



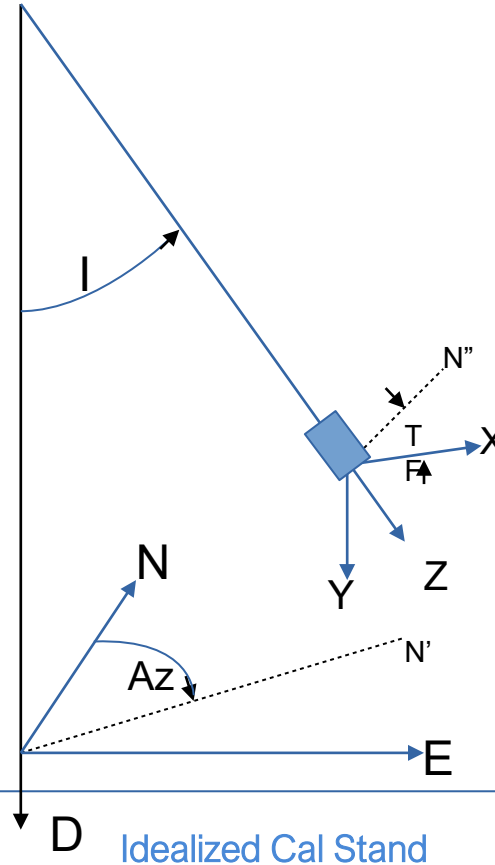
Sweep Calibration for MWD

Brett VanSteenwyk, Algorithms and Analytical
Thinking

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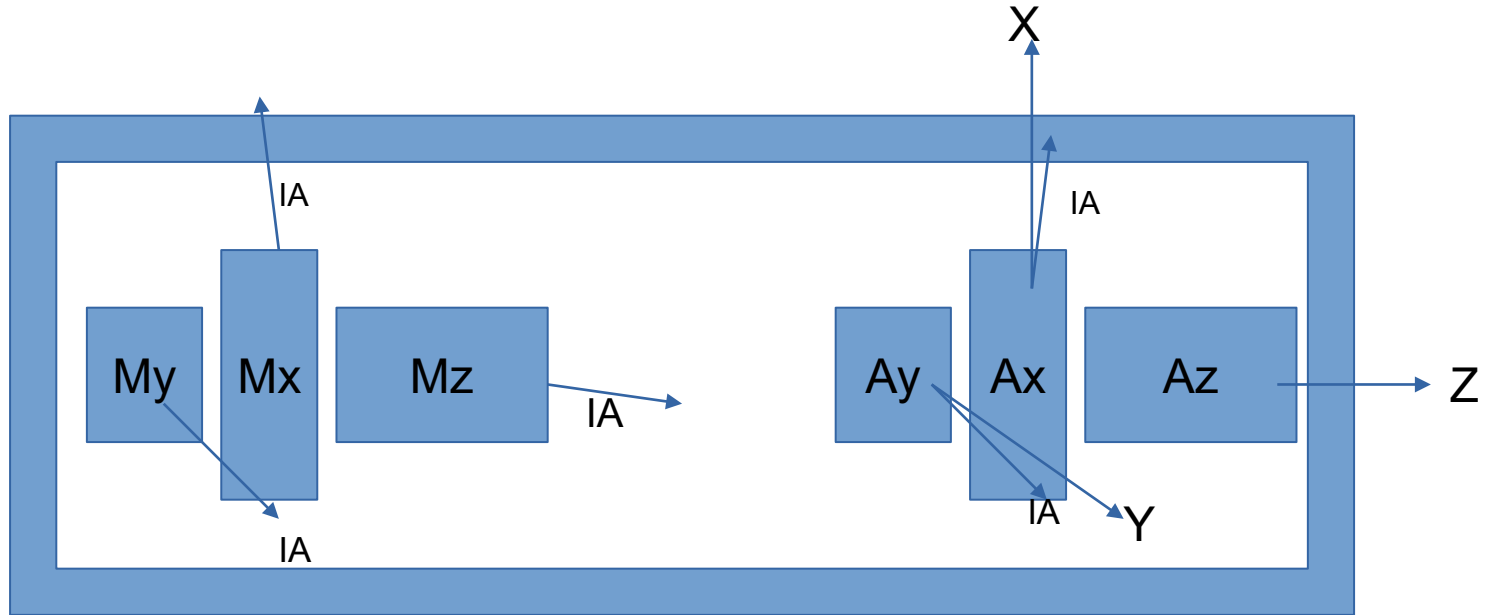
Wellbore Positioning Technical Section

Az: [N,E,D] to [N',E',D']
Inc: [N',E',D'] to [N'',E'',D'']
HTF: [N'',E'',D''] to [X,Y,Z]



Idealized Cal Stand

IA of A_z defines tool Z axis, IA of A_x in plane of X, Y is orthogonal to X



Idealized MWD Tool



Wellbore Positioning Technical Section



The Industry Steering Committee on
Wellbore Survey Accuracy (ISCWSA)

Term	X-accel	Y-accel	Z-accel	X-magnet	Y-magnet	Z-magnet	Manual angles
Scale	0.02%	0.02%	0.02%	0.03%	0.03%	0.03%	θ_{mxy} $=0.02^\circ$
Bias	0.176mg	0.189mg	0.171mg	7nT	7nT	7nT	K_{mzx} $=0.02^\circ$
Misalign	K_{axz} $=0.029^\circ$	θ_{ayx} $=0.028^\circ$	K_{ayz} $=0.029^\circ$	K_{mxz} $=0.035^\circ$	θ_{myx} $=0.035^\circ$	K_{myz} $=0.035^\circ$	K_{mzy} $=0.02^\circ$

48 readings, 18

unknowns Total Field Calibration Uncertainties, Accel & Mag



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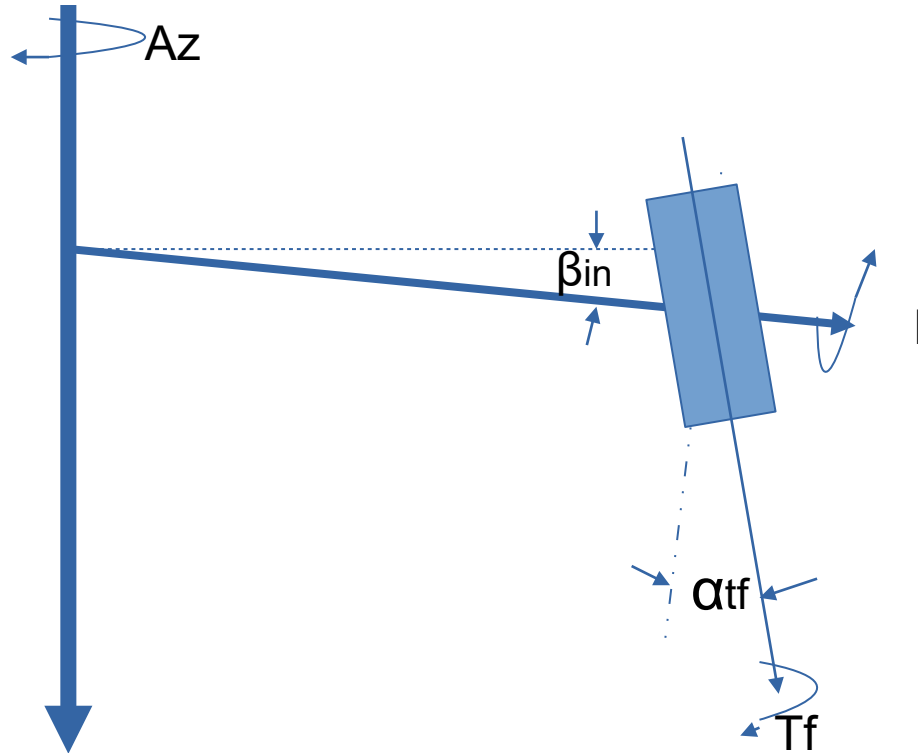
Term	X-accel	Y-accel	Z-accel	X-magnet	Y-Magnet	Z-magnet
Scale	0.023%	0.023%	0.023%	0.023%	0.023%	0.022%
Bias	0.17mg	0.17mg	0.17mg	7nT	7nT	7nT
Misalign	Kaxz =0.028°	θ_{ayx} =0.028°	Kayz =0.027°	Kmxz =0.027°	θ_{myx} =0.026°	Kmyz =0.027°
Misalign B				θ_{mxy} =0.027°	Kmzx =0.029°	Kmzy =0.029°

48 Readings, 21
unknowns

Total Field Calibration w/Dip

144 accelerometer
readings, 11
parameters
144 magnetometer
readings, 12
parameters

For 2 sweeps at 8
inclinations
each, 3 offsets:
2, 0, 1
3 Stand
misalignments



Stand Behavior: Only 2 Misalignments that are Fundamental (not Offsets)



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Term	X-accel	Y-accel	Z-accel	X-magnet	Y-magnet	Z-magnet
Scale	0.022%	0.023%	0.013%	0.033%	0.034%	0.025%
Bias	0.2mg	0.2mg	0.1mg	11nT	11nT	5nT
Misalign	Kaxz =0.012°	θayx =0.02°	Kayz =0.012°	Kmxz =0.022°	θmyx =0.03°	Kmyz =0.022°
Misalign B		Kazx =0.008°	Kazy =0.008°	θmxy =0.025°	Kmzx =0.008°	Kmzy =0.007°

Nominal Sweep Cal Results



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Term	X-accel	Y-accel	Z-accel	X-magnet	Y-magnet	Z-magnet
Scale	0.017%	0.016%	0.011%	0.014%	0.014%	0.016%
Bias	0.07mg	0.07mg	0.1mg	4nT	4nT	4nT
Misalign	Kaxz =0.008°	θayx =0.013°	Kayz =0.006°	Kmxz =0.008°	θmyx =0.014°	Kmyz =0.008°
Misalign B		Kazx =0.008°	Kazy =0.008°	θmxy =0.013°	Kmzx =0.008°	Kmzy =0.008°