

# Activity with Tomodirect™ in Aosta

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CONVEGNO

## La TOMOTERAPIA in Italia: Esperienze a confronto

*Presidenti: Umberto Ricardi - Teodoro Meloni*



Sabato  
20 novembre 2010



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5 CREDITI ECM





# Whole breast radiotherapy



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## PHYSICS CONTRIBUTION

### EVALUATION OF TWO TOMOTHERAPY-BASED TECHNIQUES FOR THE DELIVERY OF WHOLE-BREAST INTENSITY-MODULATED RADIATION THERAPY

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GUSTAVO H. OLIVERA, PH.D.,‡ BHAVIN CHAUHAN, B.S., C.M.D.,† SANFORD L. MEEKS, PH.D.,†  
KENNETH J. RUCHALA, PH.D.,‡ JASON HAIMERL, M.S.,‡ WEIGUO LU, PH.D.,‡  
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WHITE PAPER

## Reduced Contralateral Breast Dose using TomoDirect™ and Daily MVCT Imaging

Peter Hoban, Ph.D., Ranjini Tolakanahalli, M.S., Dinesh Tewatia, M.S., Stephanie Key, B.S.R.T.(R)(T), C.M.D., Nader Jaffari, B.S.R.T.(R)(T), C.M.D.\*

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journal homepage: [www.thegreenjournal.com](http://www.thegreenjournal.com)



## Breast cancer radiotherapy

### Dosimetric assessment of static and helical TomoTherapy in the clinical implementation of breast cancer treatments

Truus Reynders<sup>a,\*</sup>, Koen Tourmel<sup>a</sup>, Peter De Coninck<sup>a</sup>, Steve Heymann<sup>b</sup>, Vincent Vinh-Hung<sup>a</sup>, Hilde Van Parijs<sup>a</sup>, Michaël Duchateau<sup>a</sup>, Nadine Linthout<sup>a</sup>, Thierry Gevaert<sup>a</sup>, Dirk Verellen<sup>a</sup>, Guy!

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doi:10.1016/j.ijrobp.2008.01.047

## PHYSICS CONTRIBUTION

### EVALUATION OF COPLANAR PARTIAL LEFT BREAST IRRADIATION USING TOMOTHERAPY-BASED TOPOTHERAPY

ALYSON McINTOSH, M.D.,\* PAUL W. READ, M.D., PH.D.,\* SHIV R. KHANDELWAL, M.D.,\*  
DOUGLAS W. ARTHUR, M.D.,† A. BENTON TURNER, C.M.D.,\* KENNETH J. RUCHALA, PH.D.,‡  
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La Tomoterapia in Italia: esperienze a confronto Bard 20/11/2010



# Whole breast radiotherapy:

## TomoDirect™ (12 patients)

- 6 right-sided and 6 left-sided breast cancer treated at the Ivrea Radiotherapy Department with 2 tangential fields on a 6 MV LINAC
- TomoDirect™ treatment planning with two-fields and four-fields technique

# TomoDirect™ TPS : two-fields technique

Planning Station

Patient: No Photo  
 DOB: Sex: ID: Oncologist: Disease:  
 Plan Label: **mammella**  
 Plan Status: Plan Date: Position:

User Name: Zenone Flora

What's Next  
 Create Beam Angles  
 Create and apply beam angles.  
 Assign beam angles for multiple targets if necessary.  
 When you are finished, continue to the Optimization panel.

Save

Contouring ROIs Plan Settings Beam Angles Optimization Fractionation

Angles

Angles

Reset Angles

Protocols

| Name    | Display                             | Angle (degrees) | -Xg (leaves) | +Xg (leaves) | Status  |
|---------|-------------------------------------|-----------------|--------------|--------------|---------|
| Angle   | <input checked="" type="checkbox"/> | 51.8            | 3            | None         | Applied |
| Opposed | <input checked="" type="checkbox"/> | 243.6           | None         | 3            | Applied |

Transverse

Sagittal

Targets

| Targets |   |                                     | Use Angle                           |                                     |
|---------|---|-------------------------------------|-------------------------------------|-------------------------------------|
| Name    | Color   | Display                             | 51.8                                | 243.6                               |
| PTV2    | <span style="background-color: red; color: red;"> </span> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Start Planning Station

Wednesday, November 17, 2010 16:58:52

4:58 PM

# TomoDirect™ TPS : four-fields technique

**Planning Station**

Patient: No Photo  
 DOB: Jun 22, 1949  
 Sex: Female  
 ID: 175269  
 Oncologist: Disease: 6407

Plan Label: 4campi  
 Plan Status: Unapproved  
 Plan Date: Oct 29, 2010 1:24:40 PM  
 Position: HFS

User Name: Paola Catuzzo

**What's Next**

**Create Beam Angles**

- ➔ Create and apply beam angles.
- ➔ Assign beam angles for multiple targets if necessary.
- ➔ When you are finished, continue to the Optimization panel.

Save

Contouring ROIs Plan Settings Beam Angles Optimization Fractionation

Angles Transverse

| Name    | Display                             | Angle (degrees) | -Xg (leaves) | +Xg (leaves) | Status  |
|---------|-------------------------------------|-----------------|--------------|--------------|---------|
| Angle   | <input checked="" type="checkbox"/> | 53.0            | 3            | None         | Applied |
| Opposed | <input checked="" type="checkbox"/> | 245.0           | None         | 3            | Applied |
| Angle1  | <input checked="" type="checkbox"/> | 58.0 <b>5°</b>  | 3            | None         | Applied |
| Angle2  | <input checked="" type="checkbox"/> | 240.0           | None         | 3            | Applied |

Display Options

Lines and Wash  Lines Only  Wash Only

View Entire Treatment

Targets

| Name | Color                            | Display                             | Use Angle                           |                                     |                                     |                                     |
|------|----------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
|      |                                  |                                     | 53.0                                | 245.0                               | 58.0                                | 240.0                               |
| PTV2 | <span style="color:red">■</span> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Regions at Risk

| Name           | Color                                | Display                             |
|----------------|--------------------------------------|-------------------------------------|
| External       | <span style="color:orange">■</span>  | <input checked="" type="checkbox"/> |
| CTV2           | <span style="color:red">■</span>     | <input checked="" type="checkbox"/> |
| PTV1           | <span style="color:green">■</span>   | <input checked="" type="checkbox"/> |
| polmone dx     | <span style="color:cyan">■</span>    | <input checked="" type="checkbox"/> |
| mamm. control. | <span style="color:orange">■</span>  | <input checked="" type="checkbox"/> |
| polmone sx     | <span style="color:blue">■</span>    | <input checked="" type="checkbox"/> |
| cuore          | <span style="color:magenta">■</span> | <input checked="" type="checkbox"/> |

# Dose prescription, dose constraints and dose indexes

## PTV

- 50 Gy to 90% PTV 25 fractions 2Gy/die
- 95% PTV receives 95% dose
- PTV -  $V_{53.5 \text{ Gy}} < 3\%$
- Conformity index  $RCI = \frac{V_{PTV}}{V_{95}}$
- Homogeneity index  $HI = \frac{D_{95}}{D_5}$

## OAR

- Ipsilateral lung  $V_{20\text{Gy}} < 10\%$ ,  $V_{10\text{Gy}} < 20\%$  e  $V_{5\text{Gy}} < 42\%$
- Contralateral lung  $V_{5\text{Gy}} < 5\%$
- Contralateral breast  $D_{\text{max}} < 5\text{Gy}$
- Heart  $V_{25\text{Gy}} < 10\%$

# Tomodirect™ TPS : optimization

- Field Width 2.5 cm → Pitch 0.25 (cm/projection)
- MF: 1.8 - 2.4
- Ring and help structures for hot spots

**Optimize**

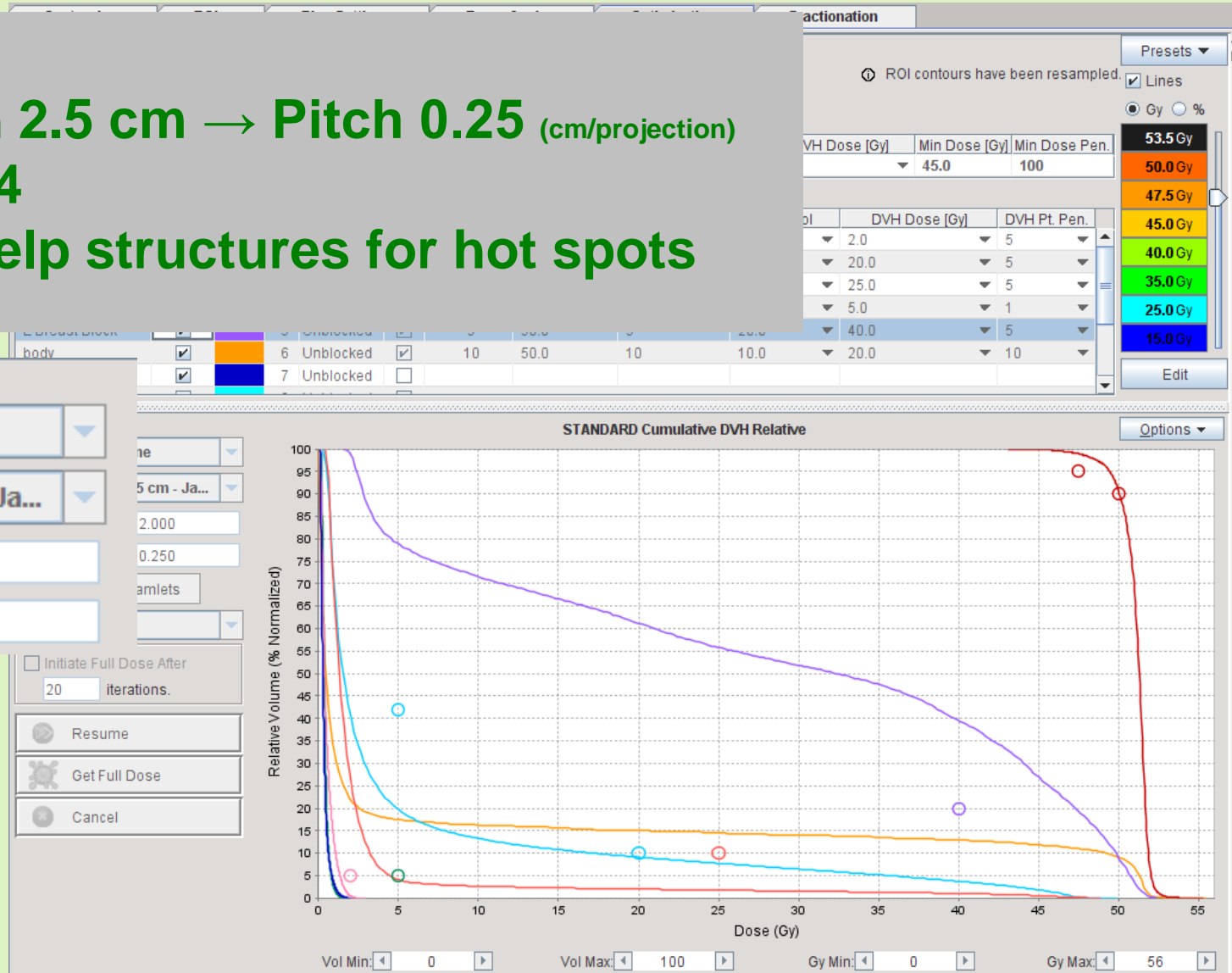
Dose Calc Grid **Fine**

Field Width **2.5 cm - Ja...**

Modulation Factor **2.000**

Pitch **0.250**

Initiate Full Dose After  
20 iterations.

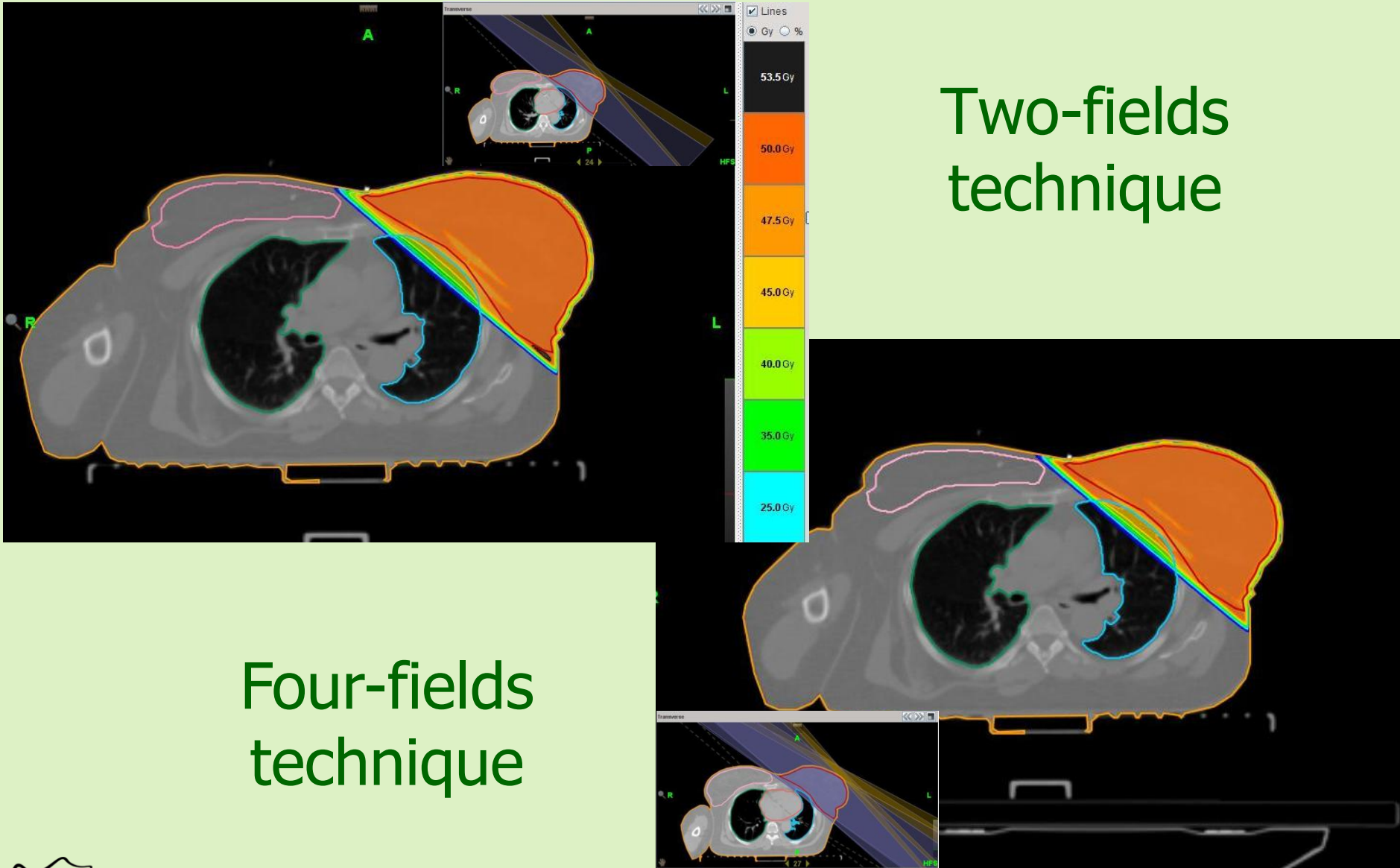




# Tomodirect™ TPS : dose distribution

Two-fields  
technique

Four-fields  
technique



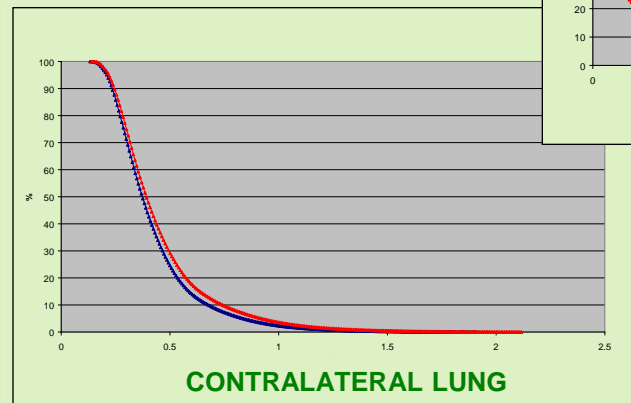
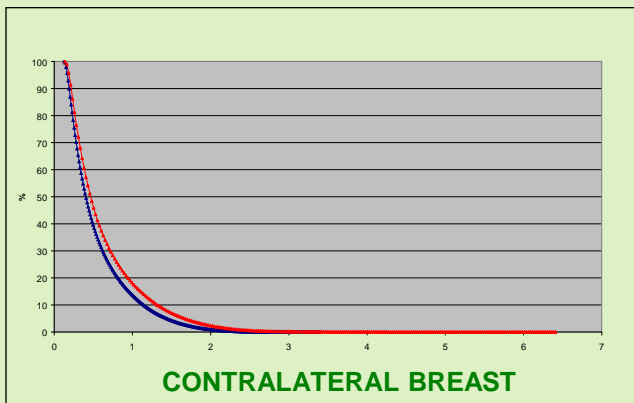
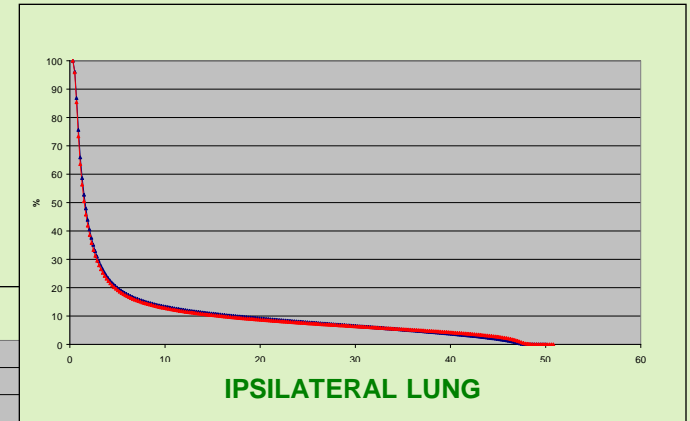
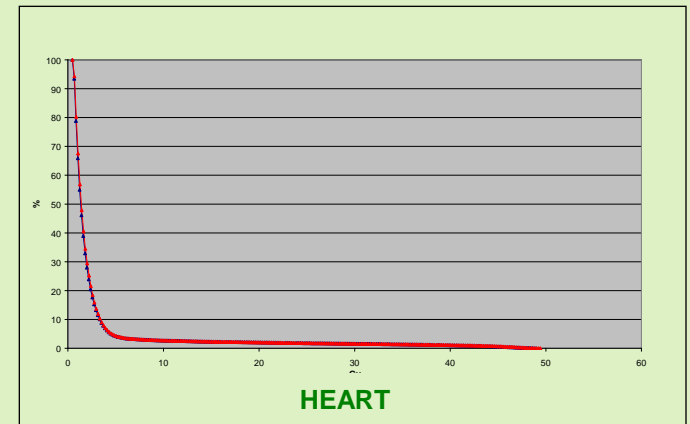
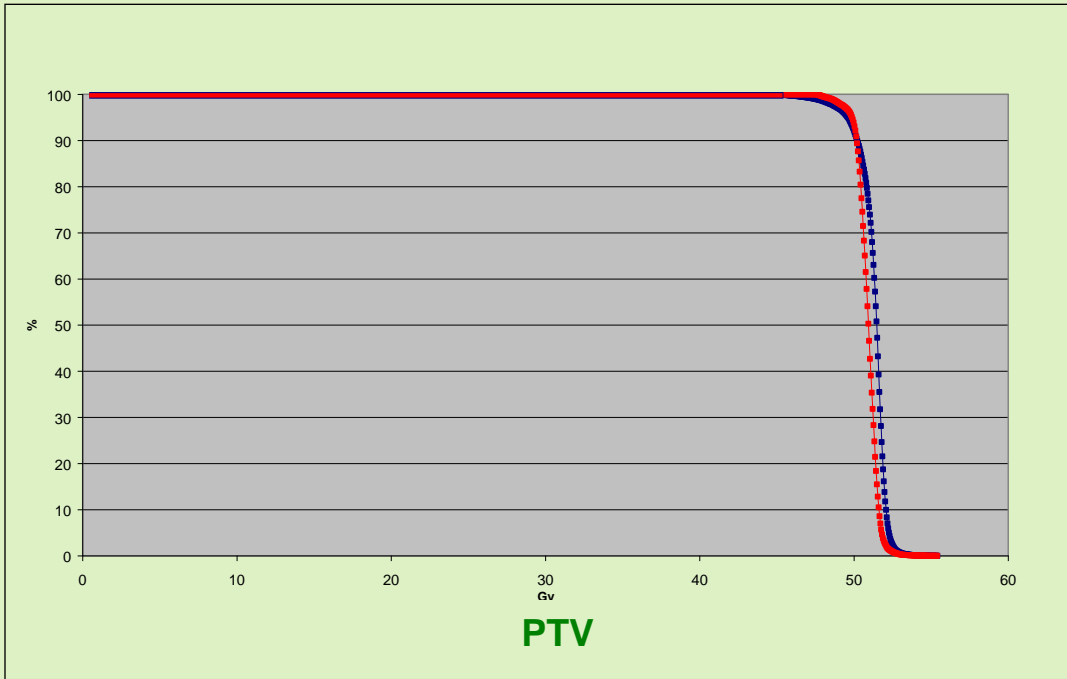
# Tomodirect™ TPS : results\*

| PTV                   | RCI   | HI    | t(sec) |
|-----------------------|-------|-------|--------|
| Two-fields technique  | 0.678 | 0.939 | 380    |
| Four-fields technique | 0.681 | 0.939 | 414    |

| OARs                  | Ipsilateral lung     |                      |                     | Controlateral lung  | Controlateral breast | Heart                |
|-----------------------|----------------------|----------------------|---------------------|---------------------|----------------------|----------------------|
|                       | V <sub>20 Gy</sub> % | V <sub>10 Gy</sub> % | V <sub>5 Gy</sub> % | V <sub>5 Gy</sub> % | D <sub>max</sub> Gy  | V <sub>25 Gy</sub> % |
| Two-fields technique  | 9.6                  | 13.8                 | 18.6                | 0                   | 2.7                  | 3.2                  |
| Four-fields technique | 9.9                  | 17.0                 | 22.9                | 0                   | 3.1                  | 2.9                  |

\* To be submitted to IJROBP

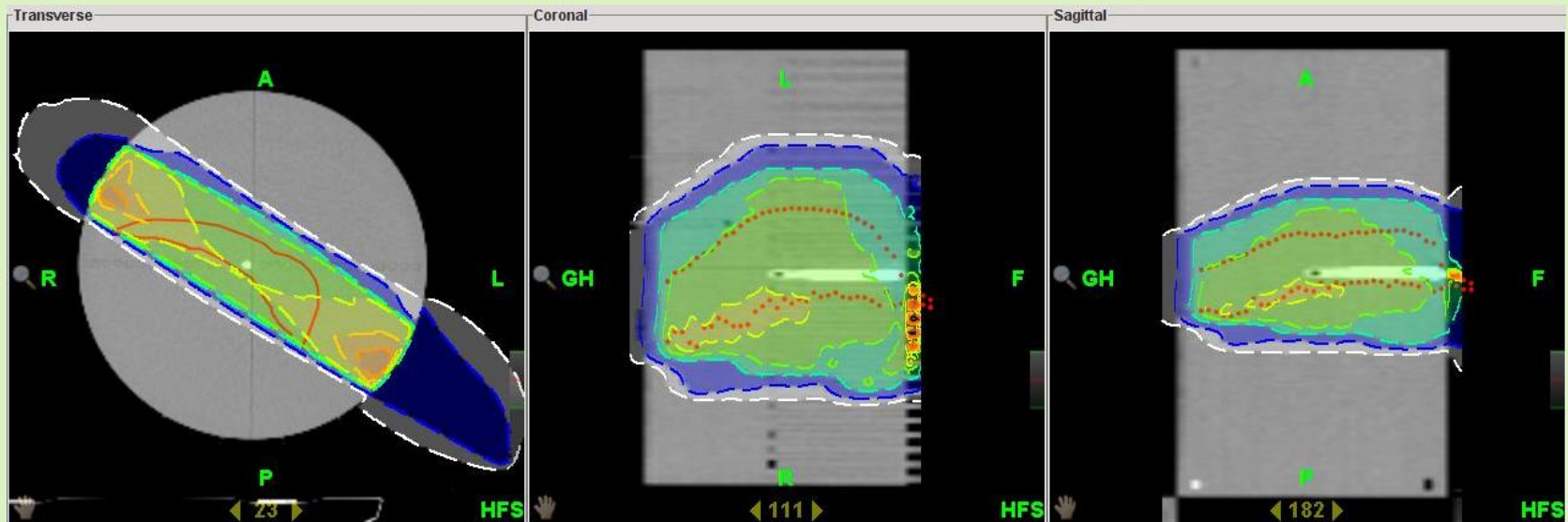
# DVH two-fields vs four-fields technique



- **Two-fields technique**
- **Four-fields technique**

# TomoDirect™ - DQA

- Dose measurement in Cheese Phantom with IC A1SL Standard Imaging
- Coronal or sagittal 2D dose distribution with GafChromic EBT2



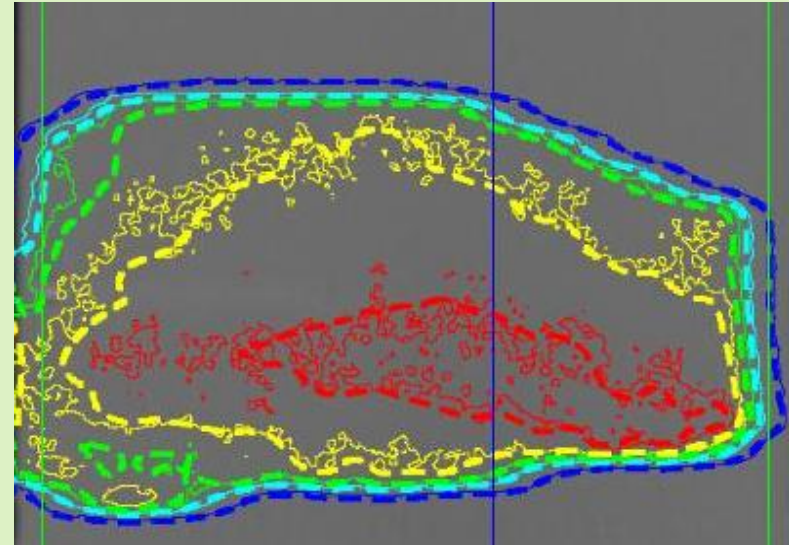
# TomoDirect™ – DQA results\*

Point dose measurements: deviation between measured and calculated values **< 1 %**

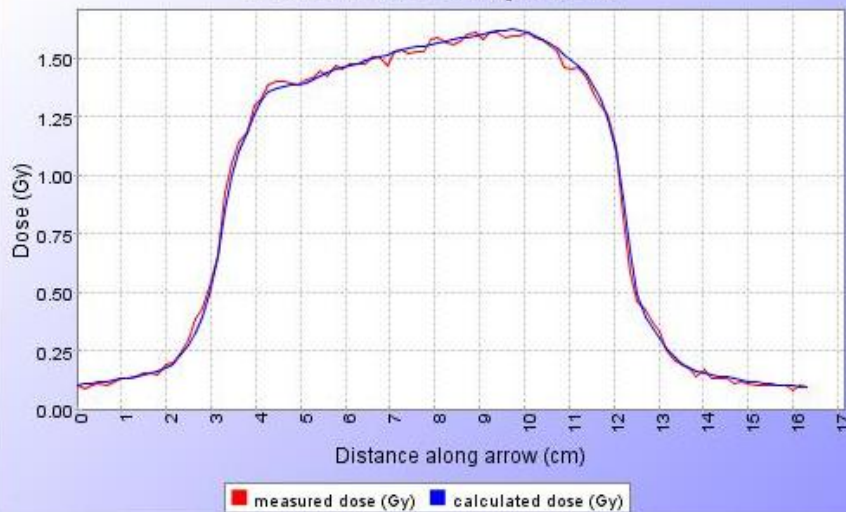
2D dose distribution Gamma index

IA<sub>DD 4% DTA 3mm</sub> > **90%**

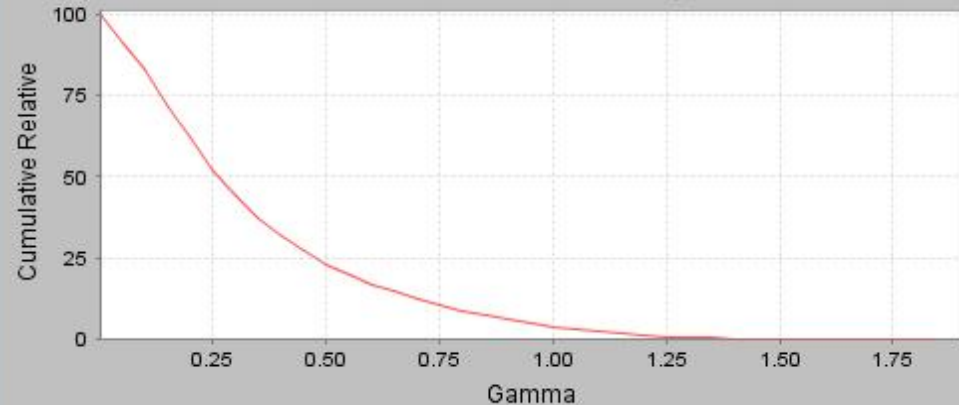
IA<sub>DD 5% DTA 3mm</sub> > **95%**



Dose Profile Comparison



Gamma Distribution Histogram



\* To be submitted to IJROBP

# Tomodirect™ vs LINAC

|   | Beam-on time | PTV          |              |
|---|--------------|--------------|--------------|
|   | sec          | RCI          | HI           |
| <b>Tomodirect™<br/>Two-fields technique</b> | <b>380</b>   | <b>0.678</b> | <b>0.939</b> |
| <b>LINAC</b>                                | <b>120</b>   | <b>0.602</b> | <b>0.896</b> |

|   | Omolateral lung     |                      |                      | Contralateral lung  | Contralateral breast | Heart                |
|---|---------------------|----------------------|----------------------|---------------------|----------------------|----------------------|
|   | V <sub>5 Gy</sub> % | V <sub>10 Gy</sub> % | V <sub>20 Gy</sub> % | V <sub>5 Gy</sub> % | D <sub>max</sub> Gy  | V <sub>25 Gy</sub> % |
| <b>Tomodirect™<br/>Two-fields technique</b> | <b>18.6</b>         | <b>13.8</b>          | <b>9.6</b>           | <b>0</b>            | <b>2.7</b>           | <b>3.2</b>           |
| <b>LINAC</b>                                | <b>16.6</b>         | <b>12.4</b>          | <b>10.6</b>          | <b>2.8</b>          | <b>3.9</b>           | <b>1.1</b>           |

# Conclusions

- TomoDirect™ represents a well-suitable treatment in terms of target dose homogeneity and conformality, dose sparing to the sensitive structures and overall treatment time
- TomoDirect™ does not necessary demand for the use of more fields than the traditional two tangential fields approach
- Results similar or better than by LINAC
- Treatment time shorter than Helical Tomo but longer than LINAC but this issue might be solved using a lower MF, a higher pitch and a 5 cm field width



Thanks for the attention