NASA Breakup Model Implementation Comparison of results

A. Rossi[1]

[1]ISTI–CNR,
Spaceflight Dynamics Section
Via Moruzzi 1, 56124 Pisa, Italy

24th IADC, Tsukuba, April 10–13, 2006

Contributions by:

- ASI: A. Rossi (ISTI-CNR)
- CNSA: Xu Minqiang
- DLR: G. Koppenwallner, T. Lips (HTG)
- ESA: M. Oswald (TU Braunschweig)
- NASA: P. Krisko

Purpose of the Internal Task

- To compare the different implementations of the new NASA breakup model for explosions and collisions, as reported in the paper by Johnson *et al.*, *Adv. Space Res*, Vol. 28, 2001.
- The aim is also to better characterise and understand possible differecences between the results of the long term evolution models.

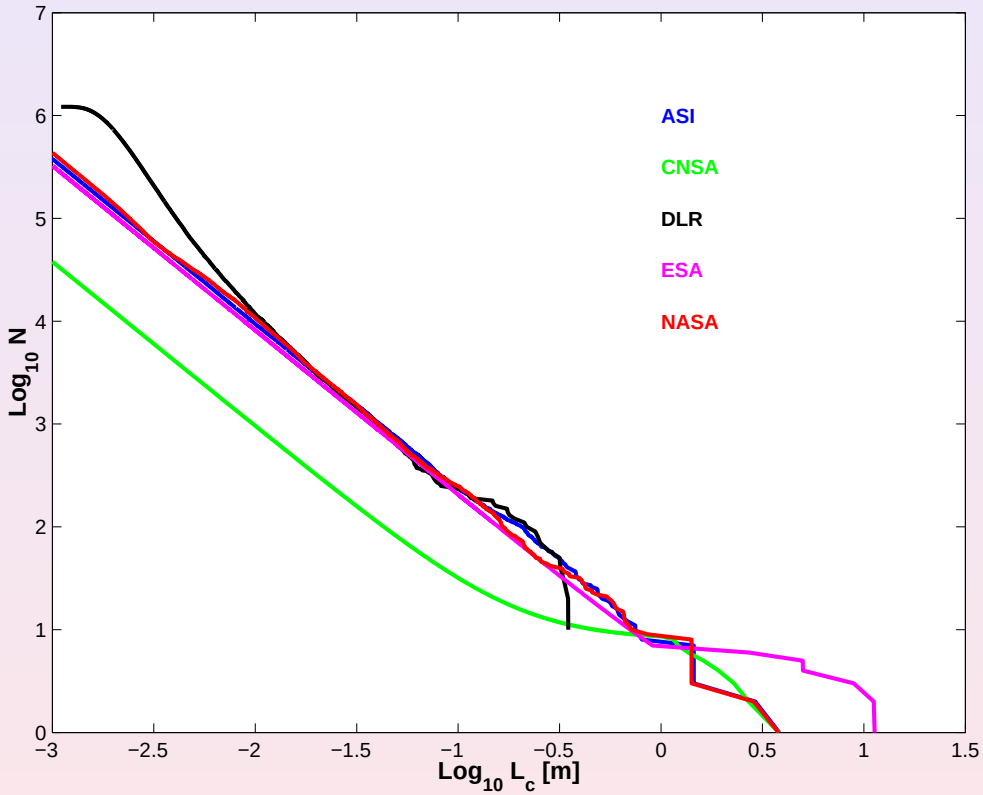
Explosion case – Study parameters

- The fragmented objects is a ROCKET BODY
- The results includes particles down to $L_c = 1$ mm
- Output data:
  1. Characteristic length L_c [m]
  2. mass [kg]
  3. area [m^2]
  4. ΔV [km/s]

Explosion case – Results - L_c

Number of objects larger than 1 mm:

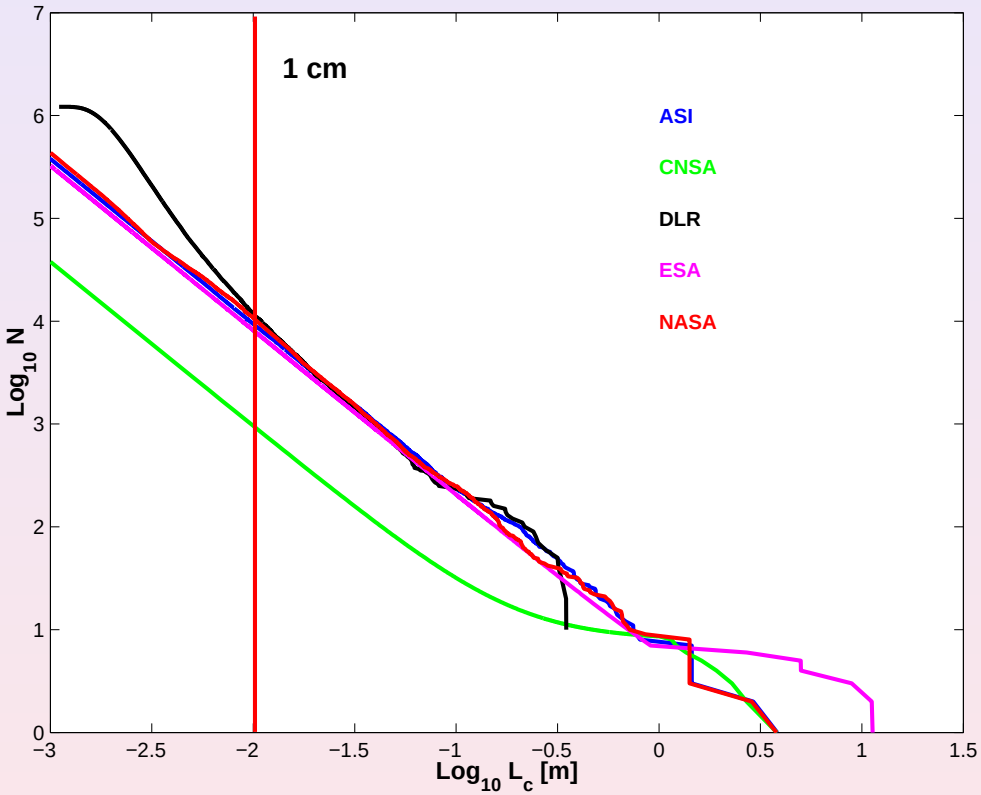
- ASI: 378 581
- CNSA: 37 865
- DLR: 1 217 054
- ESA: 324 886
- NASA: 434 928



Explosion case – Results - L_c

Number of objects larger than 1 cm:

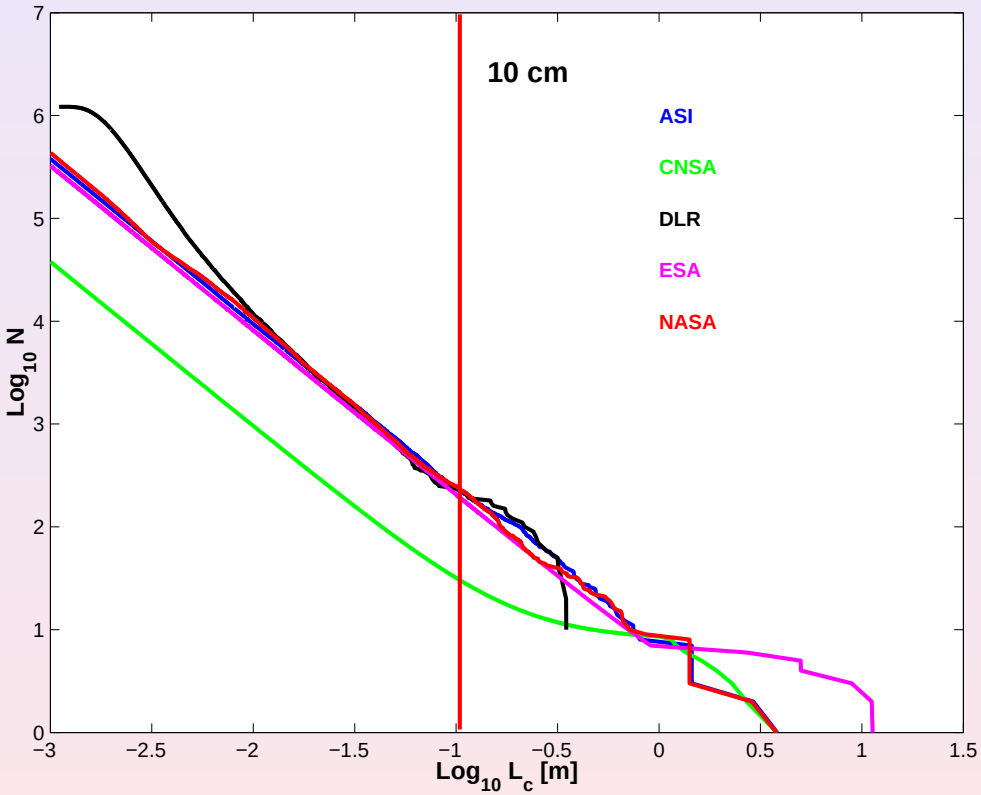
- ASI: 9 403
- CNSA: $\sim$ 960
- DLR: 11 724
- ESA: 8 159
- NASA: 10 731



Explosion case – Results - L_c

Number of objects larger than 10 cm:

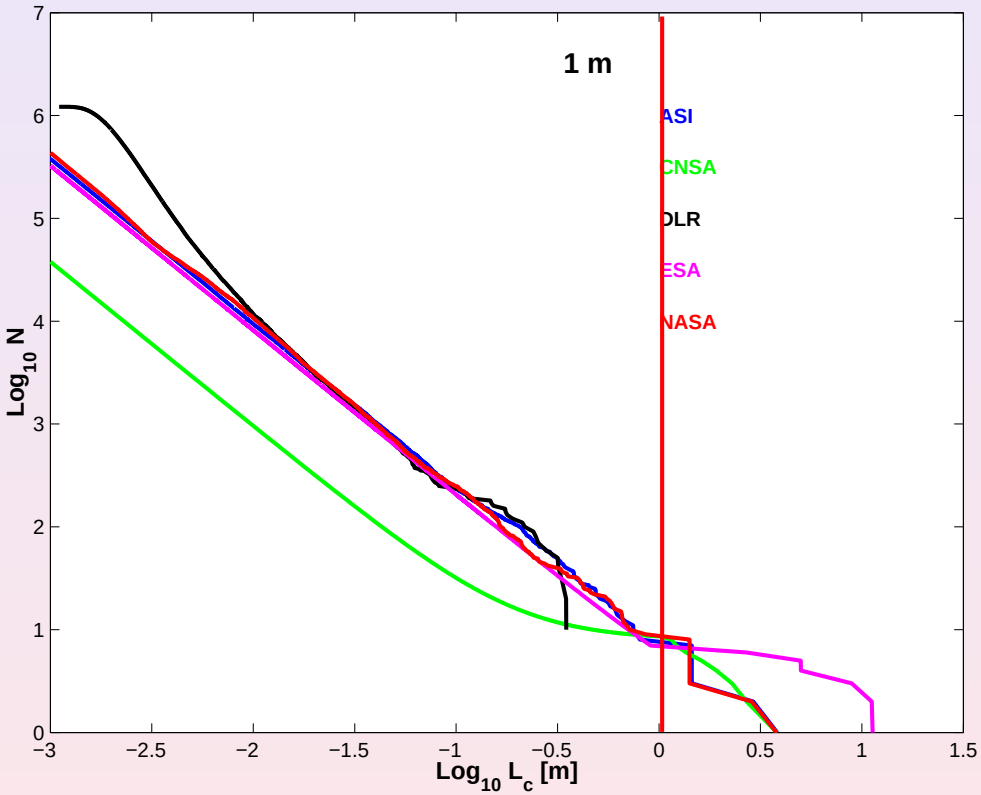
- ASI: 234
- CNSA: $\sim$ 32
- DLR: 230
- ESA: 206
- NASA: 248



Explosion case – Results - L_c

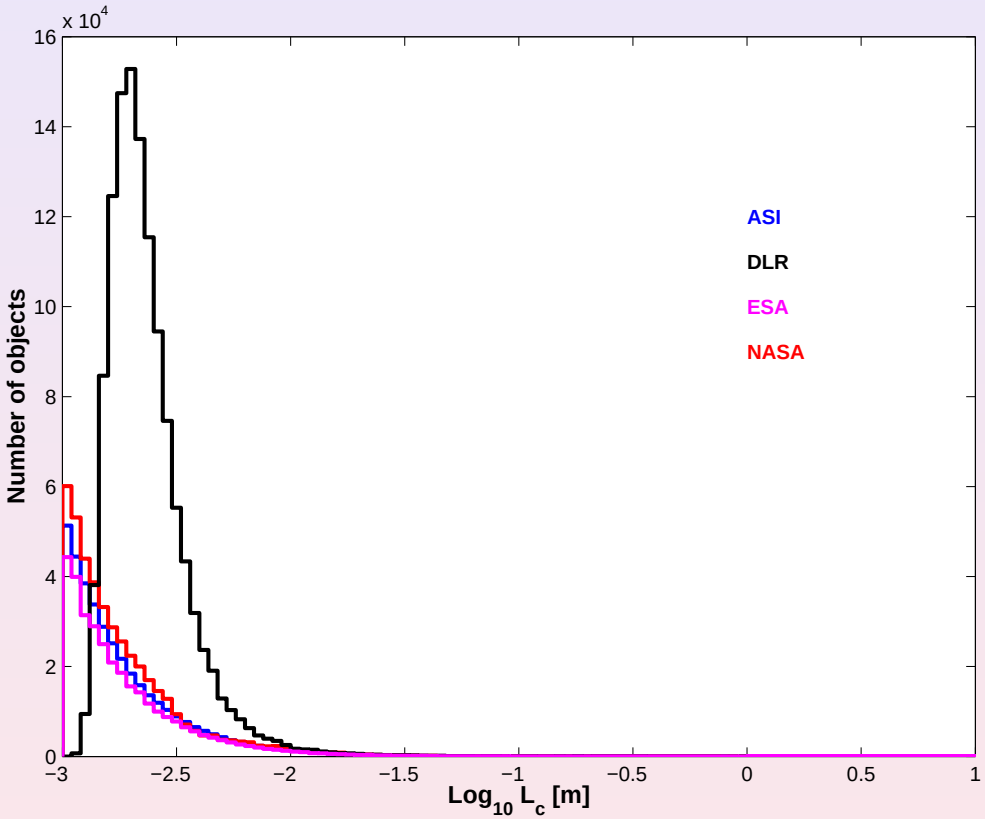
Number of objects larger than 1 m:

- ASI: 7
- CNSA: $\sim$ 9
- DLR: 0
- ESA: 6
- NASA: 8



Explosion case – Results - L_c

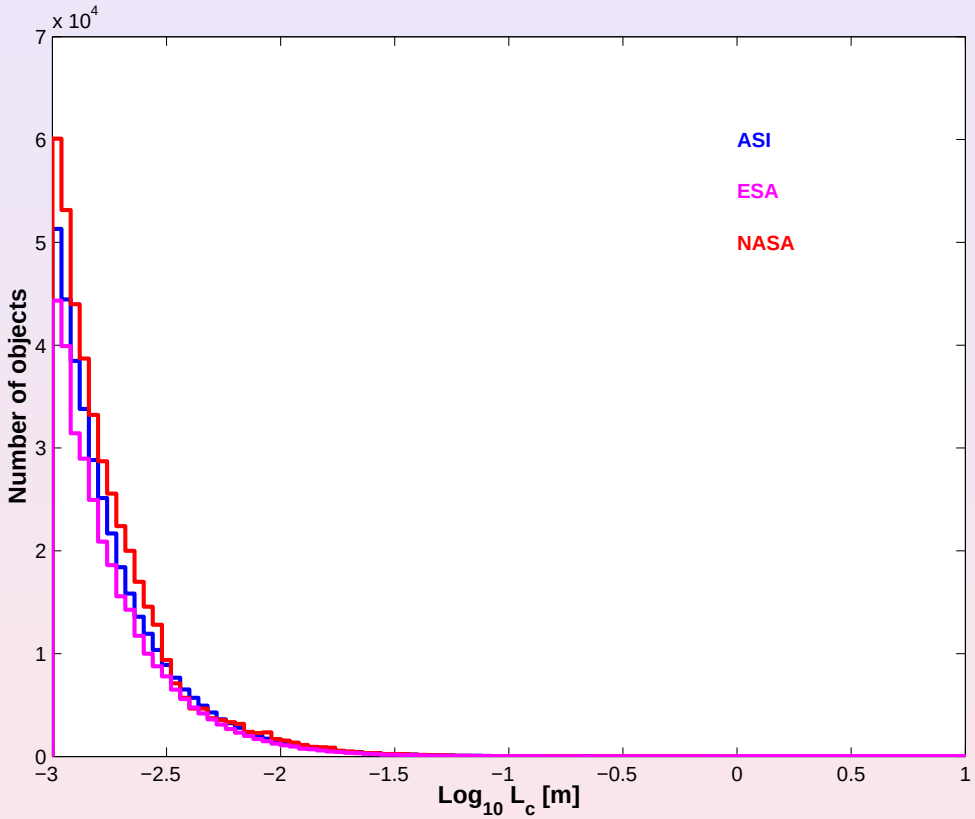
Distribution in 100 bins



Explosion case – Results - L_c

Distribution in 100 bins

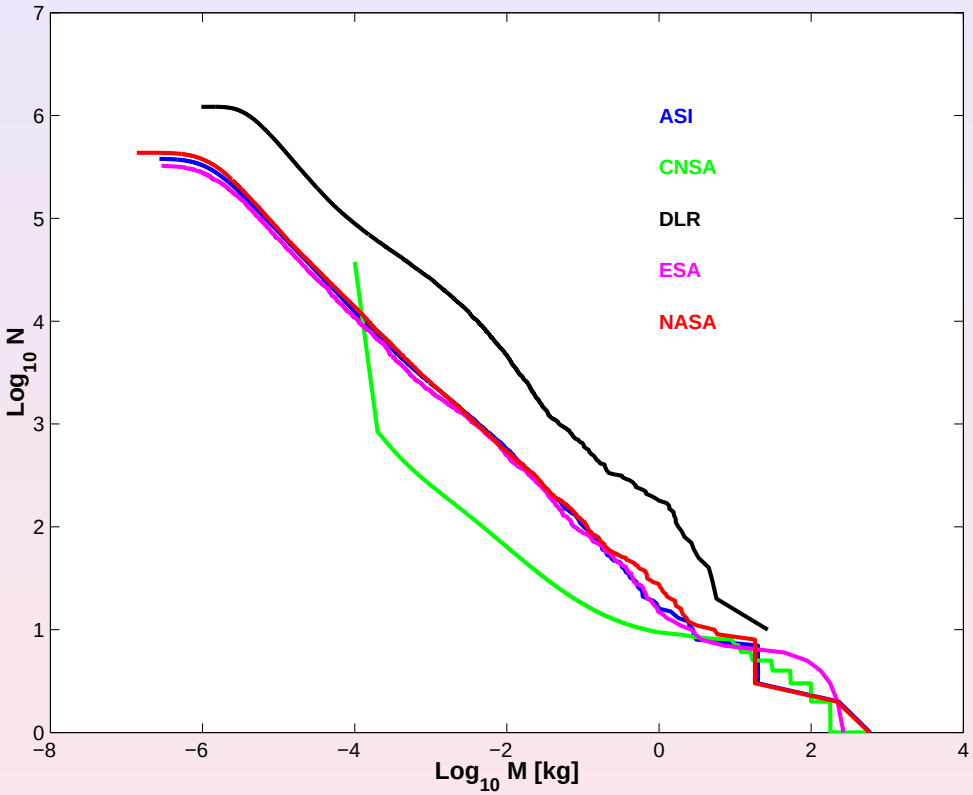
DLR results excluded



Explosion case – Results - Mass

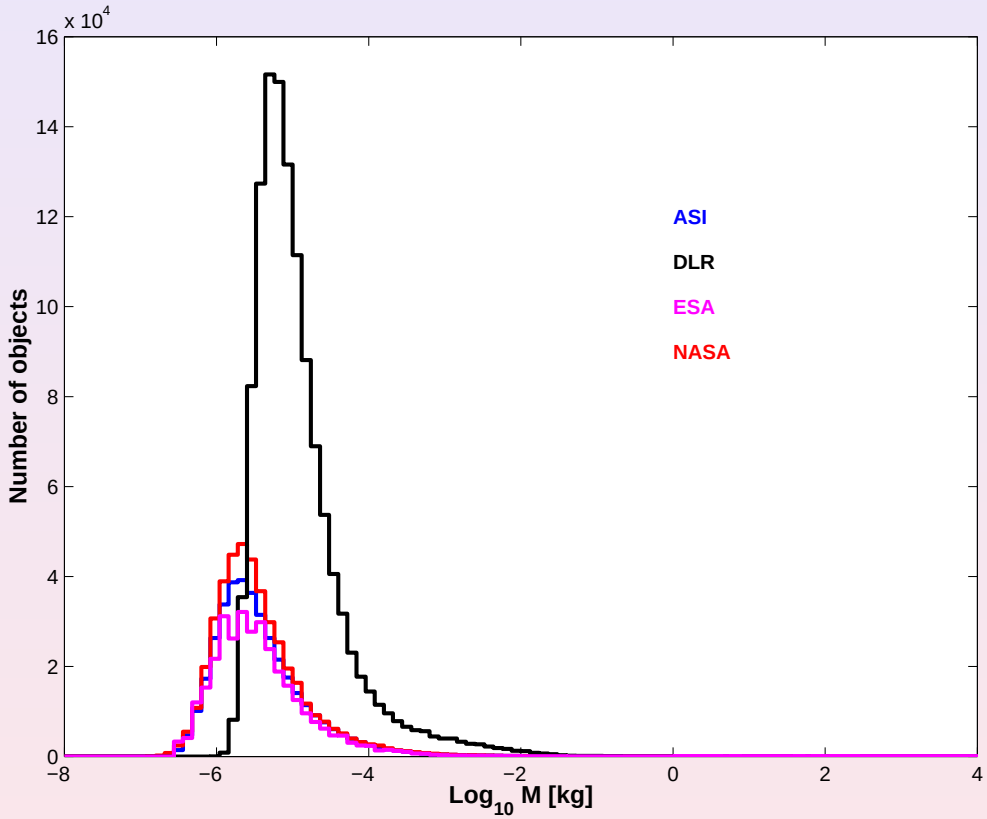
Number of objects larger than 1 gram:

- ASI: 2 472
- CNSA: $\sim$ 254
- DLR: 25 844
- ESA: 2 093
- NASA: 2 525



Explosion case – Results - Mass

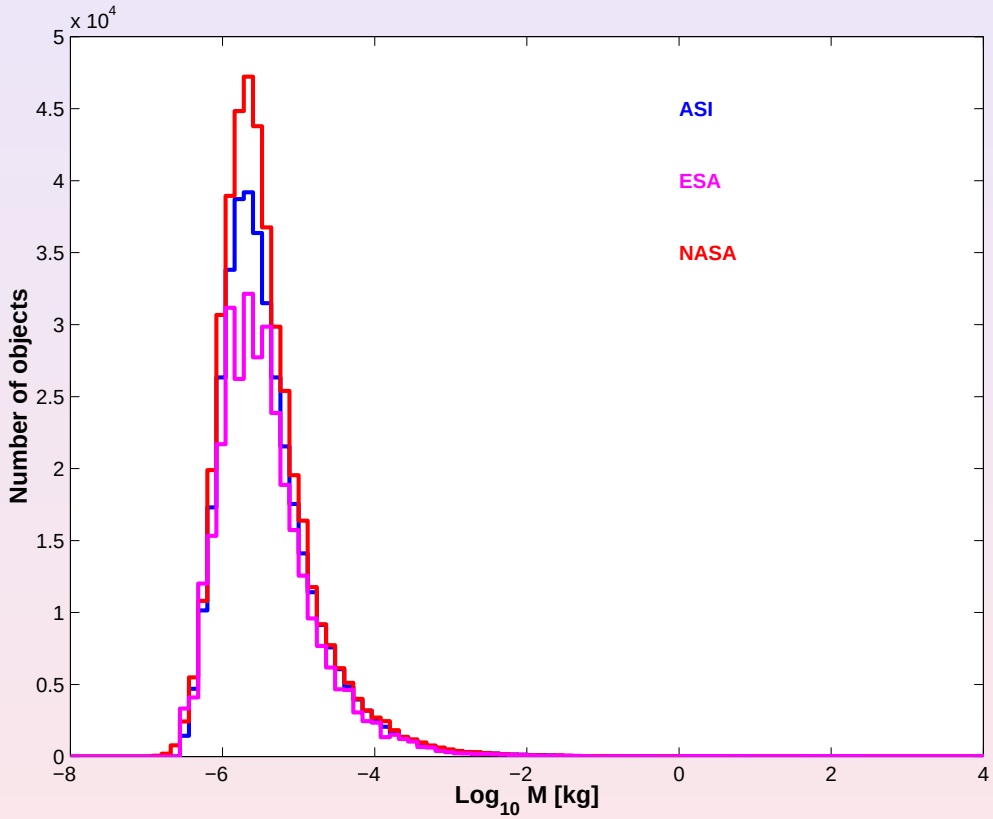
Distribution in 100 bins



Explosion case – Results - Mass

Distribution in 100 bins

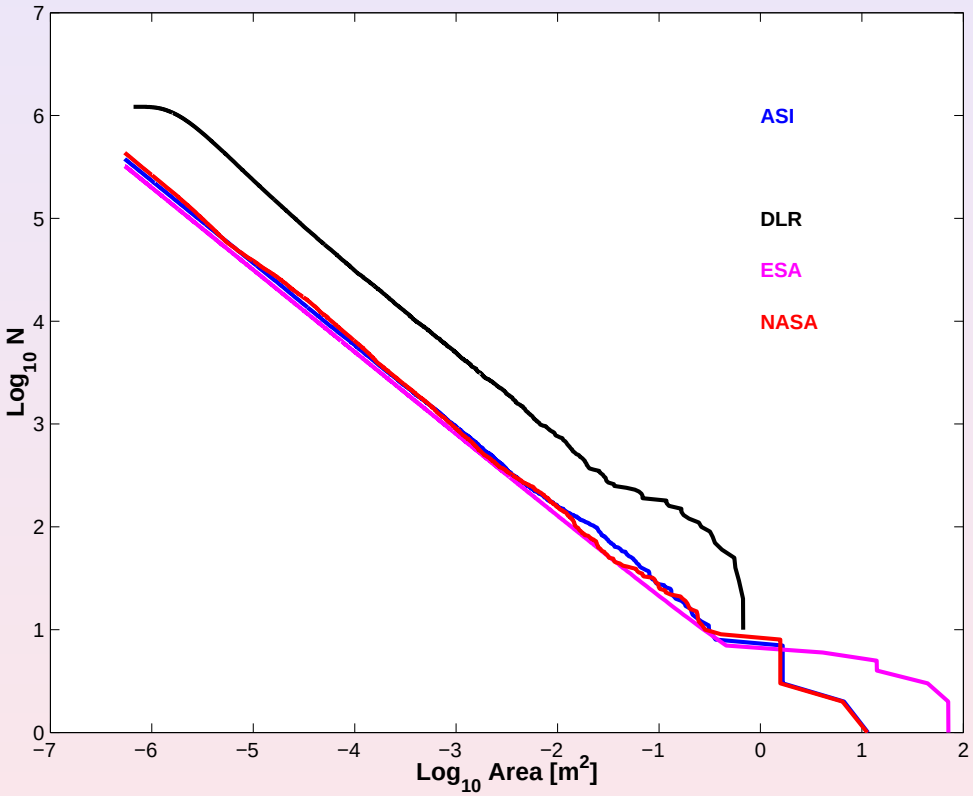
DLR results excluded



Explosion case – Results - Area

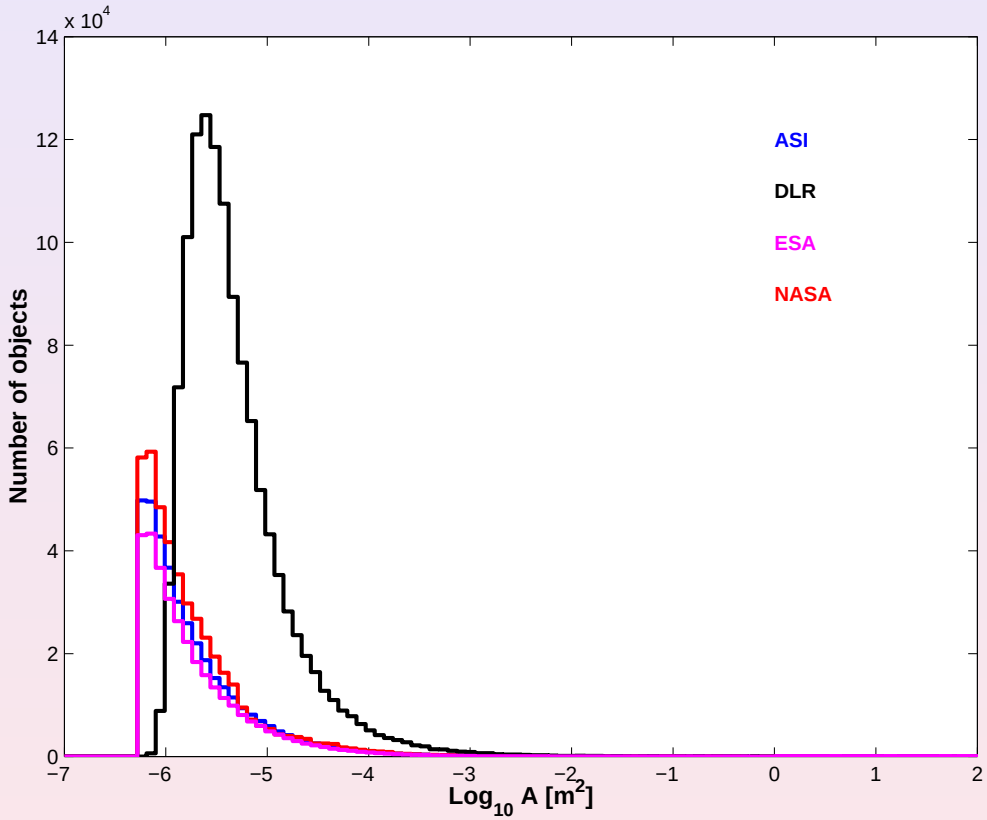
Number of objects with area larger than 1 cm^2:

- ASI: 5 878
- DLR: 31 124
- ESA: 5 024
- NASA: 6 416



Explosion case – Results - Area

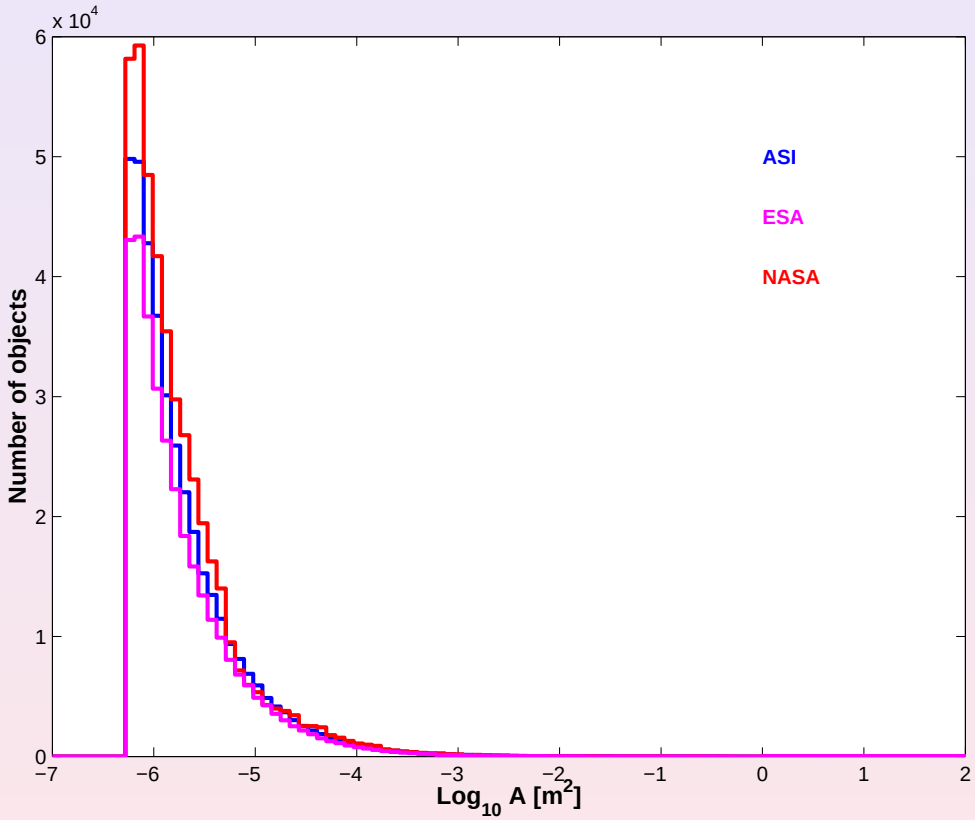
Distribution in 100 bins.



Explosion case – Results - Area

Distribution in 100 bins.

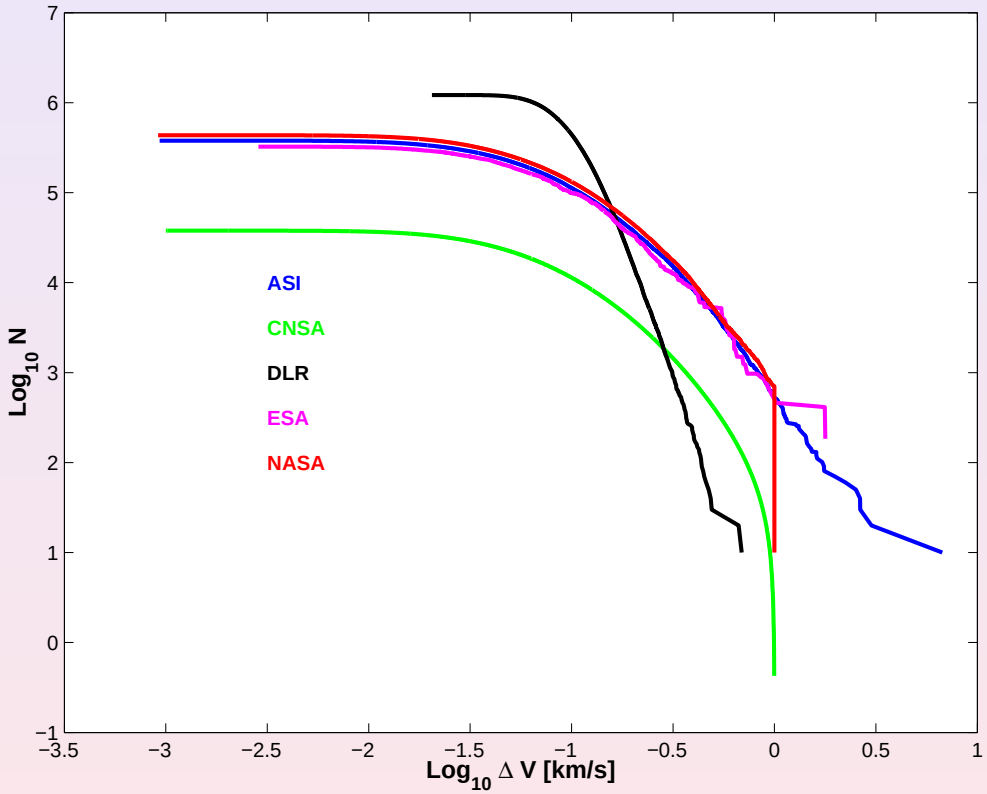
DLR results excluded



Explosion case – Results - ΔV

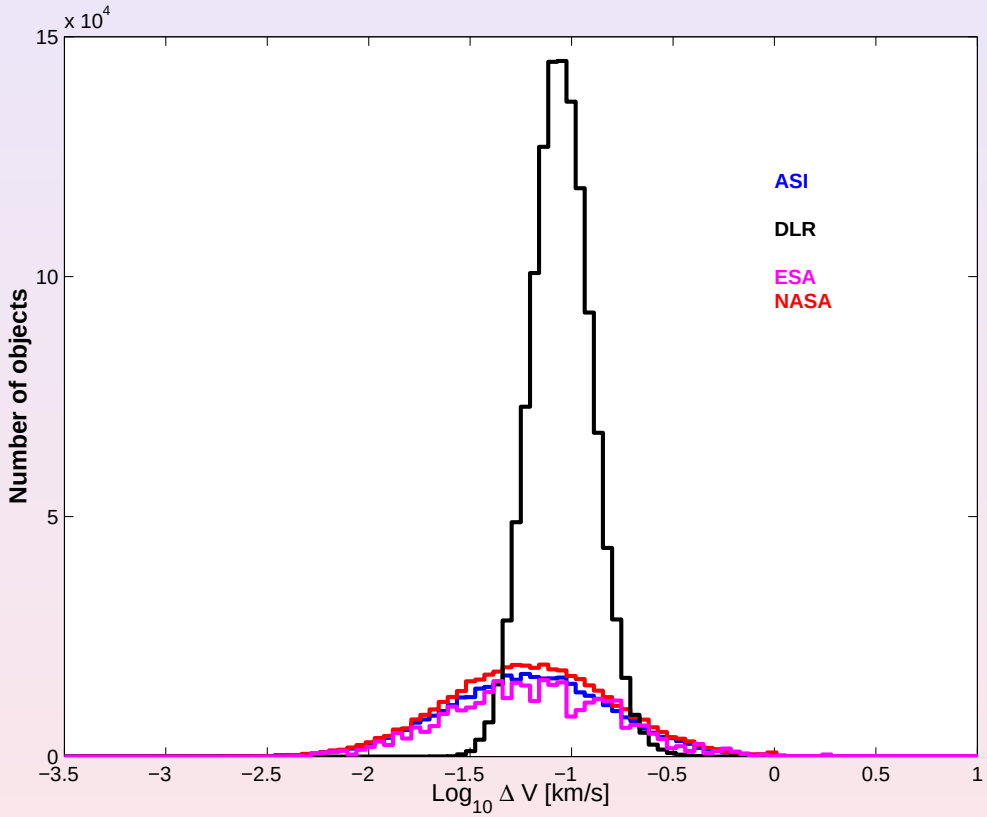
Number of objects with $\Delta V > 100$ m/s:

- ASI: 112 932
- CNSA: $\sim$ 11 380
- DLR: 31 124
- ESA: 98 717
- NASA: 132 032



Explosion case – Results - ΔV

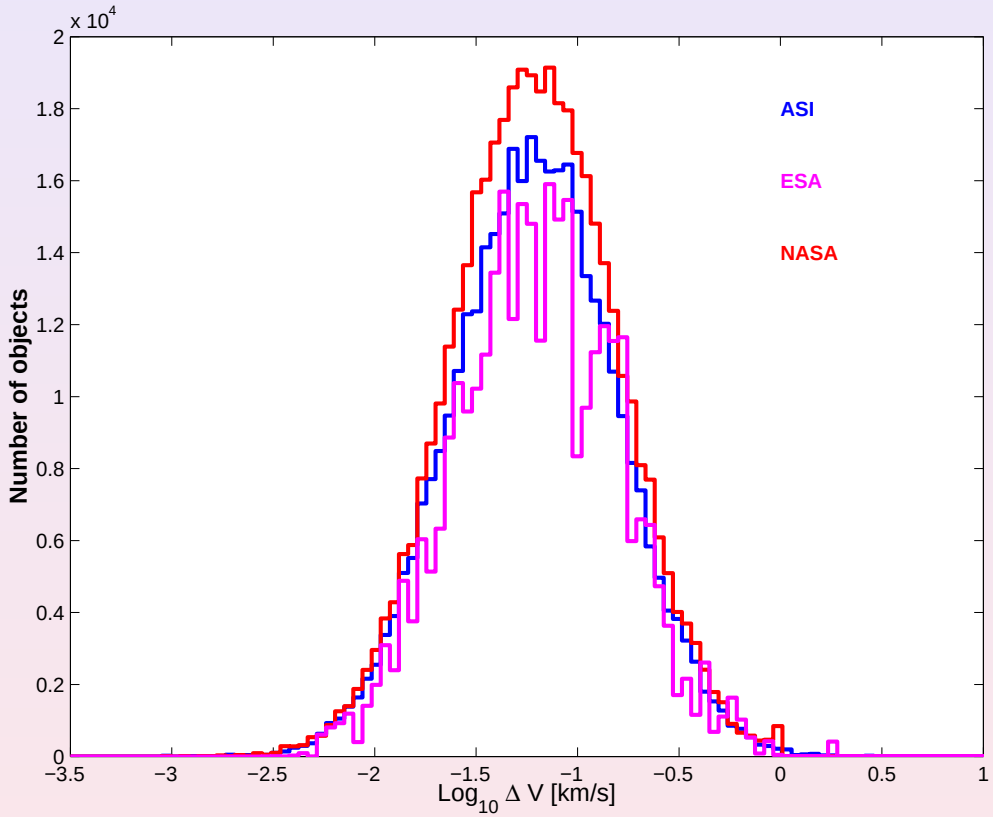
Distribution in 100 bins.



Explosion case – Results - ΔV

Distribution in 100 bins.

DLR results excluded



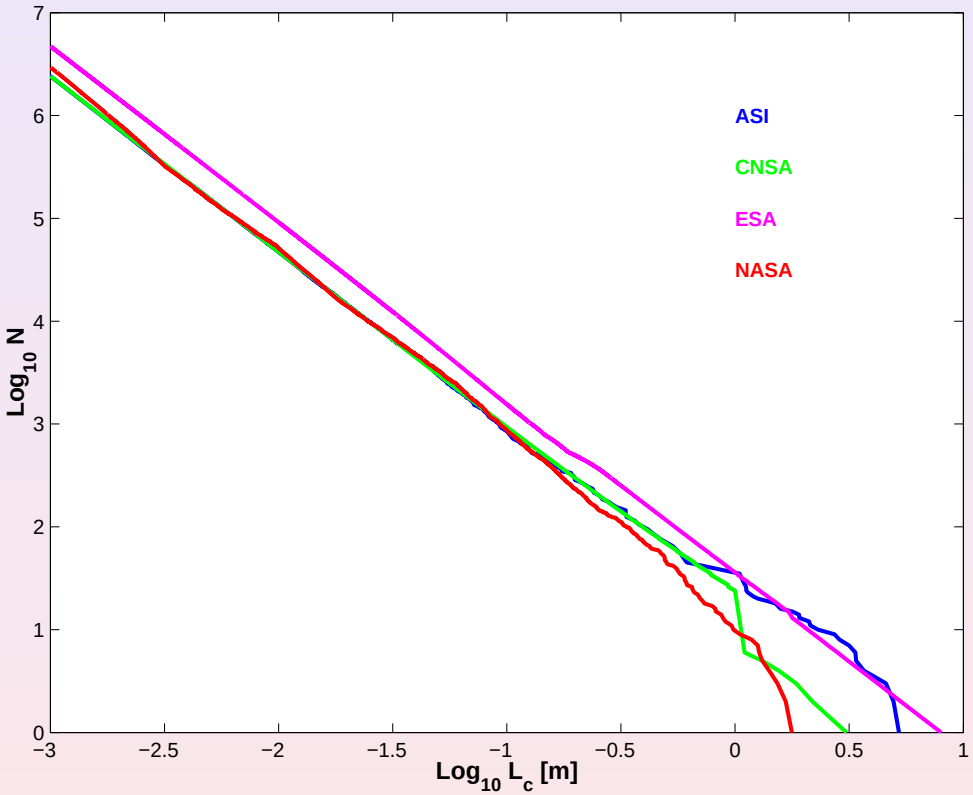
Collision case – Study parameters

- The fragmented objects is a ROCKET BODY
- Target mass: 1000 km
- Projectile mass: 10 km
- Impact velocity: 10 km/s
- The results includes particles down to $L_c = 1$ mm
- Output data:
  1. Characteristic length L_c [m]
  2. mass [kg]
  3. area [m^2]
  4. ΔV [km/s]

Collision case – Results - L_c

Number of objects larger than 1 mm:

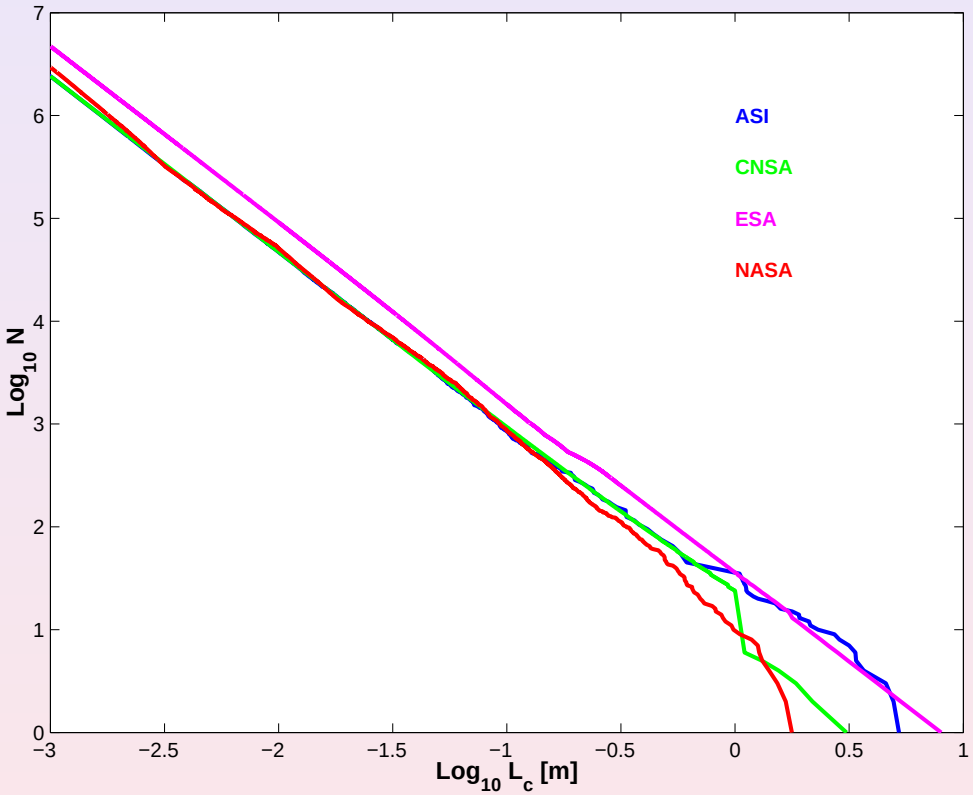
- ASI: 2 416 795
- CNSA: 2 416 790
- ESA: 4 723 391
- NASA: 2 957 159



Collision case – Results - L_c

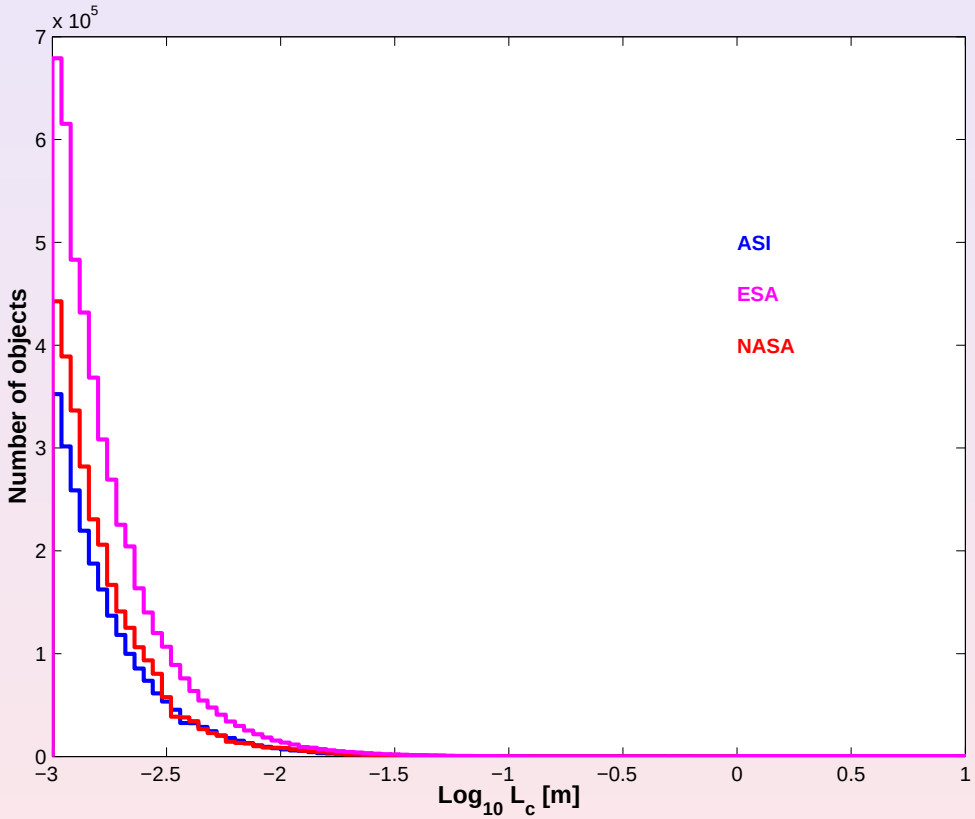
Number of objects larger than 10 cm:

- ASI: 850
- CNSA: $\sim$ 935
- ESA: 1 539
- NASA: 862



Collision case – Results - L_c

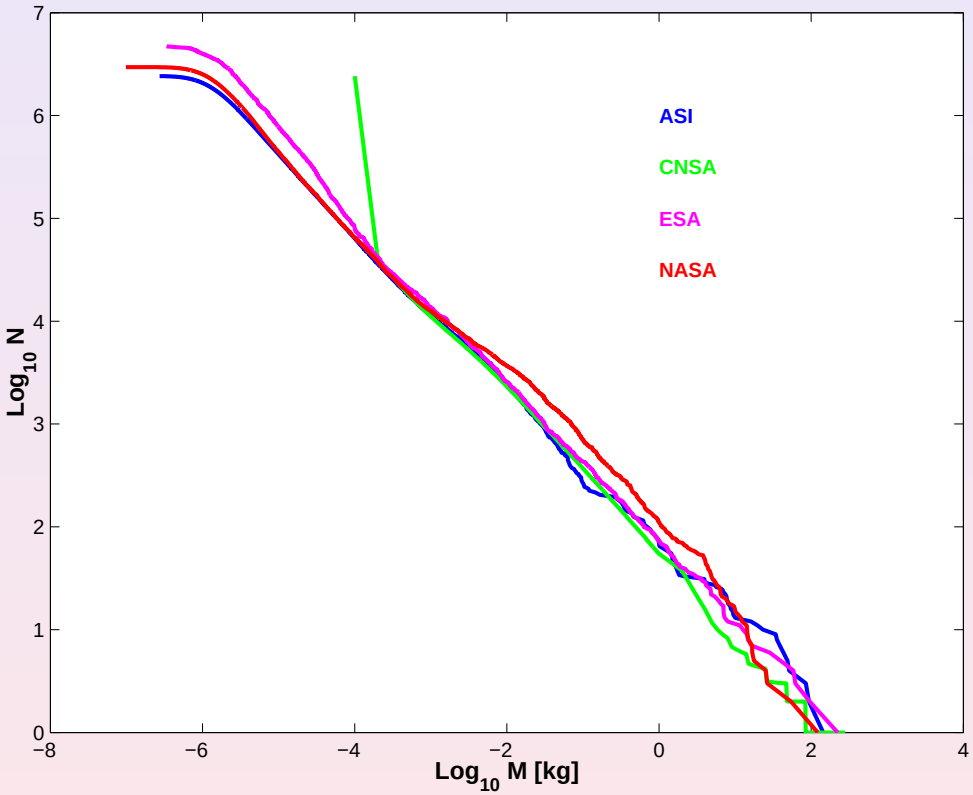
Distribution in 100 bins



Collision case – Results - Mass

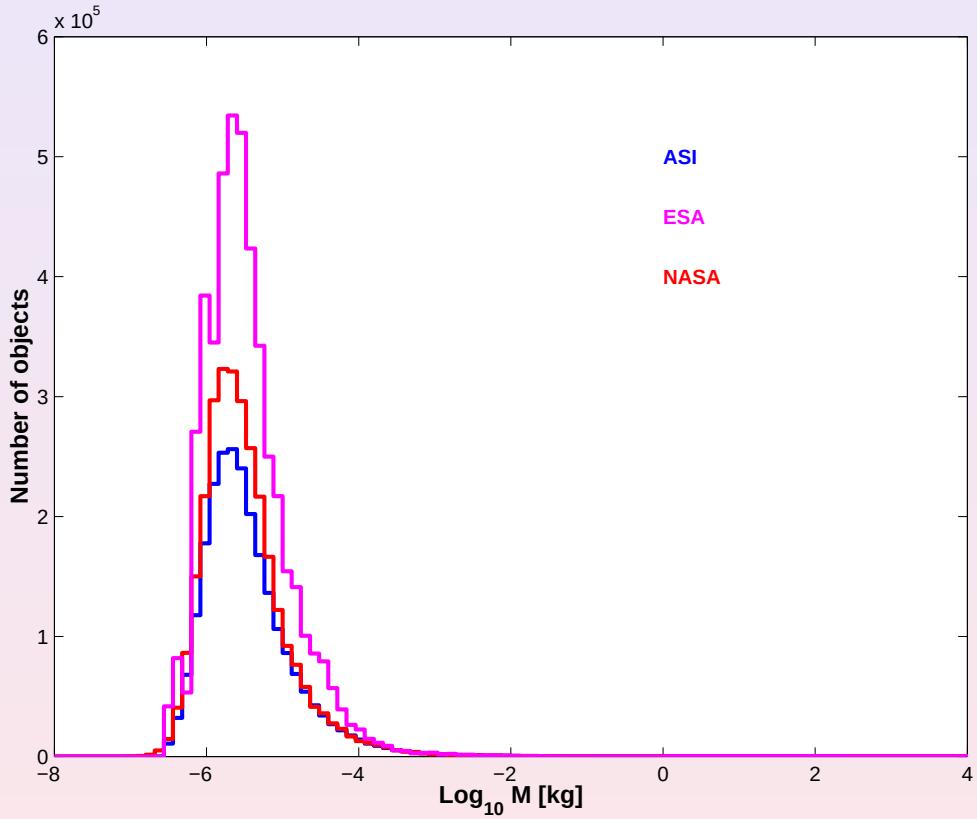
Number of objects larger than 1 gram:

- ASI: 11 330
- CNSA: $\sim$ 11 125
- ESA: 13 467
- NASA: 12 600



Collision case – Results - Mass

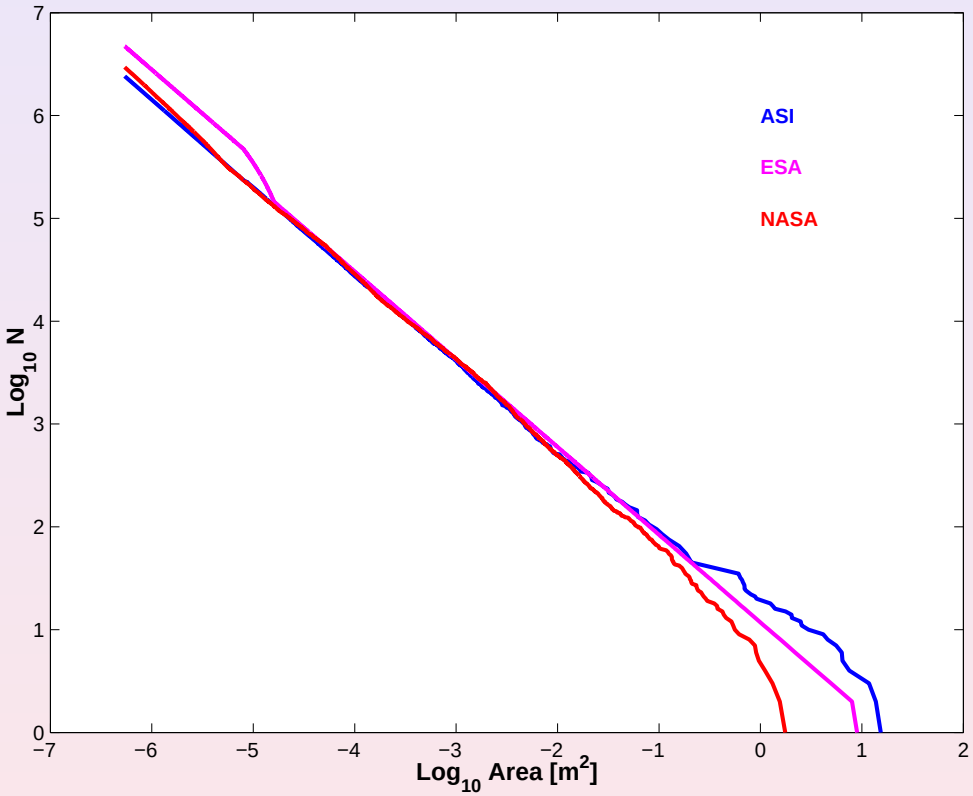
Distribution in 100 bins



Collision case – Results - Area

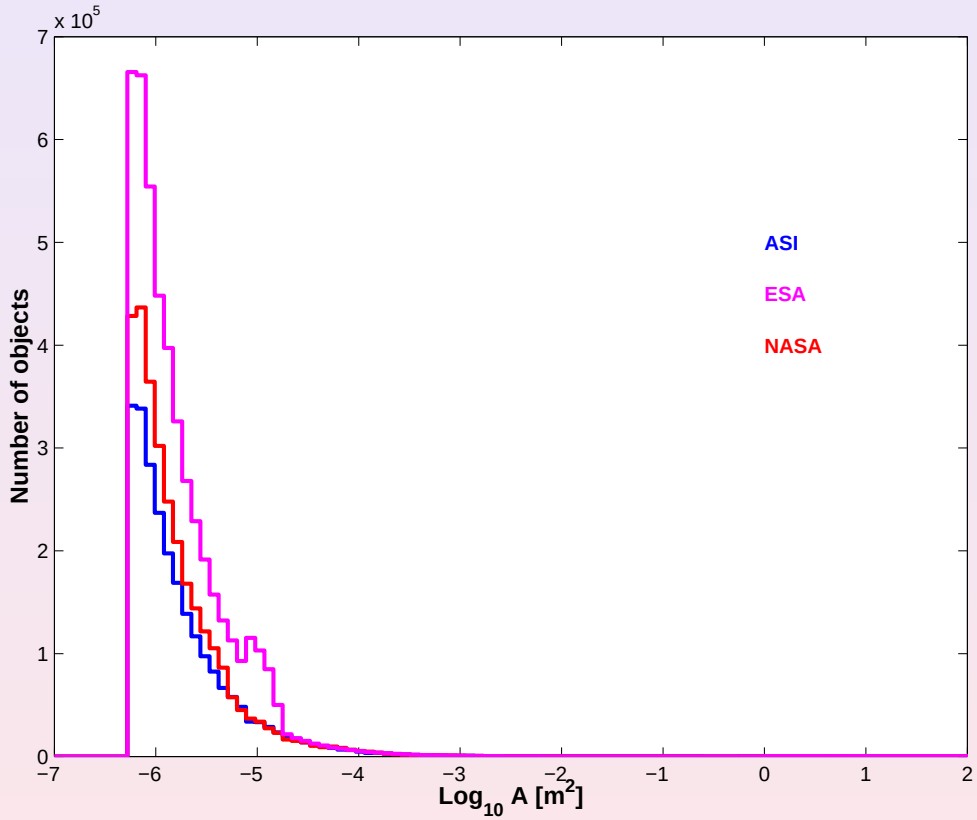
Number of objects with area larger than 1 cm^2:

- ASI: 27 450
- ESA: 30 366
- NASA: 28 892



Collision case – Results - Area

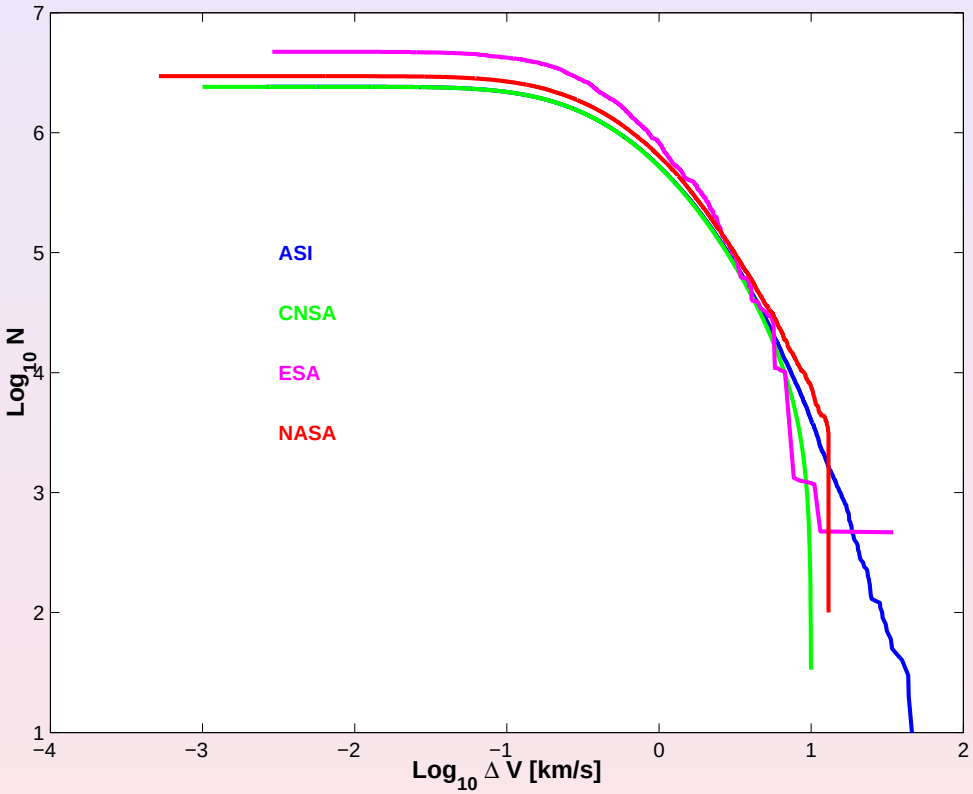
Distribution in 100 bins



Collision case – Results - ΔV

Number of objects with $\Delta V > 1$ km/s:

- ASI: 528 301
- CNSA: $\sim$ 523 120
- ESA: 822 539
- NASA: 638 537



Collision case – Results - ΔV

Distribution in 100 bins