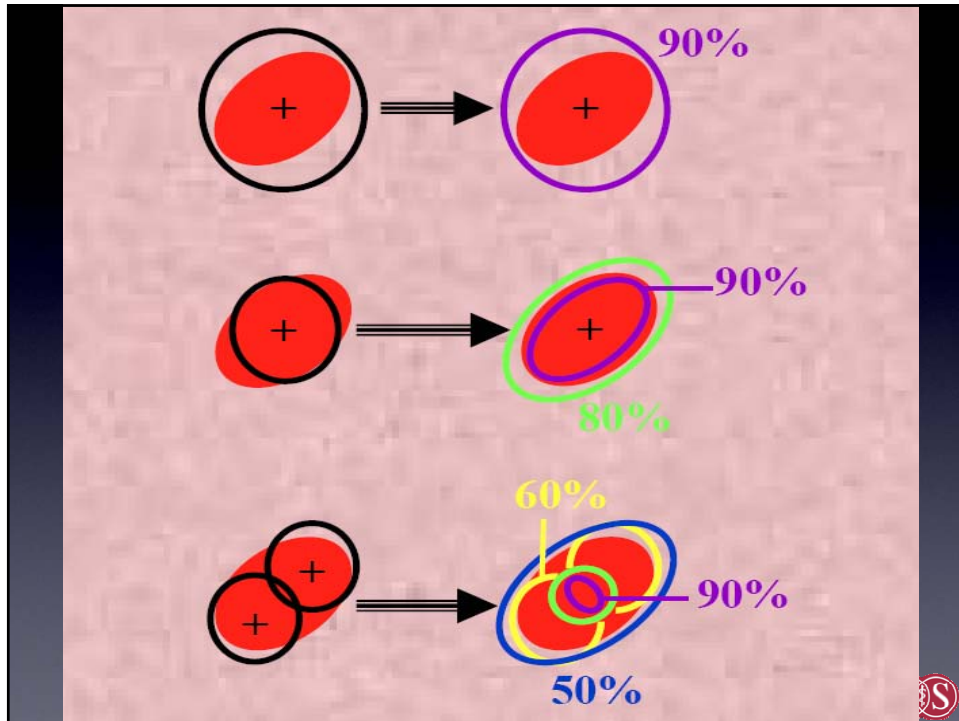
...and are oriented to deliver their radiation to a single point in space called the 'isocenter'.





The radiation is modified by circular 'collimators' inside the helmet, which have various diameters...





What disorders are managed with SRS?

1. Benign Tumors – (acoustic neuroma)
2. Vascular Malformations – (AVM)
3. Brain Metastases
4. Glioma - (low and high grade)
5. Functional Disorders - (Trigeminal Neuralgia)