ERTMS OCH TÅGSIMULERING - ATC, KAPACITET OCH FÖRARBETEENDE

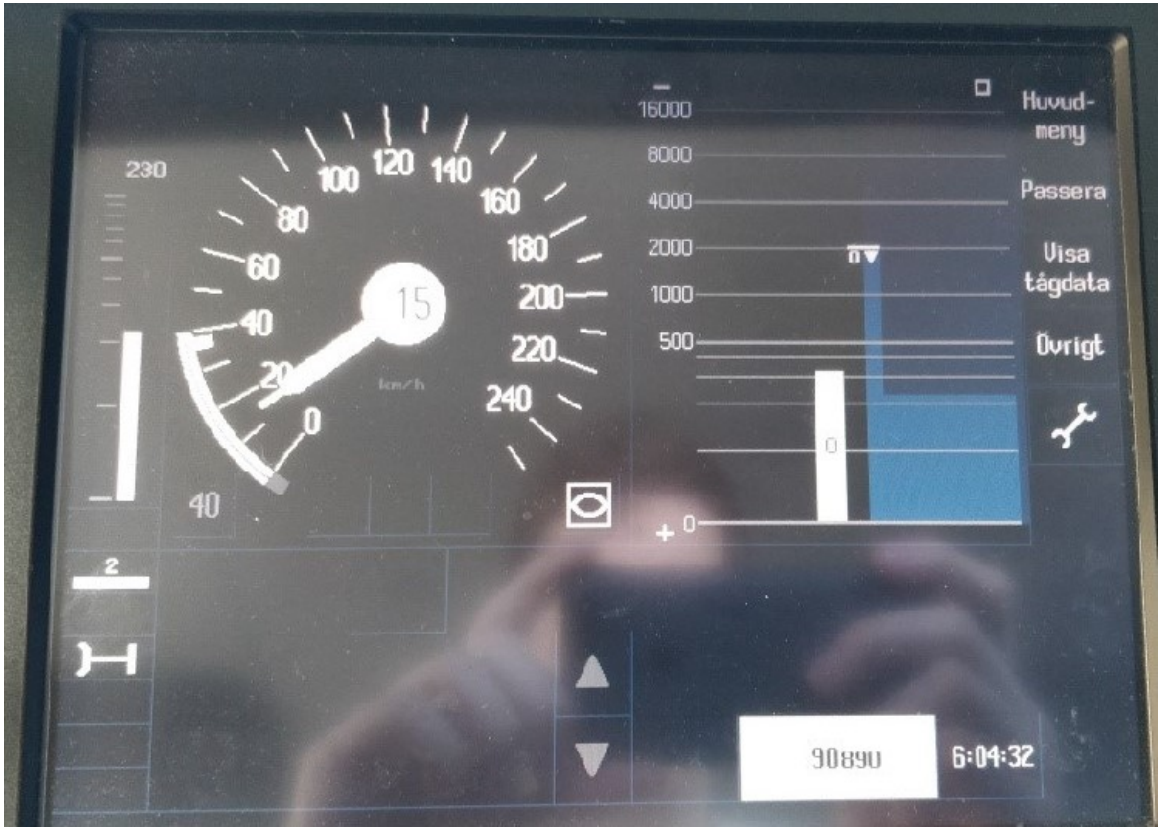
Tomas Rosberg, 21/11-2019

vti

Foto Geran De Klerk, Unsplash

Disposition

- Översikt
- Tågföring ATC
- Tågföring ERTMS
- Summering



HOW DO SIGNALING SYSTEM, DRIVING BEHAVIOUR AND CAPACITY INTERACT?

1. Validation of Real trains/VTI trainsim/RailSys for 2 different sequrity systems (ATC, ERTMS)

2. Methods for parametrization in RailSys/VTI sim based on 1.

3. How could line capacity bee optimized based on 1 and 2?

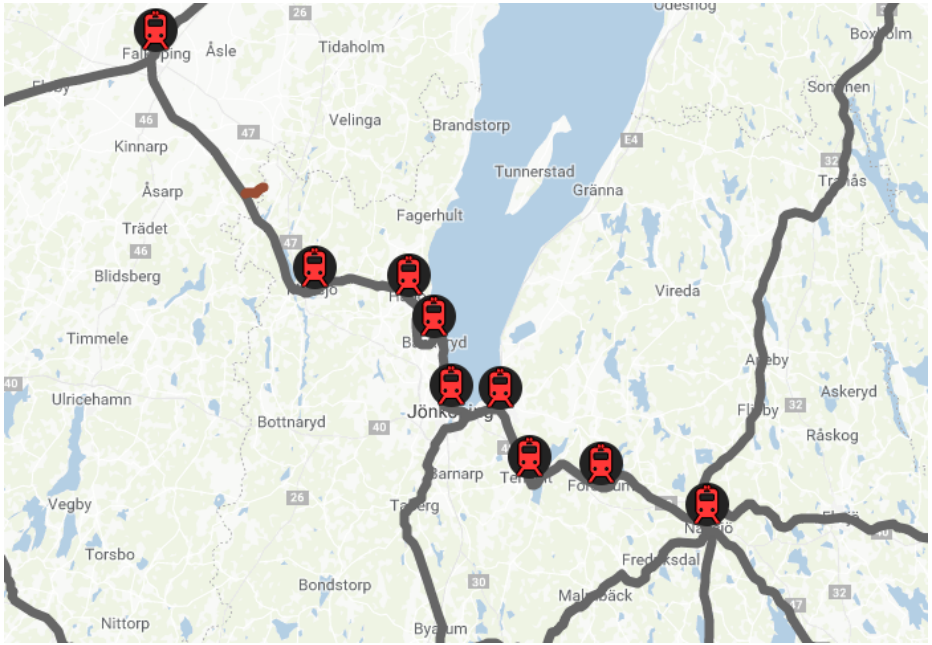
vti

PREPARATIONS

vti

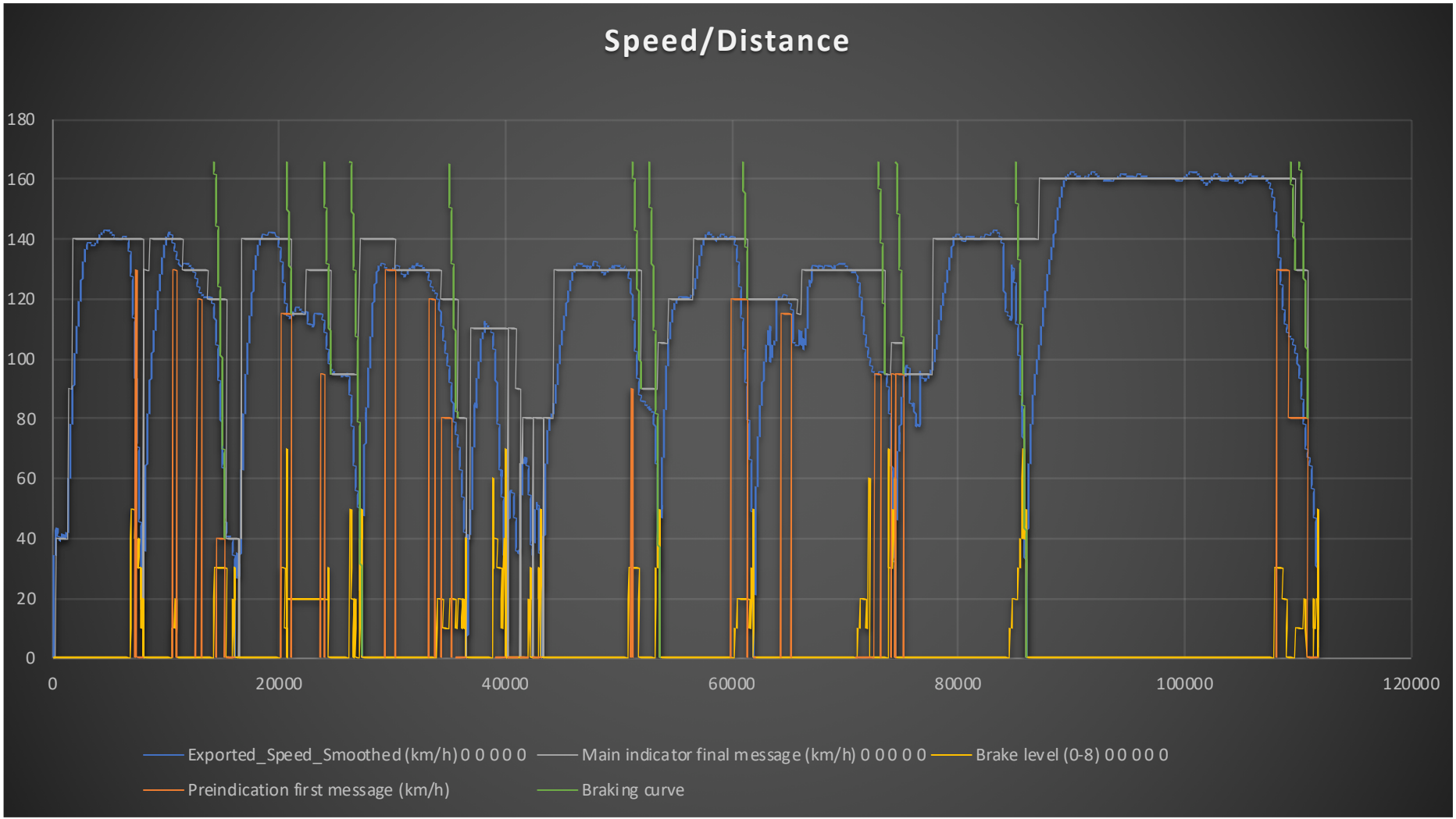
REAL TRAIN DRIVING

- Jönköpingsbanan – ATC/STM
- 1.5h single trip
- 5 days of measuring in March 2019
- Approx 30h of data



vti

PREPARATIONS - TEST SETUP REGINA

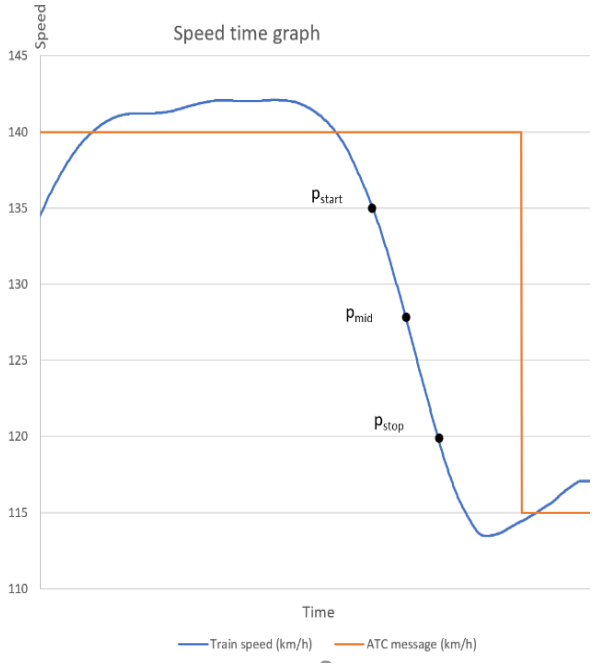

Speed/Distance
180
160
140
120
100
80
60
40
20
0
0
20000
40000
60000
80000
100000
120000
Exported_Speed_Smoothed (km/h) 0 0 0 0 0
Main indicator final message (km/h) 0 0 0 0 0
Brake level (0-8) 0 0 0 0 0
Preindication first message (km/h)
Braking curve

METHOD

RETARDATION MEASUREMENT

- p_{start} - point where train velocity was 5 km/h below permitted speed
- p_{stop} - point where train velocity was 5 km/h over target permitted speed
- p_{mid} - point where train velocity was in midway between velocity in p_{start} and velocity in p_{stop}

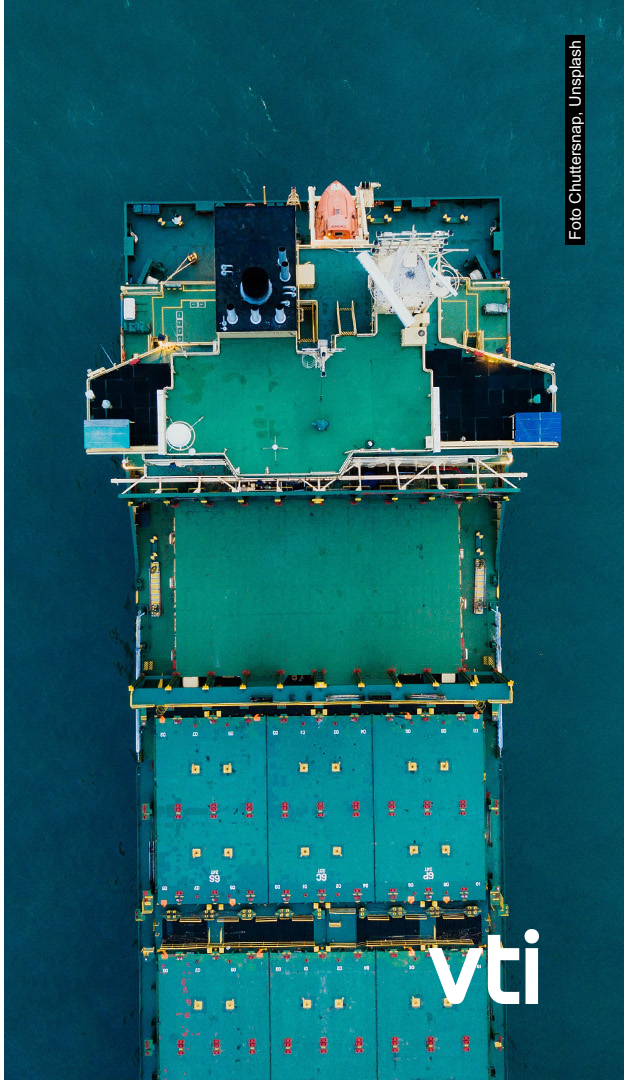
- The retardation was determined as the average value of the gradient of the two linear curves p_{start} - p_{mid} *and* p_{mid} - p_{stop}



vti

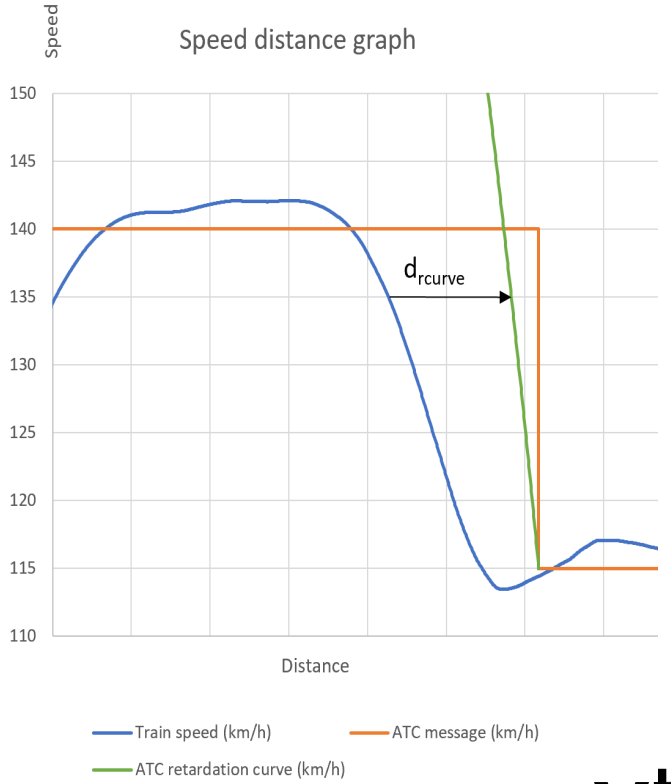
BRAKING BEHAVIOUR AND ATC SIGNAL TARGETS

- braking towards a 40 km/h target,
- braking towards a ≥ 70 km/h target
- braking towards a station without any restrictive signal point.



ATC RETARDATION CURVE

- Distance to R-Curve given by d_{rcurve}
  - *measured 5 km/h below permitted speed*
- Comparing the retardation of both curves
  - 40 km/h target
  - ≥ 70 km/h



vti

RAILSYS COMPARED TO REAL TRAIN DRIVING

Two aspects have been investigated:

1) Running times

   Sections between the 10 stations Nässjö, Forserum, Tenhult, Huskvarna, Jönköping, Bankeryd, Habo, Mullsjö, Sandhem, and Falköping, where the average running time per section was calculated from the measured running times.

2) Acceleration/retardation behaviour

   RailSys compared to VBOX real time measurements.

vti

RESULTS

vti

BRAKING BEHAVIOUR AND ATC SIGNAL TARGETS

	Target 40km/h [m/s^2]	No of braking targets	Target ≥ 70 km/h [m/s^2]	No of braking targets	Station without stopping signal point [m/s^2]	No of braking targets
Average acc.	**-0.37**		**-0.352**		**-0.465**	
Total no of targets		**28**		**66**		**72**

TRAIN DRIVING AND ATC RETARDATION CURVE

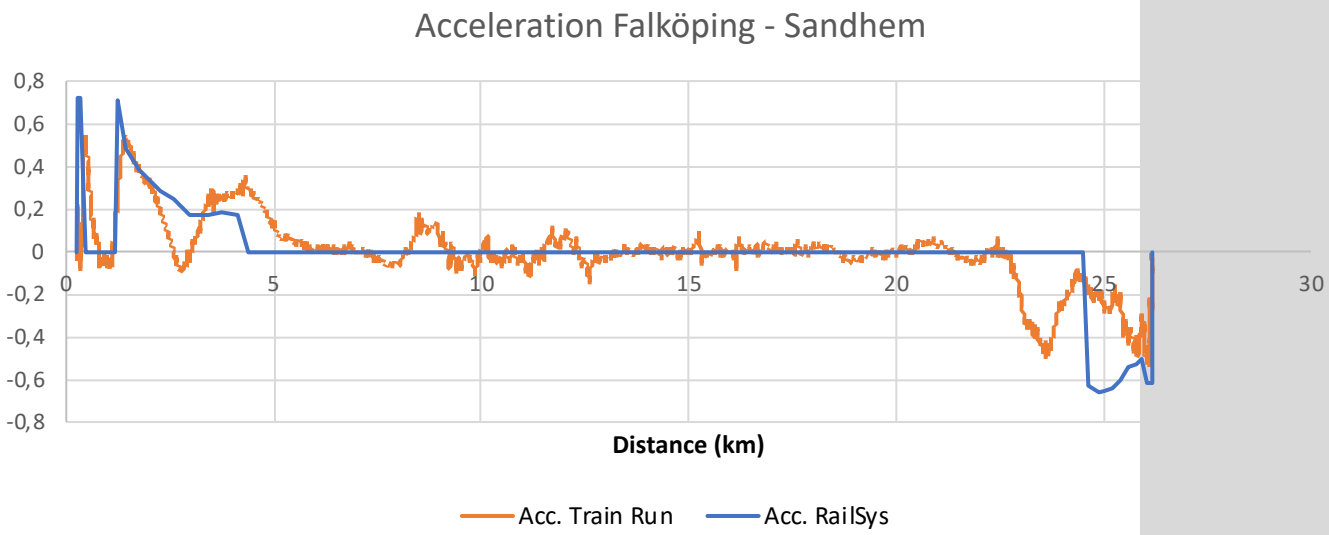
	Average acc. of R-curves [m/s^2]	No of breaking targets	Average distance to R-curve 40 km/h target, d_{rcurve} [m]	No of breaking targets	Average distance to R-curve ≥ 70 km/h target, d_{rcurve} [m]
Average acceleration	**-0.773**				
Average distance to R-curve			**838**		**882**
Total no of targets		**28**		**66**	

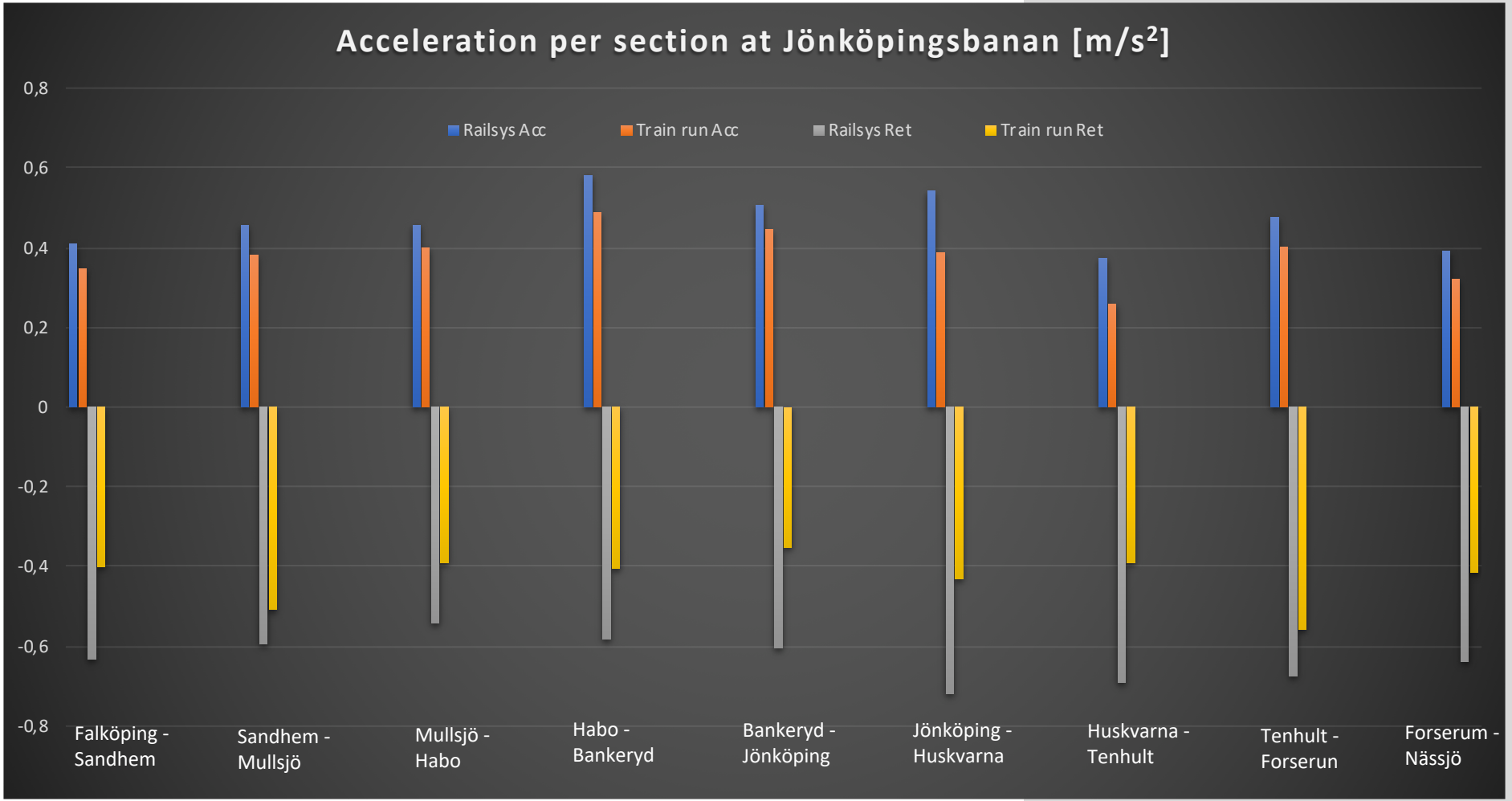
RUNNING TIMES

	Average measured running time [hh:mm:ss]	Average running time RailSys [hh:mm:ss]	Diff RailSys – measured running time [hh:mm:ss]	Timetable reference time [hh:mm:ss]
Falköping-Sandhem	00:12:31	00:11:58	00:00:33	00:12:00
Sandhem-Mullsjö	00:07:18	00:06:47	00:00:31	00:10:00
Mullsjö-Habo	00:07:17	00:07:08	00:00:09	00:07:00
Habo-Bankeryd	00:05:06	00:04:51	00:00:15	00:05:00
Bankeryd-Jönköping	00:07:06	00:06:34	00:00:32	00:06:00
Jönköping-Huskvarna	00:05:50	00:04:58	00:00:52	00:05:00
Huskvarna-Tenhult	00:06:07	00:05:35	00:00:32	00:06:00
Tenhult-Forserum	00:06:59	00:06:38	00:00:21	00:07:00
Forserum-Nässjö	00:10:19	00:09:19	00:01:00	00:10:00
Running time and difference	**01:08:34**	**01:03:48**	**00:04:46**	**01:08:00**

vti

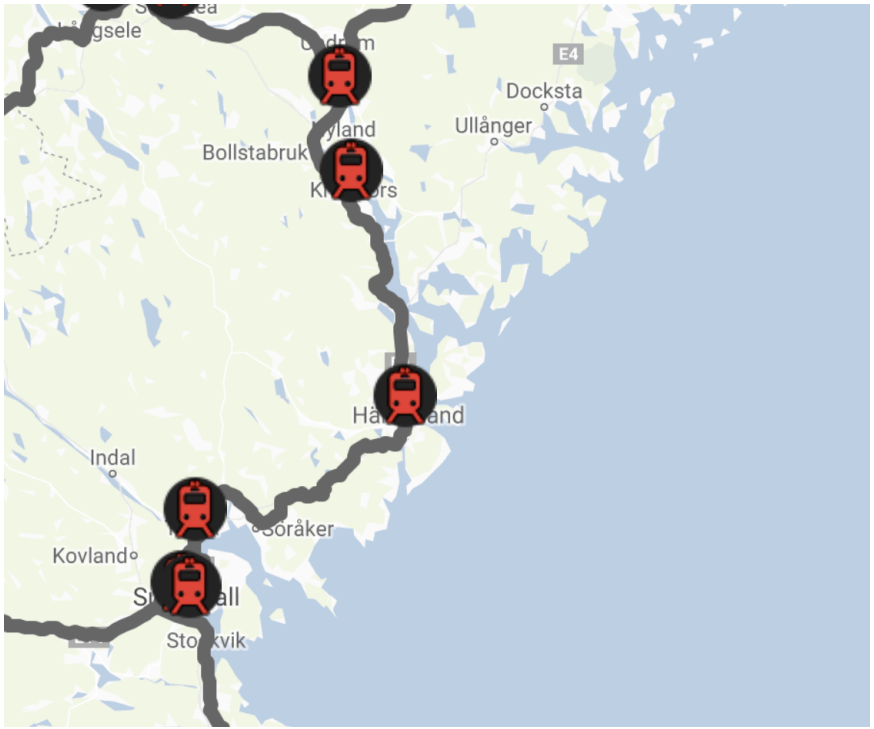
ZOOMING IN…


Acceleration Falköping - Sandhem
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
0
5
10
15
20
25
30
Distance (km)
Acc. Train Run
Acc. RailSys


Acceleration per section at Jönköpingsbanan [m/s²]
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
Railsys Acc
Train run Acc
Railsys Ret
Train run Ret
Falköping - Sandhem
Sandhem - Mullsjö
Mullsjö - Habo
Habo - Bankeryd
Bankeryd - Jönköping
Jönköping - Huskvarna
Huskvarna - Tenhult
Tenhult - Forserun
Forserum - Nässjö

ERTMS LEVEL 2 - ÅDALSBANAN

Stations:
Väster Aspby
Kramfors
Härnösand
Timrå
Sundsvall

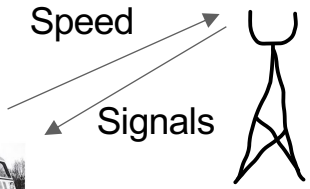


Ådalsbanan full.html

Foto Denys Bilytskyi, Mostphotos

ERTMS DATA LOGGING POSSIBILITIES

-> JRU “Black box”



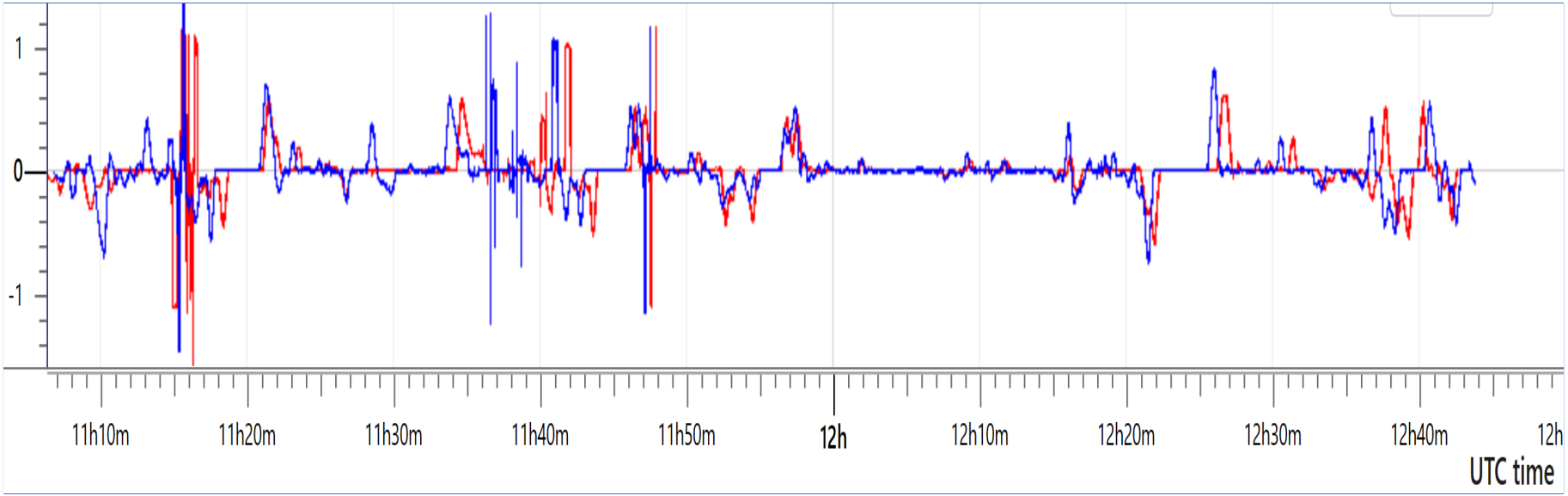
-> GSM-R logging tool (GEM in Sweden)

-> Own equipment

vti

ADDING GPS/VIDEO

ACC – SAME PATTERN AS ATC



Hastighetsmätning GEM/VBOX

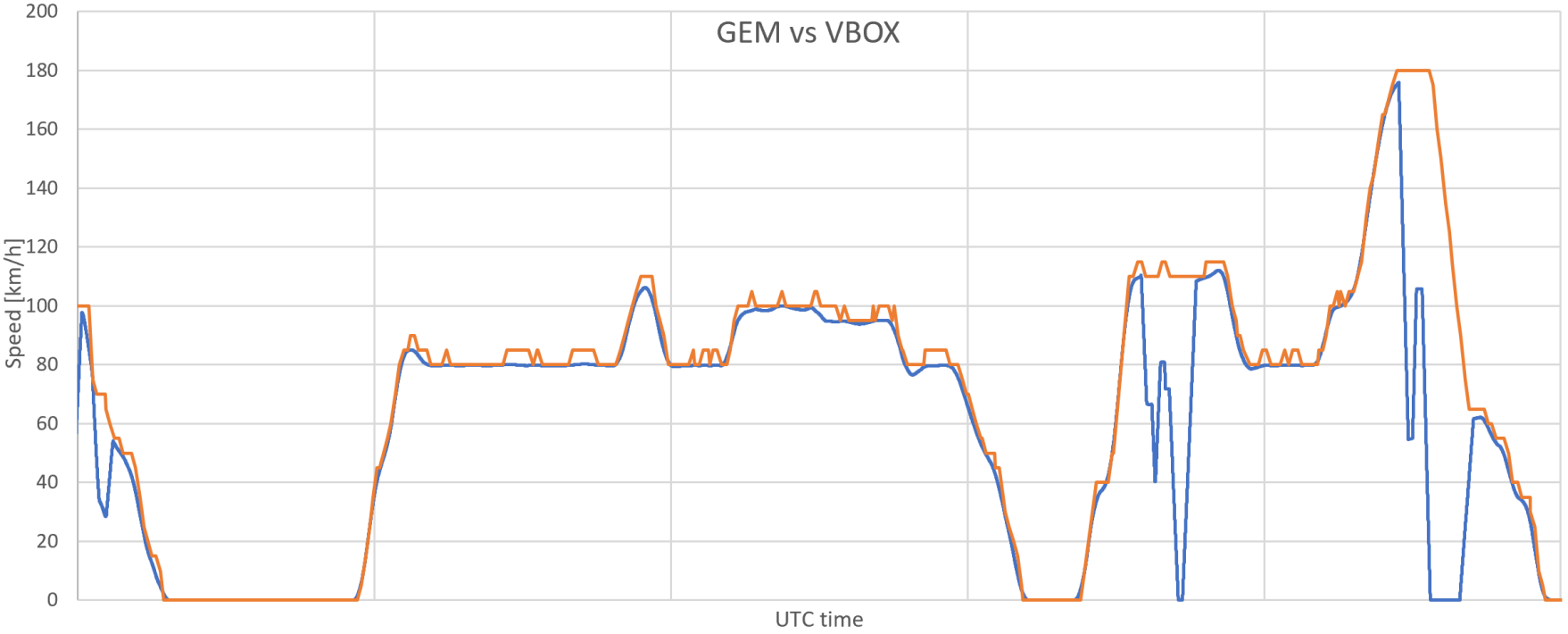


Foto Jonas Jacobsson, Unsplash

Summary

- Retardation depends on signal target.
  - Station without stopping restriction distinguish.
- Margins to unconditional braking is high.
- Differences in running times caused by different acceleration/retardation behaviour.

vti