Hypervelocity Impact Laboratory

Simulating Hypervelocity Sabot Separation

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Undergraduate Research Scholars
LAUNCH: UNDERGRADUATE RESEARCH

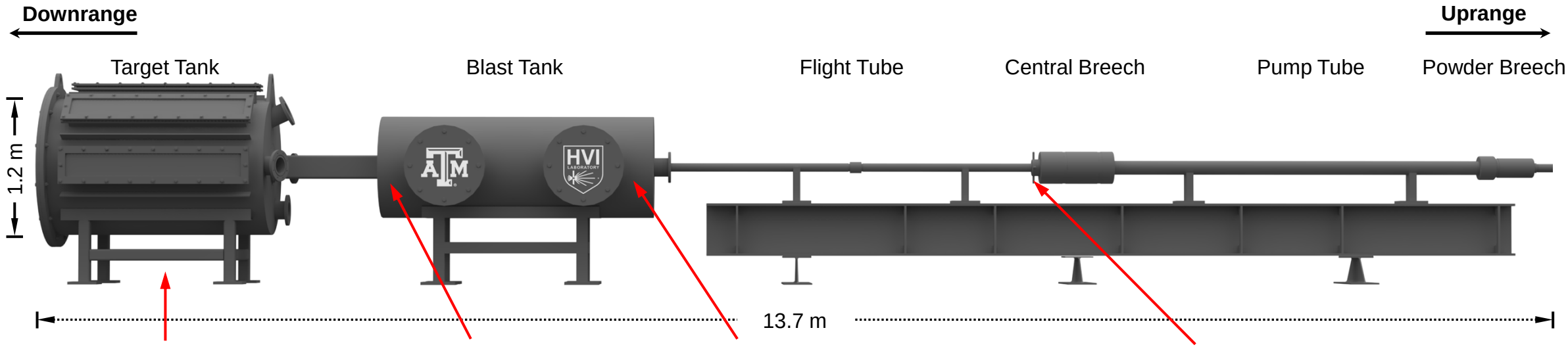
TAMU HVI Laboratory Overview

Information
Established early 2020
Location: Center for Infrastructure Renewal (CIR) at the TAMU RELLIS Campus

Projectile
Velocity: 2-8 km/s (4,400-18,000 mph)
Size: 2-10 mm (0.08-0.40 in)
Shape: cylindrical, spherical, ogive, buckshot

Target Specimen
Impact angle: 0-90°
Maximum size: 0.6 m x 0.6 m (2’ x 2’)
Maximum weight: ~90 kg (200 lb)

Experimental Setup – Projectile & Sabot Flight



Simulating hypervelocity sabot separation

Purpose

- Accurately predicting degree of separation increases testing effectiveness
- Simulation software allows for new sabot package designs for different projectile geometries

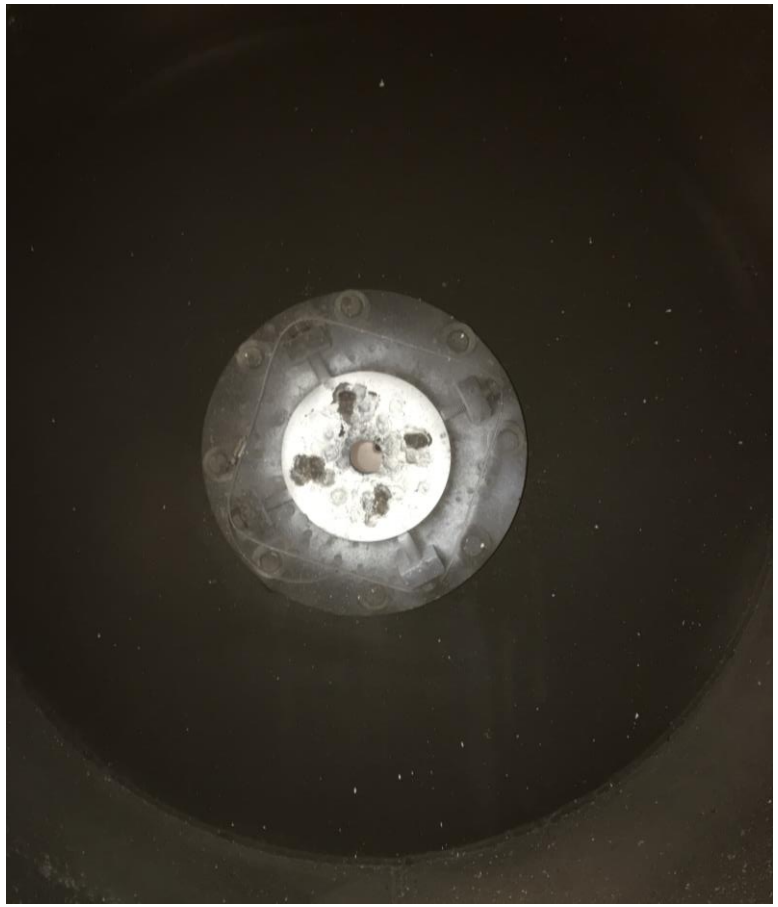
Phase I: Empirical modelling to test simulation results

- Data collected from HVI tests
- Relates degree of separation (separation radius) to flight parameters

Phase II: Development of sabot flight simulation software

- Uses newtonian impact theory for hypersonic flow
- Numerically integrates over projectile flight to find degree of separation

Phase I: Empirical modelling to test simulation results



Sabot petal impact photography normal to the stripper plate

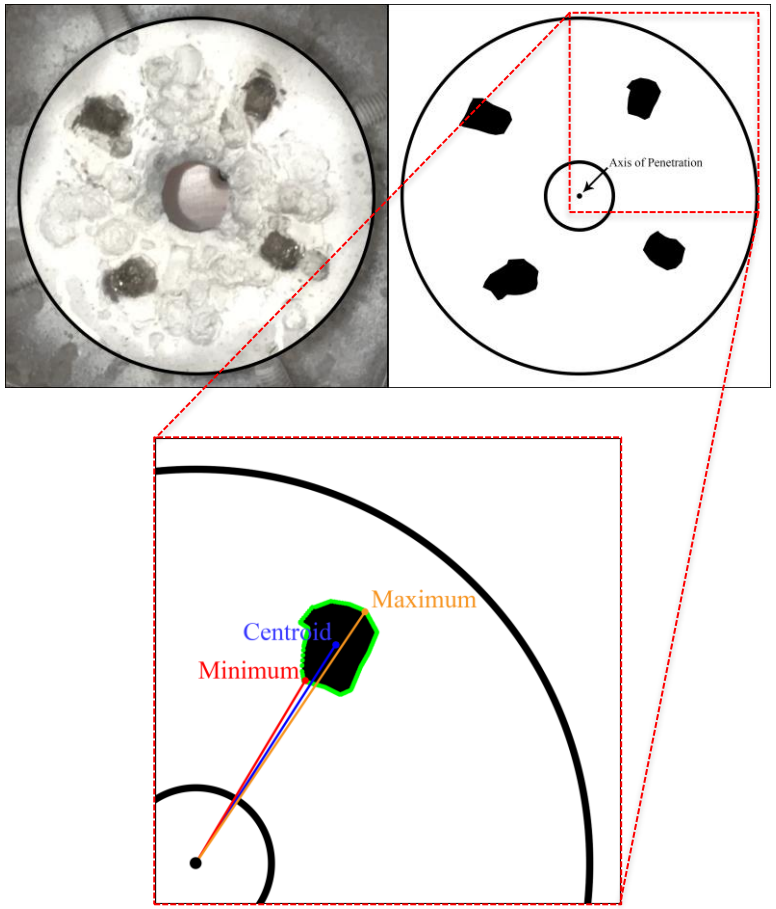
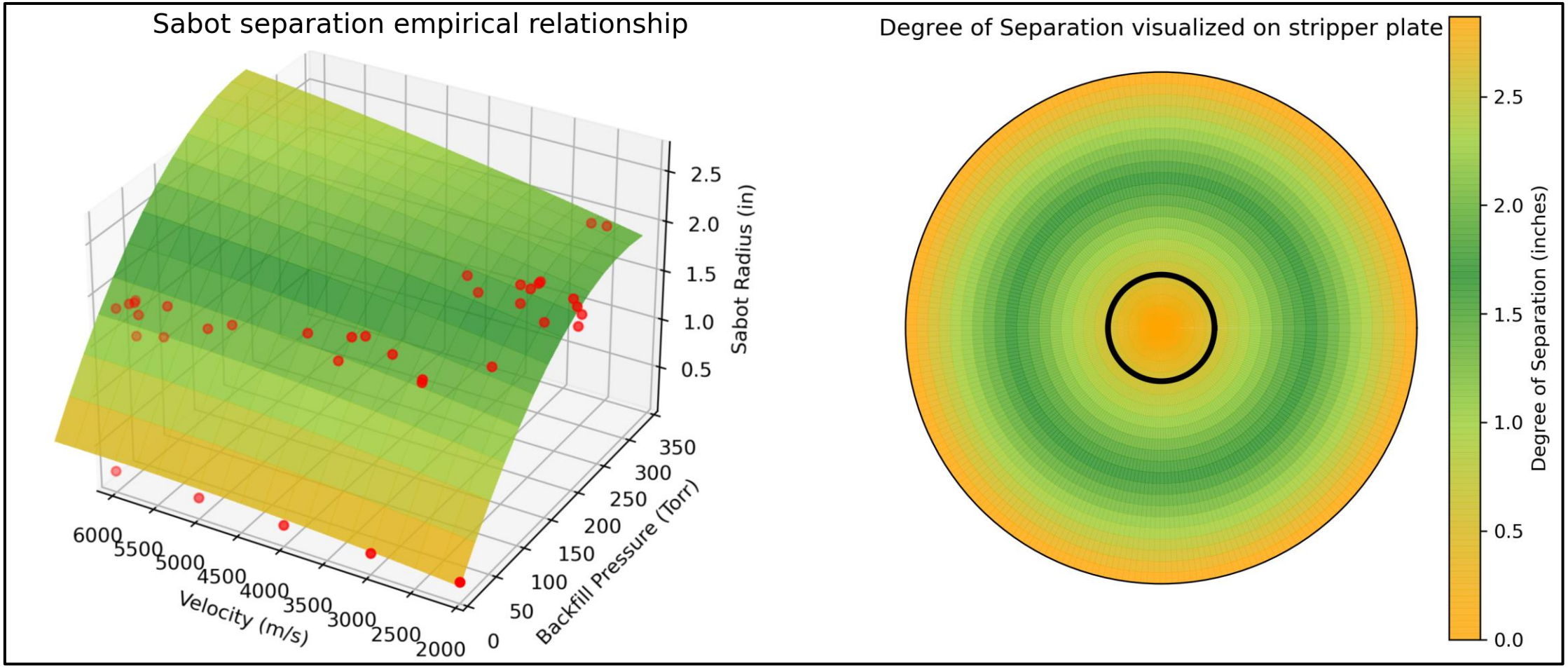


Image processing using Adobe Photoshop and Python scripts to convert image data to the degree of separation

Phase I: Empirical modelling to test simulation



Phase I: Empirical Modelling to test simulation

Polynomial regression model results

- Regressors
  - Projectile Velocity (v)
  - Backfill Pressure (P)
- Endogenous
  - Degree of separation

- Significant regressor interactions

$$\widehat{Degree\ of\ separation} = x_1 vP + x_2 v^2 P + x_3 vP^2 + x_4 P^3 + u$$

OLS Regression Results

Dep. Variable:	y	R-squared:	0.943
Model:	OLS	Adj. R-squared:	0.936
Method:	Least Squares	F-statistic:	132.3
Date:	Thu, 25 Mar 2021	Prob (F-statistic):	2.01e-19
Time:	02:56:29	Log-Likelihood:	23.373
No. Observations:	37	AIC:	-36.75
Df Residuals:	32	BIC:	-28.69
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.2591	0.062	4.203	0.000	0.134	0.385
x1	7.63e-06	6.67e-07	11.436	0.000	6.27e-06	8.99e-06
x2	-6.346e-10	6.21e-11	-10.225	0.000	-7.61e-10	-5.08e-10
x3	-2.014e-08	3.76e-09	-5.361	0.000	-2.78e-08	-1.25e-08
x4	7.037e-08	1.89e-08	3.732	0.001	3.2e-08	1.09e-07

Omnibus:	1.207	Durbin-Watson:	1.848
Prob(Omnibus):	0.547	Jarque-Bera (JB):	0.966
Skew:	-0.118	Prob(JB):	0.617
Kurtosis:	2.245	Cond. No.	5.34e+09

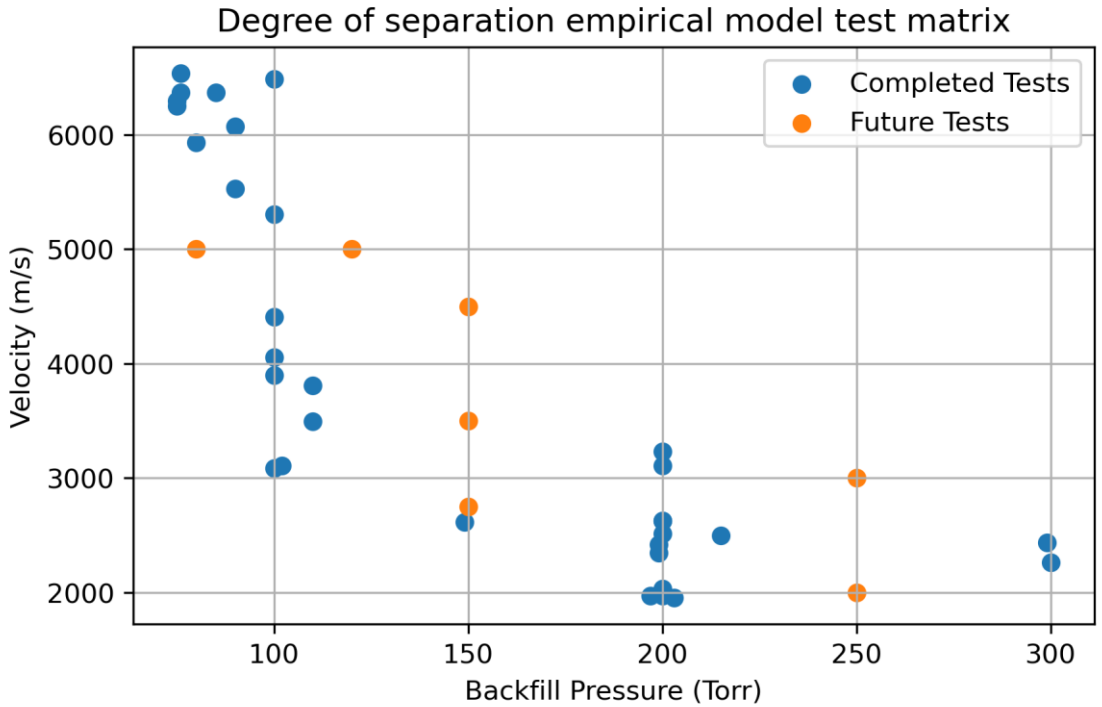
Phase II and Future Work

Finishing Phase I

- Completing test matrix to improve model accuracy

Phase II

- Work continues



Email questions to jdleaverton@tamu.edu

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