* **Objective**: Program to objectively determine an optimum seed configuration at time of implantation.
* Attraction-Repulsion Model derived from Gauss’ law of electromagnetism. Seeds = charges inside a conductor, positions are optimized when an equilibrium is reached.
* 6 Criteria:

1. Density of optimization grid points in the area of interest is uniform.

2. All optimization grid points have some attribution (attraction or repulsion).

3. Optimization grid points generate attraction or repulsion depending on dose or dose rate.

4. For each optimization grid point, attraction is defined as the force generated to increase dose or dose rate; repulsion is defined as the force generated to decrease dose or dose rate.

5. Both attraction and repulsion are determined as the function of dose or dose rate.

6. Optimization grid gives attraction or repulsion for one parameter of the source. For example, one parameter of the source is source position in permanent implant.

* seeds were taken to be isotropic point sources
* 1 pixel = 0.33 mm = minimum distance of movement
* Frame grabber is used to get ultrasound images of the prostate at 5 mm intervals
* The contours of prostate (target), urethra, and rectum (critical organs) were drawn by the radiation oncologist on captured images.
* Optimization point were defined every 3 pixels = 1 mm
* For this case the total area of optimization was 240 x 240 pixels for 15 slices.
* Clinical Restraints:

1. Prostate and Urethra with min and max dose range.
2. Rectum and Normal tissue under threshold dose range.

* Test Case:
  + 14 needles randomly placed.
  + Seeds are spaced out along the needles ever 5 mm.
  + Seeds can be turned on or off.
* Dose-rate *dij* at a point *i* of the grid in relation to the source *j.*
* *Sk* is the air kerma strength
* Λ the dose-rate constant
* φ *an*(*rij*) the anisotropy function
* g(*rij*) the radial dose function
* *rij* the distance between the source *j* and the grid *i*.
* The dose distribution *Di* is given by the sum of the dose-rate contribution from all source positions *j* with a respective dwell time *tj*:
  + L = min dose.
  + R = max dose.
  + GraL and GraR are user defined slopes
* L,R,GraL, and GraR are defined separately for each organ.
* **Displacement Vector Tj**
  + *T j* is the displacement vector for source *j*
  + *n* is the number of optimization grid points
  + *Uij* is the unit vector from point *i* to source *j*
* **New Position**
* *Txcurrentj, Tycurrentj*, and *Tzcurrentj* are the elements of the current source position
* *k* is the gain parameter
* *m* is the number of active sources inside the needle.
* To avoid local minima, *k* was decreased gradually during the iterative calculation.
* A computer variable was implemented in the repulsion process, independent of dose, to avoid overlapping of sources.
* **Equilibrium**: The process was repeated until the doses are all within the predefined constraints or the sum of an absolute value of the object function was not changed.
* The running time on the Pentium III (1 GHz) was approximately 5 min.
* Needed:
  + A needle template with 0.5-cm rectilinear grid spacing.