Eidolon PET Simulator

H. Zaidi - F. Schoenahl

Photon interaction data in Monte Carlo packages

| Monte Carlo code	Photon cross section library
EGS4 (Nelson *et al* 1985)	Storm & Israel (Storm and Israel 1970) PHOTX (Sakamoto 1993)
ITS including TIGER CYLTRAN and ACCEPT (Halbleib *et al* 1992)	XCOM (Berger and Hubbell 1987)
MCNP (Briesmeister 1997)	Storm & Israel (Storm and Israel 1970) ENDF (Hubbell *et al* 1975) EPDL89 (Cullen *et al* 1989)
GEANT (Brun *et al* 1994)	Parametric model (Brun *et al* 1994)
SIMSET (Harrison *et al* 1993)	Parametric model (Picard *et al* 1993) EPDL94 (Perkins 1994), since 1997 (Kaplan 1998)
SIMIND (Ljungberg and Strand 1989)	XCOM (Berger and Hubbell 1987)
SIMSPECT (Yanch *et al* 1993)	Storm & Israel (Storm and Israel 1970) ENDF (Hubbell *et al* 1975) EPDL89 (Cullen *et al* 1989)
MCMATV (Smith *et al* 1993)	NBS (Hubbell 1969) and polynomial fitting
PETSIM (Thompson *et al* 1992)	Parametric model (Picard *et al* 1993)
Triumph's simulator (Tsang *et al* 1995)	GEANT's parametric model (Brun *et al* 1994)
Eidolon (Zaidi et al 1998, 1999)	GEANT's parametric model (Brun *et al* 1994) EPDL97 (Cullen *et al* 1997)

Simplified functional diagram

Controller

source model → *gamma pairs* → scatter model → *gamma pairs* → scanner model

gamma pair location

detection

reference image

Sinograms

Energy spectra

statistics
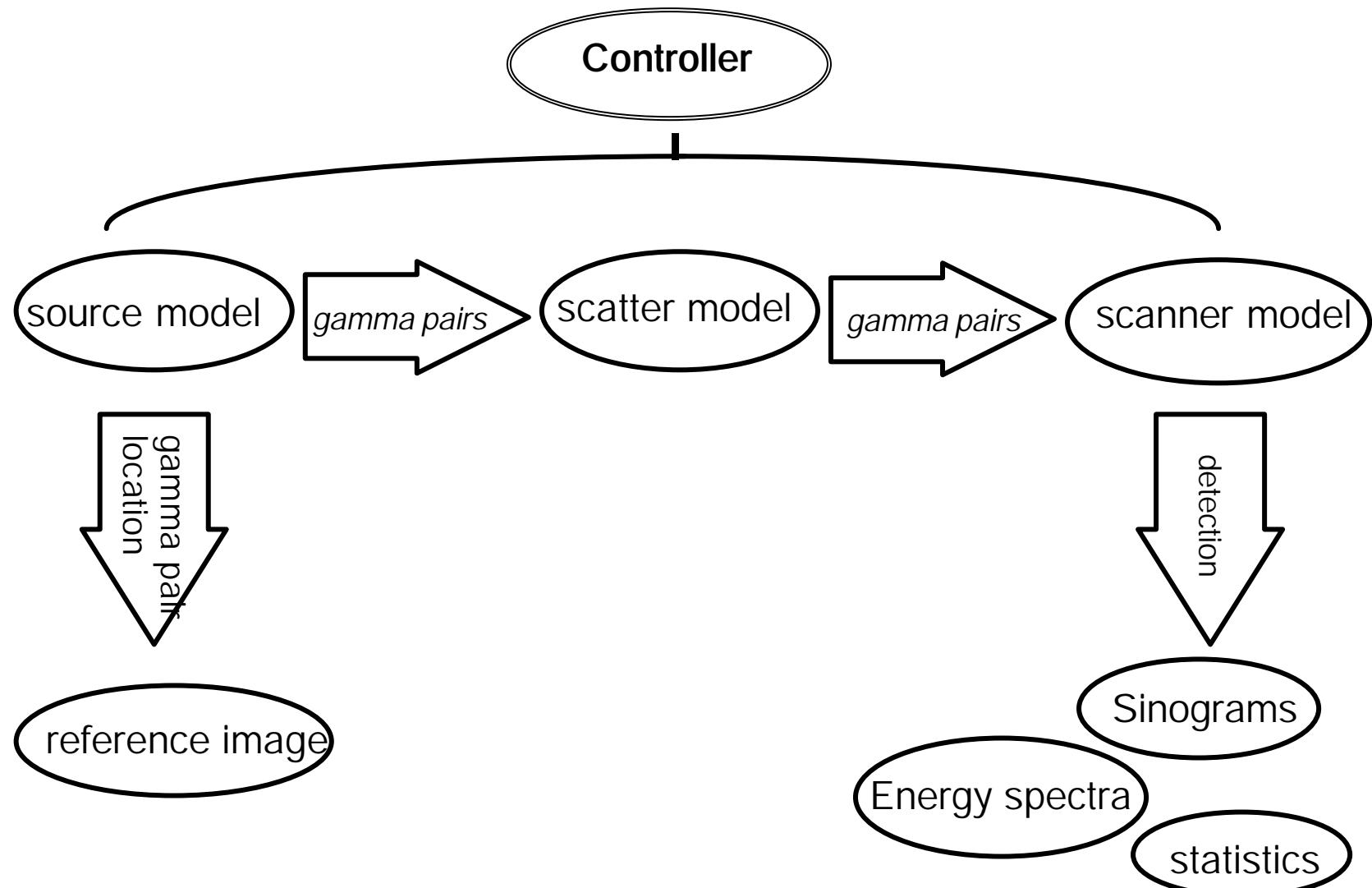
Eidolon simulator
description

PET SCANNER
N. detection rings
Ring diameter
Scintillation material
N. detectors / ring
Detector size
Detection unit
External shields
Sampling scheme
Spatial resolution
Energy resolution
Energy window
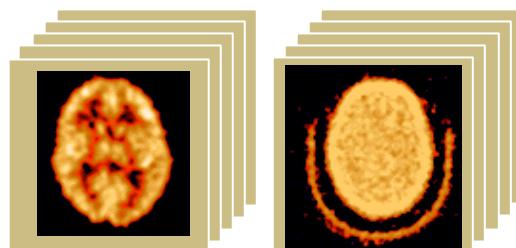
INPUT

GEANT

MAIN

radiation transport
in regions of known
geometry and
composition
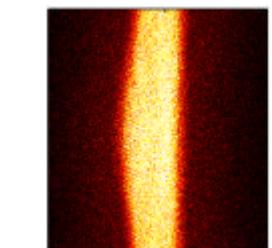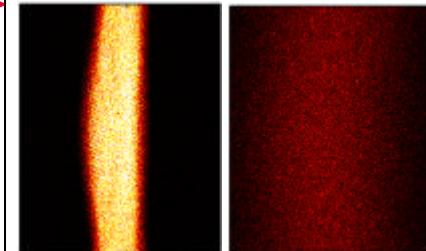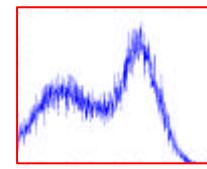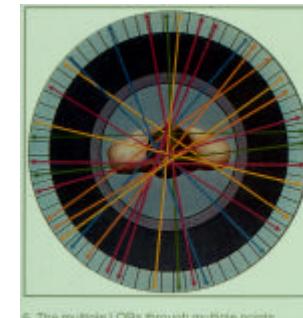
OUTPUT

Graphical user interface
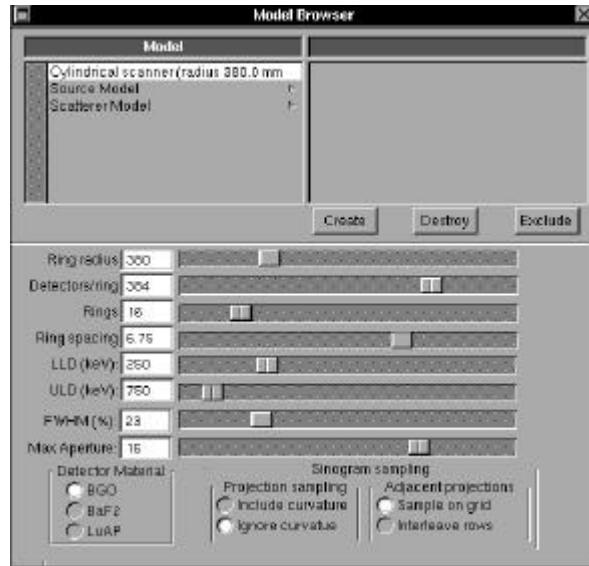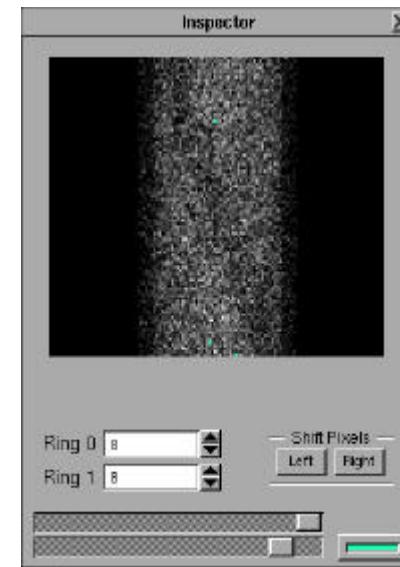
Analytical vs Voxelised phantoms

	ANALYTICAL	VOXELISED
RADIOACTIVITY DISTRIBUTION		
MEDIA DISTRIBUTION		
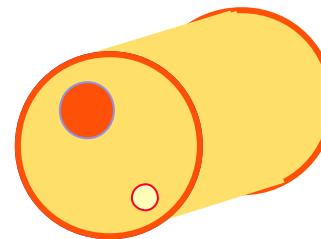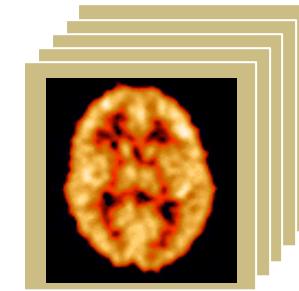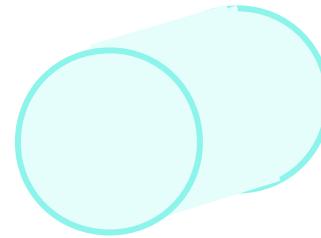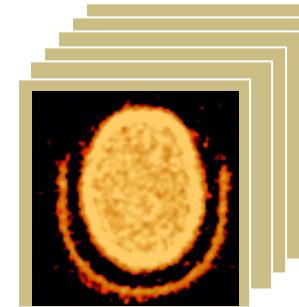
Utah Phantom
## (shape based phantom)
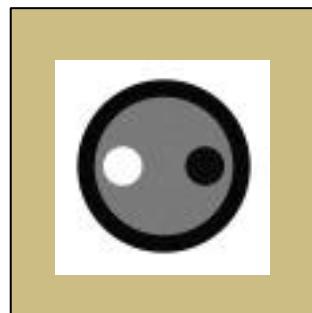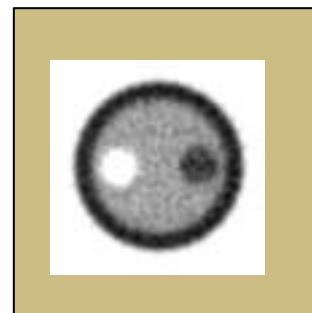
Reference   Unscattered   NC   AC
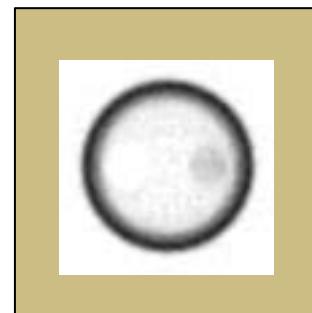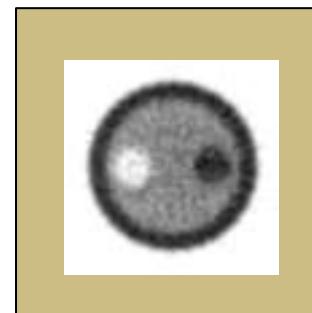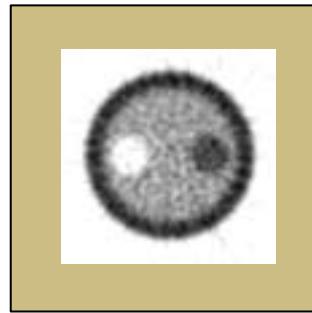
MCBSC2   MCBSC1   SRBSC   CVS

Features

Hoffman 3D brain phantom
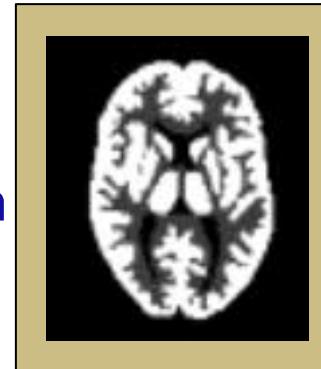
Projections
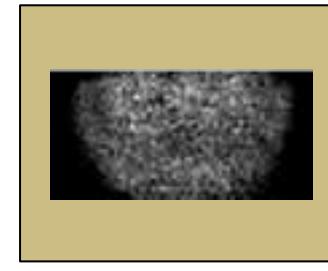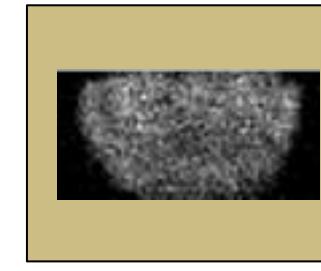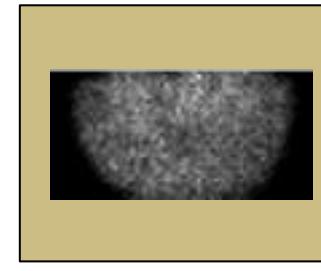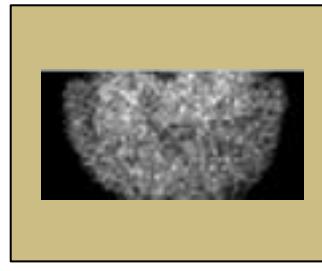
Images
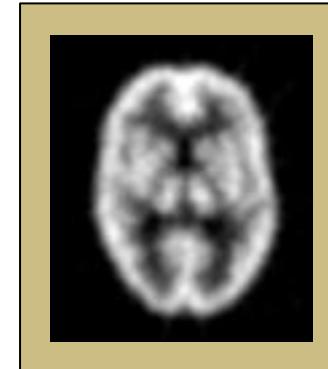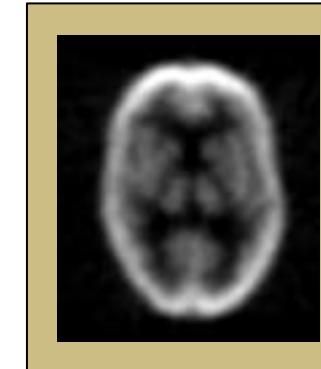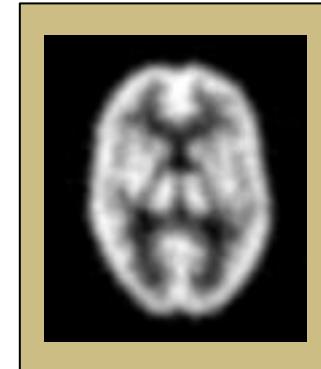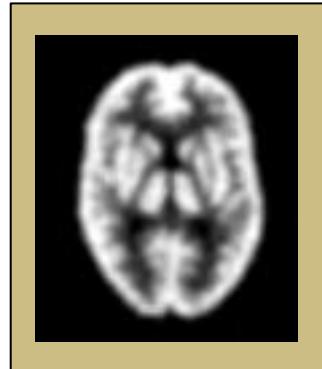
Ideal | Detector blurring | Not corrected | Corrected

Monte Carlo code
Features

- **Spatial distributions (average over angles):**

measured   MC total   MC scatter   MC unscatter

- **Energy spectra:**

MC total   MC scatter   MC unscatter
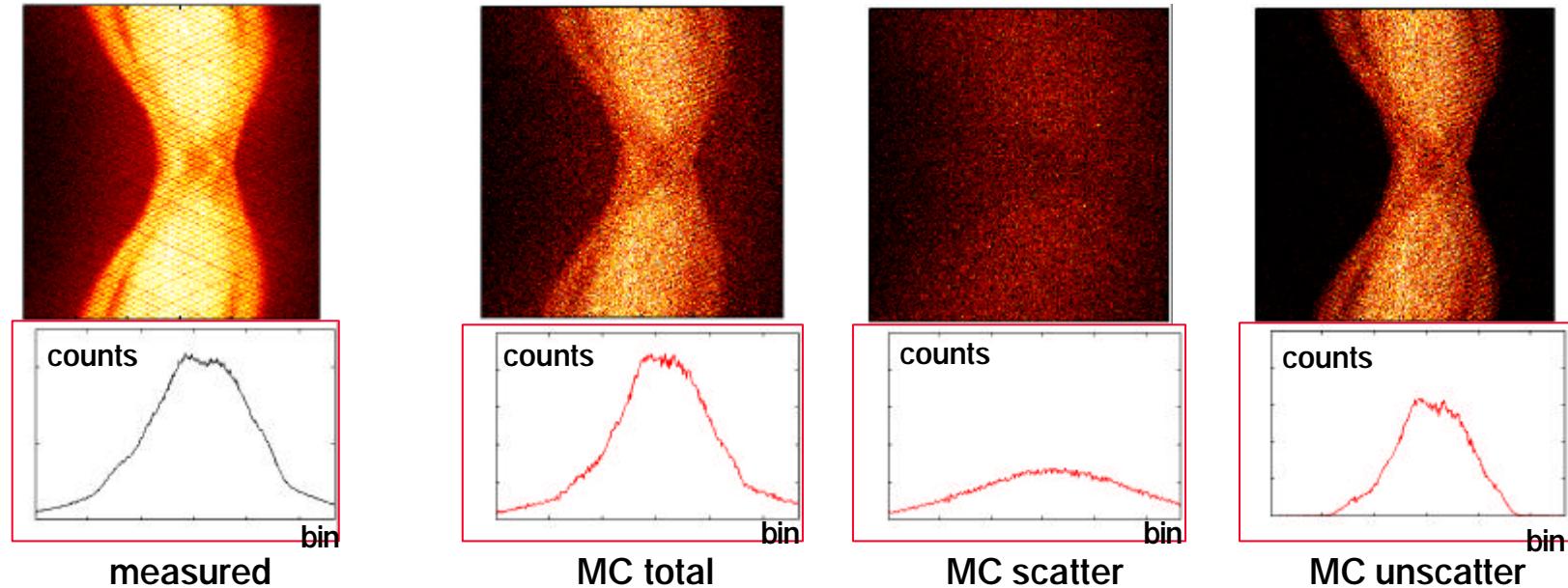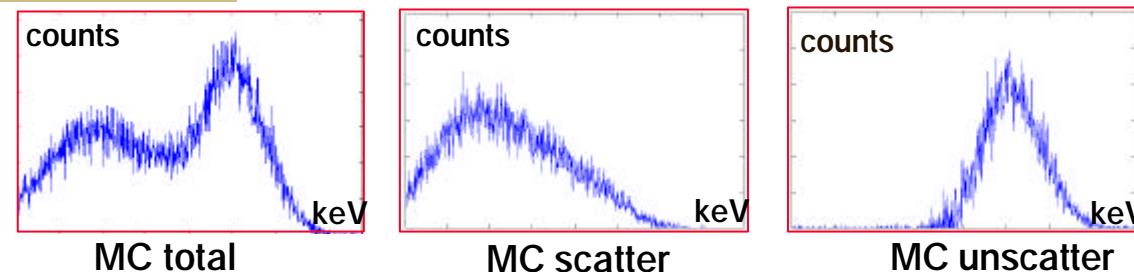
Applications to nuclear medicine and imaging

Simulation of acquisition

Raw datasets (Sinograms)

Evaluation of Scanner intrinsic Properties

Scanner models Comparison

Add modules for specific investigations

Technological development

Quantitative procedures
attenuation – scatter – PV

Reconstruction Methods
Iterative - analytic

Dosimetry?

Methodological studies

Improvement of clinical practice

Impact of scanner parameters
on tumor detection

Evaluation of Scanner intrinsic Properties

- Impact of scanner physical and geometrical properties on image contrast and resolution?

- Impact of parameters setup on acquisition?

Methodological studies

- Influence of scanner parameters on image statistical comparison?

(Statistical Parametric Mapping)
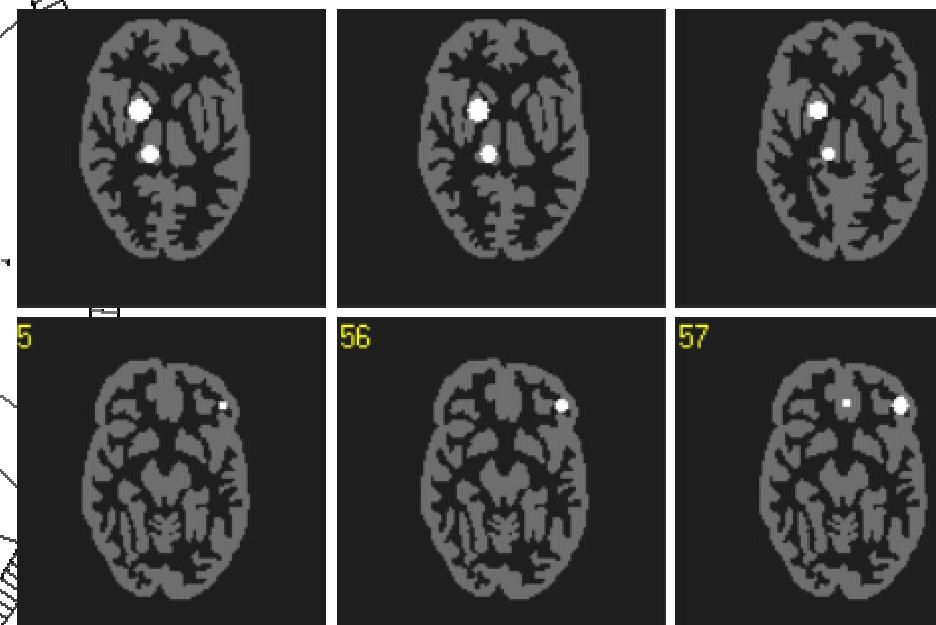
Point sources

83cm

Variance reduction (**a**)
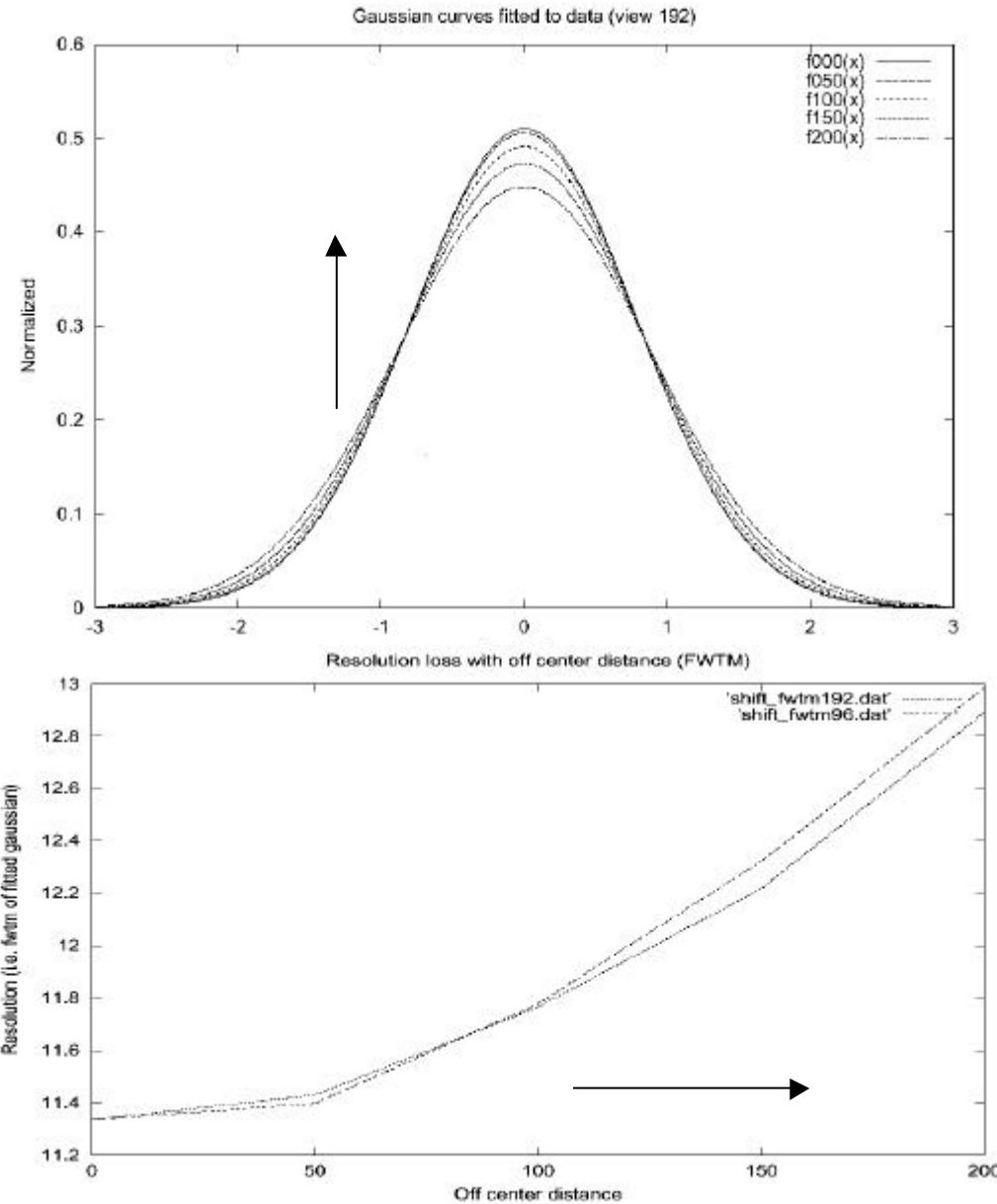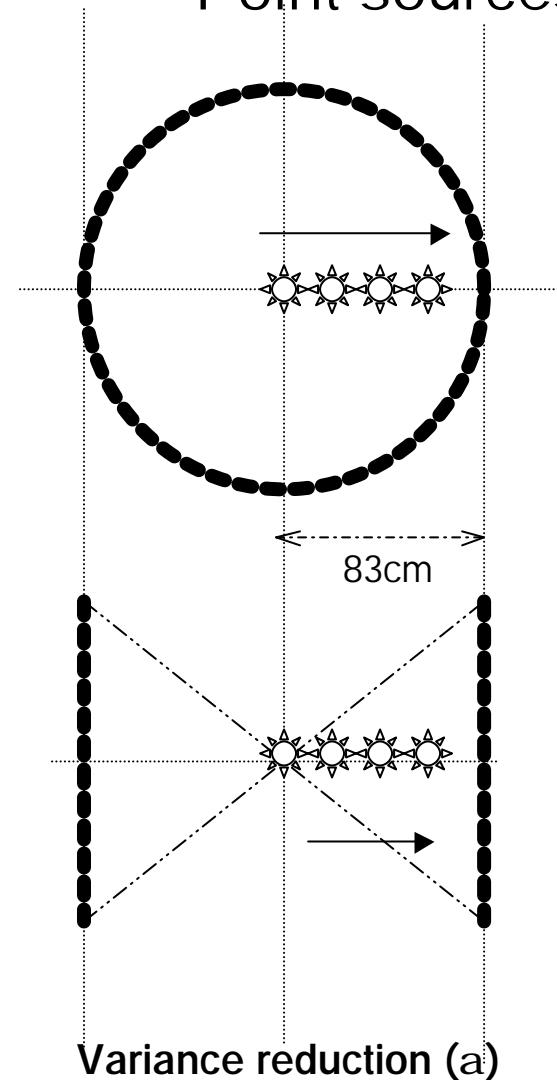
Adding a module for attenuation–correction methods evaluation

Gantry
Instance of **ScannerModel**

Rotating transmission source
Instance of **SourceModel**

Gamma Pair
Instance of **List [Photon]**

Attenuation medium
Instance of **ScatterModel**

Transmission image
Instance of **Sinogram**