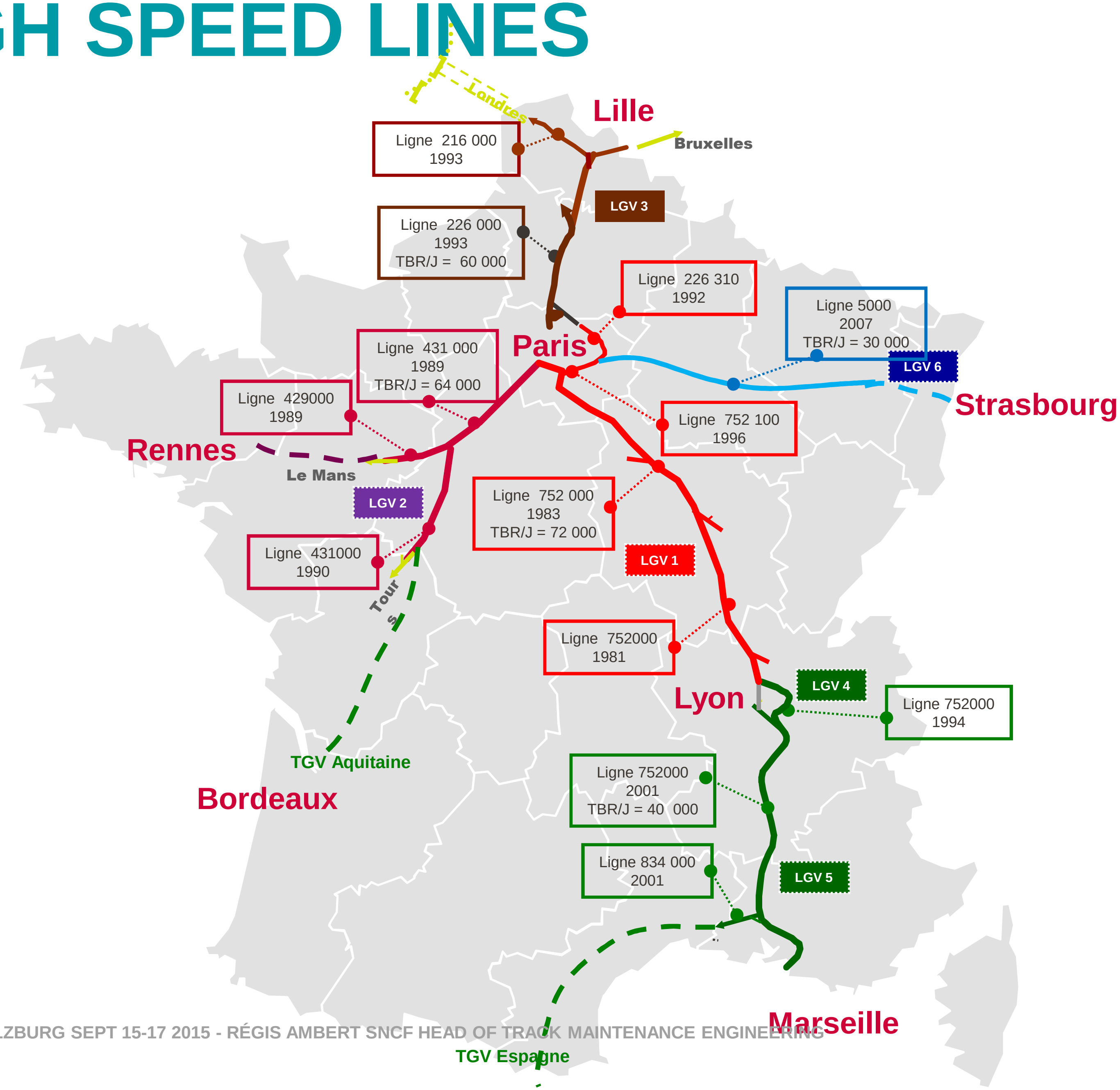
TRACK RENEWAL ON HSL

BALLAST RENEWAL WITH 160KM/H SPEED RESTRICTION

AGENDA

01. HISH SPEED NETWORK

HIGH SPEED LINES



02. WORKS SCHEDULING

RENEWAL WORKS ON PARIS-LYON HSL

Commissioning: 1981/1983

Works:

- **Lifting**: From 1988 => 2006
- **Ballast renewal:** From 1996
- **Switches renewal**: From 1996 to 2007
- **Rail renewal:** Since 2008
- **Track & ballast renewal:** Planned from 2030 (Except Pasilly : 2018-2020)

RENEWAL WORKS ON ATLANTIQUE HSL

Commissioning: 1989/1990

Works:

- **Lifting and rail replacement:**
  - tests in 2004 and 2005 (separately and together)
  - Renewal from 2006: Lifting + RR or RR alone (for branches)
- **Ballast renewal**: Starting in 2015
- **Switches renewal**: Starting in 2016
- **Track&ballast renewal:** Scheduled from 2050

HSL TRACK WORKS MASTER PLAN

The theoretical plan (example for 300km/h & 70 000t/d)

C: Commissioning
BMO : Big Maintenance Operation
BR: Ballast Renewal
RR: Rail Renewal
TBR: Track & Ballast renewal

2015-2021 master plan designed in 2012 (example of 2016):

	2016											
	JANVIER	FÉVRIER	MARS	AVRIL	MAI	JUIN	JUILLET	AOÛT	SEPTEMBRE	OCTOBRE	NOVEMBRE	DÉCEMBRE
LGV Paris Lyon									remise au profil AD Digoine	RB Km 271/295 Voie 1 Km 283/295 Voie 2 (GOM Rails à prévoir à la suite)		
LGV Atlantique					RB Kms 51,000 à 66,200 et 68,500 à 78,900 Voie 2 (GOM Rails à prévoir à la suite)				RAV PRS 15 (Rouvray) 4 Appareils + VC 988m entre ADV			
LGV Nord	RB Kms 83/87,500 et 88,200/109,700 Voie 1				RR Kms 83/87,500 et 88,200/109,700 Voie 1							
LGV Méditerranée	Remplacement de 12 AD et RB sur 12000m Rhone Nord, milieu et Sud; Roquemaure Nord et Sud; St Genies											

03. SOLUTIONS

SOLUTIONS FOR THE FIRST WORKS

Solutions based on classic lines methods

• Ballast renewal	Speed restriction 40 / 60
• Rail renewal	Speed restriction 100
• Switch renewal	Speed restriction 80
• Lifting	Speed restriction 80

CURRENT WORKS SOLUTIONS

Works type	Works track		Contiguous track [1]		Average yield per night (with 8h30 shifts)	Estimated overcost / reference solution
	Speed restriction	Length	Speed restriction	Length		
Plain track lifting	160/170	14 000	None		1200 m	
Ballast renewal	120	4 000	None		750 m for 350 clearing under sleeper 550 m for 500 under sleeper	***Reference solution***
	160 *(clearing 350 under sleeper)*	16 000 HCT			Target: 600 m for 350 clearing under sleeper	*Target: about 20% (45% for tests)*
Rail renewal	160/170	10 000	None		900 m	***Reference solution***
	220/230	10 000 or between 2 signalling stations	None or 230	Between 2 signalling stations	900 m	*Very small (1%)*
	No restriction (with rails in the track)		None		To be determined	*A calculer*
Switch renewal	100	*Depending on works length*	100	*If works on V1 & V2, none otherwise*		***Reference solution***
	120 if mechanical clearing + stabilisation		120			***Reference solution***
Expansion Joint renewal	100	*Depending on works length*	100	*If works on V1 & V2, none otherwise*		***Reference solution***
	120 if mechanical clearing + stabilisation		120			***Reference solution***
Track & Ballast renewal	120	*4 000* *in 16 000 HCT area*	None		550 m for 350 clearing under sleeper	***Reference solution***

Legend
Tests performed
Workgroups in progress

03. BALLAST RENEWAL WITH 160KM/H SPEED RESTRICTION

CONTEXT

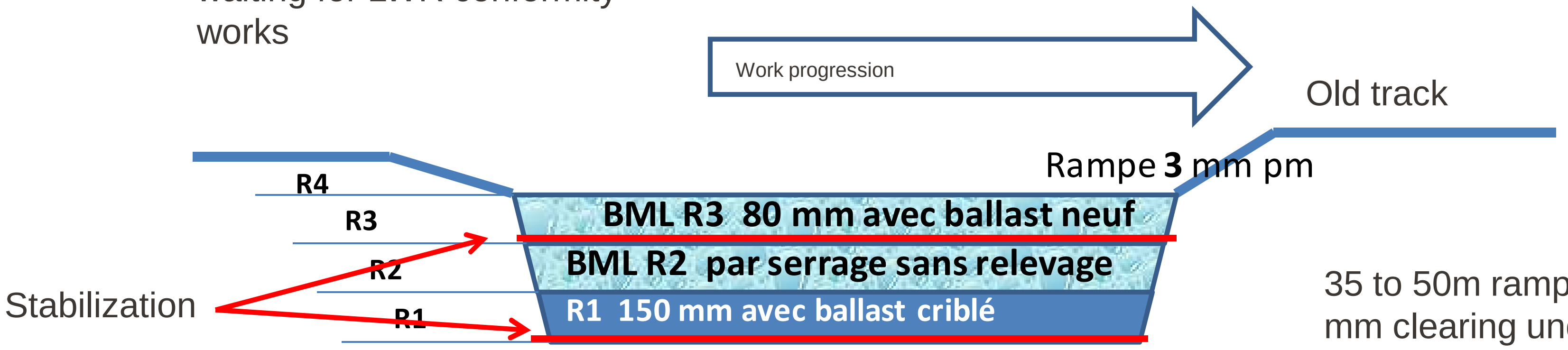
THE NEEDS:

- Raise capacity of our High Speed Lines during works
- Not suffer from more ballast renewals due to ageing

WORKS METHOD 2012 TESTS

Current methods: 120 km/h speed restriction

Track with renewed ballast waiting for LWR conformity works



35 to 50m ramp for 350 mm clearing under sleeper.

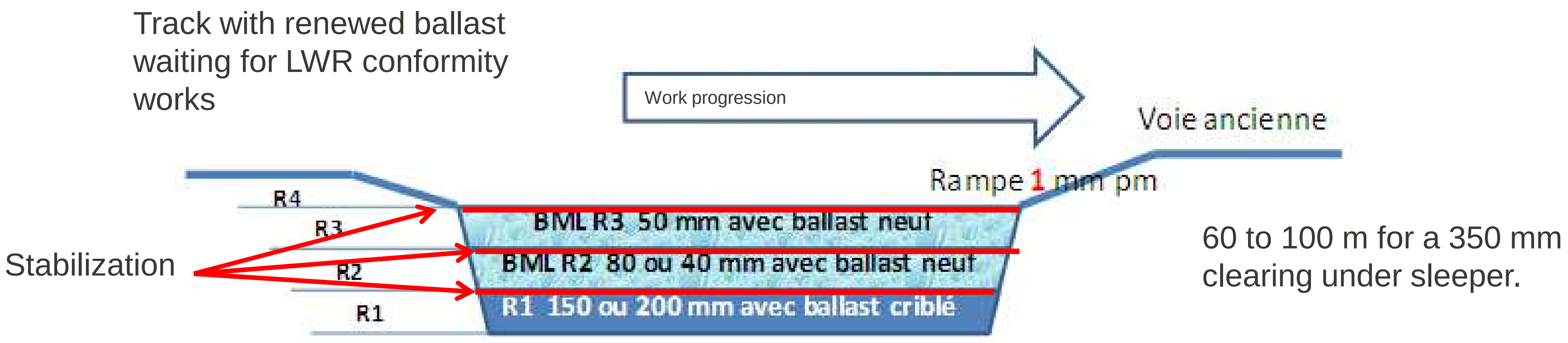
2 layers of ballast (230mm after clearing of 350mm under sleeper)

WORKS METHOD

Desired modification: 160km/h speed restriction for 350mm clearing under sleeper

Goal:

Adapt the method (track geometry, ballast height under sleeper) to be able to run at 160km/h (or 170km/h depending on the signalling technology) on the renewed track. Geometry has to stay within the norms (3m Twist ≤ 3 mm/3m and vertical alignment ≤ 3 mm) with possibility to have isolated defects.



Evolutions:

- Ballast heights
- Stabilization after each lifting

FIRST TEST PROTOCOL IN 2012

Implementation protocol:

1st Phase : (W35/36 2012)

BR tests with new ballast heights. Speed restrictions and application time are the same as usual

Two protocols have been implemented during this test campaign:

- L1 200 mm stabilized + L2 40 mm stabilized with BAS + L3 50 mm stabilized with BAS
- L1 150 mm stabilized + L2 80 mm stabilized with BAS + L3 50 mm stabilized with BAS

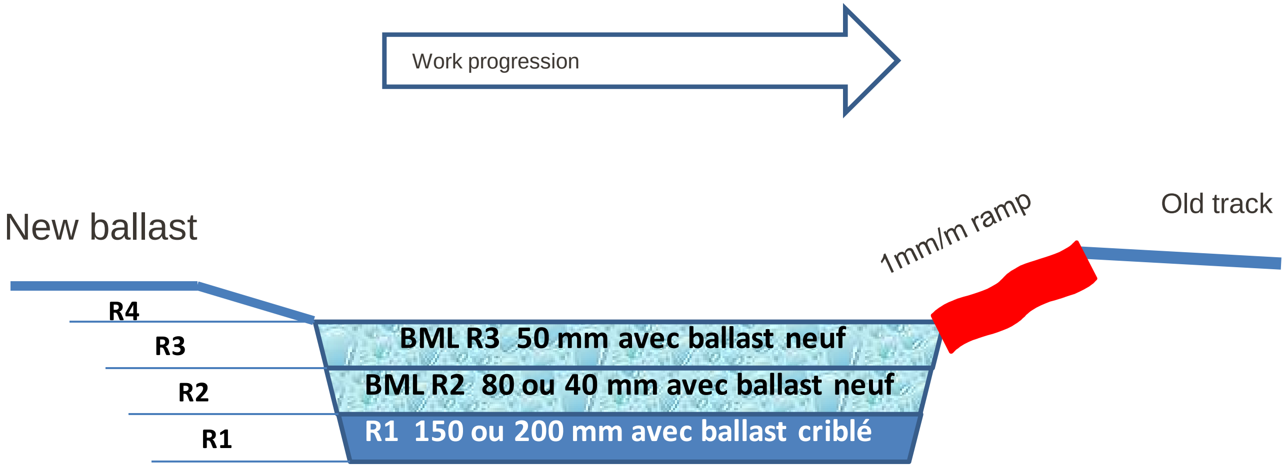
This first phase led to:

- An evaluation of track stability with new ballast heights
- An evaluation of the renewed track behaviour (stability & levelling) during the day (with commercial traffic) and during a weekend (64h with no work)
- A decision on the feasibility of phase 2 tests.

2012 TECHNICAL FEEDBACK OF THE FIRST TEST

Observations:

- No threshold exceedency implicating a speed restriction has been encountered.
- Track behaviour in terms of alignment (both vertical and horizontal) is satisfactory in plain line and in curves



- **Pumping phenomenon in the last 20m** of the ramp on both rails, probably due to a large quantity of screened ballast used and tamped in the connection with the old track. Tamping was performed without « retour chariot » => machine was lifting the old track of a few mm with no consequences on safety;

2012 : 2ND TEST

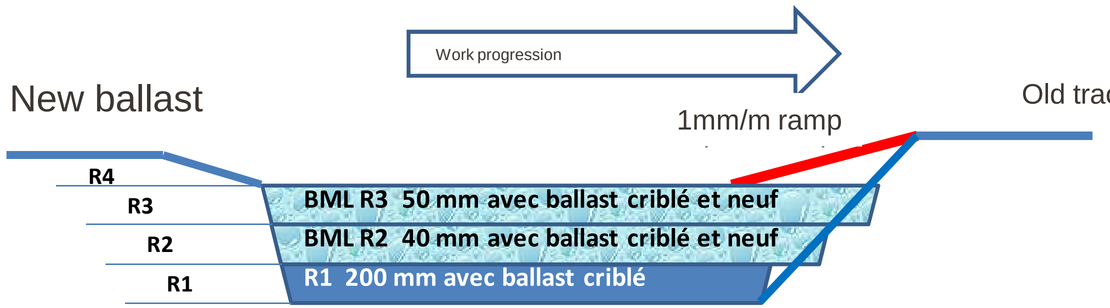
Phase 2: (W41/42 2012)

Protocol modified keeping the 120 km/h speed restriction following the pumping phenomenon in the last 20 metres,

Technical processes tested:

1. Specific correction (« report chariot ») on the end of the ramp
2. In addition to 1, additional dynamic stabilization of R1
3. In addition to 1, tamping of R2 with triple dive instead of double

Used values for the last 30m if the ramp following the first test campaign



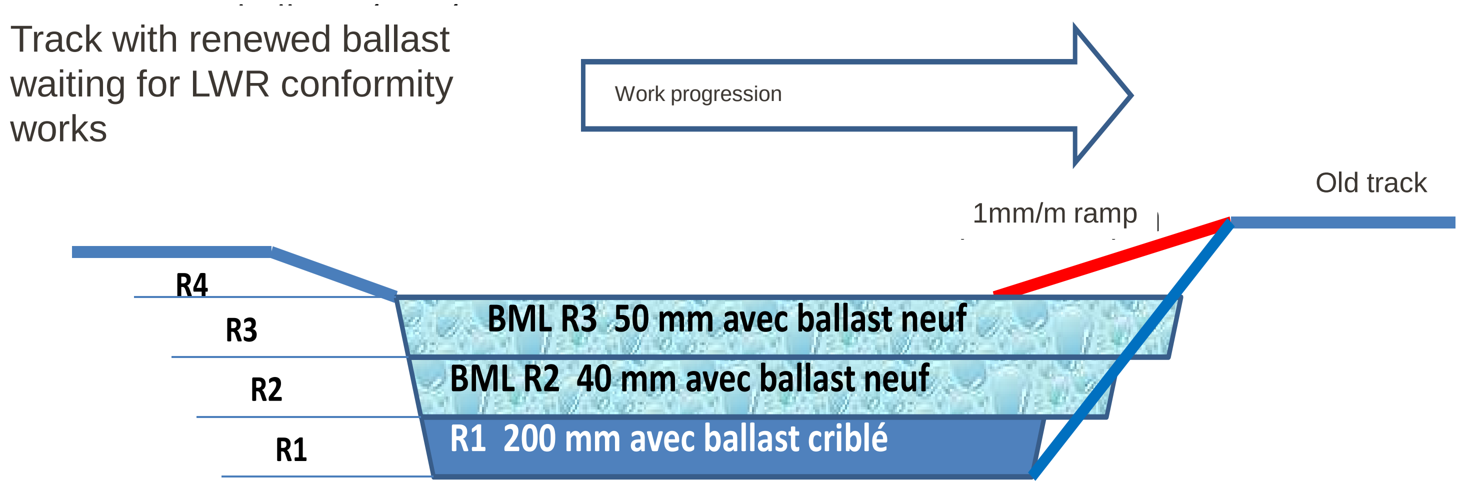
Observations:

- No threshold exceedency implicating a speed restriction has been encountered
- Track behaviour si satisfactory in terms of alignment (vertical & horizontal) in plain line and in curves.
- Track behaviour of the ramp is satisfactory. The pumping behaviour observed in the first test did not happen again.
- The two additionnal processes have shown no worthy modification of the ramp behaviour.

2012 : 3RD TEST

3rd Phase: (W49/50 2012)

Same as phase 2 with 160km/h speed restriction



Observations:

- The clearing/lifting/stabilization method defined in phase 2 is relevant.
- The radar-recorded commercial trains' speed showed an average speed of 150km/h, which technically validates the test campaign.
- The connection ramp between cleared and uncleared track was measured <1mm/m with topography instruments. The requirement (meant to avoid any shock) has been technically respected.

TECHNICAL FEEDBACK 2012 TESTS

Conclusion of 2012 tests

- The 3 test campaigns show it is not necessary to modify the level of monitoring compared to a classical well-known operation.
- The test results show that the project does not rise the level of risk (with protocol adjustments, and verification and application of the Quality Action Plan of the contractor)
- Following a safety report, it has been decided to test the BR160 protocol on a bigger distance in 2013 in order to:
  - Test the reliability of the process
  - Improve geometry quality

The protocol and monitoring policy to implement will be described in our guidelines.

OPERATIONAL FEEDBACK 2013 TESTS ON HIGH DISTANCES

BR 160 AREAS:

Localization : Paris-Lyon HSL, V1 Km373+100 to 378+500

Planning: From Sept 30 2013 to Oct 12 2013 during 10 nights

Goals:

- **Industrialization of the process**
  Yield: 5400m which means 540m /night (including specific BR160 monitoring devices installation)
- **Making the process reliable:**
  Suppression of rail defects and preliminary tamping
  Ramp realization:
  - Avoid the bump at the connection
  - Guarantee 1mm/m without excessive overtaking
  - More demanding geometry
    - « VA non atteinte »
- **2 week-ends with no work to monitor**
  Additionnal monitoring devices

OPERATIONAL FEEDBACK 2013 TESTS

BR160 is under control in terms of:

- Settling
- Levelling

Difficulties lie in the realization of the ramp between cleared and untouched track.

Remaining difficulties:

- Being able to predict the position of the ramp
- Respect of the 1mm/m ratio everywhere in the ramp
- Machines tolerances cannot be controled, which causes a risk not to respect the 1mm/m norm.
- Human factor
- Manual calculation of the ramps (Classical Topography)
- Stop at the last sleeper (difficulties of the methodology of « report chariot » => tamping of the uncleared track)
- Avoid the dip before the connection area

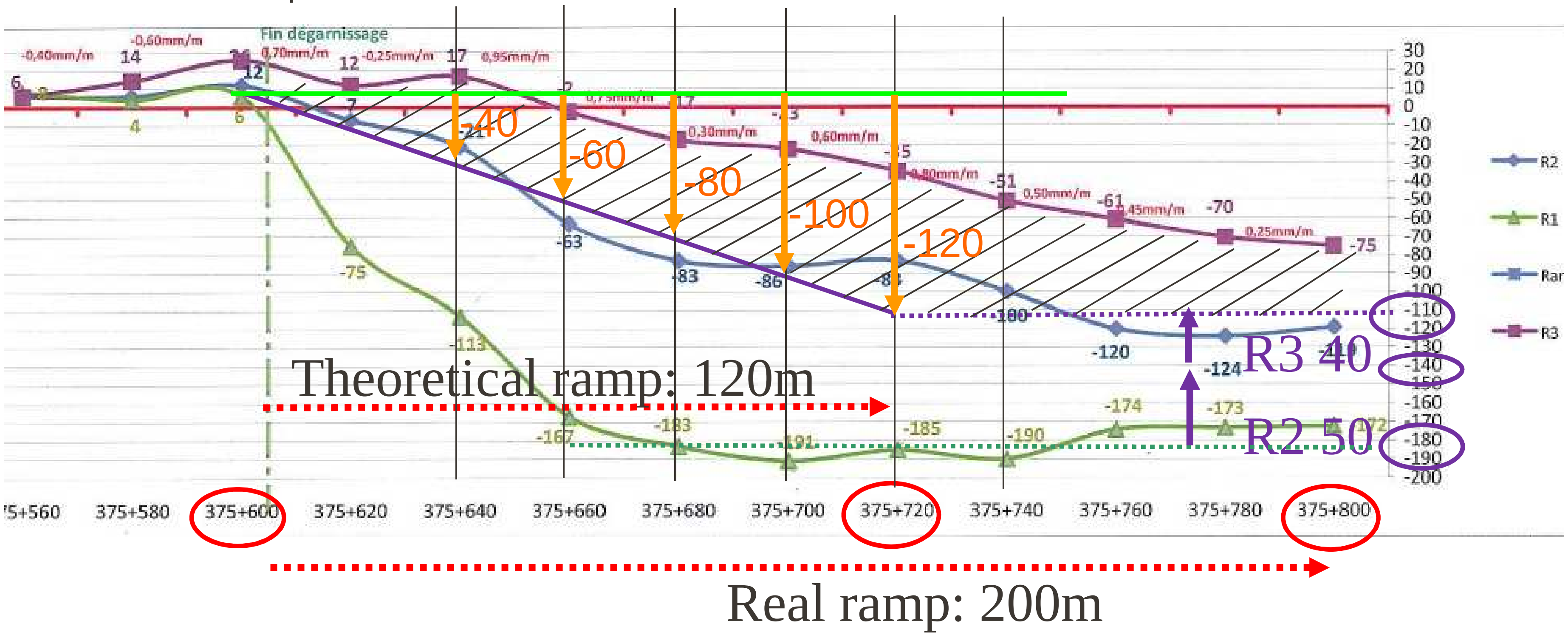
These difficulties cause longer ramps (about 200m instead of 100-120m). Calculation of the ramp is made for 0,75mm/m and the ramp goes on on the untouched track for about 50m.

« Lower pantograph » signalling kept because track level is very close to the tolerance in distance from catenary.

Technical feedback of 2013 tests

More demanding geometry

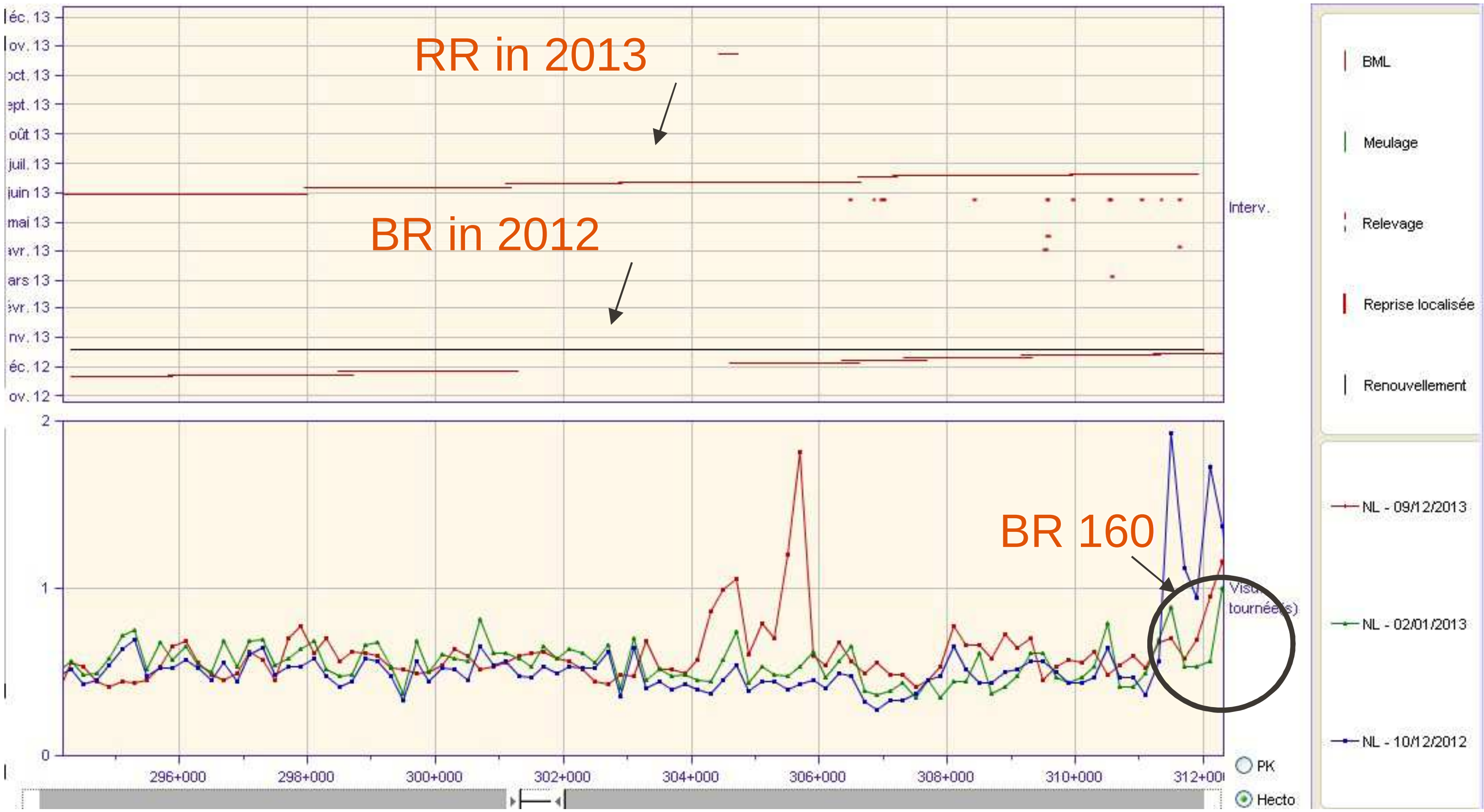
- Avoid the « bump » at the junction with « report chariot »
  - Increase the length of the ramp on uncleared track.
- 1mm/m ramp



- **Conclusion** : Definitive validation of the BR160 process

MAINTENANCE FEEDBACK

Goals: quantify the impact on maintenance of a BR 160



No direct impact of BR160 (low representativity of 2012 test) + Difficult to evaluate the impact before RR

ECONOMIC EVALUATION

Potential improvements:

- **No specific monitoring as organized for the tests**

Daily Intervention Time	0	30	60	90	120	150	180	210	…
BR 120	Splitting Unfolding	Clearing including ramps (**150min**)					Folding and ramp wedging	Ramp realization	
Test BR160	Ramp recording	Splitting Unfolding	Clearing including ramps (**110 min**)			Folding and ramp wedging Monitoring implementation	Ramp realization		
Target BR 160	Splitting Unfolding	Clearing including ramps (**130 min**)				Folding and ramp wedging	Ramp realization		
Optimized BR 160	Splitting Unfolding	Clearing including ramps (**140 min**)					Folding and ramp wedging	Ramp realization	

As a target, BR 160 won't need any specific monitoring.

This will free 20 more minutes compared to test phase.

- **Optimization: Reduction of the time necessary to realize the ramp.**

During BR160 tests, the ramp was about 200m long compared to 100 to 120m usually. This additionnal length generates a 20min loss in effective clearing time.

➢ Automatization of the realization of the ramp

ECONOMIC EVALUATION

Overcosts estimation per night

	Production time	Clearing length	Length of the ramp	Effective production	% loss of length	Overcost (%)
BR 120	2h30	785 m	35 m	750 m		
Test BR 160	1h50	580 m	80 m	500 m	33 %	39 %
Target BR 160	2h10	680 m	80 m	600 m	20 %	20 %
Optimised BR 160	2h20	733 m	80 m	653 m	13 %	12 %

Hypothesis:

- 3h30 of Daily Intervention Time
- Cost of BR120 is estimated for 350mm clearing under sleeper.

CONCLUSION

- The tests in 2012 & 2013 have enabled us to validate a method to perform ballast renewal with 160km/h speed restrictions
- The methodology is valid for 350mm clearing under sleeper.
- Cost is 15 to 20% higher
- This is a very important technical step to decrease the impact of renewal works on our High Speed Lines

SNCF RÉSEAU