EDGE CALCULATION

NCS SUBCIE 33 – LINAC QA

ANTONI
VAN
LEEUWENHOEK
NEDERLANDS KANKER INSTITUUT

NCS 33 – LINAC QA

- NCS = Netherlands/(Dutch) Commission on Radiation Dosimetry
  - Used in the Netherlands and Belgium

- NCS report 33 focusses on Linac QA
  - Prepublication on FFF beam parameters

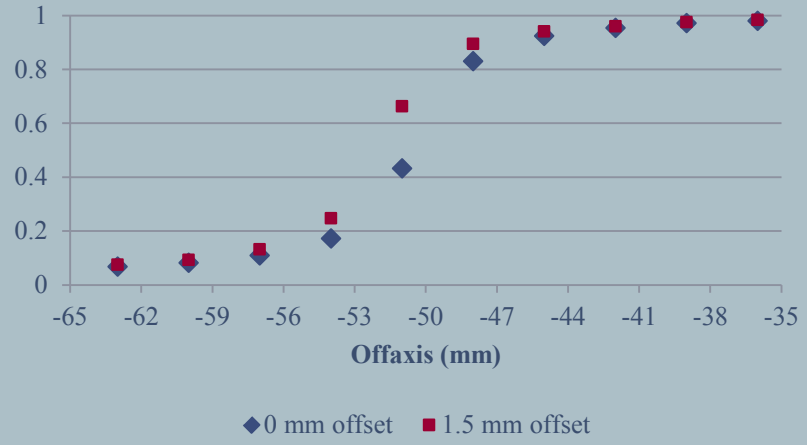
  - The inflection point is proposed for the calculation of the field edge (if no FF beam is available)
  - Different methods to calculate the inflection point
  - Most routine QA on linacs is done on array's nowadays to shorten maintenance time
  - Method of calculation should therefore be robust to different resolutions.

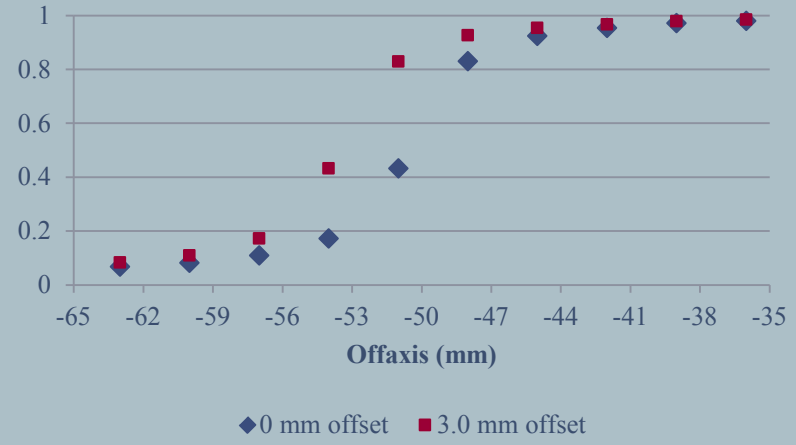
A LONG TIME AGO…

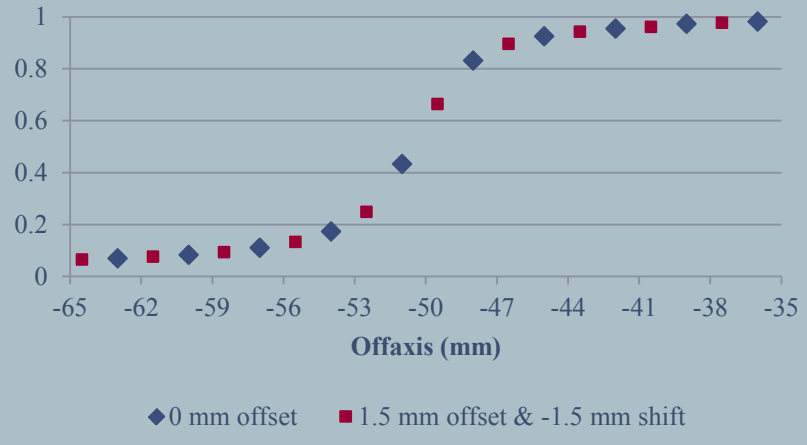
- Since 2007 we (NKI) use the Starcheck to adjust our machines.
  - Focus position, field size, etc
- We noticed a ‘unstable’ history which we could not explain (yet).

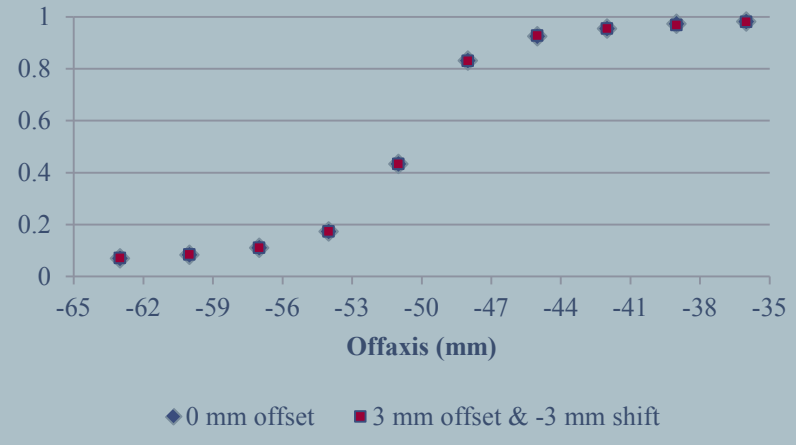
- Investigation started in 2010!
  - Placing the Starcheck on top of the SLA48.
  - Shifted the Starcheck with steps of 0.3 mm over 12 mm in both directions along the main axis
    - Fixed energy of 6 MV
    - Fixed field size of 10x10 cm

Jaws / X / Crossplane









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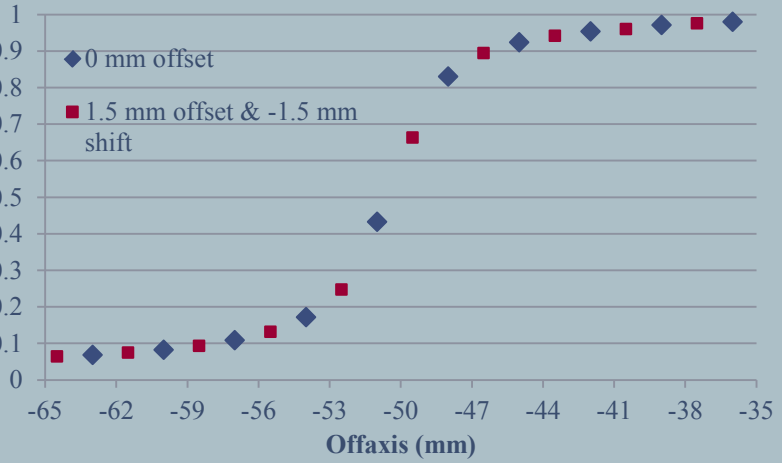
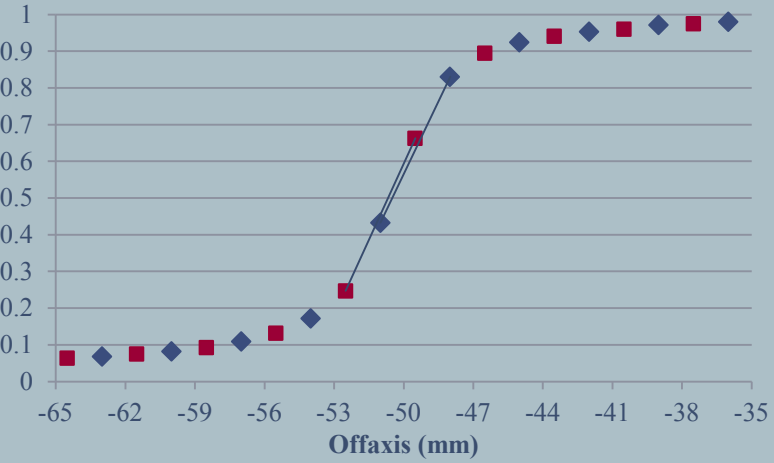
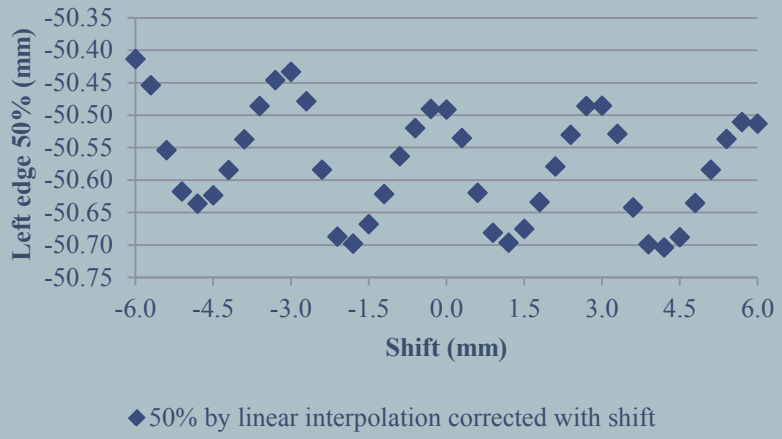
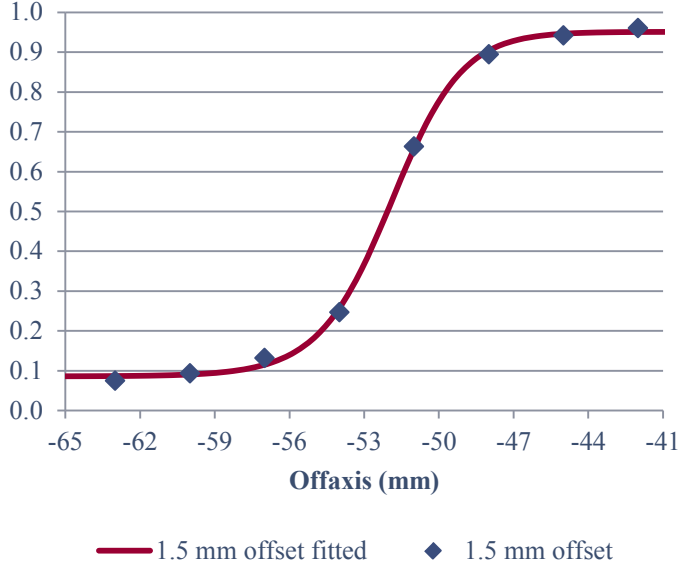




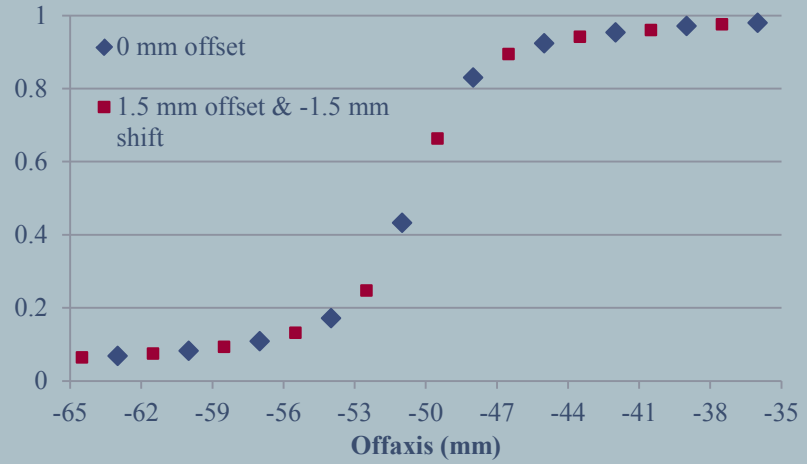


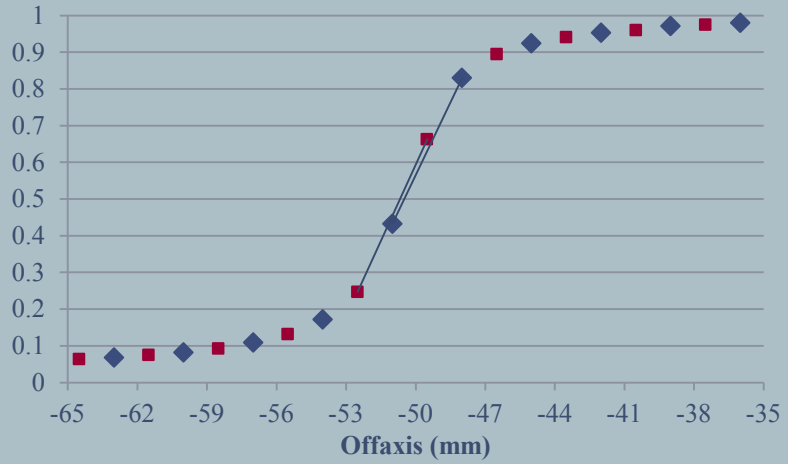
FITTING THE PENUMBRA

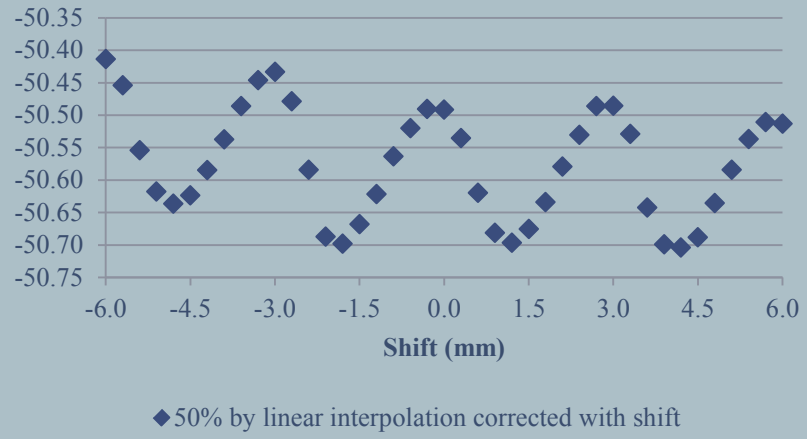
- Four parameter Logistic (4PL) Regression
  - $y = d + \frac{a-d}{1+\left(\frac{x}{b}\right)^c}$
    - **a** = the minimum value that can be obtained (i.e. what happens at 0 dose)
    - **d** = the maximum value that can be obtained (i.e. what happens at infinite dose)
    - **b** = the point of inflection (i.e. the point on the S shaped curve halfway between a and d)
    - **c** = Hill's slope of the curve (i.e. this is related to the steepness of the curve at point c).
  - Solve for $x = c\left(\frac{a-d}{y-d} - 1\right)^{\frac{1}{b}}$ (=> FWHM y = 0.5)
  - 2nd derivative $x = b\left(\frac{c-1}{c+1}\right)^{\frac{1}{c}}$ (=> Infl x = 0)

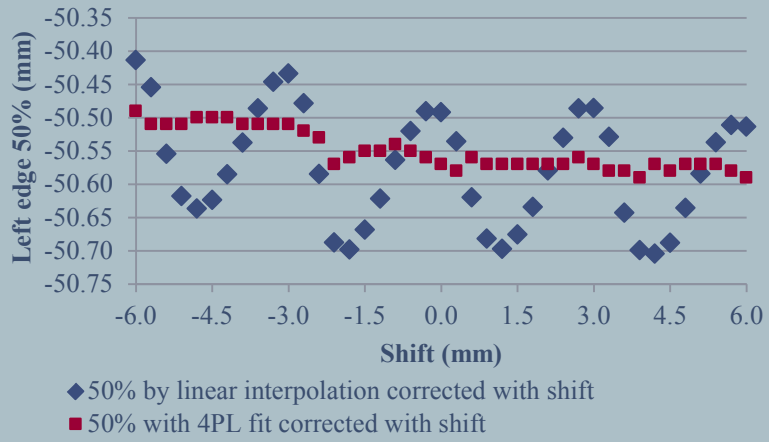


Jaws / X / Crossplane









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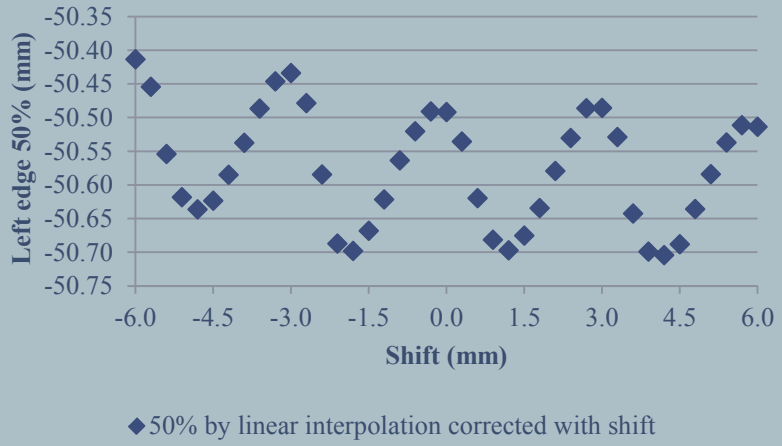
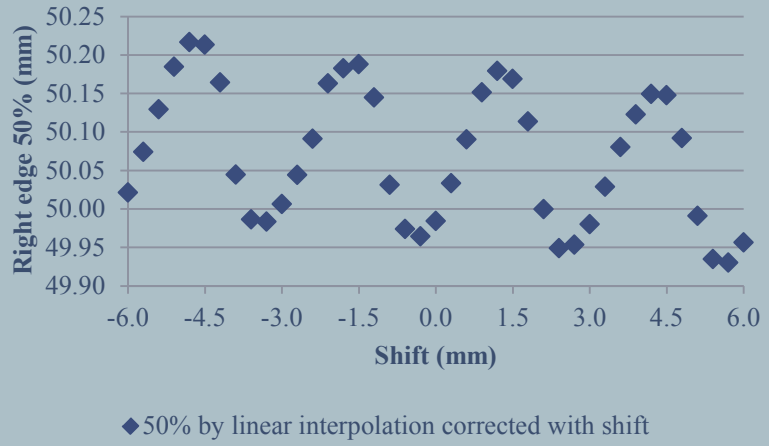
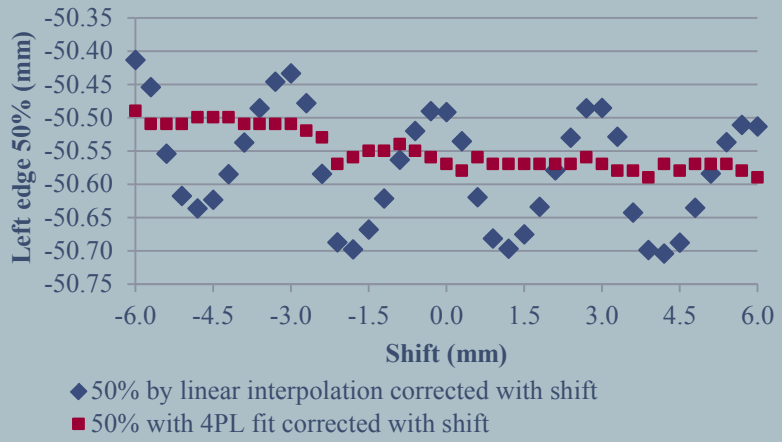
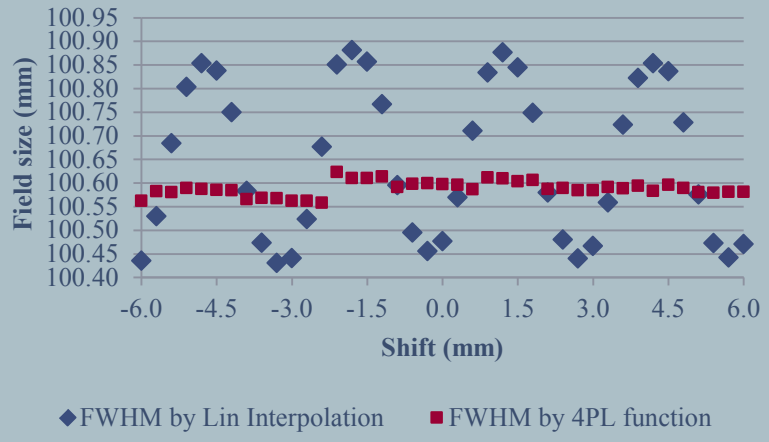








Penumbra Fitting 2020-06-03

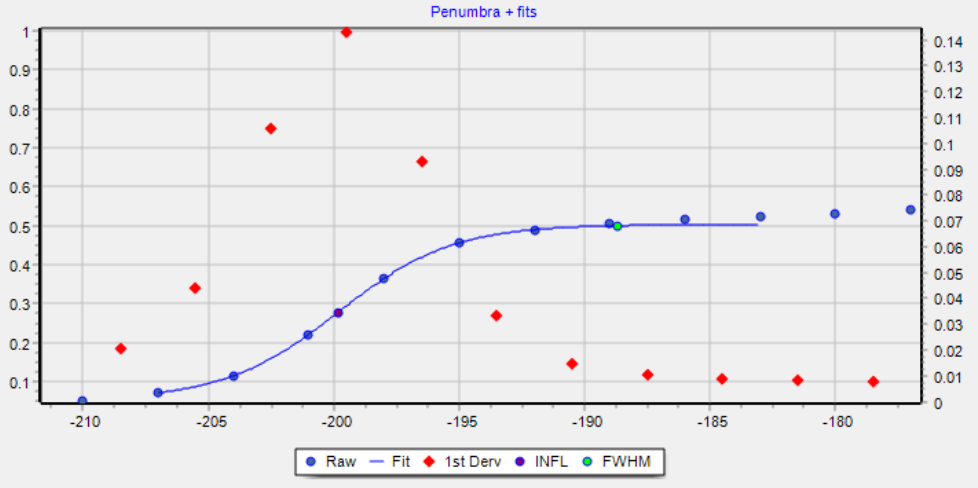
Input

-42	0.918201327
-39	0.927594125
-36	0.936543167
-33	0.945122421
-30	0.953553736
-27	0.961467326
-24	0.969085097
-21	0.976111233
-18	0.982101917
-15	0.987426937
-12	0.991716564
-9	0.99474889
-6	0.997263491
-3	0.999112487
0	1

Start fitting

Clear Input

Clear memos



Fit options

Iterations: 5

Offsetvalue: 0.01

Fitradius (mm): 12

Func. Eval.

Start Values

a: 0.4333

b: -199.5000

c: 0.1430

d: 0.0711

Slope

Pos Slope

Neg Slope

Output Parameters

```
A = 0.45611304  B = -199.80648800 C = 86.14968109  D = 0.05008880  Eval = 0.0012141982   Infl = -199.8065  FWHM = -190.1132
A = 0.45611191  B = -199.80648800 C = 86.15007782  D = 0.05008933  Eval = 0.0012141982   Infl = -199.8065  FWHM = -190.1130
A = 0.45611149  B = -199.80648800 C = 86.15035248  D = 0.05008981  Eval = 0.0012141982   Infl = -199.8065  FWHM = -190.1131
A = 0.45611140  B = -199.80648800 C = 86.15039063  D = 0.05008984  Eval = 0.0012141982   Infl = -199.8065  FWHM = -190.1131
Iterations      = 5
Offsetvalue     = 0.01
Calc. Time      = 16 ms.
Profile Res.    = 0.300 mm
FitRadius       = 15 mm
LeftIndex       = -207.00 mm
RightIndex      = -186.00 mm
Inflectiepunt   = -199.806
FWHM            = -190.113
--------------------------------------------------------------------------------
A = 4.99266100  B = -198.77673340 C = 4.97049141   D = -2.18985486  Eval = 0.0273927862   Infl = -198.7767  FWHM = -192.6598
A = 0.89256722  B = -200.28627010 C = 30.25928116  D = -0.18478867  Eval = 0.0221354691   Infl = -200.2863  FWHM = -192.5457
A = 0.45106566  B = -199.83096310 C = 87.97376251  D = 0.05177251   Eval = 0.0002666609   Infl = -199.8310  FWHM = -188.6570
A = 0.45106560  B = -199.83096310 C = 87.97374725  D = 0.05177251   Eval = 0.0002666609   Infl = -199.8310  FWHM = -188.6569
A = 0.45106548  B = -199.83096310 C = 87.97380829  D = 0.05177259   Eval = 0.0002666609   Infl = -199.8310  FWHM = -188.6569
Iterations      = 5
Offsetvalue     = 0.01
Calc. Time      = 20 ms.
Profile Res.    = 0.300 mm
FitRadius       = 12 mm
LeftIndex       = -207.00 mm
RightIndex      = -189.00 mm
Inflectiepunt   = -199.831
FWHM            = -188.657
```