

Use of EPIDs for Routine Linac QA

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CONNECTING OUR PATHWAYS
UNIFYING OUR PROFESSION
RPM - RADIATION PHYSICIAN & MEDICAL PHYSICIAN, BR



Disclosure

Our research group receives funding from
Varian Medical Systems



Introduction



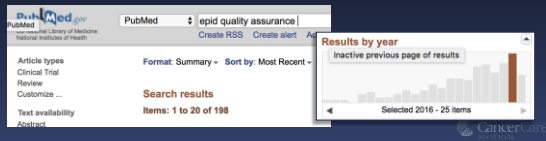
Impetus

- TG-142 outlines a number of linac QA tests to be performed daily, monthly, and annually
- Due to constrained resources, efficiency is desired in performing these tests!
- EPIDs are well suited for performing many daily and monthly tests
- We will review several EPID QA tests performed at our centre, including outputs, picket fences, profile constancy.



EPIDs

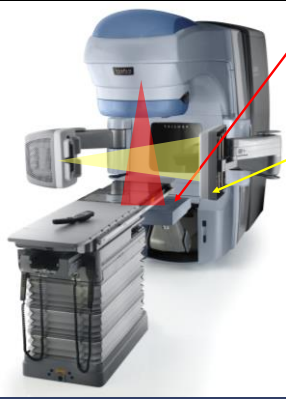
- EPID – **e**lectronic **p**ortal **i**maging **d**evice
- Developed in the 1980's and 1990's for anatomic imaging of the patient
- Investigated for dosimetry applications sporadically in the 1990s
- significant interest for dosimetry applications in 2000s



EPIDs suited for QA dosimetry

- Commonly available
- Automated deployment
- Real-time digital imaging
- Imager properties are favourable (linear, no deadtime...)
- Automated analysis and reporting





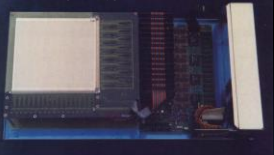
EPID – uses megavoltage x-rays (therapy beam)

kV imaging system – diagnostic quality imaging

Good geometric reproducibility (1mm lat/long, 3mm vert sag)

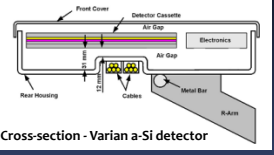
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mid-1990's prototype a-Si detector



Antonuk et al, Red Journal, 1996

- Current EPID design – aSi flat panel imager
- metal plate, phosphor scintillator, array of photodiodes
- 40cm x 30cm size. 1024x768 (aSi1000)



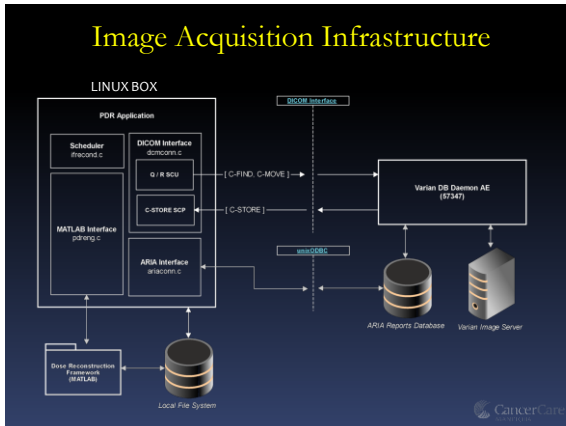
Cross-section - Varian a-Si detector

Siebers et al, Med Phys, 2004

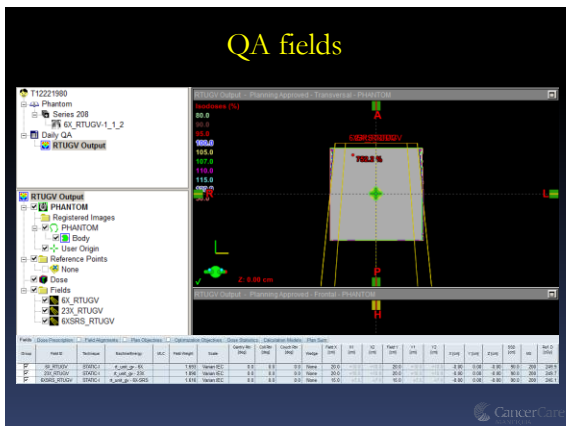
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Automated QA framework

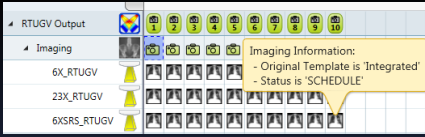
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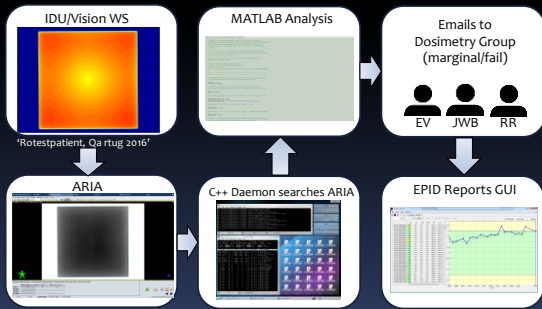
Photon Outputs



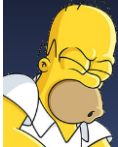
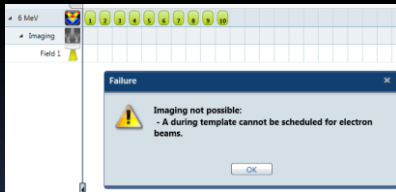
- Run by therapists during morning warm up
- Delivered in QA mode
- Fully automated analysis, PDF emailed to dosimetry group in the event of marginal/fail results.



Process flow (for photons)

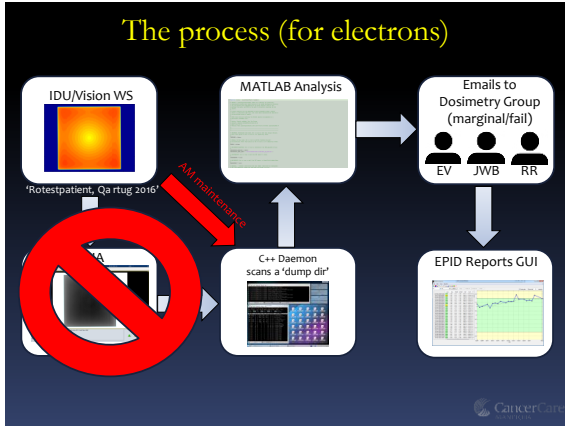


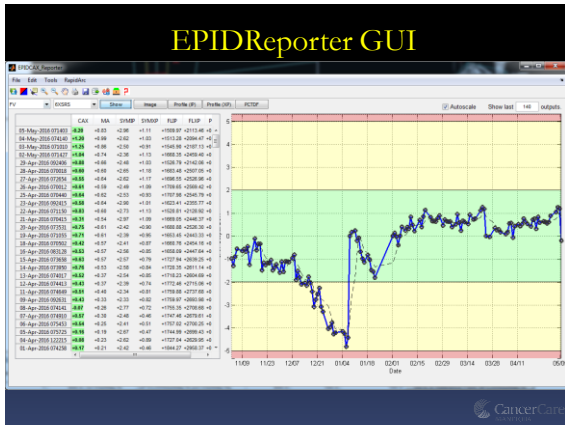
What about electron outputs?

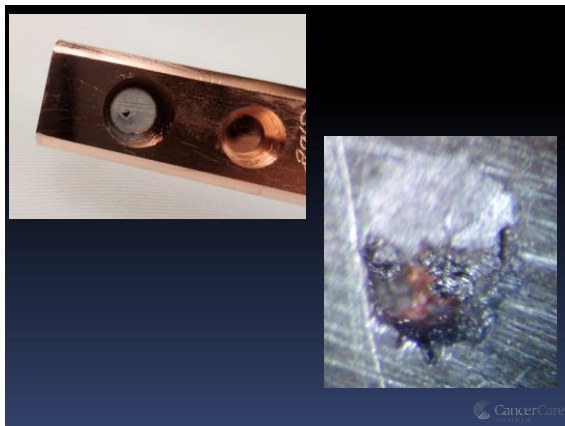


D'OH!



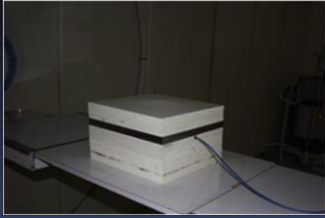






Who watches the watchers?

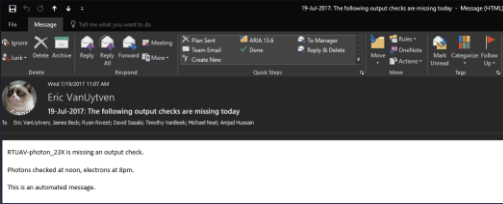
- Secondary monthly solid water check/cal in addition to yearly TG-51 cal.
- Monthly calibration of EPID baselines as necessary.



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Who watches the watchers?

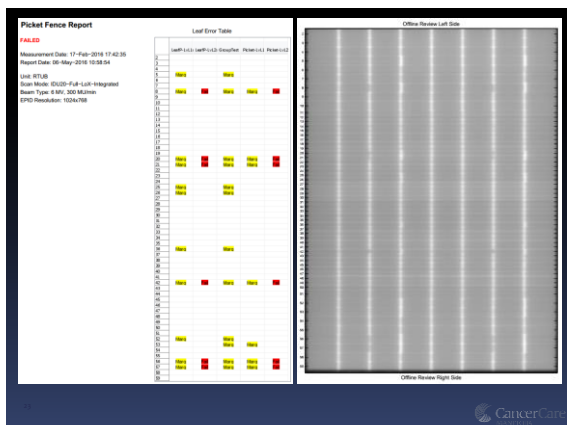
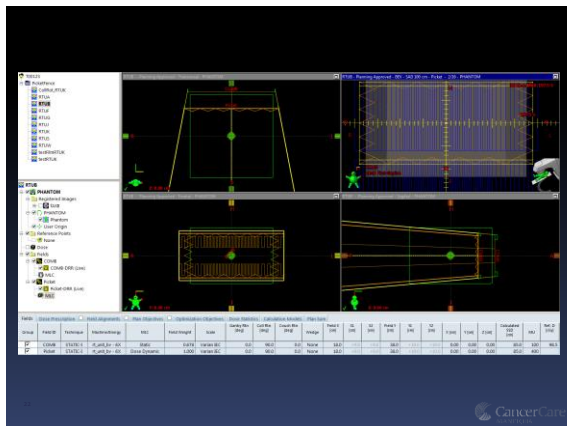
- Scheduled task running on a separate Windows machine ensures that all outputs have been gathered and processed.
- Checks photons at noon and electrons at 8pm



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Picket Fence/RapidArc QA

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RapidArc QA

[1] J. Radiat. Oncol. Biol. Phys. 2008 Oct 1;72(2):875-81. doi: 10.1016/j.radonc.2008.05.060.

Commissioning and quality assurance of RapidArc radiotherapy delivery system.

Ling CC¹, Zhang P, Achambault Y, Booness J, Tera G, Loassio T.

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Abstract
 The Varian RapidArc is a system for intensity-modulated radiotherapy (IMRT) treatment planning and delivery. RapidArc incorporates capabilities such as variable dose-rate, variable gantry speed, and accurate and fast dynamic multileaf collimators (DMLC), to optimize dose conformity, delivery efficiency, accuracy and reliability. We developed RapidArc system commissioning and quality assurance (QA) procedures.

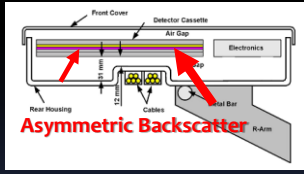
METHODS AND MATERIALS: Tests have been designed that evaluate RapidArc performance in a stepwise manner. First, the accuracy of DMLC position during gantry rotation is examined. Second, the ability to vary and control the dose-rate and gantry speed is evaluated. Third, the combined use of variable DMLC speed and dose-rate is studied.

RESULTS: Adapting the picket fence test for RapidArc, we compared the patterns obtained with stationary gantry and in RapidArc mode, and showed that the effect of gantry rotation on leaf accuracy was minimal (\pm or \pm 0.2 mm). We then combine different dose-rates (111-500 MU/min), gantry speeds (5-4.3 degrees/s), and gantry range (Delta theta = 90-12.9 degrees) to give the same dose to seven parts of a film. When normalized to a corresponding open field (to account for flatness and asymmetry), the dose of the seven portions show good agreement, with a mean deviation of 0.7%. In assessing DMLC speed (0.48, 0.92, 1.84, and 2.76 cm/s) during RapidArc, the analysis of designed radiation pattern indicates good agreement, with a mean deviation of 0.4%.

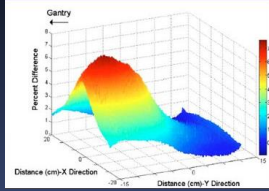
CONCLUSIONS: The results of these tests provide strong evidence that DMLC movement, variable dose-rates and gantry speeds can be precisely controlled during RapidArc.



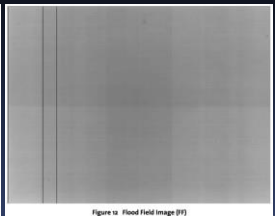
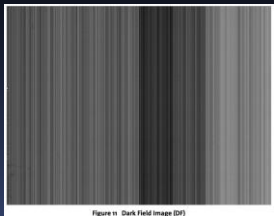
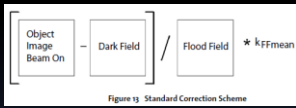
EPID profile constancy is not trivial



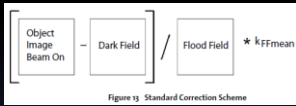
For 40x30 cm² field
 (EPID+arm)-(EPID)
 =
 Max 6%



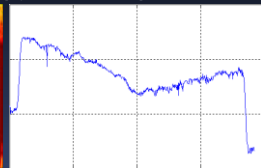
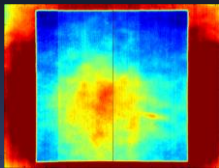
Important profile information removed



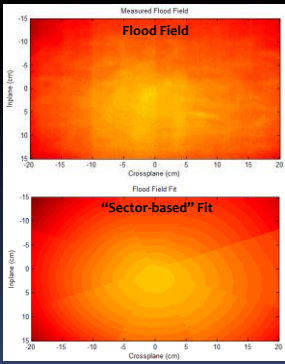
Important profile information removed



Cannot simply reverse the operation

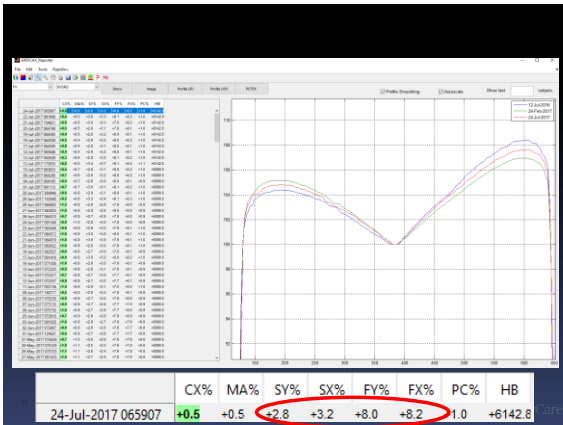


So we fit the flood field



- Keep the beam profile, remove other nonsense
- Divide flood field into radial 'sectors'
- Fit n-degree polynomial to each sector
- Final corrected image is applied to acquired EPID image via division to "reintroduce" the actual profile
- This ASSUMES backscatter component of FF = 20x20
- Do this once a month.

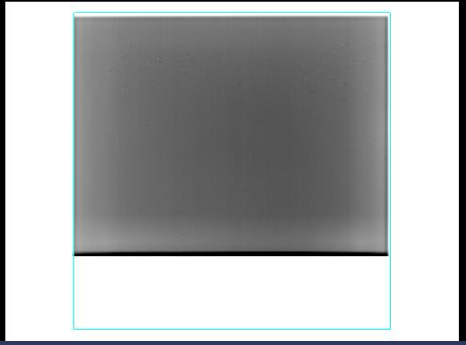




Winston-Lutz

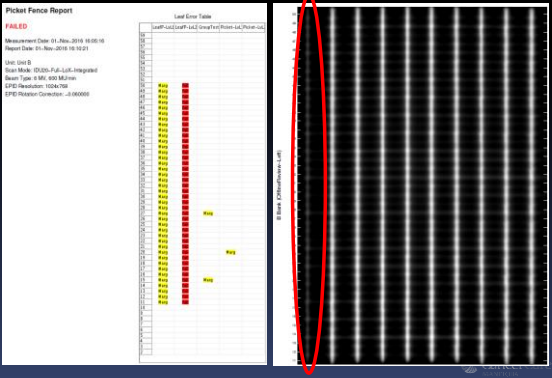


AWOL, pixels

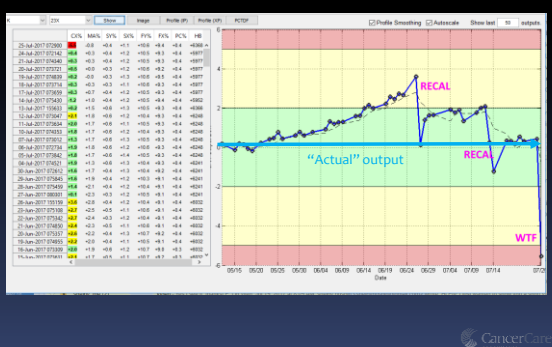


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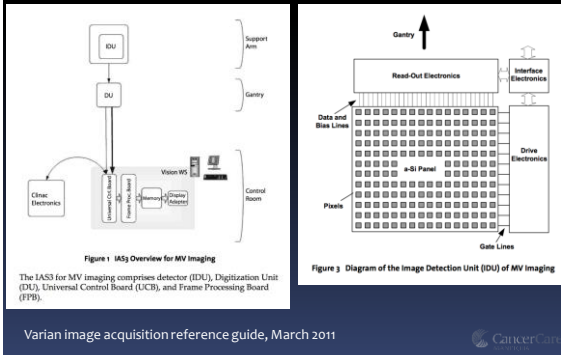
400 MU? 380 is fine, right??



RTU-K EPID – Output World Tour



Complicated hardware



Varian image acquisition reference guide, March 2011



The big payoff, aka it's worth the headache



Total time savings per day: 56 minutes
 OR
 4 more patients treated per day during clinical hours
 (2% overall increase in patient throughput)



Discussion

- EPIDs provide a fast, convenient, efficient, and cheap solution to some of the challenges of routine linac QA
- It's not a panacea. EPIDs themselves must be QA'd and kept on a tight leash
- There is a significant overall benefit and increase in QA throughput however.



Thank you, eh?