Adopting DAP as a dose metric in CT

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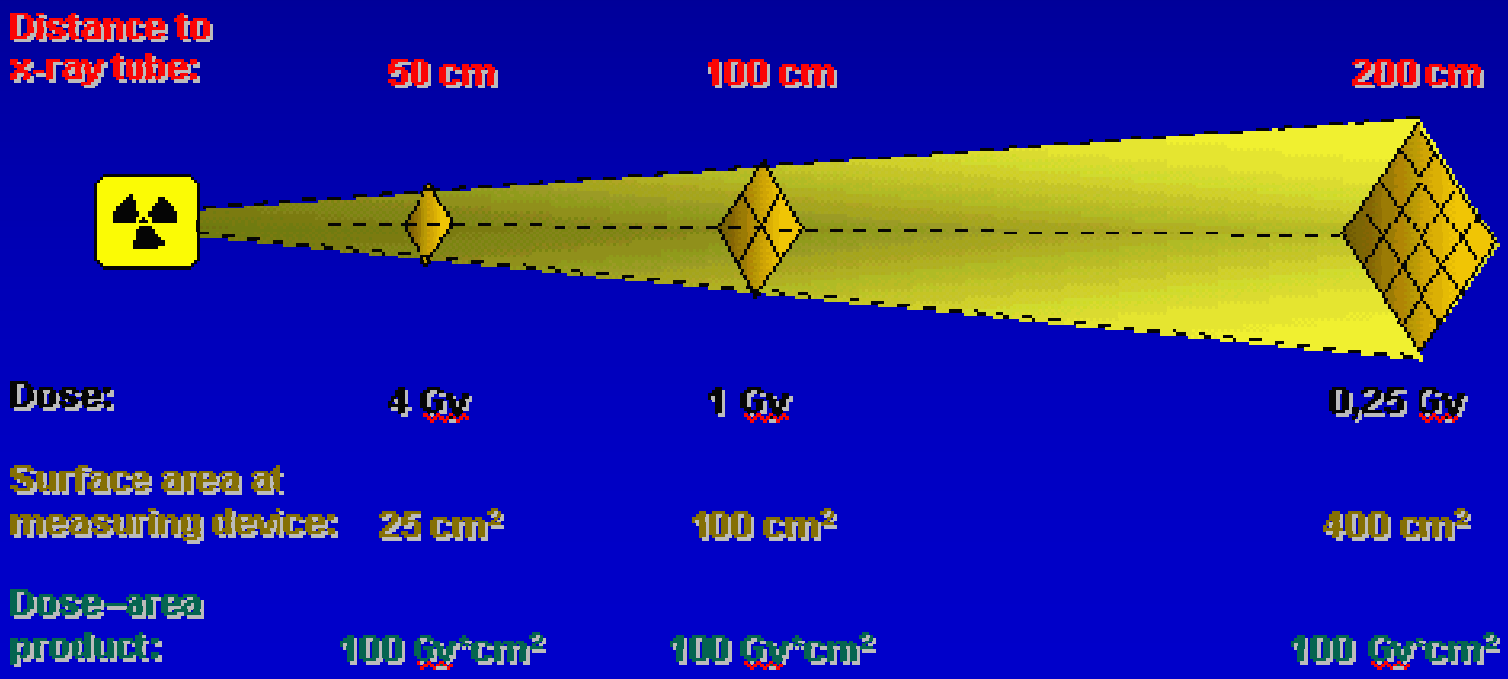
Dose Area Product (DAP) in CT

Hypothesis: There are advantages to using DAP:
(i) In quality assurance measurements
(ii) In patient dose calculations

- Problems with CTDI
- DAP measurements on a wide beam CT scanner
- Potential for patient dosimetry?

What is Dose Area Product (DAP) ?

- Int(D.dA) (equn), units: mGy cm^2
- For uniform beam ~ Dose x Area
- Proportional to total energy absorbed
- Invariant with distance from source



Problems with CTDI

- Std integration length 100 mm
  CT beams now extend up to >= 160 mm

- $CTDI_{w100}$ in 14 cm phantoms underestimates $CTDI_{w300}$:
  37-47% beam widths 8 – 128 mm (Mori et al., BJR, 2006)
  >40% at 160 mm (Geleijns et al, PMB, 2009)

Previously proposed solutions:

- Scan through small chamber e.g. Farmer:

Can't do on fixed table cone beam systems. Central dose within beam can be measured using a small chamber – a useful QA measurement, but no information on beam periphery (e.g. has collimation changed?). Would need to measure beam thickness each time on each setting as well.

- Extended phantoms:

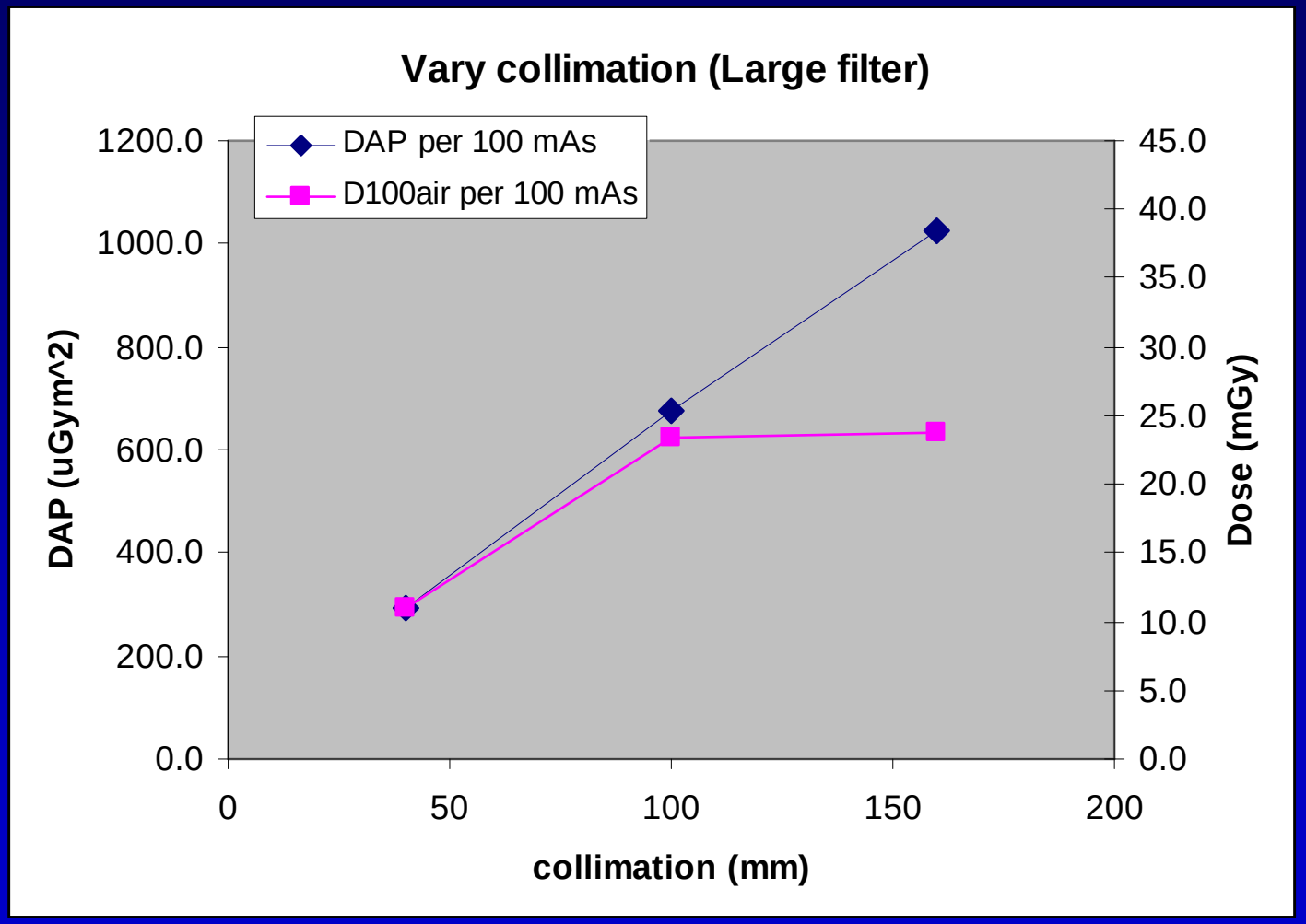
(i) Geleijns et al., …300 mm pencil chamber, 350 mm phantom -> CTDI300

(ii) RTI…..Pull small detector through phantoms during exposure using motorised jig (not commercially available system)

Cumbersome, expensive

DAP measurements

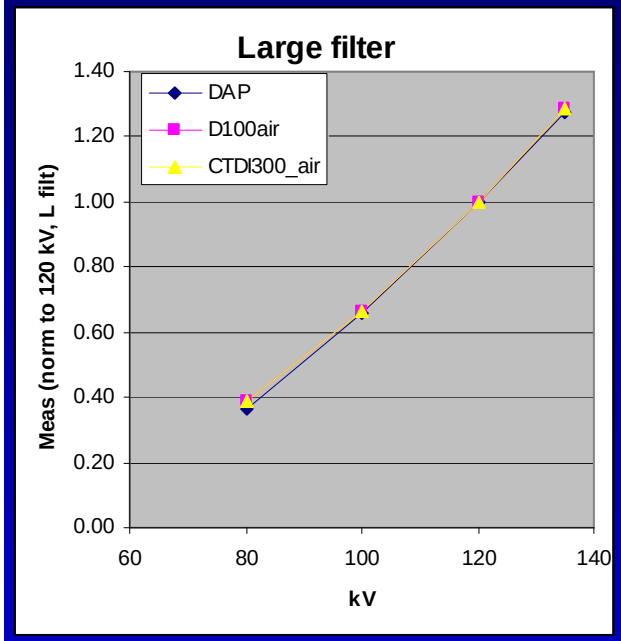
DAP vs 100mm chamber: Effect of collimation

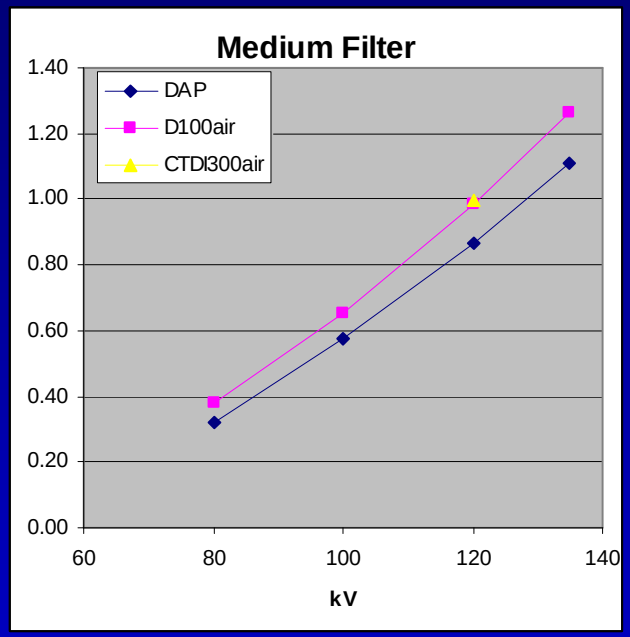


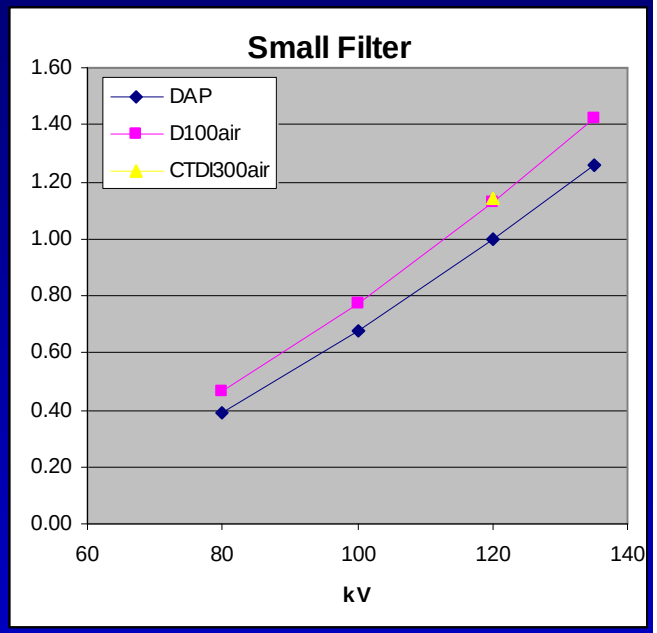
DAP vs $CTDI_{300}$: Effect of collimation (L filter)

Collimation	DAP/collim (uGym^2/mm)	norm.	CTDI300 (mGy)	norm.
40	7.28	1.14	28.8	1.13
100	6.76	1.06	26.9	1.06
160	6.41	1.00	25.4	1.00

DAP vs 100mm chamber: Effect of kVp, filter





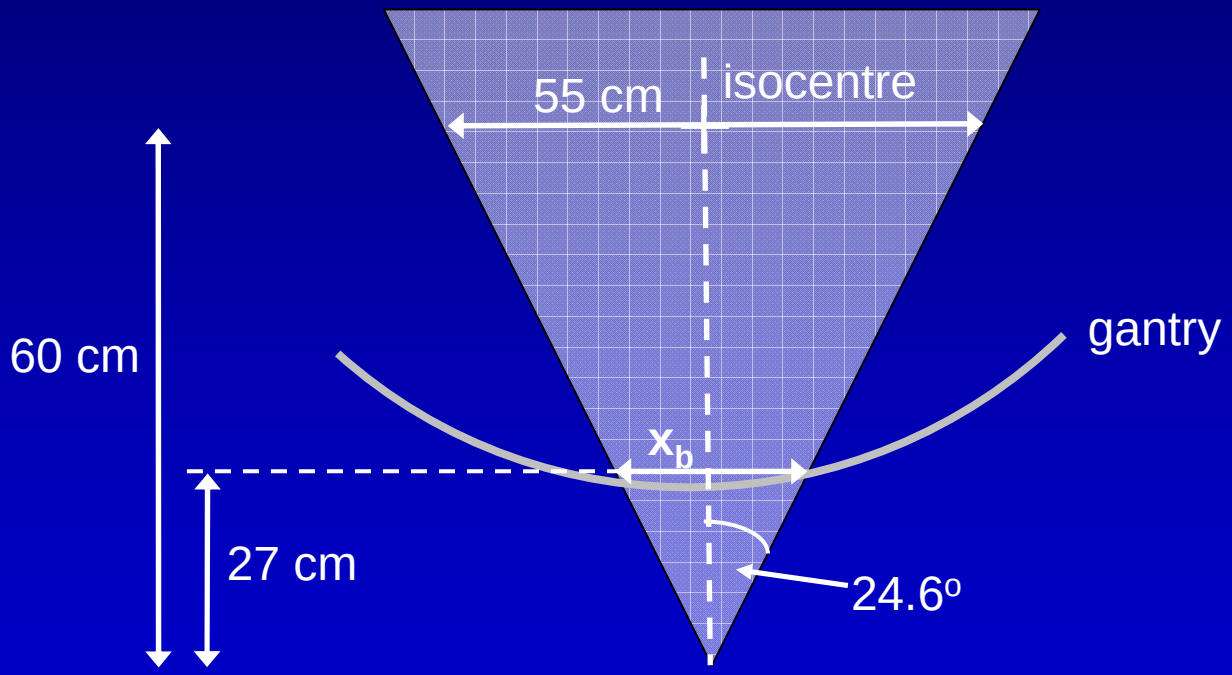


Pros & cons of DAP as a QA measurement

+	-
Whole beam	Fixed tube
Easy set-up	
Fast	

DAP: Patient dosimetry

Are we collecting all of the beam?



→ x_b = 25 cm !

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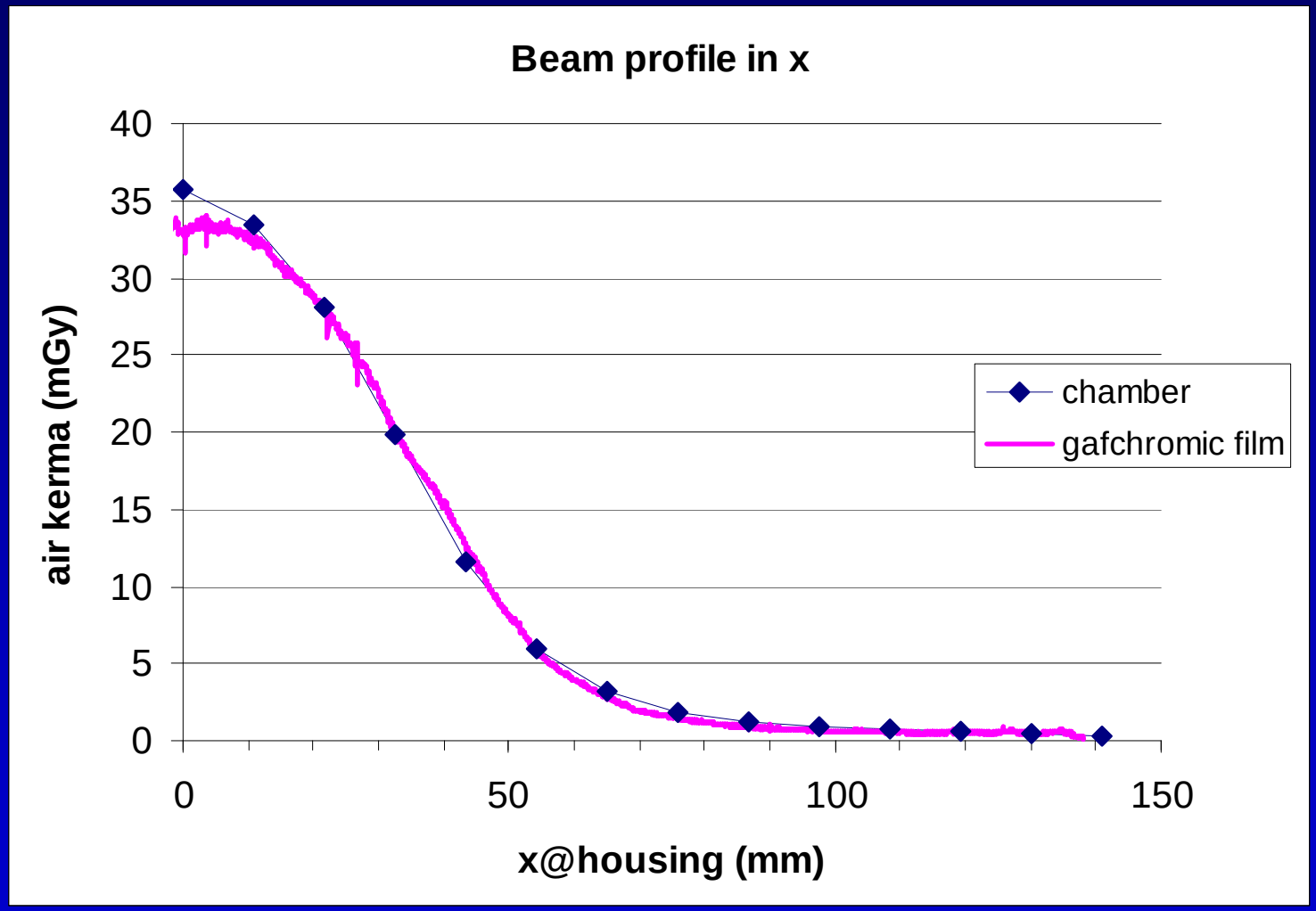

DAP in CT patient dosimetry

- CTDIw time consuming measurements
- CTDI phantom assumptions
- Additional measurements

Patient dosimetry

- Dosimetry comparison for Cardiac CTA (Toshiba Aquilion ONE)

120 kV
400 mA
0.35s x 1 rotation
L filter
160 mm collimation centred on heart

- E_{dlp}
- ImPACT CTDosimetry.xls (ICRP60)
- NRPB R262: DAP-> Dose conversion factors

Patient dosimetry: Scanner matching

- ImPACT scanner matching carried out for Toshiba Aquilion ONE
- ImPACT factor calculated from (CTDI_centre/CTDI_air), (CTDI_periphery/CTDI_air)
- Large filter, 120 kV -> Philps LX, 120 kV (MCDATASET 19)

Patient dosimetry

DLP	162 mGy.cm
Edlp (0.014)	**3.0 mSv**
ImPACT	**4.2 +0.4/-0.1 mSv**
DAP	1435 uGym^2

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Heart AP	0.86 mSv
Heart LLat	1.07 mSv
Heart PA	0.98 mSv
Heart RLat	1.12 mSv

Patient dosimetry

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Heart AP	0.86 mSv
Heart LLat	1.07 mSv
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Heart RLat	1.12 mSv
Total	**4.0 mSv** (Chest views 3.2 mSv)
Edap	2.9 x 10^{-3} mSv/uGy/m^2

Pros & cons of DAP for CT patient dosimetry

+	-
Proportional to energy imparted, risk	Beam shaping filter issues
Use same software as other radiography	
Unify units, improve understanding!	
Scout doses…	

Conclusions and further work

- DAP measurements useful in wide beam QA
- Good comparator of risk
- Preliminary dose calculations promising
- Effect of beam shaping on organ doses / effective doses to be studied
- Calculate E_{dap} for range of examinations, scanners

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