dose volume histogram comparisons for breathing adapted radiotheray of lung cancer

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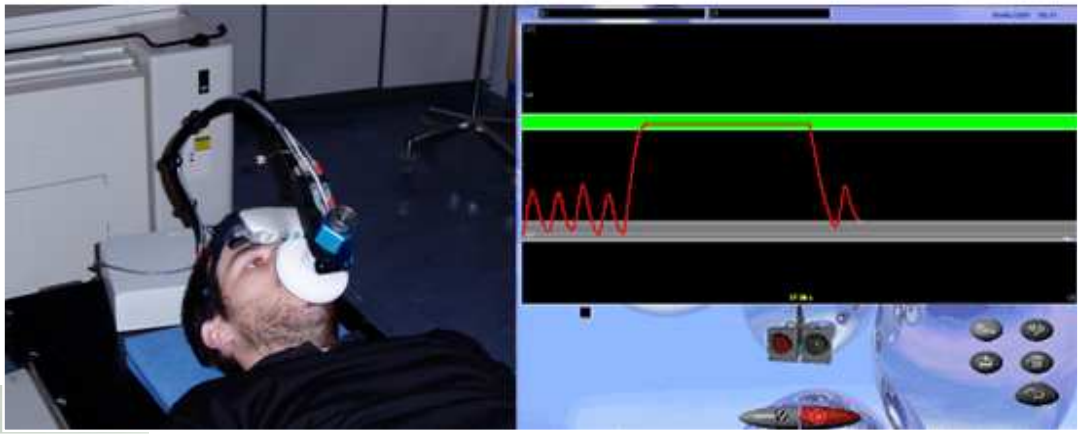
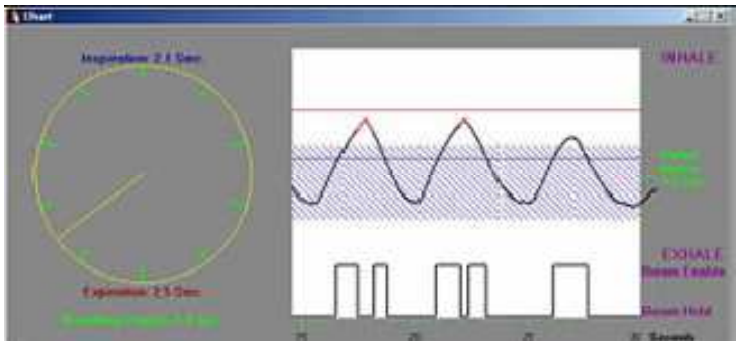
Treatment strategies for breathing-adapted radiotherapy at Institut Curie

Deep Inspiration Voluntary Breath-Hold (Dyn'R spirometer)





Gated technique with Varian RPM (GE 4D-CT)

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Cost-benefit assessment of breathing adapted techniques

Concerted action involving 20 centres in France (STIC)

Institut Curie = coordinating centre

Lung and Breast patients

reference cases :

free breathing

dosimetric and clinical end-points:

DVH analysis

Toxicity (follow-up)

● main centres ● associate centres

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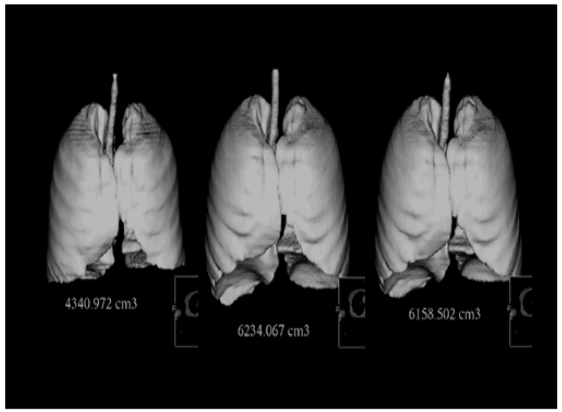
Protocol for lung tumours



3 consecutive CT scans :

–1 x Free Breathing (**FB**)

–2 x Breathing Adapted technique (**BA1** and **BA2**)

- either Deep Inspiration Breath Hold (DIBH)
- or End Inspiration Gating (EI-RPM)

Target structures

–GTV delineation

–3D expansion →

Organs at Risk

–lungs (- PTV)

–heart, oesophagus, spinal chord

	Free Breathing (FB)	Breathing Adapted (BA)
CTV	GTV + 5 mm to 8 mm margin (depending on histology)	
ITV	CTV + 3 mm (sup or med) or+ 8 mm (inf) margin	CTV_{BA1} U CTV_{BA2}
PTV	ITV + 2 mm margin	

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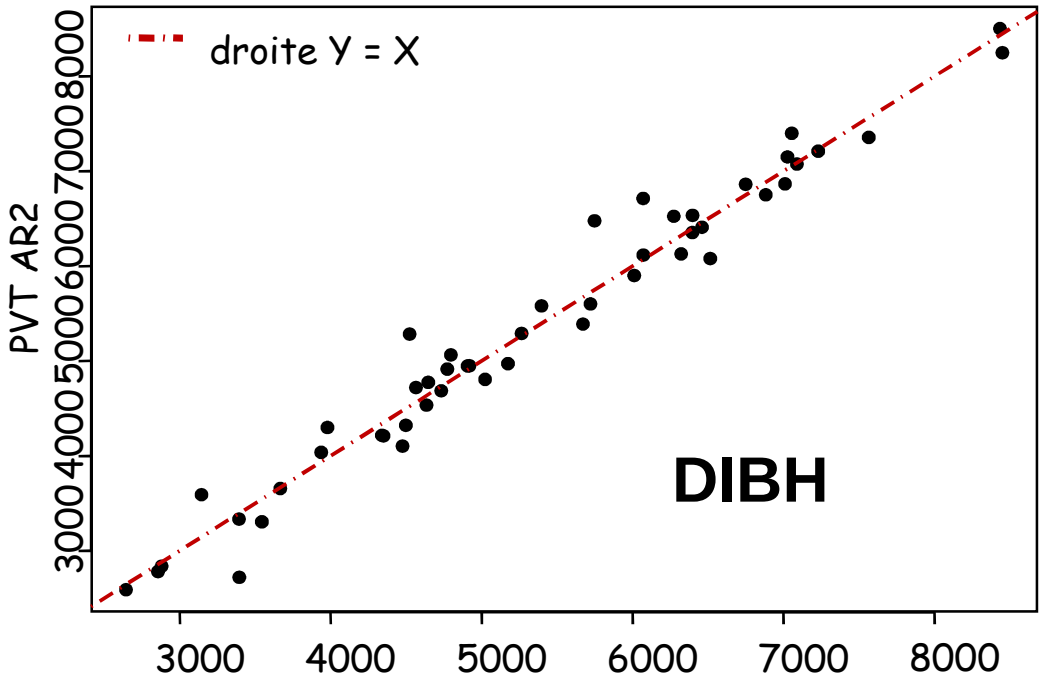
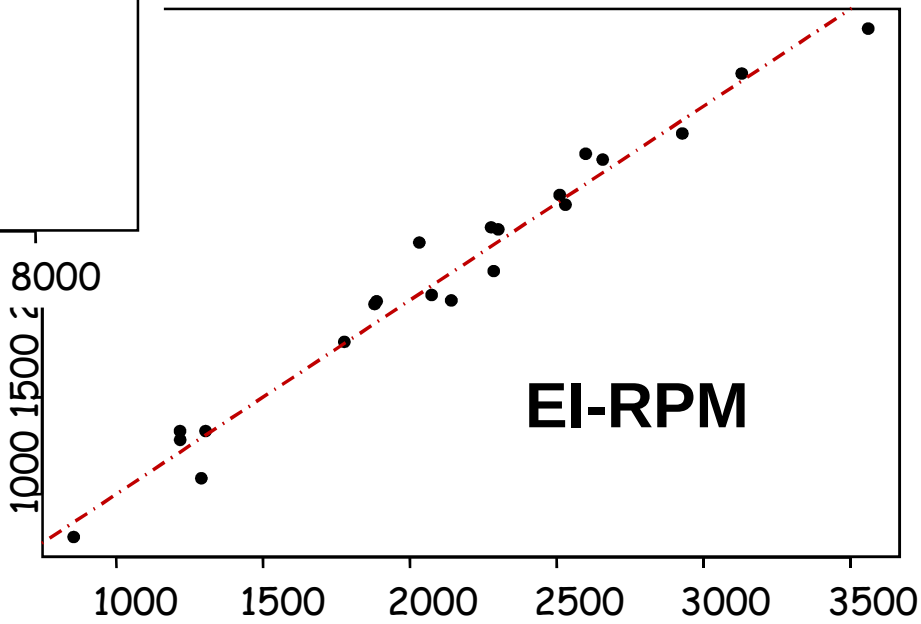
Overall repeatability of Breathing-Adapted technique





preliminary analysis of collected data ($\approx$100 patients)

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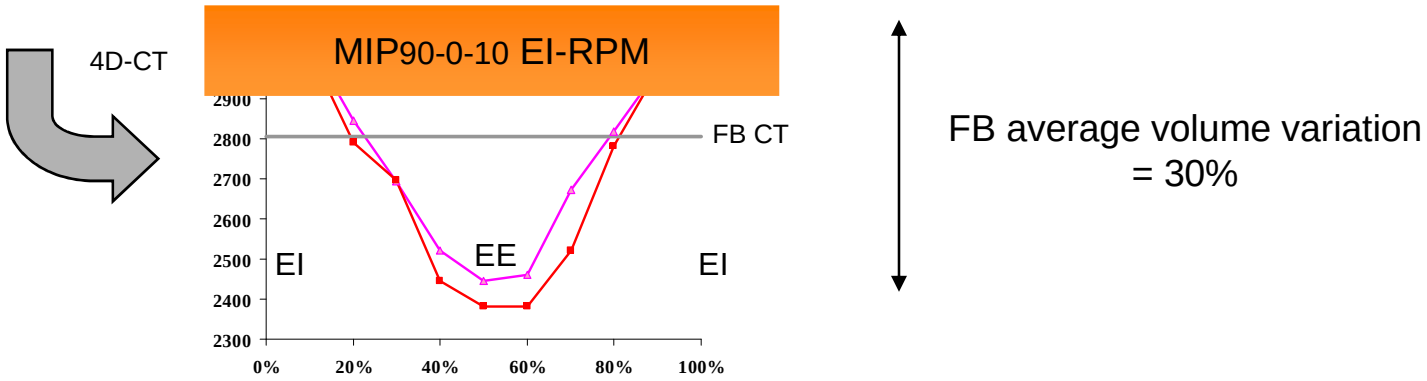
Preliminary analysis of lung volumes (cm^3)

CT	Free Breathing (FB)	Breathing Adapted (BA)	BA1-BA2	BA / FB
DIBH 13 pat.	3700 (2000-6100)	5300 (2800-7600)	70 (1%) (1-165)	+43% (+23% +65%)
EI-RPM MIP: 90-0-10% (14 pat.)	3200 (2200-3900)	3400 (2300-4200)	55 (1.5%) (0-258)	+7% (-2% +17%)



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Issues for dosimetric comparison between FB and BA technique

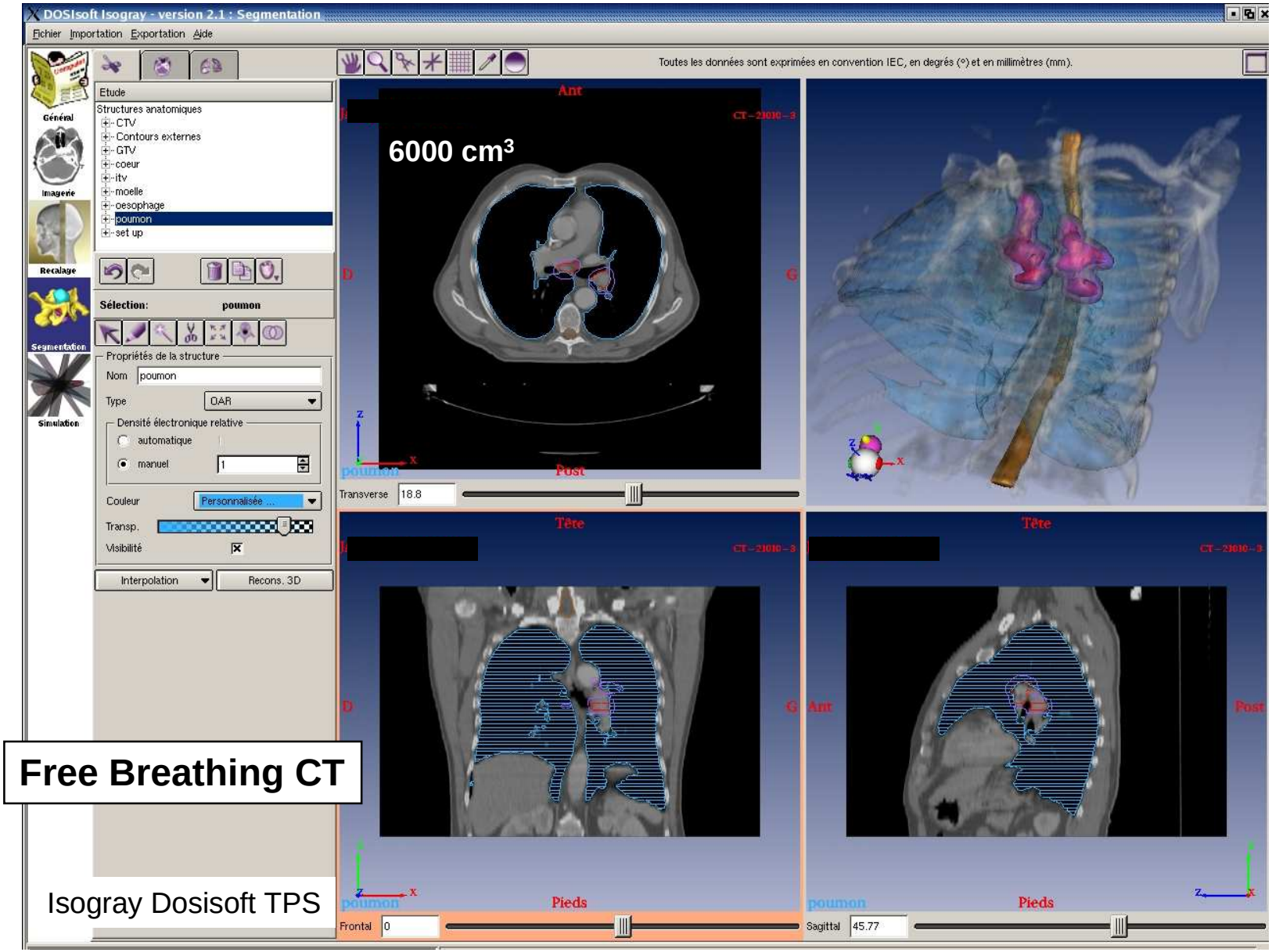
Modification of shape and position of structures

–influence on beam setup

- **GTV position**
- **margins (ITV)**

–influence on dose computation

- **patient thickness**
- **lung shape**
- **lung density**



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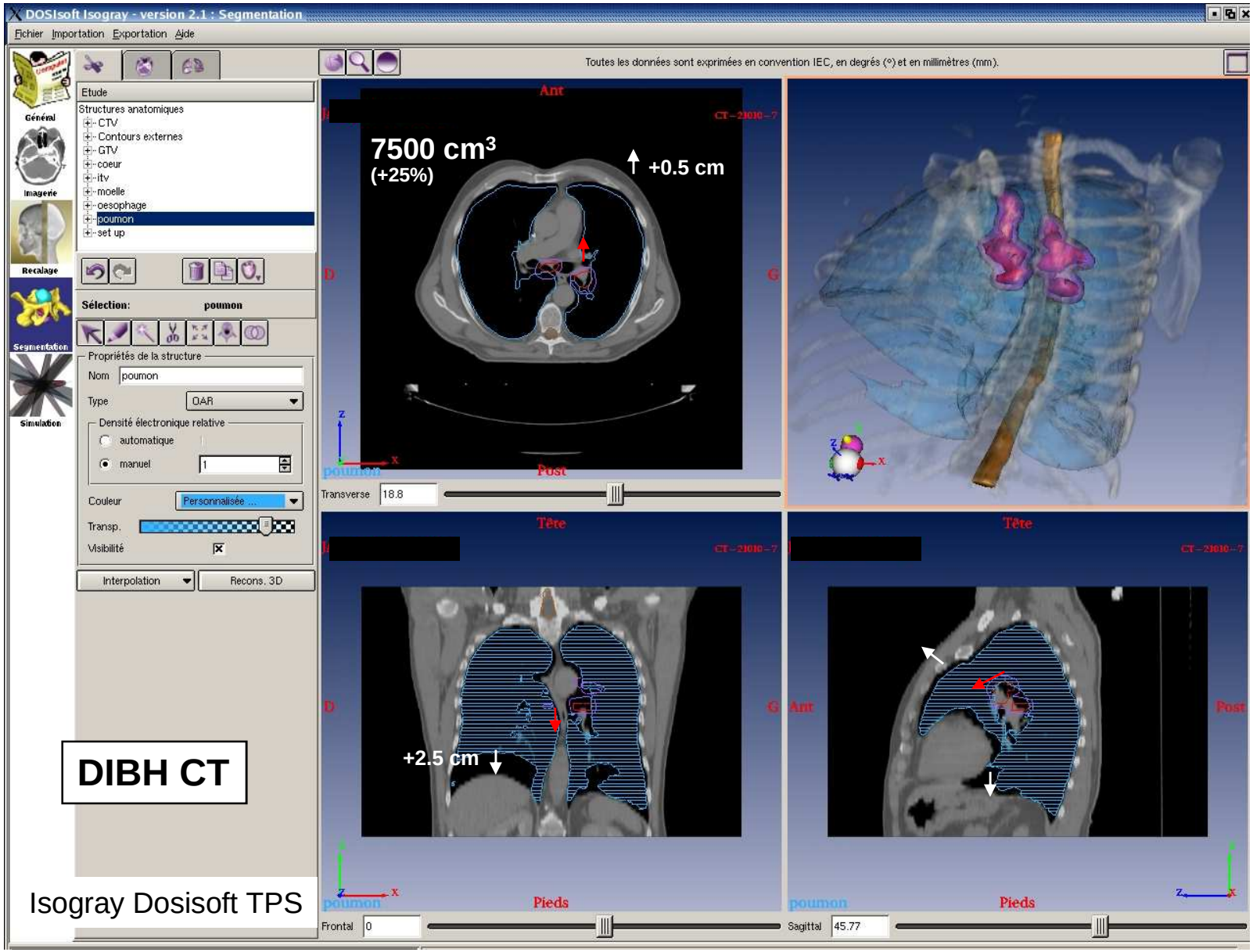

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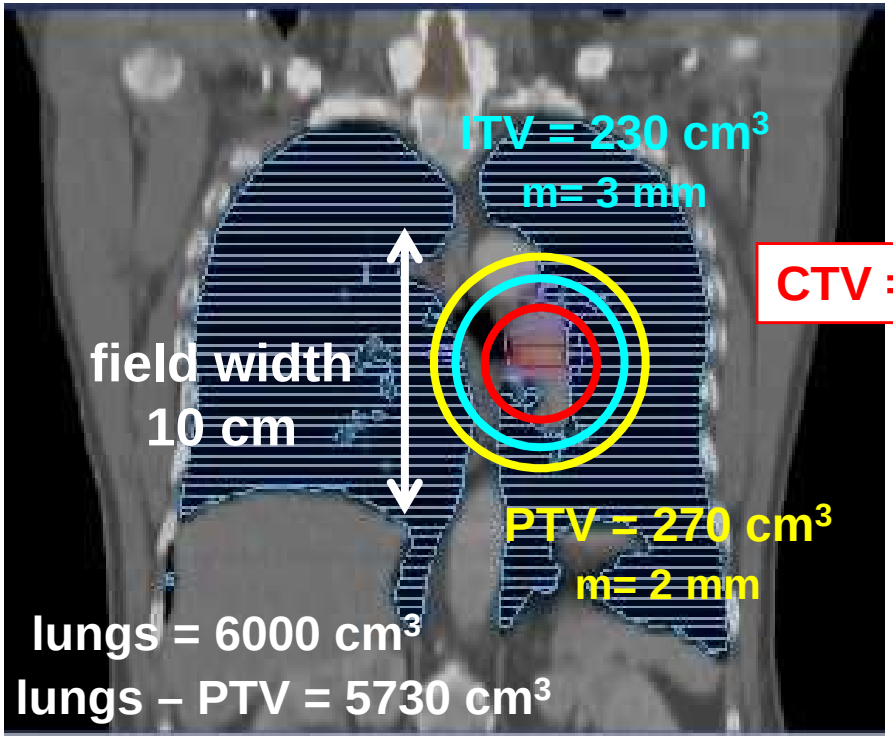
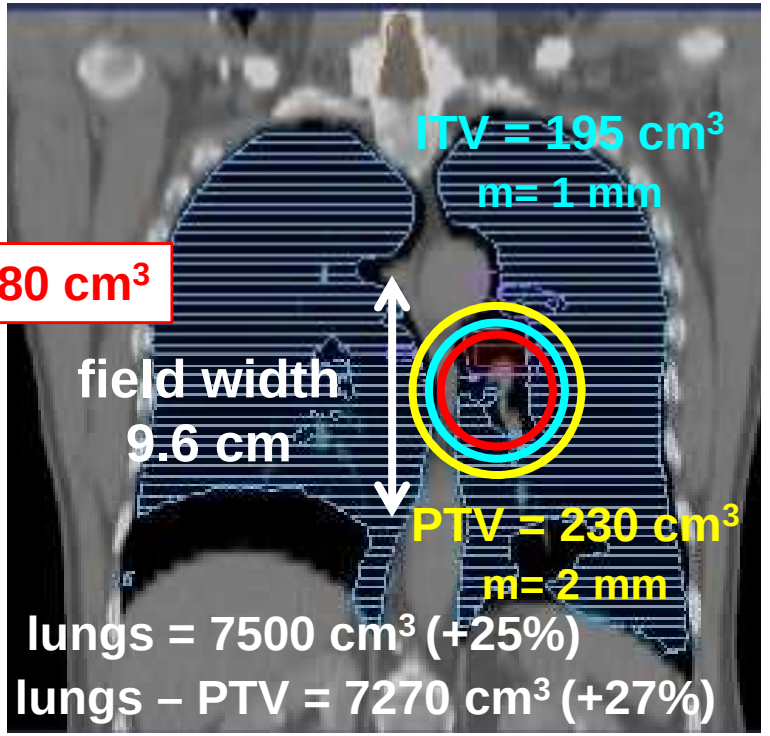
illustration of volume changes with breathing adapted radiotherapy : *margin reduction + lung volume increase*

Free Breathing



PTV/lungs = 4.5% PTV/(lungs-PTV) = 4.7%

Deep Inspiration Breath Hold



PTV/lungs = 3% PTV/(lungs-PTV) = 3.2%

larger differences for inferior lobe tumours (m_{ITV}= 8 mm)

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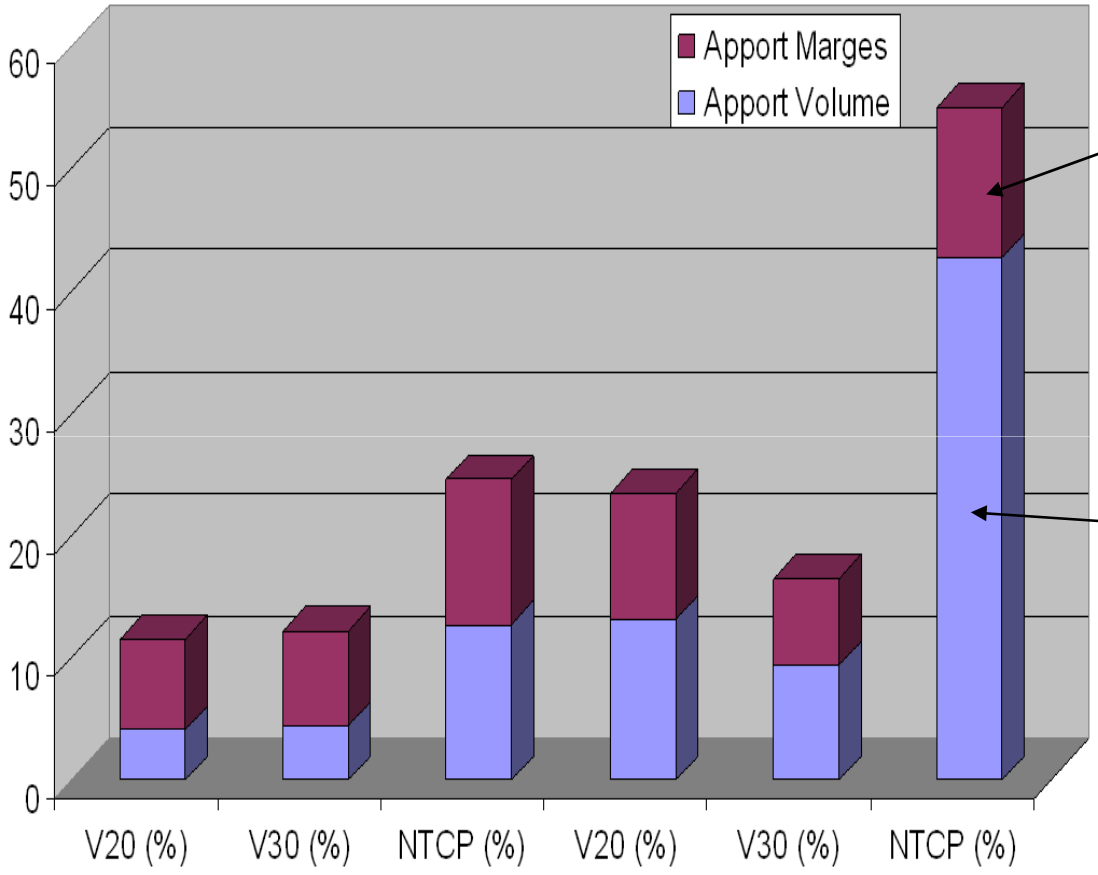
relative importance of margin reduction and lung volume increase



margin influence

lung volume influence

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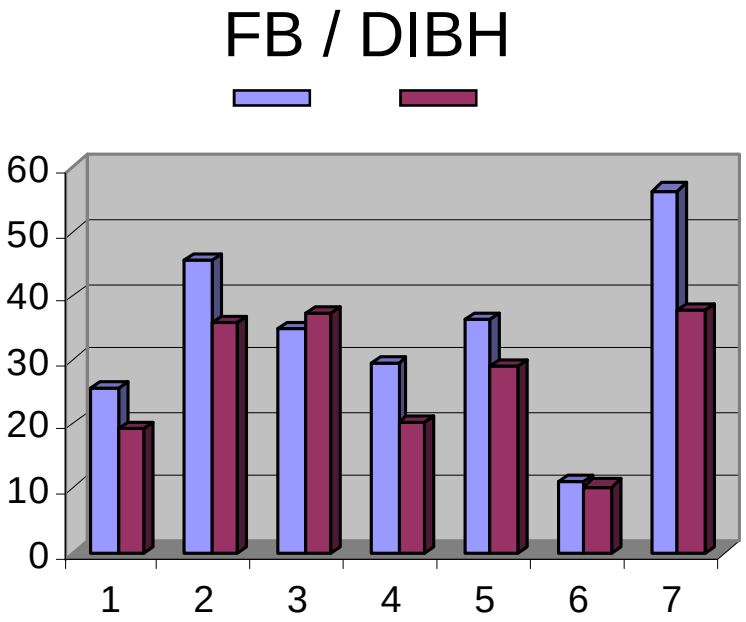
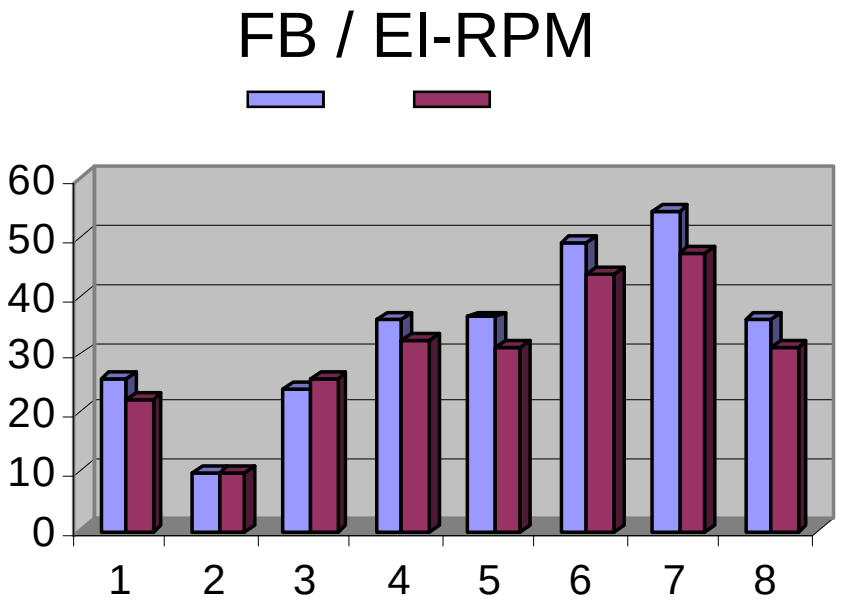
lung V20 comparison



absolute variation :
+2.5% to -18.5% (avg. -7.0%)



absolute variation :
+1.4% to -7.1% (avg.-3.1%)

V20 is expressed as % of V_{lung}-V_{PTV}

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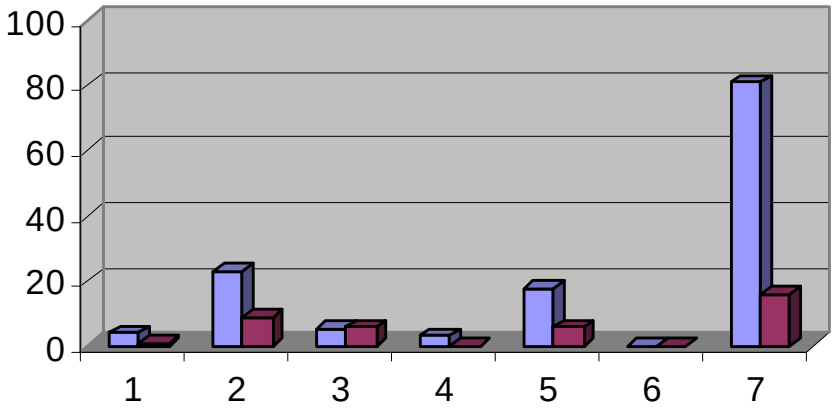
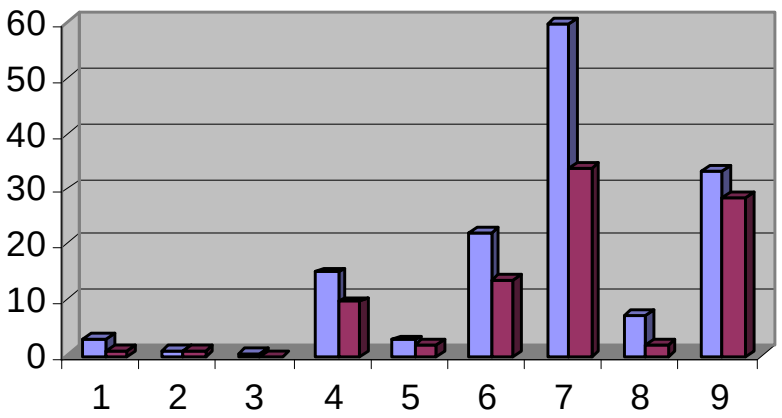
lung NTCP comparison

FB / DIBH



absolute variation :
+0.8% to -65% (avg. -13%)

FB / EI-RPM



absolute variation :
-0.1% to -26% (avg.-6%)

NTCP is calculated from LKB DVH reduction using Emami data)

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Conclusions

- **comparison of free breathing and breathing-adapted techniques implies**
  - consistency in structure contouring (=performed by the same operator)
  - sensible treatment plan adaptation from one technique to the other
  - choice of relevant coverage and toxicity indices
  - these indices may have to be reconsidered for such comparison (i.e.inclusion of variable lung volume in PTV)

- **the decrease of lung toxicity indices for BA techniques is due to**
  - increase of lung volume (i.e decrease of V_{PTV}/V_{lung})
  - margin reduction around GTV
  - field setup modification

- **deep inspiration breath-hold seems more efficient than gated technique**

- **reduction of lung toxicity indices comes mostly from lung volume increase**