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cancer Biomedical  
Informatics Grid<sup>™</sup>

# **Mouse GBM: A Pilot Collection on NBIA**

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Mouse Cancer Genetics Program  
NCI*

*Collaboration with  
Paul Mulhern and Brian Hughes*

# Introduction

## Preclinical Goals



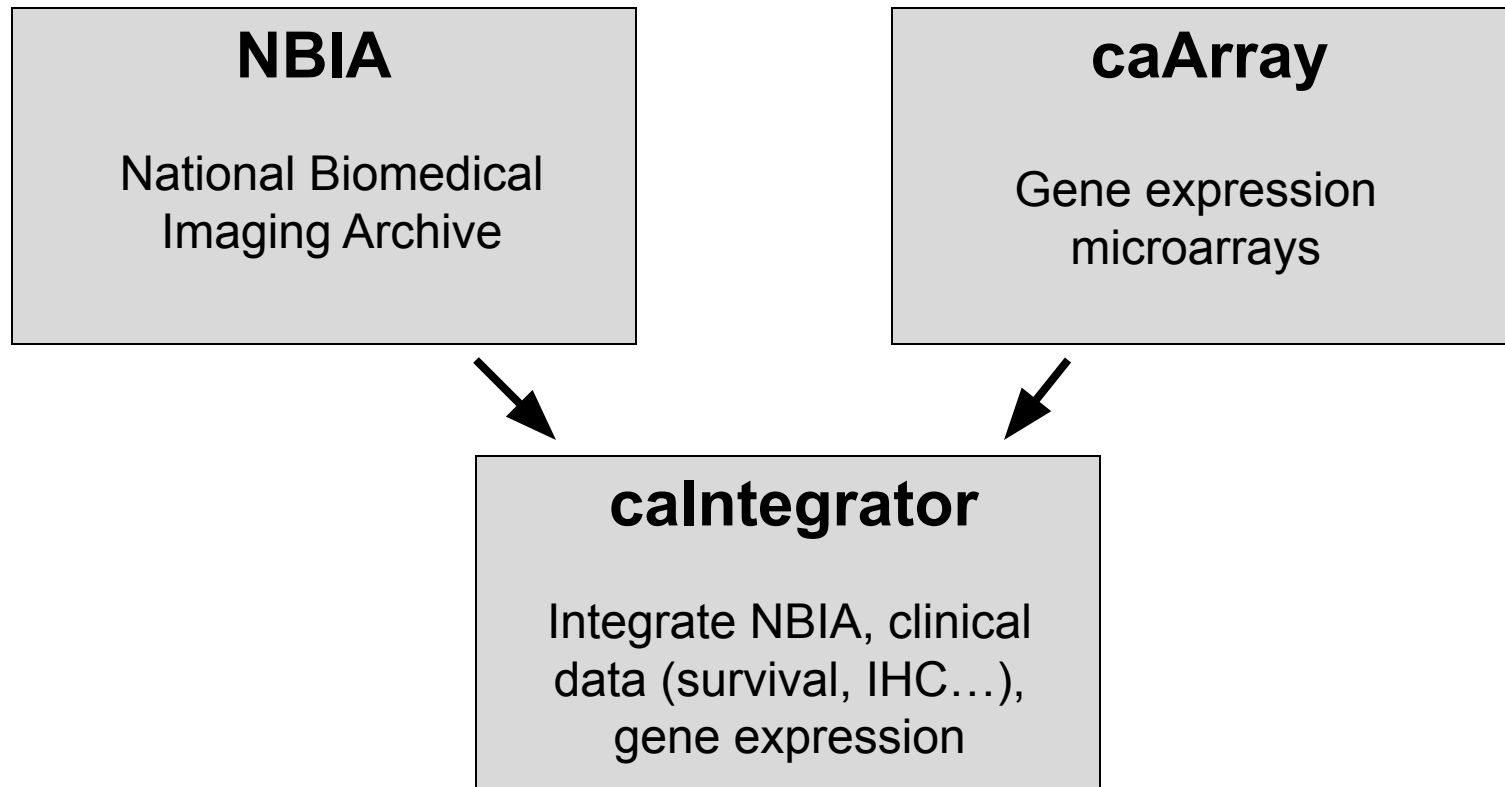
- **Goal 1:** Develop a molecular and imaging based classification for genetically engineered mouse models (GEMs) of glioblastoma multiforme (GBM)
- **Goal 2:** Use imaging to assess response of GBM GEMs to novel therapeutic regimens

# Introduction

## caBIG® Tools for Preclinical Data



- 



# Mouse GBM Pilot Collection

## Purpose



- Utilize NBIA and caIntegrator to correlate image-based features with ‘clinical’ data in GBM mouse models
  - Image-based features
    - Qualitative
    - Quantitative blood brain barrier permeability
  - ‘Clinical’ features
    - Genotype
    - Tumor histologic characteristics
    - IHC— e.g., CD31
- One time imaging in n=62 mouse patients

# Mouse GBM Pilot Collection

## Animal models



- Intracranial injection of cell lines derived from several GEMs
- **Genotypes:**
  - Rb inactivation + Ras activation (TR)
  - Rb inactivation + Ras activation + PTEN loss (TRP)
  - Rb inactivation + Ras activation + EGFR loss (TRE)

# Mouse GBM Pilot Collection

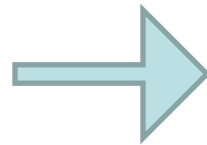
## Brain Imaging Workflow



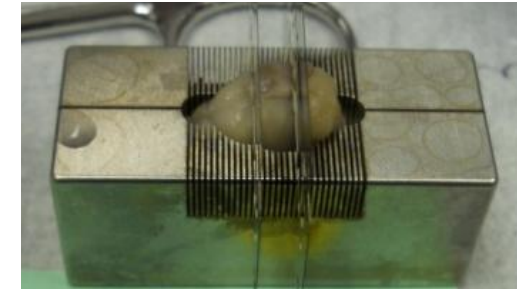
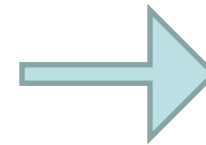
•



Four mice imaged  
at once



Philips Intera Achieva  
3.0T MRI clinical scanner  
~1hour imaging time



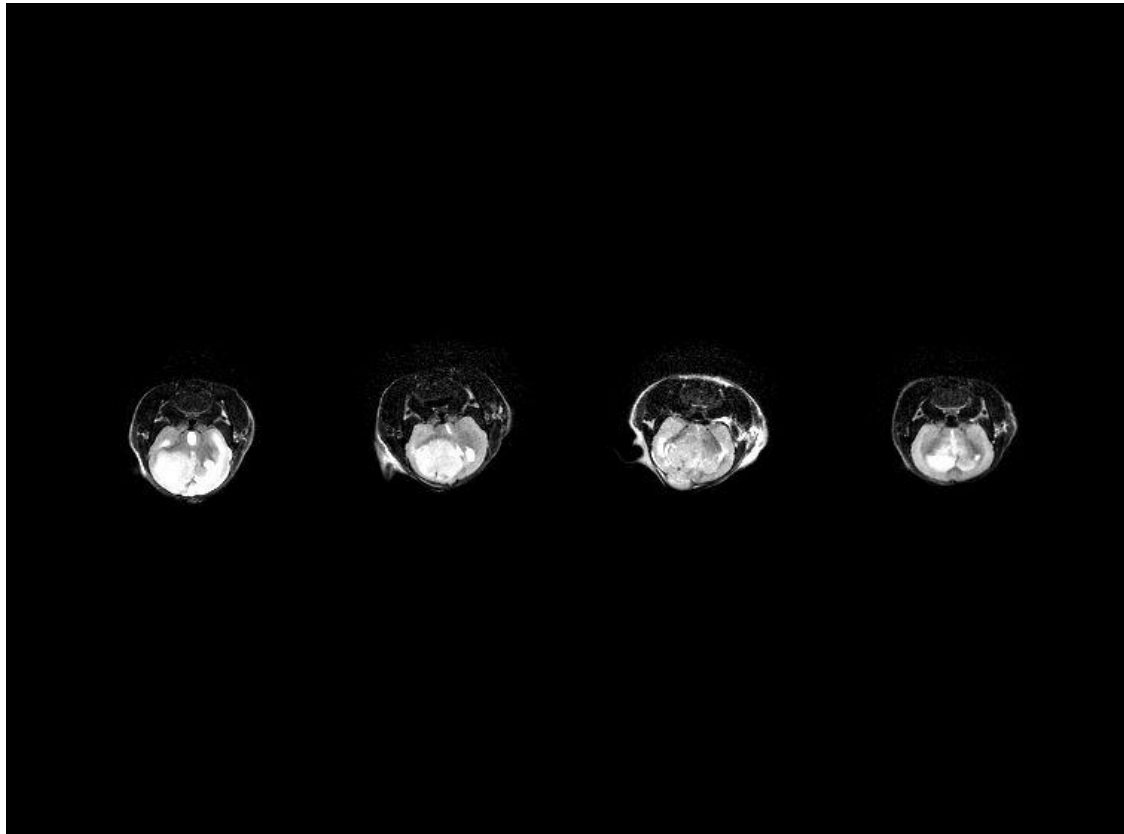
Post imaging euthanize  
and histology

# Mouse GBM Pilot Collection

## MRI Pulse Sequences



- **T2 weighted pre contrast**

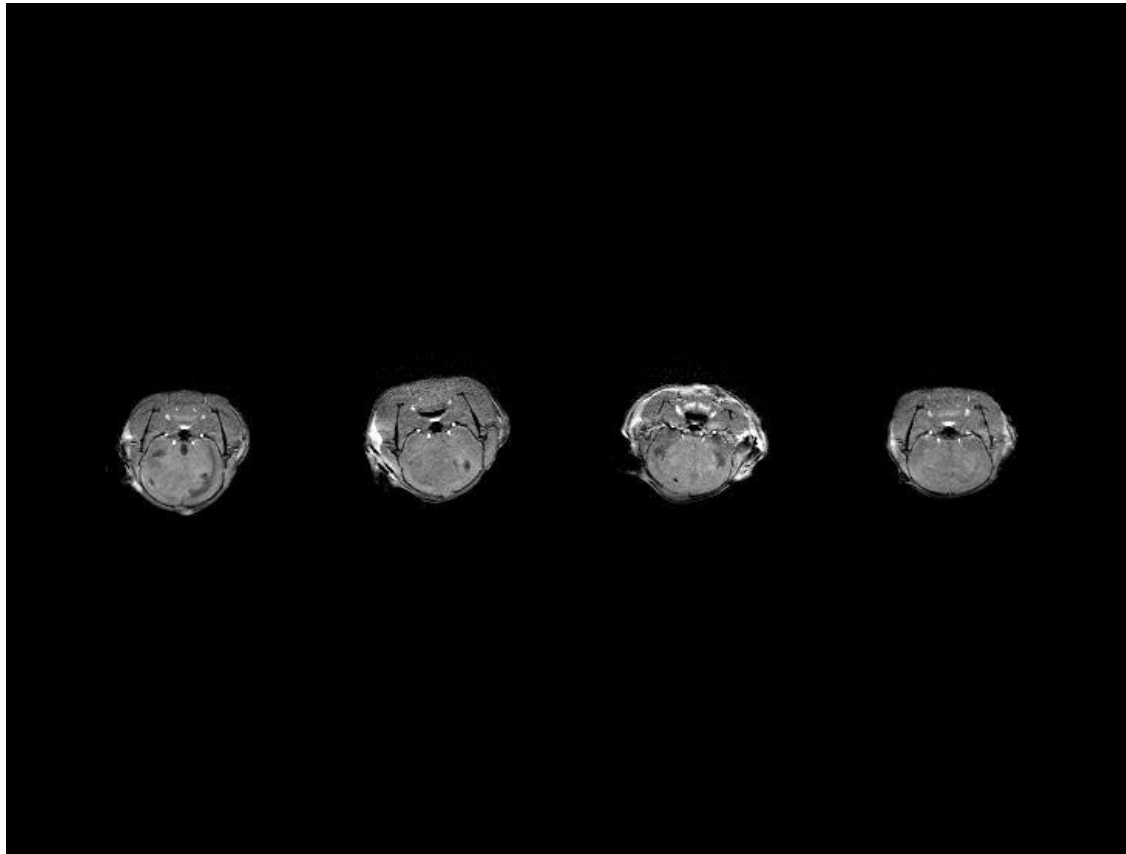


# Mouse GBM Pilot Collection

## MRI Pulse Sequences



- **T1 weighted pre contrast**



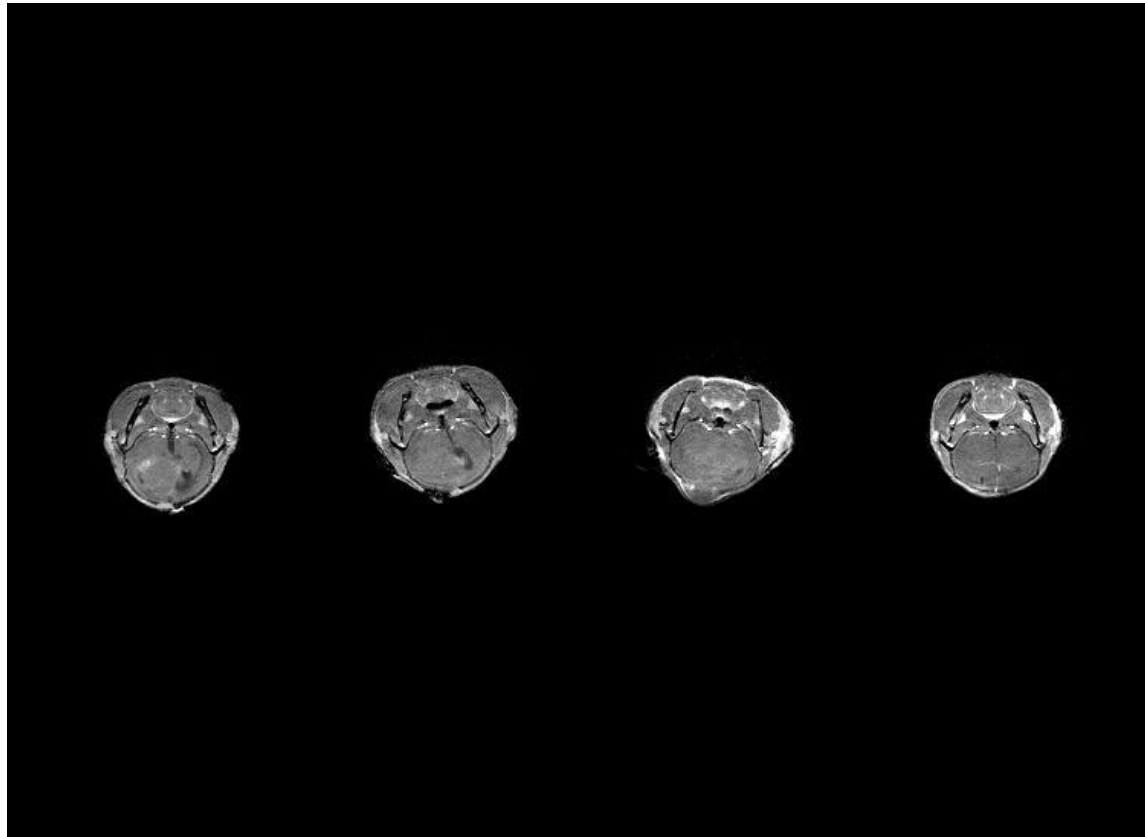


# Mouse GBM Pilot Collection

## MRI Pulse Sequences



- **T1 weighted post contrast**

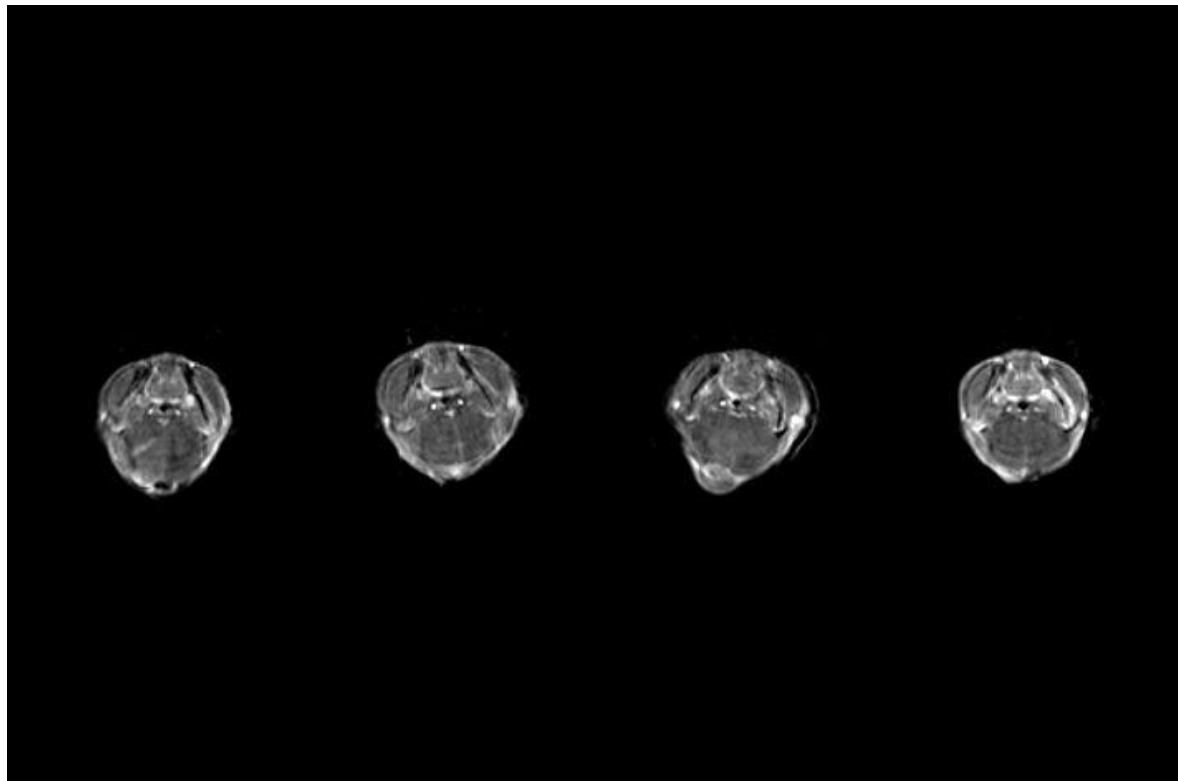


# Mouse GBM Pilot Collection

## MRI Pulse Sequences



- **Dynamic contrast enhanced series**

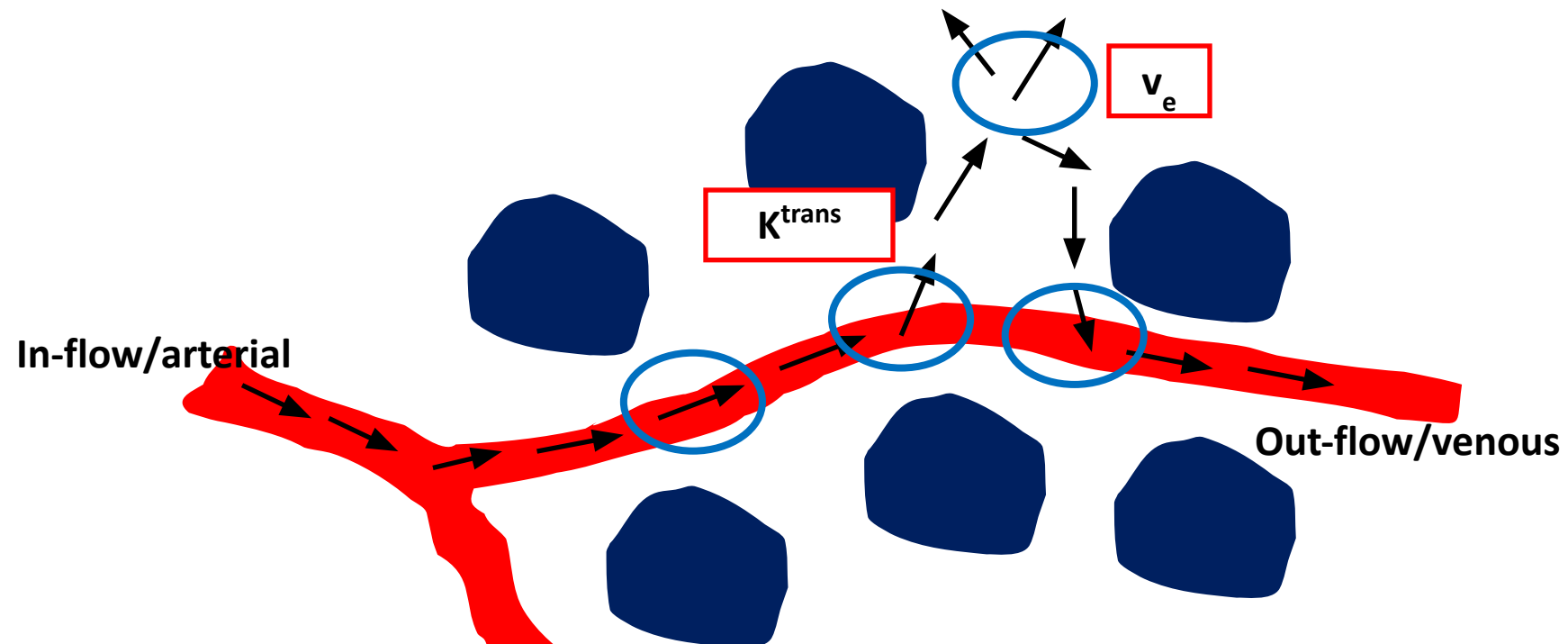


# Mouse GBM Pilot Collection

## DCEMRI and two compartment model parameters

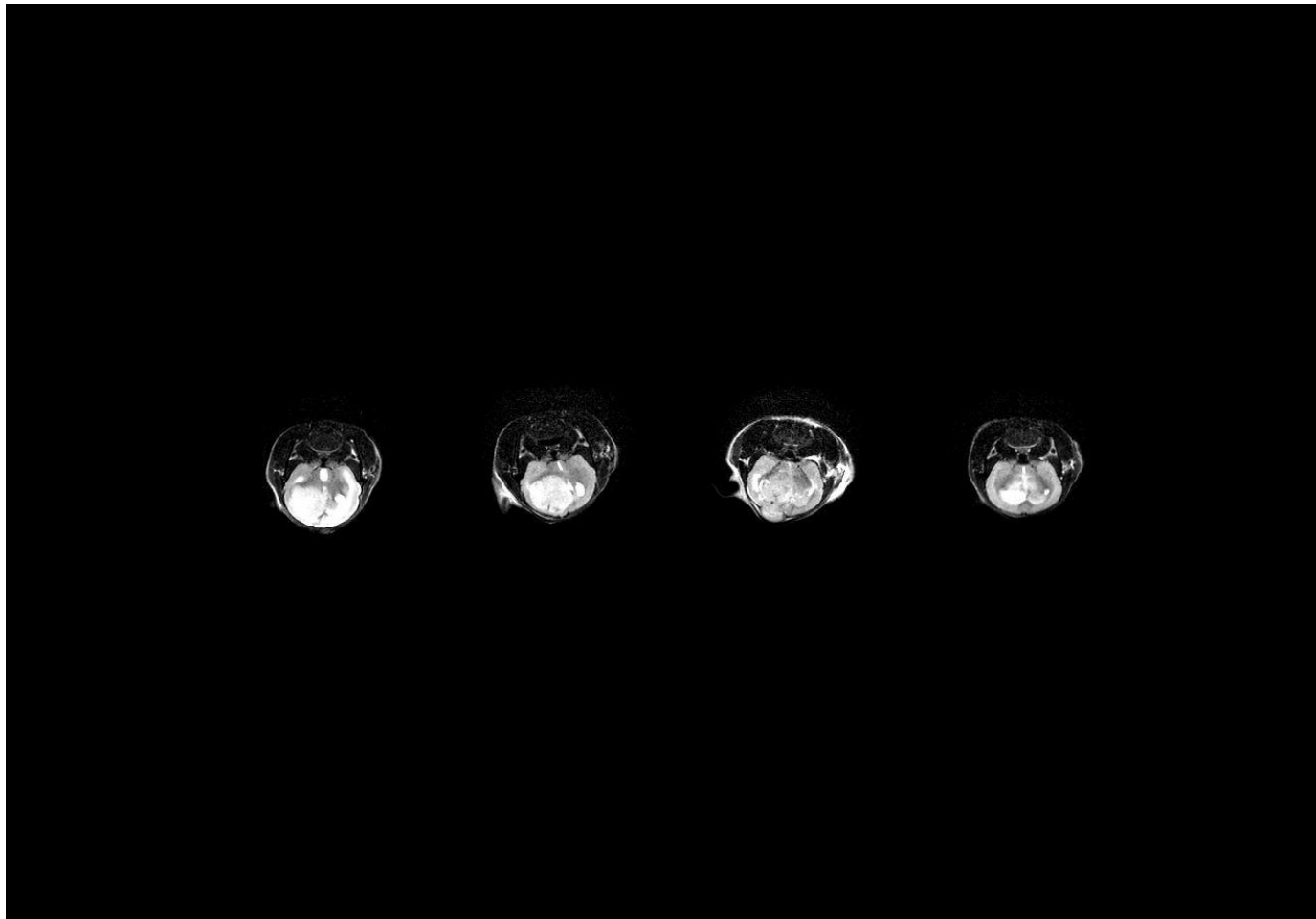


- Quantifiable information on the blood brain barrier permeability is extracted from the pattern of contrast agent uptake



# Mouse GBM Pilot Collection

Challenge: Cropping and splitting the image data



Mouse 10

Mouse 11

Mouse 66

Mouse 82

# Mouse GBM Pilot Collection

Challenge: Cropping and splitting the metadata



- **DICOM header**

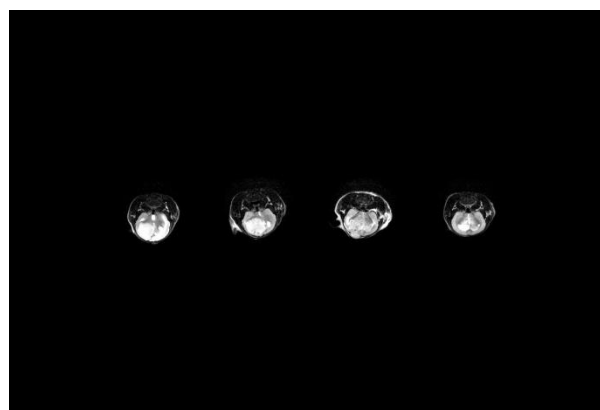
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(0018,0000) NA (SequenceDelimiterItemForRe-encod.) # 0, 0 SequenceDelimiterItem
(0010,0010) PN [SJ_DCE_10_11_66_82] # 18, 1 PatientsName
(0010,0020) LO [SJ_DCE_10_11_66_82] # 18, 1 PatientID
(0010,0030) DA [20100928] # 8, 1 PatientsBirthDate
(0010,0040) CS [M] # 2, 1 PatientsSex
```

```
(0018,9089) FD 0\0\0 # 24, 3 DiffusionGradientOrientation
(0020,000d) UI [1.3.46.670589.11.17169.5.0.4584.2011021511013196216] # 52, 1 StudyInstanceUID
(0020,000e) UI [1.3.46.670589.11.17169.5.0.4564.2011021511582801965] # 52, 1 SeriesInstanceUID
(0020,0010) SH [350910091] # 10, 1 StudyID
```

```
(0028,0010) US 1024 # 2, 1 Rows
(0028,0011) US 1024 # 2, 1 Columns
```

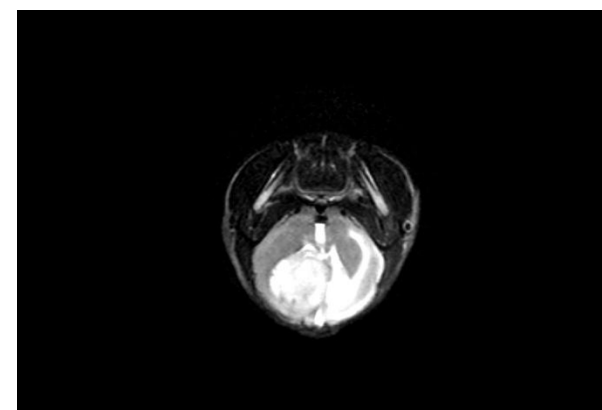
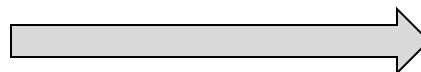
# Mouse GBM Pilot Collection

Cropping and splitting the image data



10 11 66 82

Program written in  
IDL

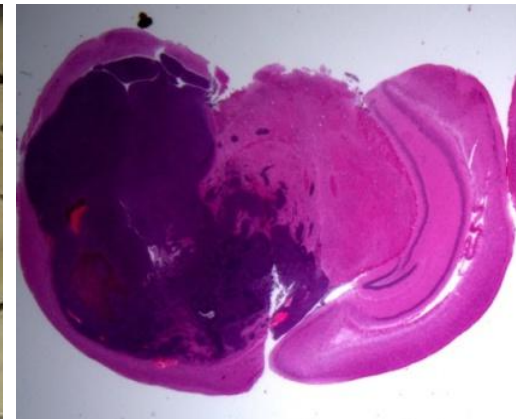
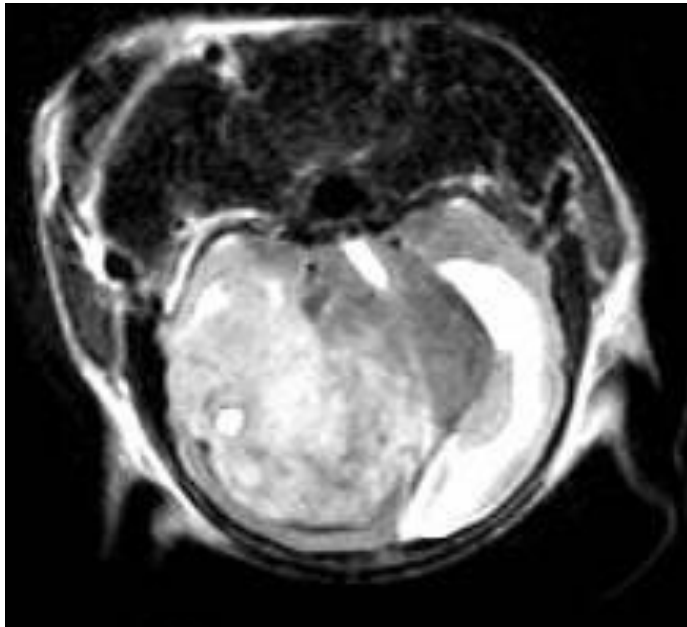


Mouse 10

- **Advantage: Image arrays 16 times smaller**

# Mouse GBM Pilot Collection

Cropping and splitting the image data



# Mouse GBM Pilot Collection

## Cropping and splitting the metadata

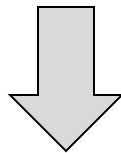


- DICOM header**

```
(0010,0010) PN [SJ_DCE_10_11_66_82] # 18, 1 PatientsName
(0010,0020) LO [SJ_DCE_10_11_66_82] # 18, 1 PatientID
(0010,0030) DA [20100928] # 8, 1 PatientsBirthDate
(0010,0040) CS [M] # 2, 1 PatientsSex

(0020,000d) UI [1.3.46.670589.11.17169.5.0.4584.2011021511013196216] # 52, 1 StudyInstanceUID
(0020,000e) UI [1.3.46.670589.11.17169.5.0.4564.2011021511582801965] # 52, 1 SeriesInstanceUID
(0020,0010) SH [350910091] # 10, 1 StudyID

(0028,0010) US 1024 # 2, 1 Rows
(0028,0011) US 1024 # 2, 1 Columns
```



Program written in  
IDL

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(0010,0020) LO [TVD_GBM_IC2_11311010] # 20, 1 PatientID
(0010,0030) DA [20100928] # 8, 1 PatientsBirthDate
(0010,0040) CS [F] # 2, 1 PatientsSex

(0020,000d) UI [1.3.46.670589.11.17169.5.0.4584.2011021511013196216.1] # 54, 1 StudyInstanceUID
(0020,000e) UI [1.3.46.670589.11.17169.5.0.4564.2011021511582801965.1] # 54, 1 SeriesInstanceUID

(0028,0010) US 256 # 2, 1 Rows
(0028,0011) US 256 # 2, 1 Columns
```



# Mouse GBM Pilot Collection

Deployment to CBIIT instance of NBIA






- **Demo: Mouse GBM on NBIA**



# Mouse GBM Pilot Collection

## Deployment to CBIIT instance of NBIA



Collection(s) <a href="#">Collection Descriptions</a>	<table border="1"><thead><tr><th>Available</th><th>Selected</th></tr></thead><tbody><tr><td><input type="checkbox"/> ? 3D Face</td><td rowspan="6">Mouse GBM</td></tr><tr><td><input type="checkbox"/> ? CT Colonography</td></tr><tr><td><input type="checkbox"/> ? LIDC</td></tr><tr><td><input checked="" type="checkbox"/> ? Mouse GBM</td></tr><tr><td><input type="checkbox"/> ? Mouse Mammary</td></tr><tr><td><input type="checkbox"/> ? NCRI</td></tr></tbody></table>	Available	Selected	<input type="checkbox"/> ? 3D Face	Mouse GBM	<input type="checkbox"/> ? CT Colonography	<input type="checkbox"/> ? LIDC	<input checked="" type="checkbox"/> ? Mouse GBM	<input type="checkbox"/> ? Mouse Mammary	<input type="checkbox"/> ? NCRI
	Available	Selected								
	<input type="checkbox"/> ? 3D Face	Mouse GBM								
	<input type="checkbox"/> ? CT Colonography									
<input type="checkbox"/> ? LIDC										
<input checked="" type="checkbox"/> ? Mouse GBM										
<input type="checkbox"/> ? Mouse Mammary										
<input type="checkbox"/> ? NCRI										
Available on NBIA (mm/dd/yyyy)	From: <input type="text"/>  To: <input type="text"/> 									
Series Includes Annotations	<input checked="" type="checkbox"/> Annotated <input checked="" type="checkbox"/> Non-Annotated									
Subject ID(s)	<input type="text"/>									

Results Per Page: 10 

 **SUBMIT**  **RESET**

# Mouse GBM Pilot Collection

## Deployment to CBIIT instance of NBIA



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National Biomedical Imaging Archive

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SEARCH >> **SUBJECT**

Search Criteria ?

\*All searches are conducted at the series level

CRITERIA SELECTED	
Collection(s)	Mouse GBM
Return cases that include	any of these modalities

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Search Results (by Subject) ?

Subjects checked  can be added to your basket.

? **HCICBIT**

**CHECK ALL**  
  **UNCHECK ALL**  
 ADD TO BASKET

	Collection ID	Subject ID	Studies	Series	<input type="checkbox"/>
<a href="#">Show Studies</a>	Mouse GBM	TVD_GBM_IC2_11311010	1 / 1	5 / 5	<input type="checkbox"/>
<a href="#">Show Studies</a>	Mouse GBM	TVD_GBM_IC2_11311011	1 / 1	5 / 5	<input type="checkbox"/>
<a href="#">Show Studies</a>	Mouse GBM	TVD_GBM_IC2_11311066	1 / 1	5 / 5	<input type="checkbox"/>
<a href="#">Show Studies</a>	Mouse GBM	TVD_GBM_IC2_11311082	1 / 1	5 / 5	<input type="checkbox"/>

4 patients found, displaying Page 1 / 1.

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# Mouse GBM Pilot Collection

## Deployment to CBIIT instance of NBIA



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Search Results (Studies for Subject TVD\_GBM\_IC2\_11311010) ?

CHECK ALL    UNCHECK ALL

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	Study Instance UID	Date				
	1.3.46.670589.11.17189.5.0.4564.2011021511013196216.1	Baseline				
	Description	Data Location				
	GBM_intracranial	NCICBIT				
	Series	Images	Description	Modality	Manufacturer	
<a href="#">Show Images</a>	1.3.46.670589.11.17189.5.0.4564.2011021511582801965.1	30	TSE_100_Cor_P4 SENSE	MR	Philips Medical Systems	<input type="checkbox"/>
<a href="#">Show Images</a>	1.3.46.670589.11.17189.5.0.4564.2011021512305717015.1	48	T1_FFE_Cor_PreC SENSE	MR	Philips Medical Systems	<input type="checkbox"/>
<a href="#">Show Images</a>	1.3.46.670589.11.17189.5.0.4564.2011021512383914016.1	12	T1_FFE_PreFA5 SENSE	MR	Philips Medical Systems	<input type="checkbox"/>
<a href="#">Show Images</a>	1.3.46.670589.11.17189.5.0.4564.2011021512390881054.1	600	Dyn22s_AP_TR9/TE3 SENSE	MR	Philips Medical Systems	<input type="checkbox"/>
<a href="#">Show Images</a>	1.3.46.670589.11.17189.5.0.4564.2011021512574228302.1	48	T1_FFE_Cor_PostC SENSE	MR	Philips Medical Systems	<input type="checkbox"/>

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# Mouse GBM Pilot Collection

## Deployment to CBIIT instance of NBIA



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Images on this page are meant to aid selection only. The downloaded DICOM files will be provided at their original resolution.

Subject ID	Study Instance UID	Date	Modality	Manufacturer	DICOM
TVD_GBM_IC2_11311010	1.3.46.670589.11.17169.5.0.4584.2011021511013196216.1	2011-02-15 00:00:00.0	MR	Philips Medical Systems	

[View series in Cine mode.](#)

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**DICOM Series Number 401 TSE\_100\_Cor\_P4 SENSE**

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6	7	8	9	10
11	12	13	14	15
16	17	18	19	20

Navigation: **1** 2

30 images found, displaying Page 1 / 2.

# Summary



- **Progress to date:** Successfully deployed individual mouse GBM MRI datasets to NBIA
- **Next steps**
  - Set up own instance of NBIA
  - Qualitative and quantitative image analysis
    - AIM features
    - $K^{\text{trans}}$ ,  $v_e$
  - Correlation of image-based features with genotype, histology, pathology
    - caIntegrator

# Mouse GBM Pilot Collection

Deployment to CBIIT instance of calnt



- **Demo: Mouse GBM on calIntegrator**

# Summary



- **Future directions**
  - caArray
  - Center for Advanced Preclinical Research (CAPR)
  - Mouse Mammary pilot collection and image-based prognostic markers