Quality Assurance in Radiotherapy
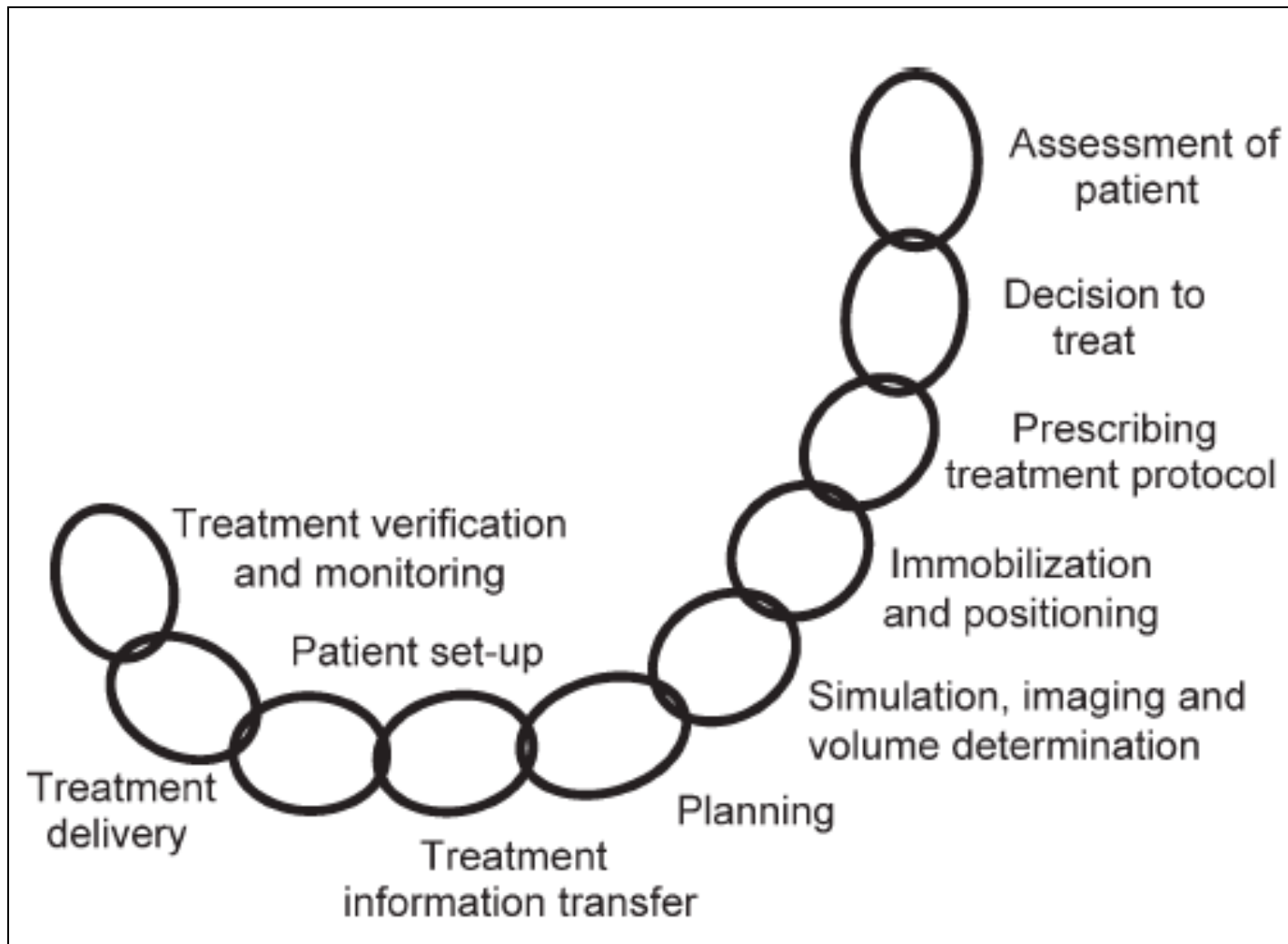
Patrizia Ciammella
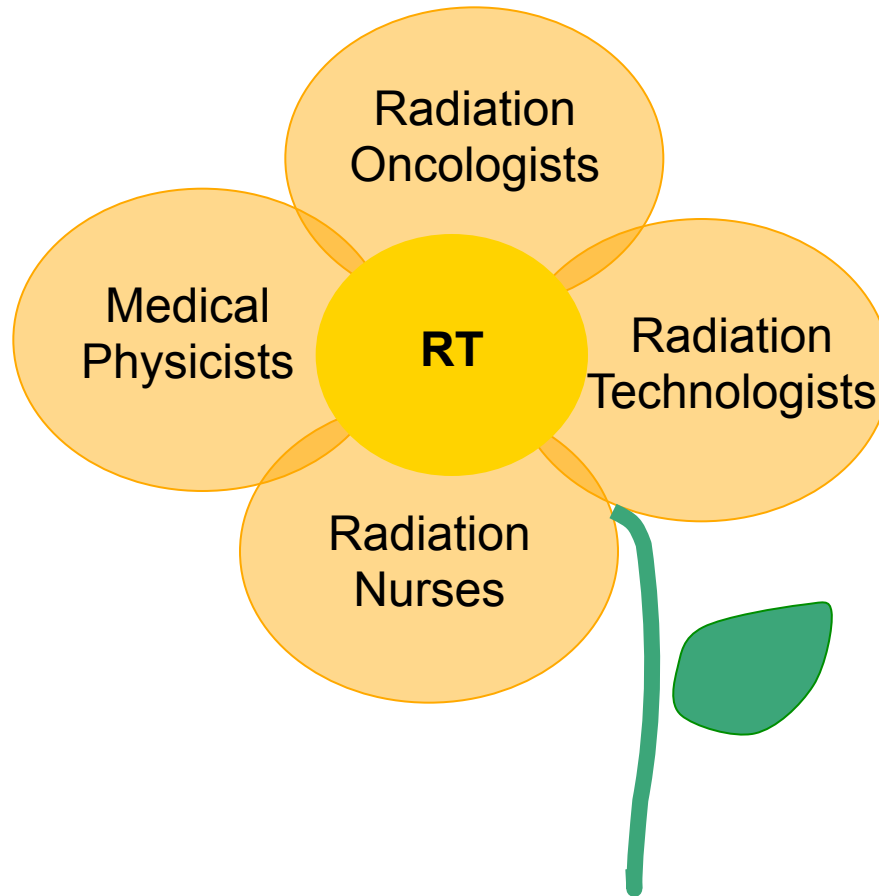
Arcispedale Santa Maria Nuova

Reggio Emilia

RT process

Assessment of patient

Decision to treat

Prescribing treatment protocol

Immobilization and positioning

Simulation, imaging and volume determination

Planning

Treatment information transfer

Patient set-up

Treatment verification and monitoring

Treatment delivery

RT team

Philosophy of radiotherapy quality assurance

Scope of quality assurance protocols

- guarantee the validity of clinical trial results

- improve the quality of clinical practice minimising the risk of errors

- increase the likelihood of desired health outcomes at the population level (equality of access, consistency, etc)

Philosophy of radiotherapy quality assurance

## Specific considerations of QART in a multicenter research setting

- determination of protocol ambiguities that may affect treatment delivery;

- education of sites in RT-specific trial guidelines;

- promotion of consistency between centers;

- ensuring sites meet minimum technical and personnel requirements;

- ensuring accuracy and integrity of data;

- estimation of inter-patient and inter-institutional variation;

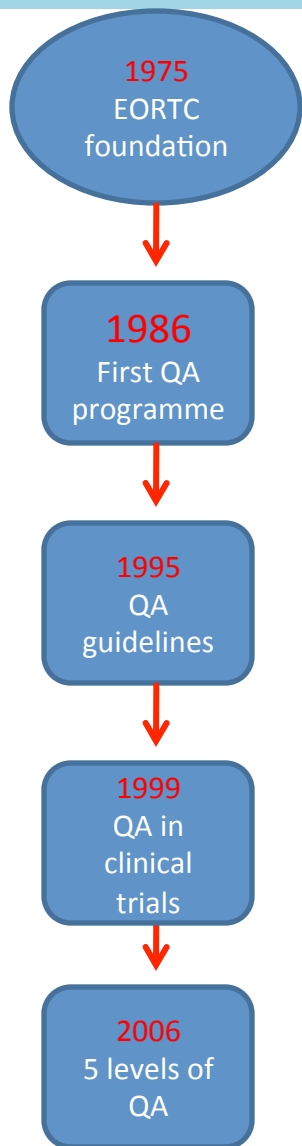- identification and correction of flaws in study design

Importance of QA protocols

> **Clinical Original Contribution**
>
> ### RANDOMIZED TRIAL WITH EARLY-STAGE HODGKIN'S DISEASE TESTING 30 GY VS. 40 GY EXTENDED FIELD RADIOTHERAPY ALONE

HD 4 FFTF PV vs. OK

OK	26 /229
PV	22 /118

Test: $p = 0.0418$
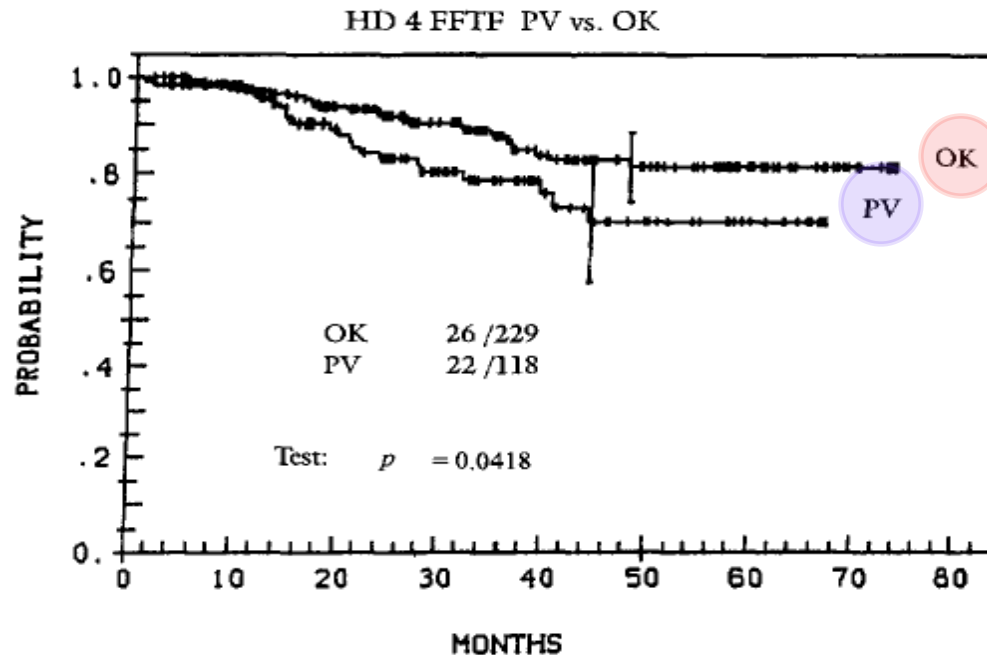
5-years FFTF was significantly influenced by the quality of radiotherapeutical procedures:
70% with protocol violations (PV) vs. 82% without PV

Quality assurance in radiotherapy

1975
EORTC foundation

↓

1986
First QA programme

↓

1995
QA guidelines

↓

1999
QA in clinical trials

↓

2006
5 levels of QA

QA strategy of the EORTC Radiation Oncology Group (ROG)

1982-2005

- Site visits

- Evaluation of institutions' staff and infrastructure

- Dosimetric checks of treatment units

- Cross-check of patients charts and portal images

- Radiobiological modelling of inter-institutional differences

- Mailed thermoluminescent dosimetry audits

2005-2011

- Level 1: Facility questionnaire, External reference dosimetry audit

- Level 2: Dummy run

- Level 3: Limited individual case Review

- Level 4: Extensive individual case Review

- Level 5: Complex dosimetry check

CLINICAL INVESTIGATION

Lymphoma

QUALITY OF RADIOTHERAPY REPORTING IN RANDOMIZED CONTROLLED TRIALS OF HODGKIN'S LYMPHOMA AND NON-HODGKIN'S LYMPHOMA: A SYSTEMATIC REVIEW

JUSTIN E. BEKELMAN. M.D..* AND JOACHIM YAHALOM. M.D.*

133 Publications identified in PubMed of controlled trials of Hodgkin Lymphoma and Non-Hodgkin Lymphoma involving radiotherapy

5 Non-duplicative publications identified in Cochrane or in references
2 in Cochrane CENTRAL
3 in references

58 Publications excluded on the basis of title and abstract
21 Not Phase III RCT
19 Secondary report of
18 Not involving EBRT

75 Publications selected for review

19 Publications excluded after obtaining full text
8 Secondary report of
7 Not Phase III RCT
3 RCT involving TBI
2 Not involving EBRT

56 Publications included from PubMed search

61 Publications included in review
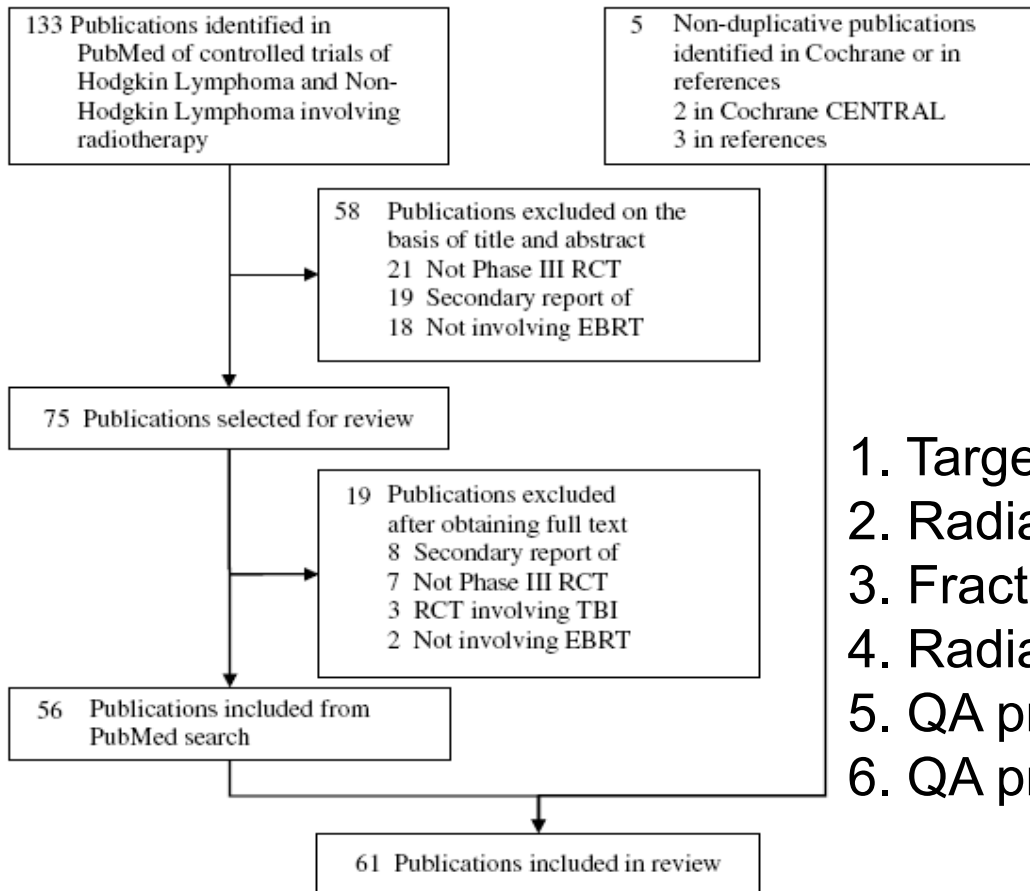
Quality Measures

1. Target volume definition
2. Radiation dose specification
3. Fractionation specification
4. Radiation prescription point specification
5. QA process use for RT
6. QA process adherence reporting for RT

Radiotherapy reporting quality

Measures of radiotherapy reporting	Adequacy of reporting	
	n	%
1. Target volume description	23	38
2. Radiation dose specification	54	89
3. Fractionation specification	39	64
4. Radiation prescription point specification	13	21
5. Quality assurance process use	12	20
6. Quality assurance process adherence reporting*	7	11

Reporting of RT in HL and NHL RCTs is **deficient**. Because the interpretation, replication, and application of RCT results depend on adequate description and QA of therapeutic interventions, consensus standards for RT reporting should be developed and integrated into the peer-review process.

Quality assurance in radiotherapy

In the last years radiation oncology is undergoing a rapid and radical transformation driving an exponential growth in the **size**, **complexity**, and **quantity of data** generated during the treatment process.

The increase is due, in part, to the success of image-guided oncology programs, which generate new images at each step in the treatment process — from diagnosis to verification, up to follow-up.

Modern QA ◊ digital data exchange and timely review

Quality assurance in radiotherapy in the 21st century

Database on infrastructure

To create data bank of the infrastructure of the member centres, to acquire data on equipment, staffing levels, treatment techniques and QA procedures

Web-based quality assurance

To use medical informatics to facilitate the education, collaboration and peer review, providing an environment in which clinical investigators can receive, share and analyse treatment planning digital data.

EORTC Radiation Oncology Group quality assurance platform: Establishment of a digital central review facility

Integrated modular central review platform

2012
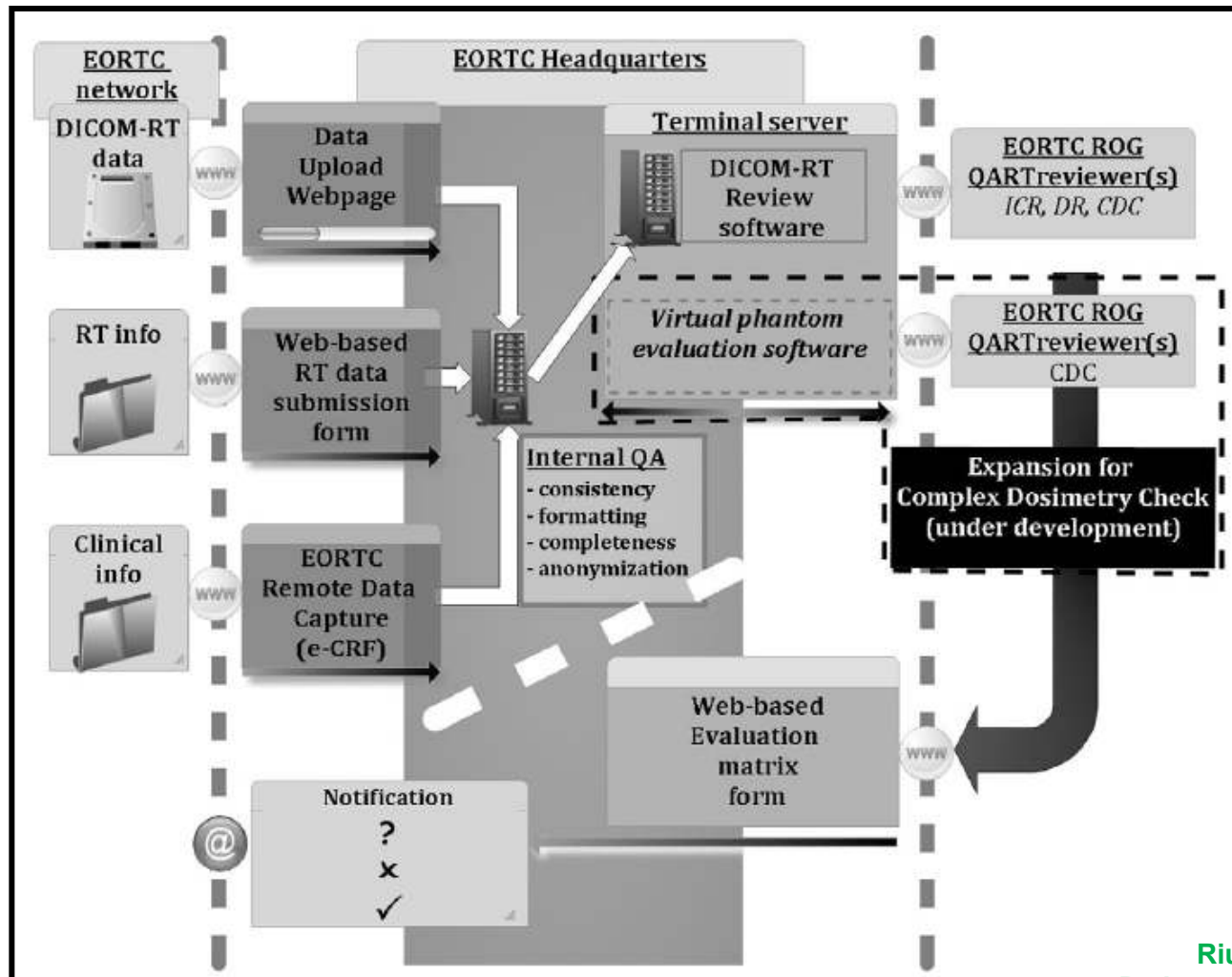
Main system requirements

Task	Parameters
General	• Network reliability in terms of up-time and fidelity of data transfer • Avoidance of local hardware and software installation • Web-based accessibility from any geographic location • Intuitive functionally evaluation tools • Uniformity of data submission procedures for all trials • Adequate firewall security • Central storage and archiving in a queriable database
Submission from centres to QART office	• Ability to upload operating-system independent • Reads in digital data (DICOM-RT) exported from multiple TPS
QART office DDIQA	• Utilize VODCA software to ensure consistency, completeness, formatting, lack of corrution and recalculation of DVHs
Central evaluation	• Document assessment of RT plan via a web-based evaluation matrix, standardize to facilitate consensus-building

A scenario for a web-based radiotherapy treatment planning system

Patients benefit

- Accessibility of advanced radiotherapy treatment services, minimising patient's transportation

Physicians benefit

- Consultation of expert colleagues
- Cooperation with reduce professional isolation

Organisations benefit

- Quality assurance in terms of dummy-runs and/or check of a real-patient treatment planning
- Minimisation of local-audits and the cost of on-site visit
- Evaluation and correlation of treatment outcome with radiotherapy parameters

RTQA platforms used by RTOG, EORTC or TROG:

- VodcaRT from Medical Software Solutions

- CERR software

- ITC remote review tool

- VelocityAI from Velocity Medical Solutions

- Mim software from Mimvista

- Artiview from Aquilab

- Swan

- (Widen)

- 2008: retrospective test
- 2009: prospective test
- 2010: currently utilize to QART procedures on ongoing EORTC trials

VODCA 5 has been created to …

➡️ Promote **in radiotherapy** clinical decision-support and knowledge management technologies in patient care and clinical research;

➡️ Disseminate methods and tools for building healthcare knowledge applications that comply with the highest quality, safety and ethical standards;

➡️ Connect individuals, hospitals, research groups and organisations who believe in the value of knowledge management, and support the share and reuse of clinical knowledge and data.

Proof of Concept (POC)

- 6 RT centres
- July-September 2012
- HL patients

VODCA 5 Network
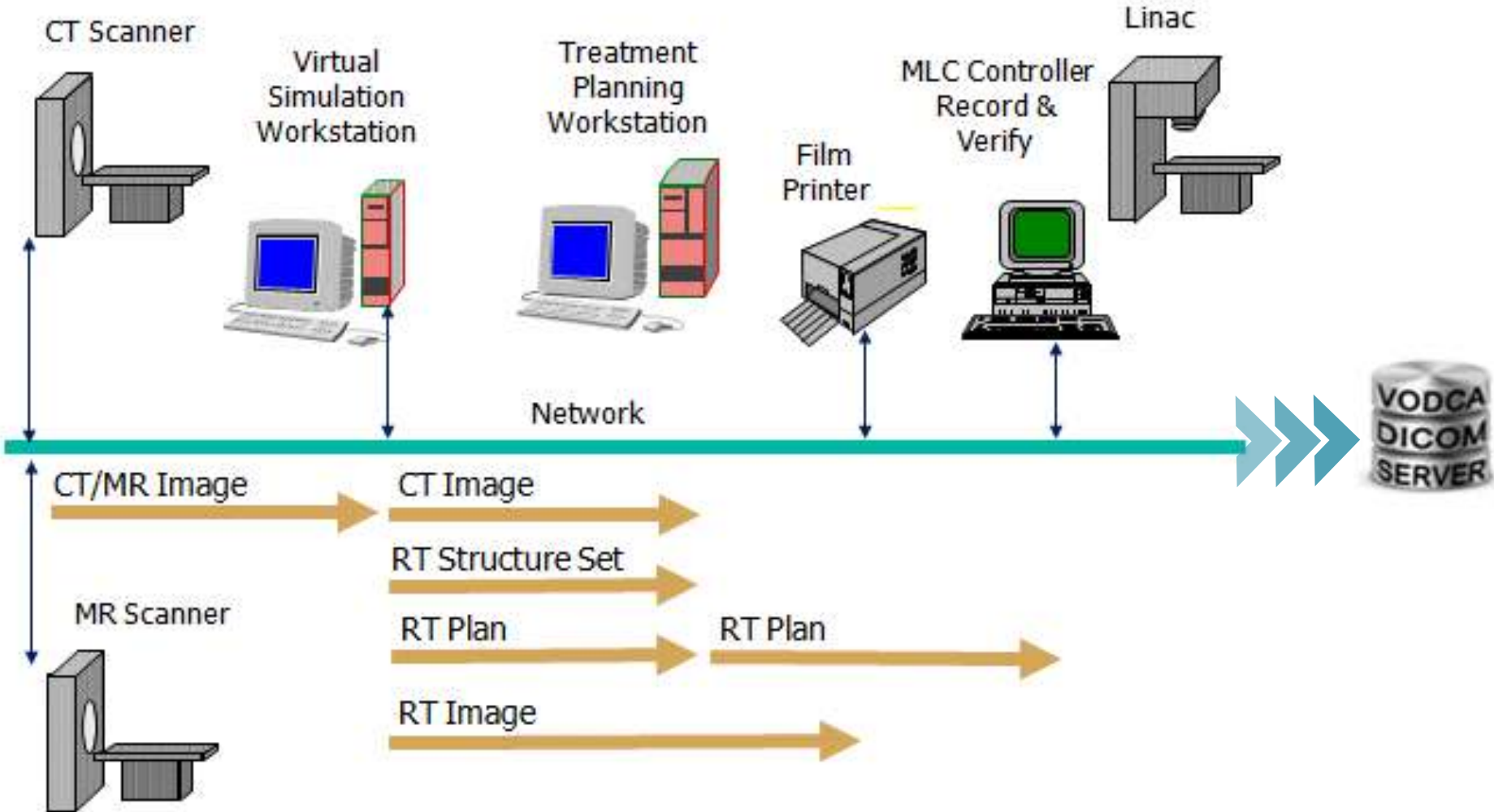
VODCA 5 Network
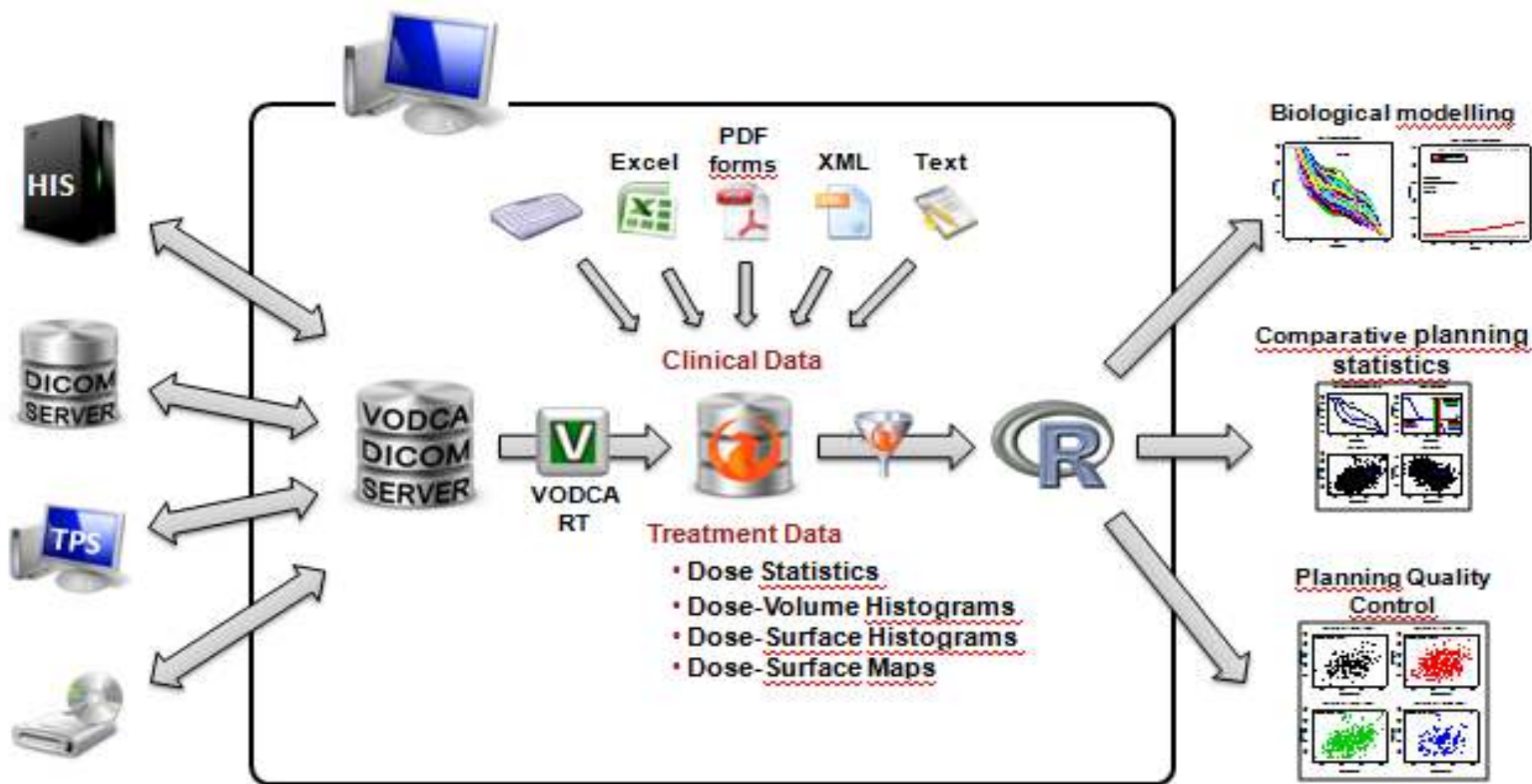
The study coordinator can customise by himself the workflow, the forms, the databases and the reports.

"VODCA on the cloud"
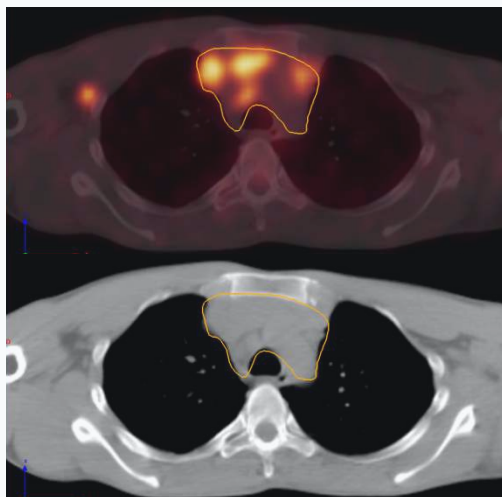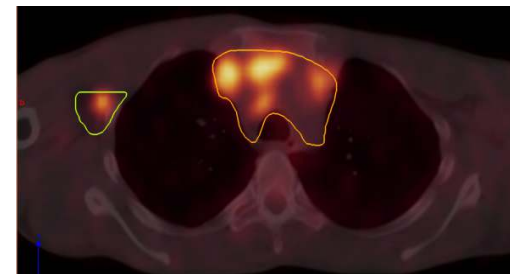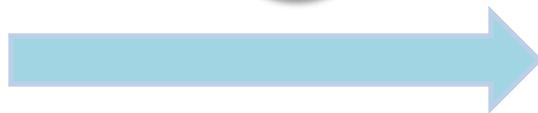
Interactive feedback procedure

Centre n

QA Reviewers

The **"VODCA Online Desktop"** is a powerful cloud-based Desktop with a customisable secure storage and it is accessible from anywhere, including tablets:

VODCA 5

Visualisation and Organisation of Data for Cancer Analysis

- **VODCA Control**
- **VODCA DICOM Server**
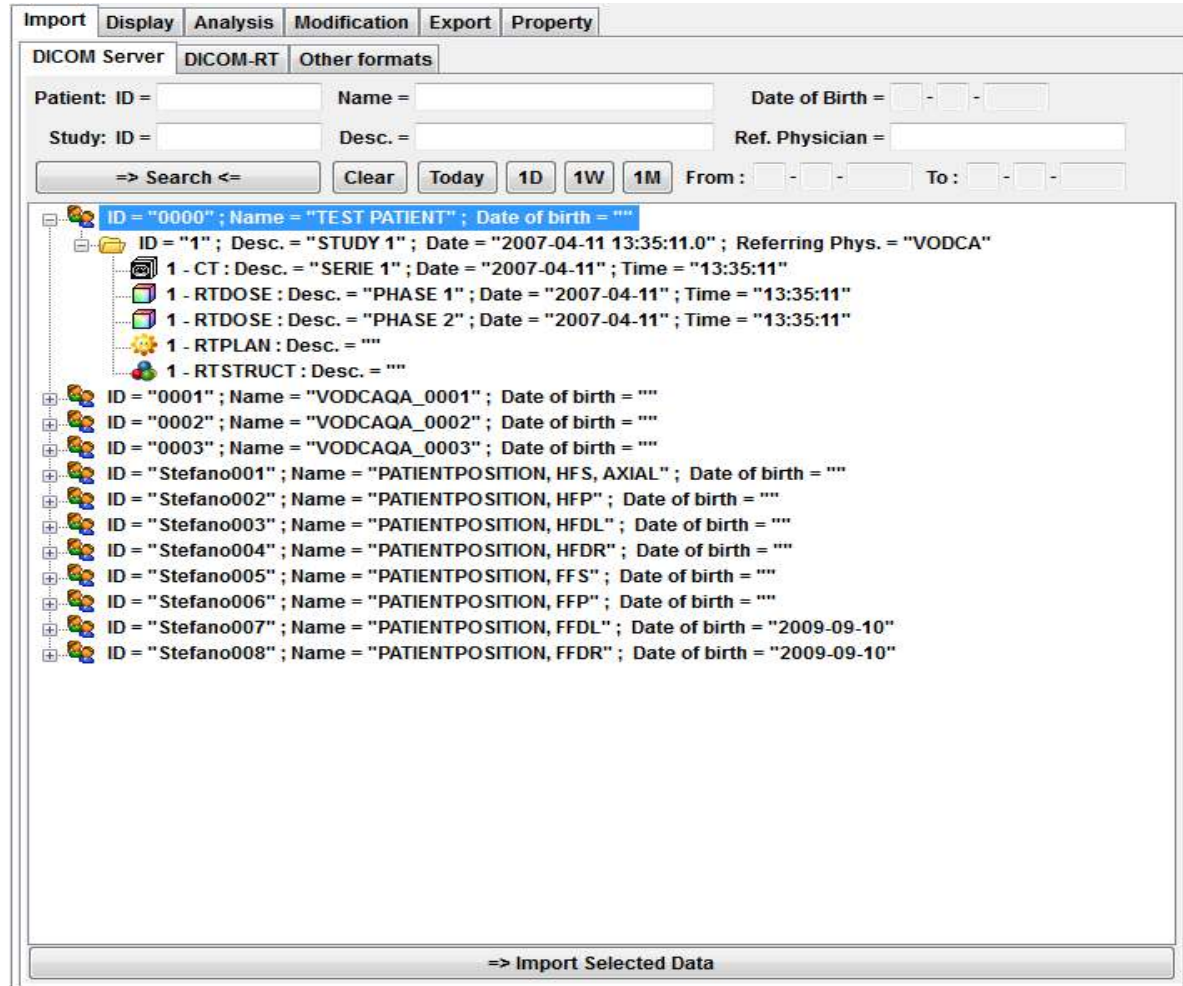
VODCA 5

- Databases

Every **patient dataset** has an unlimited amount of **user defined fields** subdivided into **3 categories**:

- **Patient** data,
- **Treatment** data, and
- **Clinical** data,

Data fields can be **added or deleted at any time** by the database administrator.

VODCA 5

- VODCA RT : "Patient data" display

Module and selected data

specific buttons

New hierarchical organisation of the

VOIs and **DVHs**

Always available operations

Data Verification Protocol
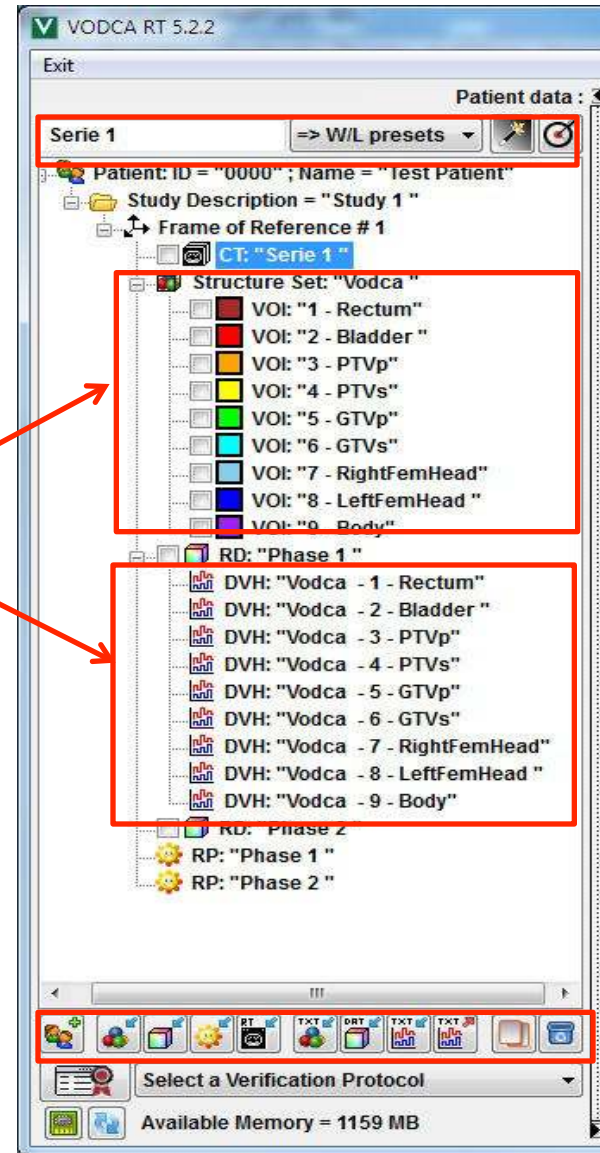
VODCA 5

- VODCA RT : Module "Display"

VODCA 5

- VODCA RT : Contouring

Generating Consensus Contour:

 Apparent agreement:

The apparent volume overlap is the agreement probability by which a voxel is selected by the experts.

 Expectation-maximization (EM) algorithm for simultaneous truth and performance level estimation (Warfield, 2004).

VODCA 5

- Data Modification
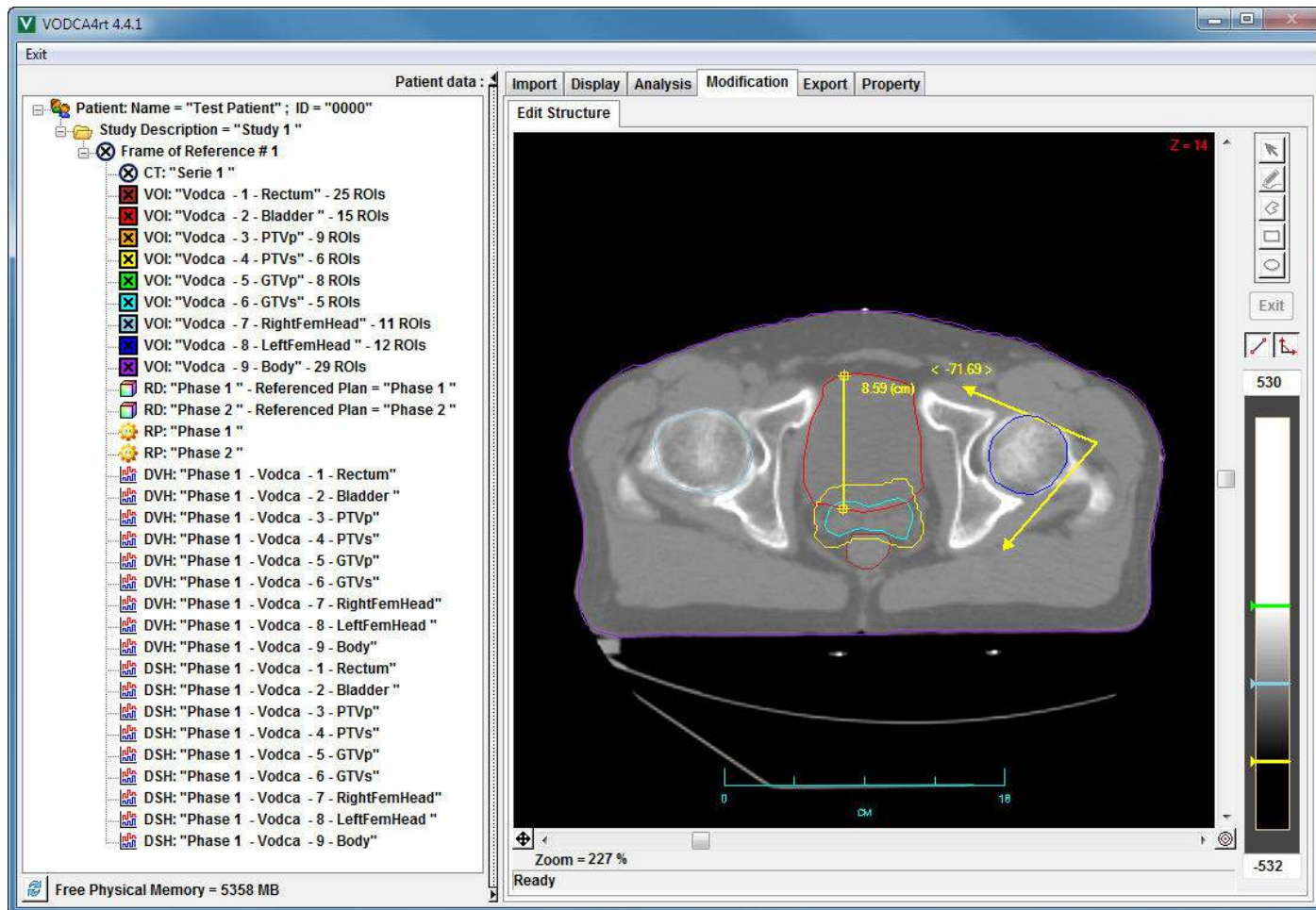
VODCA 5

- Module "Analysis" – DVH / DSH
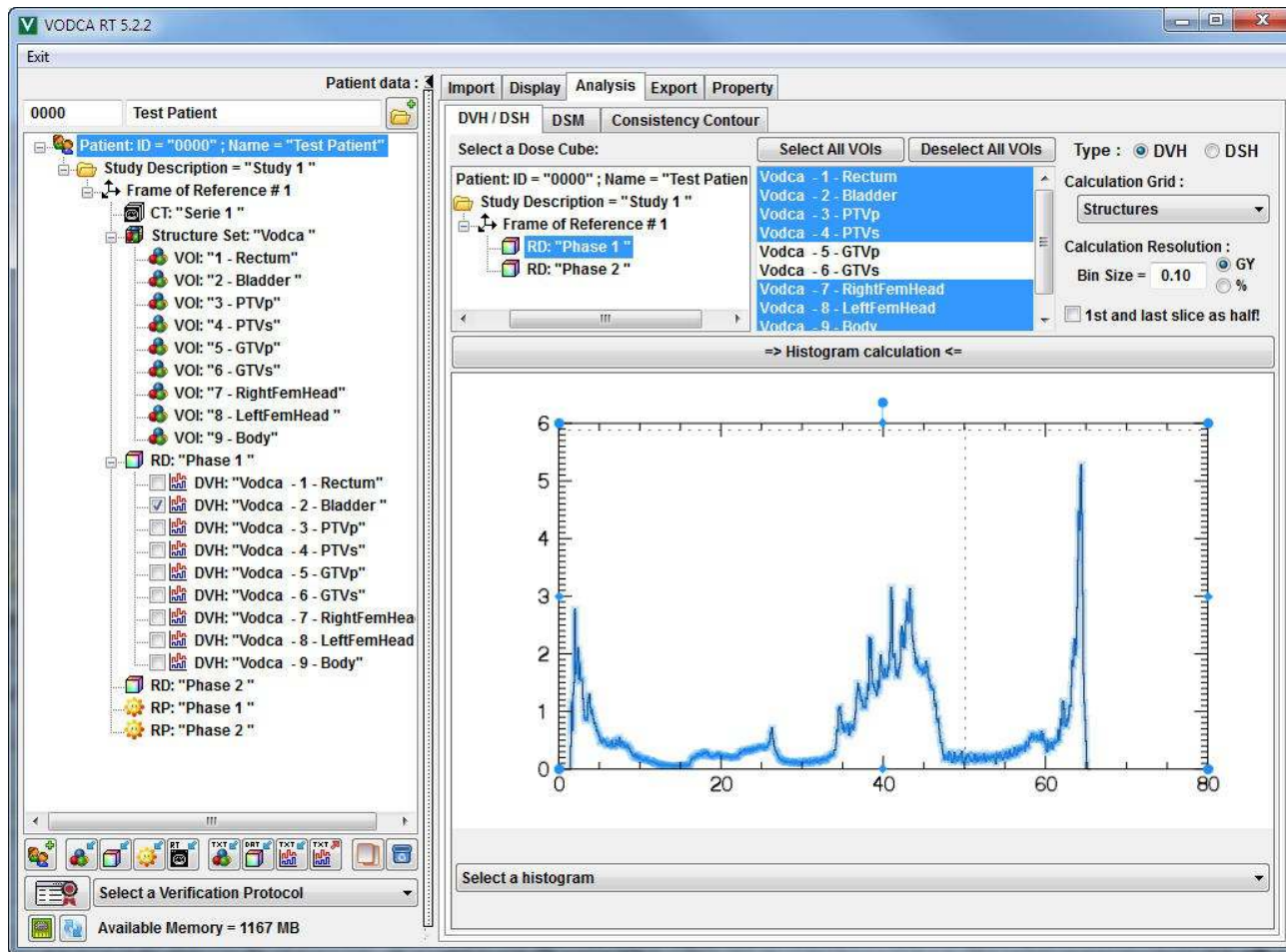
VODCA 5

- Module "Analysis" – Dummy-run
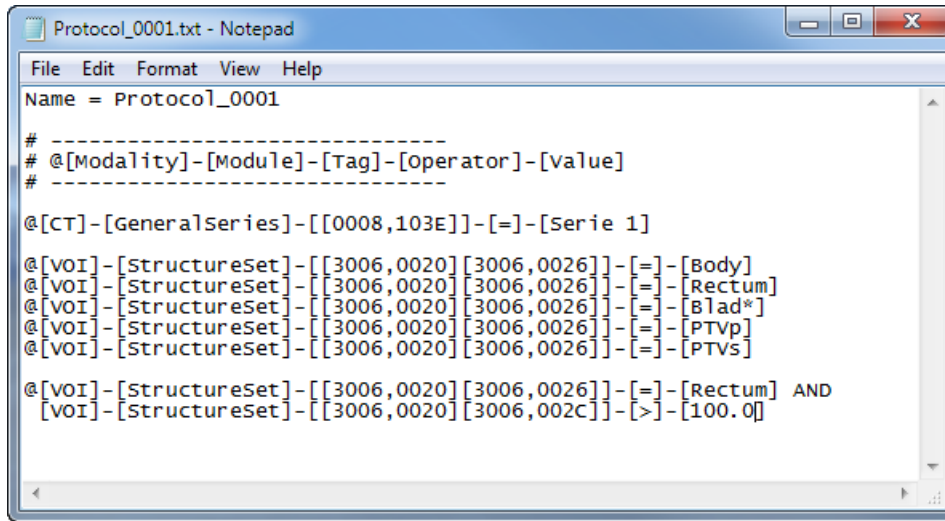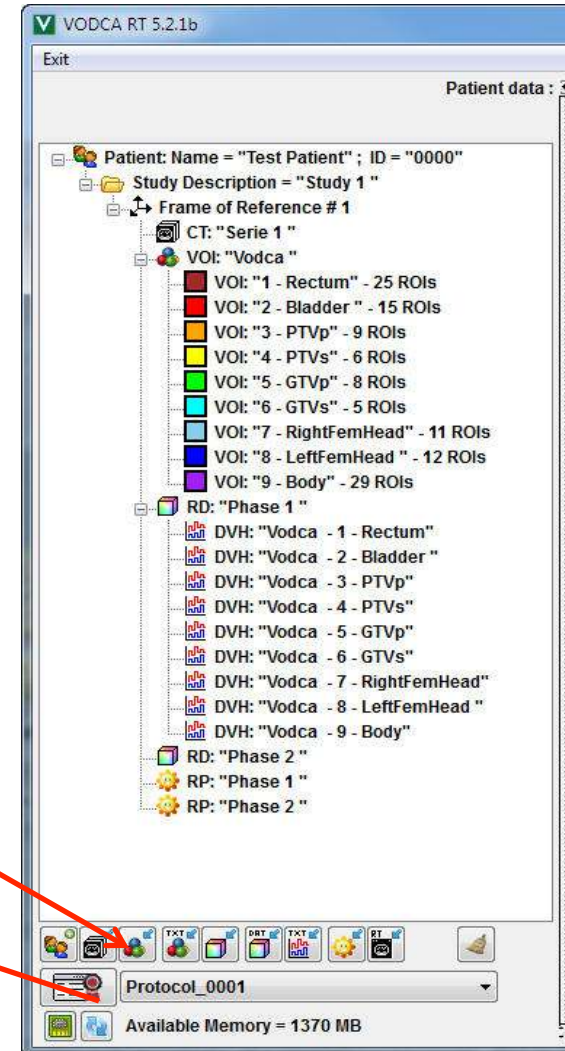

Consistency Contour

The following parameters are calculated :

- DICE
- Sensibility
- Specificity
- Volume difference
- Isocentre difference

VODCA 5

- **Data verification Protocol**

Available [Module] and [Tag] are listed in VODCA RT "Property"

Or in a format agreed with the EORTC HQ

Conclusions

QART

- Widen RT-DICOM IELSG37

- Prospective analysis with VODCA?

Grazie