

Weight data from ATK points

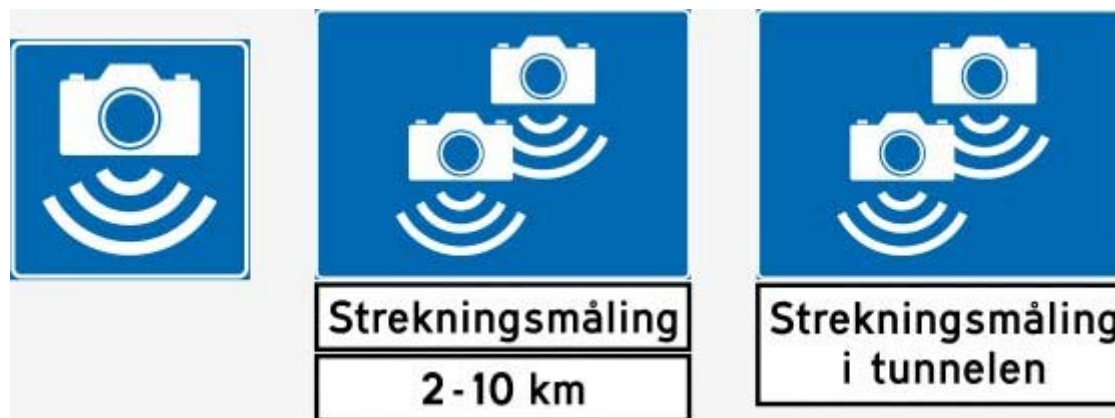
A solid base for weight statistics?

Vektdata fra ATK-punkt

Kan disse benyttes til vektstatistikk?

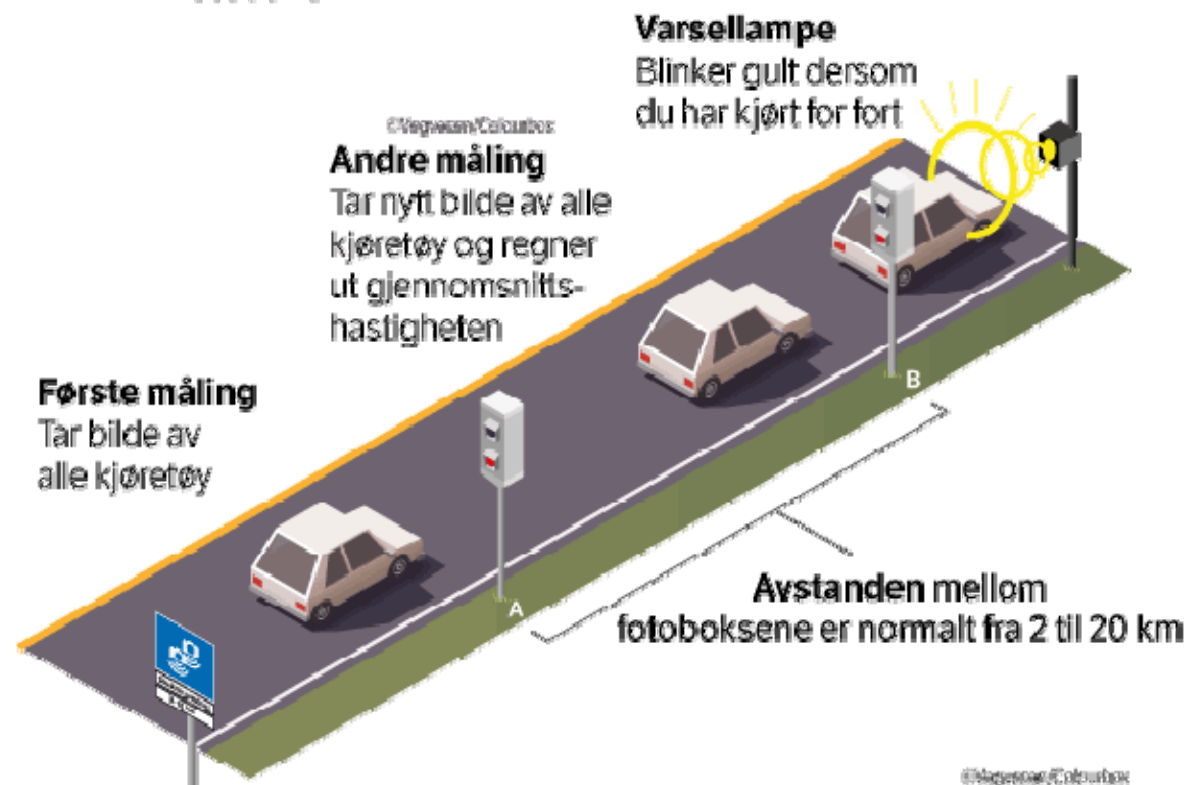
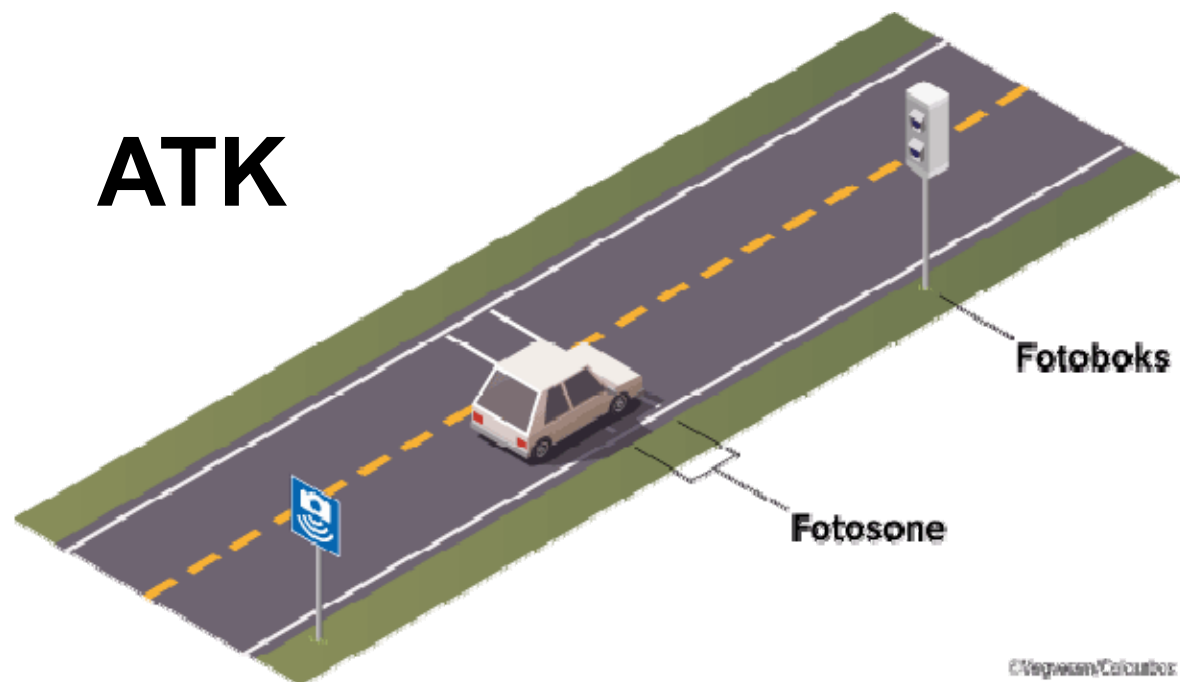
ATK

- Used for speed enforcement in Norway
- Wide coverage (250 units) across the whole country
- Operated with piezo electrical cables
- Could ATK weight data be used for WIM purposes?



ATK signs

ATK



ATK Punkt

- Consist out of a camera unit and two piezo electrical cables



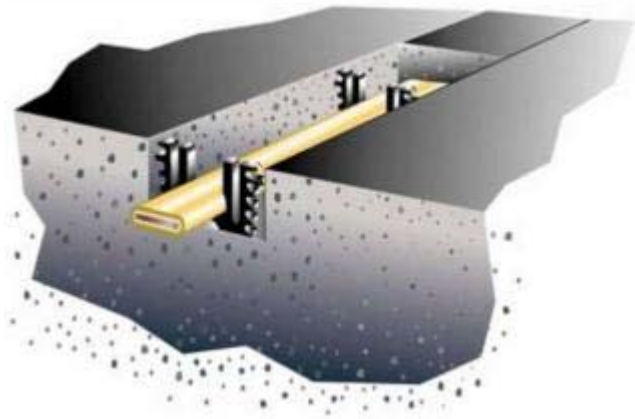
Piezoelektriske kabler på E18 Dørdal



Kamera på E18 Dørdal

Data kvalitet

- AxSpeed 100 / 200 DataRec 410
- Round / flat piezoelectric cables
- Pavement / ground consistency
- Vehicle movement characteristics



Field studies

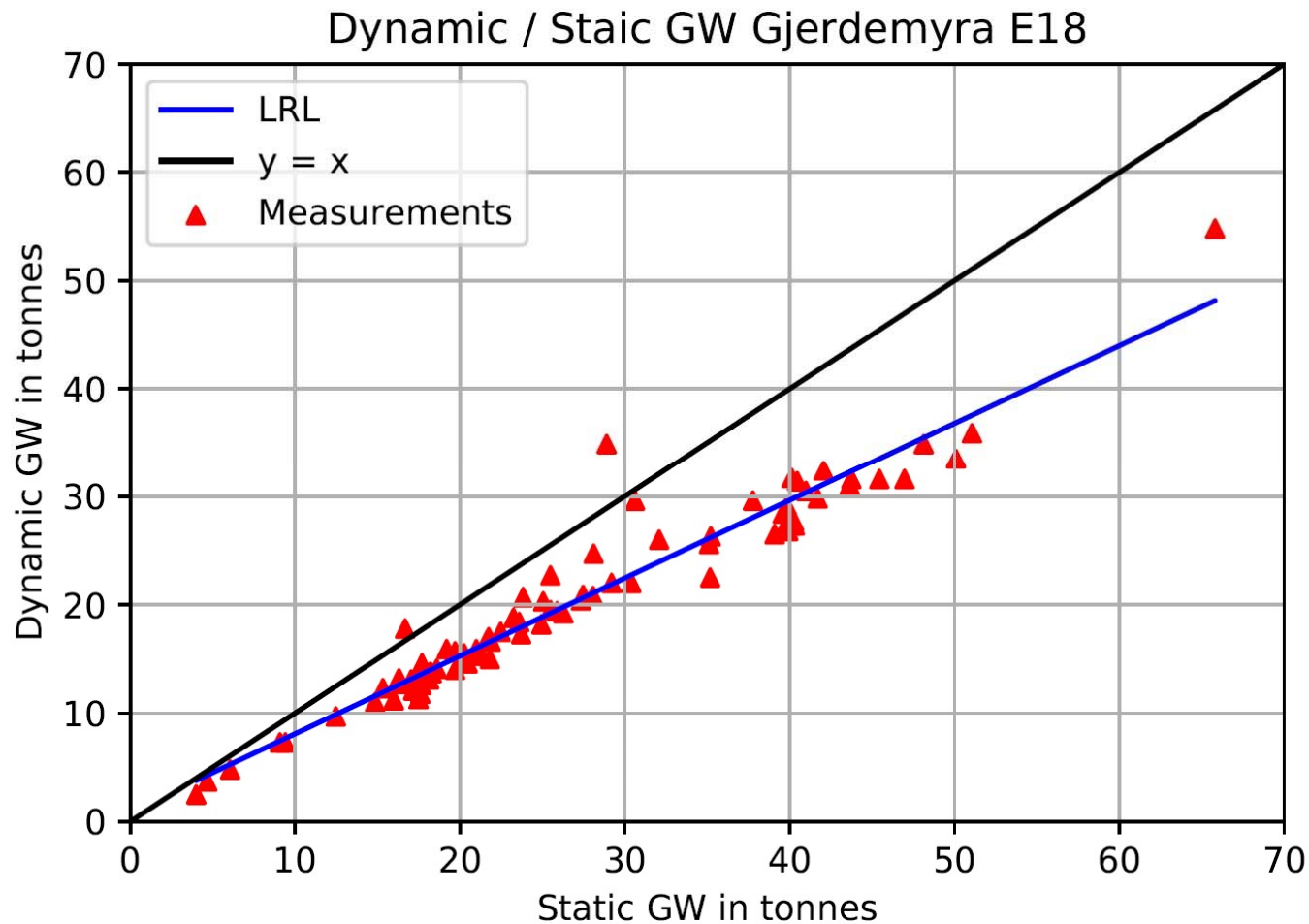
- Preliminary tests indicated that ATK data could indeed be used for WIM purposes
- Ongoing large scale field tests in different regions across the entire country



Truck weight control E6 Åsen / Nord-Trøndelag

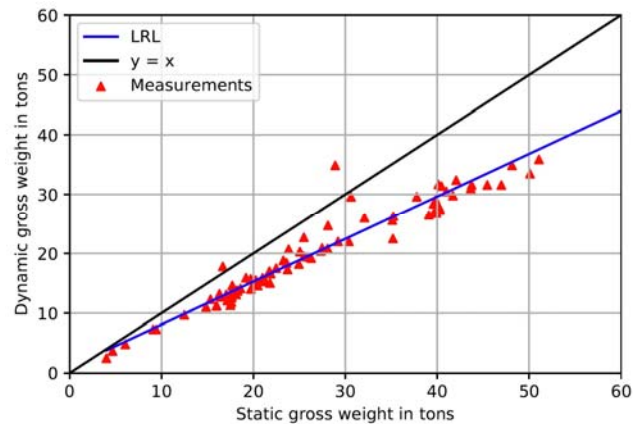


Result field study Gjerdemyra E18

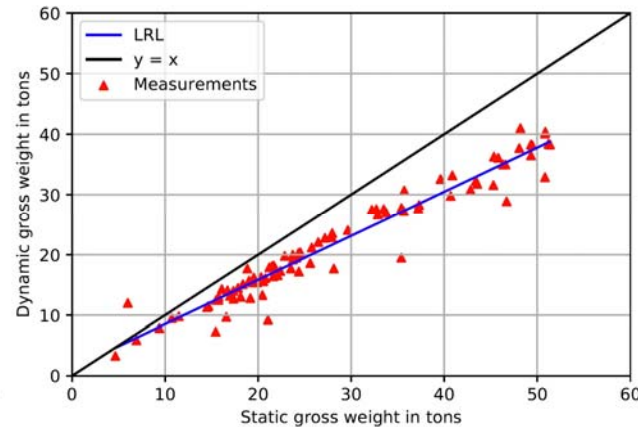


Overview Results Field-tests

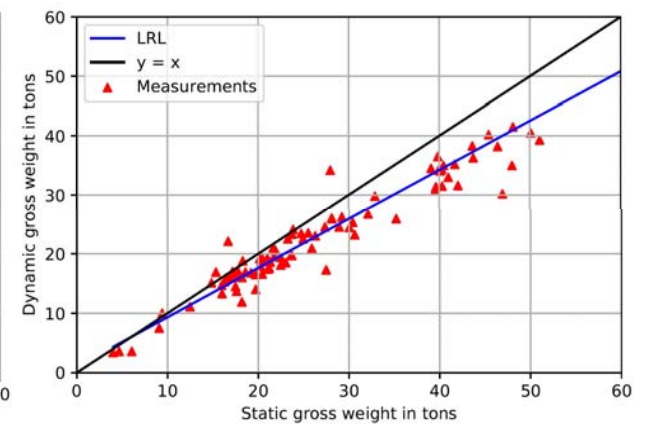
Gjerdemyra E18



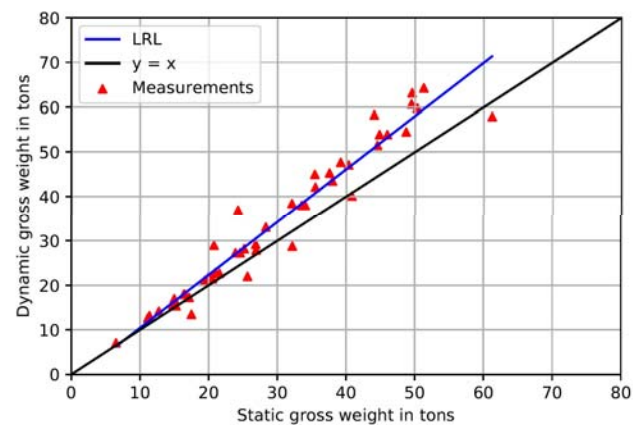
Teigkamptunnelen E6



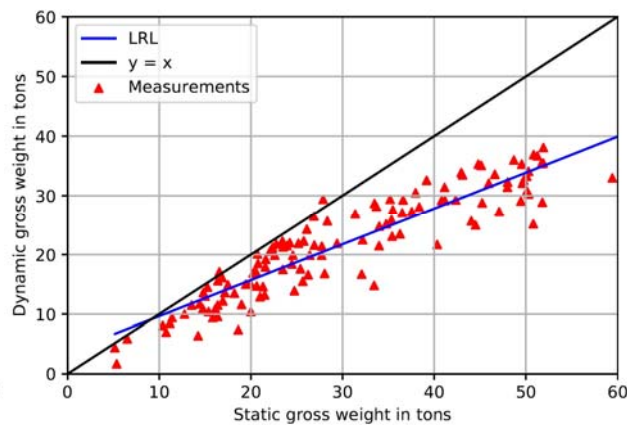
Auråen E18



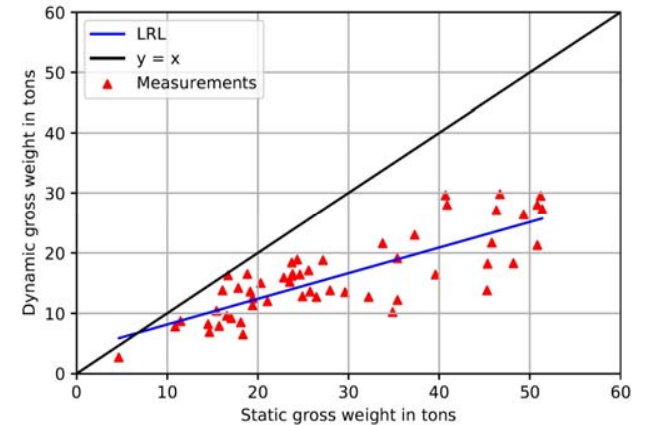
Væretunnelen E6



Åsen E6



Losna E6



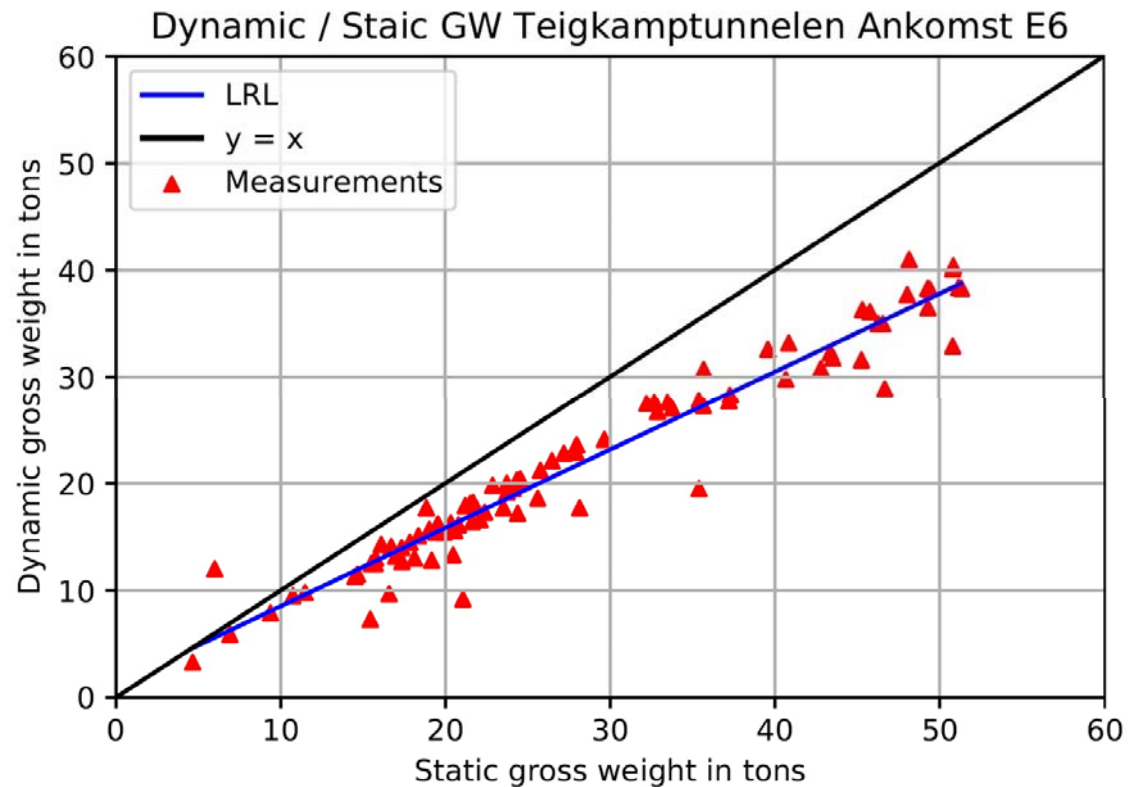
Characteristically Vehicle Class



- 7 tons as stable quality indicator
- Introduced by van Loo & Lees (2015)
- Test with Kistler Verdal / Trøndelag (E6) 2016

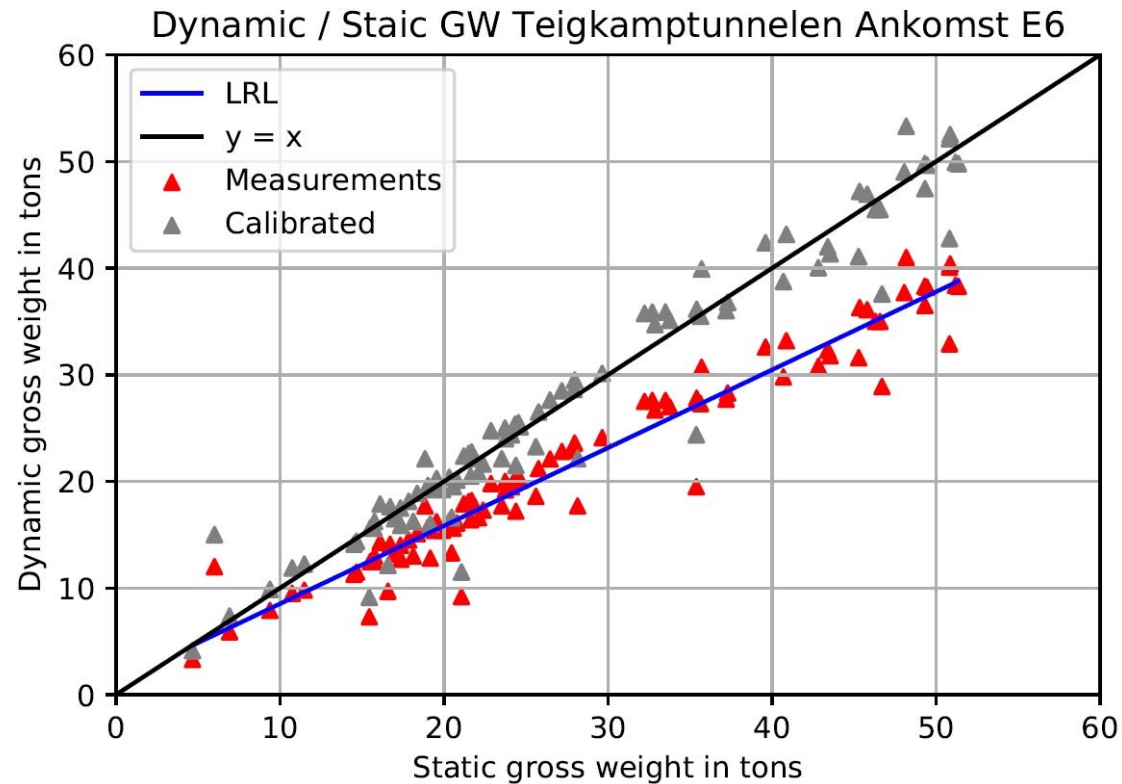
	All 6ax			SEMI		
	Mean in t	STD in t	N	Mean in t	STD in t	N
Kistler Verdal E6	6.998200	0.988884	76 559	6.944768	0.866792	36 454

Teigkamptunnel E6 Oppland



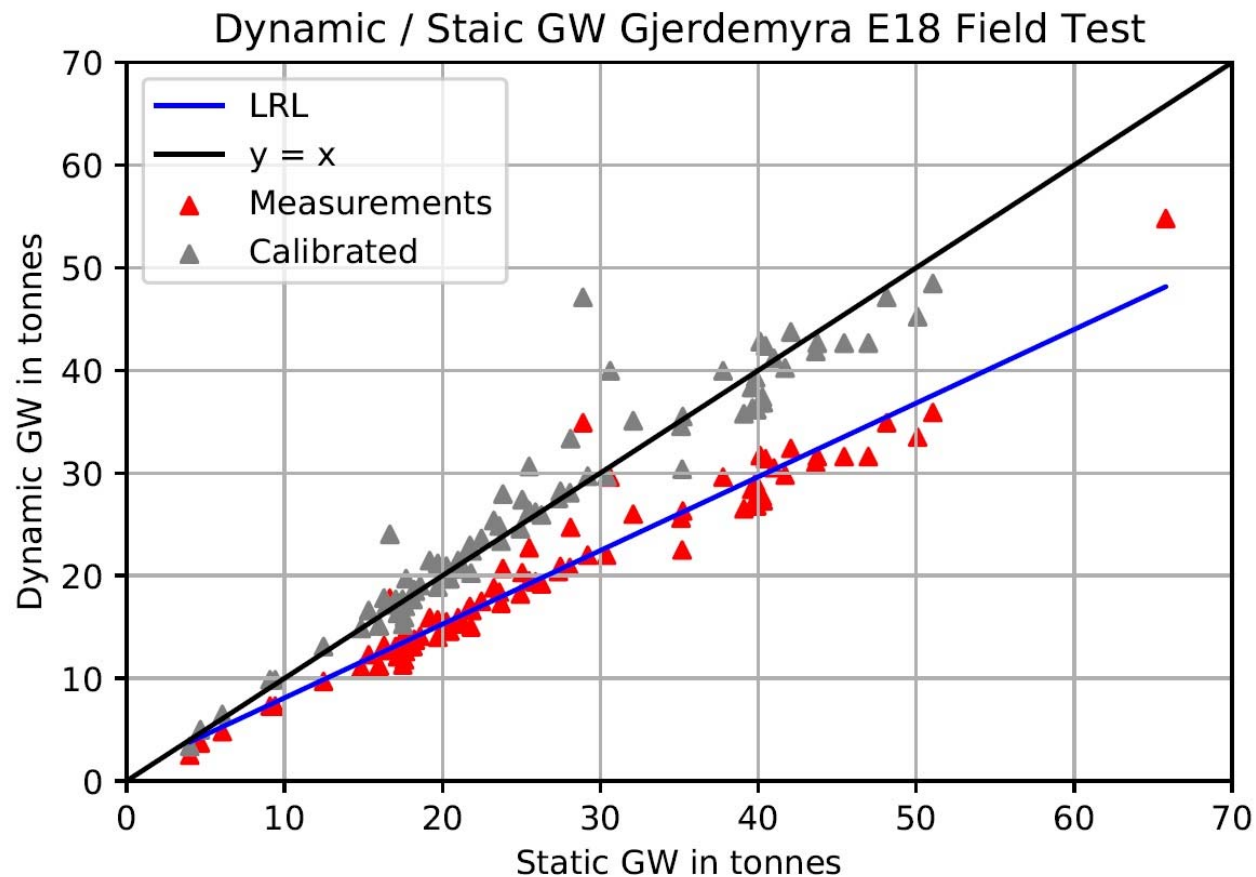
Criteria	n	Mean error	SD error	AC
Field test	92	-20.98%	15.1%	D

Teigkamptunnel E6 Oppland



Criteria	n	Mean error	SD error	AC
Field test	92	-20.98%	15.1%	D
Calibration	92	-1.22%	18.9%	D

Gjerdemyra E18 Telemark



Criteria	n	Mean error	SD error	AC
Field test	85	-24,8%	8,3%	D
Calibration	85	-2,2%	9,0%	D

Preliminary Findings

ATK
Field-tests



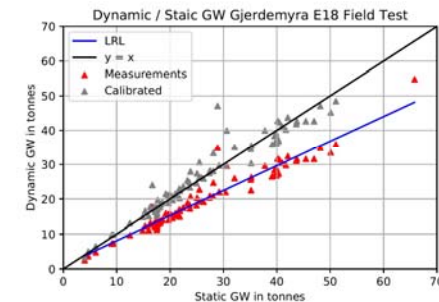
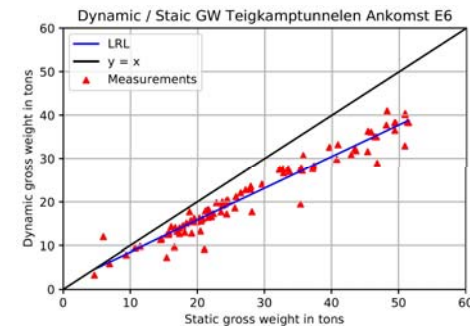
Calibration
Method



↑
7t

COST 323
Accuracy Classes

Promising
Results



➤ Demands of potential data users

Demands of users

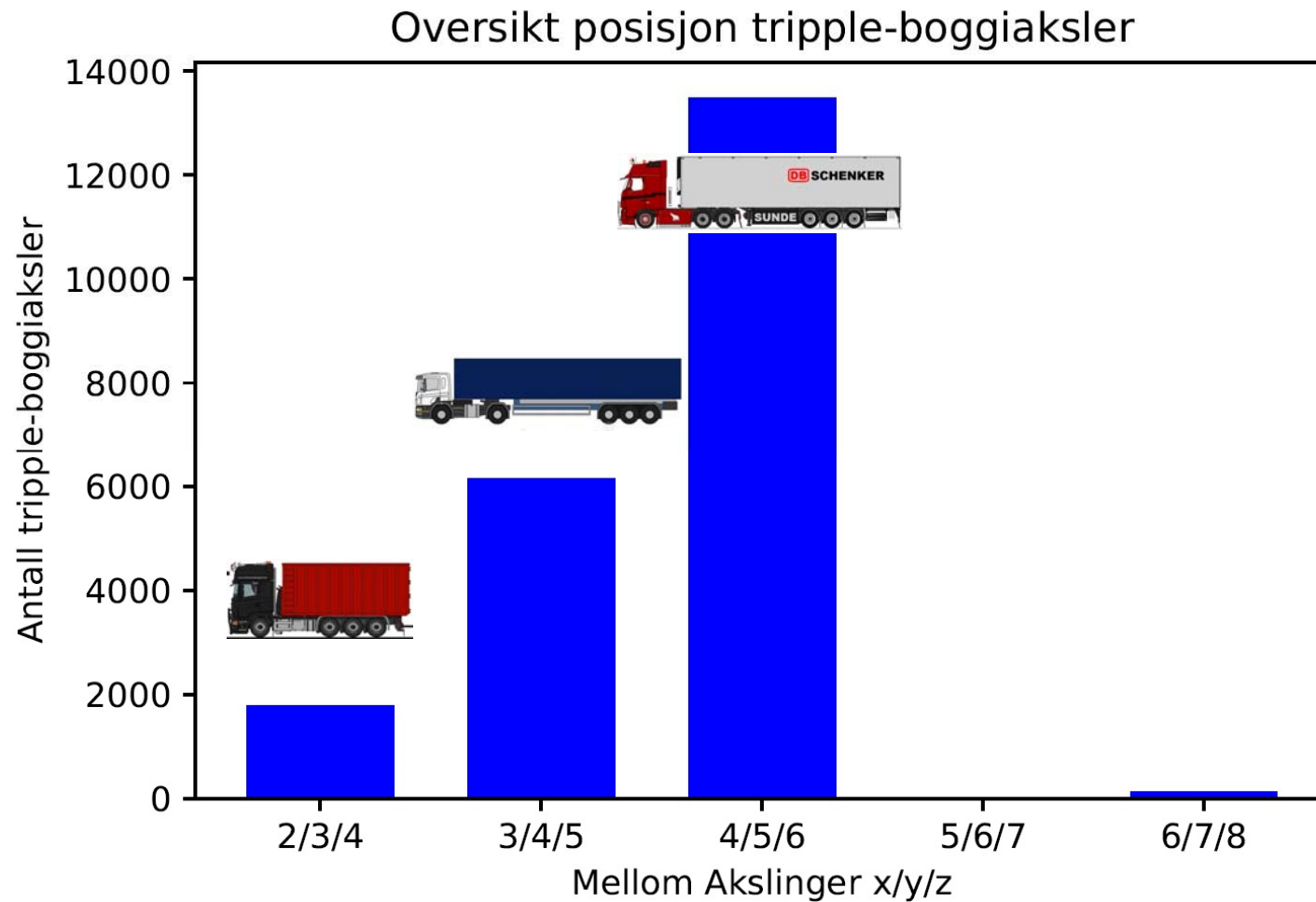
- Average amount of
 - Single axles
 - Bogie axles
 - 3-bogi axles
- Weight distributions
 - Single axles
 - Bogie axles
 - 3-bogi axles
- Tire pressure
- Share of super single wheels
- Stability over time



Bauklasse	BK 3,2				BK 1,8				BK 1,0				BK 0,3			
Dicke des frostsich. Oberbaus	45	55	65	75	45	55	65	75	45	55	65	75	35	45	55	65
Pflastersteine				10				10				8				8
				4				4				4				4
				20				20				16				16
Drainbetontragschicht (DTB) ¹⁾	~120			± 34	~120			± 34	~120			± 27	~100			± 27
Frostschuttschicht ¹⁾	~45				~45				~45				~45			
Dicke der Frostschuttschicht	–	–	31 ²⁾	41	–	31 ²⁾	41	–	18 ³⁾	28	38	48	–	18 ³⁾	28	38

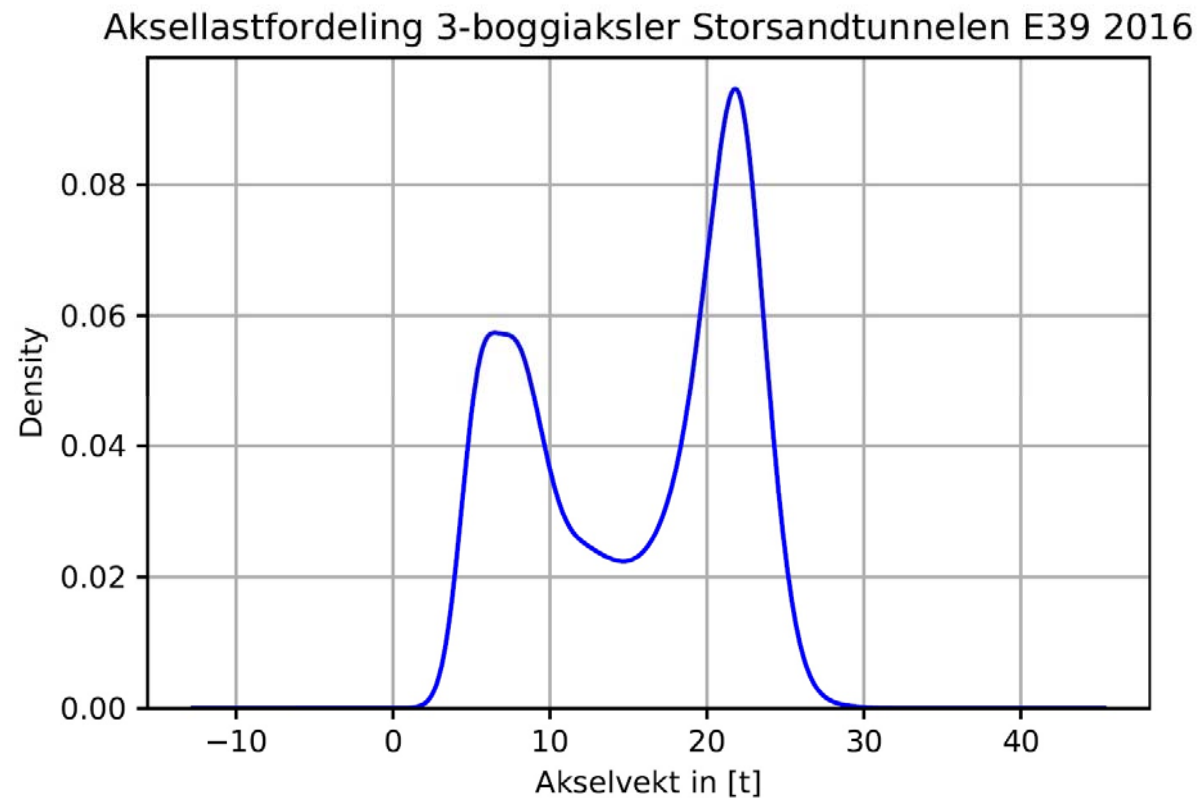
Number of 3-bogie axles

(Storsandtunnel / Sør-Trøndelag E39)



Distribution of 3-bogie axles

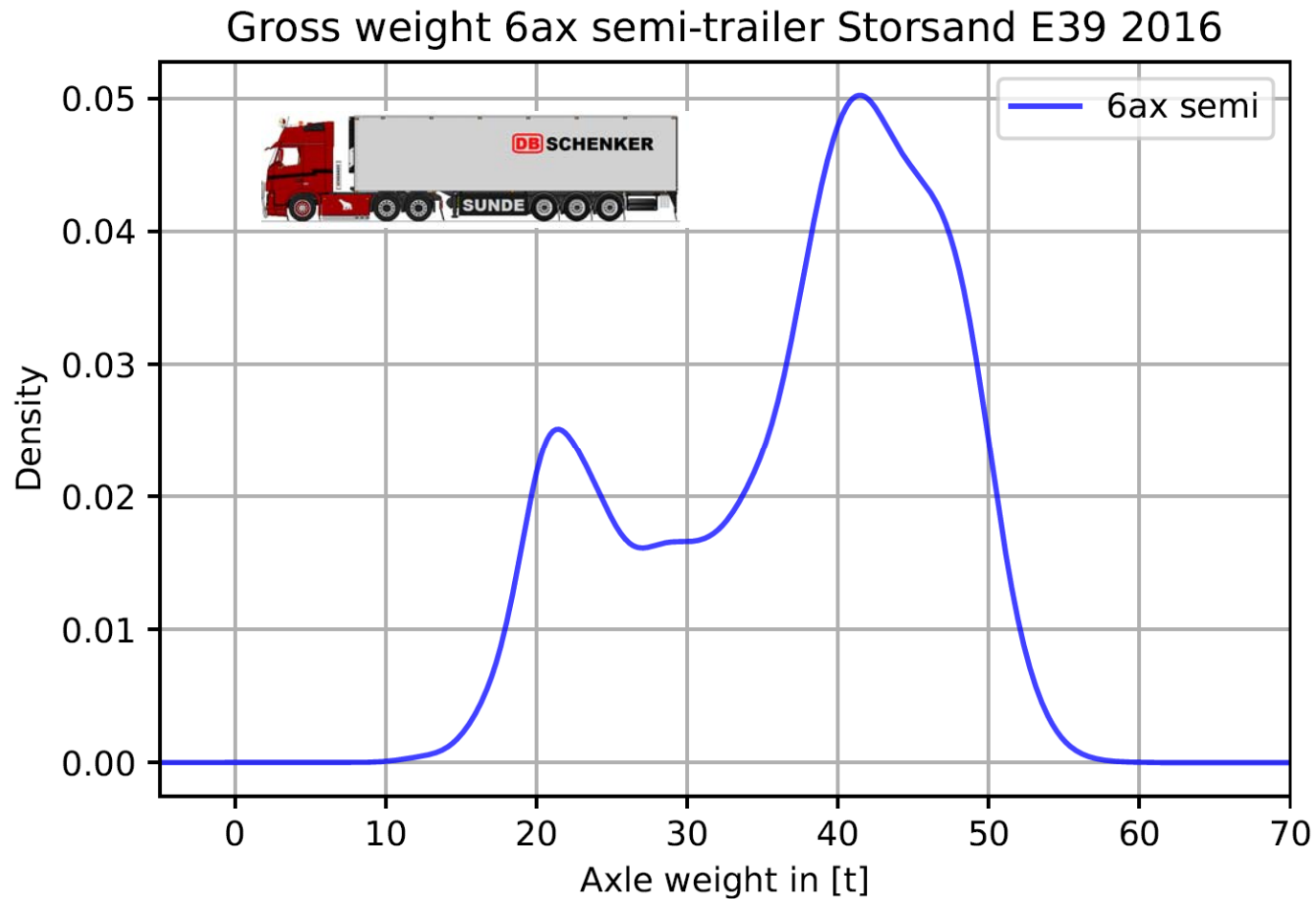
(Storsandtunnel / Sør-Trøndelag E39)



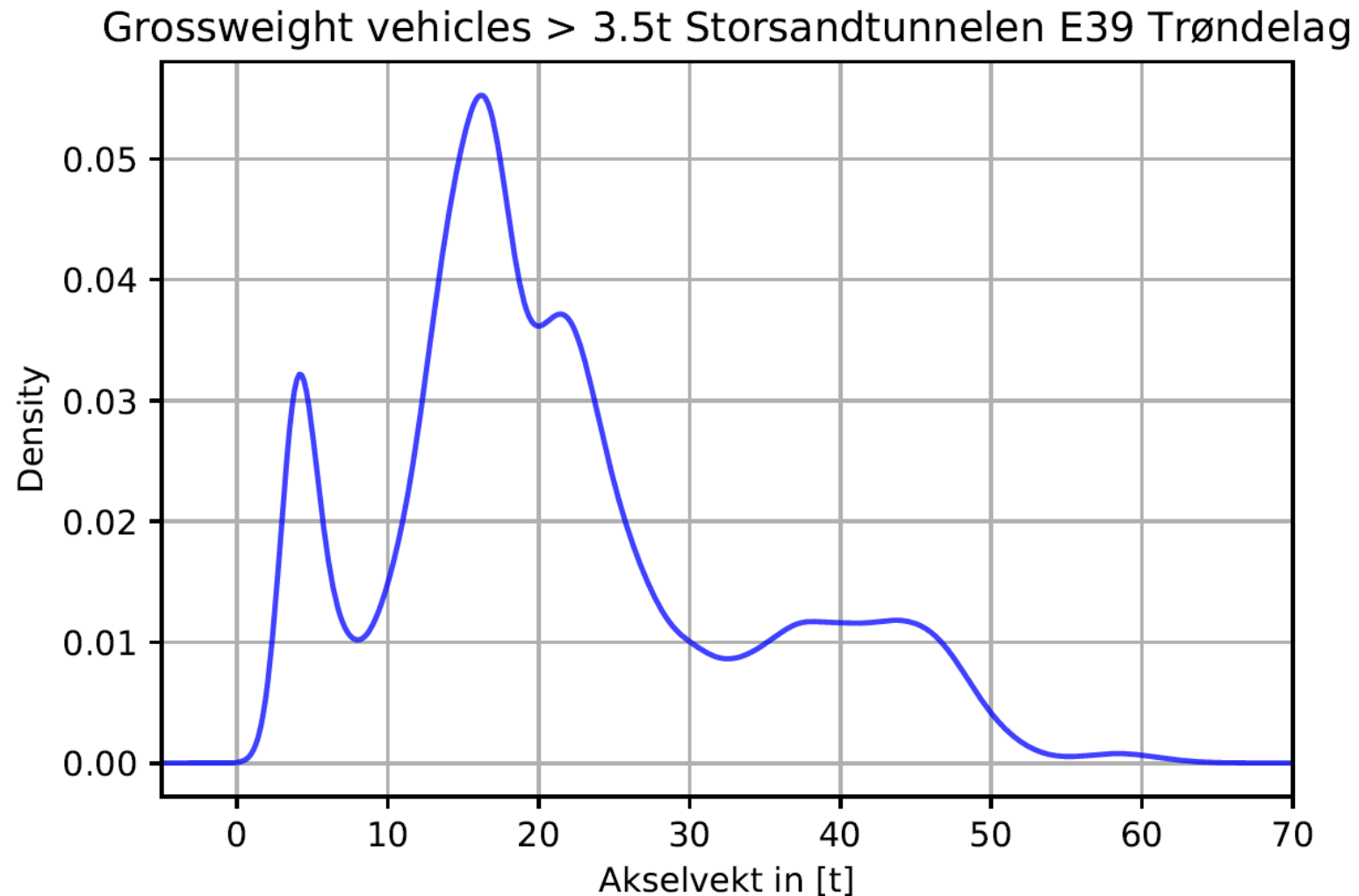
	Antall	Mean in t	STD in t	Tillatt max. Vekt in t
3-boggi	21 557	15.49	6.71	24

Gross weight 6ax semi-trailer

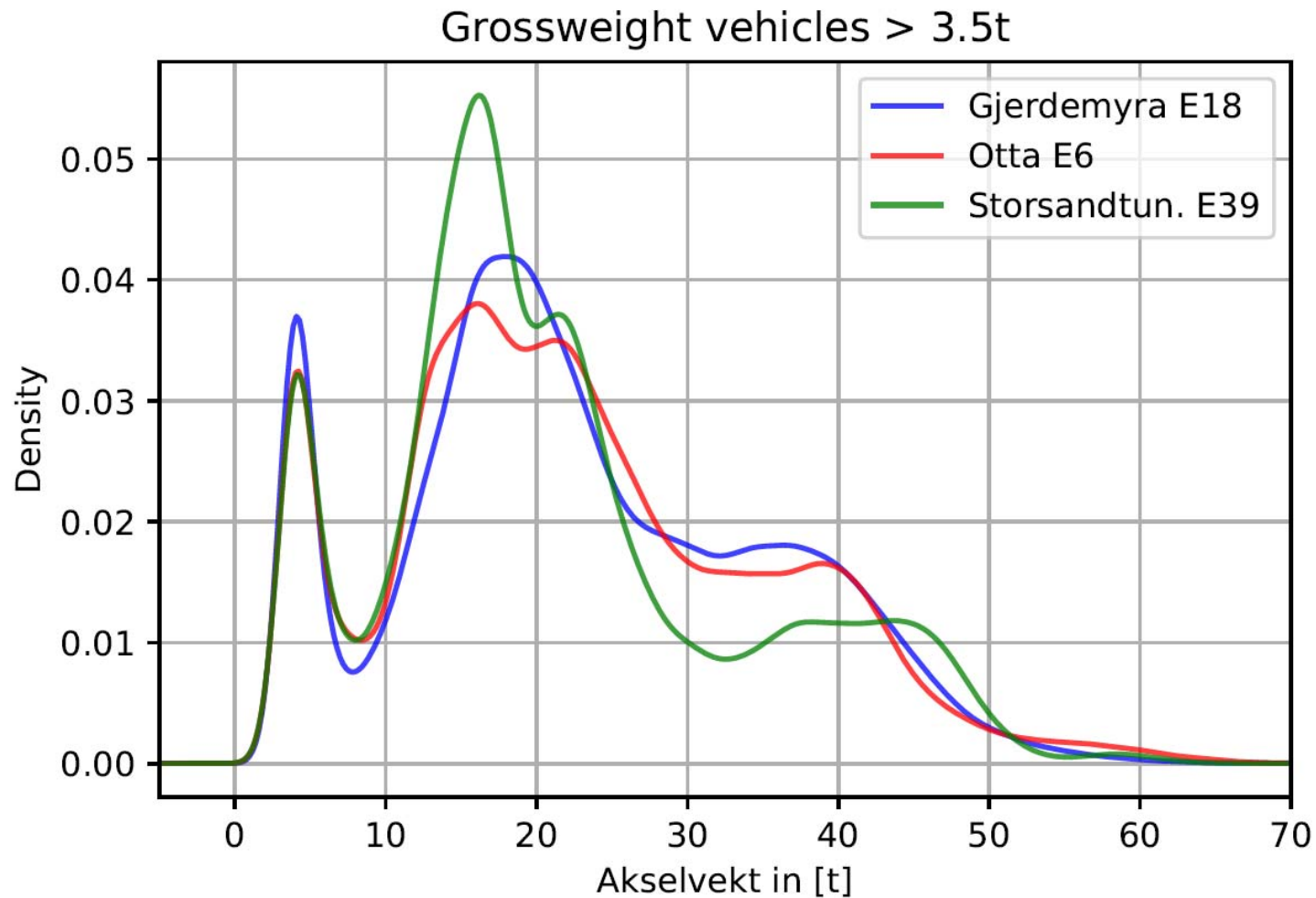
(Storsandtunnel / Sør-Trøndelag E39)



Totalvekt 6ax Lastebiler



Gross weight vehicles >3.5t

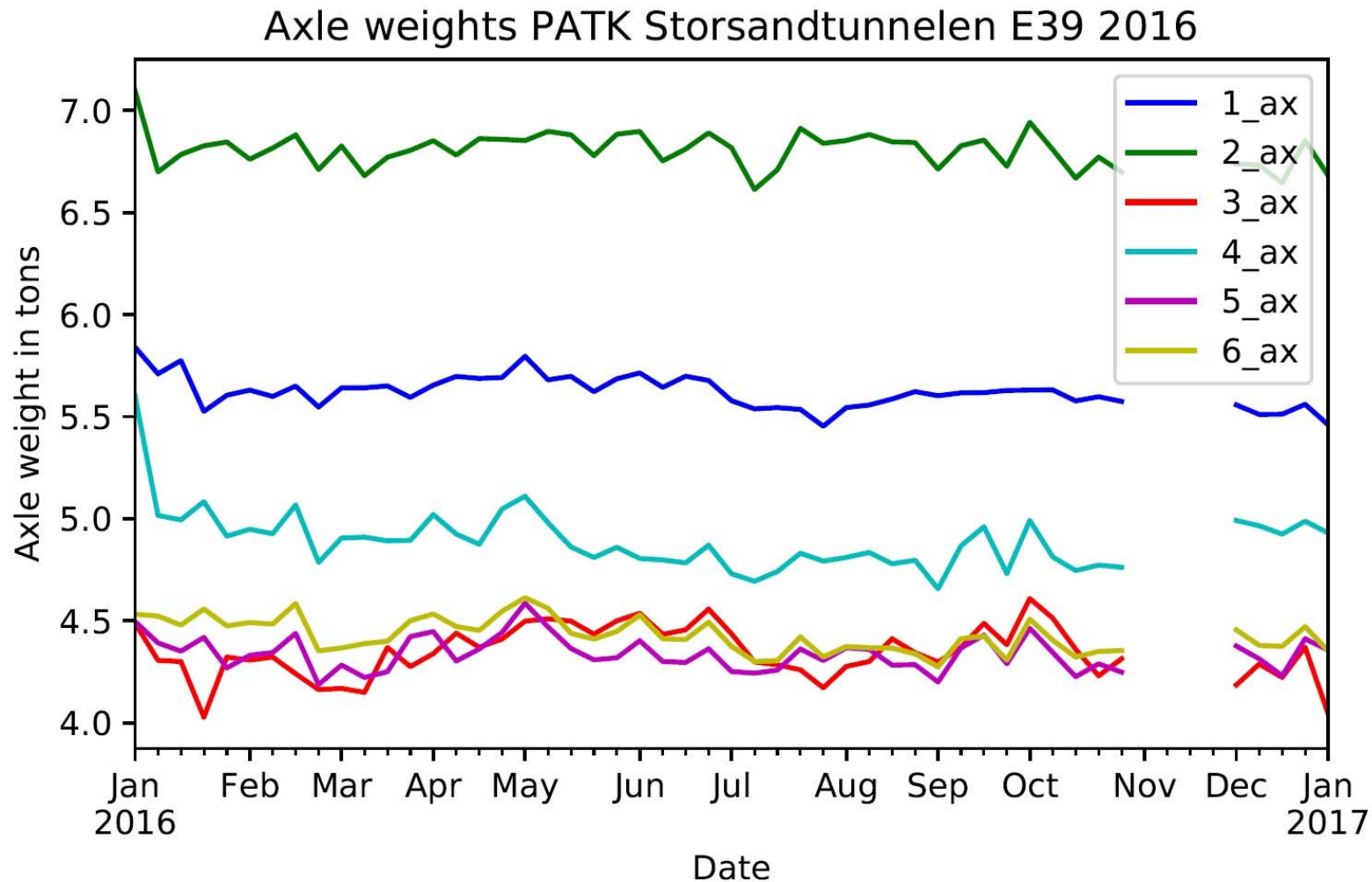


Tungbil? 3,5t vs. 5,6m

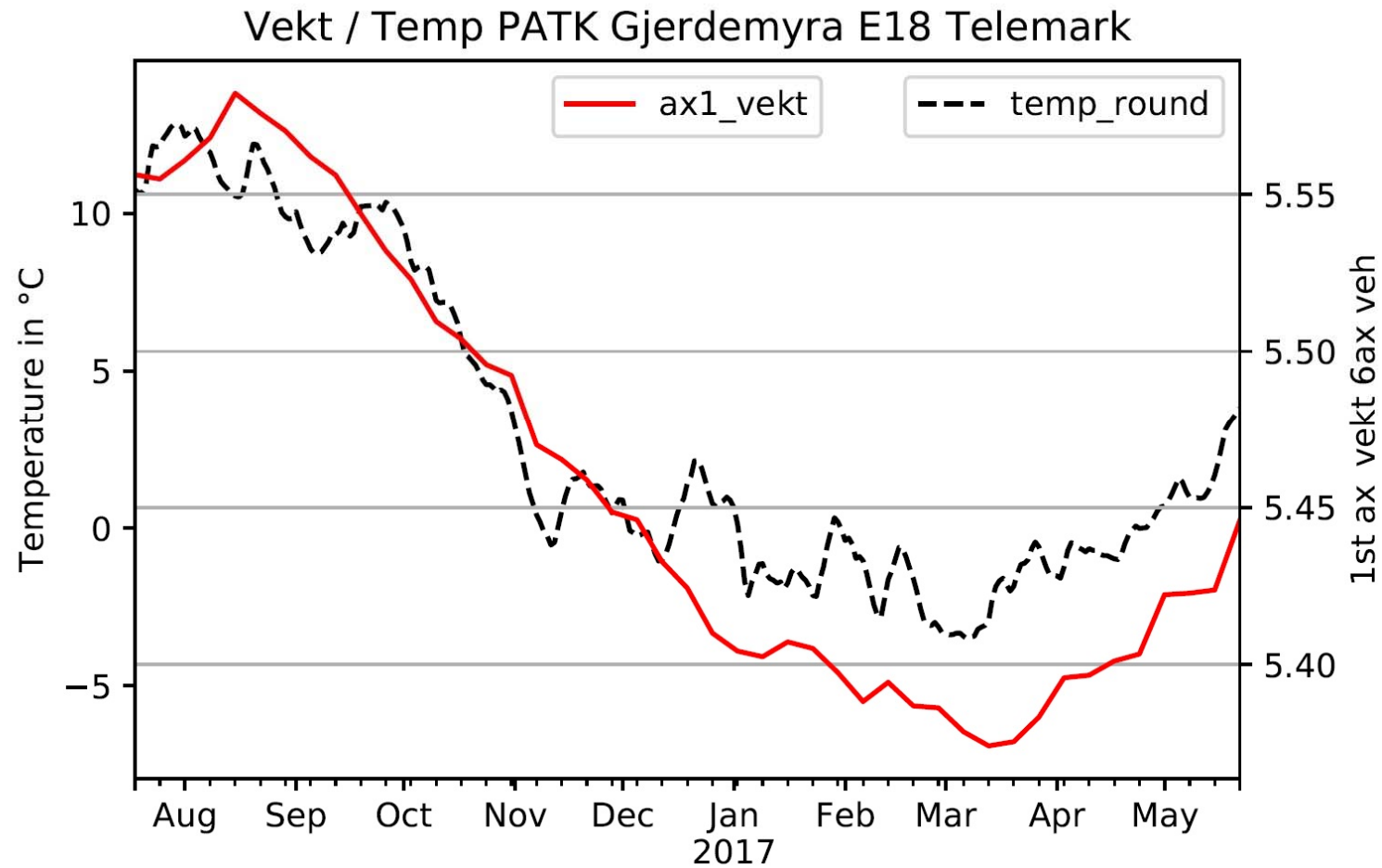
- Forskjeller i kategorisering av lastebiler
- Lenge vs. vektbaserte systemer

Kontrollsted	Kjøretøyer	Aks. pr Kjt.	Lastebiler	Aksler	Aks. pr L.	% tunge	% Datainn
Storsand E39	1 436 097	2.18	130 221	474 364	3.72	9.0 %	12 %
Gjerdemyra E18	1 708 376	2.47	237 902	1 076 614	4.52	13.9 %	18 %
Otta Sør E6	1 430 387	2.32	203 691	846 550	4.16	14.2 %	19.0 %
Teigkamptunnelen E6 (A)	344 082	2.49	59 699	264 953	4.44	17.4 %	~ 22.6%
Teigkamptunnelen E6 (B)	338 531	2.48	57 681	256 475	4.45	17.0 %	~ 22.6%
Verdal E6 (KIST.)	2 792 707	2.21	250 511	1 038 187	4.11	9.0 %	12.7 %

Storsandtunnelen E39 Sør-Trøndelag



Gjerdemyra E18 Telemark



Conclusions

- ATK weight signals could indeed be used for WIM
- Demand for data
- Further error evaluation needed
- Run further field tests



Kontakt

Maximilian Böhm
Torbjørn Haugen
Jorunn Riddervold Levy
Anna Rodum Bjøru

Traffic Engineering Research
Center

NTNU

maximilian.boehm@ntnu.no

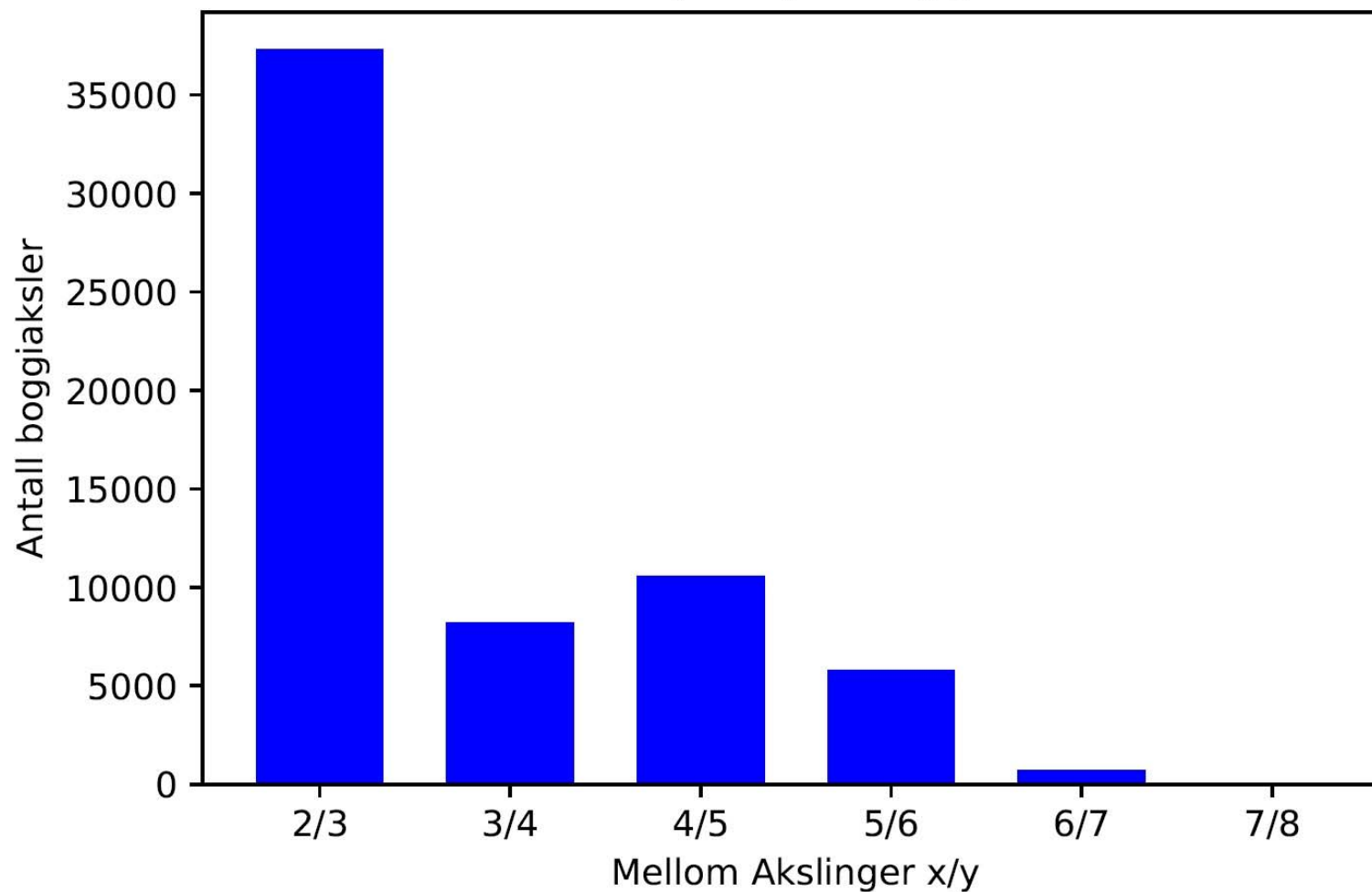


Statens vegvesen
Norwegian Public Roads
Administration

Boggiaksler

(Storsandtunnel / Sør-Trøndelag **E39**)

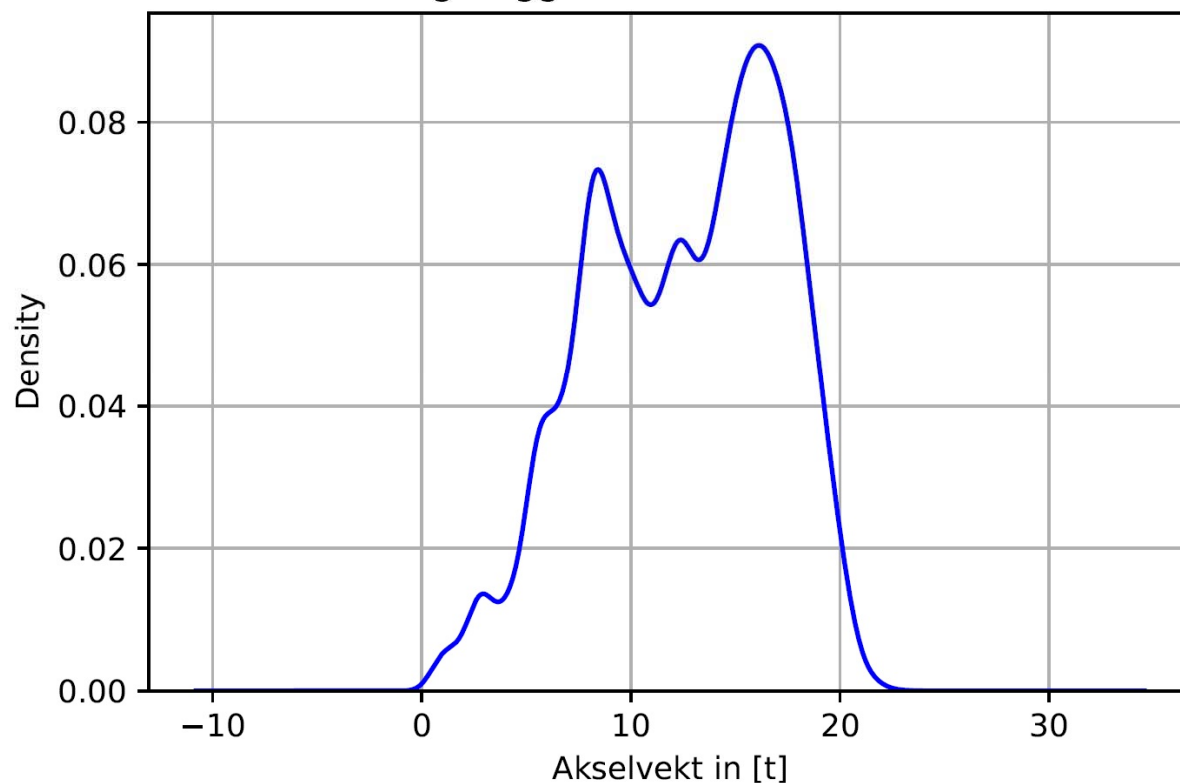
Oversikt posisjon boggiaksler



Boggiaksler

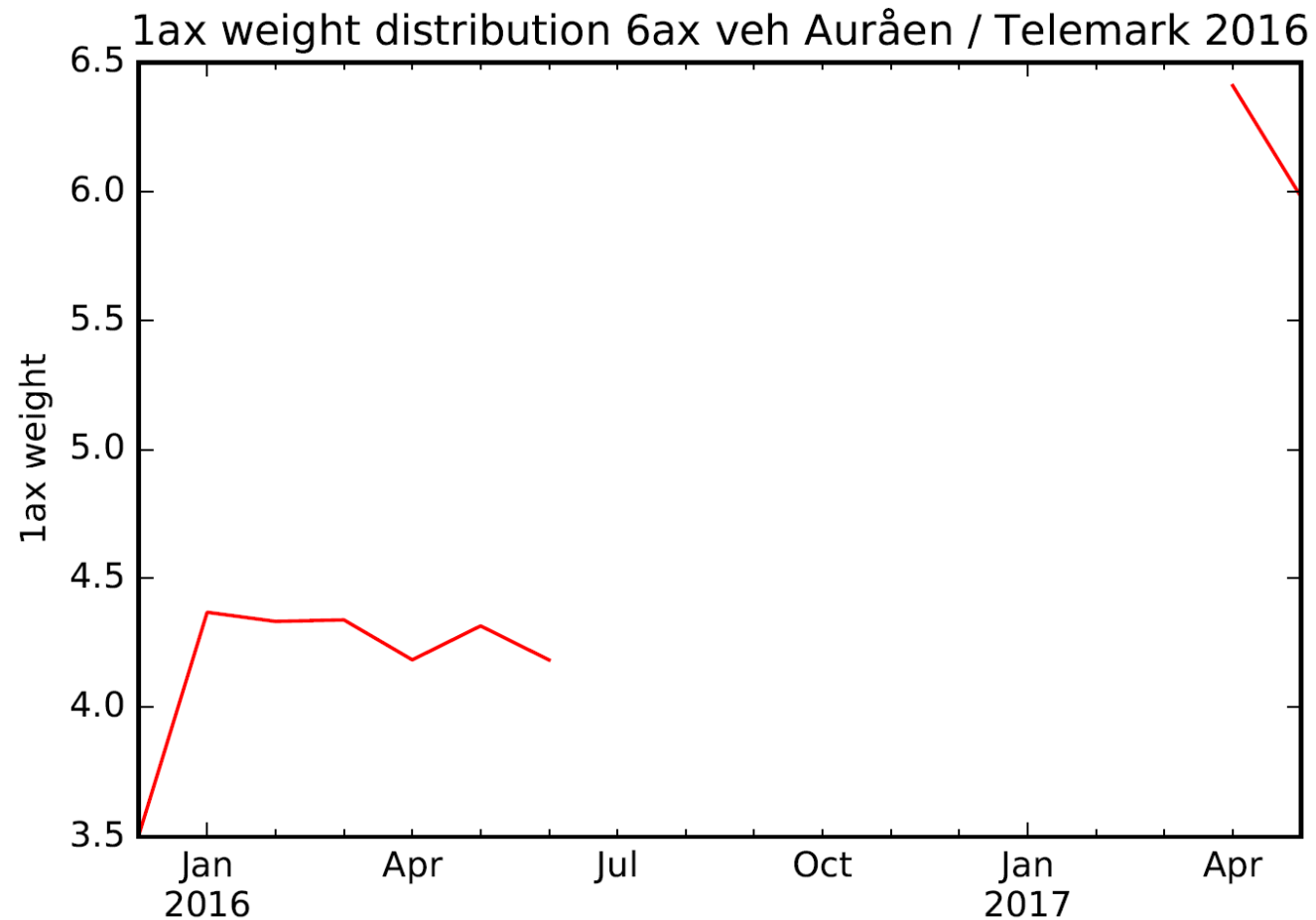
(Storsandtunnel / Sør-Trøndelag E39)

Aksellastfordeling boggiaksler Storsandtunnelen E39 2016



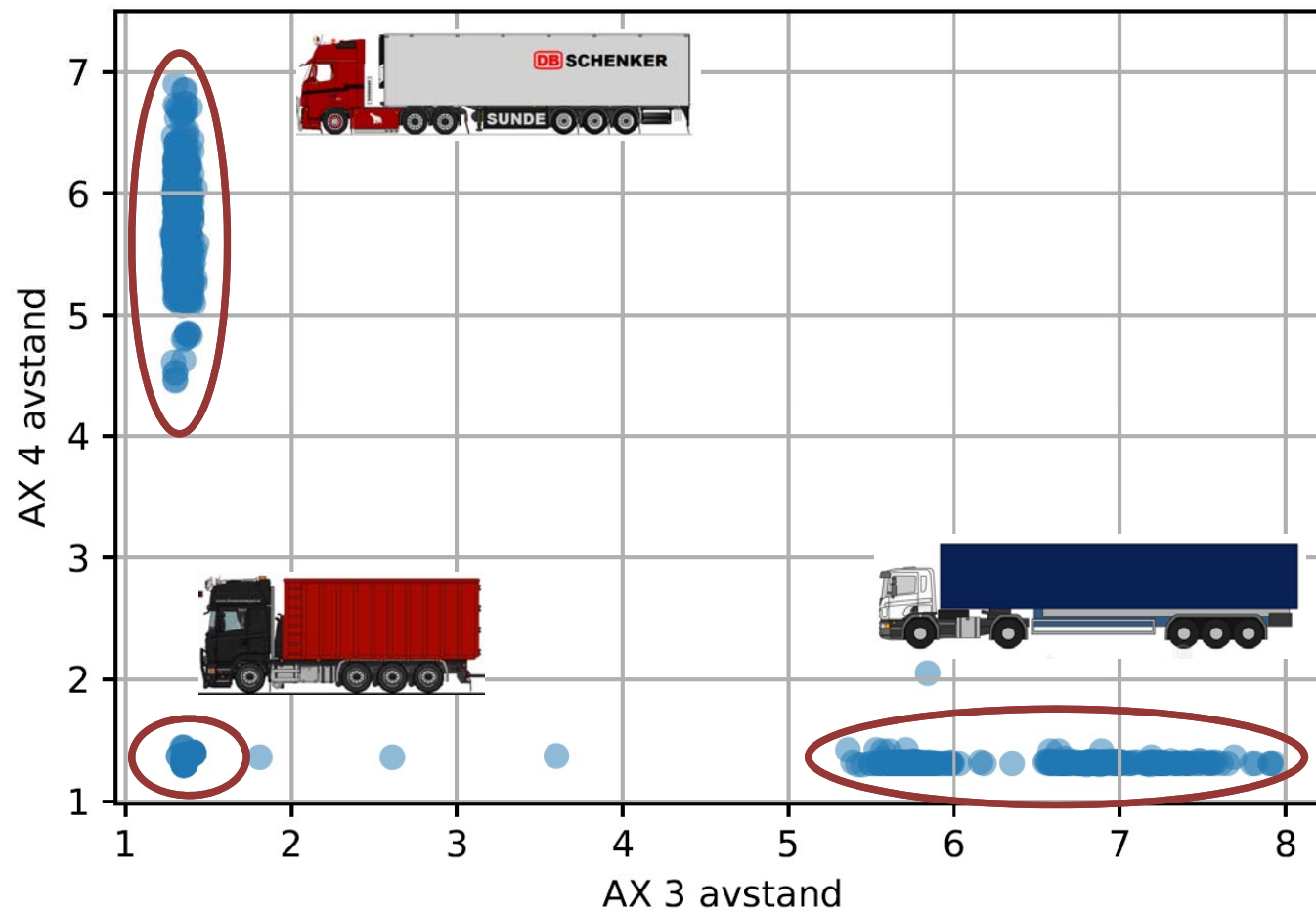
	Antall	Mean in t	STD in t	Tillatt max. Vekt in t
Boggi	62 188	12.54	4.51	18

Gjerdemyra E18 Auråen



Kategorisering

Axle 3/4 avstand Storsandtunnellen E39



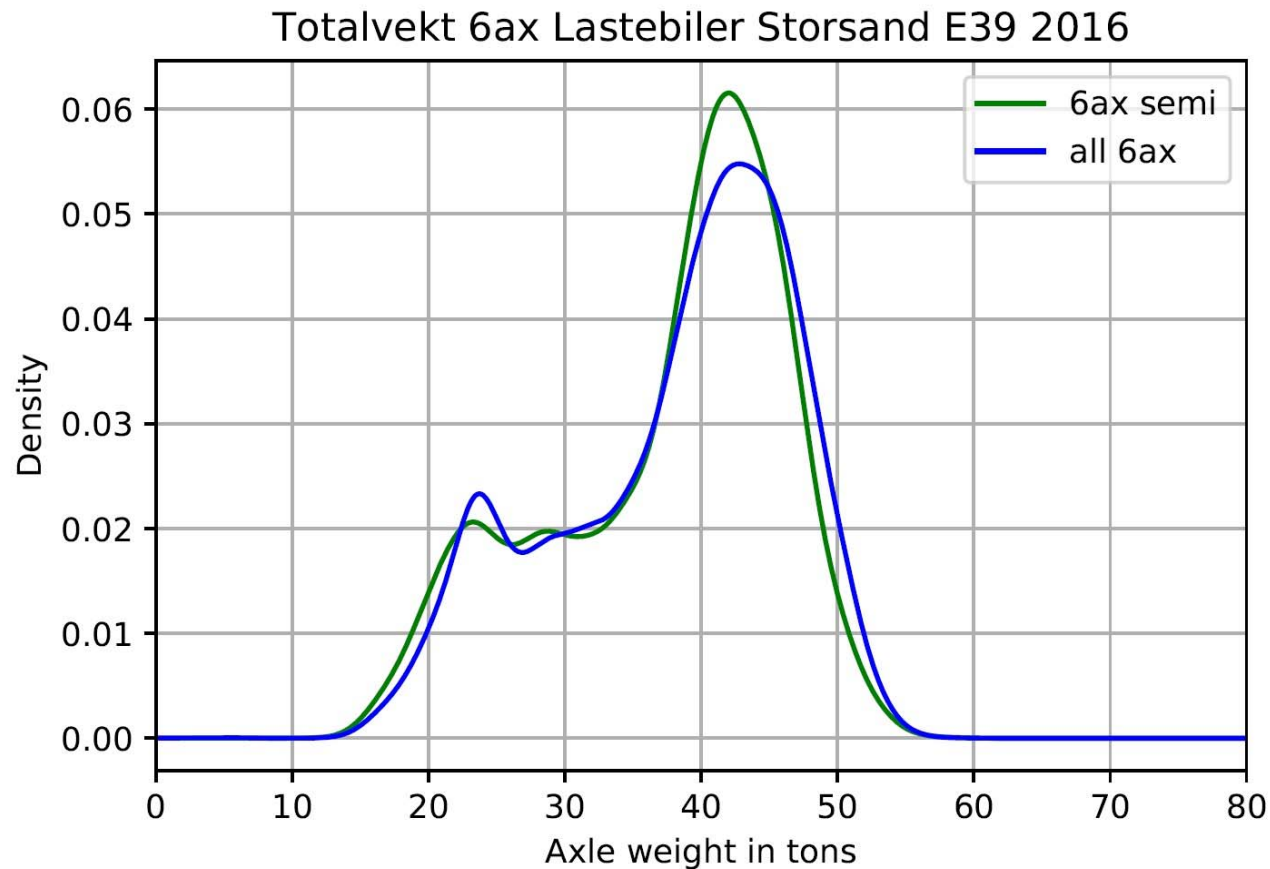
2 / 3-boggi per lastebil [C_v = individuell]

- Bruk av utviklet kalibreringsmetodikk
- % boggi aksler per lastebil

Kontrollsted	Kjøretøyer	Lastebiler	% Lastebiler	2-boggi	% 2-boggi	3-boggi	% 3-boggi
Storsand E39	1 436 097	120 888	8.42 %	83 477	69.05 %	21 637	17.90 %
Gjerdemyra E18	1 708 369	234 125	13.70%	175 589	75.00 %	77 316	33.02 %
Auråen E18	815 496	120 974	14.83 %	89 385	73.89 %	38 517	31.84 %
Otta Sør E6	1 430 387	197 008	13.77 %	153 425	77.88 %	54 080	27.45 %
Teigkamptunnelen E6 (A)	344 082	59 209	17.21 %	47 825	80.77 %	17 961	30.33 %
Teigkamptunnelen E6 (B)	338 531	60 218	17.79 %	46 724	77.59 %	17 431	28.95 %

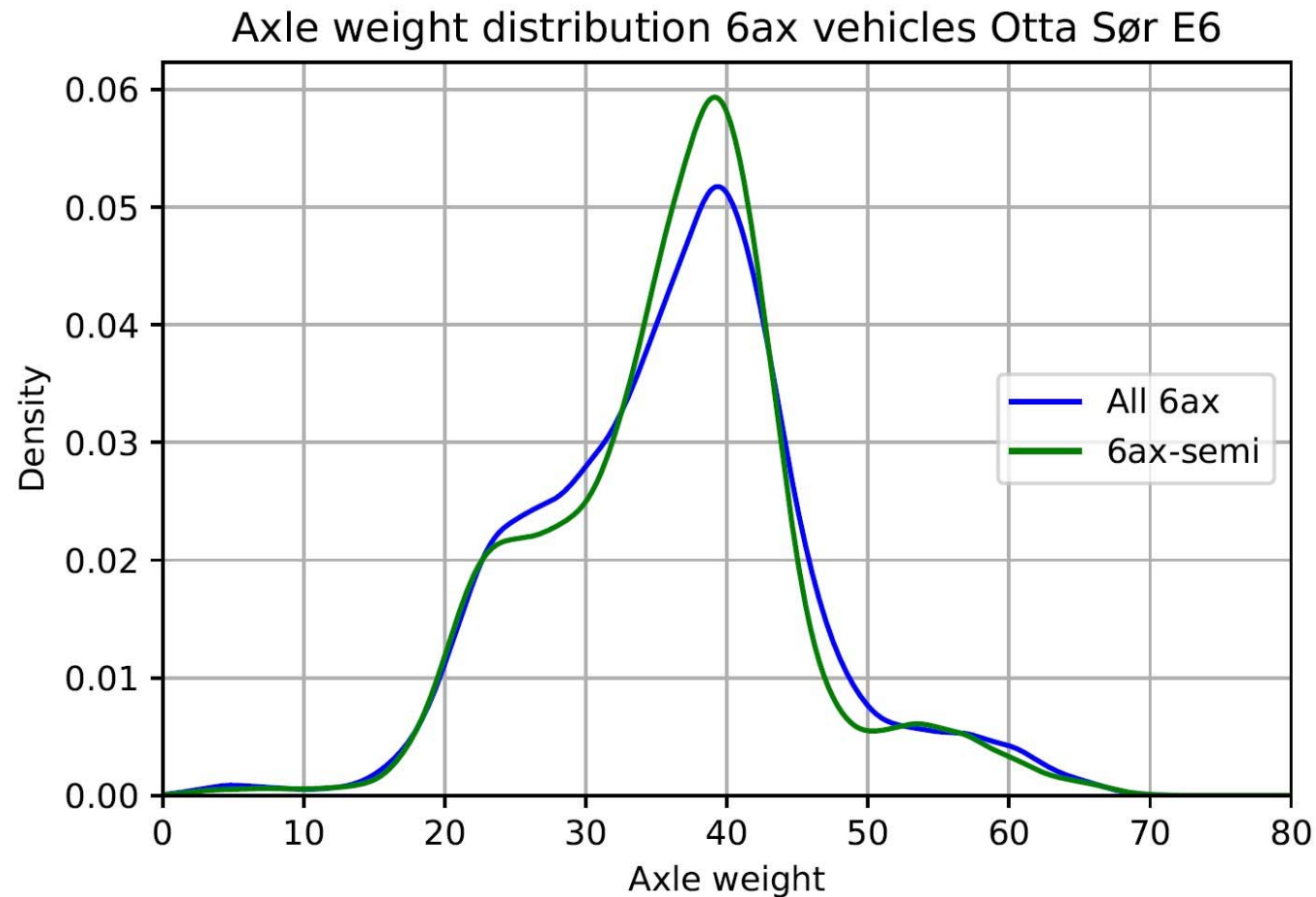
Totalvekt 6ax Lastebiler

(Storsandtunnel / Sør-Trøndelag E39)

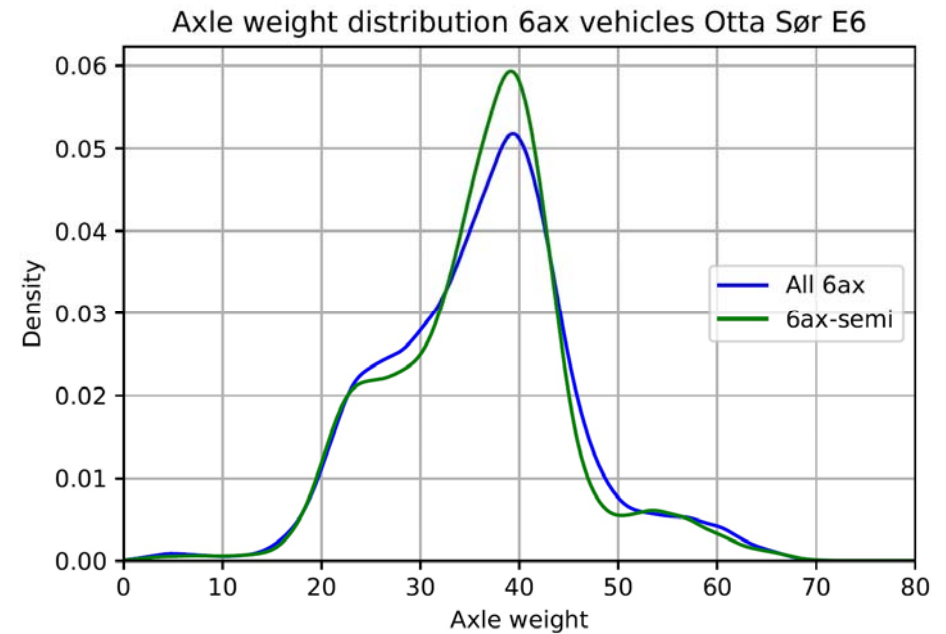
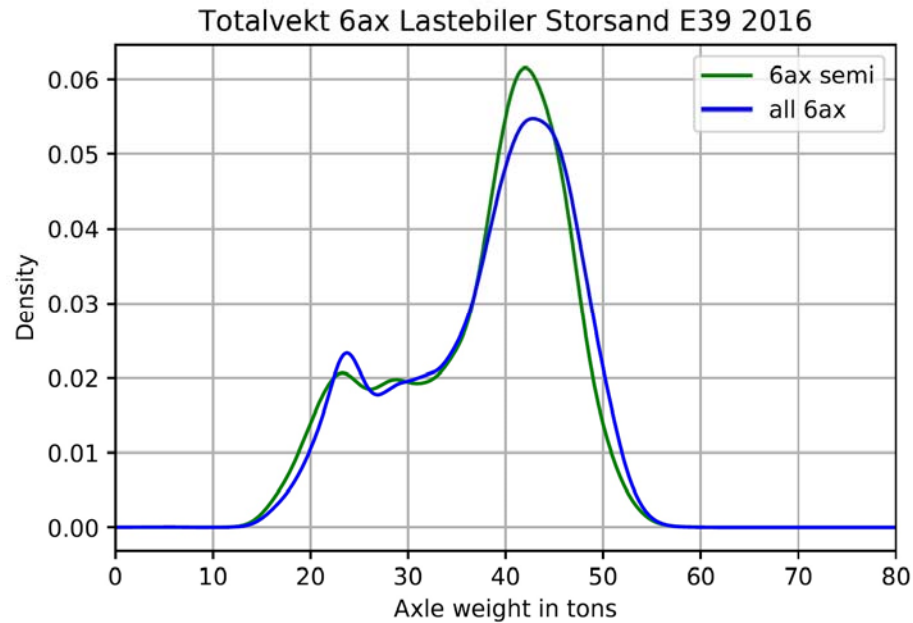


Totalvekt 6ax Lastebiler

(Otta Sør / Oppland **E6**)



Totalvekt 6ax Lastebiler

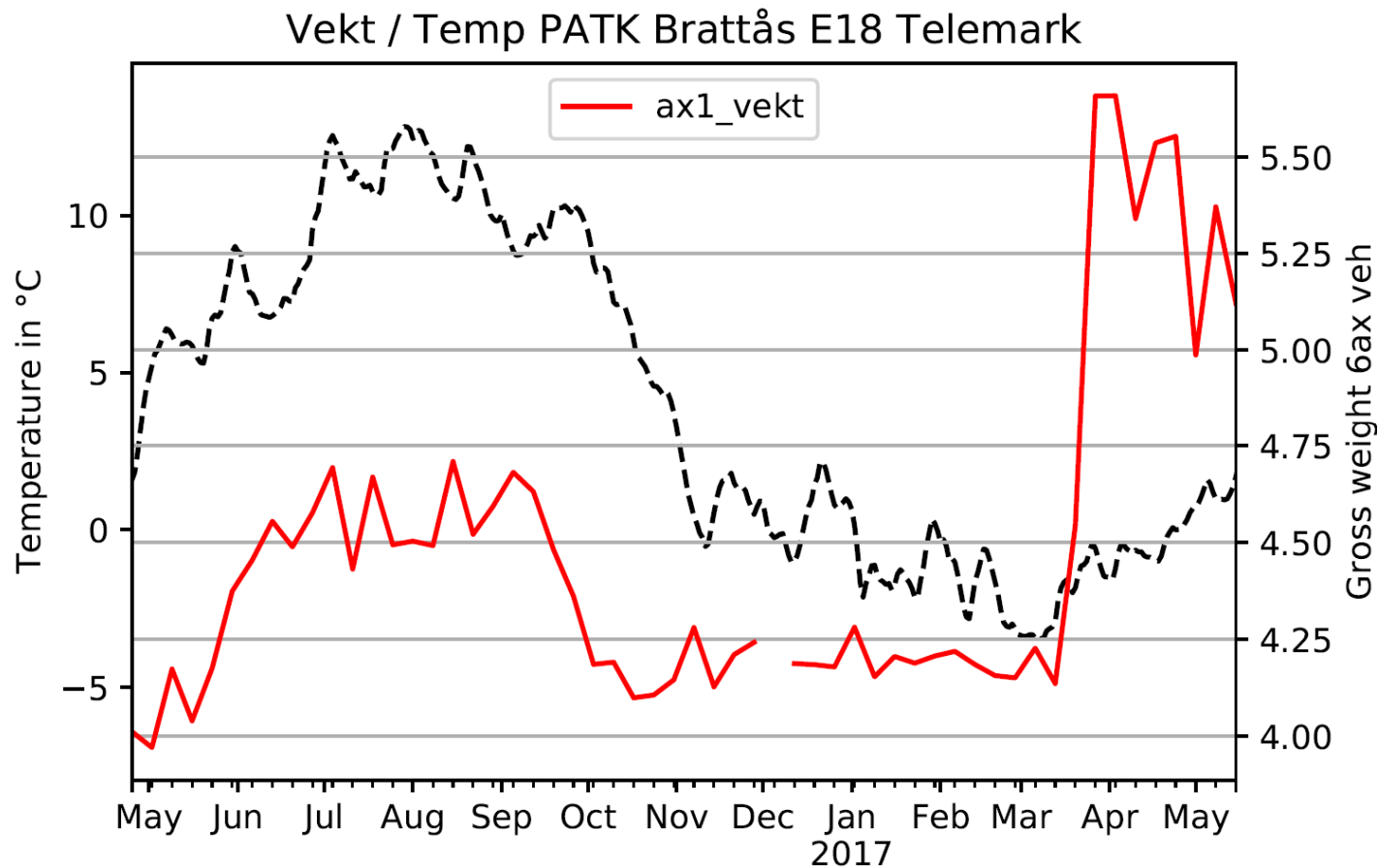


2 / 3-boggi per lastebil [C_v = individuell]

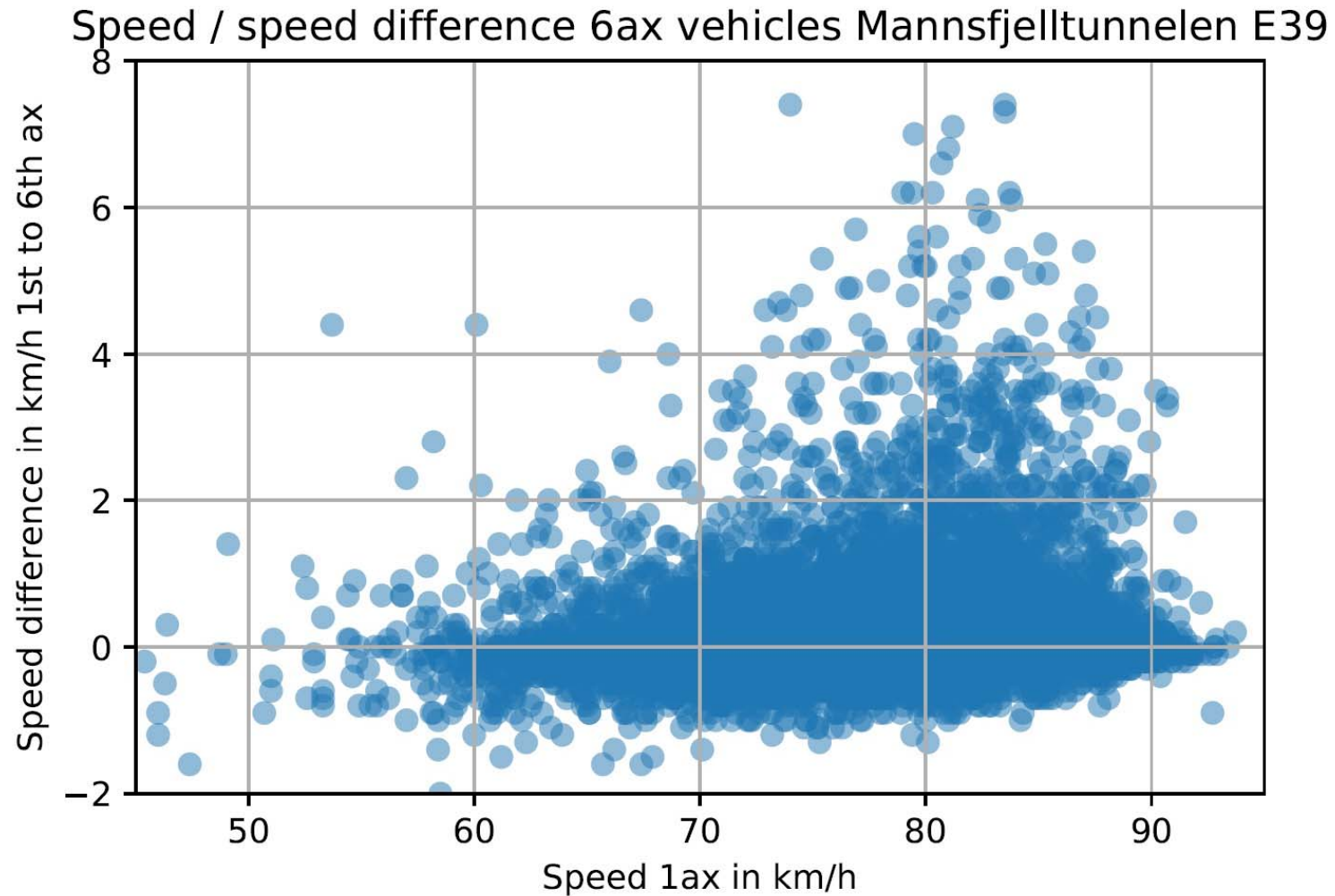
- Bruk av utviklet kalibreringsmetodikk
- % boggi aksler per kjøretøy

Kontrollsted	Kjøretøyer	Lastebiler	% Lastebiler	2-boggi	% 2-boggi	3-boggi	% 3-boggi
Storsand E39	1 436 097	120 888	8.42 %	83 477	5.81 %	21 637	1.51 %
Gjerdemyra E18	1 708 369	234 125	13.70 %	175 589	10.28 %	77 316	4.53 %
Auråen E18	815 496	120 974	14.83 %	89 385	10.96 %	38 517	4.72 %
Otta Sør E6	1 430 387	197 008	13.77 %	153 425	10.73 %	54 080	3.78 %
Teigkamptunnelen E6 (A)	344 082	59 209	17.21 %	47 825	13.90 %	17 961	5.22 %
Teigkamptunnelen E6 (B)	338 531	60 218	17.79 %	46 724	13.80 %	17 431	5.15 %
Gjennomsnitt							

Gjerdemyra E18 Brattås



Mannsfjell E39 Trøndelag



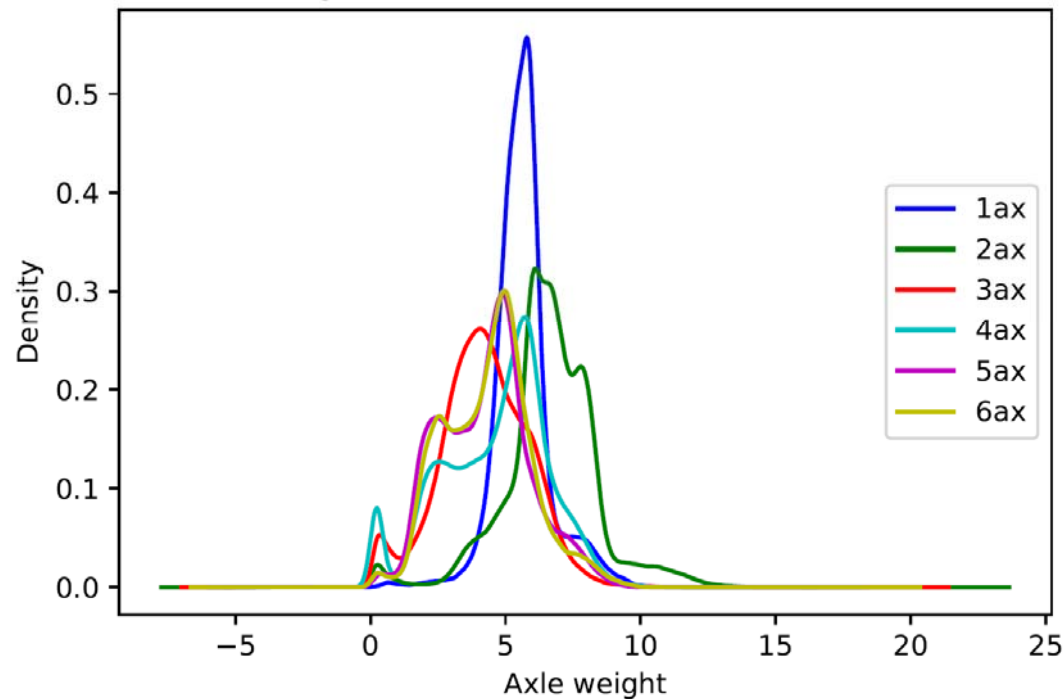
Mannsfjell E39 Trøndelag

All 6ax				SEMI		
Δ speed	Mean in t	STD in t	N	Mean in t	STD in t	N
All	5.737110	0.641877	34 551	5.693562	0.567009	23 641
$0.0 \leq \Delta < 0.5$	5.727249	0.627145	17 773	5.680465	0.559049	12 511
$0.5 < \Delta < 1.0$	5.966780	0.692938	1 177	5.939636	0.612287	825
$1.0 < \Delta < 2.0$	6.026560	0.793280	625	6.019457	0.589463	442
$2.0 < \Delta < 3.0$	6.050249	0.914556	201	6.121569	0.669440	153
$0 < \Delta < -0.5$	5.725378	0.612098	13 811	5.672766	0.548988	9 088
$0 < \Delta < -1.0$	5.448087	0.776684	732	5.439735	0.585716	453

All 6ax			SEMI	
Δ speed	Mean in t	STD in t	Mean in t	STD in t
all	5.737110	0.641877	5.693562	0.567009
< 0.5	5.721460	0.628511	5.674378	0.558511
< 1.0	5.728826	0.631721	5.682559	0.561213
< 2.0	5.733511	0.636553	5.688057	0.563664
< 3.0	5.735400	0.637867	5.690663	0.565311
< - 0.5	5.431290	0.785355	5.427439	0.581275
< - 1.0	5.190196	0.873900	5.284615	0.512239

Otta Sør E6 Oppland

Axle weight distribution 6ax vehicles Otta Sør E6



Axles	Mean in t	STD in t
1 axle	5.60	0.95
2 axle	6.66	1.63
3 axle	4.30	1.59
4 axle	4.41	1.87
5 axle	4.22	1.53
6 axle	4.40	1.56

Akselavstand I

Tabell 1

Aksel/ akselkombinasjon	Akselavstand i meter	Tonn			
		Bk10	BkT8	Bk8	Bk6
Aksellast (frirullende hjul)		10	8	8	6
Aksellast drivaksel		11,5 ¹	8	8	6
Last fra to aksler	1,30 – 1,79 (boggi)	18 ^{1, 2}	14	12	9
	1,20 – 1,29 (boggi)	16	12	12	9
	0,80 – 1,19	15	11,5	11,5	8,5
	Under 0,80	10	8	8	6
Trippelboggi	1,30 – 1,79 ³	24	19	16	12
	1,00 – 1,29 ⁴	22	18	16	12
	Under 1,00 ⁴	16	12	12	9



Akselavstand III



2 / 3-boggi per lastebil [$C_v = 1.30$]

Stasjon	Kjøretøyer	Lastebiler	% Lastebiler	2-boggi	% 2-boggi	3-boggi	% 3-boggi
Storsand E39 [test]	53 127	5 479	10.3 %	3537	63.6 %	949	17.3 %
Storsand E39	1 436 097	130 221	9.0 %	83 581	64.2 %	21 637	16.6 %
Verdal E6							
Gjerdemyra E18	1 708 369	245 633	14.4 %	175 797	71.5 %	77 316	31.5 %
Otta Sør E6	1 430 387	213 861	14.9 %	157 813	73.8 %	54 166	25.3 %
Teigkamptunnelen E6 (A)	344 082	62 310	18.1 %	47 888	76.9 %	17 961	28.8 %
Teigkamptunnelen E6 (B)	338 531	60 218	17.8 %	46 724	77.6 %	17 431	28.9 %

Aksler per Lastebil

	Kjøretøyer	Aksler pr Kjøretøy
Gjerdemyra	1 708 376	2.4682
Storsand	2 026 876	2.2647
Verdal	2 792 707	2.2067
Otta	1 430 387	2.3155

- Data innsamlet fra ATK Storsandtunnel på E39
- Data innsamling Jan. 2016 – Des. 2016
- Truck = kjøretøy over 3,5 t

Stasjon	Lastebiler	Aksler	Aksler pr	Tidsrommet	% tunge	% Datainn	Cut off vekt
Storsand E39	130 975	497 908	3.80	12 måneder	10.4 %	12 %	3.5
Verdal E6	250 511	1 038 187	4.11	12 måneder	9.0 %	12.7 %	3.5
Gjerdemyra E18	237 902	1 076 614	4.52	11 måneder	13.9 %	18 %	3.5
Otta Sør E6	203 691	846 550	4.16		14.2 %	19.0 %	3.5

Average amount of Axles

(Storsandtunnel / Sør-Trøndelag E39)

- Data collected at ATK Storsandtunnel on E39
- Data collection Jan. 2016 – Dec. 2016
- Truck = vehicle over 3,5 t gross weight

Trucks	Axels	Axels per truck
130 975	497 908	3.8

	Number	Axel combination per Truck
Single Axle	308 889	2.3584
Boggi axle	62 177	0.4747
Trippel axle	21 555	0.1646