

Single and multi-slice doses using a rapid CT dose calculator

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Acknowledgement to: ImPACT

Presentation

- Practical problems in calculating CT dose
- Our approach
 - an E_{dip} method
 - minimum number of parameters

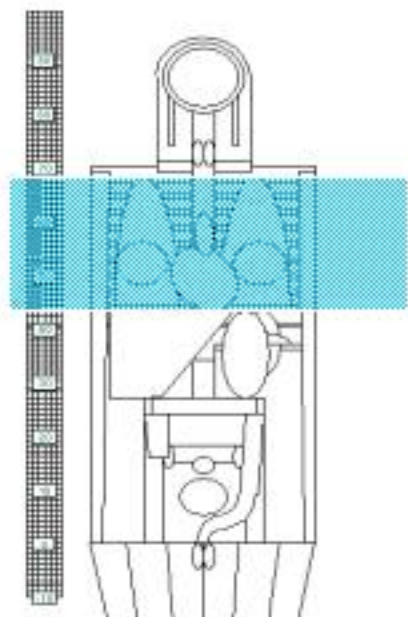
What do we need to calculate?

- **Effective dose**
 - risk, radiation incidents
 - comparison with other radiological exams
 - ethics
- **Dose-length Product (DLP)**
 - dose audit
 - comparing protocols
- **DLP → Effective dose**
- **Total mAs → Effective dose**

Effective dose:

Method using Monte-Carlo datasets

- **Problem of different patient sizes**
- **Getting the total mAs to add up**
- **What CTDI?**
- **Multiple sequences or variations?**



Getting total mAs to add up

- Modify pitch:

→ 'Squash' or 'stretch' spiral to fit standard phantom

Pitch \rightarrow Pitch \times $\frac{\text{std phantom total mAs}}{\text{meas total mAs}}$

Effective dose:

Method using Monte-Carlo datasets

- Setting anatomical limits
- Getting the total mAs right
- **What CTDI?**
- Multiple sequences or variations?

Effective dose:

Method using Monte-Carlo datasets

- Setting anatomical limits
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- What CTDI?
- **Multiple sequences or variations?**

Effective dose: E_{dlp} method

EUR 16262 (1999):

$$E = E_{\text{DLP}} \cdot \text{DLP}$$

www.drs.dk/guidelines/ct/quality/index.htm

- E_{DLP} is “region-specific normalised effective dose” ($\text{mSv mGy}^{-1} \text{cm}^{-1}$)
- Regions: head, neck, chest, abdomen, pelvis
- “Broad estimate” of effective dose

Effective dose: E_{dlp} method

Advantages

- Quick
- Anatomy oriented
(don't need to
know lengths)

Disadvantages

- No organ doses
- Inaccurate ?

Our Approach

Use NRPB Monte Carlo dataset and ImPACT's CTDosimetry spreadsheet to calculate accurate E_{DLP} factors for each scanner

Dose calculation by simple E_{DLP} lookup



The DLP Guidebook

[click to enter]



The DLP-Guidebook

Your Key to the Kingdom



DLP Guidebook

Click the magic

Obtaining DLP

$$DLP = CTDI_{vol} \cdot (End(cm) - Start(cm))$$

$$= \left[{}_z CTDI_w \cdot \frac{mAs/rotn}{100} \cdot \frac{l}{Pitch} \right] \cdot (End(cm) - Start(cm))$$

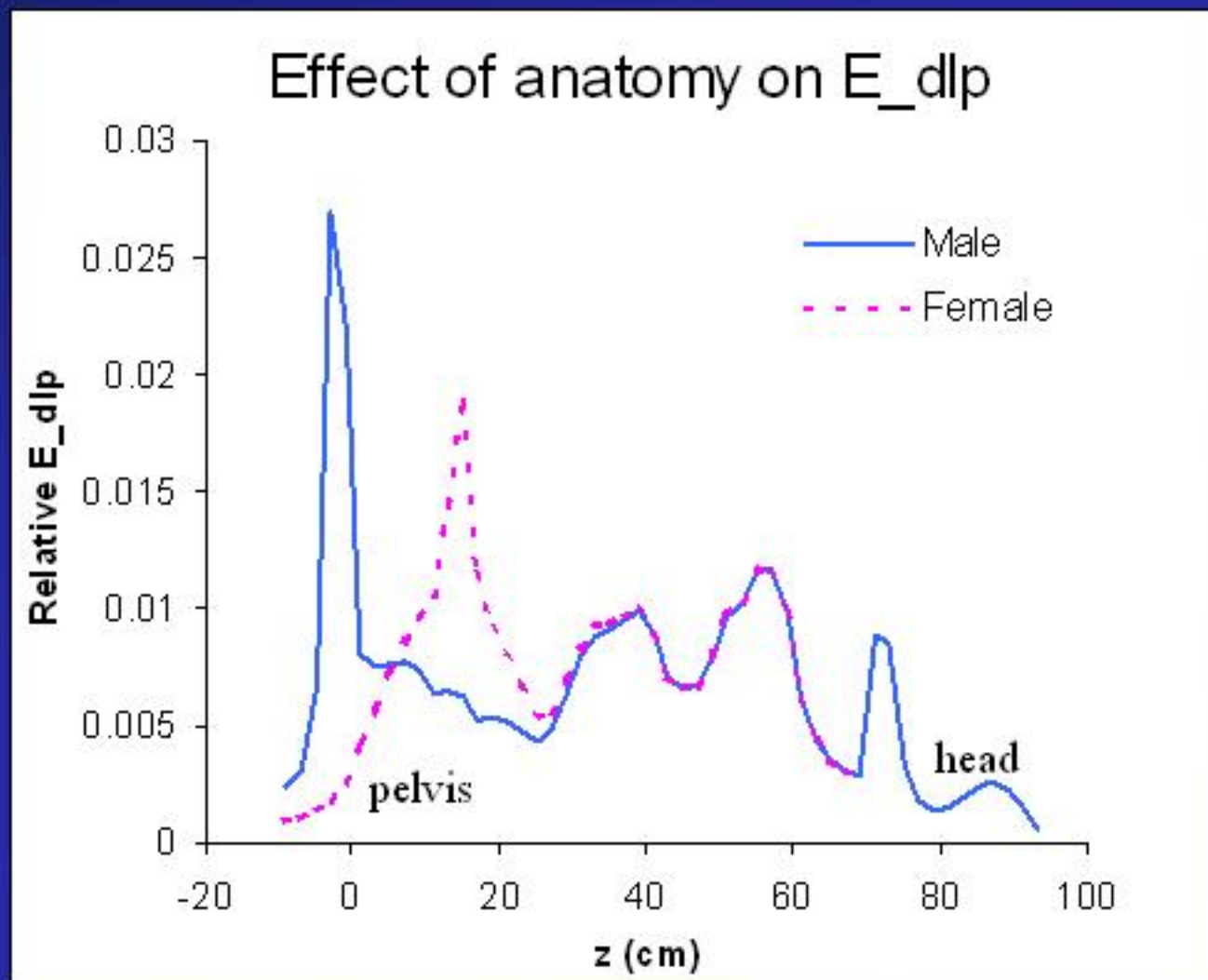
$$= \left[{}_z CTDI_w \cdot \frac{mAs/rotn}{100} \cdot \frac{collimation(mm)}{feed/rotn(mm)} \right] \cdot (End(cm) - Start(cm))$$

$$= {}_z CTDI_w (collimation) \cdot \frac{Total \ mAs}{1000}$$

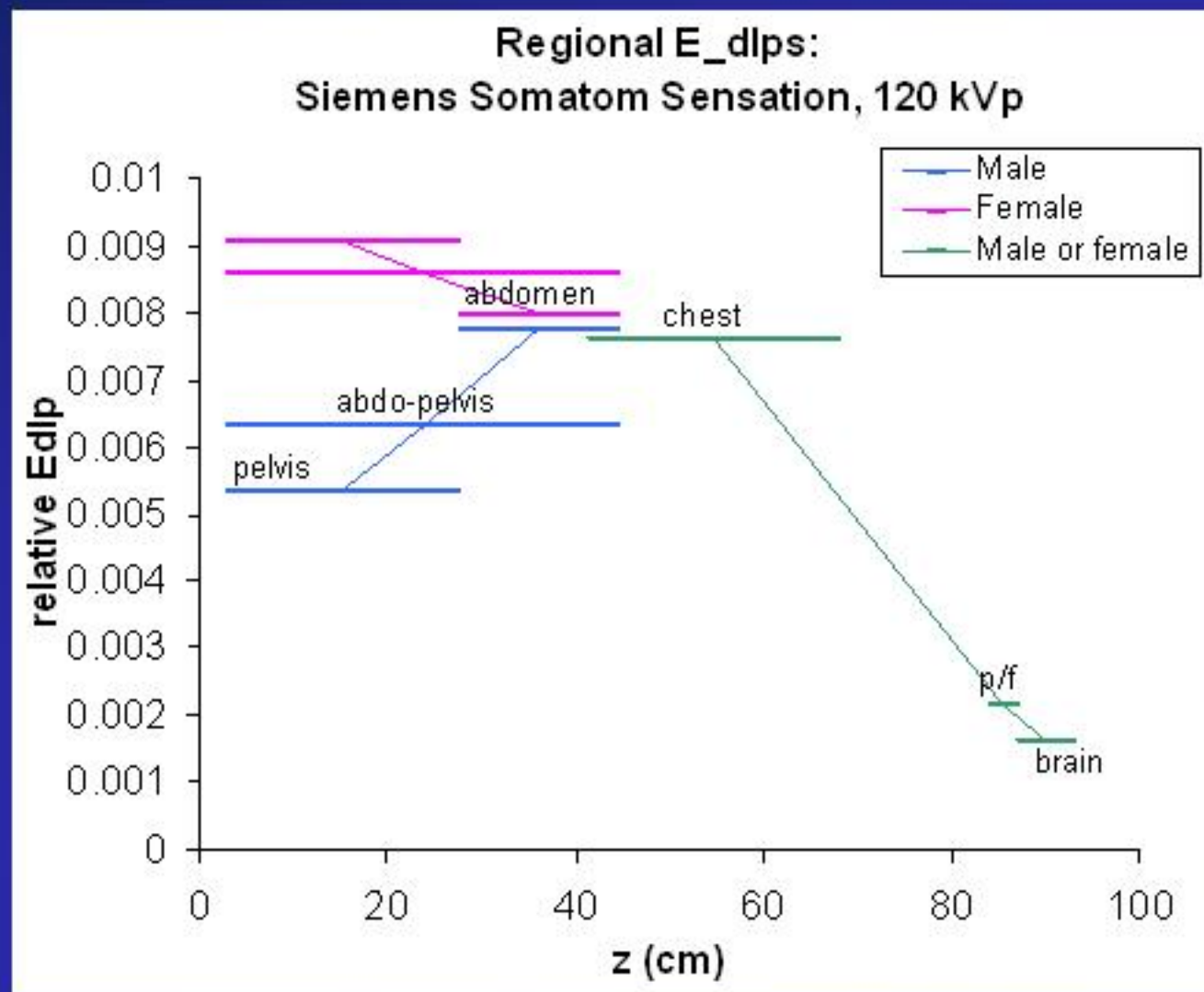
Factors affecting E_{dlp}

- **Scanner**
 - **Head / Body**
 - **kVp**
 - **Male / Female**
 - **Region scanned**
- } Determine scanner matching

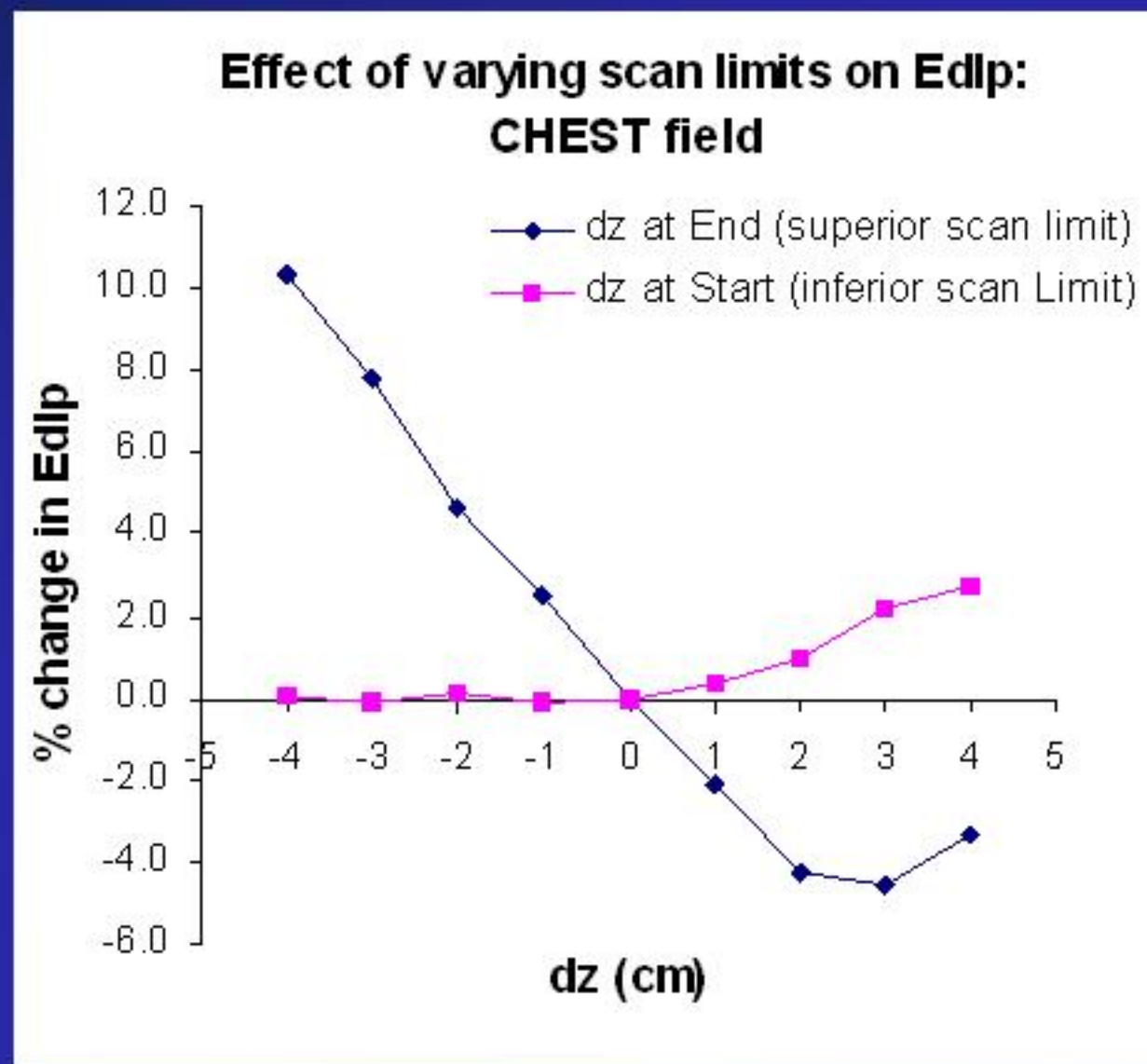
E_{dlp} : Effect of anatomical region



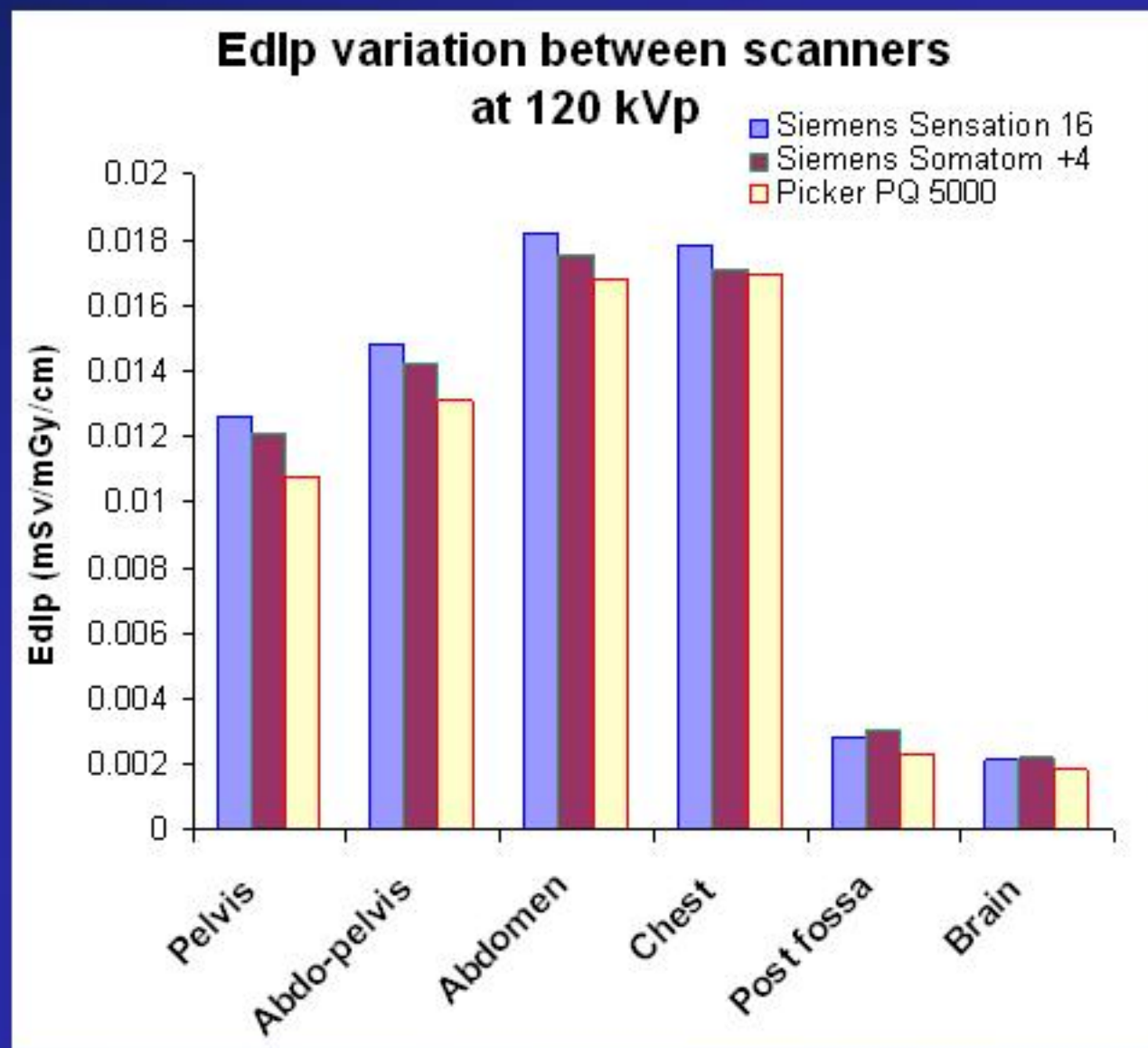
E_{dlp} : Effect of anatomical region



Errors due to region positioning



E_{dlp} : Scanner variations



EDINBURGH CT DOSE CALCULATOR

^ Scanner	vhk
Male (m) / Female (f)	m
^ No. sequences	1
Sequence	1
^ kVp	120
^ Collimation	24
^ Protocol/body region	Chest
Total mAs	1401
<input type="button" value="Calculate"/>	
TOTAL	
DLP (mGy cm)	277
Effective dose (mSv)	4.9

EDINBURGH CT DOSE CALCULATOR

^ Scanner	vhk
Male (m) / Female (f)	vhk
^ No. sequences	qmh
Sequence	rielf_16
^ kVp	rielf_4
^ Collimation	wgh_dcn
^ Protocol/body region	wgh_main
	wgh_oncol
	StJ
	z
	Chest
Total mAs	1401
	Calculate
	TOTAL
DLP (mGy cm)	277
Effective dose (mSv)	4.9

EDINBURGH CT DOSE CALCULATOR

^ Scanner	vhk
Male (m) / Female (f)	m
^ No. sequences	1
Sequence	1
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<input type="button" value="Calculate"/>	
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EDINBURGH CT DOSE CALCULATOR

^ Scanner	vhk
Male (m) / Female (f)	m
^ No. sequences	1
Sequence	1
^ kVp	120
^ Collimation	24
^ Protocol/body region	Chest
Total mAs	Pelvis Abdo-pelvis Abdomen Chest Neck Sinuses Post fossa Brain
	TOTAL
DLP (mGy cm)	277
Effective dose (mSv)	4.9

EDINBURGH CT DOSE CALCULATOR

^ Scanner	vhk
Male (m) / Female (f)	m
^ No. sequences	1
Sequence	1
^ kVp	120
^ Collimation	24
^ Protocol/body region	Chest
Total mAs	1401
<input type="button" value="Calculate"/>	
TOTAL	
DLP (mGy cm)	277
Effective dose (mSv)	4.9

EDINBURGH CT DOSE CALCULATOR

^ Scanner	vbk	
Male (m) / Female (f)	m	
^ No. sequences	2	
Sequence	1	2
^ kVp	120	120
^ Collimation	24	24
^ Protocol/body region	Chest	Abdomen
Total mAs	1401	1671

Calculate

	TOTAL		
DLP (mGy cm)	277	110	387
Effective dose (mSv)	4.9	2.1	7.0

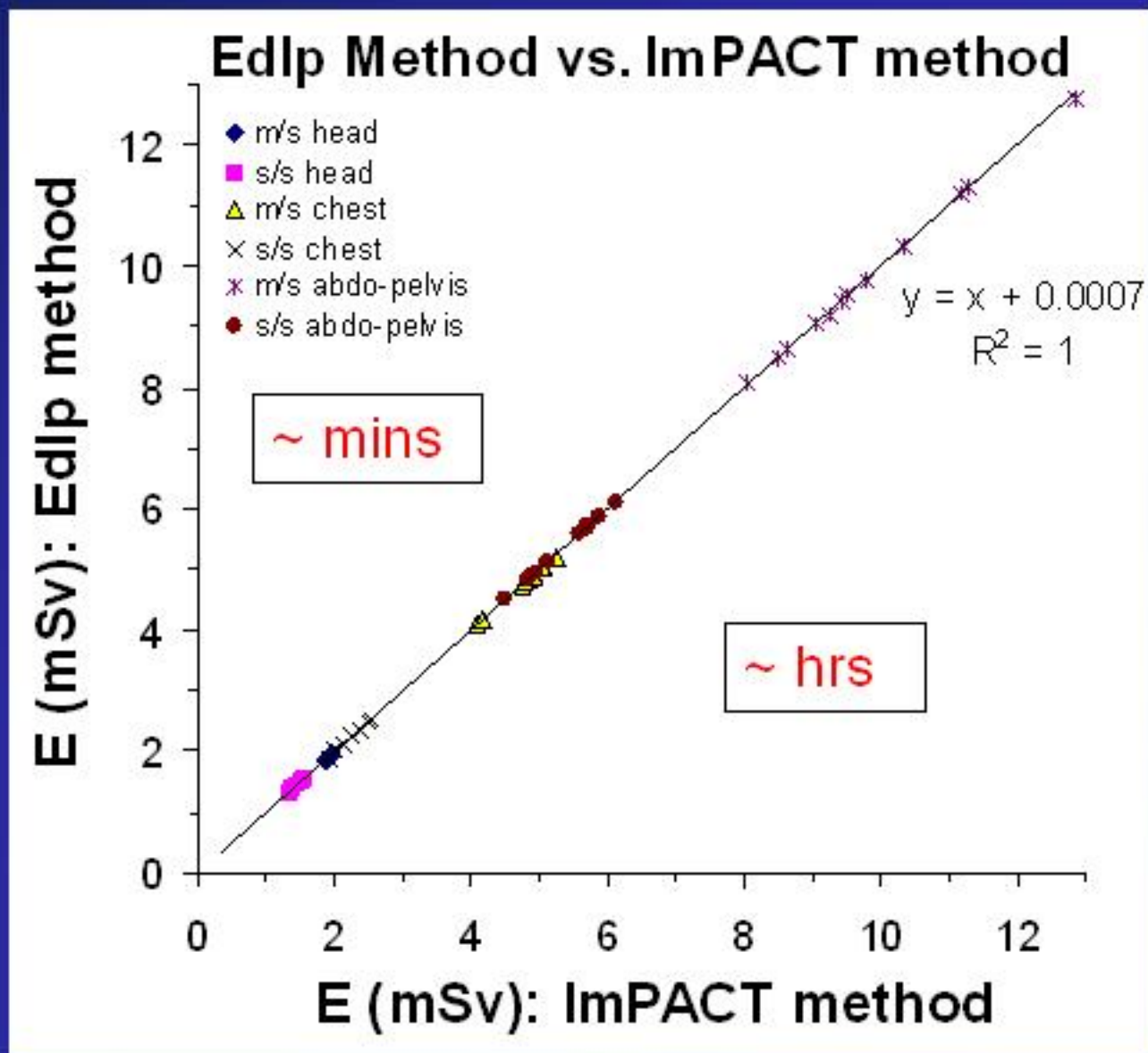
1 Location:
 2 Scanner: Siemens Somatom Sensation 16

NORMALISED Edp VALUES	Standard protocol information		80		100		120		140			
			Start	End	Male	Female	Male	Female	Male	Female	Male	Female
			1 Pelvis	3	27.5	0.00406	0.00697	0.00536	0.00907	0.00536	0.00907	0.00536
2 Abdo-pelvis	3	44.5	0.00485	0.00662	0.00631	0.00859	0.00631	0.00859	0.00631	0.00859		
3 Abdomen	27.5	44.5	0.00607	0.00621	0.00777	0.00800	0.00777	0.00800	0.00777	0.00800		
4 Chest	44.5	68	0.00542		0.00686		0.00686		0.00686			
5 Neck	68.5	82	0.00315		0.00363		0.00363					
6 Sinuses	77.5	86.5	0.00134		0.00160		0.00160					
7 Post fossa	84	87	0.00183		0.00215		0.00215					
8 Brain	87	93	0.00141		0.00163		0.00163					

18 CTDI Date: 3.4/07/03

Filter	collim	80	100	120	140	
nCTDIw	Body	18	2.5	4.88	7.9	12.0
	Head	18	7.6	13.44	20.0	
nCTDIair	Body	18	6.4	11.88	18.5	23.8
	Head	18	11.0	18.17	26.4	
nCTDIair	Body	2			23.06	
		9			21.1	
		10			16.49	
		12			21.56	
		18			18.535	
		24			19.22	

Effective dose: Example data



Conclusions

Our method gives effective dose and DLP:

- **quickly**
- **easily from minimum no. input parameters**
- **linked to department practice**
- **linked to QA data**
- **overscan included**
- **easily for many patients, multiple sequences**
- **accurate c.f. ImPACT / NRPB data**