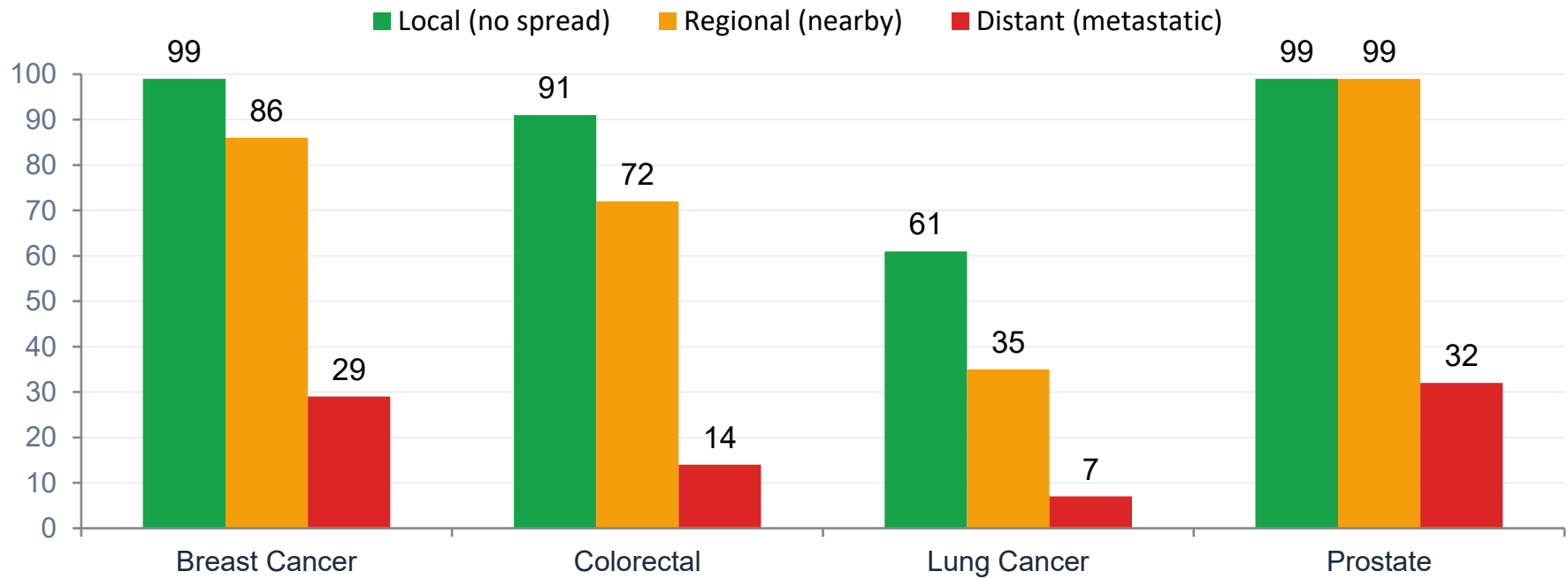


Imaging and Targeting Tumors Like Never Before

Earlier Detection of Cancer= Dramatically Better Survival

5-year survival rates by stage at diagnosis



⚡ **Key: metastatic breast cancer 5-yr survival = 29% vs 99% when caught locally**

Why Imaging Is the Most Important Oncology Decision

Every treatment protocol in metastatic disease starts with — and is defined by — the imaging modality chosen

~50%

of cancer patients develop
distant metastases

30%

of brain metastases missed
on standard protocol MRI

25%

of patients restaged after
PET-CT — management changed

2.5×

more OMD detected with
PET-CT vs CT alone

Why distant metastases matter?



~50%

of patients have **distant metastases**
at time of diagnosis



90%

of all cancer deaths are
caused by **metastatic spread**



5–12×

lower 5-year survival
when
metastases are present



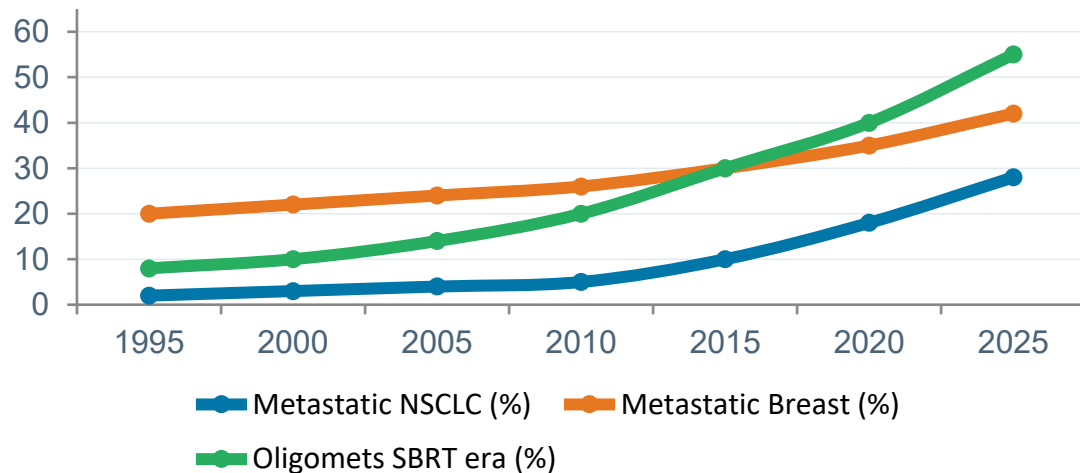
€18B

annual EU healthcare
cost
of **metastatic disease**

Metastatic Cancer Survival — 30-Year Revolution

Imaging precision + ablative RT: from 2% to 58.6% five-year overall survival in oligometastatic disease

5-Year Overall Survival (%) — Metastatic Disease by Era



SABR-5: Median OS 64.6 months · 5-yr OS 58.6%
Imaging-guided SBRT = metastatic cancer potentially curable

1990s Standard chemotherapy

5-yr OS: 2–20%

2000s Targeted therapy
EGFR/HER2

5-yr OS: 4–26%

2010s PET-CT + SRS/SBRT

5-yr OS: 30–40%

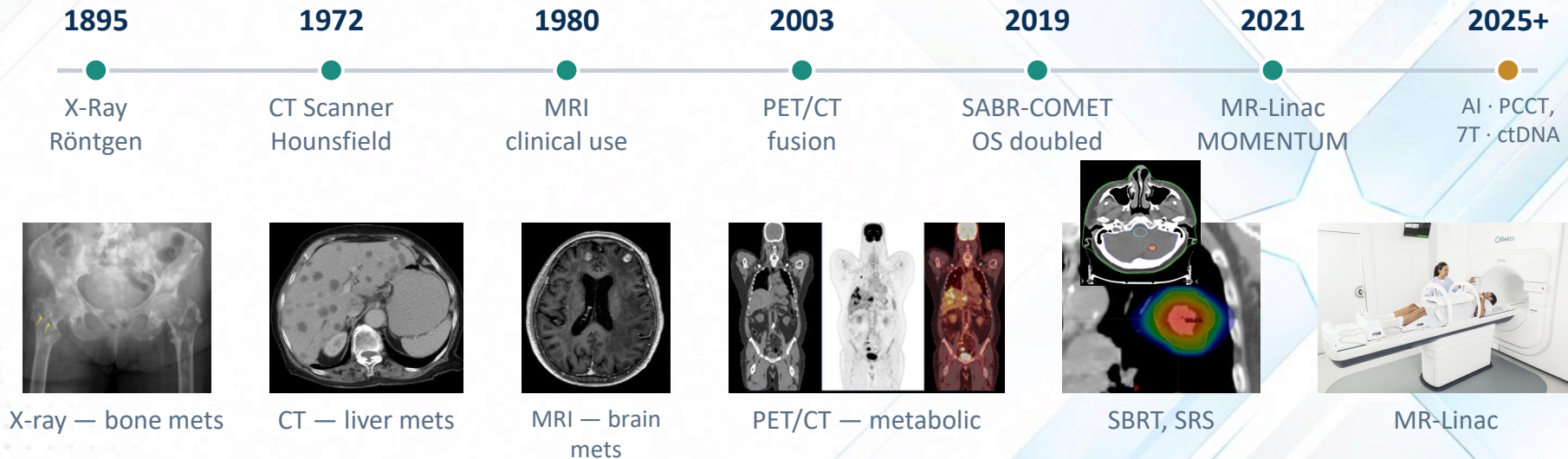
2020s MR-Linac · PSMA-PET · AI

5-yr OS: *Up to 58.6%*

130 Years of Imaging Innovation

CONNEXUS

From Röntgen's first X-ray to AI-guided precision — and what comes next



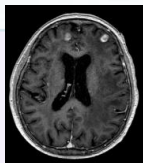
Below imaging threshold → above imaging threshold → ablative treatment → potential cure

MRI — No Radiation, soft tissue detailed information

CONNEXUS

Magnetic fields reveal what X-rays and CT cannot — soft tissue with sub-millimetre precision

T1 / T2 Standard MRI

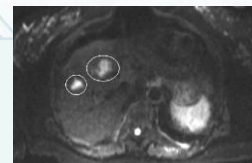


Gold standard for brain metastases.
Gadolinium contrast lights up tumour.
Finds lesions **down to 2–3 mm.**

91%

sensitivity
for brain mets

DWI Diffusion Imaging



Measures water movement in tissue.
Dense tumour cells restrict flow →
glow bright.
Finds liver mets CT misses.

87%

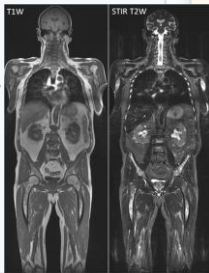
sensitivity for
liver mets (DWI)

WB-MRI Whole-Body MRI

91%

sensitivity vs
78% for
CT+scintigraphy

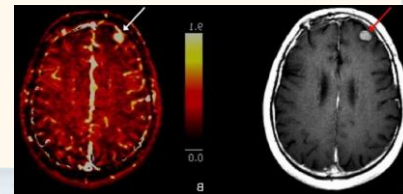
Full-body staging — no radiation.
Superior to CT+bone scan for myeloma.
Single session replaces multiple tests.



DCE Perfusion Mapping

Weeks

Tracks contrast through tumour vessels. **earlier than**
Monitors anti-angiogenic drug response. **CT response signal**
Detects response before size changes.



MRI Simulator in SRS & SBRT — Dedicated Radiotherapy Planning MRI

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Flat-table 0.5-3T MRI bore with laser alignment, isocenter marking, and RT-specific sequences — no CT sim needed



MRI-SIM Key Advantages

Superior GTV Delineation

5–10× better soft-tissue contrast vs CT · Brain, prostate, liver, pancreas
· Eliminates CT-MRI registration error (~2mm systematic shift)

MRI-Only Workflow

MRI-derived synthetic CT for dose calculation · Eliminates CT dose +
2nd appointment · 48-hr faster treatment initiation in clinical practice

Dedicated RT Sequences

T1+Gd (GTV) · T2 (OARs) · DWI (tumour biology) · DCE (perfusion) ·
MRSI (spectroscopy) · All in one session

Flat Table + Laser Grid

Matches treatment couch geometry · Isocenter reproducibility <1mm ·
Patient immobilisation identical to treatment position

Margin Reduction

MRI-only SRS: PTV margins 1mm vs 2–3mm CT · MR-Linac: 2mm vs
4mm PTV (MIRAGE Phase III p=0.01) · More GTV dose, less OAR dose

Functional Imaging Integration

DWI: tumour cellularity · DCE: perfusion · BOLD: oxygenation · Enables
dose painting on biology, not anatomy alone

MRI-Guided Adaptive Radiotherapy — The MR-Linac

Real-time MRI during every fraction · online replanning · smaller margins, less toxicity

80.8%

of fractions adapted online (adapt-to-shape) — 1,000-patient real-world cohort

93%

of fractions improved by adaptive planning — SMART Master Trial, 193 patients

84.6%

1-yr overall survival, pancreatic ablative SMART (50 Gy / 5 fx) vs ~55% historical

1.9%

grade 3+ toxicity — patient-reported quality of life unchanged (PROMIS-10)



1.5T MR-Linac — real-time MRI during beam delivery

PET/CT — Seeing Cancer's Metabolism

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A radioactive sugar makes active tumour cells glow — combined with CT for exact location



The Warburg Effect

Cancer cells consume glucose 10× faster than normal cells.

^{18}F -FDG (radioactive sugar) accumulates → tumours glow on the scan.

30%

of staging plans
changed by
PET/CT

94%

sensitivity for
lymph
node mets
(NSCLC)

90%

sensitivity for
bone mets
(PSMA-PET)

Specialised tracers for each cancer type:

^{18}F -FDG

Most cancers

Universal metabolic tracer

PSMA

Prostate cancer

Finds mets at very low PSA

DOTATATE

Neuroendocrine

Maps hormone receptors

^{18}F -NaF

Bone metastases

2× sensitive vs bone scan

FAPI

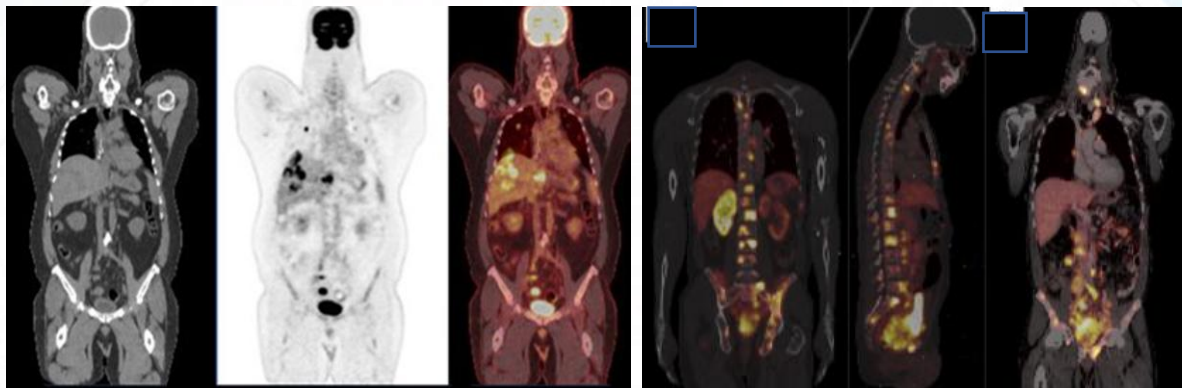
Multiple cancers

Finds tumours FDG misses

PET/CT in Clinical Practice — FDG & Ga-68-PSMA

CONNEXUS

Metabolic imaging that changes staging, treatment intent and survival



FDG-PET/CT — liver metastases

CT · PET · fused: tumours glow by glucose uptake

Ga-68-PSMA PET/CT — prostate cancer

Bone & nodal metastases at low PSA

30% of staging plans changed by PET/CT

2.5× more OMD detected vs CT
(PETABC 2025)

>90% PSMA-PET sensitivity vs 70% bone scan

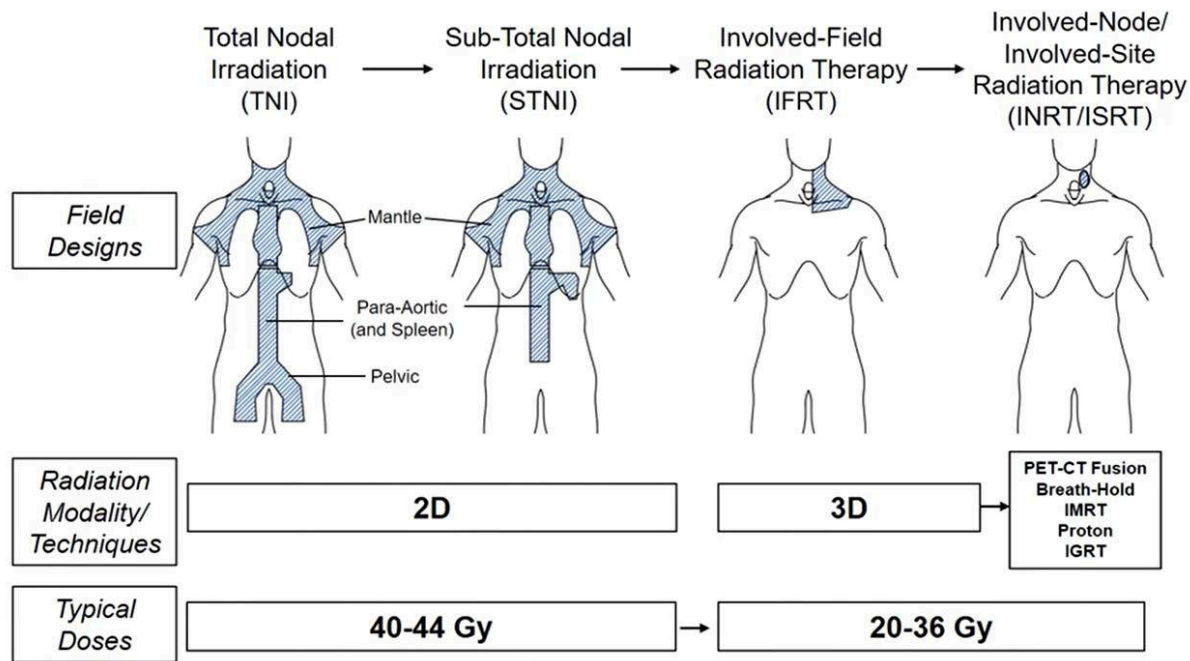
83% / 93% sensitivity / specificity — M-staging NSCLC

Stage III NSCLC: 22 vs 14 months median OS · Lymphoma: 83% vs 71% 5-yr PFS ·
Colorectal mets: 45% 5-yr OS with PET-guided resection

FDG-PET/CT in Hodgkin lymphoma

reduced treatment field and dose, improved treatment results and quality of life of the patients

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SRS & SBRT

Precision Radiotherapy

Ablating metastases with sub-millimetre accuracy

Precision Radiotherapy — At a Glance



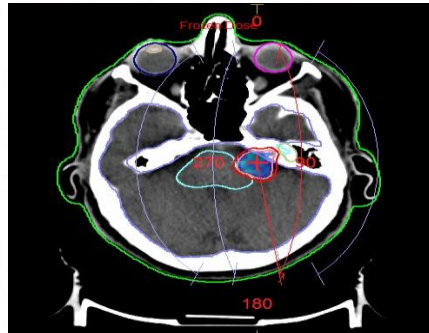
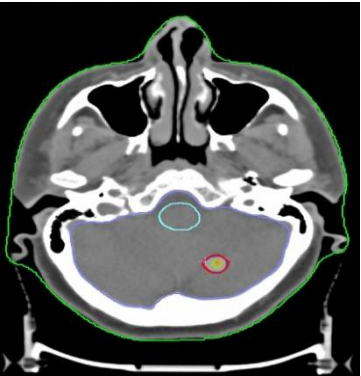
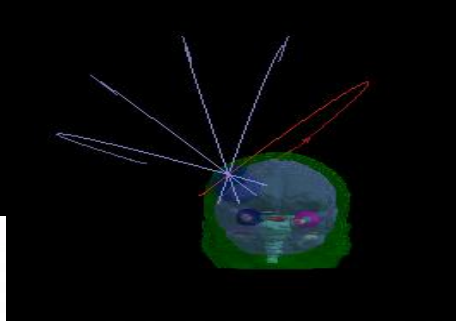
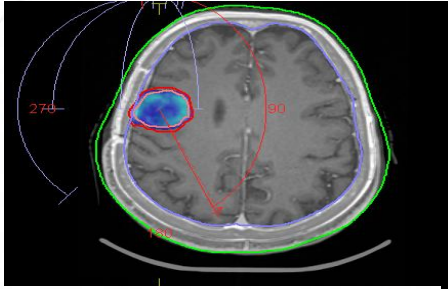
Radiosurgery and SBRT: the same tool, a completely different strategy

	Conventional RT	SRS (Radiosurgery)	SBRT / SABR
Sessions	25–37	1	1–5
Dose / session	1.8–2 Gy	15–24 Gy	7.5–20 Gy
Duration	5–7 weeks	1 day	3–8 days
Accuracy	~5–10 mm	< 0.5 mm	1–2 mm
PTV margin	5–10 mm	0–2 mm	3–5 mm
Where used	Large fields	Brain	Body metastases
Biology	Sub-lethal repair between sessions	Ablative — vascular + immune kill	Ablative + immune activation

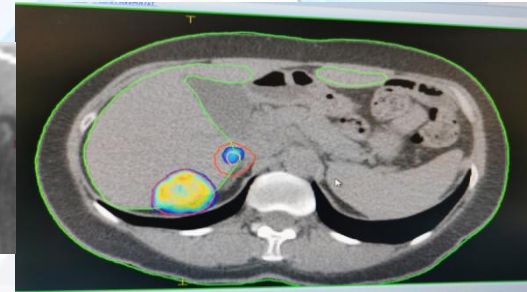
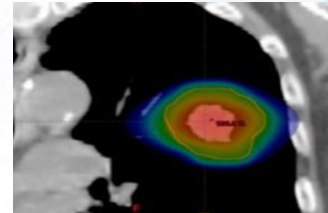
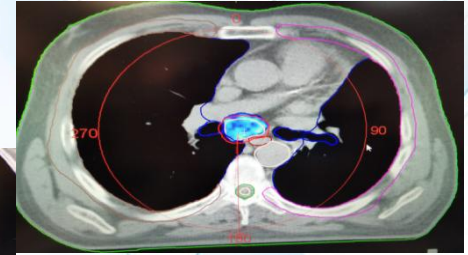
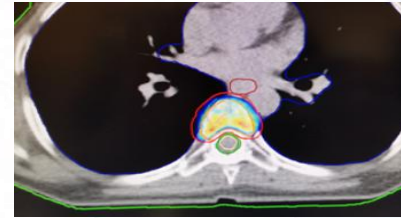
Radiosurgery

CONNEXUS

- Intracranial SRS



- Extracranial SBRT



Radiosurgery Machines

CONNEXUS

Dedicated platforms for sub-millimetre, ablative precision — brain and body



Gamma Knife

Intracranial SRS · 201 Co-60 sources



ZAP-X

Self-shielded gyroscopic SRS



CyberKnife

Robotic arm · real-time tracking

Linac-based SRS

Versa HD & conventional linacs



Helical radiotherapy

TomoTherapy / Radixact

Dedicated SRS platforms in clinical use: Gamma Knife · CyberKnife · ZAP-X · Linac-based SRS · Helical (TomoTherapy)

The Oligometastatic Paradigm — Imaging as the Gatekeeper

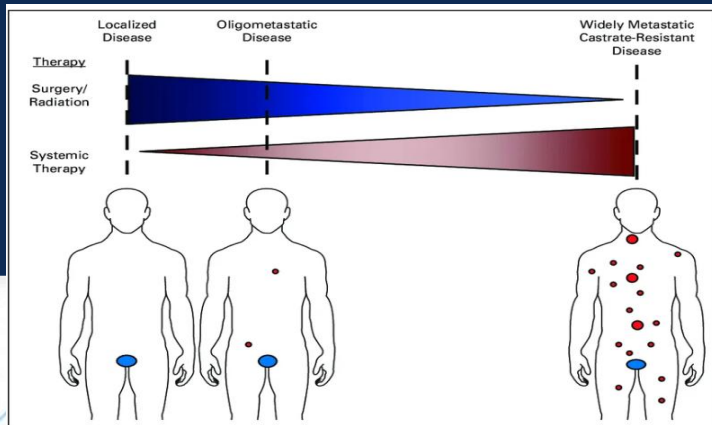
ESTRO/EORTC: $\leq 3-5$ metastases amenable to local ablative therapy · Imaging modality must be specified

ESTRO/EORTC Consensus

$\leq 3-5$ metastases

amenable to **local** ablative therapy

Imaging determines curative intent vs palliative care



~55%

of metastatic patients have OMD on modern imaging (PET + cMRI)

Christ et al., IJROBP 2023 n=7,000

72%

of OMD patients have 1–2 mets SRS/SBRT is the ideal approach

Same cohort

2.5×

more OMD detected by FDG-PET vs conventional CT/bone scan

PETABC Trial, Radiology 2025

SABR-COMET — Survival Doubled



The landmark trial: SBRT to all metastatic sites vs standard care alone

 **Design: 99 patients · 1–5 metastases · Any cancer · Any body site · Randomised controlled trial**

Standard of Care Alone

Chemotherapy or hormone therapy — whatever the oncologist would normally prescribe.

5-yr OS: 17.7%

SBRT + Standard Care

Ablative radiotherapy to ALL met sites (1–5 sessions per site) added to standard care.

5-yr OS: 42.3%

2.4×

more patients
alive at 5 years

+13 mo

median OS benefit
(28 → 41 months)

HR 0.57

mortality risk
reduced by 43%

Phase III

SABR-COMET-10
now ongoing

Imaging Precision Directly Improves Quality of Life



Better imaging → smaller targets → less toxicity → preserved cognition, function, and daily life

Brain — Cognition Preserved

- ▶ SRS vs WBRT: **superior neurocognitive outcomes** — ASCO-SNO-ASTRO 2022 Level I
- ▶ 3T SPACE MRI finds 30% more lesions → SRS replaces WBRT in more patients
- ▶ CYBER-SPACE RCT: 77% WBRT-free at 12m with thorough MRI monitoring
- ▶ WBRT: 50–90% global cognitive decline at 1 year — avoided by imaging precision

SMART/MR-Linac PROs

- ▶ SMART Master Trial: PROMIS-10 **patient-reported outcomes unchanged from baseline**
- ▶ MR-Linac real-world: acute grade 3 tox 1.6% in 1,000-patient cohort
- ▶ Pancreas SMART: 1-yr OS 84.6% vs 55% — **fewer late GI complications**
- ▶ Abdominopelvic OMD: 12-mo OS 96%; **QoL preserved via online margin reduction**

SBRT — Toxicity Reduction

- ▶ AI auto-segmentation: uniform GTV → consistent OAR sparing across institutions
- ▶ 4D-CT/MRI gating: liver mean dose reduced, NTCP reduced significantly
- ▶ SBRT monotherapy: STFS 69.7% at 1–2yr — less chemotherapy toxicity needed
- ▶ 1–5 sessions vs 6 weeks chemoRT — patients maintain active daily life

WB-MRI — QoL Through Early Dx

- ▶ **Earlier OMD detection → earlier ablative RT → later or no systemic therapy**
- ▶ Radiation-free staging — eliminates cumulative CT scan dose over years
- ▶ ctDNA + imaging: 68% reduction in imaging frequency while maintaining sensitivity
- ▶ Avoids over-treatment: WB-MRI differentiates pseudo-progression vs true metastasis

AI & Radiomics — Seeing Beyond the Human Eye



Deep learning finds what the eye misses — and contours it in seconds

94%

sensitivity for brain metastases < 3 mm (deep-learning MRI)

96%

AI sensitivity for liver metastases — near radiologist accuracy

40%

less contouring time with AI auto-segmentation

82%

accuracy predicting EGFR/KRAS mutations from CT texture

What is Radiomics?

Every pixel holds mathematical information about texture, shape and density. AI learns which patterns predict:

- Response to immunotherapy
- Where cancer will spread next
- Benign vs malignant — without biopsy

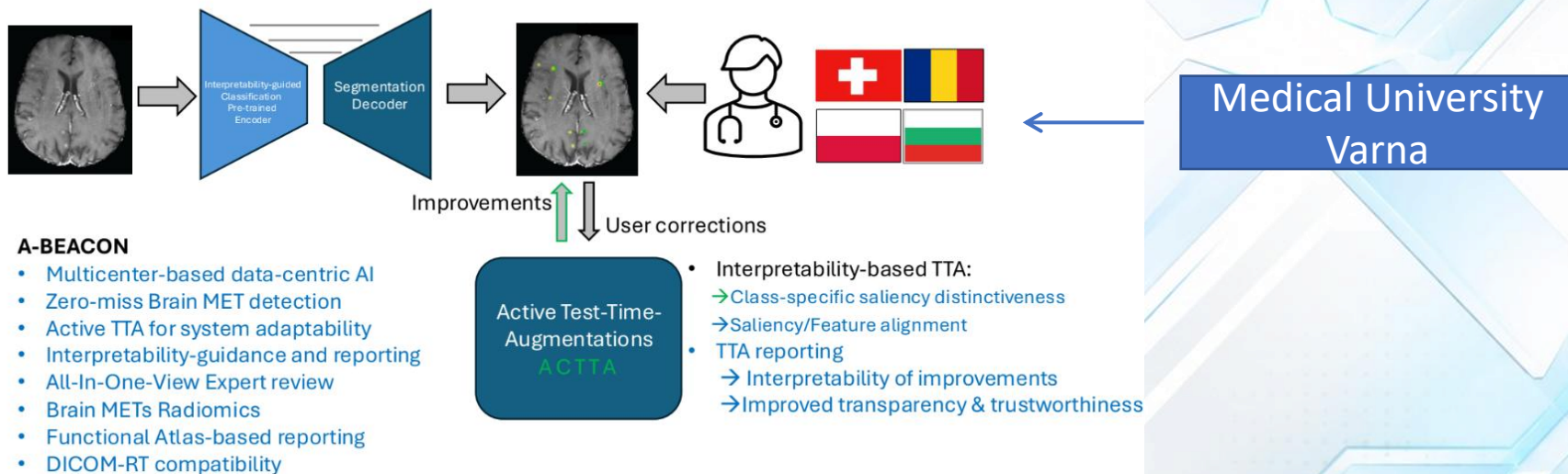
Clinical Applications

- Auto-contouring: planning from 2 hours to < 5 minutes
- Lesion detection on whole-body PET/CT — no missed regions
- Adaptive replanning on MR-Linac as the tumour changes
- Radiation necrosis vs true progression after SRS



A-BEACON project SNSF MAPS Projects

- MAPS is a multilateral initiative that supports collaborative research projects between scientists based in Switzerland and their colleagues in Bulgaria, Croatia, **AI-based Brain METastases TraCking and SegmentatiON - A-BEACON**



Next-Generation Scanners — Smaller Lesions, Lower Dose

Photon-Counting CT

IN CLINICAL USE

0.2 mm **–32–66%**

spatial resolution
(2× conventional
CT)

radiation dose
(abdomen /
chest)

5×

detectability of 4
mm
lung nodules

- **Detectors count every X-ray photon** and measure its energy — sharper and spectral images from one scan.
- **Liver:** 15% higher tumour-to-liver contrast for hypovascular metastases.
- **Lung:** *ultra-low-dose follow-up for patients who need many scans.*
- **Contrast:** *up to 27% less contrast agent.*

The Future of Metastasis Imaging

Technologies entering clinical practice now — and in the next decade

7T Ultra-High-Field MRI

- **Resolution doubles** vs standard 1.5–3T MRI
- **Sub-millimetre brain met detection** — finds leptomeningeal disease
- Metabolic spectroscopy without radioactive tracers
- FDA-cleared for brain imaging, expanding access

PET/MRI — Two Scans in One

- **Metabolic activity + best soft-tissue contrast in one session**
- Detects 13% more liver mets than PET/CT
- Superior prostate N-staging: 91% vs 84%
- **64% less radiation:** ~5 mSv vs ~14 mSv

Foundation AI Models

- **Whole-body analysis of every organ in seconds** — no missed regions
- **~96% sensitivity, 200× faster than manual reads**
- **Fuses CT + MRI + PET + genomics in one prediction**
- **Tracks every lesion over time** — beyond RECIST

Imaging precision IS treatment precision — every millimetre counts

“Never be afraid to
ask questions,
because if you never
ask, the answer is
always no.”

Sheena Yap Chan

• Prof. Elitsa Encheva, MD, PhD,
Head Radiotherapy Department,
University Hospital Saint Marina
Varna,
Medical University Varna
email: dr.encheva@gmail.com

