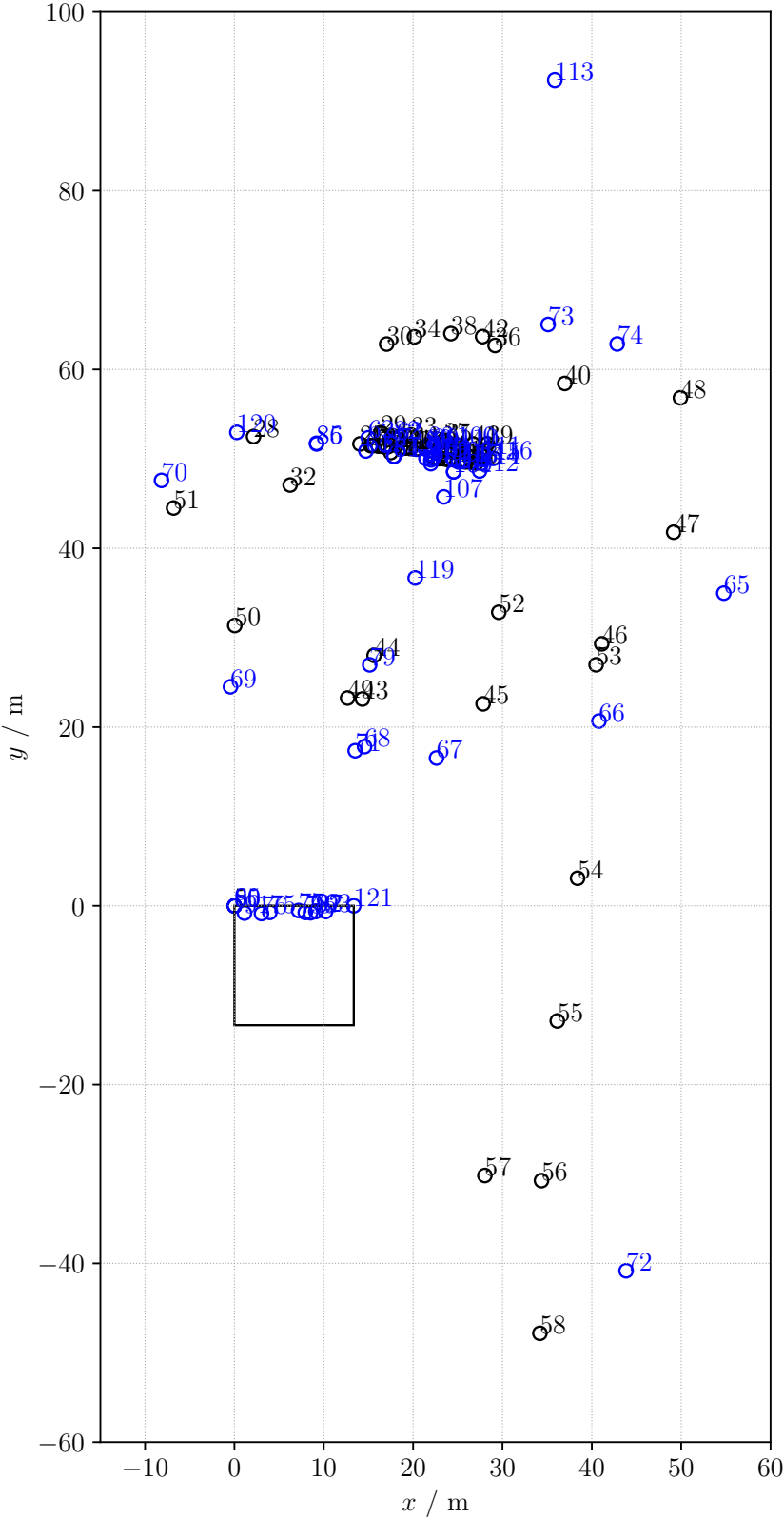


Coordinate System



The horizontal (x, y) coordinates were derived from the ‘raw’ cartesian set, translated, so that the origin matches the north-east corner of the facilities building, and rotated so that the x -axis is parallel to that building. For the elevation z the target staff height, which matched the height of the total station’s measure head, was subtracted from z_{raw} . $z = 0$ is therefore the (averaged) elevation of the ground at the location of the total station.

Label Explanation:

ref[1,2]-*	Reference points (building corners)
pad[1–4], pipe[1–3]	charge hole (pipe) locations
pad[1–4], balls[1,2]	pre-blast location of buried balls
pad[1–4], ej.br.[1,2]-[1,2]	ejecta branch [1 or 2], [start,end]
EL[1,2]	electrostatic field sensors
mic [0°–180°]	BYU microphones
gi[1–4]	BYU ground impedance
80m	the ‘80 meter’ point
daq	BYU data acquisition
pad[1–4], block[1–4]	photogrammetry helpers
4k[1–6]	4k video camera ring
FLIR[1,2]	thermal cams (Dave: did you run #2?)
Kestrel	weather tool
tree	tree location on which a camera was mounted
[INGV,UB]-[c1,c2,NAC,cam#2]-pad[1–4]	roof top cameras
pp-pad[1–4], [1–6]	post-blast ping-pong balls

Table 1: Positions in common coordinate system.

point #	label	x m	y m	z m
5	ref1-1	0.000	0.000	2.764
6	pad1, pipe1	15.481	51.474	−1.273
7	pad1, pipe2	16.096	51.427	−1.284
8	pad1, pipe3	16.712	51.357	−1.263
9	pad2, pipe1	19.100	51.213	−1.264
10	pad2, pipe2	19.718	51.157	−1.245
11	pad2, pipe3	20.349	51.083	−1.242
12	pad2, pipe1a	22.894	50.031	−1.275
13	pad3, pipe1	22.874	50.027	−1.265
14	pad3, pipe2	23.183	50.533	−1.270
15	pad3, pipe3	23.493	50.002	−1.265
16	pad4, pipe1	25.988	49.668	−1.276
17	pad4, pipe2	26.317	50.168	−1.283
18	pad4, pipe3	26.581	49.628	−1.254
19	pad1, balls1	15.240	51.485	−1.433
20	pad1, balls2	17.183	51.359	−1.416
21	pad2, balls1	18.606	51.281	−1.428
22	pad2, balls2	20.543	51.133	−1.411
23	pad3, balls1	22.396	50.110	−1.421

Table 1: Positions in common coordinate system.

point #	label	x m	y m	z m
24	pad3, balls2	23.971	49.886	-1.424
25	pad4, balls1	25.720	49.679	-1.412
26	pad4, balls2	27.058	49.532	-1.400
27	pad1, ej.br.1-1	14.047	51.672	-1.469
28	pad1, ej.br.1-2	2.140	52.500	-1.710
29	pad1, ej.br.2-1	16.364	52.932	-1.470
30	pad1, ej.br.2-2	17.039	62.839	-2.064
31	pad2, ej.br.1-1	17.491	50.706	-1.386
32	pad2, ej.br.1-2	6.235	47.075	-1.487
33	pad2, ej.br.2-1	19.765	52.667	-1.447
34	pad2, ej.br.2-2	20.147	63.645	-2.000
35	pad3, ej.br.1-1	23.715	51.960	-1.451
36	pad3, ej.br.1-2	29.170	62.681	-1.852
37	pad3, ej.br.2-1	23.446	52.084	-1.441
38	pad3, ej.br.2-2	24.227	64.011	-1.961
39	pad4, ej.br.1-1	28.291	51.693	-1.502
40	pad4, ej.br.1-2	36.969	58.435	-1.847
41	pad4, ej.br.2-1	26.699	51.670	-1.470
42	pad4, ej.br.2-2	27.777	63.673	-1.892
43	EL1	14.328	23.140	-1.317
44	EL2	15.633	28.021	-1.289
45	mic 90°	27.831	22.600	-1.299
46	mic 120°	41.106	29.312	-1.410
47	mic 150°	49.160	41.798	-1.525
48	mic 180°	49.914	56.829	-1.898
49	mic 60°	12.666	23.251	-1.241
50	mic 30°	0.042	31.359	-0.680
51	mic 0°	-6.808	44.505	-1.684
52	byu-?	29.586	32.840	-1.218
53	gi1	40.479	26.967	-1.309
54	gi2	38.403	3.081	-0.060
55	gi3	36.134	-12.879	-0.024
56	gi4	34.364	-30.743	0.502
57	80m	28.028	-30.173	0.487
58	daq	34.187	-47.821	2.038
60	ref1-2	0.000	0.000	2.770
61	pad1, block1	14.714	50.882	-1.341
62	pad1, block2	14.975	52.357	-1.368
63	pad1, block3	18.159	52.183	-1.337
64	pad1, block4	17.868	50.276	-1.319
65	4k6	54.769	34.981	-1.520
66	4k5	40.793	20.676	-0.888
67	4k4	22.615	16.543	-0.139
68	4k3	14.565	17.814	1.459
69	4k2	-0.436	24.506	0.729

Table 1: Positions in common coordinate system.

point #	label	x m	y m	z m
70	4k1	-8.162	47.594	-0.919
71	FLIR1	13.519	17.357	-0.288
72	FLIR2	43.833	-40.829	0.820
73	Kestrel	35.106	65.026	-1.988
74	tree	42.837	62.851	-2.025
75	UB-c1-pad1	3.969	-0.737	5.085
76	UB-c2-pad1	3.026	-0.868	5.007
77	INGV-NAC-pad1	7.184	-0.526	4.906
78	INGV-cam#2-pad1	7.931	-0.746	4.697
79	unknown	15.139	26.961	-
80	ref1-3	0.017	-0.021	2.769
81	pad2, block1	17.841	50.291	-1.319
82	pad2, block2	17.840	52.305	-1.340
83	pad2, block3	21.702	51.614	-1.332
84	pad2, block4	21.435	50.068	-1.303
85	pp-pad2, 1	9.184	51.746	-1.600
86	pp-pad2, 2	9.203	51.670	-1.597
87	pp-pad2, 3	16.925	51.544	-1.624
88	pp-pad2, 4	21.369	51.116	-1.388
89	pp-pad2, 5	21.483	51.328	-1.388
90	pp-pad2, 6	22.224	50.930	-1.388
91	UB-c1-pad2	1.129	-0.816	5.103
92	UB-c2-pad2	9.119	-0.614	4.937
93	INGV-NAC-pad2	10.207	-0.643	4.944
94	INGV-cam#2-pad2	-	-	-
95	ref1-4	0.006	-0.020	2.773
96	UB-c1-pad2a	8.526	-0.781	5.033
97	UB-c2-pad2a	9.129	-0.618	4.941
98	pad3, block1	21.978	49.465	-1.295
99	pad3, block2	22.221	51.440	-1.331
100	pad3, block3	24.885	51.581	-1.363
101	pad3, block4	24.542	48.569	-1.250
102	pp-pad3, 1	21.996	49.883	-1.363
103	pp-pad3, 2	22.161	50.117	-1.374
104	pp-pad3, 3	22.031	50.525	-1.369
105	pp-pad3, 4	24.536	49.892	-1.384
106	pp-pad3, 5	24.545	49.925	-1.389
107	pp-pad3, 6	23.431	45.749	-1.312
108	tree-cam	-	-	-
109	pad4, block1	24.525	48.546	-1.289
110	pad4, block2	25.177	51.438	-1.358
111	pad4, block3	27.760	50.561	-1.323
112	pad4, block4	27.442	48.646	-1.292
113	pp-pad4, 1	35.854	92.379	-2.993
114	pp-pad4, 2	27.648	49.504	-1.332

Table 1: Positions in common coordinate system.

point #	label	x m	y m	z m
115	pp-pad4, 3	27.650	49.917	-1.342
116	pp-pad4, 4	28.979	50.058	-1.450
117	pp-pad4, 5	25.581	49.710	-1.361
118	pp-pad4, 6	25.081	49.657	-1.342
119	pp-pad4, 7	20.232	36.681	-1.278
120	pp-pad4, ?	0.274	52.964	-1.756
121	ref2-2	13.357	0.000	2.703

Raw Data

Position data were measured in spherical coordinates. Angles are stored in decimal degrees. The polar angle ϕ is recorded clockwise (I don't know why), in the range $0^\circ \leq \phi \leq 360^\circ$. The azimuth is the standard $0^\circ \leq \theta \leq 90^\circ$. The spherical coordinate were converted into a 'raw' cartesian set $(x_{\text{raw}}, y_{\text{raw}}, z_{\text{raw}})$ with

$$\begin{aligned}
x_{\text{raw}} &= r \cos(-\phi\pi/180^\circ) \sin(\theta\pi/180^\circ) \\
y_{\text{raw}} &= r \sin(-\phi\pi/180^\circ) \sin(\theta\pi/180^\circ) \\
z_{\text{raw}} &= r \cos(\theta\pi/180^\circ)
\end{aligned}$$

Table 2: Raw data.

point #	h_{off} m	r m	ϕ °	θ °	x_{raw} m	y_{raw} m	z_{raw} m
5	0.000	26.091	266.0937	87.4541	-1.776	26.005	1.159
6	1.915	36.530	23.5036	91.5113	33.488	-14.563	-0.963
7	1.935	36.394	24.4506	91.5016	33.119	-15.059	-0.954
8	1.925	36.246	25.4001	91.4915	32.731	-15.542	-0.943
9	1.935	35.895	29.1611	91.4908	31.335	-17.485	-0.934
10	1.905	35.811	30.1440	91.5127	30.957	-17.977	-0.945
11	1.905	35.719	31.1512	91.5119	30.558	-18.471	-0.942
12	1.935	34.710	35.3223	91.5605	28.310	-20.061	-0.945
13	1.925	34.705	35.2900	91.5604	28.317	-20.042	-0.945
14	1.915	35.224	35.5941	91.5616	28.580	-20.574	-0.960
15	1.935	34.718	36.3128	91.5425	27.965	-20.552	-0.935
16	2.105	34.649	40.4714	91.2832	26.352	-22.484	-0.776
17	2.125	35.165	41.1541	91.2438	26.598	-23.029	-0.763
18	1.905	34.703	41.4505	91.5746	26.001	-22.964	-0.954
19	1.605	36.593	23.1328	92.2440	33.625	-14.365	-1.433
20	1.605	36.210	26.1412	92.2418	32.481	-15.941	-1.416
21	1.605	36.009	28.3820	92.2730	31.656	-17.103	-1.428
22	1.605	35.781	31.4632	92.2606	30.497	-18.661	-1.411
23	1.605	34.782	34.4957	92.3418	28.642	-19.682	-1.421
24	1.605	34.656	37.1157	92.3554	27.612	-20.895	-1.424
25	1.605	34.642	40.0307	92.3355	26.503	-22.263	-1.412
26	1.605	34.703	42.2544	92.3123	25.665	-23.316	-1.400

Table 2: Raw data.

point #	h_{off} m	r m	ϕ °	θ °	x_{raw} m	y_{raw} m	z_{raw} m
27	1.605	36.986	21.3523	92.2755	34.420	-13.456	-1.469
28	1.605	41.688	5.2755	92.3515	41.476	-3.830	-1.710
29	1.605	37.868	25.1617	92.2254	34.249	-16.088	-1.470
30	1.605	47.669	27.4417	92.4820	42.266	-21.947	-2.064
31	1.605	35.528	26.5220	92.2350	31.765	-15.853	-1.386
32	1.605	35.012	7.2206	92.4334	34.703	-4.397	-1.487
33	1.605	37.334	30.3018	92.2212	32.209	-18.823	-1.447
34	1.605	48.312	31.2011	92.3722	41.288	-25.006	-2.000
35	1.605	36.703	36.4425	92.2656	29.503	-21.785	-1.451
36	1.605	48.027	42.0140	92.2105	35.657	-32.121	-1.852
37	1.605	36.808	36.0108	92.2436	29.751	-21.624	-1.441
38	1.605	48.772	36.0107	92.3040	39.420	-28.652	-1.961
39	1.605	37.057	43.5541	92.3229	26.834	-25.513	-1.502
40	1.605	45.941	52.5645	92.3038	27.903	-36.449	-1.847
41	1.605	36.755	41.1247	92.2915	27.665	-24.154	-1.470
42	1.605	48.794	40.2031	92.2227	37.239	-31.473	-1.892
43	1.605	10.343	351.3850	97.3149	10.143	1.537	-1.317
44	1.605	13.807	9.0944	95.3557	13.574	-2.173	-1.289
45	1.605	9.993	75.5114	97.4700	2.479	-9.593	-1.299
46	1.605	24.466	87.4943	93.3030	1.068	-24.402	-1.410
47	1.605	38.610	79.0515	92.2633	7.327	-37.878	-1.525
48	1.605	50.547	67.1254	92.1522	19.635	-46.539	-1.898
49	1.605	11.558	345.4727	96.1637	11.124	2.882	-1.241
50	1.605	26.395	339.5257	91.4752	24.719	9.230	-0.680
51	1.605	40.330	348.5424	92.3926	39.492	8.004	-1.684
52	1.605	19.474	58.3416	93.5849	10.201	-16.544	-1.218
53	1.605	22.665	91.4700	93.3100	-0.580	-22.620	-1.309
54	1.605	21.278	157.5845	90.1608	-19.670	-8.114	-0.060
55	1.605	32.039	184.1604	90.0427	-31.955	2.324	-0.024
56	1.605	48.014	196.1535	89.4006	-46.116	13.357	0.502
57	1.605	46.091	203.5446	89.3949	-42.252	18.411	0.487
58	1.605	64.589	200.5141	88.1914	-60.463	22.623	2.038
60	0.000	26.080	263.3250	87.4401	-3.028	25.877	1.165
61	1.605	36.088	19.4049	92.1301	34.014	-11.982	-1.341
62	1.605	37.498	20.1925	92.0912	35.170	-12.935	-1.368
63	1.605	36.942	25.0308	92.0735	33.451	-15.620	-1.337
64	1.605	35.067	24.3140	92.1559	31.934	-14.428	-1.319
65	1.605	39.048	89.3349	92.2307	0.453	-39.016	-1.520
66	1.605	20.478	104.4841	92.4856	-5.117	-19.808	-0.888
67	1.605	1.971	83.1202	94.0352	0.236	-1.952	-0.139
68	0.000	6.913	320.1409	91.2106	5.305	4.430	-0.146
69	0.000	23.345	322.5319	92.1516	18.516	14.191	-0.876
70	0.000	43.550	347.3134	93.3228	42.415	9.548	-2.524
71	1.605	7.775	314.2637	92.1223	5.423	5.564	-0.288
72	1.605	60.660	187.4152	89.2251	-60.147	7.828	0.820

Table 2: Raw data.

point #	h_{off} m	r m	ϕ °	θ °	x_{raw} m	y_{raw} m	z_{raw} m
73	1.605	51.644	45.3216	92.2057	36.285	-36.695	-1.988
74	1.605	52.281	54.1648	92.2203	30.585	-42.353	-2.025
75	0.000	23.726	256.1348	81.5654	-5.624	22.786	3.480
76	0.000	24.489	257.4406	82.0136	-5.274	23.671	3.402
77	0.000	21.344	250.5444	81.1041	-7.024	19.883	3.301
78	0.000	21.004	248.5932	81.5343	-7.583	19.342	3.092
79	-	13.511	2.5314	74.1518	12.985	-0.574	3.690
80	0.000	26.079	263.2653	87.4408	-3.055	25.873	1.164
81	1.605	35.085	24.2731	92.1550	31.961	-14.413	-1.319
82	1.605	37.090	24.5539	92.0709	33.714	-15.403	-1.340
83	1.605	36.268	30.5537	92.1046	31.211	-18.424	-1.332
84	1.605	34.718	30.1602	92.1505	29.997	-17.431	-1.303
85	1.605	38.284	11.4508	92.3958	37.489	-7.594	-1.600
86	1.605	38.206	11.4426	92.3954	37.414	-7.573	-1.597
87	1.605	36.436	23.0155	92.5553	33.502	-14.232	-1.624
88	1.605	35.768	30.0356	92.2244	30.942	-17.890	-1.388
89	1.605	35.981	30.2138	92.2107	31.070	-18.093	-1.388
90	1.605	35.600	31.4147	92.2351	30.359	-18.542	-1.388
91	0.000	25.896	260.3651	82.2358	-4.294	25.297	3.498
92	0.000	20.217	246.1833	80.5137	-8.052	18.242	3.332
93	0.000	19.621	243.5450	80.2011	-8.614	17.310	3.339
94	0.000	-	-	-	-	-	-
95	0.000	26.087	263.2810	87.4347	-3.049	25.882	1.168
96	0.000	20.718	247.2345	80.4753	-7.907	18.841	3.428
97	0.000	20.215	246.1535	80.5017	-8.061	18.236	3.336
98	1.605	34.126	31.0851	92.1741	29.205	-17.607	-1.295
99	1.605	36.107	31.3824	92.1128	30.804	-18.790	-1.331
100	1.605	36.434	35.5700	92.1443	29.615	-21.179	-1.363
101	1.605	33.401	35.5308	92.1444	27.163	-19.397	-1.250
102	1.605	34.547	31.0945	92.2613	29.560	-17.828	-1.363
103	1.605	34.786	31.3557	92.2632	29.682	-18.087	-1.374
104	1.605	35.189	31.1229	92.2302	30.101	-18.175	-1.369
105	1.605	34.720	35.2908	92.2842	28.317	-20.043	-1.384
106	1.605	34.754	35.3004	92.2902	28.341	-20.067	-1.389
107	1.605	30.495	34.0116	92.4649	25.255	-17.042	-1.312
108	0.000	-	-	-	-	-	-
109	1.605	33.377	35.5058	92.2130	27.151	-19.370	-1.289
110	1.605	36.324	36.0514	92.1428	29.347	-21.362	-1.358
111	1.605	35.846	40.3207	92.1155	27.312	-23.179	-1.323
112	1.605	33.906	40.4000	92.1830	25.802	-21.959	-1.292
113	1.605	78.473	40.3909	92.1859	59.725	-50.813	-2.993
114	1.605	34.788	40.4655	92.1942	26.447	-22.561	-1.332
115	1.605	35.194	40.3407	92.1858	26.806	-22.766	-1.342
116	1.605	35.609	42.4007	92.3337	26.274	-23.992	-1.450
117	1.605	34.660	37.0422	92.2510	27.644	-20.863	-1.361

Table 2: Raw data.

point #	h_{off} m	r m	ϕ °	θ °	x_{raw} m	y_{raw} m	z_{raw} m
118	1.605	34.545	36.2312	92.2259	27.844	-20.402	-1.342
119	1.605	21.358	27.3425	93.4303	18.938	-9.792	-1.278
120	1.605	42.974	0.5852	92.3417	42.936	-0.439	-1.756
121	0.000	17.221	236.0218	86.3448	-9.605	14.251	1.098