# New Instrumentation New Algorithms for SPECT

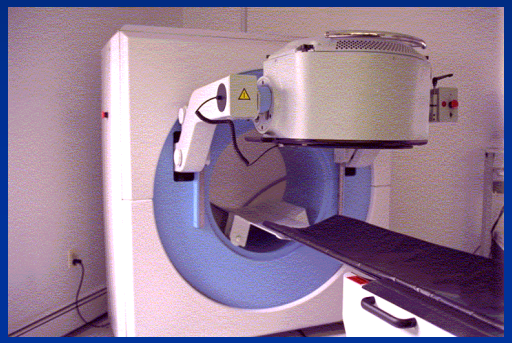


JASON BEIRNE

# IS2 Medical Systems

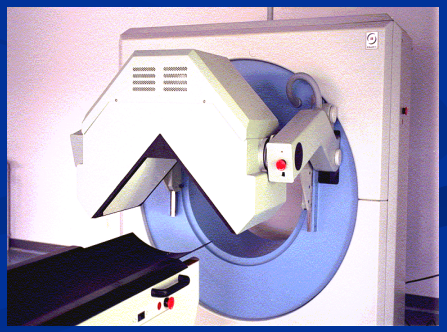
- Founded 1996 by Iain Stark (developer of the world's first digital gamma camera) in Ottawa
- "Best Performance; Best Price"
  - State of the art electronics
  - Non-proprietary parts
  - Common components
  - "All-in-the-Head" electronics
- First camera installed Feb 1999
- Installed base now over 60 units

# Current Product Line



SC

SR



DCC

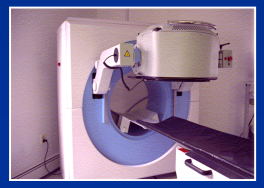
# Pulse CDCC

# Upgrade Paths

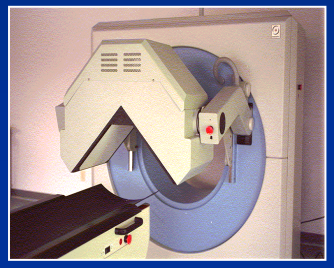
IS2 cameras are all designed to be field upgraded.

All units can undergo "upstream" or "downstream" upgrades.

Upgrades typically only take a few hours and generally can be done without disrupting patient flow.

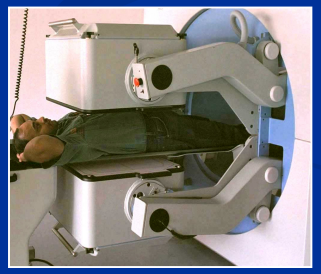


SC

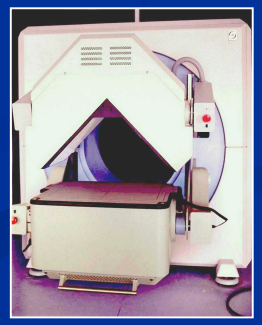


DCC

SR



WBCam



GPTri

# Specifications

3.0mm Intrinsic Spatial Resolution FWHM - best in the industry
9% Intrinsic Energy Resolution - best in the industry
Uniformity (+/-2% int; +/-1.5% diff) - best in the industry
Count rate (220 kcps max, 180 kcps 20% loss) - best in the industry
Center of rotation better than 0.5mm - best in the industry
Slip Ring - continuous, full 360° rotation - clockwise, counter-clockwise
Feet-in or Head-in imaging
Upgradeable - upstream, downstream - unique to IS2
Tele-Nucs - most advanced remote reading, servicing, teaching
Bed - 450 lb (205 kg) weight capacity (carbon fiber) - best in the industry
Full 6'8" (203 cm) whole body scan length - best in the industry

*TRUE ALL DIGITAL DESIGN - down to each PMT*

# Reliability

IS2 recently upgraded its ISO registration. As part of its quality process IS2 studied the reliability of a selection of 50 camera installations over one year.

40% of cameras had uptime of 100%

84% of cameras had an uptime of 99.90% or better

Five least reliable cameras had an average uptime of 99.71%

Cameras less than 6 months old had an average uptime of 99.99%

Cameras greater than 36 months old had an average uptime of 99.92%

On average less than one service call per month per camera was experienced

***Average uptime for all cameras of 99.94%***

***No camera had an uptime of less than 99.57%***

attributed to digital architecture, built-in capability for remote fault finding and corrective action, and robust mechanical design.

*"I've looked hard at the camera. You and I both know there are no expensive parts that will break."*

# Segami

- Founded in 1995 to develop and market affordable, best-in-class, workstations for nuclear medicine
- First to produce a NM system based on MS-Windows NT architecture

# Mirage

- High speed processing
- Image fusion
- Full connectivity
- Multi-format
- Multi-modality data exchange
- Historical archiving capabilities

# Universal Connectivity

- Standard interfaces like DICOM and Interfile
- Import most NM/PET data formats directly
- Analogue and digital acquisition solutions for many legacy camera systems

**Supported File Formats**

-Interfile
-DICOM
-GE Advance
-GE Starcam
-CTI ECAT
-ADAC Pegasys
-Siemens ICON
-Toshiba
-SMV XT/STP
-Elscint USTU
-Trionix

**Acquisition Solutions**

-Siemens Analogue Orbiter
-Siemens Analogue Diacam
-Siemens Bodyscan
-Siemens Portable LEM
-Siemens ROTA
-GE X-series
-GE Starcam, 2000 & 3000
-GE 400T
-GE Maxi
-ADAC/Philips ARC3000
-Picker SX250
-Picker SX300
-Elscint SP4
-Elscint SP6
-Hitachi 600
-Toshiba 910
-Toshiba 620
-Scintronix
-Searle PhoGamma Series


Evolution in tomography:
ReSPECT
ReSPECT
ML-EM
Wiener postfiltered
ML-EM
Filtered
Backprojection
segami
SCIVIS
WISSENSCHAFTLICHE
BILDVERARBEITUNG

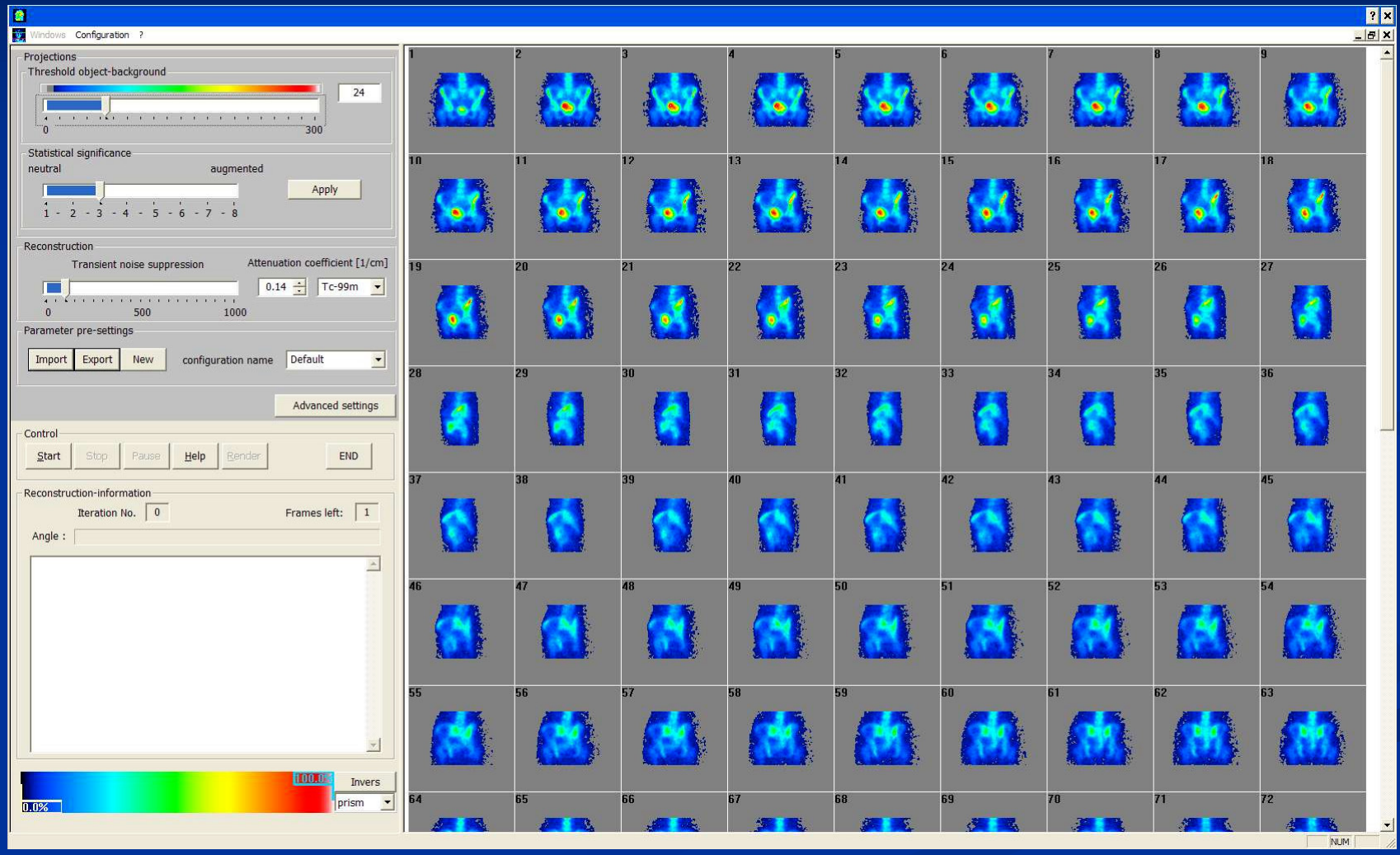
# ReSPECT

- Unique 3D Iterative Reconstruction Technique
- Corrects for Attenuation (homogeneous transmission map)
- Corrects for Scatter (zeroth order subtraction method)
- Corrects for Collimator Blurring (using PSF)

# ReSPECT

- Reduces structure elimination due to hot structures (e.g. bladder, gall bladder)
- Reduces artifacts due to truncated projections
- Improves image quality in extreme low count studies (e.g. In-111)
- General improvement in contrast and resolution

# ReSPECT


Windows Configuration ?
Projections
Threshold object-background
24
0
300
Statistical significance
neutral
augmented
Apply
1 - 2 - 3 - 4 - 5 - 6 - 7 - 8
Reconstruction
Transient noise suppression
Attenuation coefficient [1/cm]
0.14
Tc-99m
0
500
1000
Parameter pre-settings
Import
Export
New
configuration name
Default
Advanced settings
Control
Start
Stop
Pause
Help
Render
END
Reconstruction-information
Iteration No.
0
Frames left:
1
Angle :
100.0%
0.0%
Invers
prism
NUM

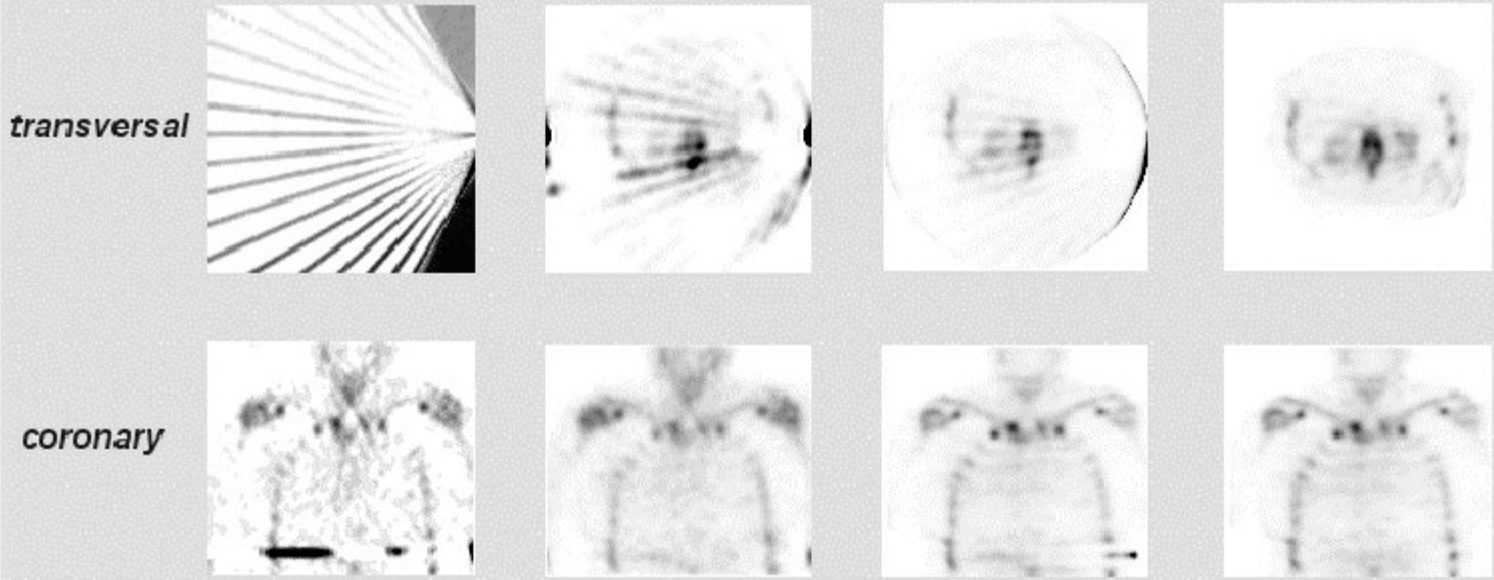
# ReSPECT

ReSPECT

OSEM 5 iterations

Butterworth Fc: 0.3; Order: 6

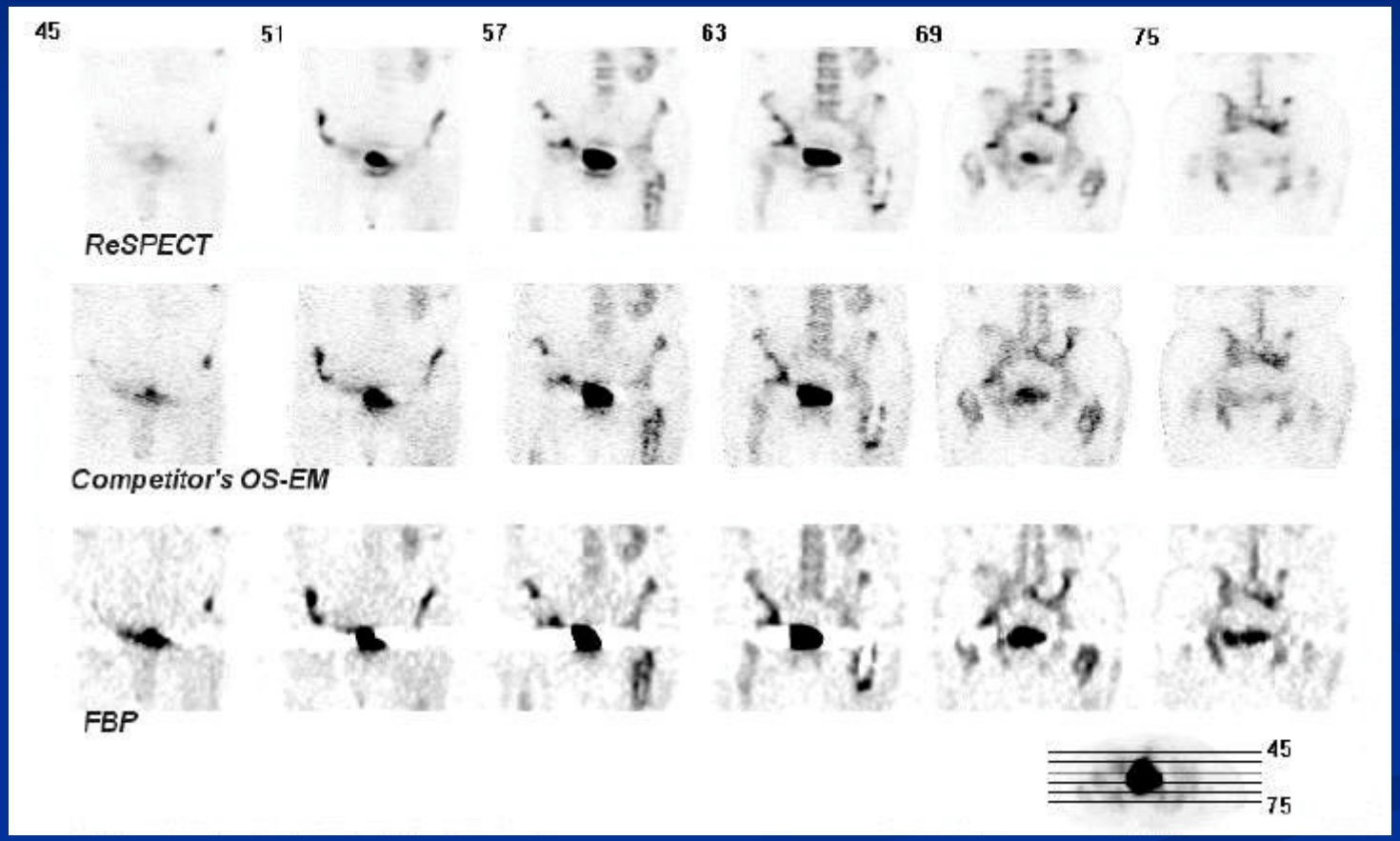
# ReSPECT



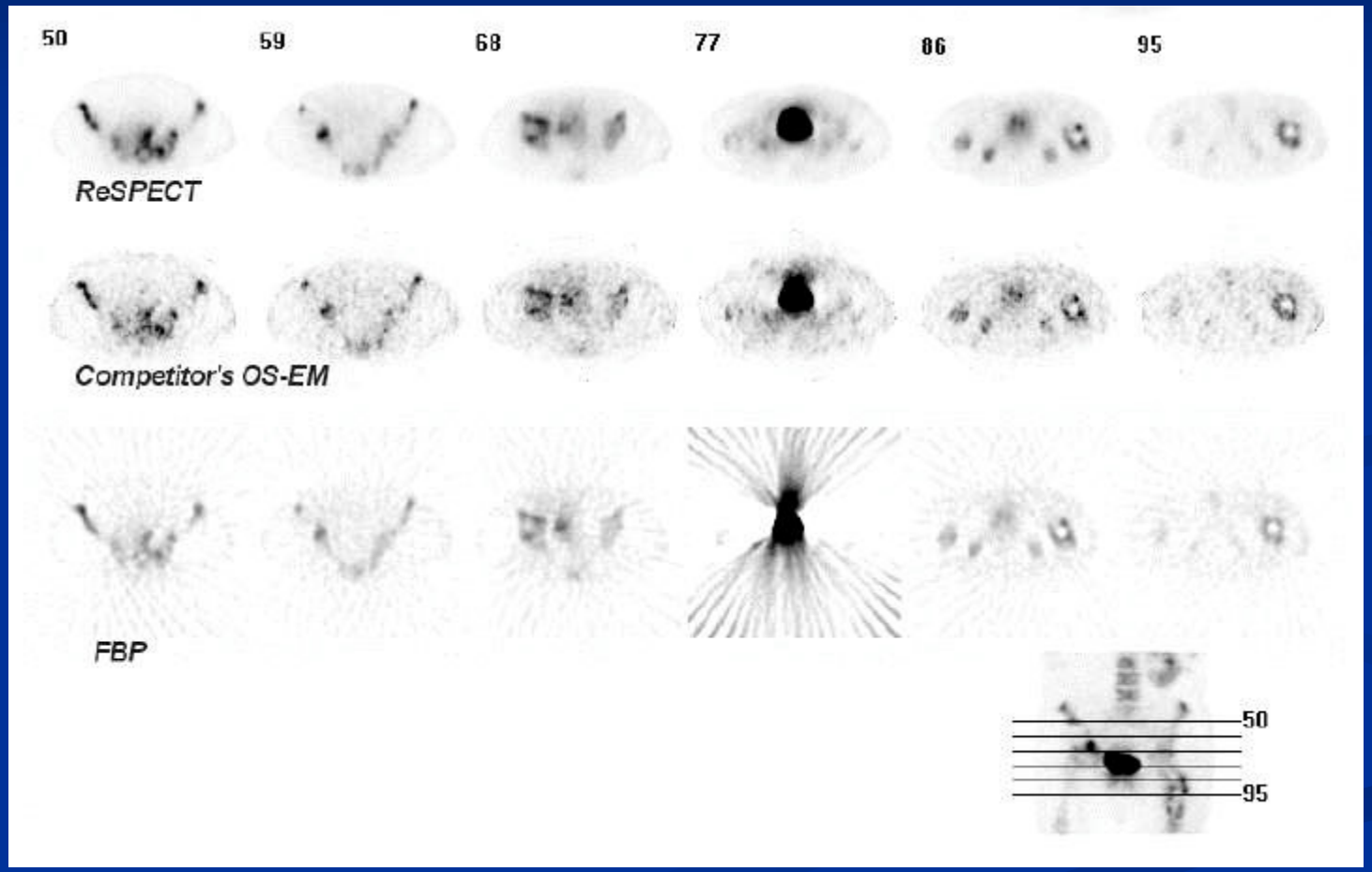

This example shows reconstructions of a $^{99m}$Tc-bone-SPECT study with the question of osseous metastases of the vertebrae. The study was aggravated by a paravasat in the left upper extremity; moreover the projections are truncated, thus the paravasat is seen only in half the numbers of projections.

The upper row shows transversal slices in the height where the paravasat is located. The lower row shows coronary slices. Each column shows results of different reconstruction methods: 1) filtered back-projection, 2) ML-EM with ordered subsets (OS-EM) of an actual implementation of a leading gamma-camera manufacturer, 3) ML-EM with ordered subsets (OS-EM) as own implementation, and 4) ReSPECT. The greyscales of the different reconstructions are adjusted for comparison.

# ReSPECT



# ReSPECT



# Validations:

- Höffken, H., Schurrat, T., Mahall, C., Gratz, S., Gotthardt, M., Béhé, M., and Behr, T.M.: *Welchen Vorteil bieten iterative Rekonstruktionsverfahren bei der semiquantitativen Auswertung der I-123-FP-CIT- und der I-123-IBZM-SPECT?,* In: *Nuklearmedizin als Paradigma molekularer Bildgebung* Abstract volume of the 40th annual meeting of the DGN 2002, Eds.: Brink, I., Högerle, S., and Moser, E., Blackwell (2202)
- *Clinical quality rating of different SPECT-reconstruction programs,* to be published