UNIVERSITY of MARYLAND
SCHOOL OF MEDICINE
DEPARTMENT OF RADIATION ONCOLOGY

SBRT for Breast Cancer – from Idea to Clinical Reality

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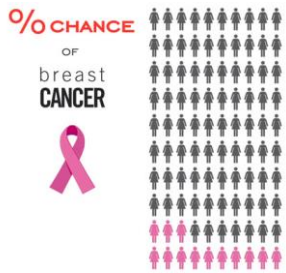
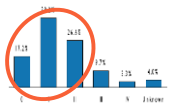
More than 1.5 Million New Cases Per Year



Stage Distribution Over Time

	1974 - 1985	1995-2001
Localized	48%	63%
Regional	41%	29%
Metastatic	7%	6%

Cancer Statistics, 1990, 2005, CA Cancer J Clin.



83% are Early Stage
(NCI Cancer Trend Progress Report - 2008)

NIH Consensus Statement. Treatment of early-stage breast cancer; 1990 18–21

Oxford Overview of Trials of BCS +/- RT

NSABP B-06	NSABP B-21
Milan 3	West Midlands
Uppsala-Orebro	CRC UK
St. George's	Swedish
Ontario	Scottish

EBCTCG, Lancet 366, 2087:2005
Punglia RS et al, NEJM 356, 2399, 2007
EBCTCG, Lancet. 378: 1707–16, 2011 (17 trials, n=10,800)

Summary of Trials of BCS +/- RT

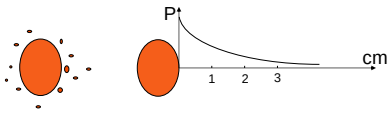
(At 15 years)	BCS Alone	BCS + RT
Local Recurrence	32.0%	10.3%
BC Mortality	35.9%	30.5%
Any Death	40.5%	35.2%

Why RT improves LC & OS?

Multi-focal, multi-centric nature

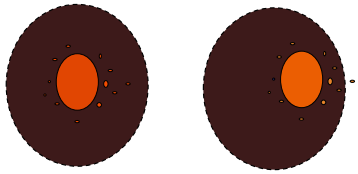
Gallanger and Martin, Cancer 24:1170-78, 1969 (N=113)

Holland R, et al: Histologic multifocality of Tis, T1-2 breast carcinomas. Cancer 56:979-90, 1985 (<4cm IBC, N=264, 63% ext. foci)



Most LR happens near the excision site.

A Reasonable Model



68% do not need RT

32% need RT

Role of RT: sterilize residual tumorlets or microextension left in the breast by surgeons

No Need to Treat the Entire Breast

Pioneered by Clinicians at W. Beaumont Hospital

LDR

I-125 implants

HDR

Breast HDR template

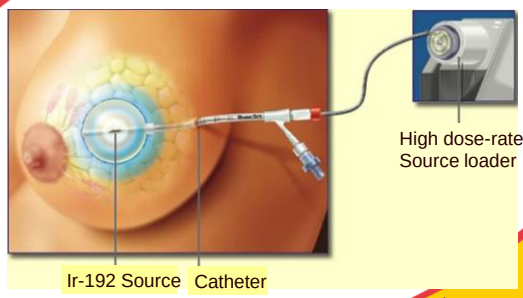
Mounting Clinical Evidence

Vicini, et al. Low-dose-rate brachytherapy as the sole radiation modality. *Int J Radiat Oncol Biol Phys.* 1997;38:301–310.

Chen PY, et al. Long-term cosmetic results and toxicity after accelerated partial-breast irradiation … by interstitial brachytherapy *Cancer* 2006 106(5):991-9

Wazer, et al. …HDR brachytherapy alone for T1/T2 breast cancer. *Int J Radiat Oncol Biol Phys.* 2002;53:889–897

MammoSite



MammoSite Result Paper

Chao KK, et al. Analysis of treatment efficacy, cosmesis, and toxicity using the MammoSite breast brachytherapy …. Int J Radiat Oncol Biol Phys. 2007; 69(1):32-40.

Dragun AE, et al. Patient satisfaction and quality of life after MammoSite breast brachytherapy. Am J Surg. 2008; 196(4):545-8.

Harper JL, et al. Six-year experience: long-term disease control outcomes for partial breast irradiation using MammoSite balloon brachytherapy. Am J Surg. 2010; 199(2):204-9.

NSABP B-39 (RTOG 0413) APBI trial

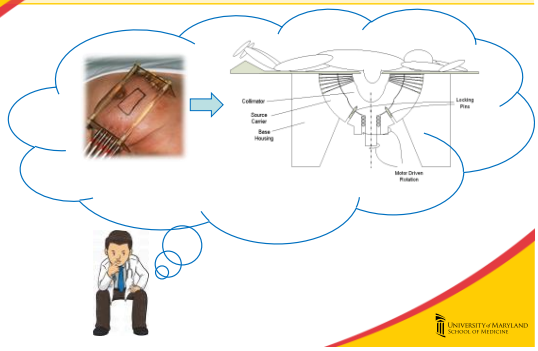
NSAPB B-39/RTOG 0413: "a randomized Phase III study of conventional whole breast irradiation (WBI) versus partial breast irradiation (PBI) for women with Stage 0, I or II breast cancer," activated March 21, 2005.

Brachy: ~5% LR in 5 yrs, >80% with good cosmesis
- Invasive, operator dependent

MammoSite: ~1% LR in 3 yrs, (93% ER+, 6% node+)
- Infection (9.3%), persistent seroma (32.6% at 5yr)

3DCRT or IMRT (~73%): 3.85Gy x 10 BID, ~2.3% LR @3yrs
- 25% grade 2+ subcu fibrosis (Hepel et al), 29% adverse cosmesis compared to WBI (RAPID trial).

Is there a convenient, consistent, noninvasive, less toxic way?



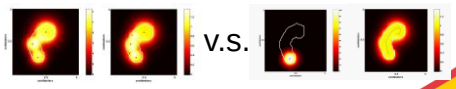
Time to validate idea

Questions:

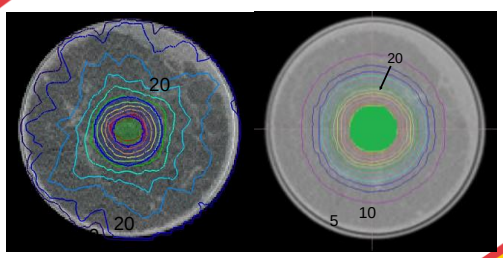
1) Can it compete with Brachy?
2) Can it do better than IMRT?

Method:

- Monte-Carlo simulation of a focal spot with 36 2.5cm diameter Co-60 beams, 36cm SAD
- Dynamic Dose Painting ignoring shot deformations

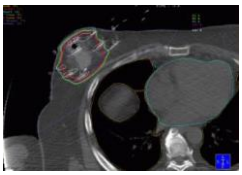


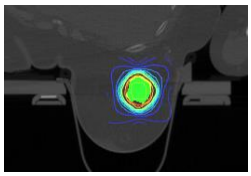
7-field IMRT vs GammaPod™



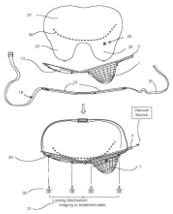
7-field IMRT GammaPod

Brachy-like dose distribution

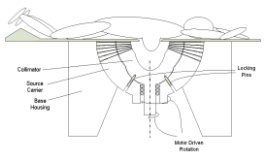




The SBIR Grant Proposal

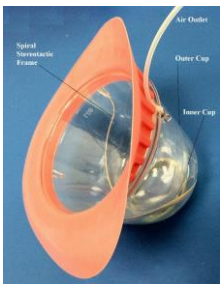


Prone Breast Stereotaxy

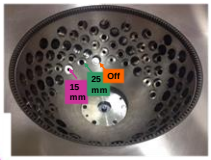


Breast SBRT Treatment Machine

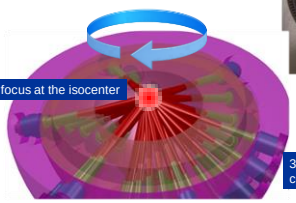
Vacuum Cups and Imaging Couch



Beam Configuration



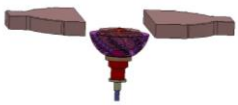
15 mm and 25 mm collimators

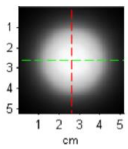


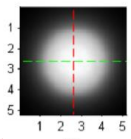
36 Co-60 sources, continuously rotating

Prototype in 2010

Close up of source geometry



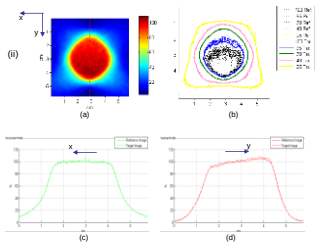




GammaPod™ system does not yet have a certificate of conformity and is not presently available for commercial distribution in the U.S.

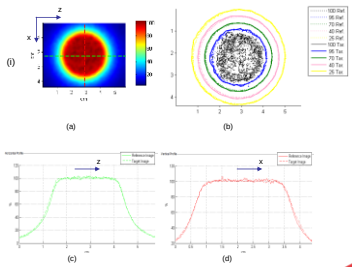
Dose Distribution Measurement

Dose Distribution for 25 mm Static Shot- xy plane (axial)

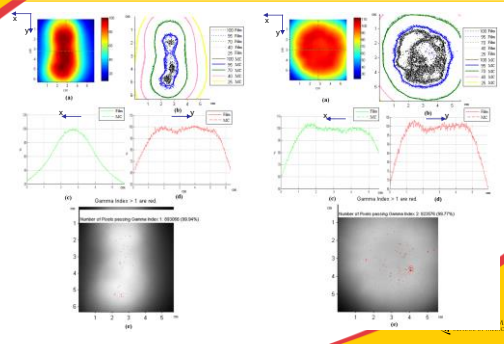


Dose Distribution Measurement

Dose Distribution for 25 mm Static Shot- xz plane (coronal)



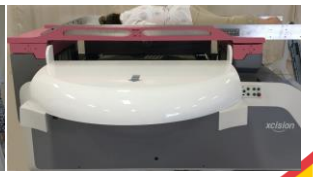
Patient Plan Verification



New Design

Prone, external beam, partial breast irradiation

Patient standing on the treatment loader, with shielding doors closed.



Patient lying prone, above the treatment position, with shielding doors open.

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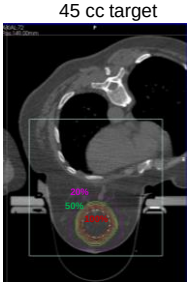
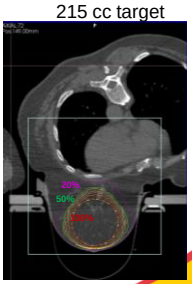
Example Dose Distributions

45 cc target



215 cc target



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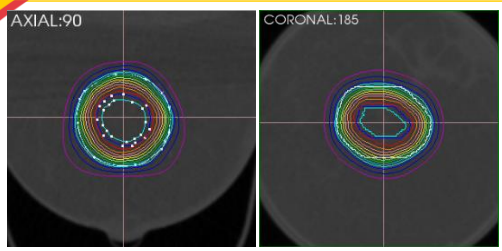
SRS + APBI



3.5cm Tumor+3mm gets 18Gy
6.1 cm Tumor bed gets 10Gy

No need for surgery
No need for 5-7 weeks of radiation
1-3 irradiation is enough

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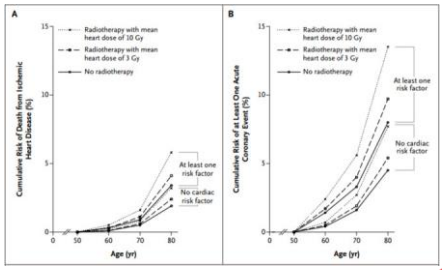
Cardiac Toxicity of Radiotherapy



From Darby et al: Risk of Ischemic Heart Disease in Women after Radiotherapy for Breast Cancer, NEJM 368(11), 2013

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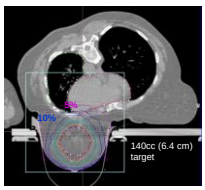
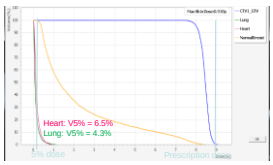
Heart and lung dose estimates (left breast target)





In this example:

Heart V5% = 6.5%
Lung V5% = 4.3%

RTOG0413/NSABP B39 constraints:
Heart V5% <40%
Lung V30% < 15%

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Ypod *Consortium*

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MARLENE AND STEWART GREENEBAUM CANCER CENTER

KU MEDICAL CENTER

UT SOUTHWESTERN Medical Center

Allegheny Health Network

The Ottawa Hospital Foundation | La Fondation de l'Hôpital d'Ottawa

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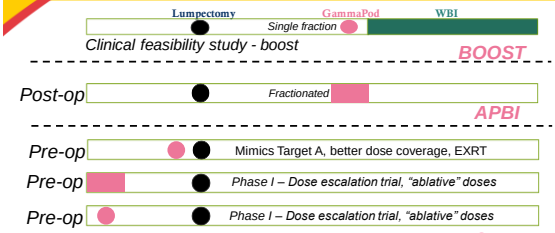
Currently Proposed Consortium Trials



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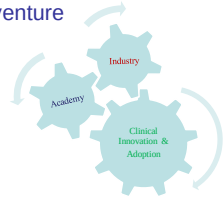
Summary

- An idea of a dedicated breast SBRT system conceived during clinical service
- Enabled by grant funding
- Clinical realization through a commercial venture



Tomotherapy
VMAT/Rapid Arc
ViewRay
Mevion
Velocity
MRI-Linac

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Clinical Consortium Members
Xcision Employees

Thank You!