“PRATICAL USE OF DYNALOGS ANALYSIS IN SEVEN LINACS IN IMRT AND VMAT TECHNIQUES OVER 20 MONTHS”

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Purpose

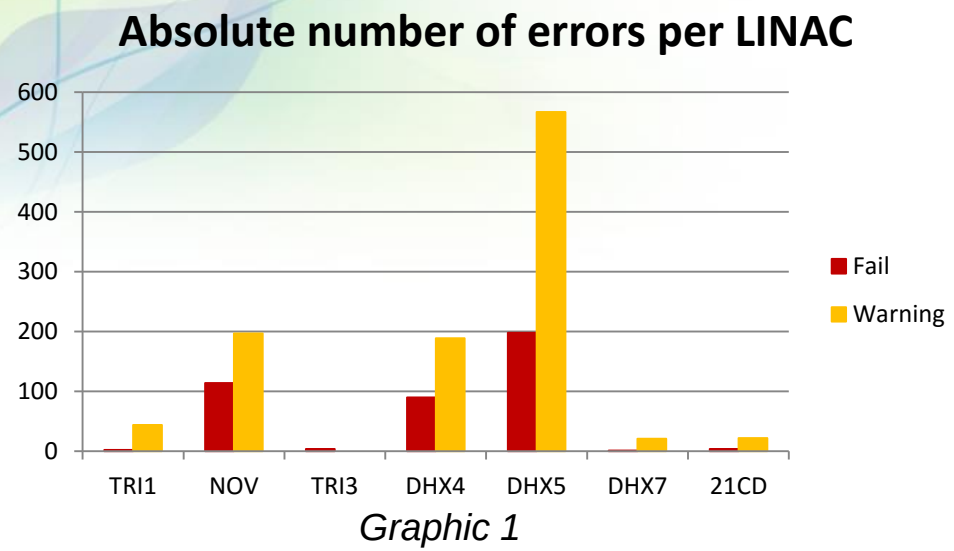
The aim of this study is to substantiate a possible correlation between MLC behavior, through the analysis of the Dynalog files's (DLGf) using FractionCheck software (Version 6.40 of DoseLab) - analysis in real time or not - and the failure of the QA procedure.

Introduction

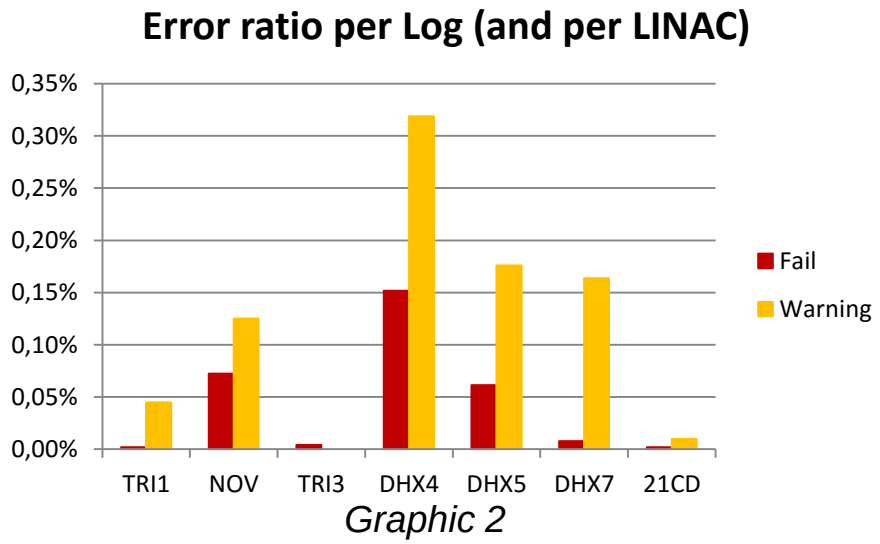
DLGf analysis can provide important information about deviations from planned and actual movement (positioning and velocity) of the MLC, during an IMRT or VMAT treatment delivery. Pre-treatment verification (QA) allows the comparison of the calculated and delivered dose distributions. In case of failure, the treatment plan must be reviewed and possible sources of fault must be tracked.

Methods

Data from IMRT and VMAT DLGf acquired from May 2014 to February 2016 in 7 linacs was statistical analyzed as a complementary data source for the QA procedures. The analyzed results were expressed in "Warning" and "Fail" accordingly to the tolerances in TG142 report.



Graphic 1



Graphic 2

Dynalogs Analysis: "Fails" and "warnings" graphics (1 and 2) by Linac over 20 months

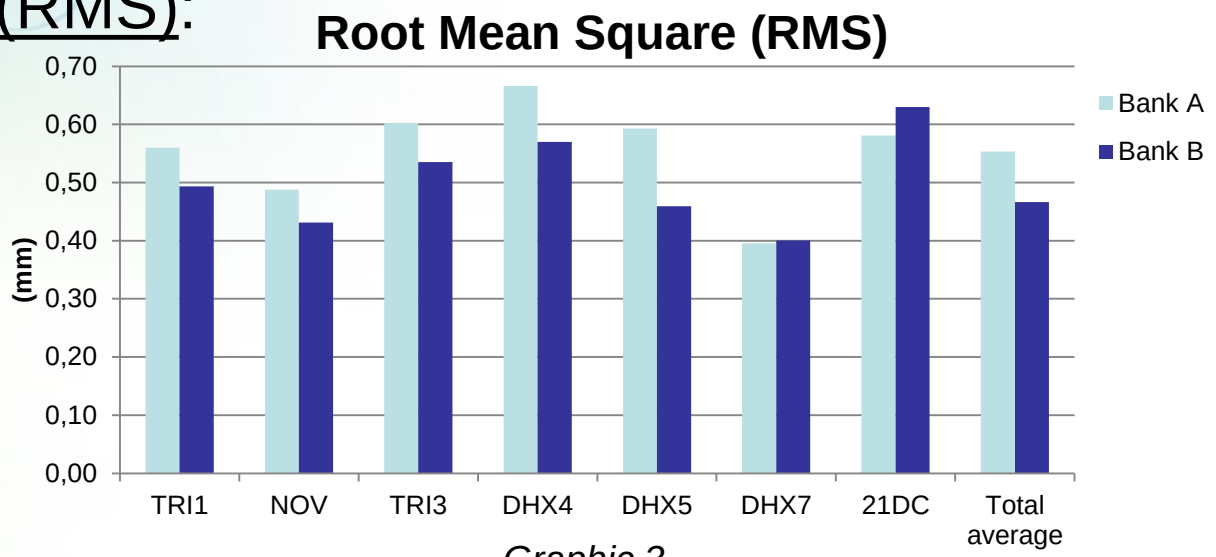
Methods

Other parameters were also analyzed by the software…

- Root Mean Square (RMS):

LINAC	Average Bank A (mm)	Average Bank B (mm)
TRILOGY 1	0,56	0,49
NOVALIS TX	0,49	0,43
TRILOGY 3	0,60	0,54
DHX 4	0,67	0,57
DHX 5	0,59	0,46
DHX 7	0,40	0,40
2100CD	0,58	0,63
Total average	0,55	0,47

Table 1



Graphic 3

Average values of RMS for bank A and B of MLC per Linac over 20 months and total average for cases of warnings and fails in dynalogs (Table 1 and Graphic 3).

- Beam-On: For all Linacs and for all cases of warnings and fails detected in dynalogs, the average value of the cumulative time the beam was on as a percentage of the total treatment time for a field was of 84,83% (there is no tolerance).

Methods

- Percentil 95th (95P): the percentage of cases of fails and warnings obtained for the 95th percentile |error| of the file for all moving MLC leaves was of 0,8% and the Linac with more errors with this parameter was the DHX5.

- MaxRMS: The average obtained for the maximum RMS error of all moving leaves in a file (only for fails and warnings cases analysed) was:

	MLC	
	Bank A	Bank B
Max RMS Average	0,86	0,76

Table 2

- MaxLag for MLC:

Max Lag Value	Tolerance	Number	Ratio
0	Pass	79	5,03%
1	Pass	79	5,03%
2	Warn	1133	72,07%
3	Fail	217	13,80%
4	Fail	60	3,82%
5	Fail	4	0,25%

Table 3 – Ratio of cycles detected in Dynalogs Analysis.

- and Gamma-function distribution:

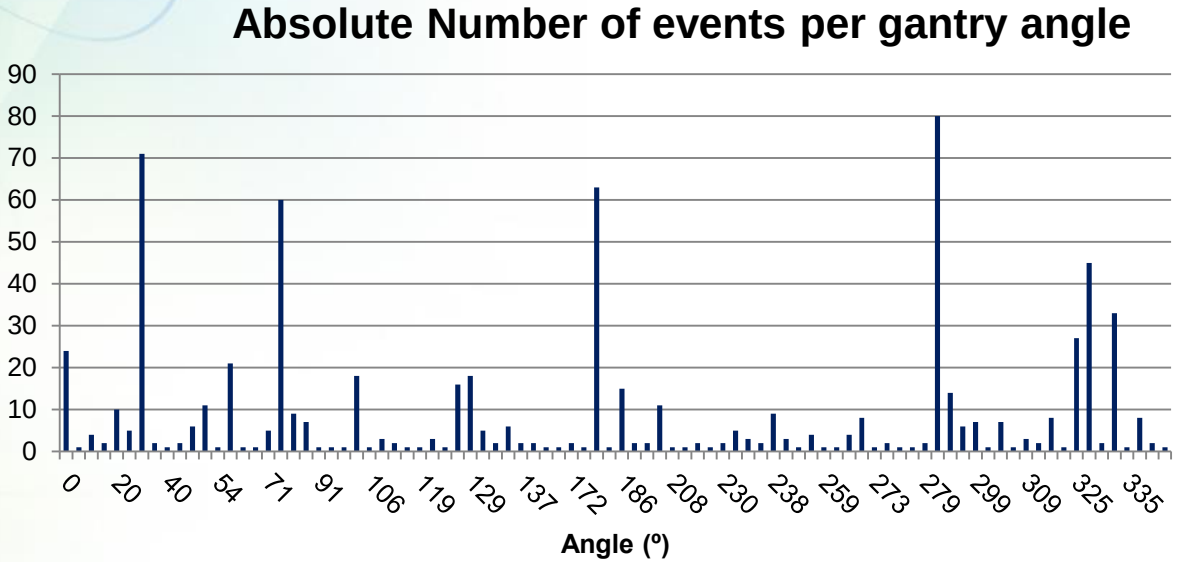
LINAC	Gamma Average
TRI1	97,3%
NOVALIS	90,3%
TRI3	94,8%
DHX4	94,0%
DHX5	91,8%
DHX7	100,0%
2100CD	97,2%

Table 3 – Percentage of Gamma function distribution in cases of fails and warnings over 20 months, for a Gamma criteria of 2% dose and 1DTA in mm. Remember that the tolerance is: Warn at 4% difference (<96%) and Fail at 5% difference (<95%).

Methods

Results were reviewed considering several factors…

- Gantry angle:



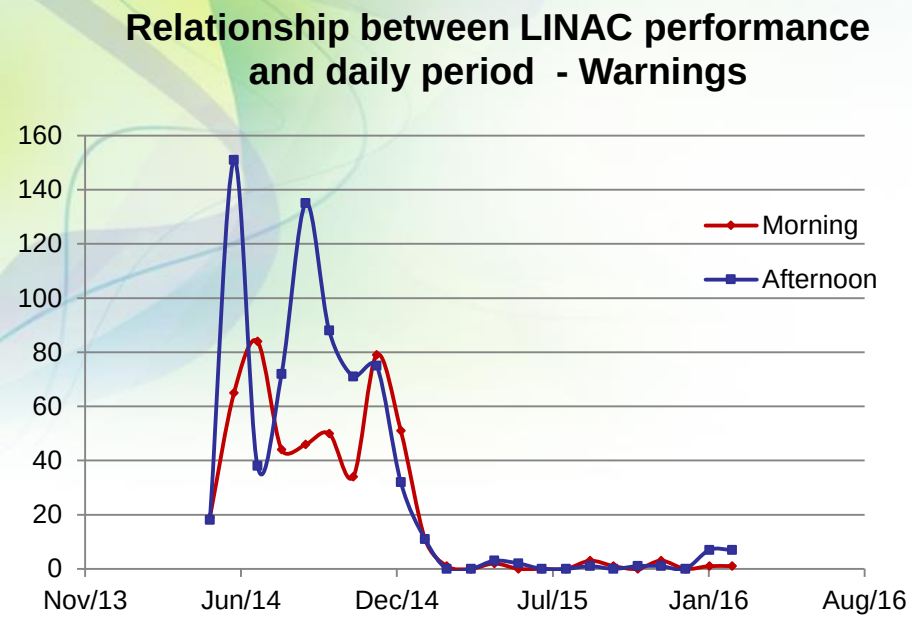
Graphic 4

The objective is to compare the relationship between the angle of gantry during treatment and the effect of gravity on the MLC.

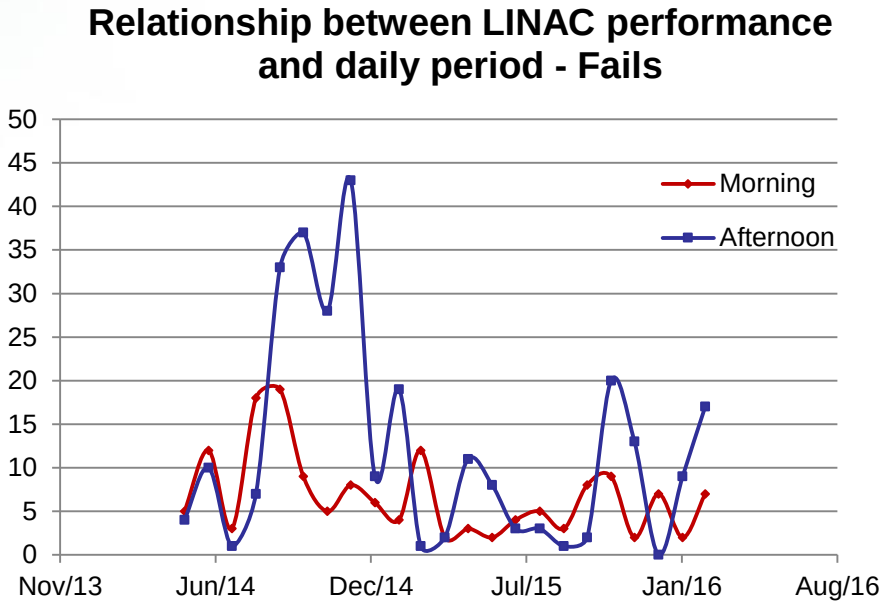
- MLC maintenance (Mechanical and dosimetric tests results): it was compared the dates of periodic maintenance of MLC, other tests and malfunctions with errors identified in dynalogs in terms of time to assess the correlation between both - there is no relationship.

Methods

- Day time: it was intended to study the performance of the Linacs over day (dependence on the heating of the machine).



Graphic 5



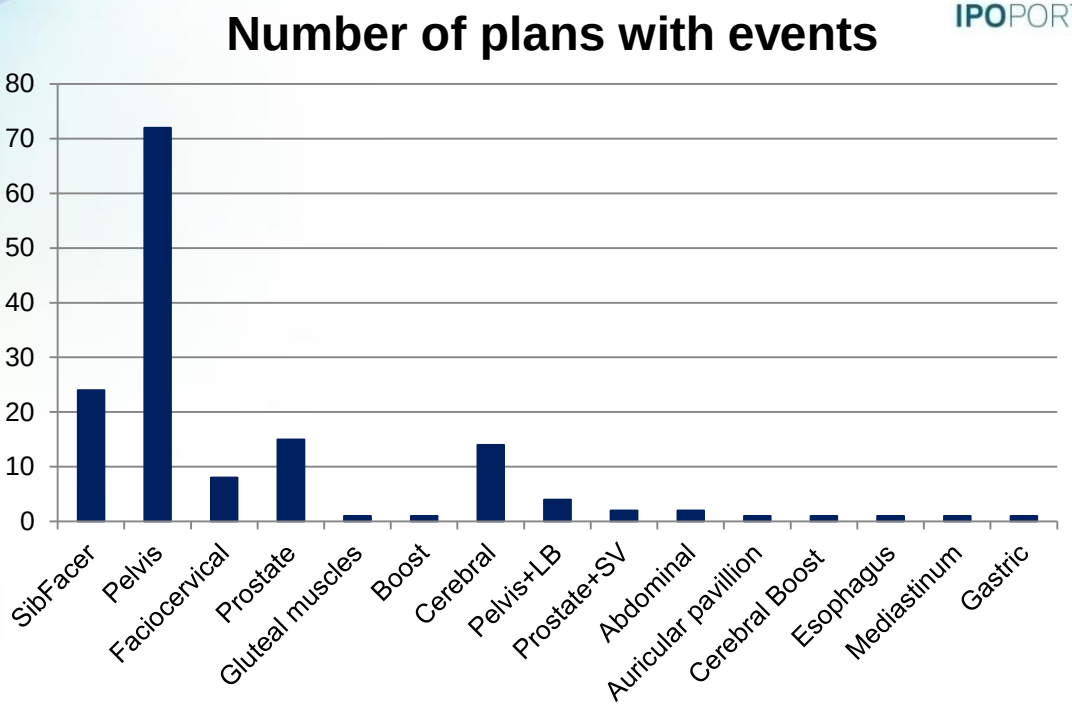
Graphic 6

Graphic 5 and 6: Absolute number os errors (warn and fail) obtained in DLG files for all Linacs over almost 2 years.

Methods

- Pathology's type:

The intent is to study the dependence per pathology (number of absolute cases) according to the obtained errors (fail and warn).



Graphic 7

- and Network Upgrade (version ARIA 8.8 to 13.5): It occurred at the end of January 2015 and were noted improvements in Warns registration in all Linacs. There was equipment behavioral change taking into account the network upgrade (and updating the calculation algorithms in TPS), as we can see in graphic 5 (and 6).

Results

RMS	*MaxRMS*	*MaxLag (of bank A and B of MLC)*	*Gamma Analysis*
There were only 3 cases in which the RMS exceeded the tolerance of 2,0 mm, that is 0,18 % of cases in which there was DLG failures or warnings. That means that there were no problems with leaf motors and dose rate is proper.	The average is far below the tolerance (3,5 mm, according to the TG-142 and warn at 1,5 mm and fail at 2,0 mm according to the equipment supplier). 0,4 % of cases of DLG errors were due to the MaxRMS.	88,2% of cases of DLGs errors were due to the maximum beam off lag of the file, most of them before the network upgrade.	10,42% of cases of DLGs errors were due to this parameter, most of them after the network upgrade.

- After the tests of May 2014 on Novalis (MLC 120) it was found that for an **increase in the dose rate**, the 95P's, MaxRMS's and RMS's (for each leaf) parameters worsen.

- Crossing the analyzed data to the type of treatment revealed that the IMRT cases have worse outcomes than the VMAT ones. "

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Conclusions

- Although the information obtained from DLGf can be very useful in some particular situations, it does not predict the outcome of IMRT or VMAT QA procedures.

- No correlation between DLG information and the results obtained from the QA measurements (VerySoft analysis – version 6.2) were verified.

- MLC's performance does not depend on the treatment's gantry angle and pathology.
It does not depend critically on day time due to linac heating.
Further investigation will be done.