



# Pylinac: A toolkit for performing TG-142 QA-related imaging tasks on a linear accelerator

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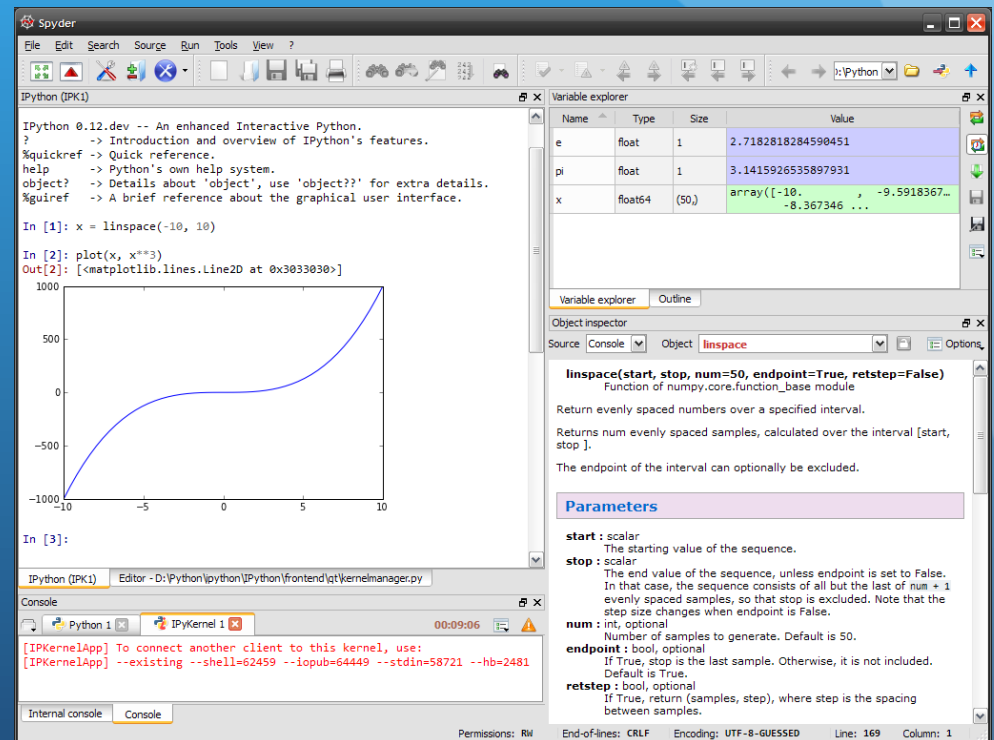
# Purpose

Python toolkit codes is designed to assist medical physicists to automate analysis of imaging quality assurance (QA) tests for the linear accelerator as required quantitatively following the recommendations of the AAPM TG-142 report. It has eight modules examining different QA test.

# Methods

A minimal amount of code is required to run pylinac algorithms

The analyzing accomplished by including DICOM images into the required QA module.



The screenshot displays the Spyder Python IDE interface. The main window shows the IPython console with the following code and output:

```
IPython 0.12.dev -- An enhanced Interactive Python.  
? -> Introduction and overview of IPython's features.  
%quickref -> Quick reference.  
help -> Python's own help system.  
object? -> Details about 'object', use 'object??' for extra details.  
%gui? -> A brief reference about the graphical user interface.  
  
In [1]: x = linspace(-10, 10)  
  
In [2]: plot(x, x**3)  
Out[2]: [<matplotlib.lines.Line2D at 0x3033030>]
```

The plot shows a cubic function  $y = x^3$  over the interval  $x \in [-10, 10]$ . The x-axis ranges from -10 to 10, and the y-axis ranges from -1000 to 1000. The curve passes through the origin (0,0) and reaches approximately (-10, -1000) and (10, 1000).

The Variable explorer on the right shows the following variables:

Name	Type	Size	Value
e	float	1	2.7182818284590451
pi	float	1	3.1415926535897931
x	float64	(50,)	array([-10.         , -9.5918367...

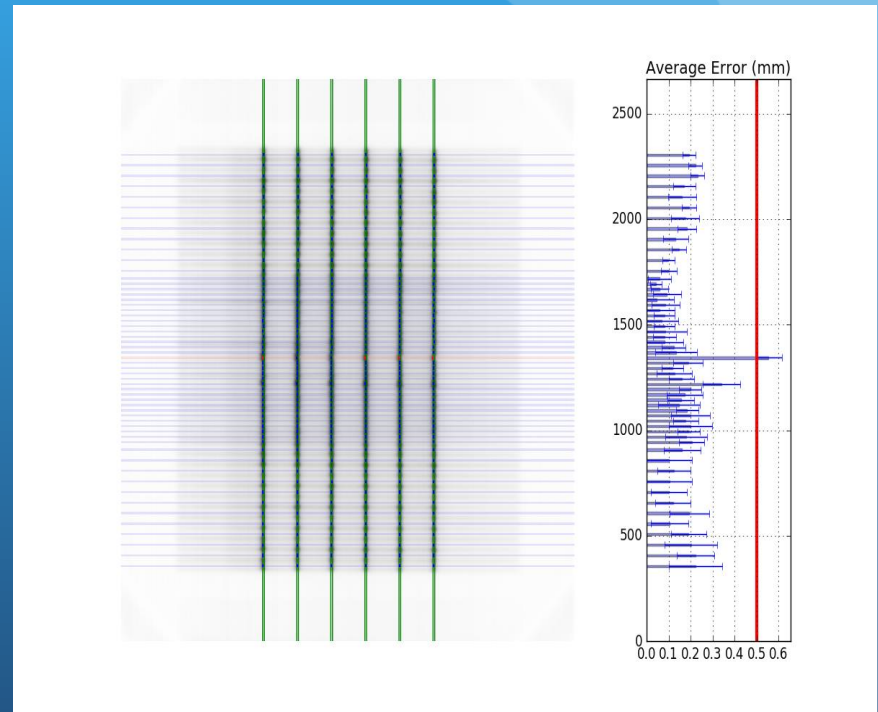
The Object inspector shows the details for the `linspace` function:

```
linspace(start, stop, num=50, endpoint=True, retstep=False)  
Function of numpy.core.function_base module  
Return evenly spaced numbers over a specified interval.  
Returns num evenly spaced samples, calculated over the interval [start, stop].  
The endpoint of the interval can optionally be excluded.  
  
Parameters  
start : scalar  
The starting value of the sequence.  
stop : scalar  
The end value of the sequence, unless endpoint is set to False. In that case, the sequence consists of all but the last of num + 1 evenly spaced samples, so that stop is excluded. Note that the step size changes when endpoint is False.  
num : int, optional  
Number of samples to generate. Default is 50.  
endpoint : bool, optional  
If True, stop is the last sample. Otherwise, it is not included. Default is True.  
retstep : bool, optional  
If True, return (samples, step), where step is the spacing between samples.
```

# Results - Picket Fence Module

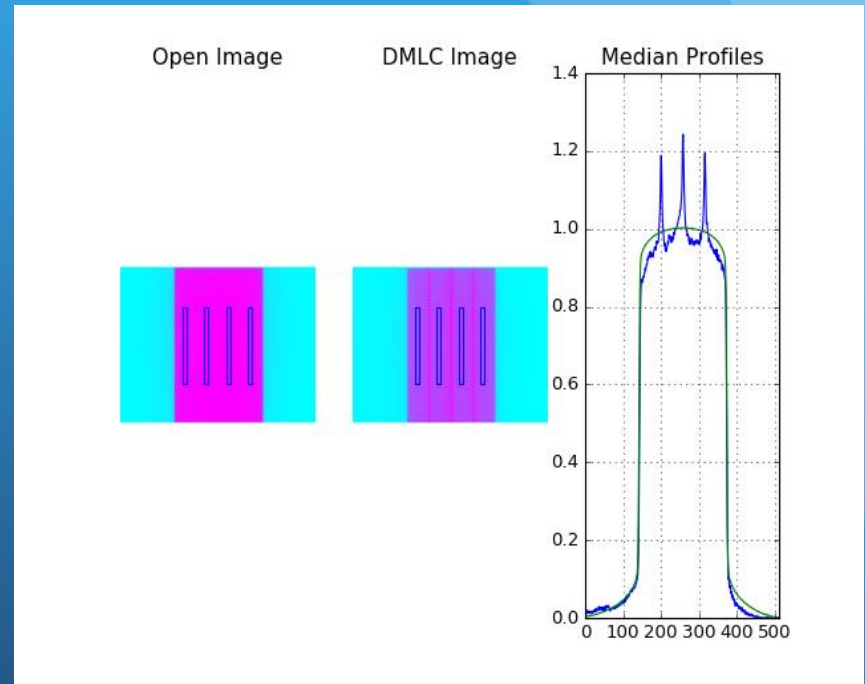
The module was used to verify the accuracy of MLC position against gantry position for Varian 2100 C/D.

The Module measures picket FWHM for all leaves at each stopping point in the pattern.



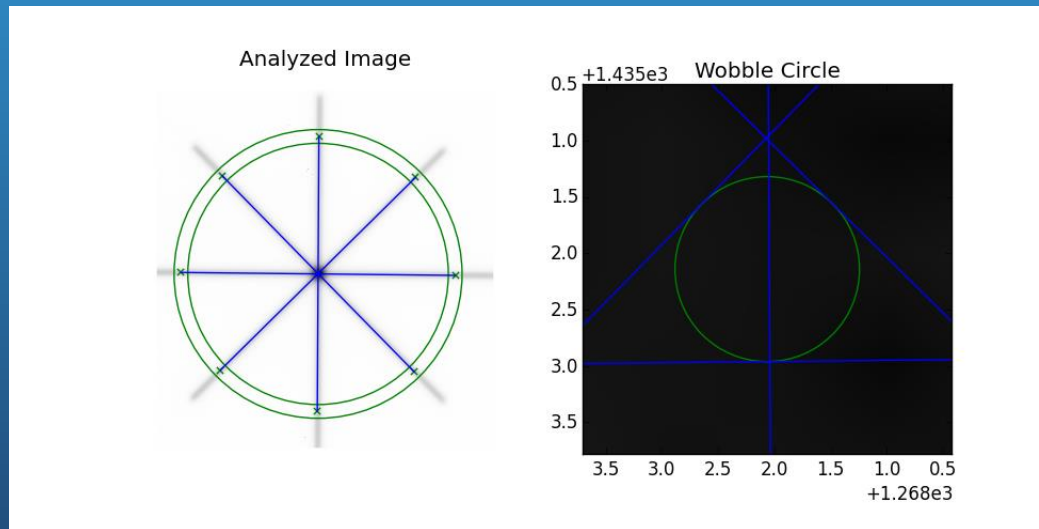
# Results - VMAT Module

The analysis is according to the Varian RapidArc QA tests and procedures, specifically the Dose-Rate & Gantry-Speed (DRGS) and Dose-Rate & MLC speed (DRMLC) tests.



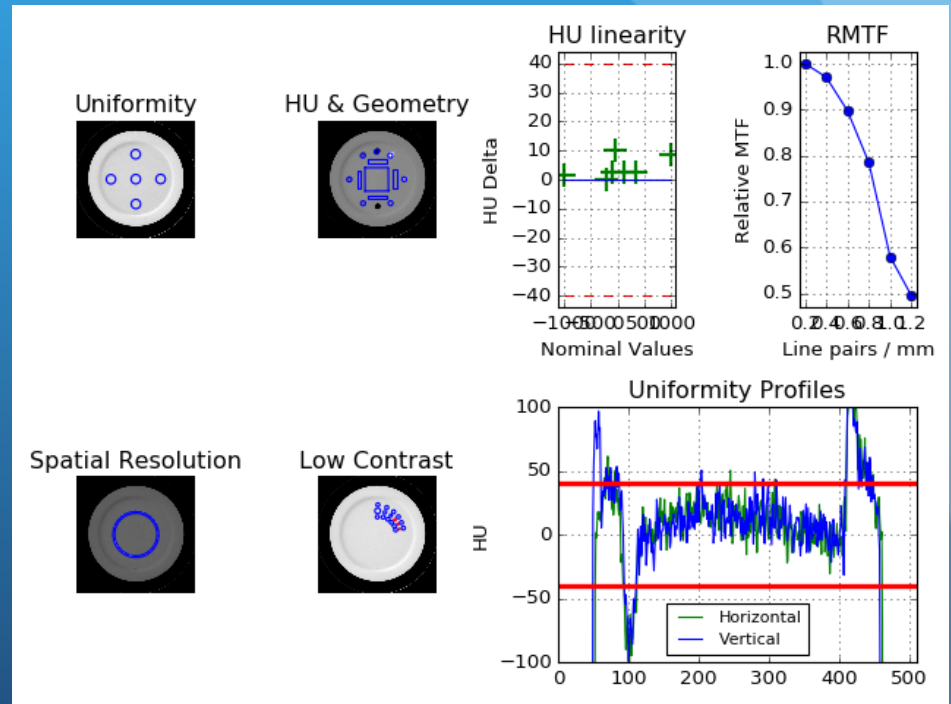
# Results - Starshot Module

The Starshot module analyses a Starshot image made of radiation spokes, whether gantry, collimator, MLC or couch.

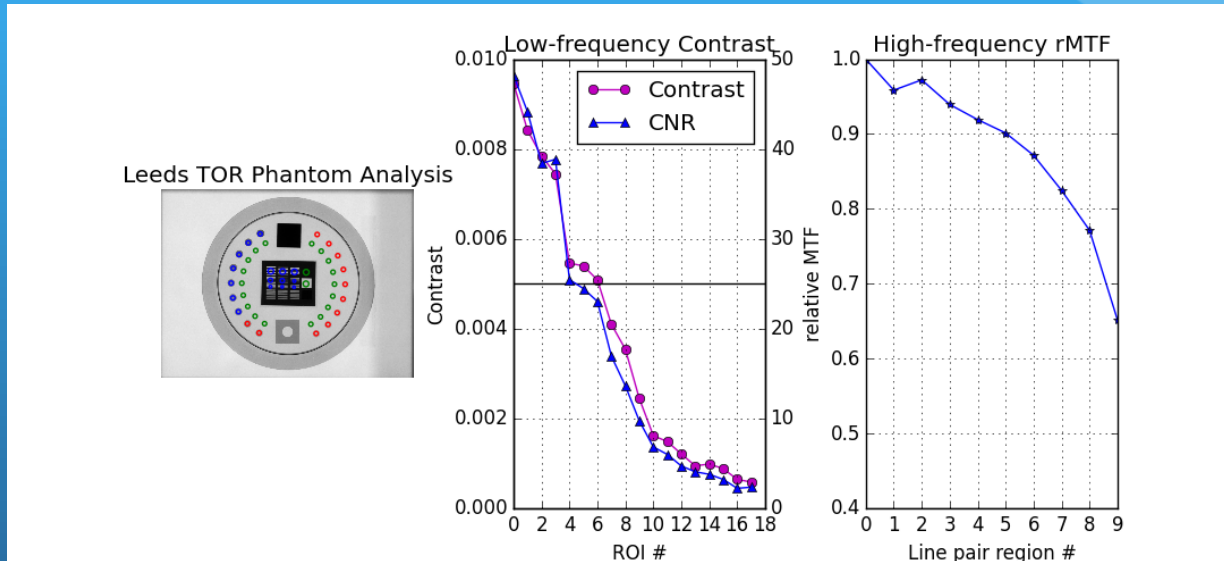


# Results - CBCT Module

The CBCT module automatically analyzes DICOM images of a CatPhan 504 or 503 acquired when doing CBCT or regular CT quality assurance.



# Result - Planar Imaging module



The module analyzes phantom images taken with the kV or MV imager in 2D. The module uses MTF rather than subjective “How many line pairs can I see?”. The results depend on many factors such as imaging technique (kV, mAs) and also the setup used during acquisition.



# Conclusion

Pylinac has been shown to be a versatile tool for each test and is carefully designed to fully address a required test of the TG-142 imaging tasks. However, some tests can give unreliable results if an Restriction is violated.

# Acknowledgment

A TG-142 toolkit and web service for doing routine linear  
accelerator quality assurance <https://assuranceqa.herokuapp.com>