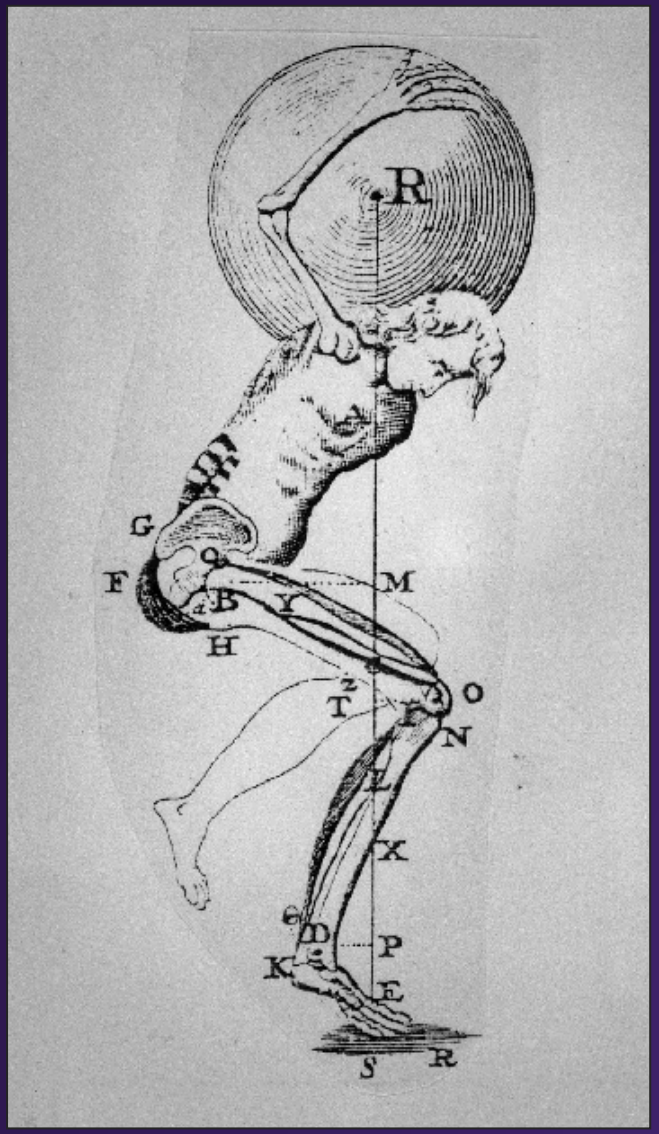


Musculoskeletal Biomechanics

BIOEN 520 | ME 527

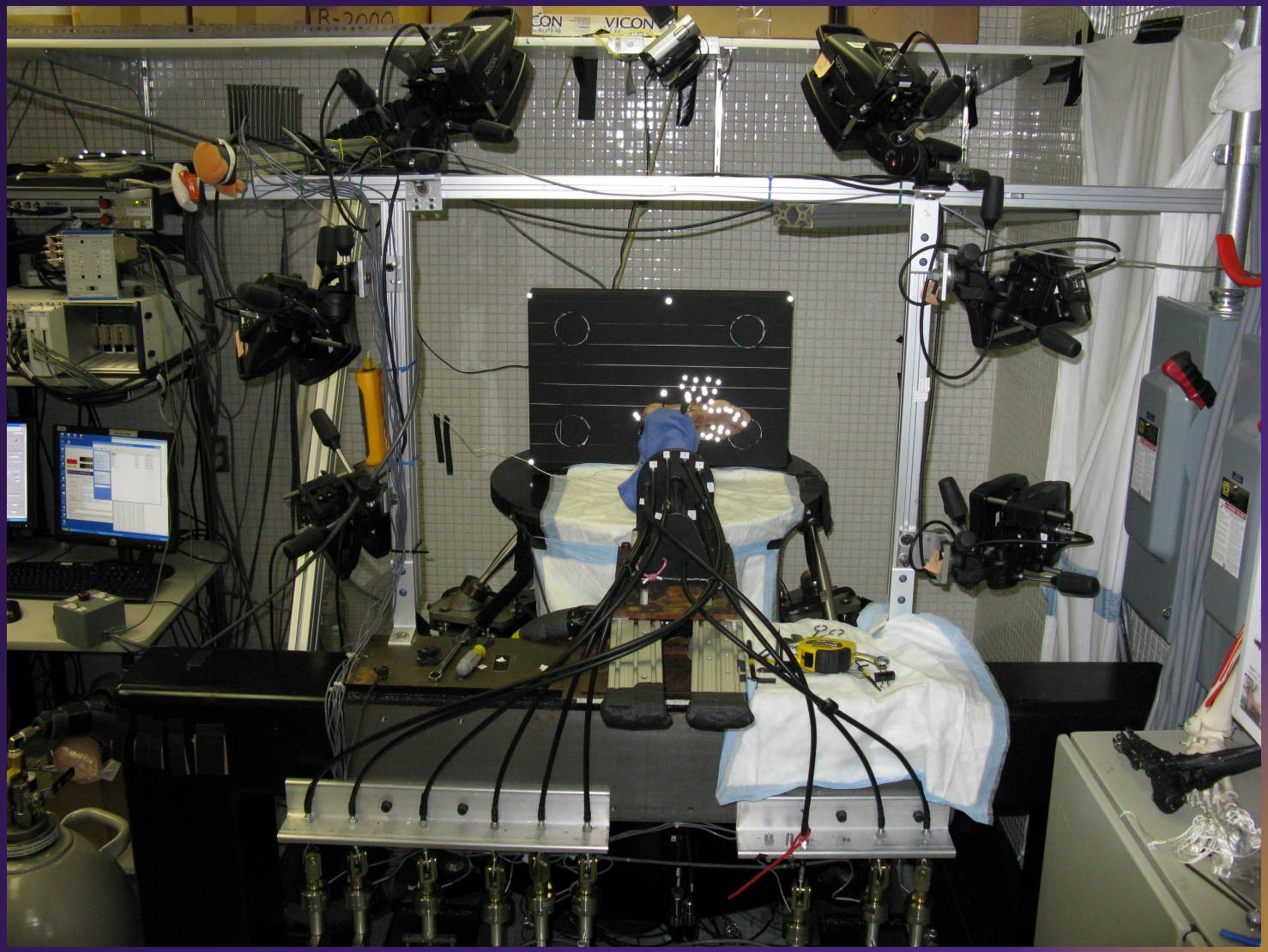
Lab 2

Cadaveric Gait Simulation

Lab 2 Overview...

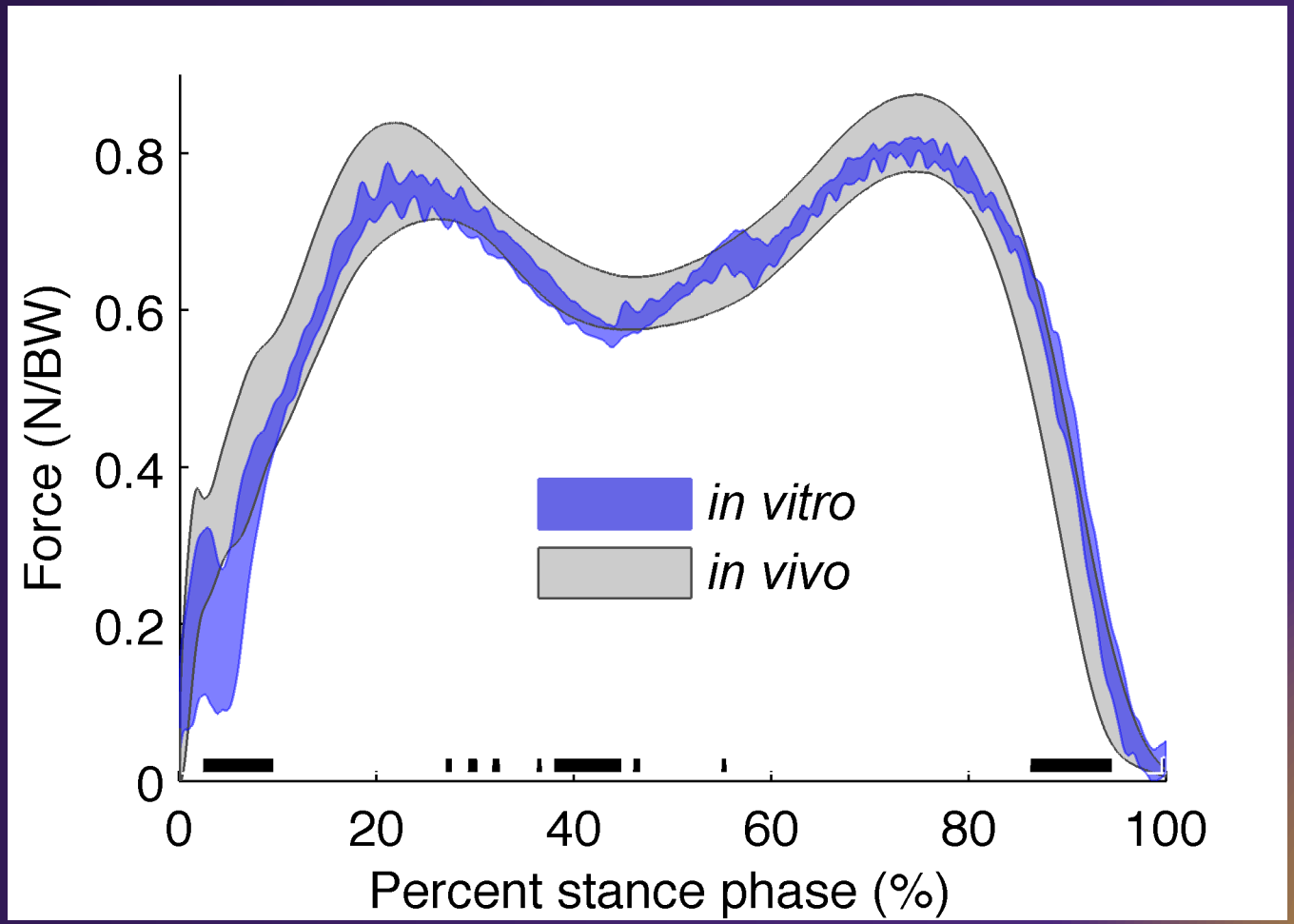
- Gait lab tour and demo
- Biomechanical testing lab tour and demo
- Lab 2 assignment

Robotic Gait Simulator



vGRF with the RGS

3 learning cycles, 5.6% BW RMS tracking error

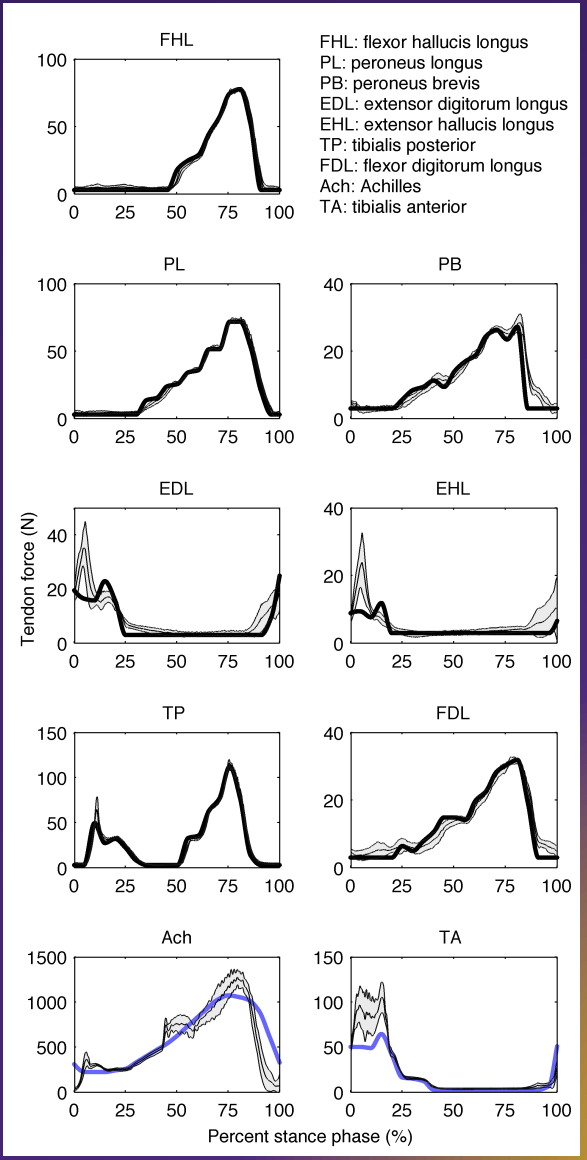


Muscle forces with the RGS

RMS tracking error for extrinsic tendons ranged from 2.6N for FDL to 5.6N for TP

mean value of 3.9N across all 18 final trials

TA and Achilles were adjusted by controller



RGS

- *inputs:*

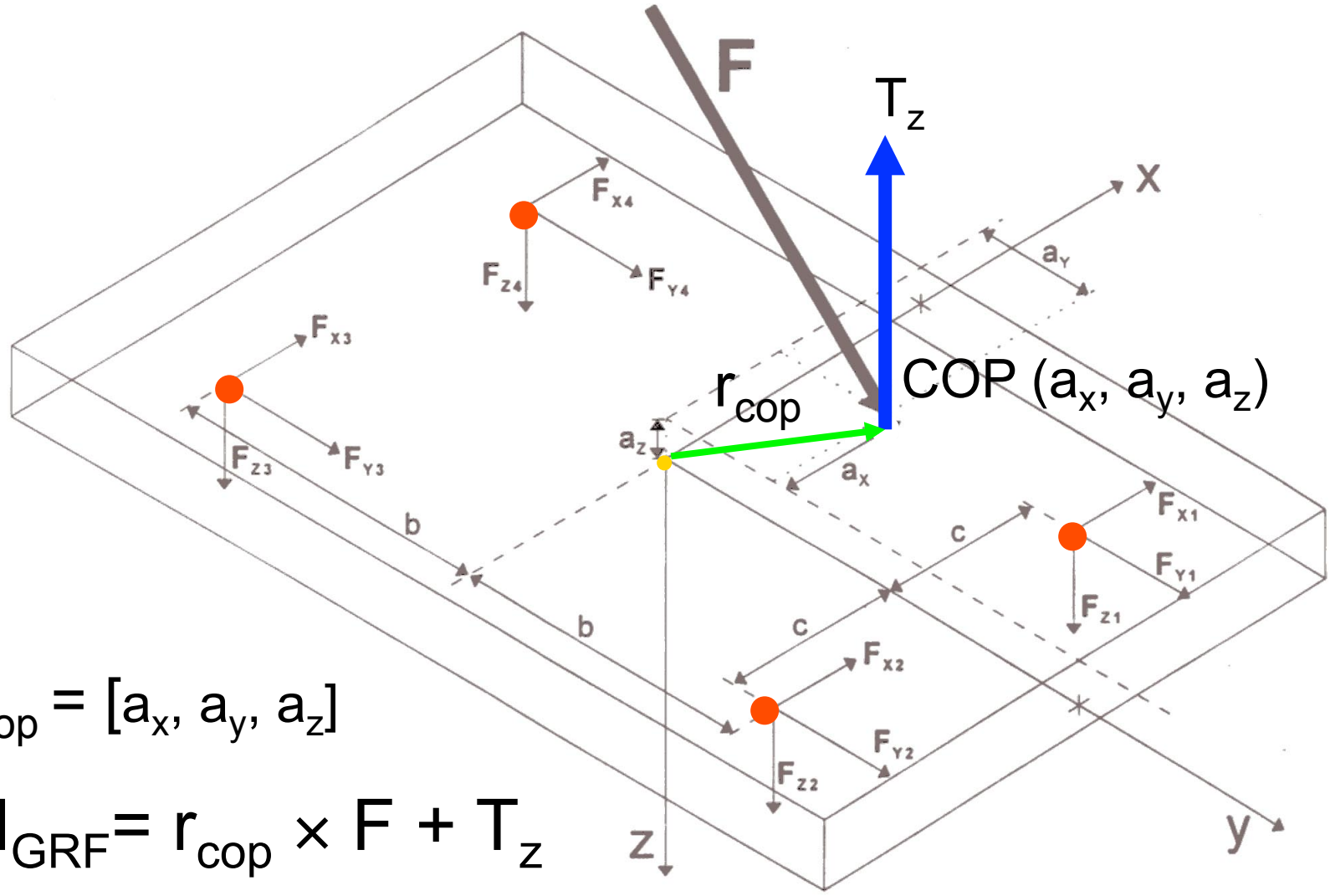
  tibia kinematics, muscle forces, and the vertical ground reaction force
- *outputs:*

  plantar pressure, center of pressure (CoP), and foot bone kinematics

Lab assignment

- Part I: Calculate CoP from force plate
  - Kistler, 8 channels (8 forces)
  - AMTI, 6 channels (3 forces and 3 moments)
  - 1000Hz, mechanical grounding
- Part II: Compare CoP from force plate to pressure mat
  - array of many small capacitive force sensors
  - 36 Hz, more coarse

Summing GRF



$r_{cop} = [a_x, a_y, a_z]$

$M_{GRF} = r_{cop} \times F + T_z$

Data header

#7/12/2013																		
#11:18 AM																		
#0180L																		
#Simulation number: 10																		
#BW=889.000000																		
#Total simulation time (sec): 4.09200																		
#Foot type: Left_Foot																		
#Motor number: 1 (Ach) 3 (PB_) 4 (EDL) 5 (EHL) 6 (TA_) 7 (TP_) 8 (FDL) 9 (FHL)																		
#Motor gains: 1 (0.260) 3 (0.250) 4 (0.250) 5 (0.250) 6 (0.250) 7 (0.250) 8 (0.250) 9 (0.250)																		
#Force units Newtons. Tigger units Volts.																		
#MTR1	MTR2	MRT3	MRT4	MRT5	MRT6	MRT7	MRT8	MRT9	GRF_Z1	GRFZ2	GRF_Z3	GRF_Z4	GRF_X12	GRF_X34	GRF_Y14	GRF_Y23	Trig	Fach	Fta
#Fuzzy iterative vGRF control simulation.																		
#Precondition simulation number 3 of 3																		
14.905	4.011	4.001	6.903	3.81	16.975	3.961	4.014	5.271	-0.464	3.54	6.596	5.116	-0.27	2.053	-3.535	-1.988	5.11	26	16.49
13.285	4.011	3.942	6.862	3.904	18.264	3.93	4.014	5.271	-1.548	13.554	5.046	16.584	-0.219	8.922	-8.444	-2.42	5.124	26	11.362
12.859	4.011	4.001	6.741	3.951	18.472	3.961	3.989	5.293	-1.781	10.365	8.838	11.239	-0.329	4.521	-7.678	-5.797	5.109	26	12.835
12.688	3.983	4.001	6.822	3.951	18.679	3.93	3.965	5.316	-1.565	6.728	12.728	6.175	0.103	0.875	-6.895	-9.369	5.12	26	14.346
12.432	3.983	4.001	6.822	3.857	18.804	3.961	4.014	5.271	-1.065	4.171	15.036	3.56	1.405	-0.838	-6.592	-11.392	5.119	26	15.338
12.177	4.011	4.119	6.862	3.998	18.97	3.992	4.038	5.293	-0.481	3.656	14.904	4.222	3.266	-0.016	-6.987	-11.18	5.117	26	15.463

Data header

#7/12/2013									
#11:18 AM									
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#Simulation number: 10									
#BW=889.000000									
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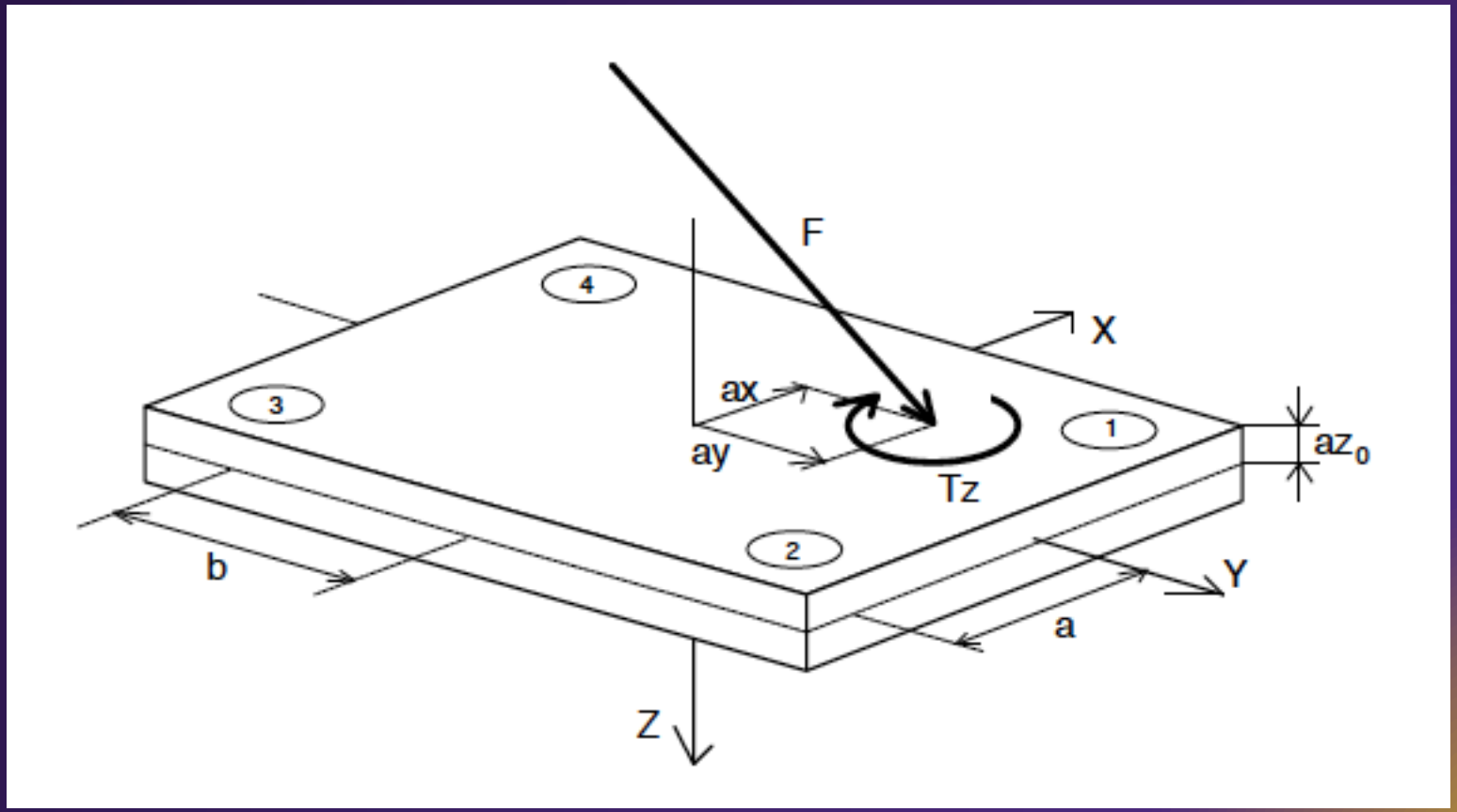
#Motor gains: 1 (0.260) 3 (0.250) 4 (0.250) 5 (0.250) 6 (0.250) 7 (0.250) 8 (0.250) 9 (0.250)									
#Force units Newtons. Tigger units Volts.									
#MTR1	MTR2	MRT3	MRT4	MRT5	MRT6	MRT7	MRT8	MRT9	GRF_Z1
#Fuzzy iterative vGRF control simulation.									
#Precondition simulation number 3 of 3									
14.905	4.011	4.001	6.903	3.81	16.975	3.961	4.014	5.271	-0.464
13.285	4.011	3.942	6.862	3.904	18.264	3.93	4.014	5.271	-1.548
12.859	4.011	4.001	6.741	3.951	18.472	3.961	3.989	5.293	-1.781
12.688	3.983	4.001	6.822	3.951	18.679	3.93	3.965	5.316	-1.565
12.432	3.983	4.001	6.822	3.857	18.804	3.961	4.014	5.271	-1.065
12.177	4.011	4.119	6.862	3.998	18.97	3.992	4.038	5.293	-0.481

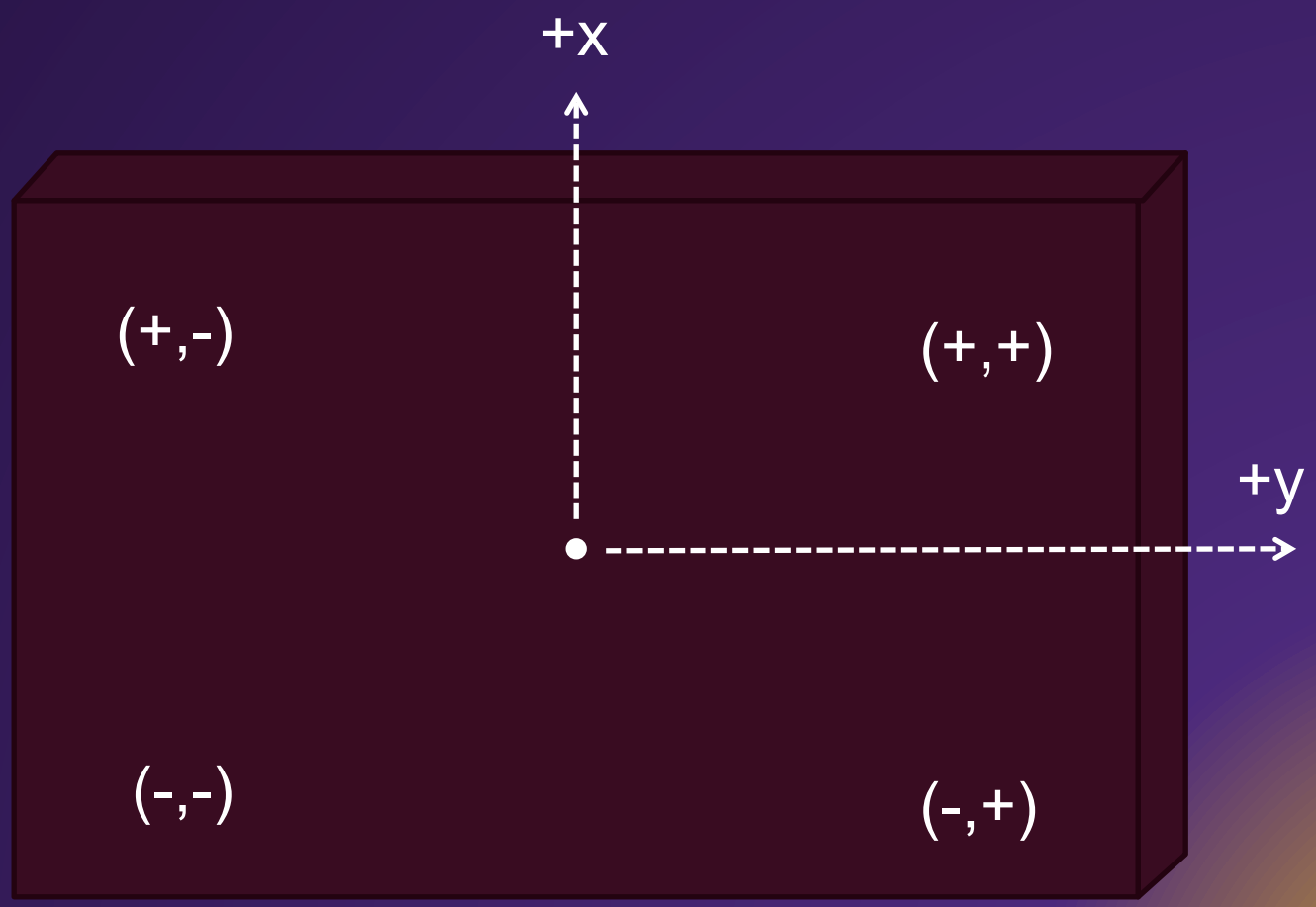
Data header

GRF_Z1	GRFZ2	GRF_Z3	GRF_Z4	GRF_X12	GRF_X34	GRF_Y14	GRF_Y23	Trig	Fach	Fta
-0.464	3.54	6.596	5.116	-0.27	2.053	-3.535	-1.988	5.11	26	16.49
-1.548	13.554	5.046	16.584	-0.219	8.922	-8.444	-2.42	5.124	26	11.362
-1.781	10.365	8.838	11.239	-0.329	4.521	-7.678	-5.797	5.109	26	12.835
-1.565	6.728	12.728	6.175	0.103	0.875	-6.895	-9.369	5.12	26	14.346
-1.065	4.171	15.036	3.56	1.405	-0.838	-6.592	-11.392	5.119	26	15.338
-0.481	3.656	14.904	4.222	3.266	-0.016	-6.987	-11.18	5.117	26	15.463
-0.048	5.15	12.53	7.482	4.983	2.825	-7.804	-9.03	5.123	26	14.905
0.036	7.857	9.431	11.421	5.6	6.073	-8.36	-5.738	5.123	26	14.172
-0.264	10.697	6.761	13.92	4.737	8.362	-8.192	-2.36	5.123	26	13.745
-0.731	12.242	5.607	13.804	2.598	8.888	-7.105	0.035	5.111	26	14.056
-1.181	12.308	6.662	11.222	-0.033	7.302	-5.388	0.687	5.121	26	14.905
-1.348	10.581	9.036	7.267	-2.096	4.903	-3.645	-0.456	5.108	26	16.698
-1.281	8.488	11.41	3.775	-2.688	2.443	-2.744	-2.403	5.119	26	18.052
-1.115	7.193	12.992	2.038	-1.775	0.349	-3.106	-4.019	5.117	26	18.797
-0.931	7.26	12.695	2.501	-0.168	-0.228	-4.369	-4.57	5.13	26	19.038

Force plate dimensions



Kistler force plate coordinate system



novel pressure mat coordinate system