Table 1 Volumes of each gas-expanding area of the GAEA and gas bottles collecting Hayabusa2 container gases

Area name	volume [cm^3]
V-Container	200
V-FL	15
V-Gauge	64
V-1	31.9
V-2	36.4
V-3	36.5
V-PQ	15.5
V-SORB	25.6
V-QMS (cross)	33.3
QMS (W)	296
V-QMSW [#]	329
V-NTTP	45.4
V-OP	53.7
V-CRTP	46.4

See Fig. 1 for area definition.

[#] V-QMSW = V-QMS (cross) + QMS (W).

Gas bottle	volume [cm^3]
Bottles at normal temperature	
NT #1 - #6	750
P-NT #1 - #6	40
Bottles for cold-trap	
CR #1 - #3	50
P-CR #1 - #3	15

P-: pipet attached to the bottle.

Table 2 Reduction factors of gases for measuring and collecting Hayabusa2 container gases using the GAEA

Description	Reduction condition	Fraction
Gases in the container after expanding to V-Gauge	(V-Container/V-Container+V-FL+V-Gauge)	0.717
Gases kept in V-PQ for the QMS measurement [a]	(V-PQ/V-Container+V-FL+V-Gauge+V-1+V-2+V-PQ)	0.0428
Gases collected in a NT bottle (each of NT #1 - #4) [b]	(V-Container+V-FL+V-Gauge+V-1+V-2/V-Container+V-FL+V-Gauge+V-1+V-2+V-PQ) × (NTbottle/V-Container+V-FL+V-Gauge+V-1+V-2+V-NTTP+4* NTbottle+4*P-NTbottle)	0.202
Gases collected in CR #1 [c]	(V-Container+V-FL+V-Gauge+V-1+V-2/V-Container+V-FL+V-Gauge+V-1+V-2+V-PQ) × (V-Gauge+V-1+V-2+V-NTTP/V-Container+V-FL+V-Gauge+V-1+V-2+V-NTTP+4* NTbottle+4*P-NTbottle) × (CRbottle/V-Gauge+V-1+V-2+V-3+V-NTTP+V-CRTP+CRbottle+P-CRbottle)	0.00736
Gases collected in CR #2 [c]	(V-Container+V-FL+V-Gauge+V-1+V-2/V-Container+V-FL+V-Gauge+V-1+V-2+V-PQ) × (V-Gauge+V-1+V-2+V-NTTP/V-Container+V-FL+V-Gauge+V-1+V-2+V-NTTP+4* NTbottle+4*P-NTbottle) × (V-Gauge+V-1+V-2+V-3+V-NTTP+V-CRTP/V-Gauge+V-1+V-2+V-3+V-NTTP+V-CRTP+CRbottle+P-CRbottle) × (V-CRbottle/V-Gauge+V-1+V-2+V-3+V-NTTP+V-CRTP+CRbottle+P-CRbottle)	0.00588
Gases collected in NT #6	V-Container+V-FL+V-Gauge+V-1+V-2/V-Container+V-FL+V-Gauge+V-1+V-2+V-PQ) × (V-Container+V-FL/V-Container+V-FL+V-Gauge+V-1+V-2+V-NTTP+4*NTbottle+4*P-NTbottle) × (V-Container+V-FL+V-Gauge+V-1+V-2/V-Container+V-FL+V-Gauge+V-1+V-2+V-PQ) × (NTbottle/V-Container+V-FL+V-Gauge+V-1+V-2+V-3+V-OP+NTbottle+P-NTbottle)	0.0339

See Fig. 2 and Table 1 for the area names and volumes.

Fractions are calculated using the area volumes shown in Table 1.

[a] Gases kept in V-PQ are reduced before introducing into the QMS if the gas pressure is high.

[b] Fraction of gases collected in each bottle of NT #1 - #4.

[c] Fraction of gases collected in CR #1 or CR #2 for the case assuming at normal temperature.

Table 3 Calibration condition, intensities of *m/z* 28 and 40, and sensitivity of ^{40}Ar

Calib. No	Date	Area during meas.[a]	Pressure in QMS [b] [Pa]	Amount of ^{40}Ar in QMS [cm^3STP]	I40 [A]	I28/I40	Sensitivity of ^{40}Ar [c] [cm^3STP/A]
8	7/8/20	PQ-	1.5E-05	4.37E-10	7.94E-13	120	550
9	7/14/20	PQ-	1.5E-05	4.33E-10	7.50E-13	184	577
10 (a)	7/21/20	PQ-	1.5E-05	4.29E-10	5.35E-13	90	802
10 (b)		V2-	3.1E-05	1.00E-09	1.70E-12	101	535
10 (c)		Vga-	6.6E-05	2.65E-09	3.50E-12	95	587
11 (a)	8/18/20	PQ-	1.5E-05	4.25E-10	4.92E-13	89	867
11 (b)		V2-	3.1E-05	9.96E-10	1.56E-12	87	563
11 (c)		V1-	2.5E-05	8.74E-10	1.00E-12	98	730
11 (d)		Vga-	4.4E-05	1.75E-09	2.00E-12	100	634
12	9/16/20	PQ-	1.5E-05	4.21E-10	8.05E-13	165	527
13 (a)		PQ-	6.0E-06	1.73E-10	2.65E-13	182	640
13 (b)		Vga-	3.9E-06	1.55E-10	1.44E-13	656	798
					Average of all data:	164	651
						±159	±119
					Average of data on 7/21 and 8/18:	94	653
						±6	±125

Quantitative terrestrial atmosphere was used as calibration gas. Volume fraction of ^{40}Ar is 0.0093.

[a] Areas to which calibration gases were introduced for the QMS measurements.

PQ-: [V-PQ + V-QMSW], V2-: [V-2 + V-PQ + V-QMSW], V1-: [V-1 + V-2 + V-PQ + V-QMSW], Vga-: [V-Gauge + V-1 + V-2 + V-PQ + V-QMSW]

[b] Pressures in the QMS during analyses are calculated based on the gas amounts and area volumes.

[c] Sensitivities are calculated using the measured data at 54 sec after introducing gases into the QMS.

All sensitivities are corrected as the analytical volume conditions to be [V-PQ + V-QMSW].

Table 4 Specifications and measured ranges of m/z for the QMS (Watmass) of the GAEA.

Specification	
Filament	Y_2O_3-Ir
Emission current	2 mA
Electron energy	70 eV
SEM voltage	900 V
Integration time	32 msec

Mode	SORB-AC [a]	Scan time [b]	*m/z*
Recipe 1. Peak scan	close	~120 sec (~6 scan)	peak scan from 1 to 100
Recipe 2. Peak jump	close	~90 sec	peak jump at 2, 3, 4, 14, 15, 16, 17, 18, 28, 29, 32, 34, 40, 44, 45, 46, 64, 66, 69, 78
Recipe 3. Peak scan	open	~90 sec (~10 scan)	peak scan from 1 to 44
Recipe 4. Peak jump	open	~90 sec	peak jump at 1, 2, 3, 4, 6, 12, 16, 18, 20, 21, 22, 24, 28, 29, 30, 32, 33, 34, 36, 38, 40, 44, 45, 46, 69, 78, 84, 132
Recipe 5. Peak scan		optional	peak scan from 1 to 200

A procedure plan used for the measurements of gases in the Hayabusa2 sample container.

Measurements are performed sequentially from Recipe 1 to Recipe 4 in each gas fraction.

Recipe 5 is also applied in the case where gas amount is high.

[a] Gases are measured without SORB-AC, and then with SORB-AC by opening the valve.

[b] Basic scan time is shown here. It is manually operated according to measured gas amounts and compositions.