ACM2002

Impact Cratering Experiment with a Porous Target : On Ejecta Velocity Distribution

○T. Michikami[1,2], K. Moriguchi[3], M. Abe[1], S. Hasegawa[1], A. Fujiwara[1]

[1] The Institute of Space and Astronautical Science

[2] Kobe University

[3] HITACHI Software Engineering Co., Ltd

T.Michikami et al., "Ejecta velocity distribution for impact cratering experiments on porous and low strength" Planetary and Space Science, 55 (2007) 70-88

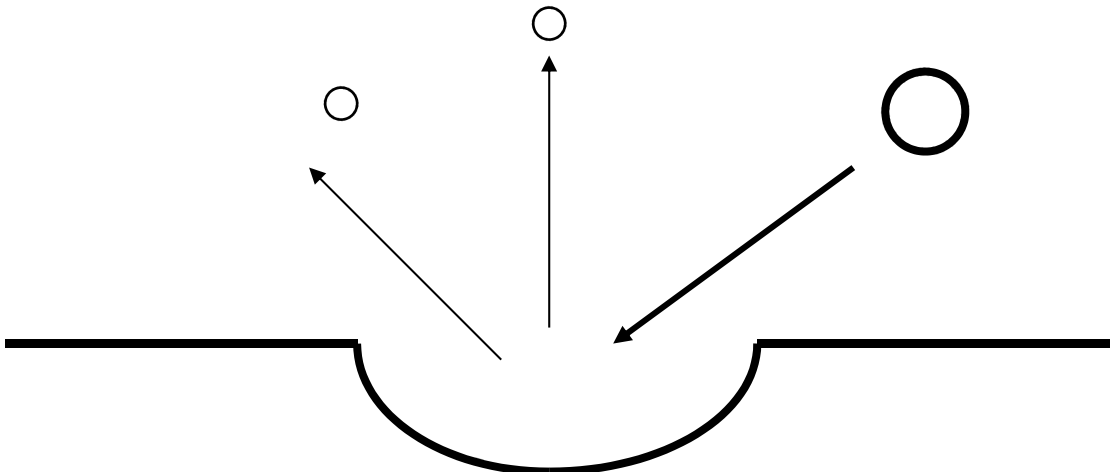
◆ Past Impact Cratering Experiments

Gault et al. (1963)

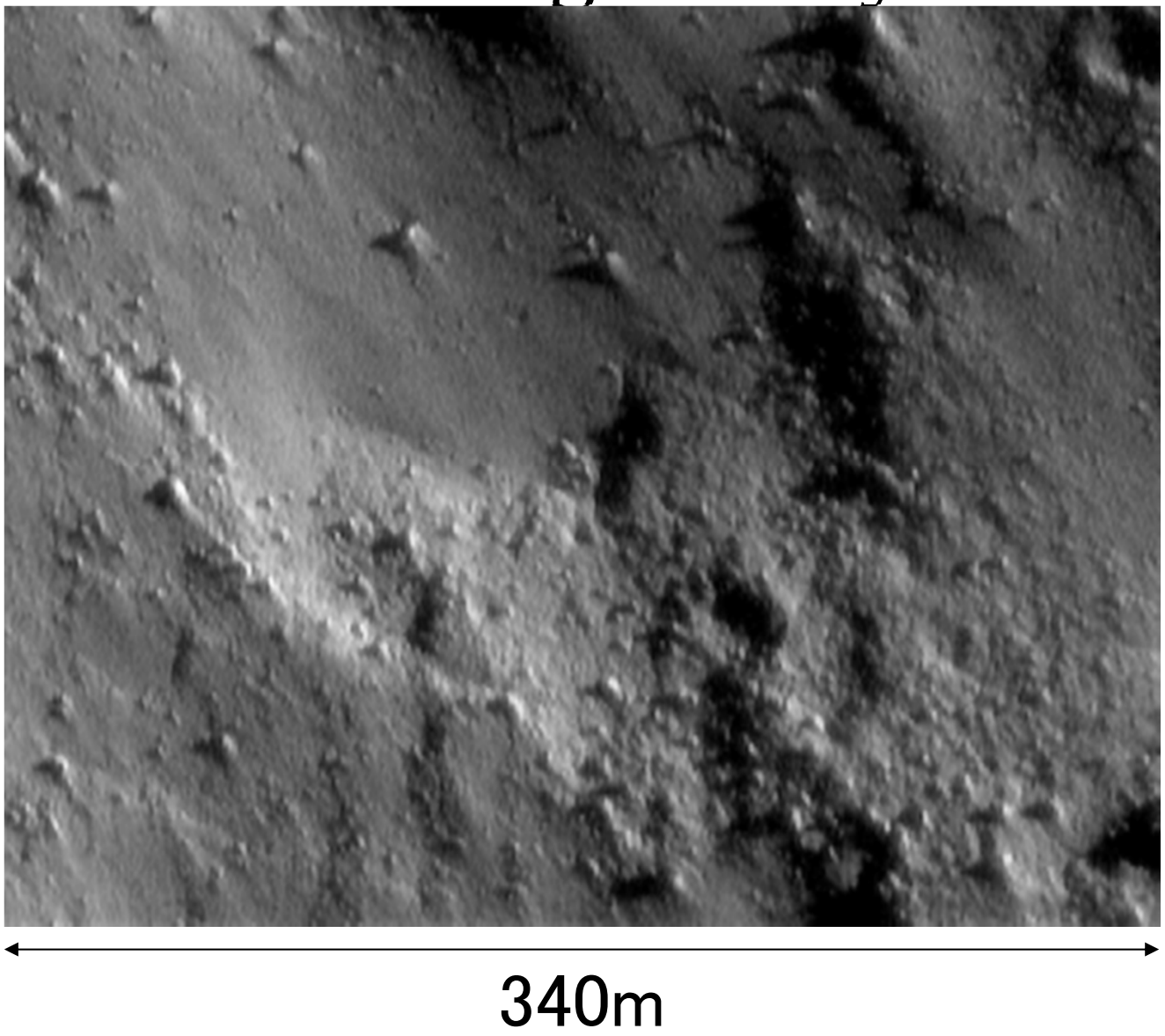
Target : Basalt

Ejecta Velocity: v > 45m/s

➡ Ejecta velocity is too large to have a regolith layer on the surface of an Eros sized-asteroid.
(Escape velocity of Eros 3 to 17m/s [Veverka et al. 2000])



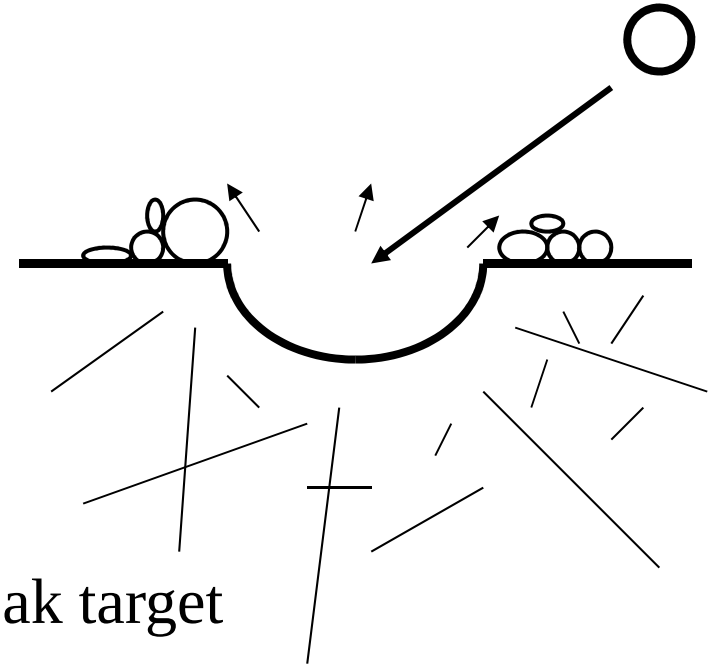
A Surface of asteroid 433Eros is covered with regolith layer.



◆ Purpose

To investigate the ejecta velocity distribution with a porous and structurally weak target.

➡ Impact cratering experiments were carried out.



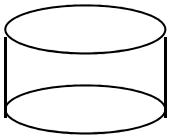
Porous and structurally weak target

◆ Impact Experiments

- **Target : 6 type** (porosity7-80%, compressive strength0.5-250MPa)

  Target Material : soda lime glass beads

  Target size : height 4.0cm diameter 8.0cm



- **Projectile** : **Alumina sphere of 1mm-diameter**

  (density 3700kg/m^3)

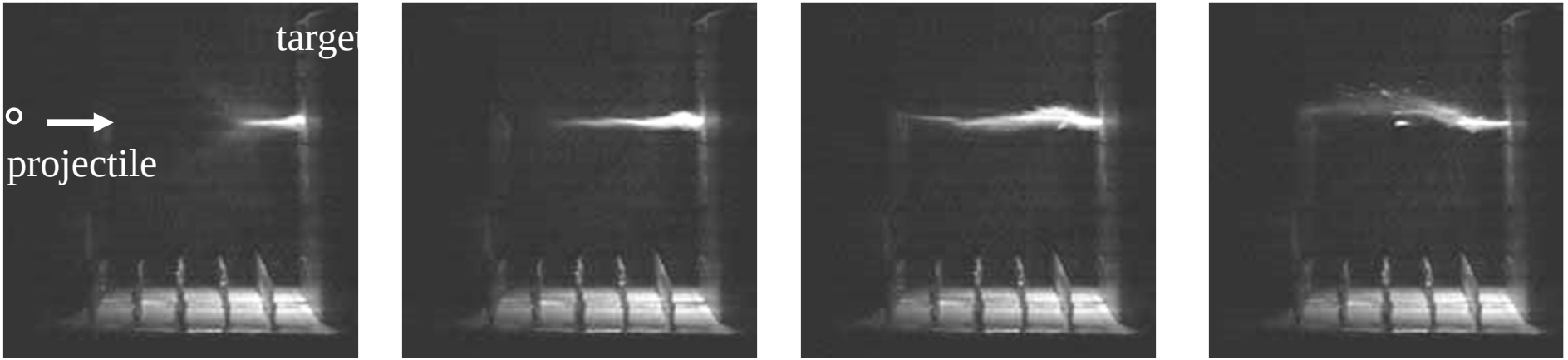
- **Impact Angle** : **Vertical**
- **Impact Velocity** : **1-4km/s (nominal 4km/s)**
- **Pressure in Chamber : 50-500Pa**
- **High Speed Camera** :

  2250 frame / s (Time Resolution 0.4ms)

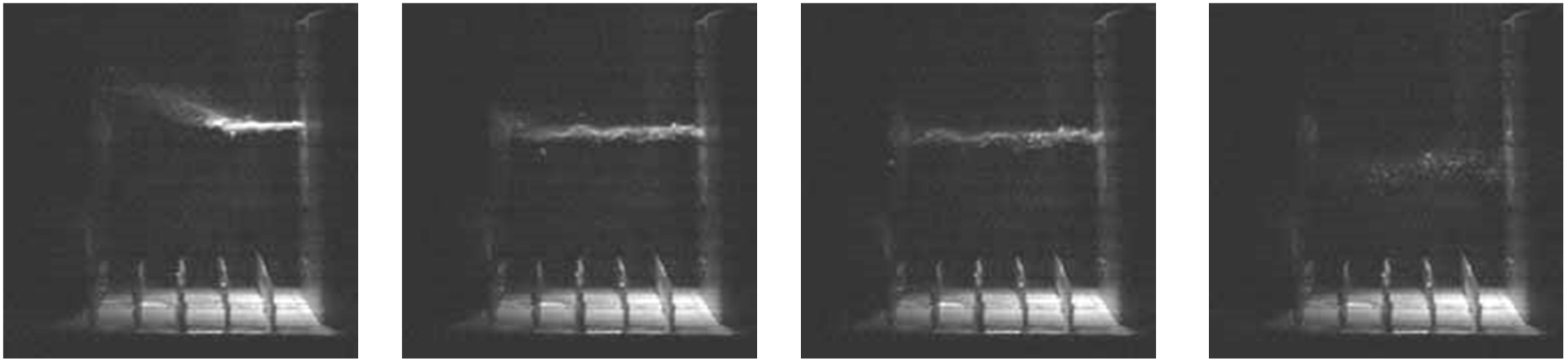
◆ Target Properties and Impact Velocities

Target Group	Shot Number (Target Number)	Sintering Temperature (℃)	Porosity (%)	Density (kg/m^3)	Impact Velocity (km/s)
P7 (245±31MPa)	512 (# 7)	750	7.7 ± 0.2	2308 ± 5	4.06
	515 (# 13)	750	9.3 ± 0.3	2269 ± 8	3.53
	525 (# 8)	750	4.2 ± 0.4	2394 ± 10	3.59
P30 (34.2+4.6MPa)	550 (#19)	700	28.2 ± 0.3	1796 ± 7	3.73
	554 (#11)	700	30.9 ± 0.1	1727 ± 3	4.47
P39 (5.5±2.5MPa)	566 (#58)	675	38.1 ± 0.4	1547 ± 9	4.01
	568 (#52)	675	39.5 ± 0.4	1512 ± 10	3.67
	555 (#59)	675	38.2 ± 0.1	1544 ± 4	4
	569 (#56)	675	40.9 ± 0.4	1479 ± 11	1.72
	570 (#62)	675	38.5 ± 0.3	1538 ± 6	1.6
	572 (#60)	675	40.0 ± 0.3	1500 ± 8	1.22
P43 (0.53±0.22MPa)	514 (# 10)	650	43.2 ± 0.1	1421 ± 3	3.97
	516 (# 15)	650	43.1 ± 0.1	1424 ± 2	3.17
	523 (# 33)	650	43.2 ± 0.4	1421 ± 10	4.21
P60 (0.8±0.2MPa)	518 (# 29)	650	59.2 ± 0.2	1019 ± 4	4.14
	524 (# 30)	650	58.2 ± 0.4	1046 ± 9	3.97
P80	513 (# 35)	650	83.6 ± 0.1	411 ± 2	3.94

◆ Ejection Behavior



Time[msec] 0 0.4 2.7 8.0

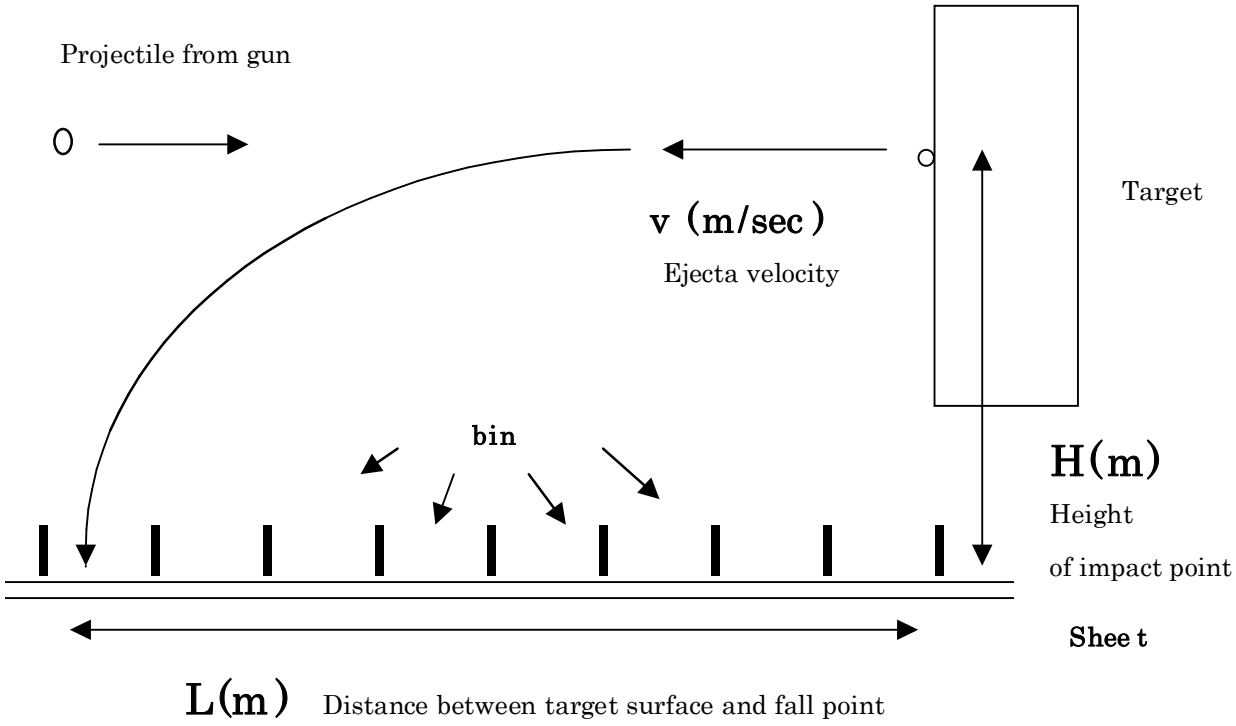


15.1 33.7 44.4 83.5

P39 Shot 566 (porosity 38.1%)

size scale
5cm

◆Estimation of Ejecta Velocity



Ejecta Velocity

$$V = L\sqrt{\frac{g}{2H}}$$

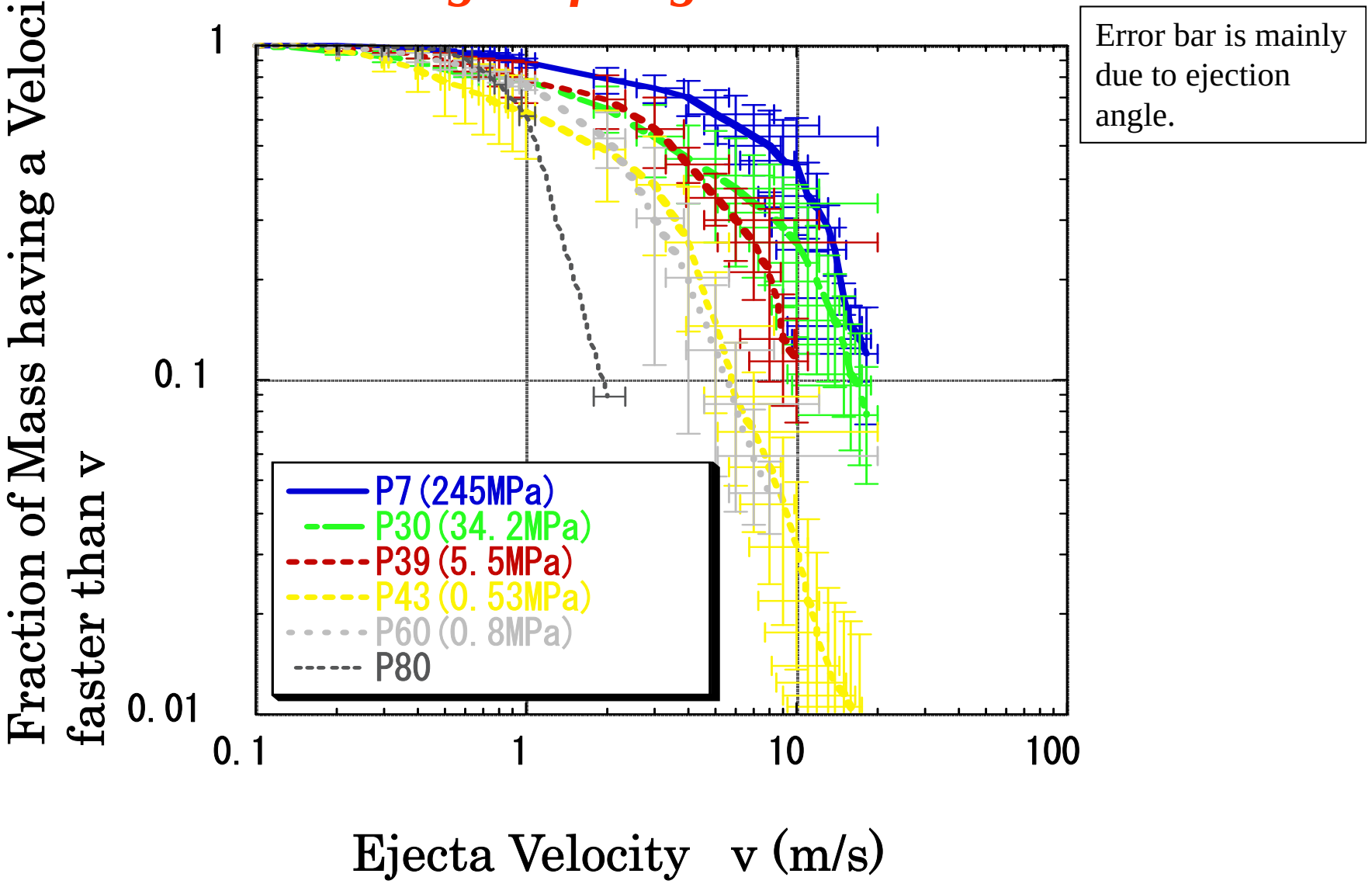
L= 0 – 2.7m

H= ~0.1m

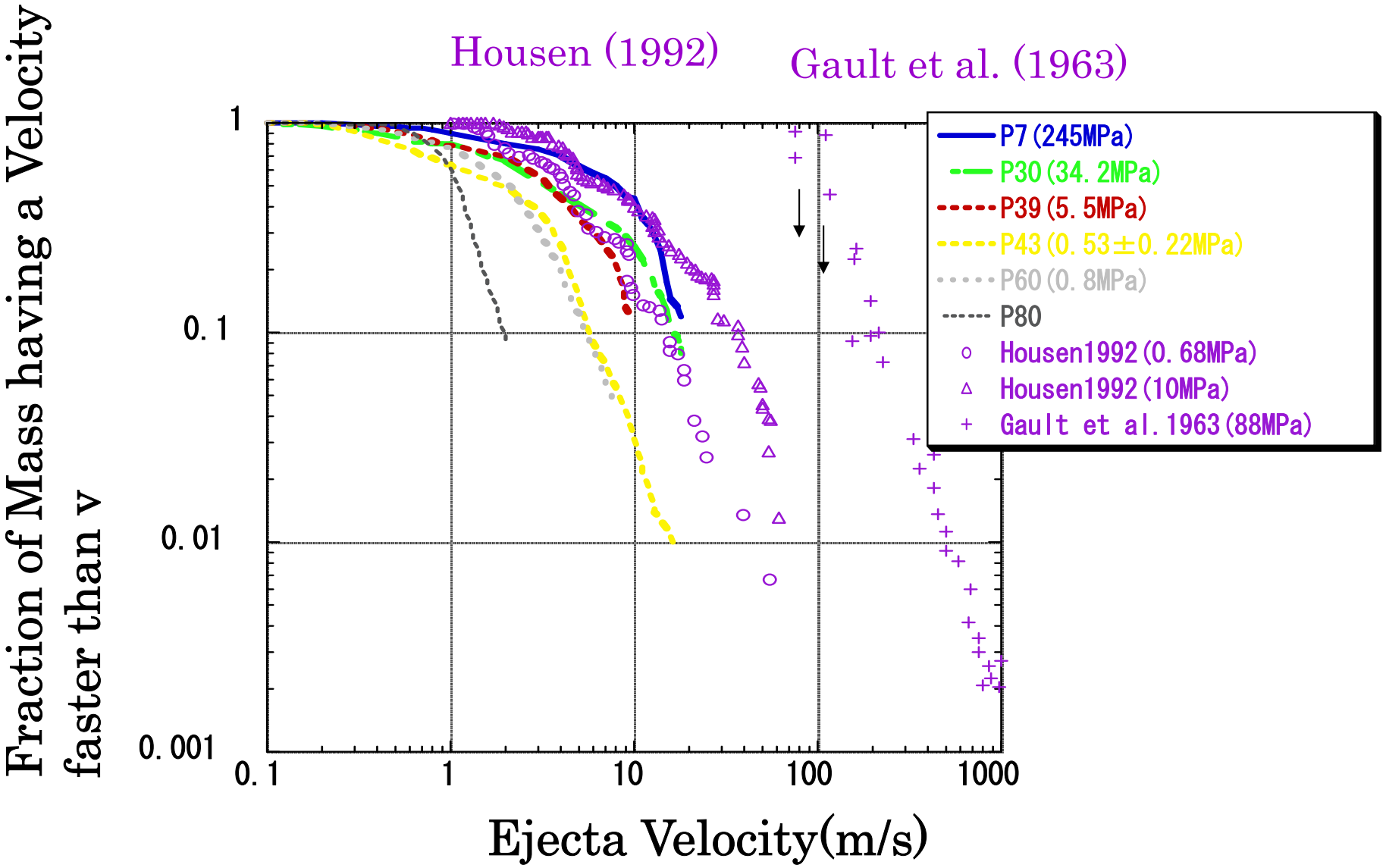
Fig.3.1. Configuration of experimental setup.

◆Ejecta Velocity Distribution

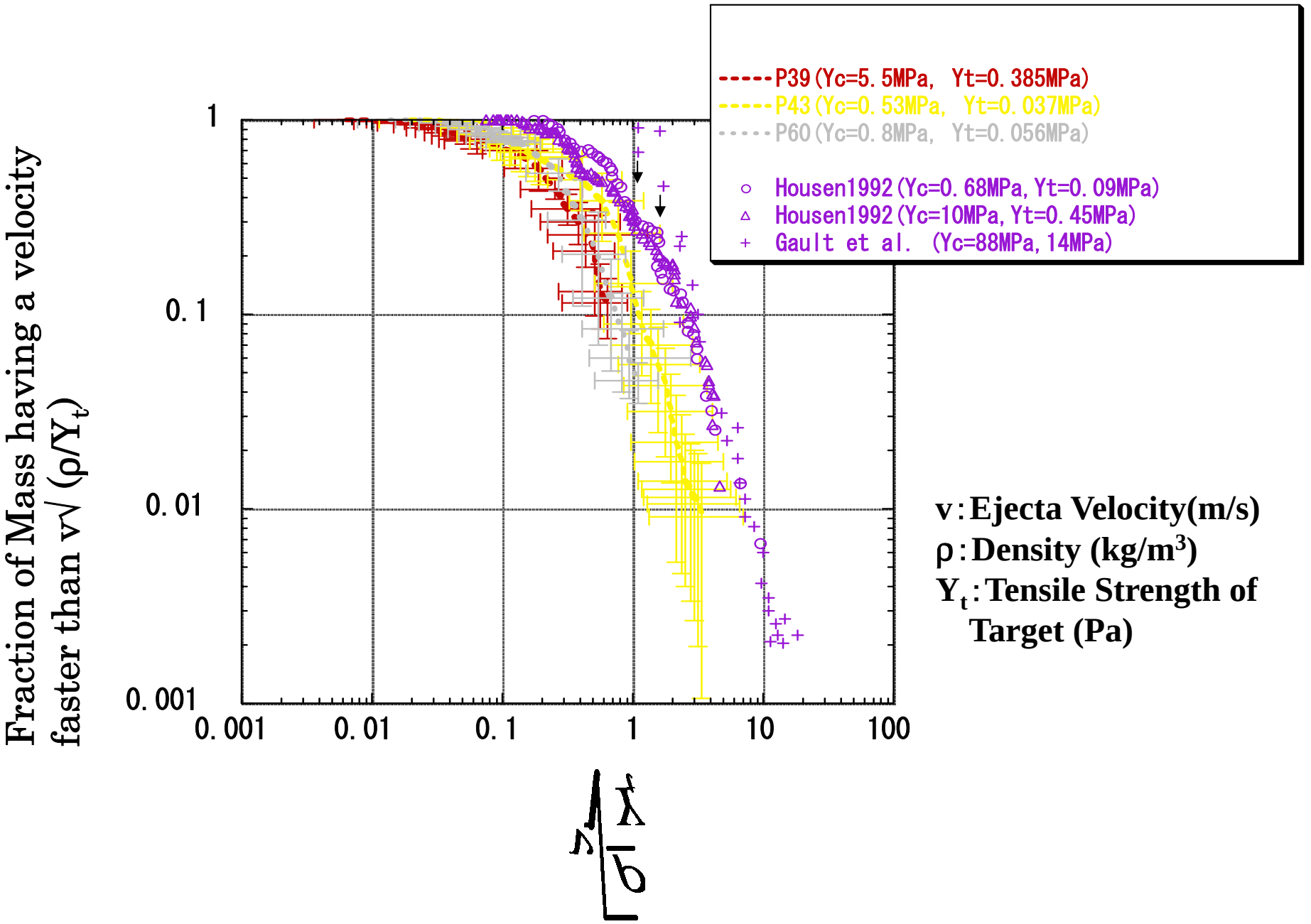
➡ ***Mean of ejecta velocity decreases with decreasing material strength of target.***



◆Comparison with past results



◆Normalized Velocity Distribution using Housen's parameter



v : Ejecta Velocity(m/s)
ρ : Density (kg/m^3)
Y_t : Tensile Strength of Target (Pa)

Conclusions

- The mean velocity of the ejecta velocity decreases with decreasing material strength of the target.

➡ e.g., The amount of ejecta with velocity lower than 1m/s is about 40% of the total mass in the P43 target (porosity 43% and compressive strength 0.5MPa).

- The ejecta velocity distribution of our experiments is lower than those of Gault et al's (1963) and Housen's (1992) experiments.