

Additional parameters of program system BLUH

x, y = image coordinates normalized to maximal radial distance 162.6mm (scale factor: 162.6 / maximal radial distance) $r^2 = x^2 + y^2$ $b = \arctan (y/x)$ t_{gps} =GPS time
Pxx = numerical value of additional parameter

parameters 1 – 12 = basic set of additional parameters

1. $x' = x - y \cdot P1$	$y' = y - x \cdot P1$	angular affinity
2. $x' = x - x \cdot P2$	$y' = y + y \cdot P2$	affinity
3. $x' = x - x \cdot \cos 2b \cdot P3$	$y' = y - y \cdot \cos 2b \cdot P3$	
4. $x' = x - x \cdot \sin 2b \cdot P4$	$y' = y - y \cdot \sin 2b \cdot P4$	
5. $x' = x - x \cdot \cos b \cdot P5$	$y' = y - y \cdot \cos b \cdot P5$	
6. $x' = x - x \cdot \sin b \cdot P6$	$y' = y - y \cdot \sin b \cdot P6$	
7. $x' = x + y \cdot r \cdot \cos b \cdot P7$	$y' = y - x \cdot r \cdot \cos b \cdot P7$	tangential distortion 1
8. $x' = x + y \cdot r \cdot \sin b \cdot P8$	$y' = y - x \cdot r \cdot \sin b \cdot P8$	tangential distortion 2
9. $x' = x - x \cdot (r^2 - 16384) \cdot P9$	$y' = y - y \cdot (r^2 - 16384) \cdot P9$	radial symmetric r^3
10. $x' = x - x \cdot \sin(r \cdot 0.049087) \cdot P10$	$y' = y - y \cdot \sin(r \cdot 0.049087) \cdot P10$	radial symmetric
11. $x' = x - x \cdot \sin(r \cdot 0.098174) \cdot P11$	$y' = y - y \cdot \sin(r \cdot 0.098174) \cdot P11$	radial symmetric
12. $x' = x - x \cdot \sin 4b \cdot P12$	$y' = y - y \cdot \sin 4b \cdot P12$	
13. $x' = x + x \cdot P13$	$y' = y + y \cdot P13$	= focal length or GPS shift Z
14. $x' = x + P14$	$y' = y$	= principal point x or GPS shift x'
15. $x' = x$	$y' = y + P15$	= principal point y or GPS shift y'
16. $x' = x + x \cdot t_{gps} \cdot P16$	$y' = y + y \cdot t_{gps} \cdot P16$	GPS drift Z
17. $x' = x + t_{gps} \cdot P17$	$y' = y$	GPS drift x'
18. $x' = x$	$y' = y + t_{gps} \cdot P18$	GPS drift y'
19. $x' = x + (x \cdot \cos \kappa + y \cdot \sin \kappa) \cdot P19$	$y' = y$	GPS-datum X
20. $x' = x$	$y' = y + (-x \cdot \sin \kappa + y \cdot \cos \kappa) \cdot P20$	GPS-datum Y
21. $x' = x$	$y' = y + t_{gps}^2 \cdot P21$	
22. $x' = x - (y/f - x/r^2) \cdot P22$	$y' = y - (y/f - y/(c^2 + y^2)) \cdot P22$	
23. $x' = x - \arctan y/x \cdot P23$	$y' = y$	
24. $x' = x - \sin (y/300.) \cdot P24$	$y' = y$	
25. $x' = x$	$y' = y - \sin (y/300) \cdot P25$	
26. $x' = x - \sin (y/150.) \cdot P26$	$y' = y$	22 - 26 for panoramic photos
27. $x' = x - x \cdot \sin(r \cdot 0.08)/r^{3/2} \cdot P27$	$y' = y - y \cdot \sin(r \cdot 0.08)/r^{3/2} \cdot P27$	27 - 28 for special camera
28. $x' = x - x \cdot (r^4 - 2.6843 \cdot 108) \cdot P28$	$y' = y - y \cdot (r^4 - 2.6843 \cdot 108) \cdot P28$	calibration (fish eye)
29. $x' = x - ((0.9 \cdot x + 1.11 \cdot y) \cdot x) \cdot P29$	$y' = y - ((1.11 \cdot y + 0.9 \cdot x) \cdot y) \cdot P29$	DMC excentricity

parameters 30 – 41 individual parameters for DMC-quarter images – should not be used together with parameter 79

30. $x' = x$	$y' = y - x \cdot x - 32 \cdot x \cdot P30$	for lower right quarter	DMC
31. $x' = x$	$y' = y - x \cdot x + 32 \cdot x \cdot P30$	for lower left quarter	DMC
32. $x' = x$	$y' = y - x \cdot x + 32 \cdot x \cdot P30$	for upper left quarter	DMC
33. $x' = x$	$y' = y - x \cdot x - 32 \cdot x \cdot P30$	for upper right quarter	DMC
34. $x' = x - x \cdot y \cdot P34$	$y' = y$	for upper right quarter	DMC
35. $x' = x$	$y' = y - x \cdot y \cdot P35$	for upper right quarter	DMC
36. $x' = x - x \cdot y \cdot P36$	$y' = y$	for lower right quarter	DMC
37. $x' = x$	$y' = y - x \cdot y \cdot P37$	for lower left quarter	DMC
38. $x' = x$	$y' = y - x \cdot y \cdot P37$	for lower left quarter	DMC
39. $x' = x$	$y' = y - x \cdot y \cdot P38$	for lower left quarter	DMC
40. $x' = x - x \cdot y \cdot P40$	$y' = y$	for upper left quarter	DMC
41. $x' = x$	$y' = y - x \cdot y \cdot P41$	for upper left quarter	DMC

parameters 42 – 73 camera specific parameters for UltraCam

UltraCam sub-images: 7 8 1
 6 2
 5 4 3

BSXU=11.25 BSYU=17.25 for vertical UltraCam format
 BSXU=17.25 BSYU=11.25 for horizontal UltraCam format

42 – 49 scale parameters for UltraCam
 50 – 57 shift X parameters for UltraCam
 58 – 65 shift Y parameters for UltraCam
 66 – 73 rotation parameters for UltraCam

42. $x' = x - BSXU \cdot P42$	$y' = y - BSYU \cdot P42$	UltraCam sub area 1
43. $x' = x - BSXU \cdot P43$	$y' = y$	UltraCam sub area 2
44. $x' = x - BSXU \cdot P44$	$y' = y + BSYU \cdot P44$	UltraCam sub area 3
45. $x' = x$	$y' = y + BSYU \cdot P45$	UltraCam sub area 4
46. $x' = x + BSXU \cdot P46$	$y' = y + BSYU \cdot P46$	UltraCam sub area 5
47. $x' = x + BSXU \cdot P47$	$y' = y$	UltraCam sub area 6
48. $x' = x + BSXU \cdot P48$	$y' = y - BSYU \cdot P48$	UltraCam sub area 7
49. $x' = x$	$y' = y - BSYU \cdot P49$	UltraCam sub area 8

50. $x' = x - P50$	$y' = y$	UltraCam sub area 1
51. $x' = x - P51$	$y' = y$	UltraCam sub area 2
52. $x' = x - P52$	$y' = y$	UltraCam sub area 3
53. $x' = x - P53$	$y' = y$	UltraCam sub area 4
54. $x' = x - P54$	$y' = y$	UltraCam sub area 5
55. $x' = x - P55$	$y' = y$	UltraCam sub area 6
56. $x' = x - P56$	$y' = y$	UltraCam sub area 7
57. $x' = x - P57$	$y' = y$	UltraCam sub area 8

58. $x' = x$	$y' = y - P58$	UltraCam sub area 1
59. $x' = x$	$y' = y - P59$	UltraCam sub area 2
60. $x' = x$	$y' = y - P60$	UltraCam sub area 3
61. $x' = x$	$y' = y - P61$	UltraCam sub area 4
62. $x' = x$	$y' = y - P62$	UltraCam sub area 5
63. $x' = x$	$y' = y - P63$	UltraCam sub area 6
64. $x' = x$	$y' = y - P64$	UltraCam sub area 7
65. $x' = x$	$y' = y - P65$	UltraCam sub area 8

66. $x' = x - (y - BSYU) \cdot P66$	$y' = y + (x - BSXU) \cdot P66$	UltraCam sub area 1
67. $x' = x - y \cdot P67$	$y' = y + (x - BSXU) \cdot P67$	UltraCam sub area 2
68. $x' = x - (y + BSYU) \cdot P68$	$y' = y + (x - BSXU) \cdot P68$	UltraCam sub area 3
69. $x' = x - (y + BSYU) \cdot P69$	$y' = y + x \cdot P69$	UltraCam sub area 4
70. $x' = x - (y + BSYU) \cdot P70$	$y' = y + (x + BSXU) \cdot P70$	UltraCam sub area 5
71. $x' = x - y \cdot P71$	$y' = y + (x + BSXU) \cdot P71$	UltraCam sub area 6
72. $x' = x - (y - BSYU) \cdot P72$	$y' = y + (x - BSXU) \cdot P72$	UltraCam sub area 7
73. $x' = x - (y - BSYU) \cdot P73$	$y' = y + x \cdot P73$	UltraCam sub area 8

74 – 77 distortion of DMC sub-cameras (view direction $x = 10.06^\circ$, view direction $y = 17.66^\circ$)

$$WX = \text{atan}(x/120.) \quad WY = \text{atan}(y/120.) \quad WR = \sqrt{WX^2 + WY^2} \quad RO = \sqrt{x^2 + y^2}$$

for $x > 0$. and $y < 0$. : $WTX = WX - 0.17558$ $WTY = WY + 0.30823$

for $x > 0$. and $y > 0$. : $WTX = WX - 0.17558$ $WTY = WY - 0.30823$

for x<0. and y>0. : WTX=WX+0.17558 WTY=WY-0.30823

for x<0. and y<0. : WTX=WX-0.17558 WTY=WY+0.30823

$$RSING = \sqrt{(120 \cdot \tan(WTX))^2 + (120 \cdot \tan(WTY))^2}$$

$$FACR = (RSING^2 - 1850.) \cdot 1.0E-7$$

$$FACRX = FACR \cdot 120 \cdot \tan(WTX)$$

$$FACRY = FACR \cdot 120 \cdot \tan(WTY)$$

$$FACRS = (FACRX \cdot x/RO + FACRY \cdot y/RO) / (\cos(WR) \cdot \cos(WR))$$

$$FACTS = -(FACRX \cdot y/RO + FACRY \cdot x/RO) / \cos(WR)$$

$$74. \quad x' = x - FACRS \cdot x/RO - FACTS \cdot y/RO \cdot P74 \quad y' = y - FACRS \cdot y/RO + FACTS \cdot x/RO \cdot P74$$

$$75. \quad x' = x - FACRS \cdot x/RO - FACTS \cdot y/RO \cdot P75 \quad y' = y - FACRS \cdot y/RO + FACTS \cdot x/RO \cdot P75$$

$$76. \quad x' = x - FACRS \cdot x/RO - FACTS \cdot y/RO \cdot P76 \quad y' = y - FACRS \cdot y/RO + FACTS \cdot x/RO \cdot P76$$

$$77. \quad x' = x - FACRS \cdot x/RO - FACTS \cdot y/RO \cdot P77 \quad y' = y - FACRS \cdot y/RO + FACTS \cdot x/RO \cdot P77$$

parameter 79 = common change of focal length of DMC-sub-cameras

$$79. \quad x' = x - x \cdot |y| \cdot 0.000188 \cdot P79 \quad y' = y - (|x| \cdot y^3 \cdot 0.000000015 + y^3 \cdot 0.0000012) \cdot P79$$

parameter 80 = same formula like 74 – 77, but one value for all sub-cameras

parameter 80 should not be used together with parameters 74 - 77

$$80. \quad x' = x - FACRS \cdot x/RO - FACTS \cdot y/RO \cdot P80 \quad y' = y - FACRS \cdot y/RO + FACTS \cdot x/RO \cdot P80$$