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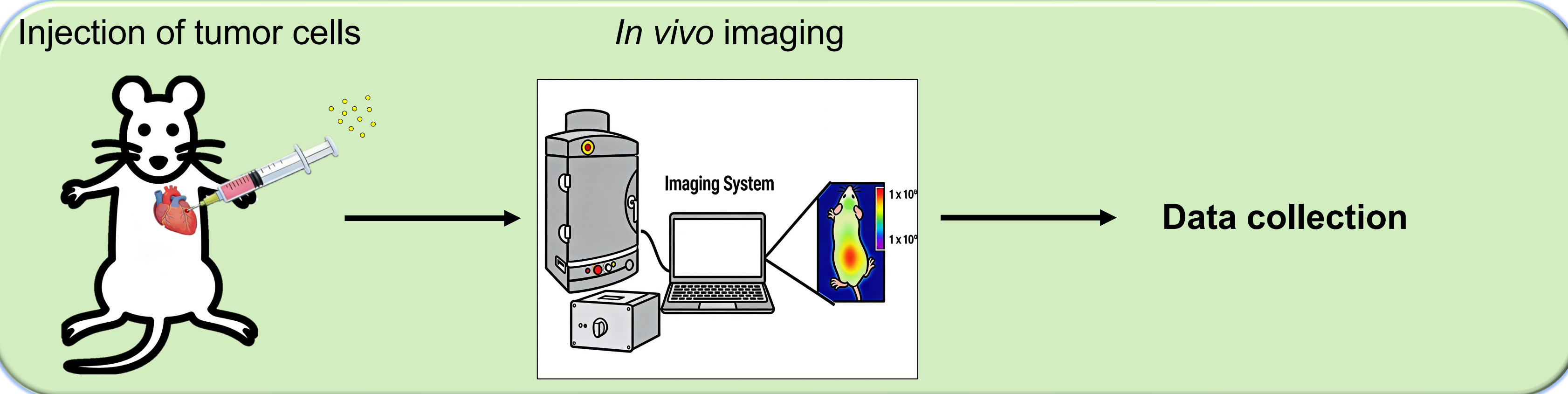
Abstract

Background: A comprehensive understanding of cancer progression requires experimental models capable of dynamically capturing both localized tumor growth and the multi-step process of systemic dissemination. Conventional models often recapitulate isolated aspects of this cascade, thereby limiting their translational relevance.

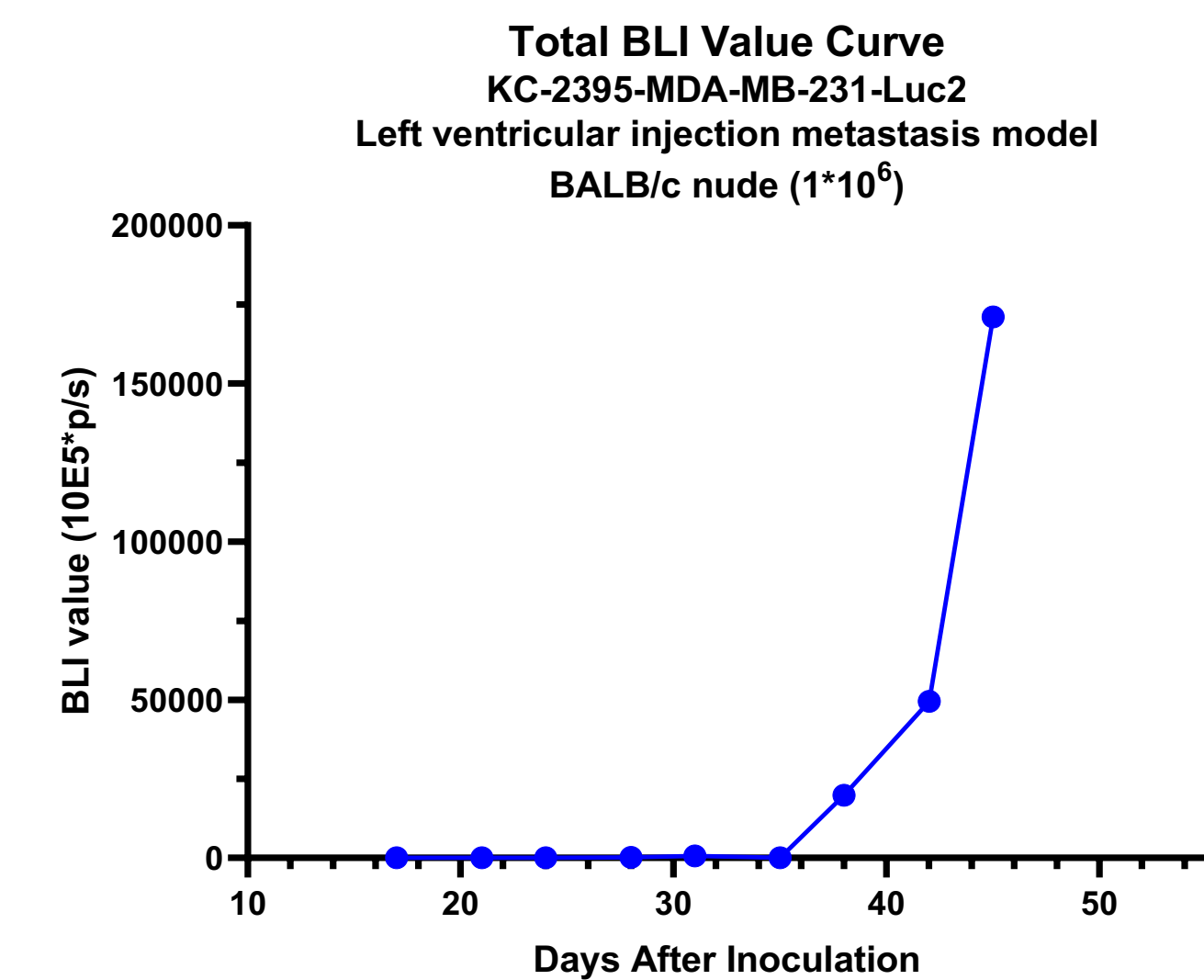
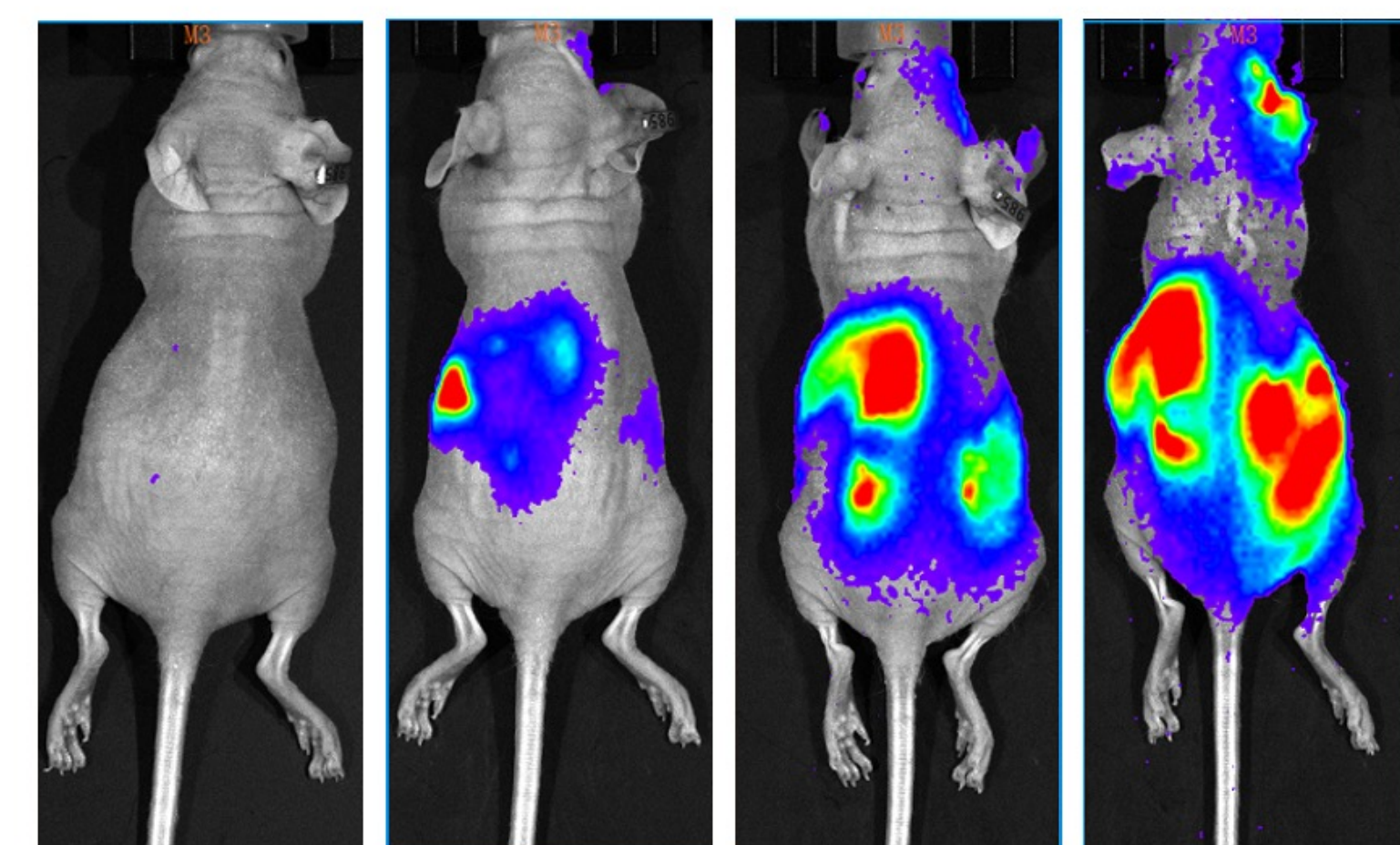
Methods: We engineered a series of site-specific cancer models in immunodeficient mice, with disease progression continuously monitored by bioluminescent imaging (BLI). These included: 1. Intracardiac injection of MDA-MB-231-Luc2 cells to model disseminated metastatic seeding. 2. Intratibial and intracranial inoculation to evaluate site-specific growth of breast cancer cells in bone and brain microenvironments. 3. Intravenous injection of Ba/F3 and lymphoma cells to simulate hematogenous dissemination. 4. A systematic analysis of intracranial engraftment topography, where A375-GFP-Luc cells were inoculated at stereotactic coordinates 0.5 mm anterior, 1.0 mm anterior, and 0.5 mm posterior to the bregma.

Results: The platform robustly recapitulated diverse disease phenotypes. Intracardiac injection resulted in widespread bioluminescent signals indicative of metastatic colonization. Orthotopic tibial and intracranial inoculations led to progressive, quantifiable local tumor growth. Intravenous injection of hematopoietic cells produced a systemic pattern of leukemic proliferation. Importantly, the intracranial implantation site emerged as a key determinant of disease progression: injections posterior to the bregma were associated with a significantly greater propensity for metastatic dissemination compared to anterior sites.

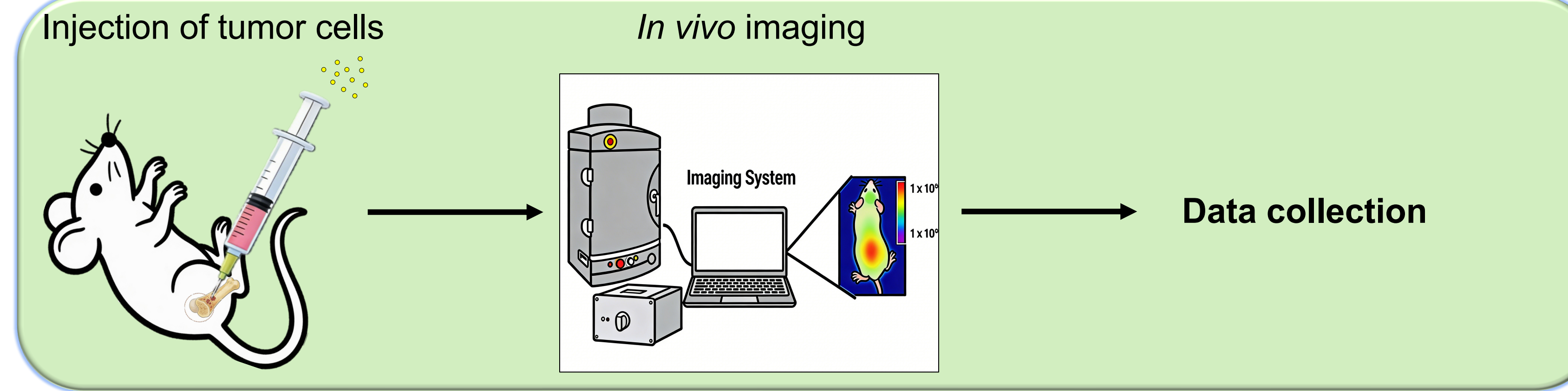
Left ventricular injection metastasis model



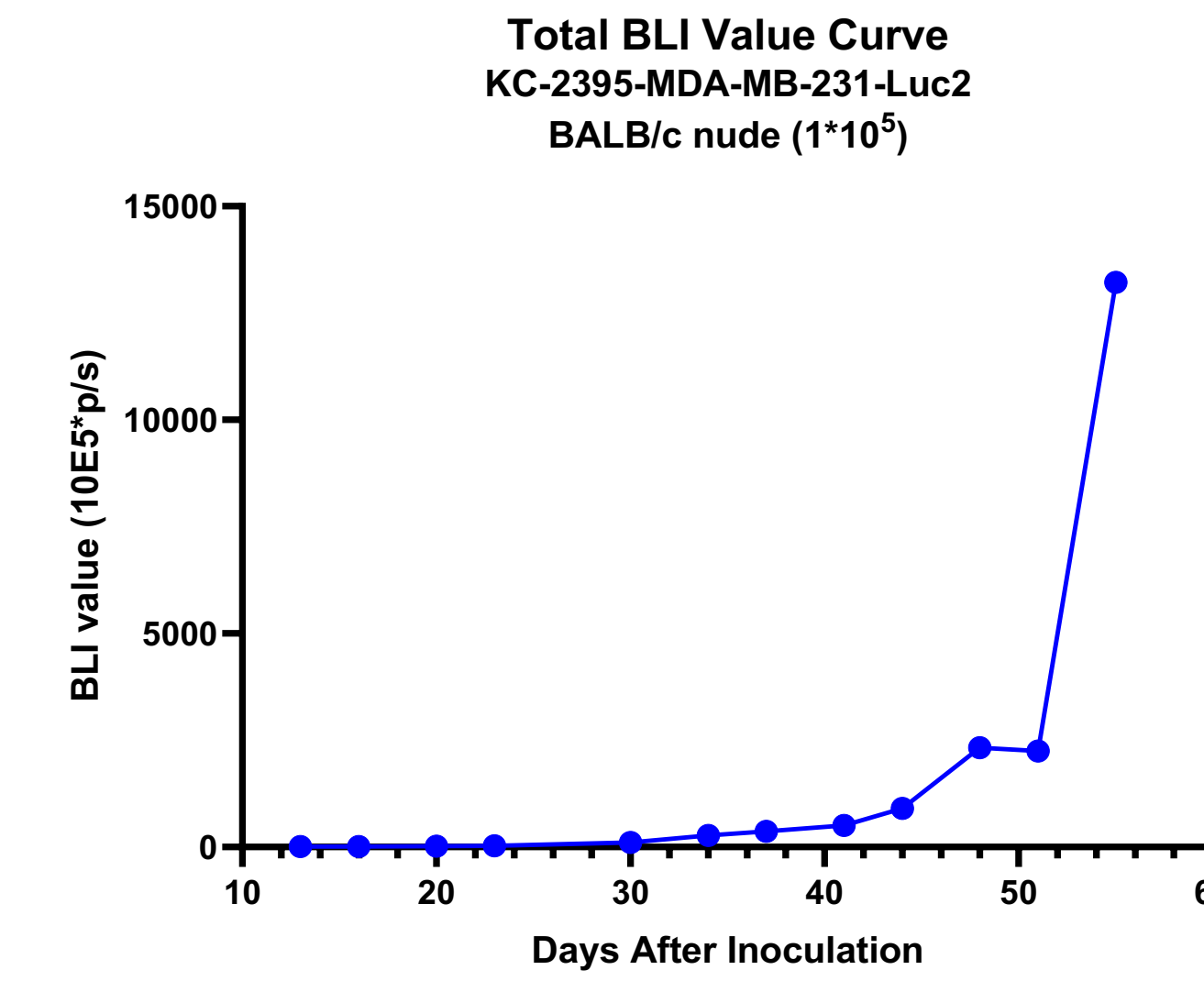
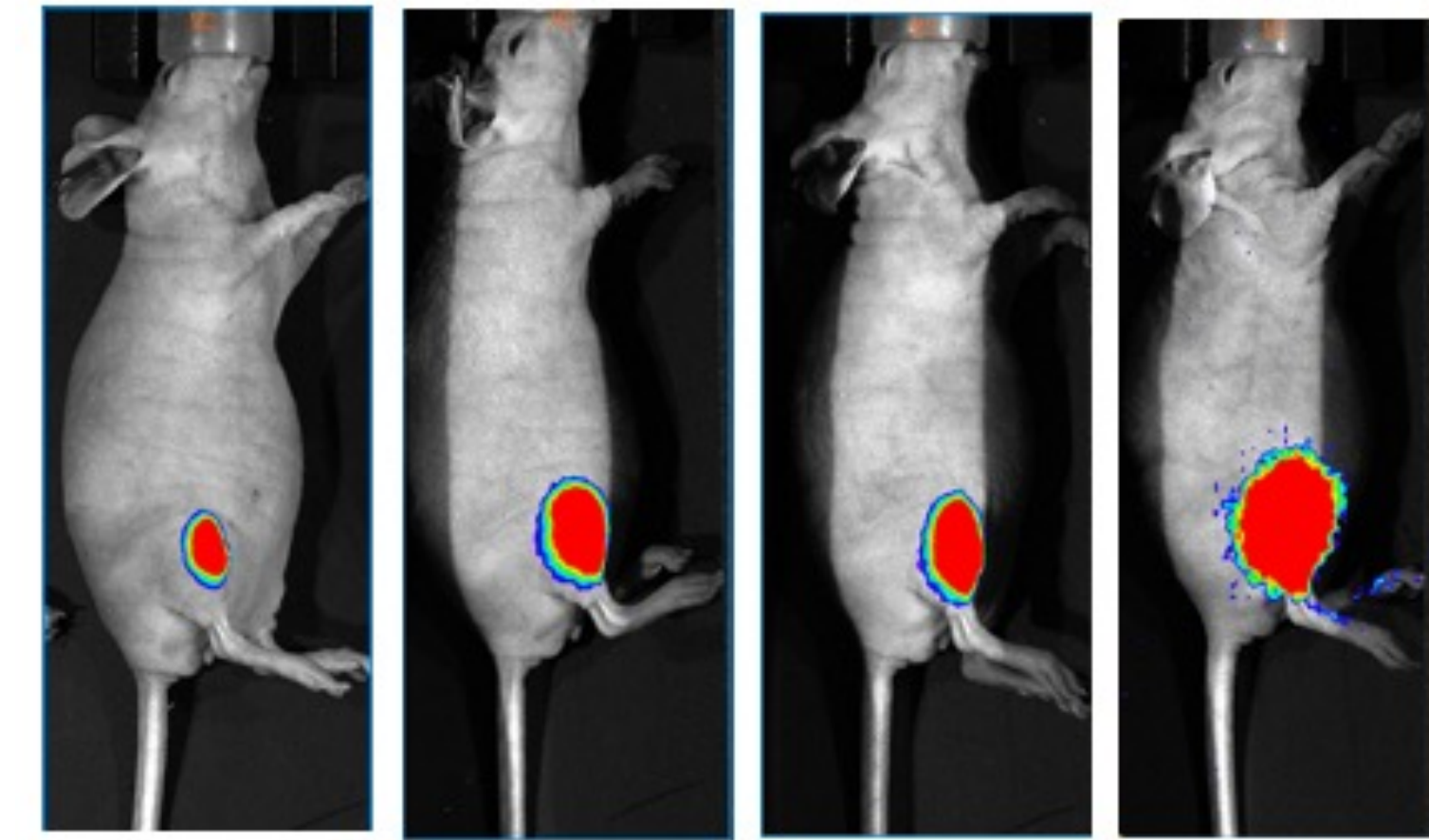
Day38 Day42 Day45 Day49



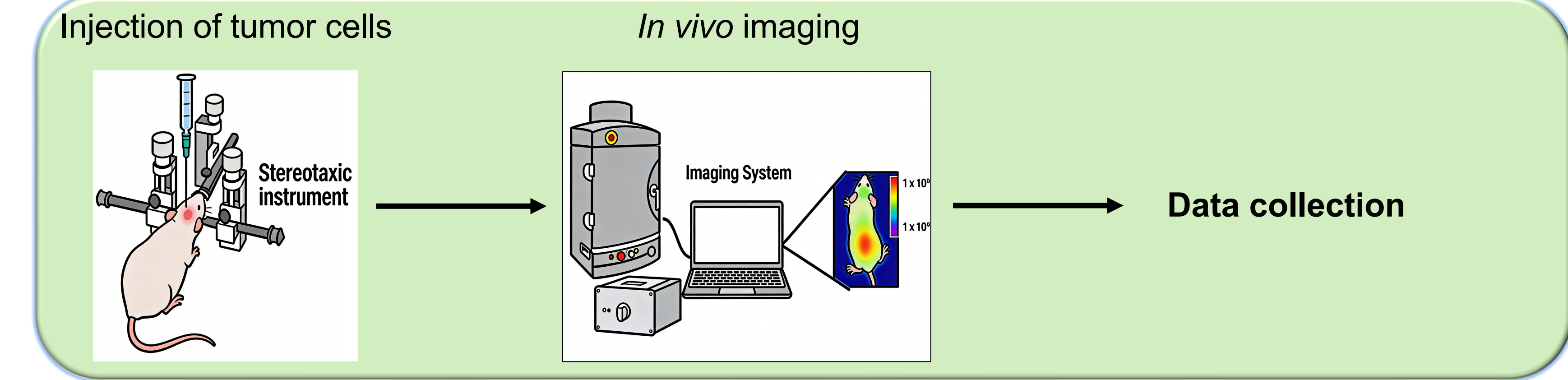
Orthotopic tibial model



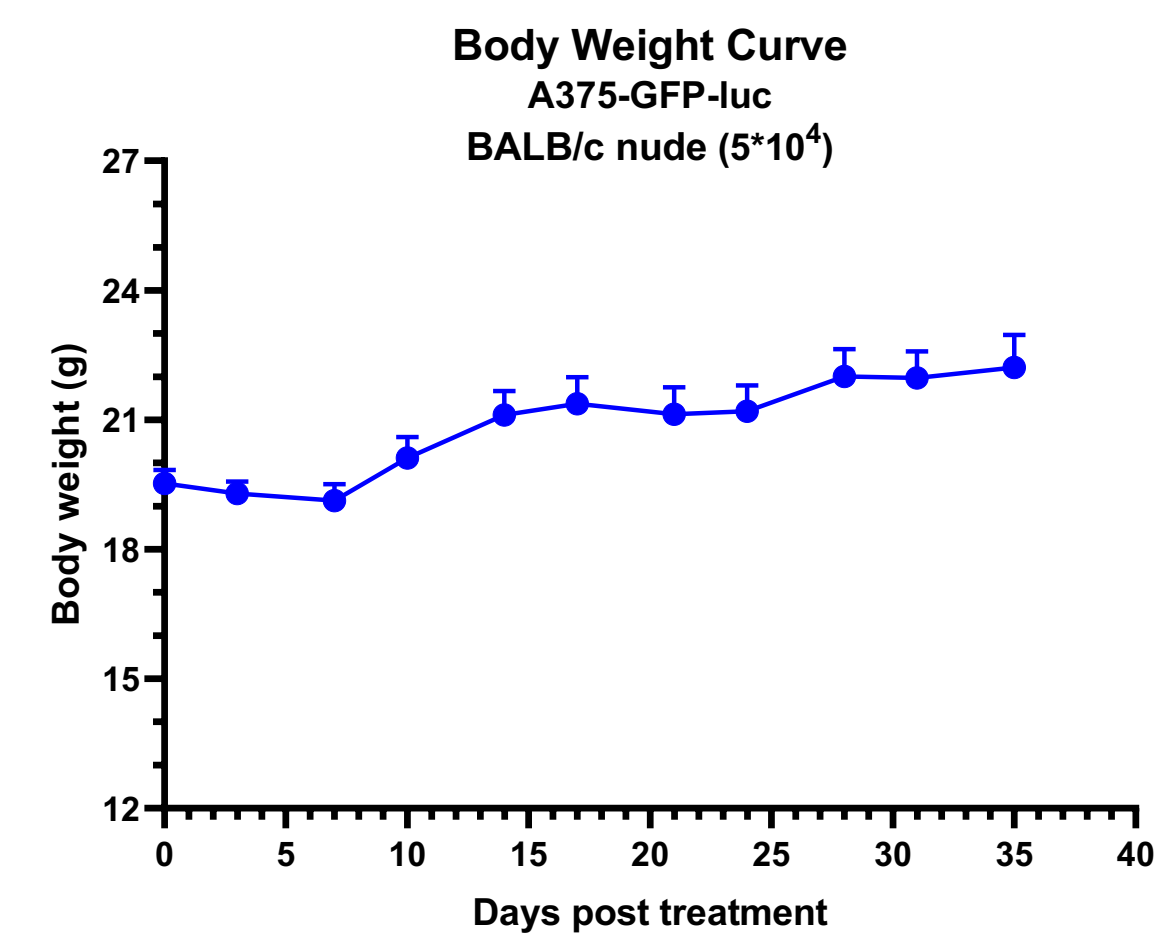
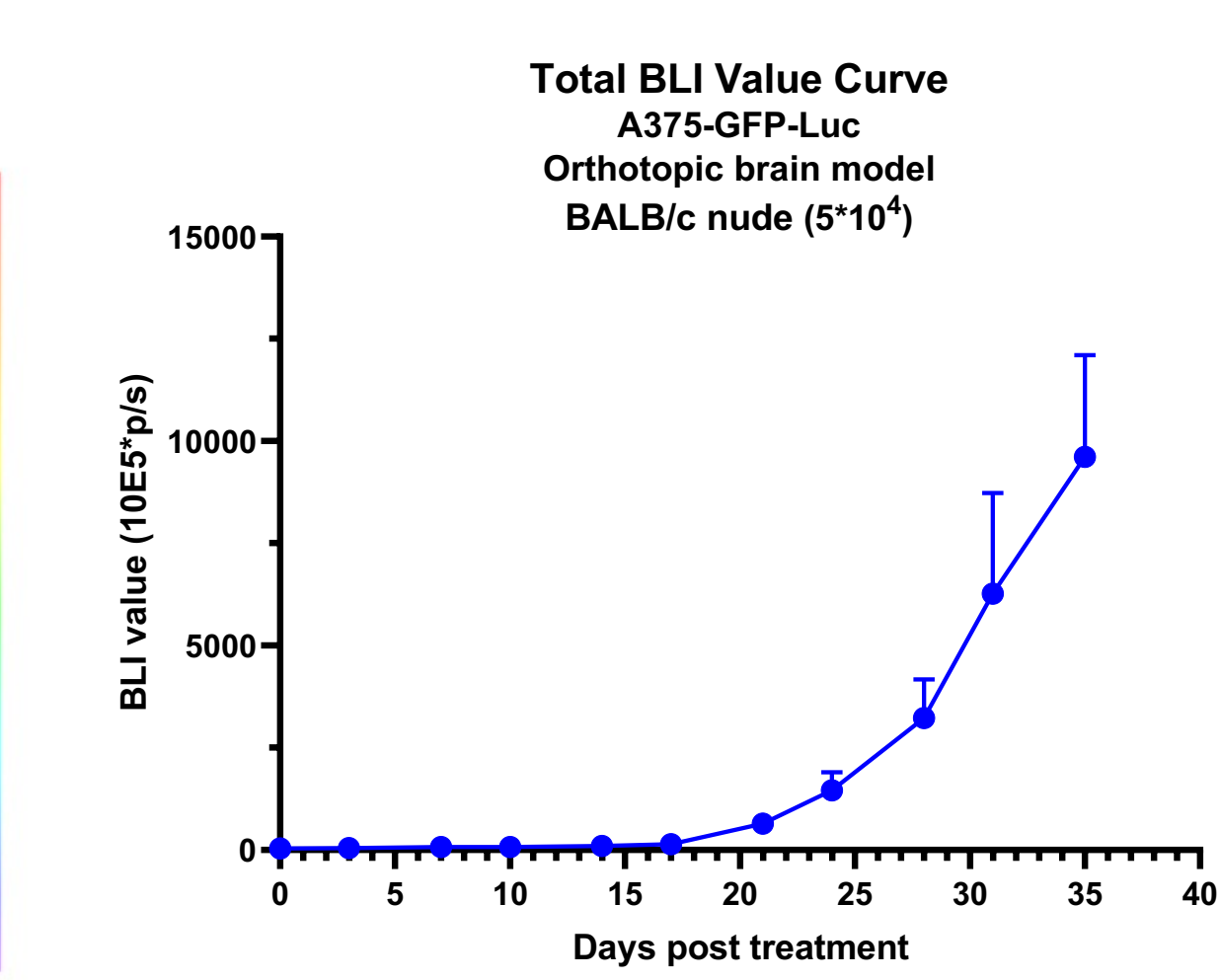
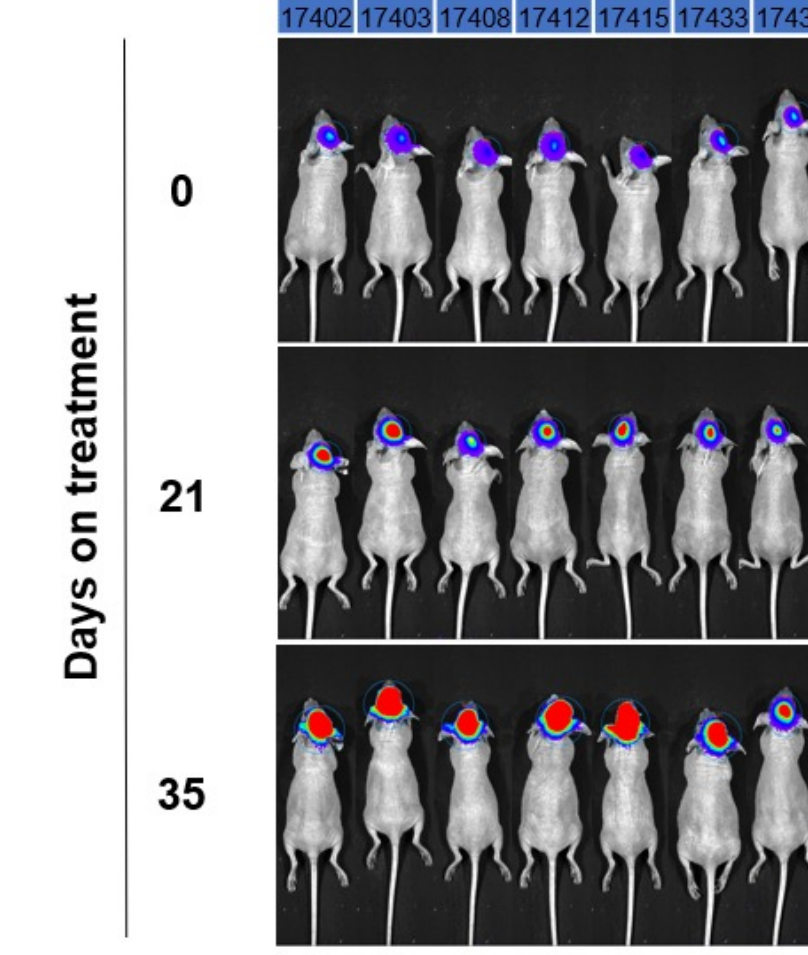
Day44 Day48 Day51 Day55



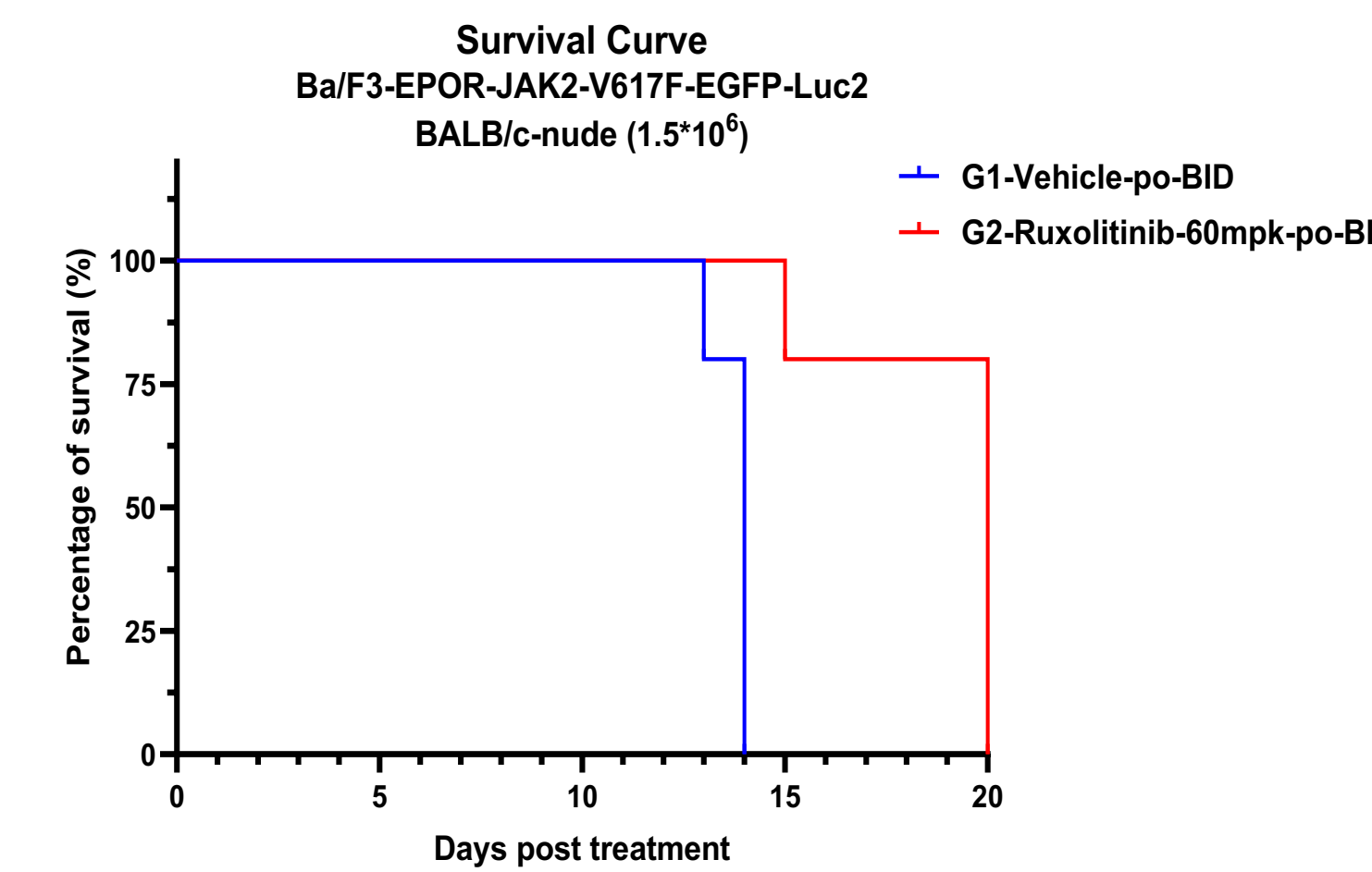
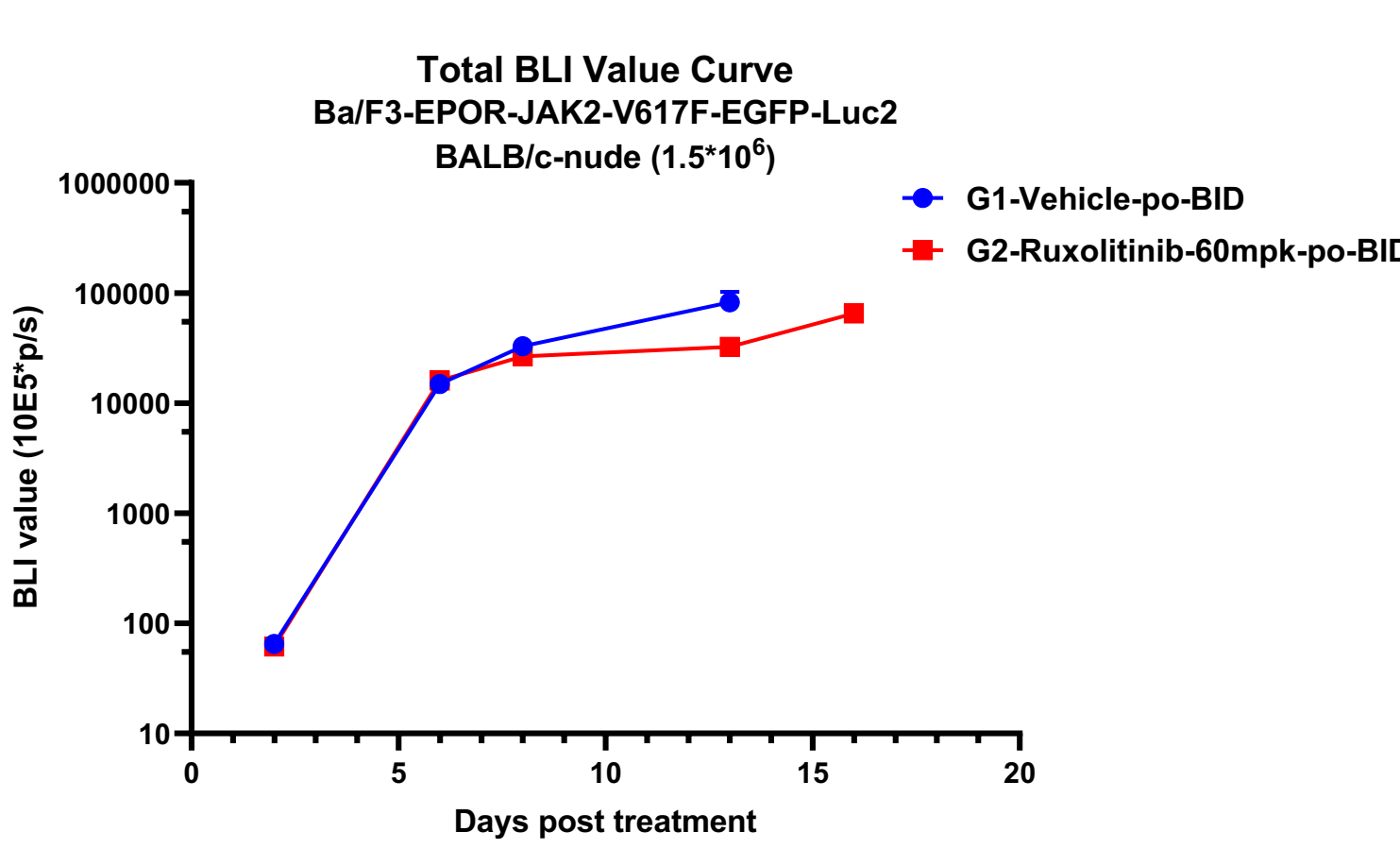
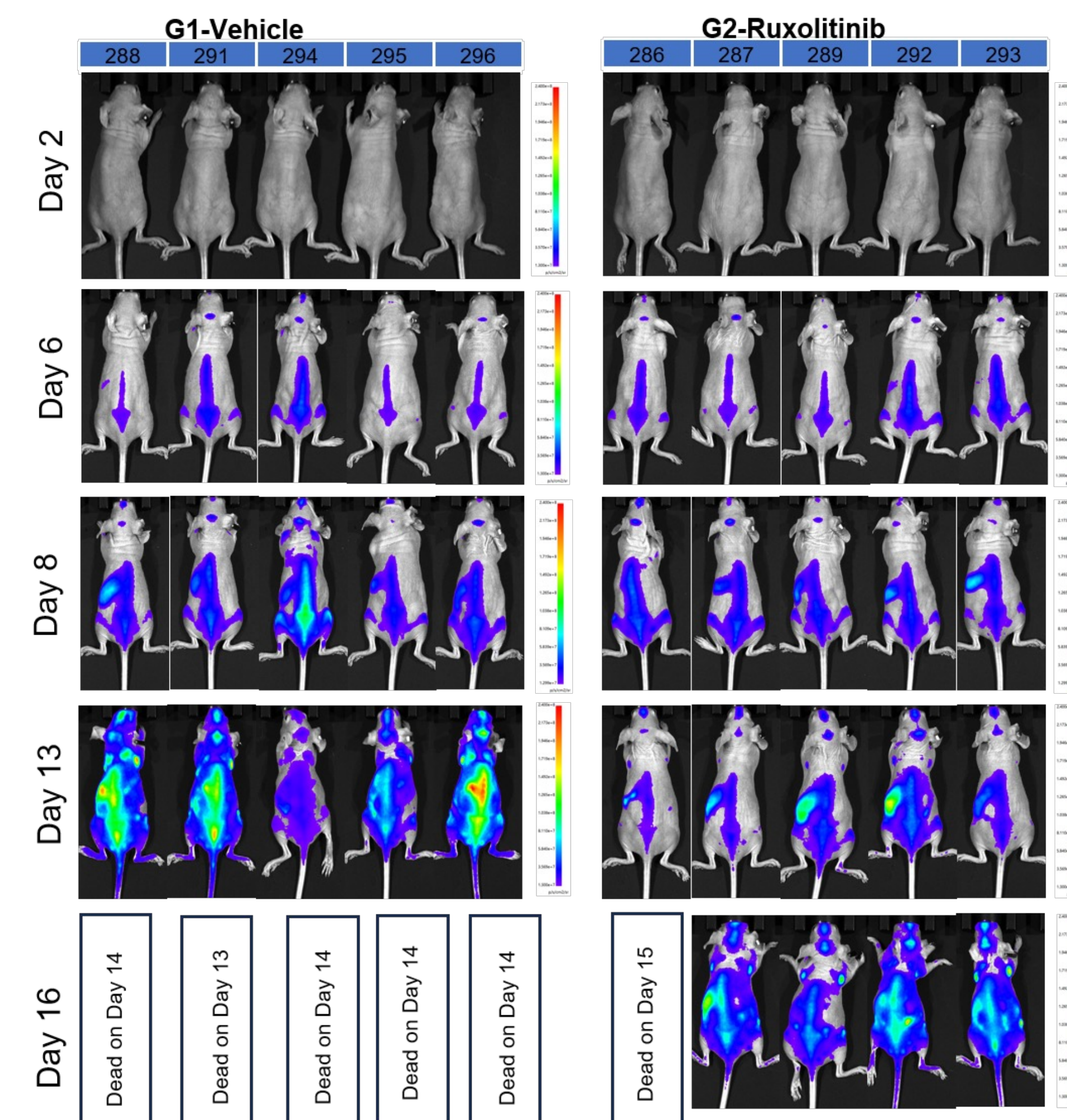
Orthotopic brain model



G1-Vehicle



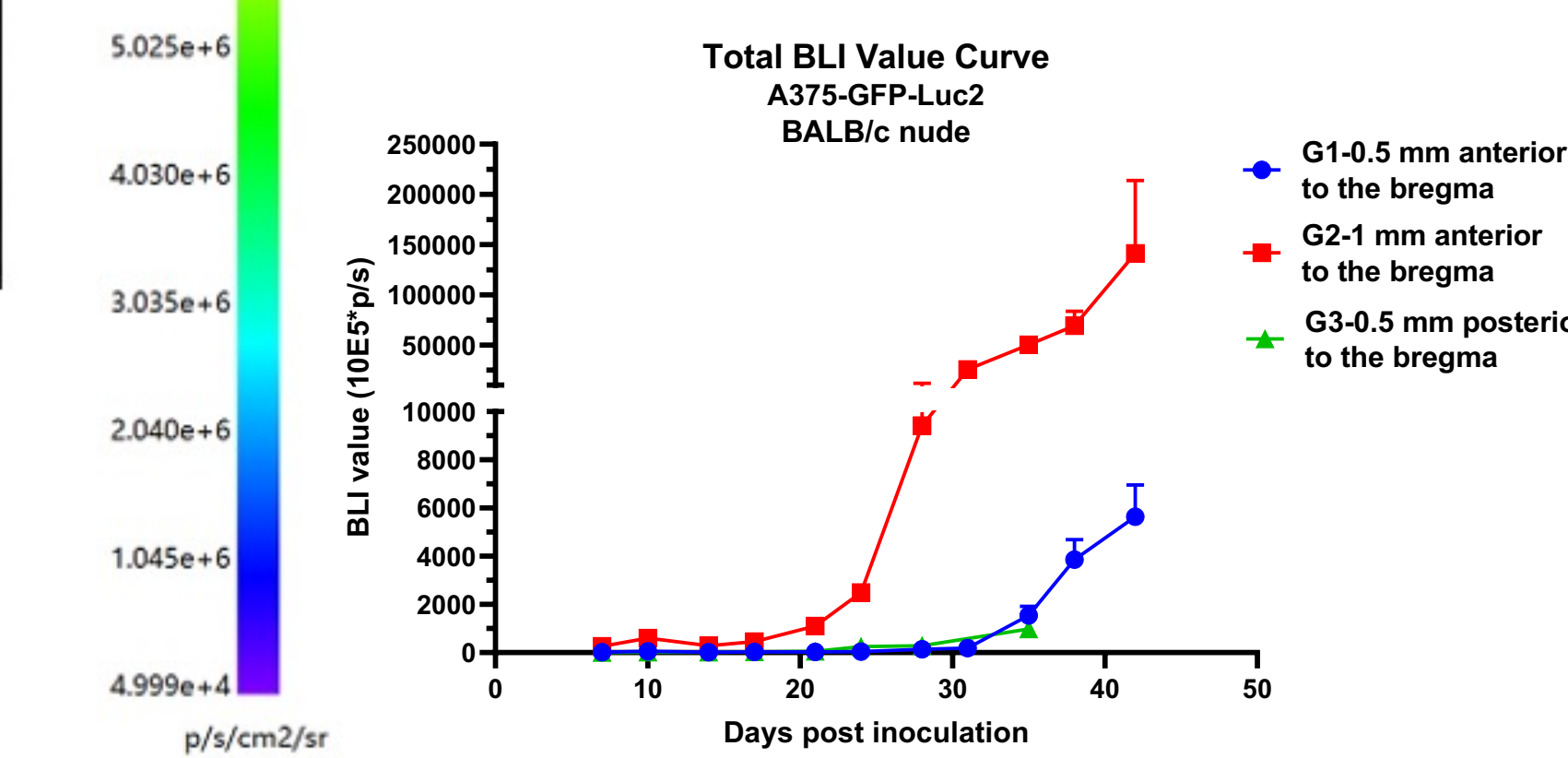
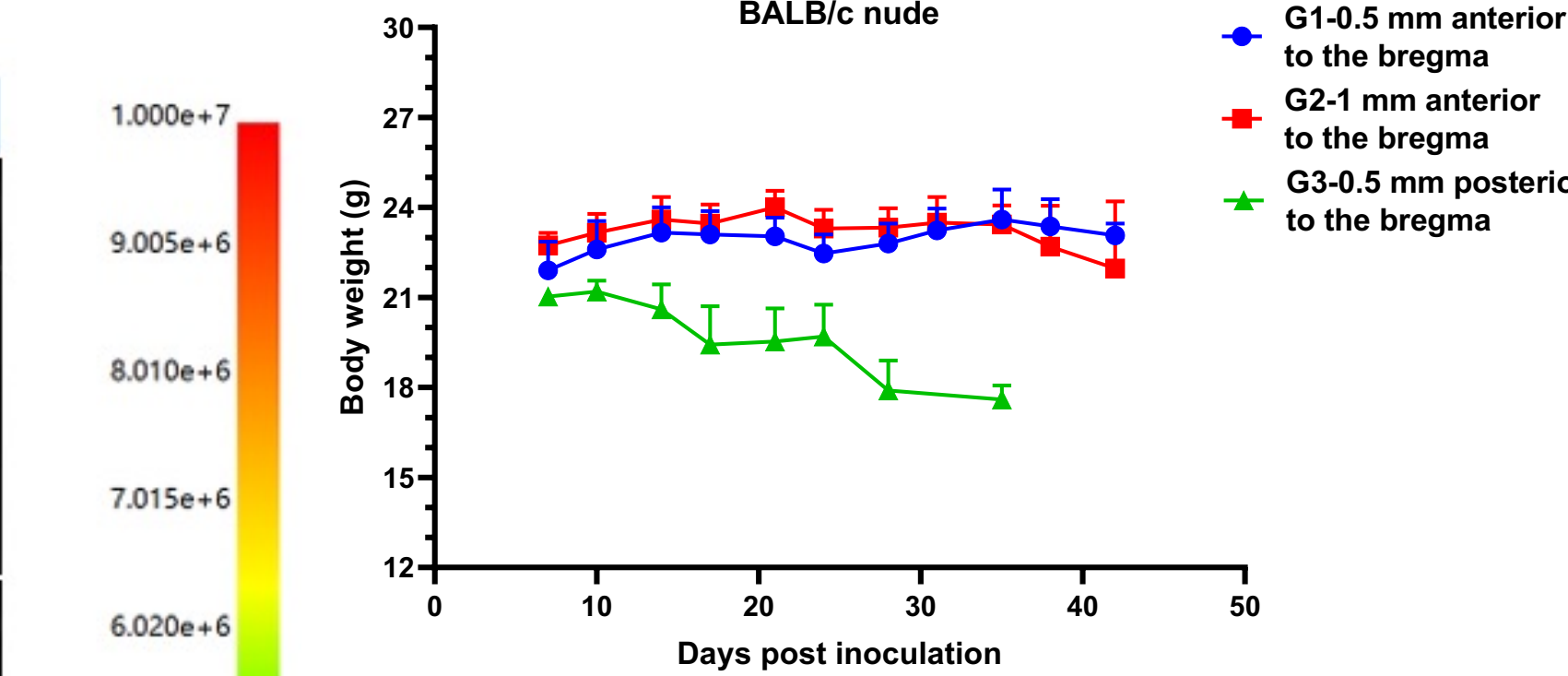
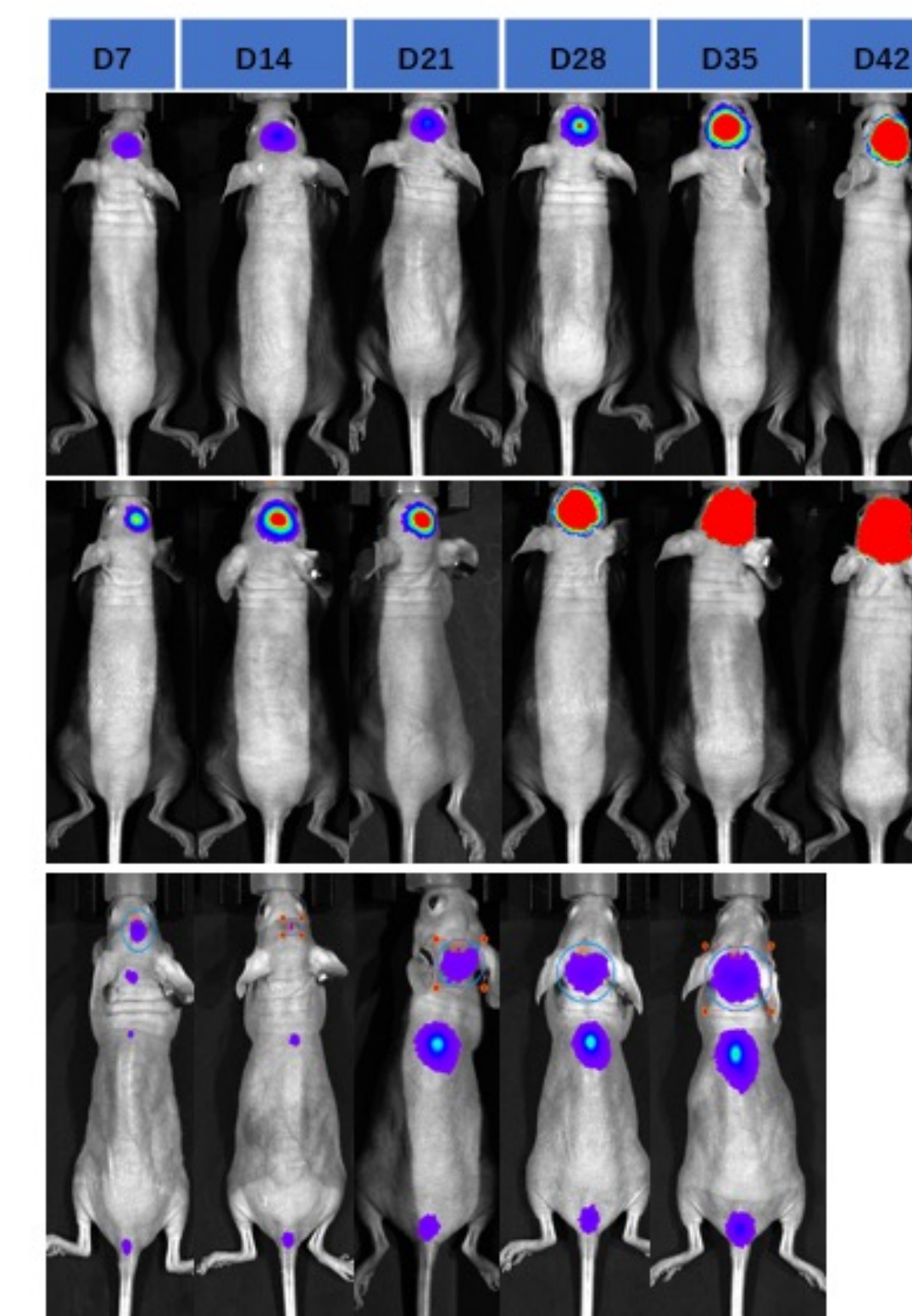
Tail vein injection metastasis model



G1-0.5 mm anterior to the bregma

G2-1 mm anterior to the bregma

G3-0.5 mm posterior to the bregma



Conclusion

We developed a validated multifunctional *in vivo* platform that quantifies spatiotemporal tumor dynamics in multiple disease models. It enables investigation into organ-specific tumor biology and evaluation of therapeutic efficacy against cancer.