OPENTRACK nextRail17 RATP

Modernization of the RATP Railway Network

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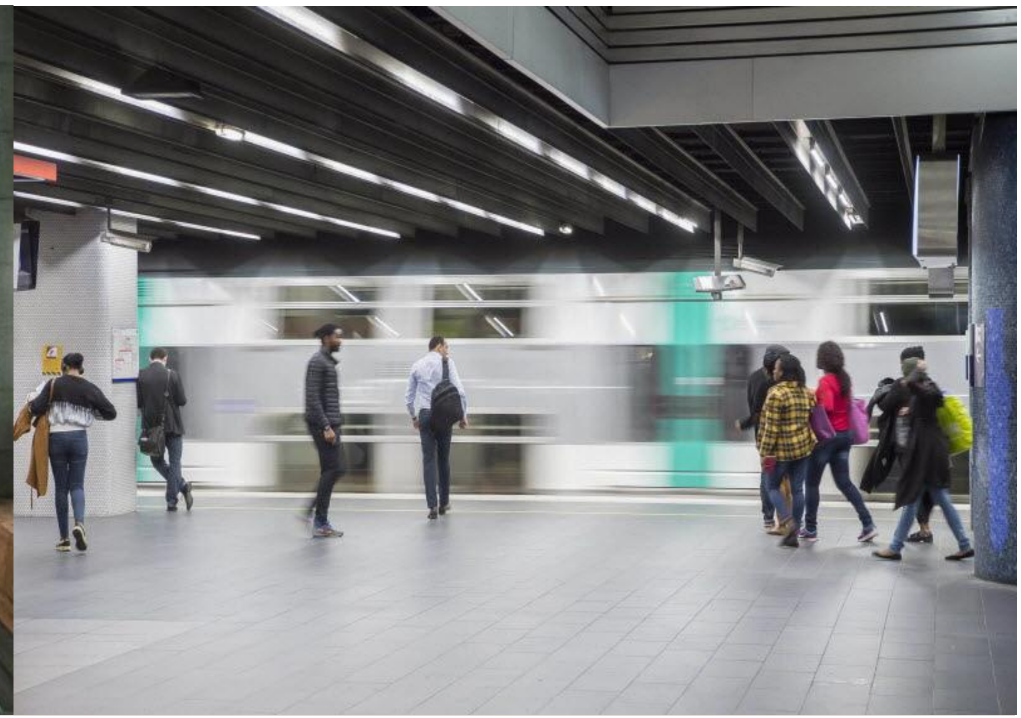


The RATP group problematic

16 (M), 2 (RER) and 8 (T)

≈ 3 billions passengers/year

One of the most dense in the world

Increase of passengers number ⇒ maximum productivity, reach system intrinsic capacity

A small disturbance can impact dramatically the traffic performance

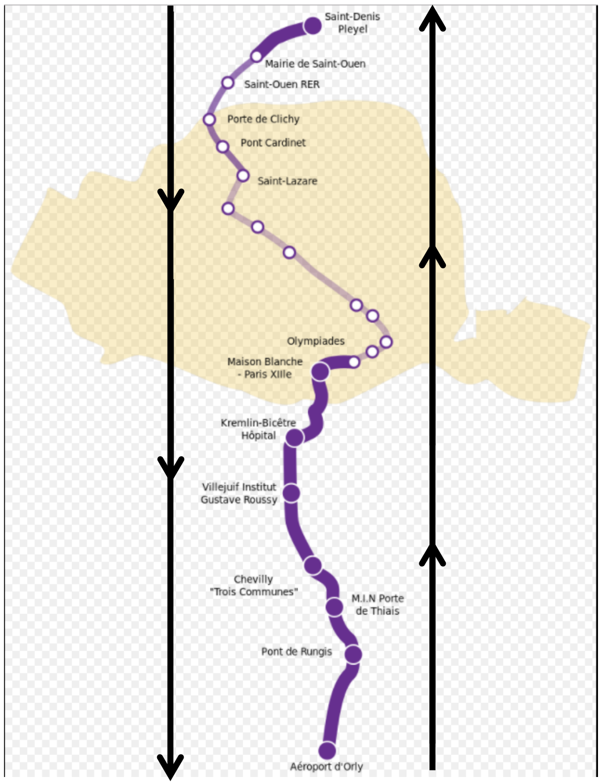
Operating studies help determine strategies optimizing KPY such as punctuality, robustness etc…

Railway network operation strategies : Line 14

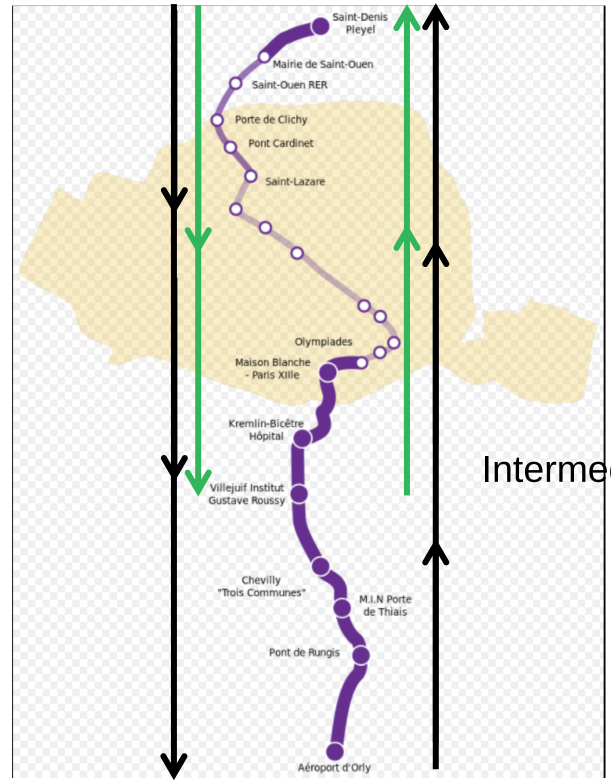
Classical operation

Terminus 1

Terminus2



Classical operation + intermediate terminus



Terminus 1

Intermediate terminus

Terminus2

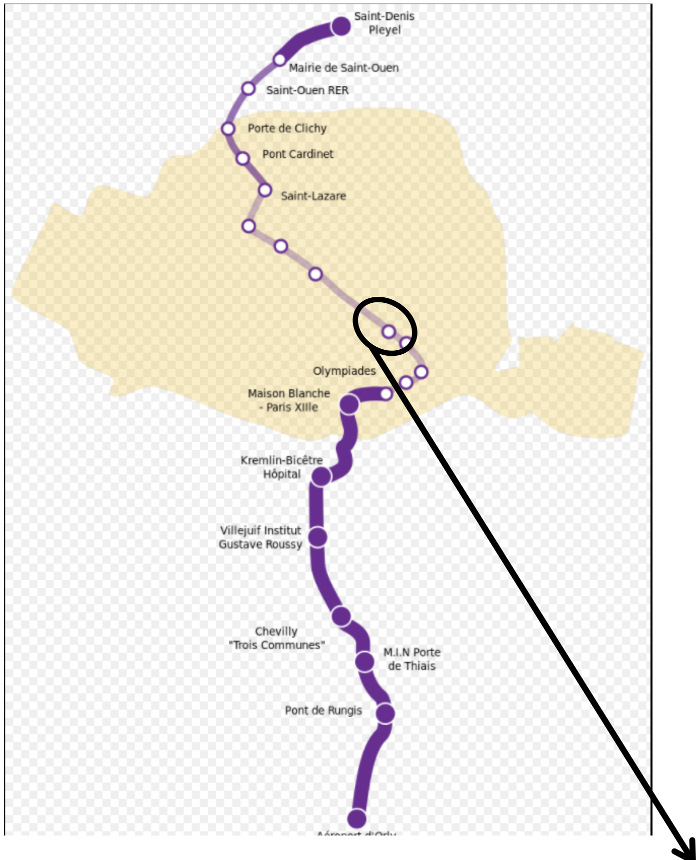
Two operating strategies considered

- Classical operation (Headway = 90s)
- Classical operation + intermediate terminus (Headway = 90s/180s)

Which one is the best?

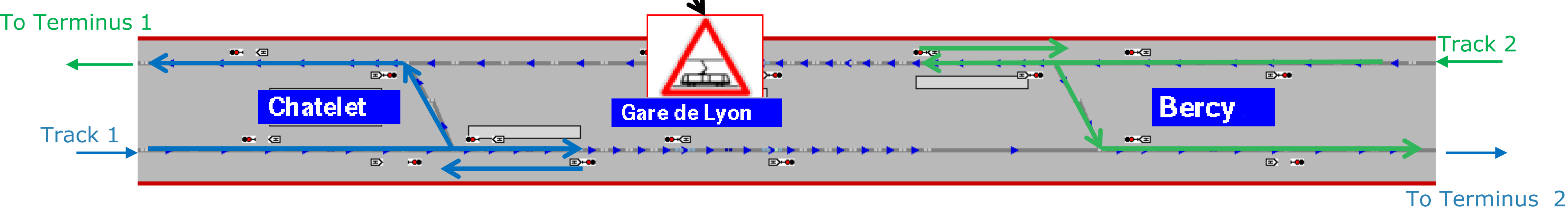
- Punctuality
- Robustness

Simulation of an incident



Simulation of an incident

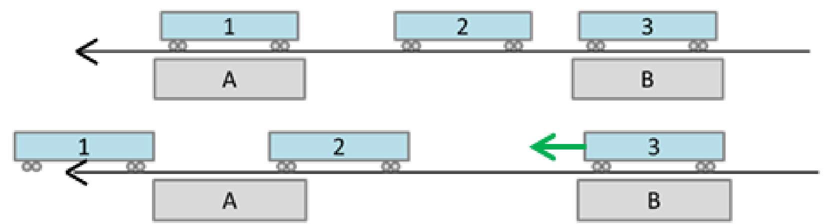
- Damage train can't move for 15 min
- Localization : Gare de Lyon Station Track 2
- Delay before first turn around : 5 min



Implementation of regulation methods in OpenTrack (1/2)

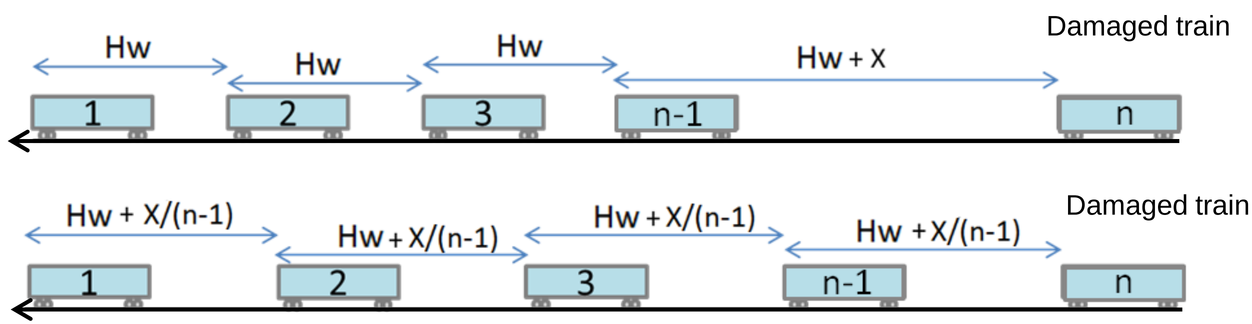
Anti-stacking (using trains connections)

- Two trains (2 & 3) can't be in the same interstation if another train (1) is still waiting in the next station (A)
- Train 3 has to wait in station B until train 1 leaves station A



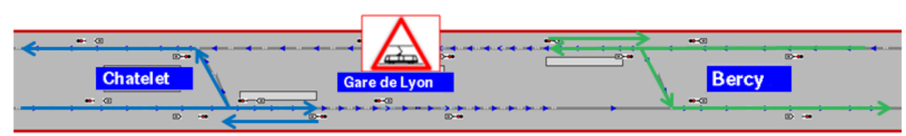
Ahead regulation (using trains connections)

- Limit huge headway creation by adding delay to trains ahead of the incident
- Delay added :
  - Train 1 : 0
  - Train 2 : X/(n-1)
  - Train 3 : 2X/(n-1)
  - Train n-1 : (n-2).X/(n-1)
- Max headway : Hw + X/(n-1)



Implementation of turn around (modification of itineraries)

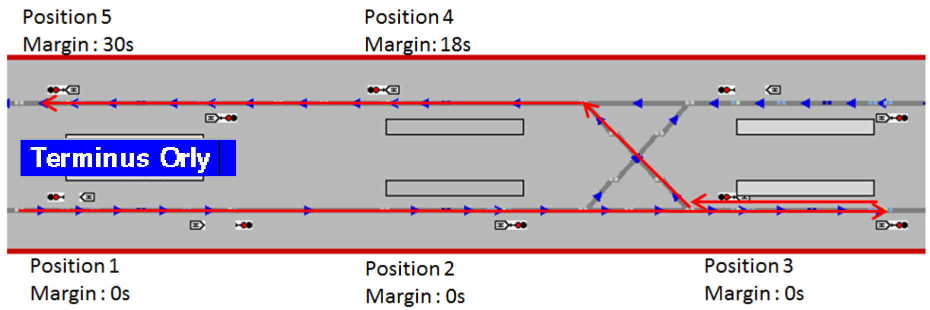
- After 5 min, trains are turned around using the switch in the stations juxtaposing the incident



Implementation of regulation methods in OpenTrack (2/2)

Terminus margins (Timetable management)

- Trains can reduce their delay using the margins set up in each position of a terminus
- Margin = $DwT_{timetable} - DwT_{mini}$
- Total Margins = ∑Margins = 100s
- Departure delay = Arrival delay - 100s



Faster speed profile (Train category management)

- When a train is late, it can change its speed profile to reduce its running time in the interstation up to 4% of the “normal” running time

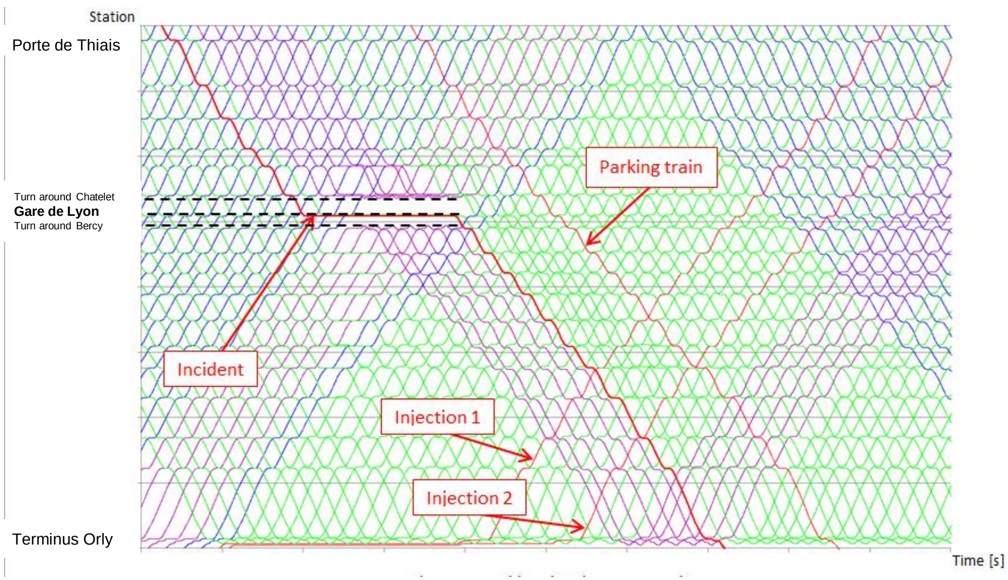
Train Parking/Injection (Courses management)

- When a train delay is too important, it’s possible to park this train and inject another one in the correct corridor to reduce its delay instantly

Simulations results and analyze

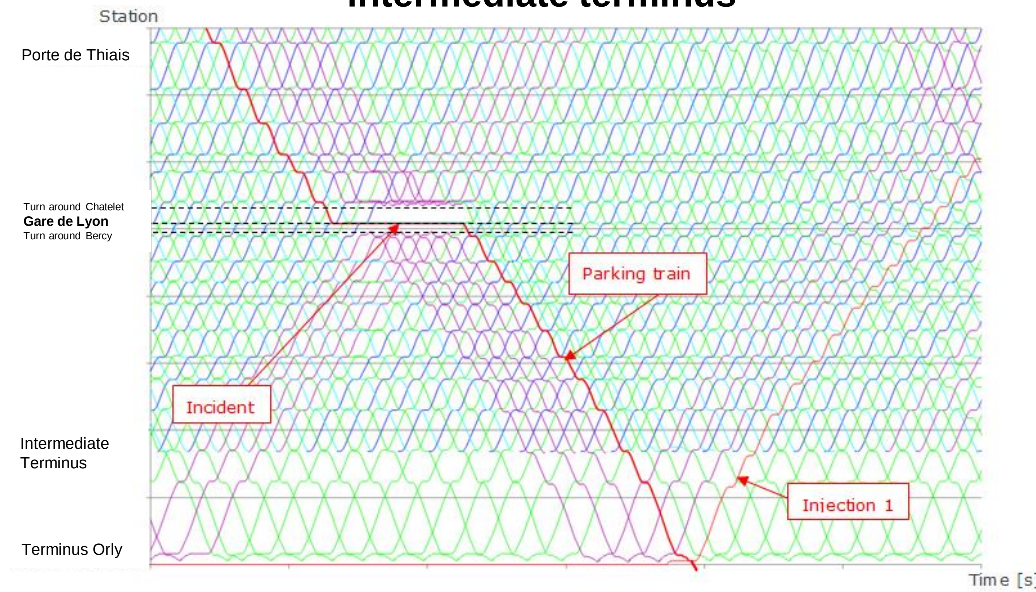
Simulation during morning peak hours

Classical operation



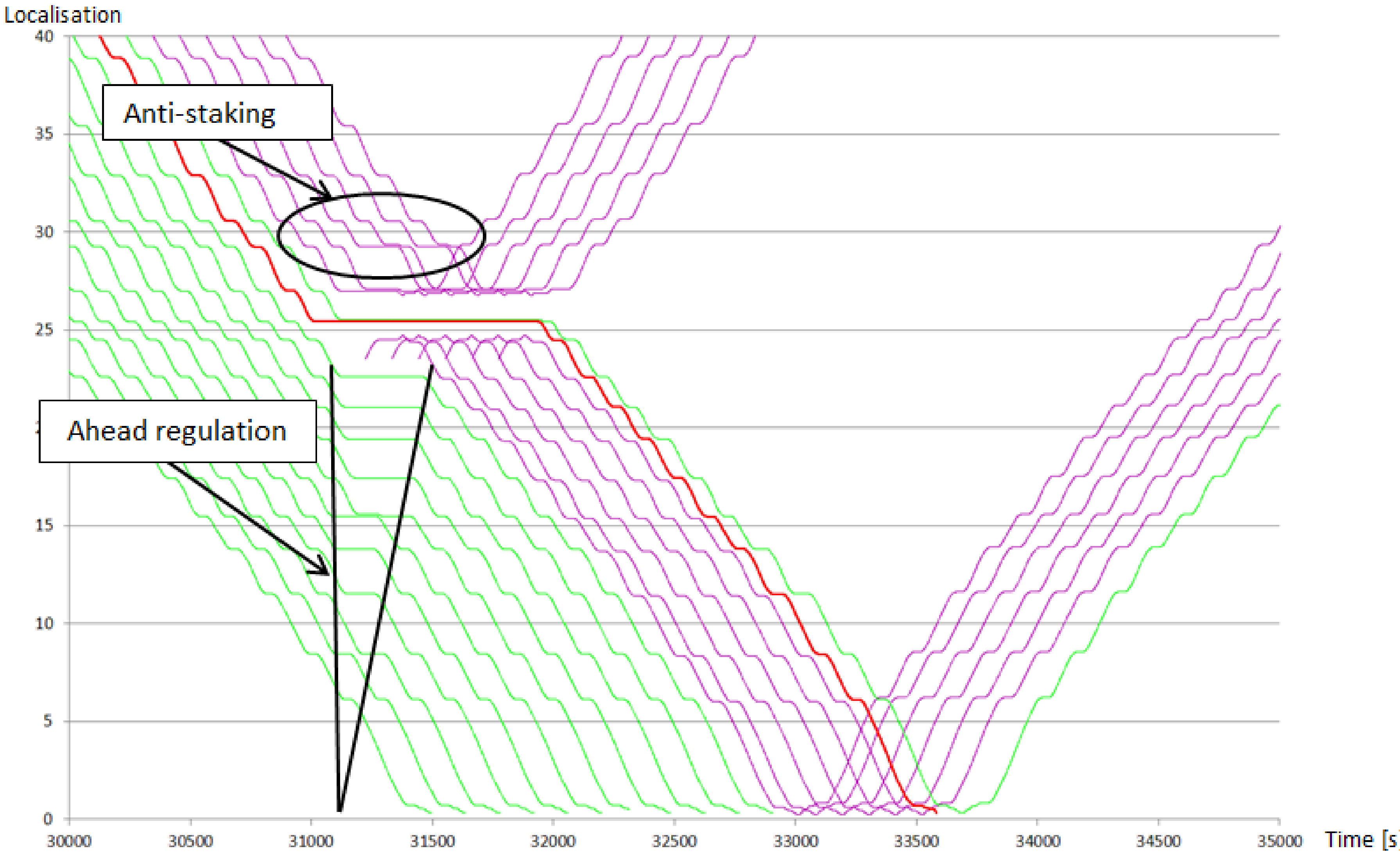
- Trains coming from Terminus 2
- Trains coming from Terminus 1
- Trains turned around
- Trains parked/injected

Classical operation + intermediate terminus

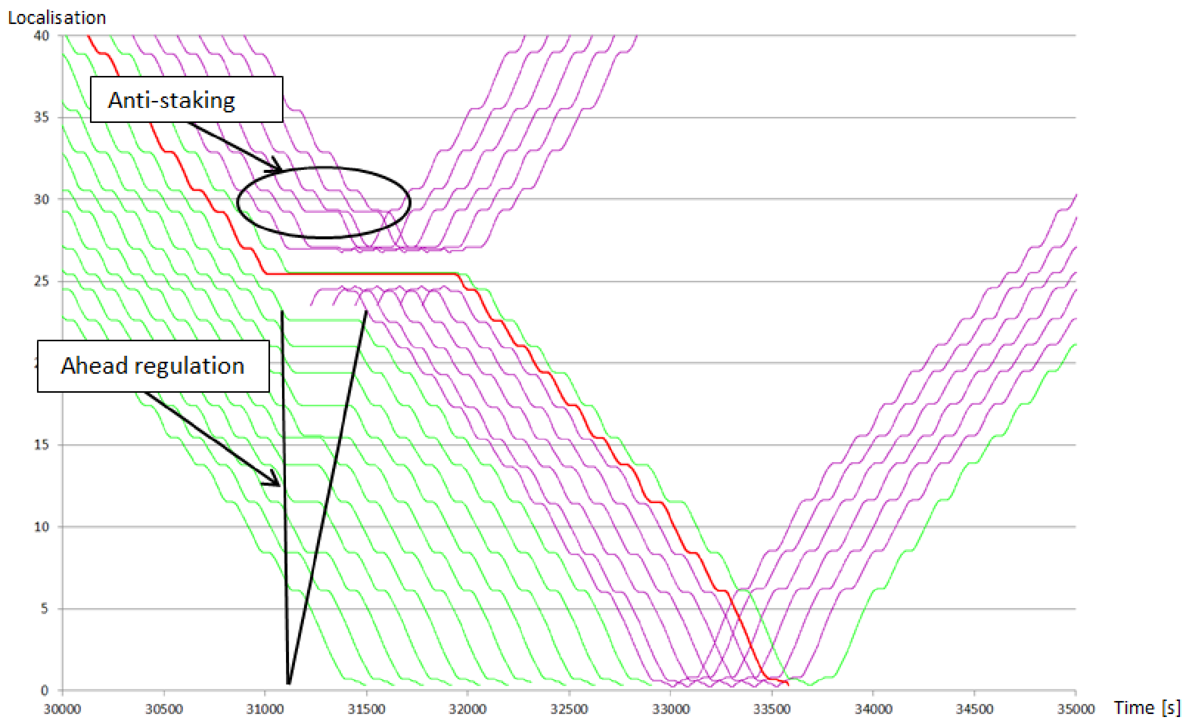


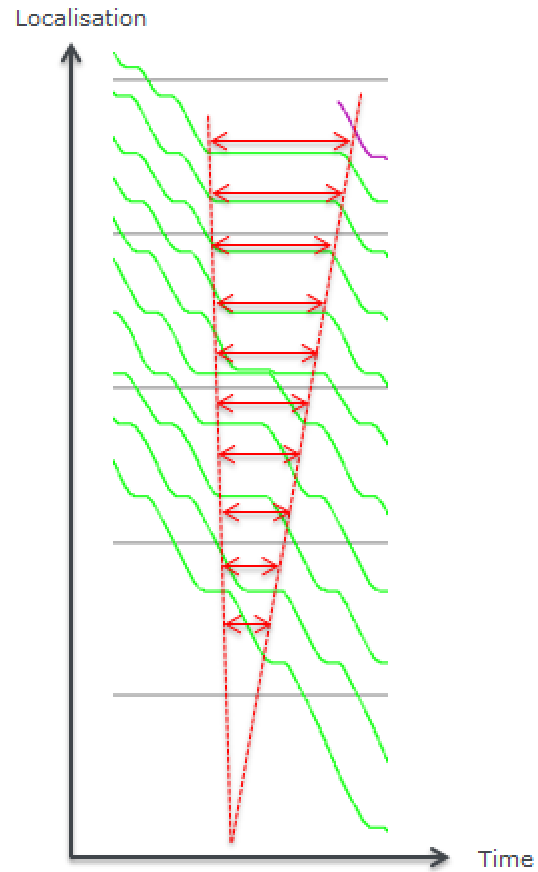
- Trains running on the Spiral
- Trains departing from the intermediate terminus Track 2
- Trains going to the intermediate terminus Track 1
- Trains turned around
- Trains parked/injected

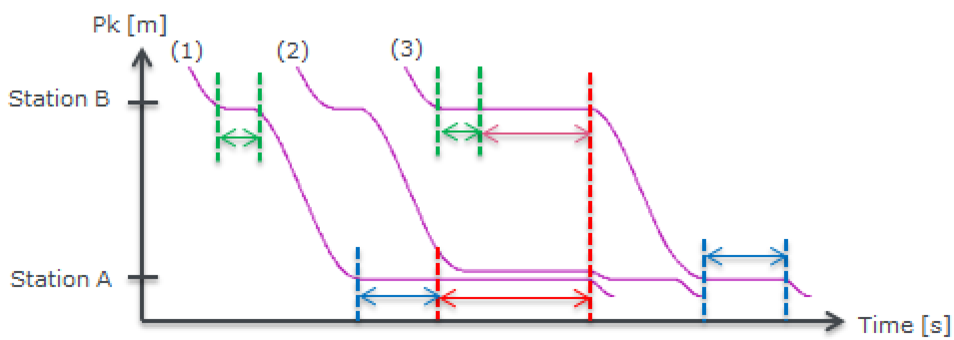
Simulations results and analyze



Simulations results and analyze



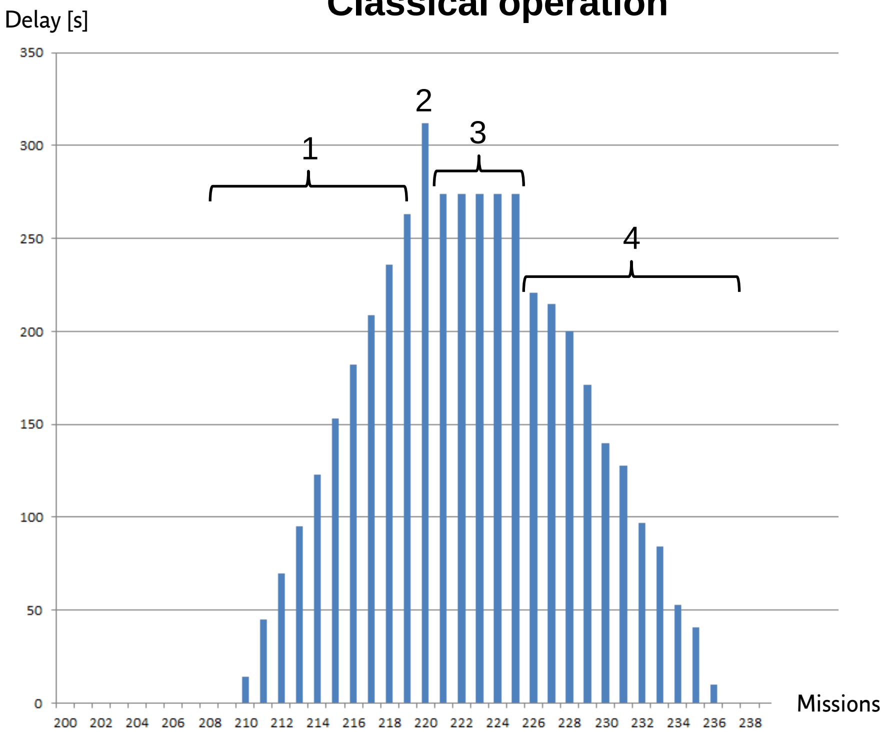




Simulations results and analyze

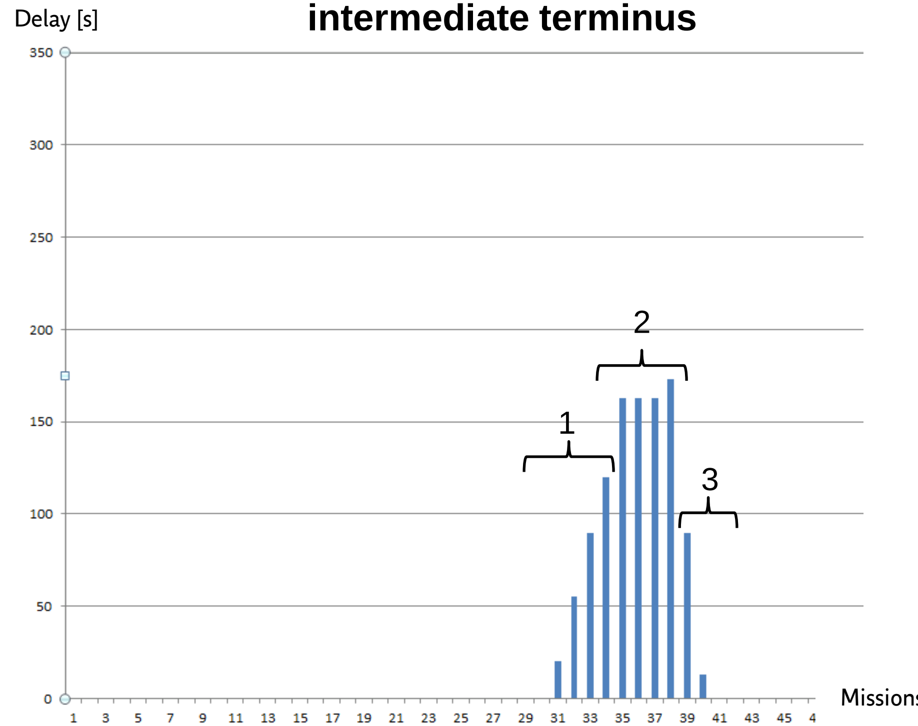
Delay comparison : Arrival in terminus 2

Classical operation



1 : Increase of delay due to the ahead regulation
2 : Maximum delay -> First train turned
3 : Homogeneous delay
4 : Decrease of delay (anti-staking)

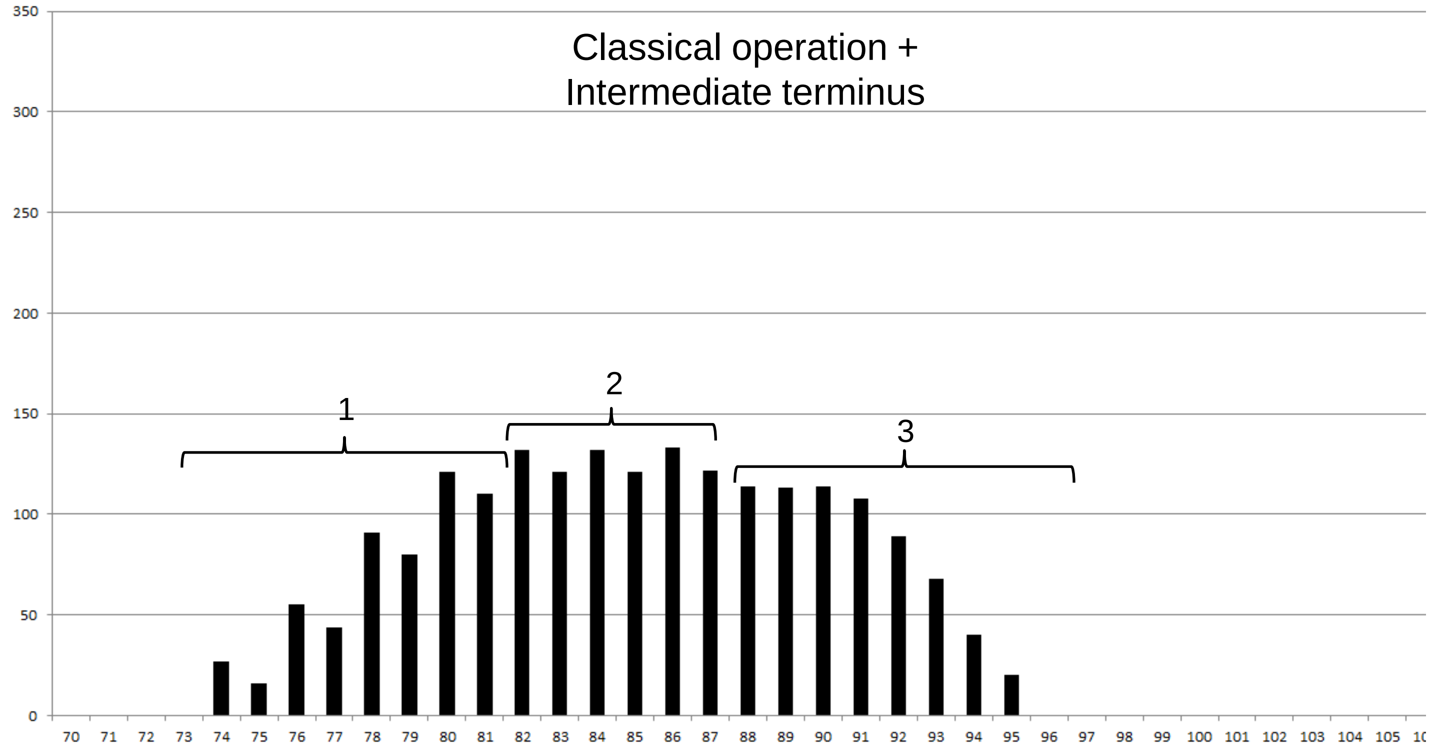
Classical operation + intermediate terminus



1 : Increase of delay due to the ahead regulation
2 : Homogeneous delay
3 : Decrease of delay (anti-staking)

Simulations results and analyze

Departure delay from the intermediate terminus



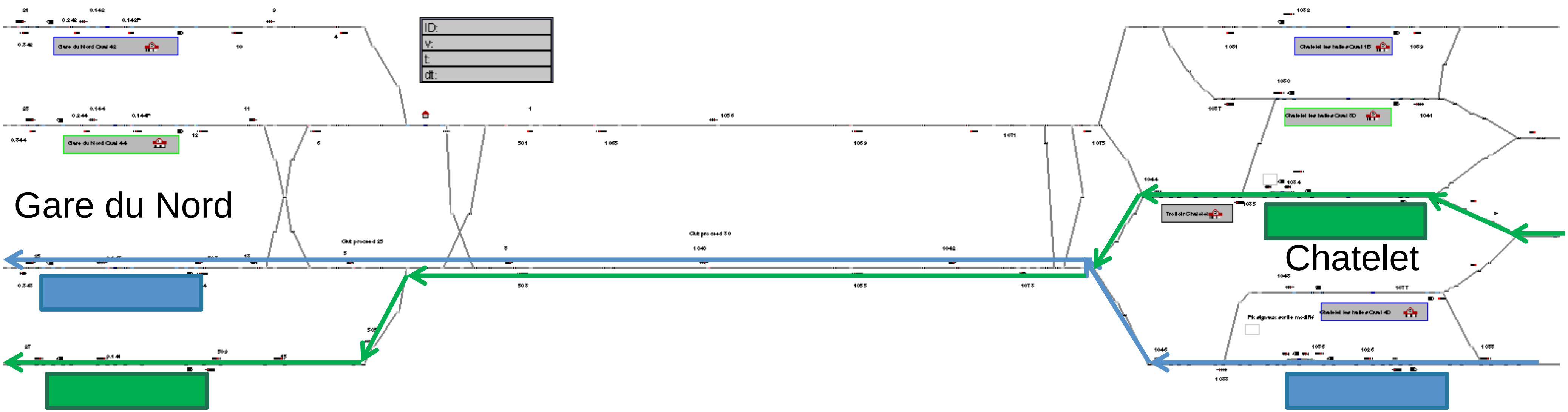
1 : Increase of delay due to the ahead regulation
2 : Homogeneous delay
3 : Decrease of delay

Simulations results and analyze

Performance indicators	Classical operation	Classical operation + Intermediate terminus
Number of turn around	12	12
Number of injection	2	1
Number of parking	2	1
Maximum headway	422	318
Maximum delay	312	208
Time for recovery	58min33s	51min45

Calibration of the junction model on Line B/D

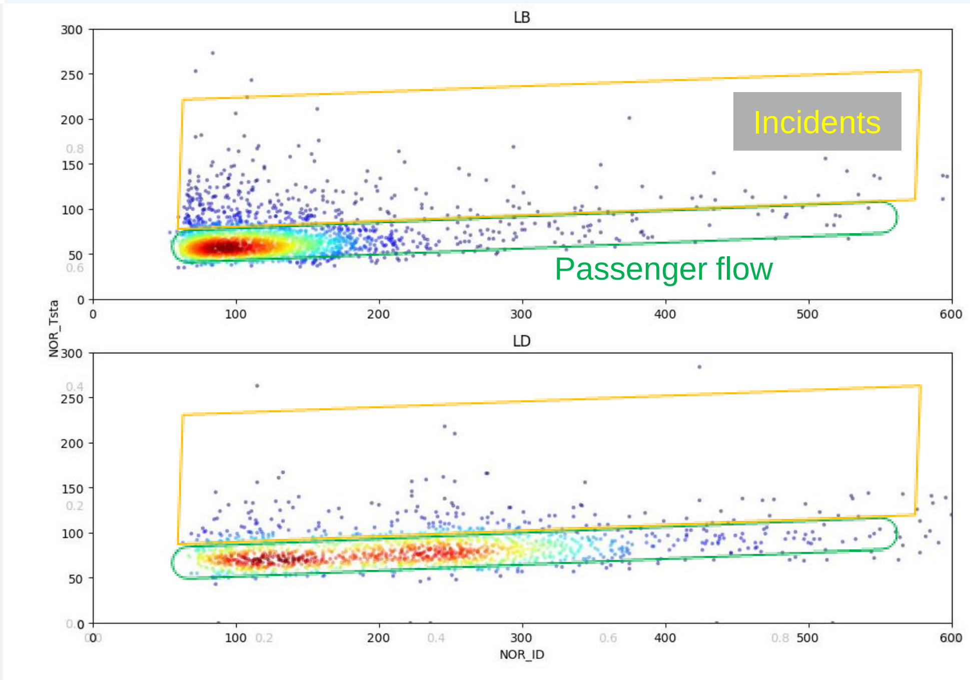
Infrastructure between Chatelet and Gare du Nord stations.

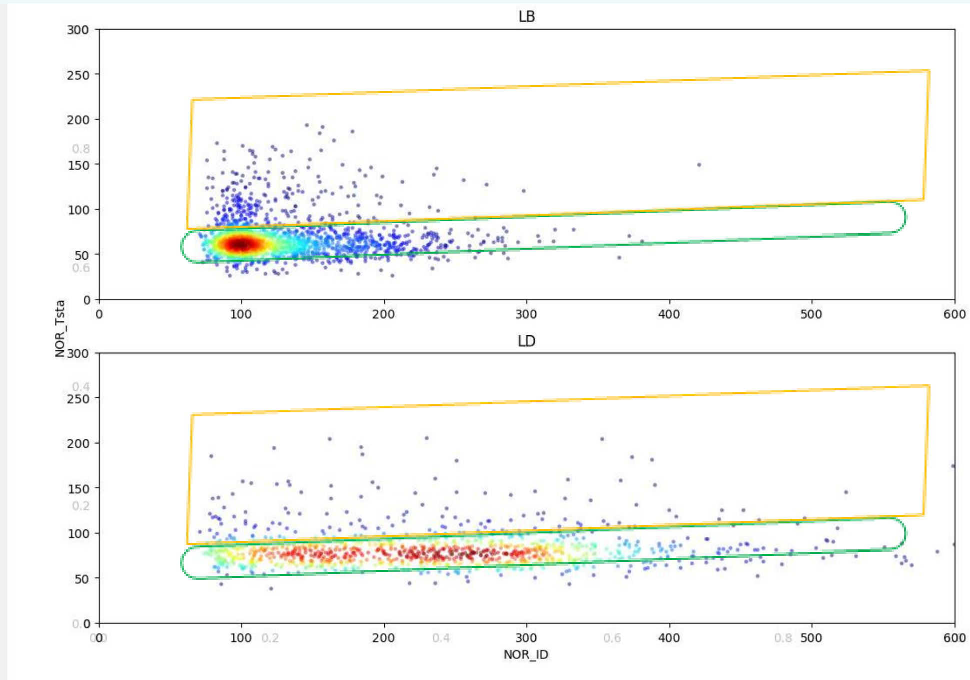


Headway B Line : 180s
Headway D Line : 180s/360s/360s
Circulation cycle : B-D-B-D-B-B-D-B

Circulation Feedback/Simulation – Gare du Nord Station Dwell Time

Feedback	Simulation
Dwell time at Gare du Nord station as a function of the dynamic headway	



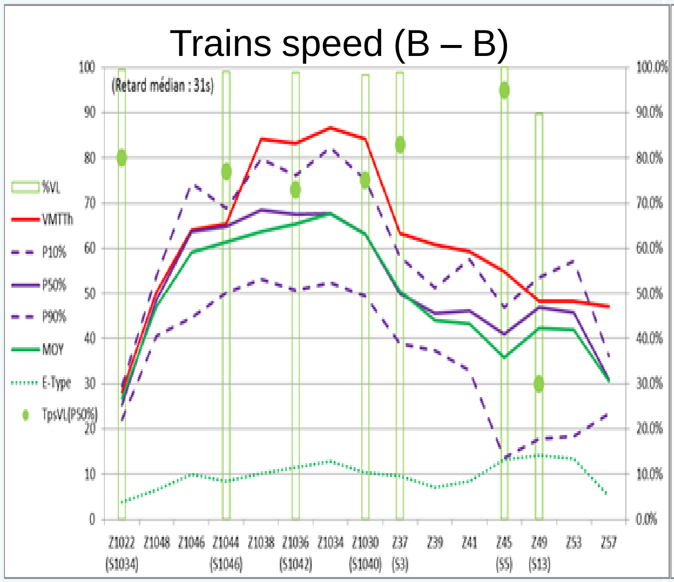


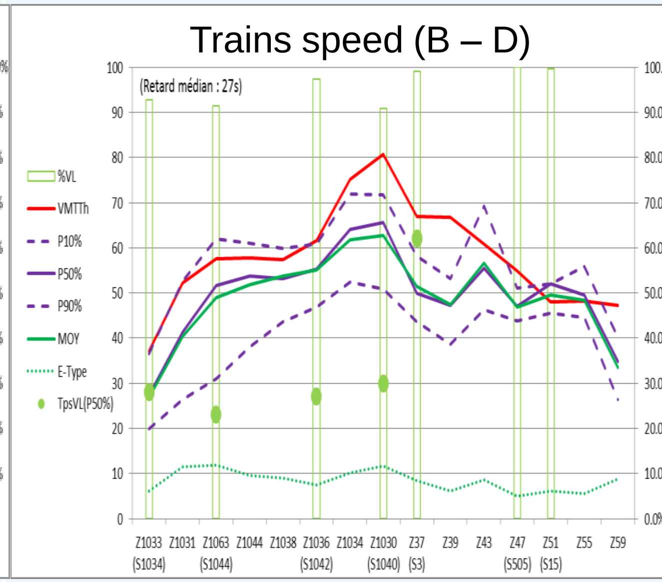
Feedback	Simulation
Mean Dwell Time : B = 68 s et D = 83 s	Mean Dwell Time : B = 68 s et D = 82 s

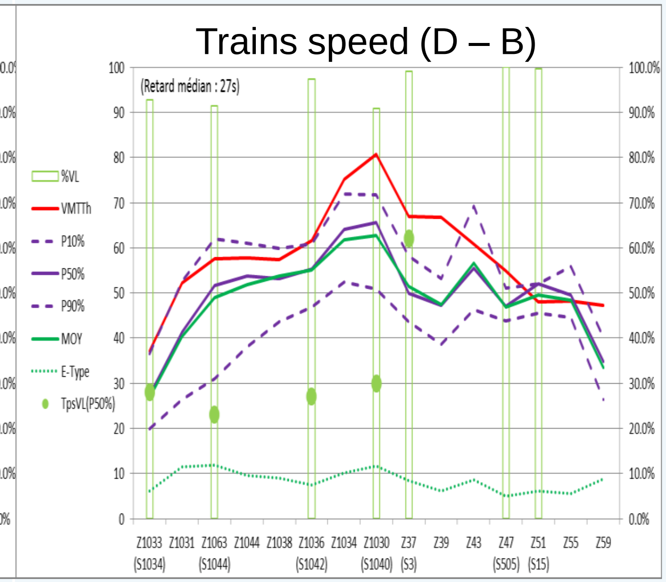
Circulation Feedback/Simulation – Tunnel Running Time (1/2)

Line B	Line D

Trains speed for each track circuit of the tunnel







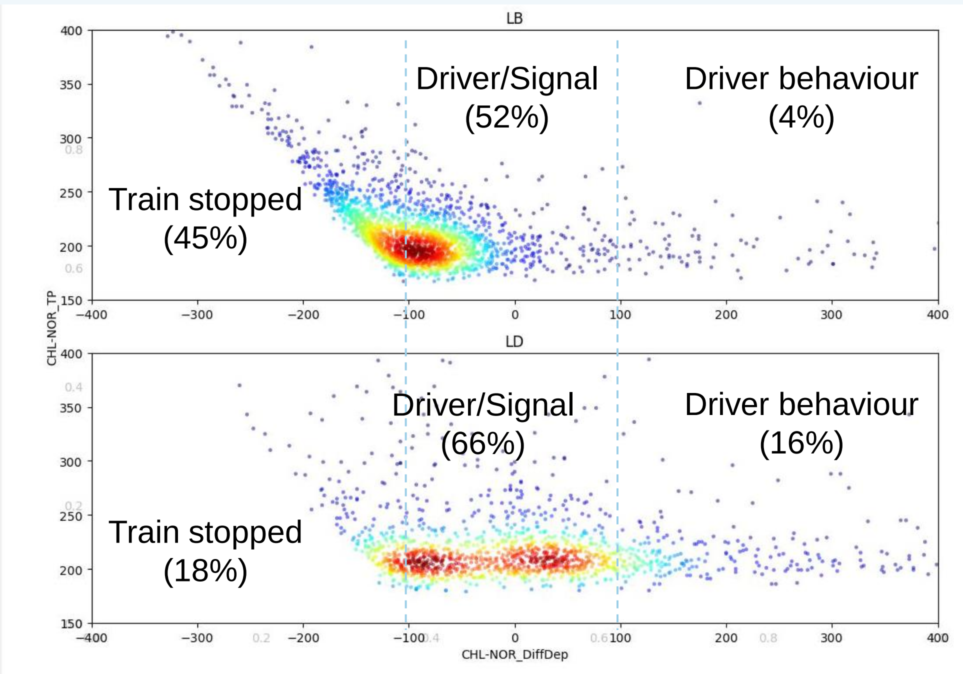
Less than 10% of the trains manage to achieve the theoretical running time
However 90% of the trains only see green aspects

➔ Drivers slow their speed to avoid yellow aspects

Circulation Feedback/Simulation – Tunnel Running Time (2/2)

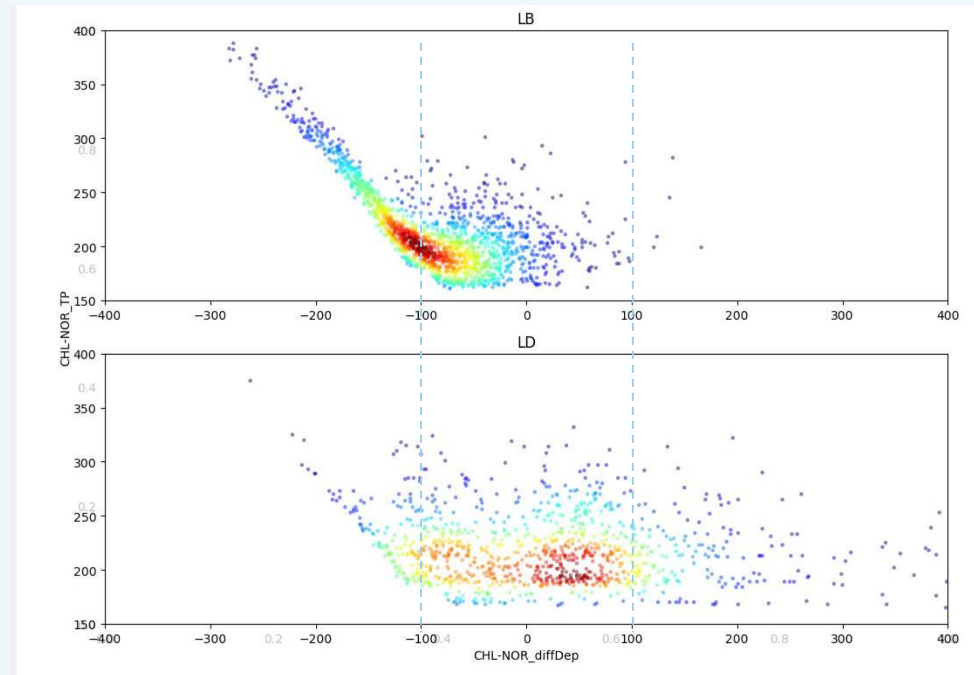
Feedback	Simulation
Running time in the tunnel as a function of the spatial headway	

Feedback



Mean Running Time : B = 215 s et D = 222 s

Simulation

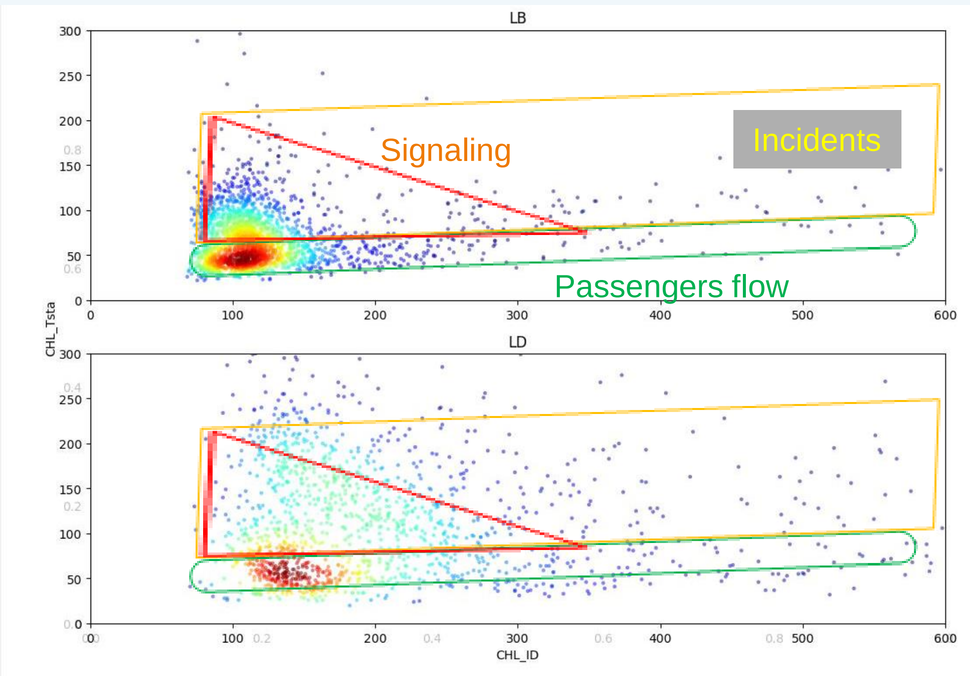


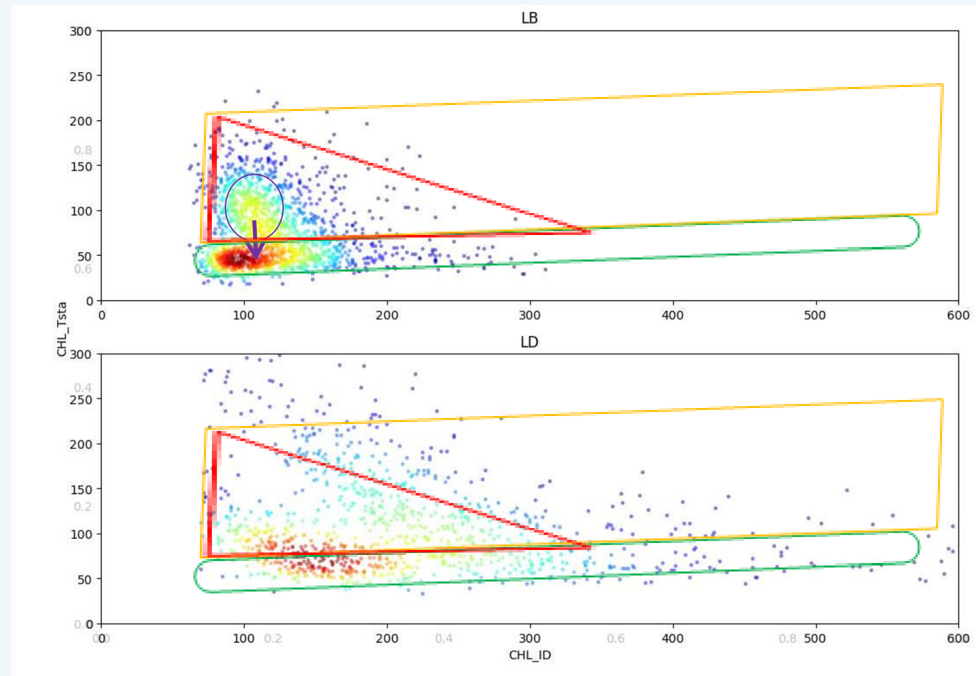
Mean Running Time : B = 217 s et D = 220 s

Circulation Feedback/Simulation – Chatelet Station Dwell Time

Feedback	Simulation

Dwell time at Chatelet station as a function of the dynamic headway





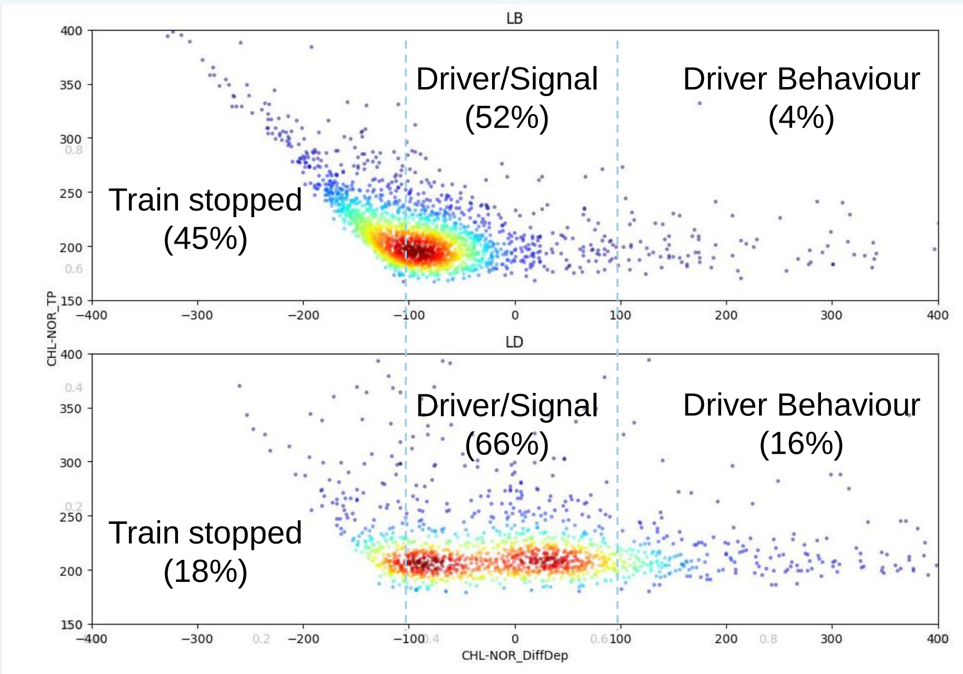
Mean Dwell Time: B = 68 s et D = 109 s	Mean Dwell Time : B = 77 s et D = 110 s

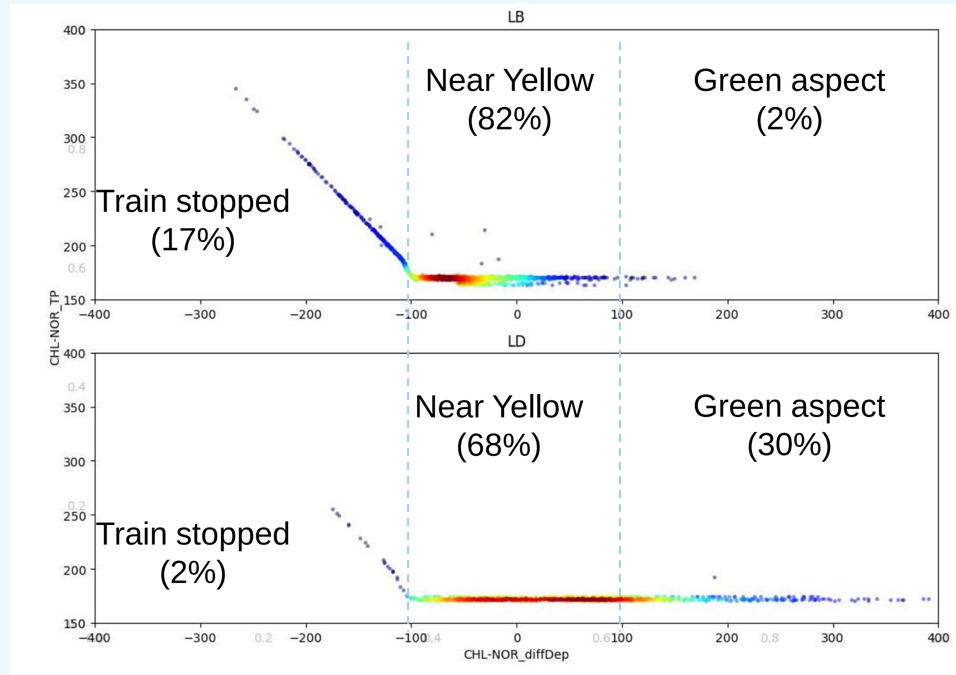
Difficulty to mix junction regulation and dwell time distribution

Circulation Feedback/Simulation AP – Tunnel Running Time

Feedback	Simulation AP

Running time in the tunnel as a function of the spatial headway





Mean Running Time : B = 215 s et D = 222 s	Mean Running Time : B = 176 s et D = 173 s

Mean Running Time : B = -40s / D = -60s

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Thank you for your attention