



# ANALYSIS OF WIM SYSTEMS IN THE CONTINENTAL MOTORWAY TEST (CMT2)

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# FRAME OF THE CMT

- ◆ Motorway A31 (Metz-Nancy)
- ◆ 4500 HGV/D on the measurement lane
- ◆ Heavy European traffic
- ◆ CMT1 Duration: 17 months (3/97 - 7/98)
- ◆ CMT2 Duration: 21 months (10/98 - 8/00)
- ◆ 8 Weigh-In-Motion systems, 5 manufacturers

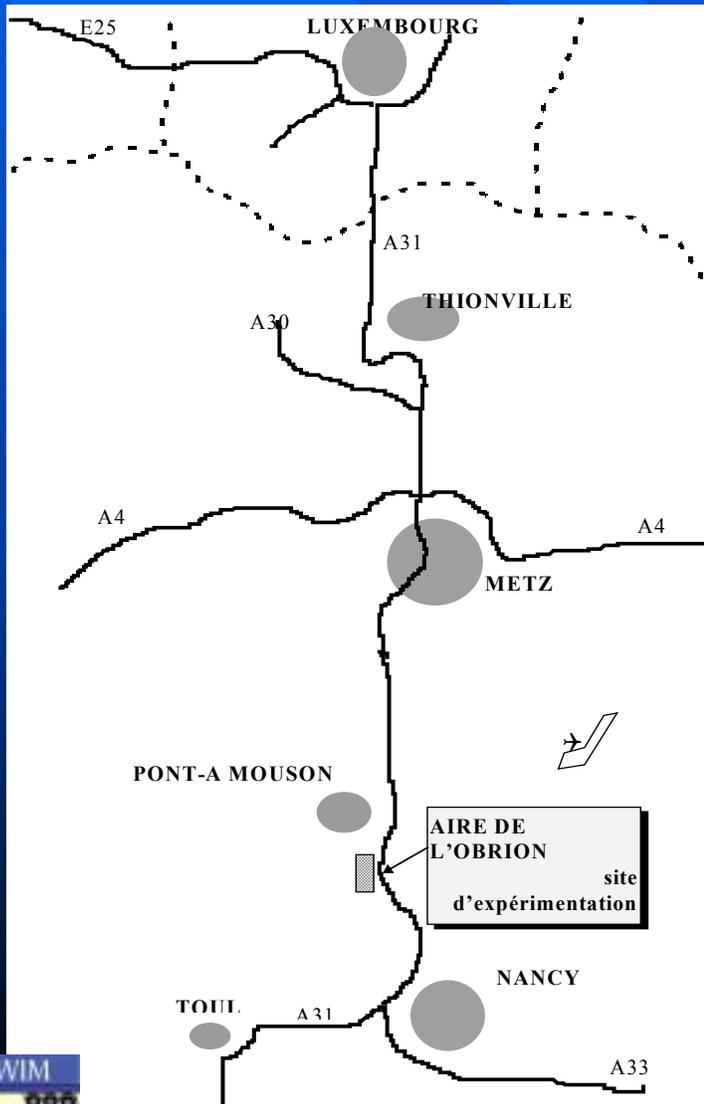


# OBJECTIVES CMT1

- ◆ Accuracy
- ◆ Durability and reliability
- ◆ Support to manufacturers



# SITE LOCATION

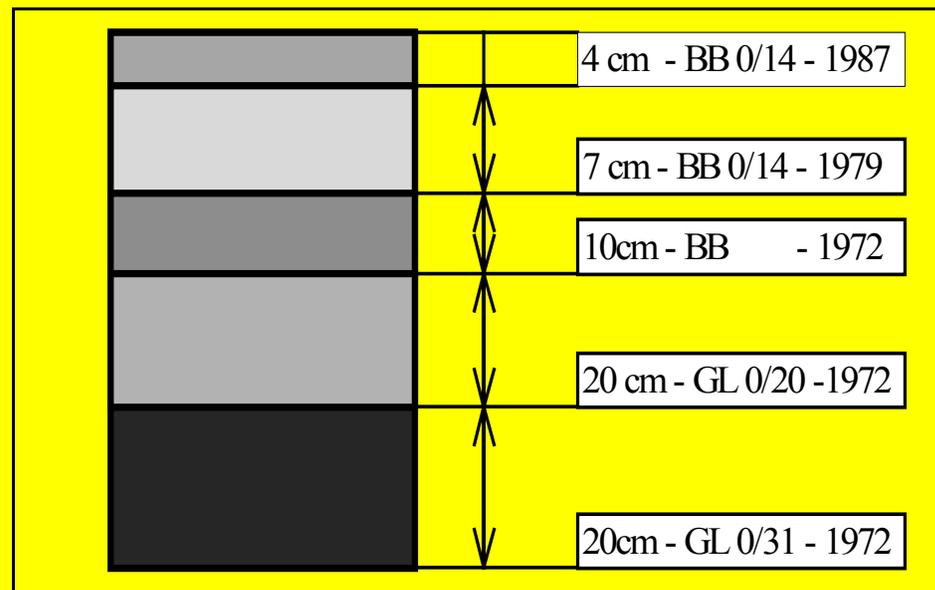


## Site characteristics:

- ◆ Eastern France, Metz-Nancy
- ◆ 300 km east from Paris
- ◆ International traffic (NL, BE, DE, LU, FR, CH, IT, ES...)
- ◆ Public motorway



# PAVEMENT CHARACTERISTICS (1)



**PAVEMENT STRUCTURE**



# PAVEMENT CHARACTERISTICS (2)

CRITERIA	MEASUREMENTS	TOLERANCES CLASS I
Radius of curvature (m)	$\infty$	$\geq 1000$ m
Longitudinal slope	$< 1\%$	$\leq 2\%$
Transverse slope	$3\%$	$\leq 3\%$
Rutting (mm)	$\approx 4$	$\leq 4$
Deflection (1/100 mm)	5	$\leq 15$
Evenness: APL (SW - MW - LW)	between 0.71 and 1.19	$\leq 1.3$
Evenness: IRI ( m/km )	9 - 9 - 10	$\geq 9$

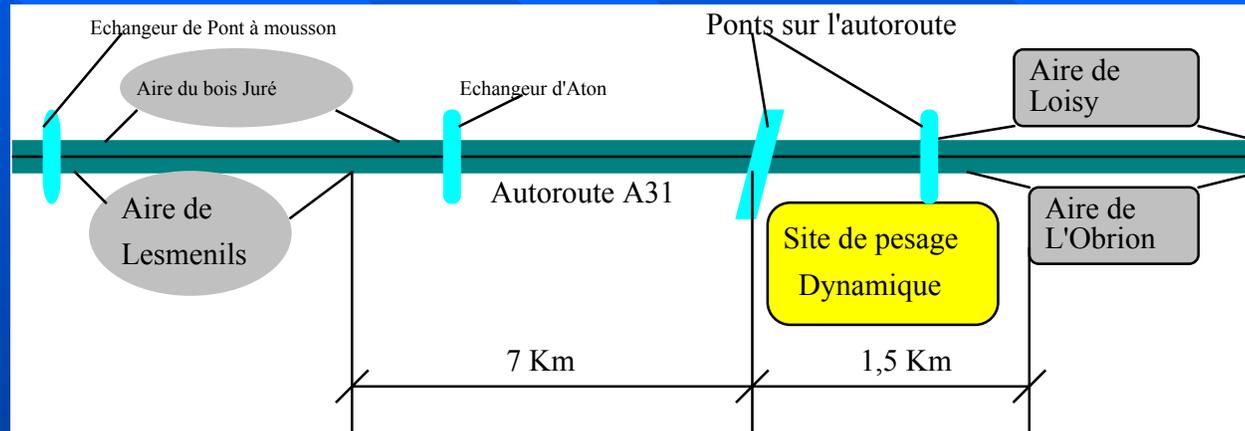
## COST 323 Specification



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# REFERENCE STATIC LOADS

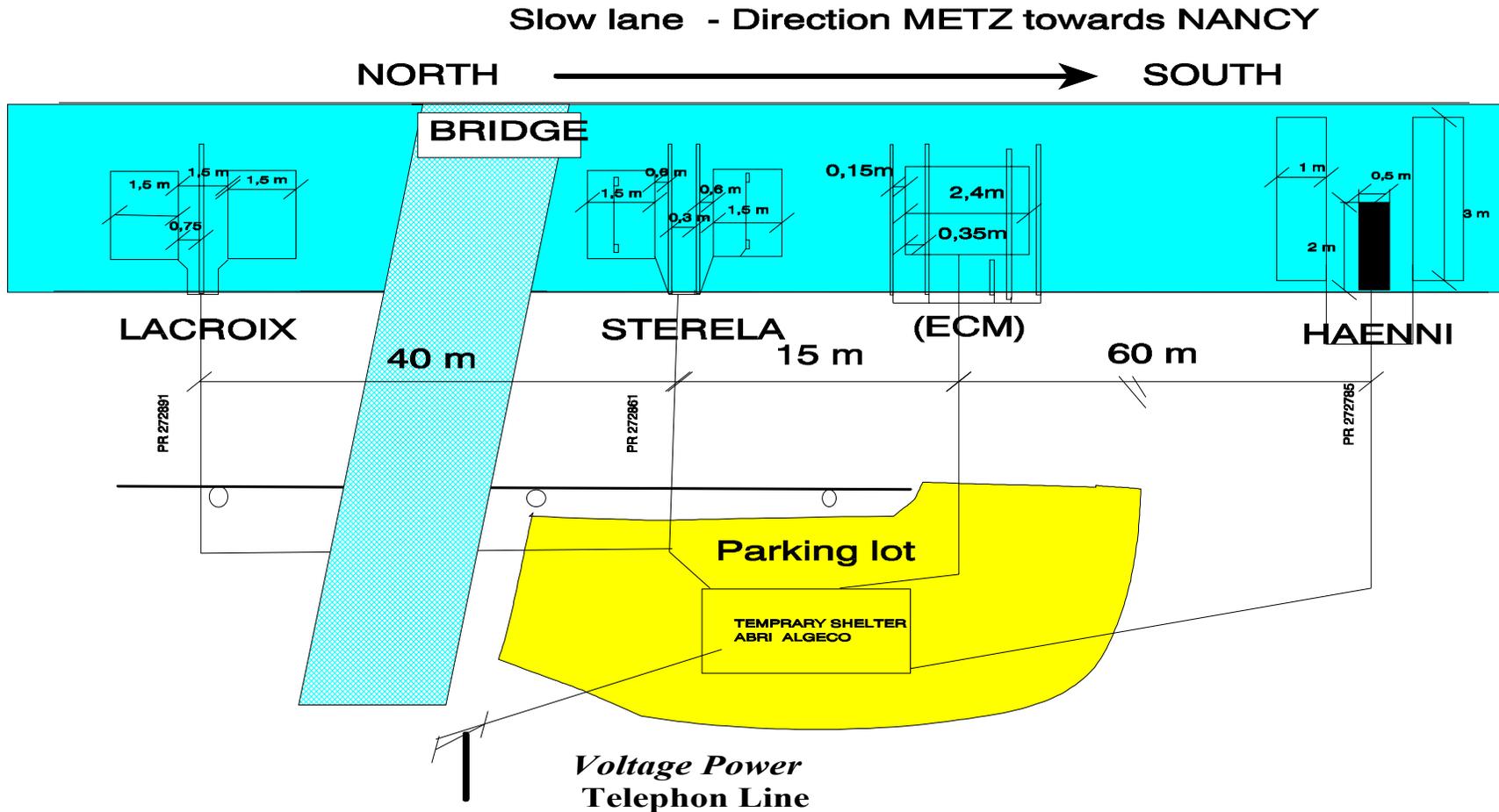


Static weighing area  
5 km upstream

- ◆ Portable axle scales CAPTELS with a short ramp (class IV OIML)
- ◆ Accuracy on GW: +/- 3 % (max. error), checked by comparison with weigh-bridge



# SYSTEMS INSTALLATION



# System description

Manufacturers	WIM Sensor(s)	Detection Sensor(s)	Electronics	Installation
LACROIX (FR)	1 piezo-ceramic bar with fibreglass ('Transfibre')	2 inductive loops	SIREDO	Sept. 96
STERELA (FR) 2 systems	1 piezo-ceramic nude cable Vibracoax, Ø 8 mm	2 inductive loops/ 4 magnetic sensors	SIREDO	Sept. 96
ECM (FR) 2 systems	2 piezo-ceramic bars	1 inductive loop	HESTIA P	Feb. 97
MSI/ECM 1	2 piézo-polymer ribbons	1 inductive loop	Hestia P	June 98
MSI/ECM 2	2 piézo-polymer bars	1 inductive loop	Hestia P	June 98
HAENNI (CH)	1 capacitive mat	2 inductive loops	Racktel 8000	Sept. 96





# CMT1 TEST



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# SYSTEM CALIBRATION

4 systems calibrated in February 1997

- ◆ Piezoceramic sensor by automatic self-calibration :
  - modification of reference value
- ◆ Capacitive scale + temperature compensation:
  - adjustment of target values

2 systems calibrated in June 1998



# TEST PLAN

- ◆ 20 measurement days: 3/3/97 - 01/08/98
- ◆ 684 pre-weighed lorries with 6 systems
- ◆ 70 pre-weighed lorries with 2 systems
- ◆ temperature range: -2 + 36 °C
- ◆ Analyse vs Specification COST 323
- ◆ Full reproducibility (R2)
- ◆ Environmental repeatability and reproducibility conditions:
  - ⌚ (I) per day
  - ⌚ (II ) per seasons (3 seasons)
  - ⌚ (III) all seasons



# ACCURACY: Condition (R2), Environment III

◆ 2 systems in class B (10)

◆ 2 systems in class C (15)

◆ 1 system in class D+ (20)

◆ 1 system in class E (30)

◆ 1 system in class D+ (20)

◆ 1 system in class E (40)

6 systems  
installed  
in 1997

2 systems  
installed  
in 1998



BIAS





# CMT2 TEST



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# SYSTEM CALIBRATION

4 systems calibrated in May 99

- ◆ New calibration by Axle ranks → modification of reference value
  - ◆ 2 systems with piezo-ceramic sensor
  - ◆ 2 systems with piezo-polymer sensor
- ◆ automatic self-calibration → modification of reference value

2 systems not calibrated - same value as in 1997

New Capacitive mat installed in May 1999



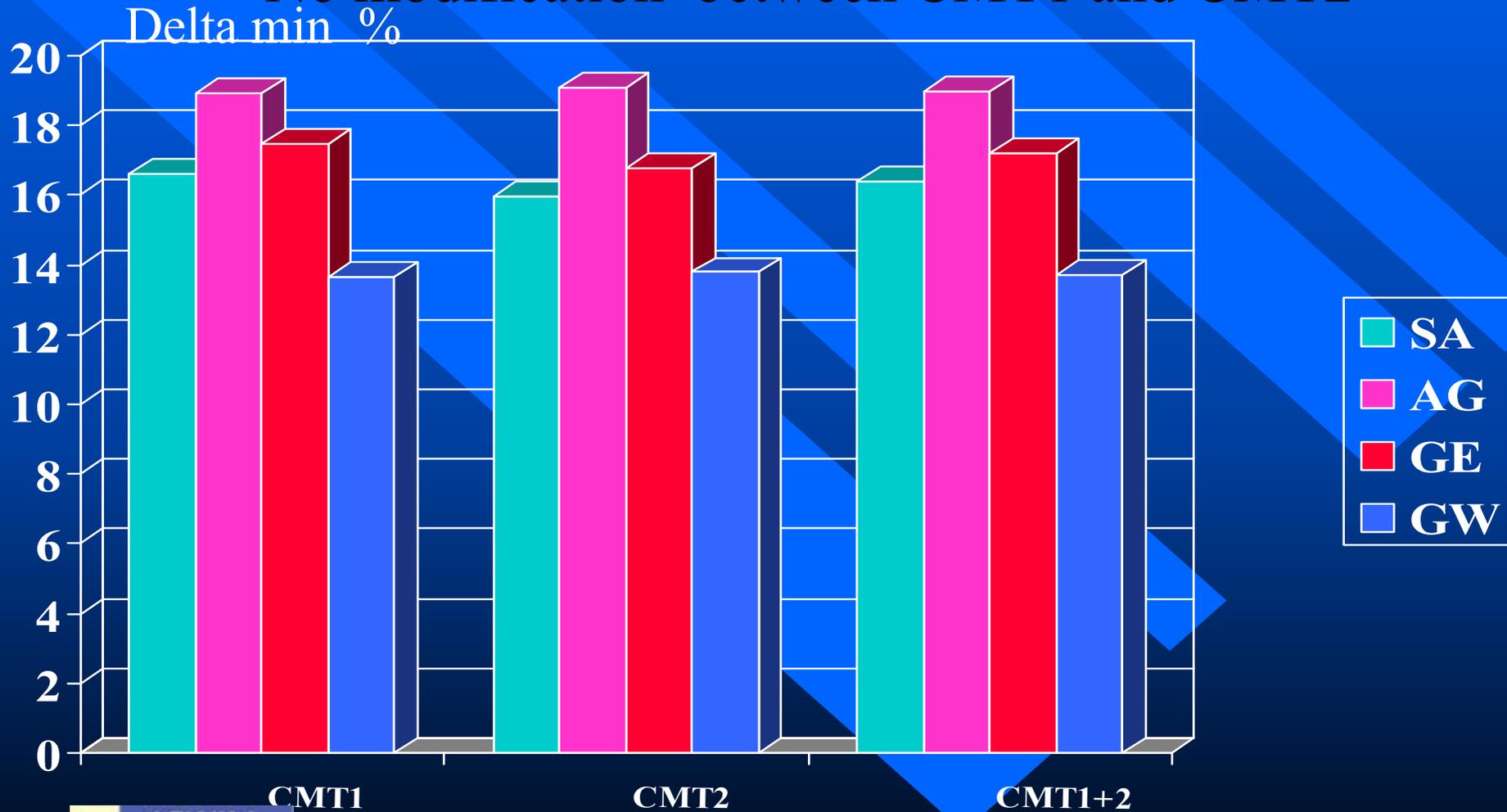
# TEST PLAN

- ◆ 17 measurement days: 20/10/98 - 16/04/00
- ◆ 281 pre-weighed lorries with 2 systems
- ◆ 207 pre-weighed lorries with 4 systems
- ◆ 109 pre-weighed lorries with 1 system
- ◆ temperature range: -3 + 35 °C
- ◆ Analyse vs Specification COST 323
- ◆ Full reproducibility (R2)
- ◆ Environmental repeatability and reproducibility conditions:
  - ⊙ (I) per day
  - ⊙ (III) all seasons

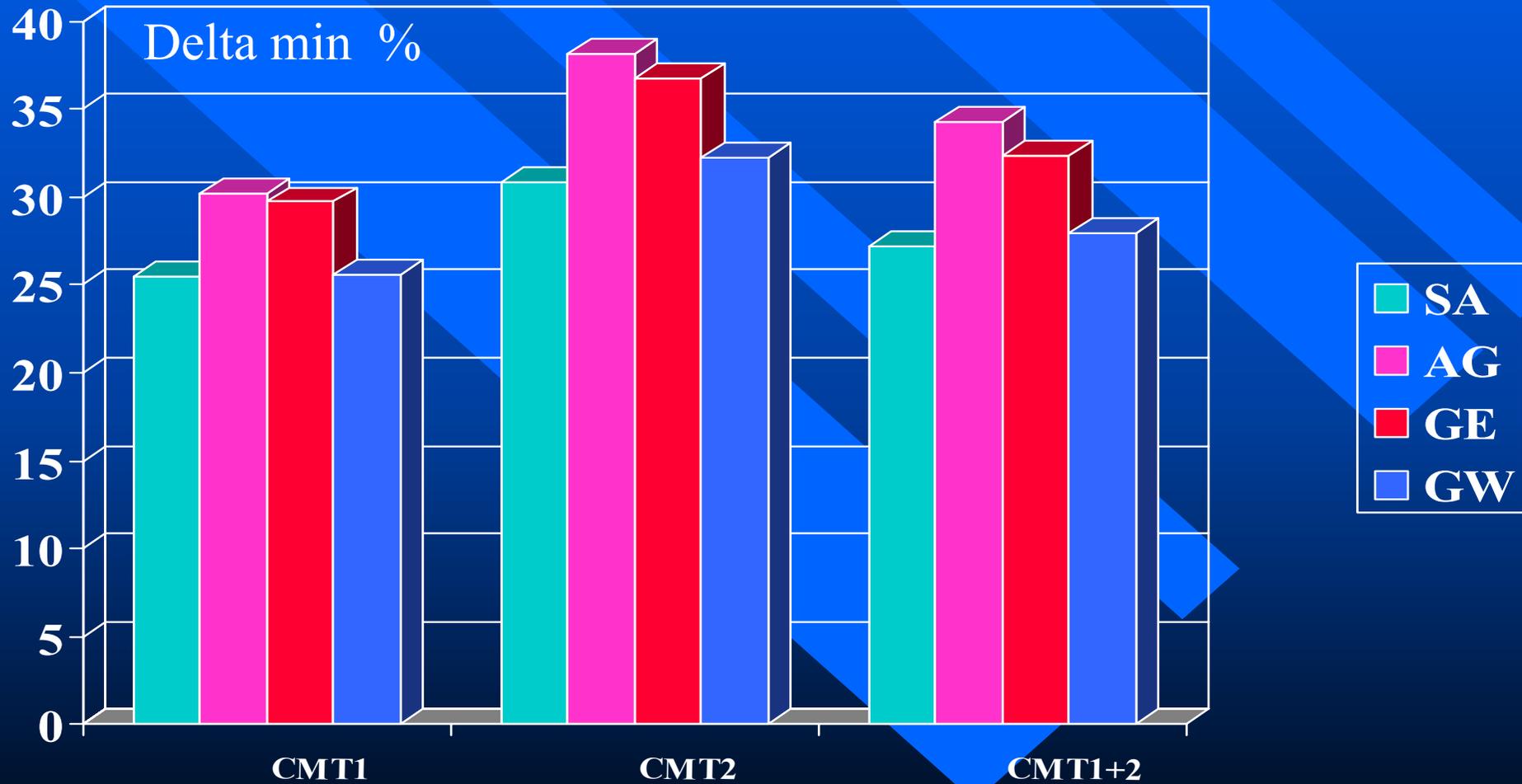


# LACROIX (SOFREL) - 1 piezo-ceramic bar-

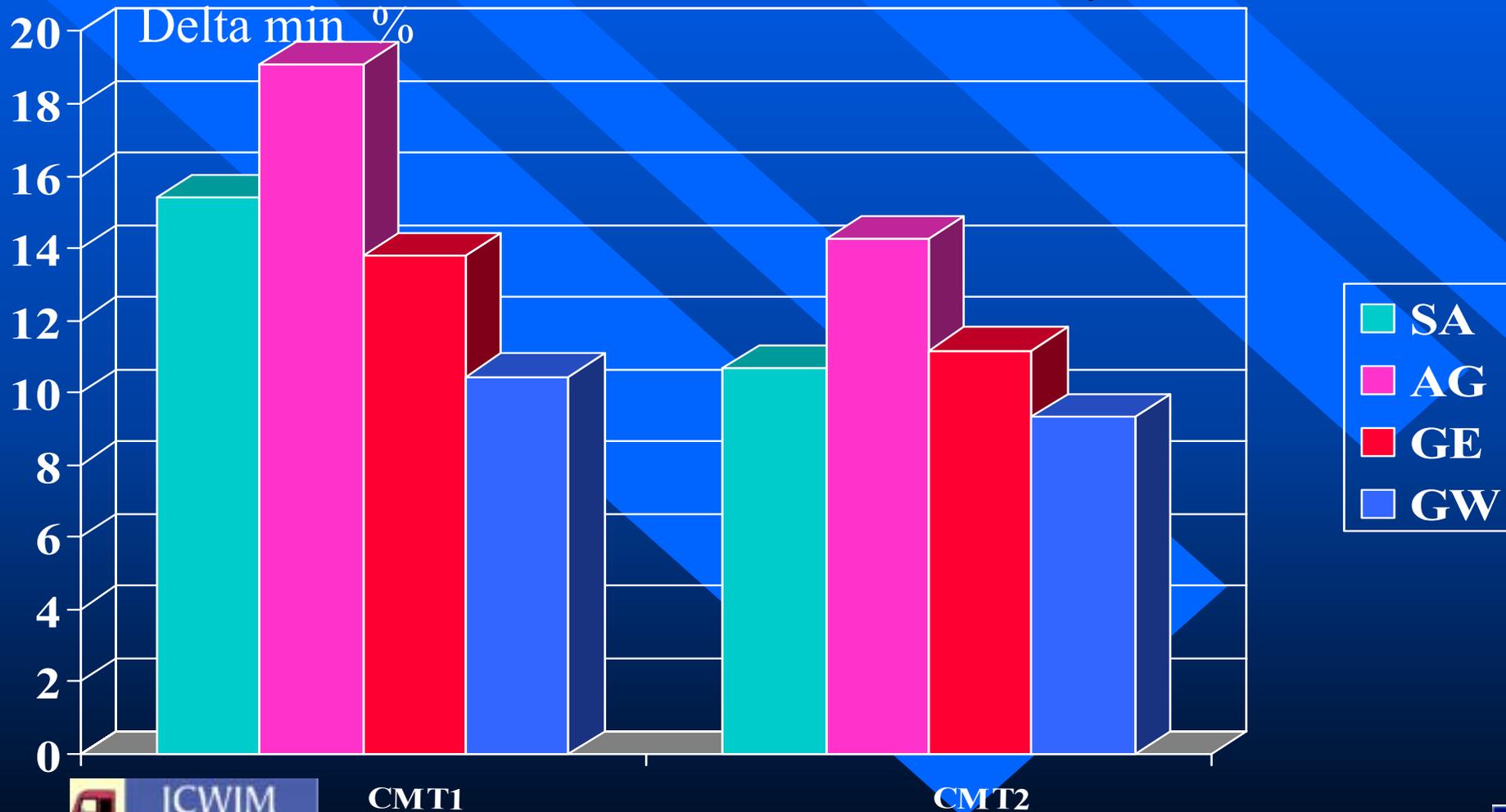
No modification between CMT1 and CMT2



# STERELA 1 - 1 piezo-ceramic nude - 8 mm - No modification between CMT1 and CMT2



# ECM1 - 2 Piezo-ceramic bars - CMT2 with modification value of calibration by axle ranks

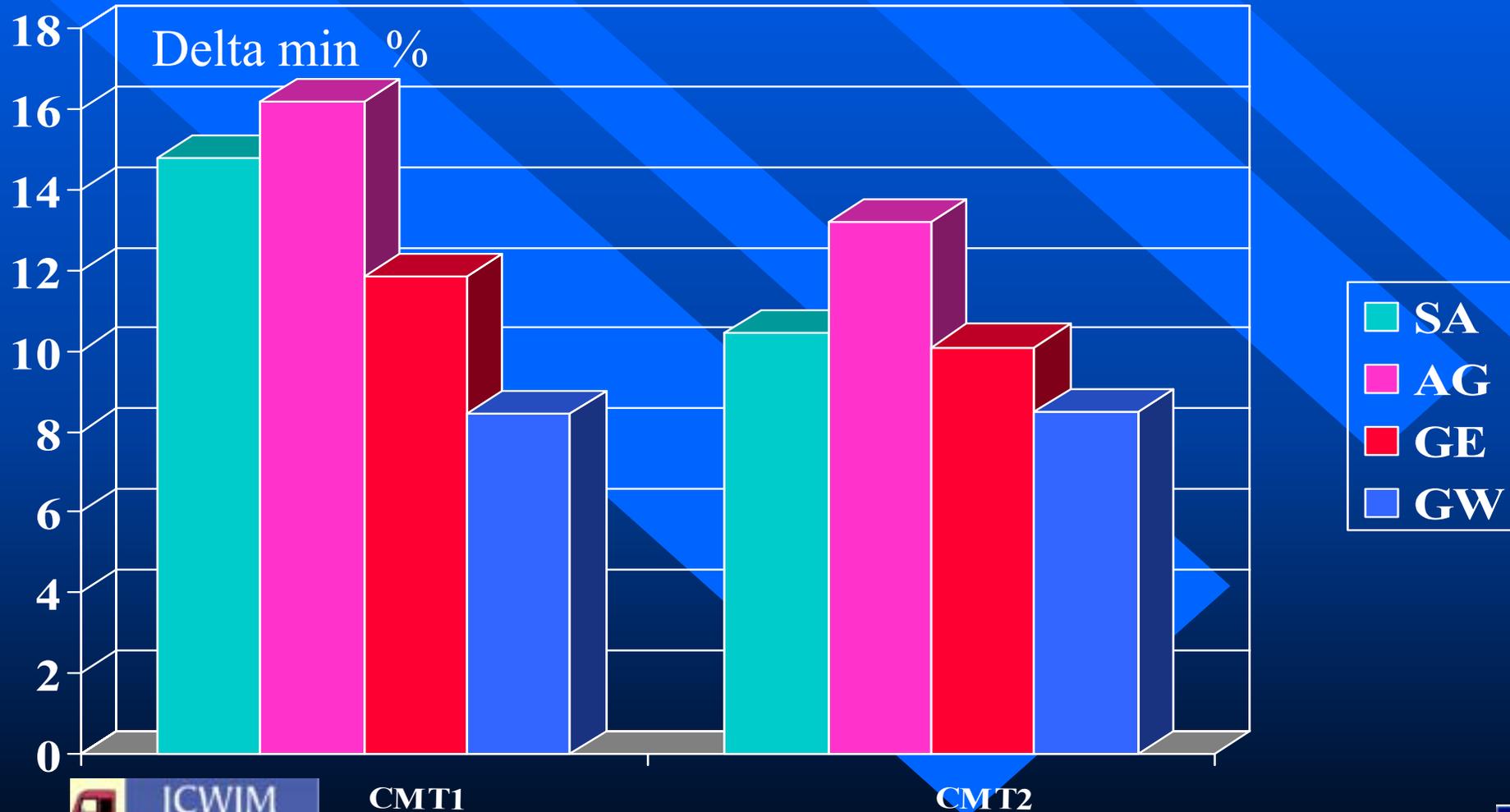


CMT1

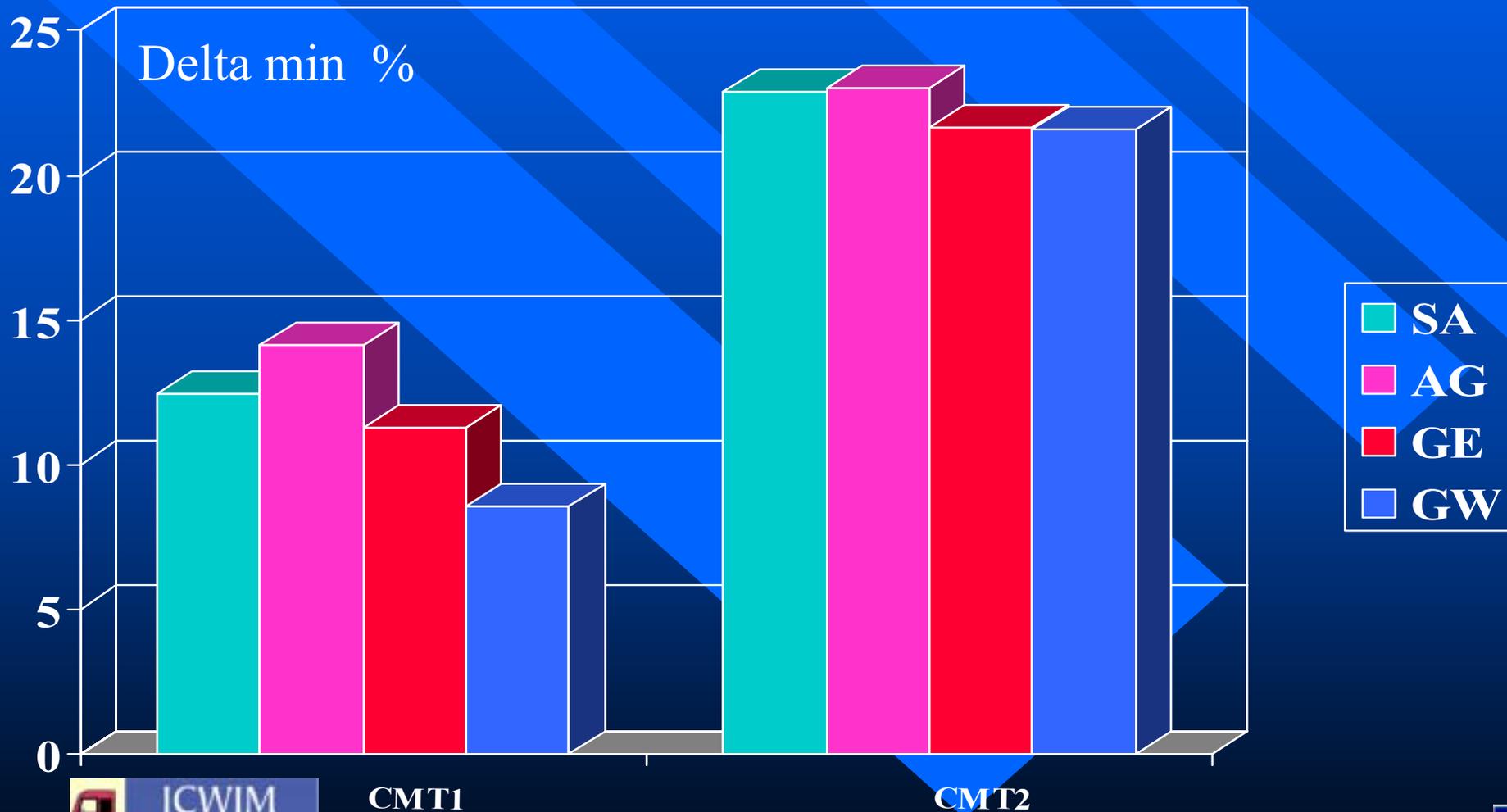
CMT2



# ECM2 - 2 Piezo-ceramic bars - CMT2 with modification value of calibration by axle ranks



# HAENNI - CMT2 with new capacitive mat



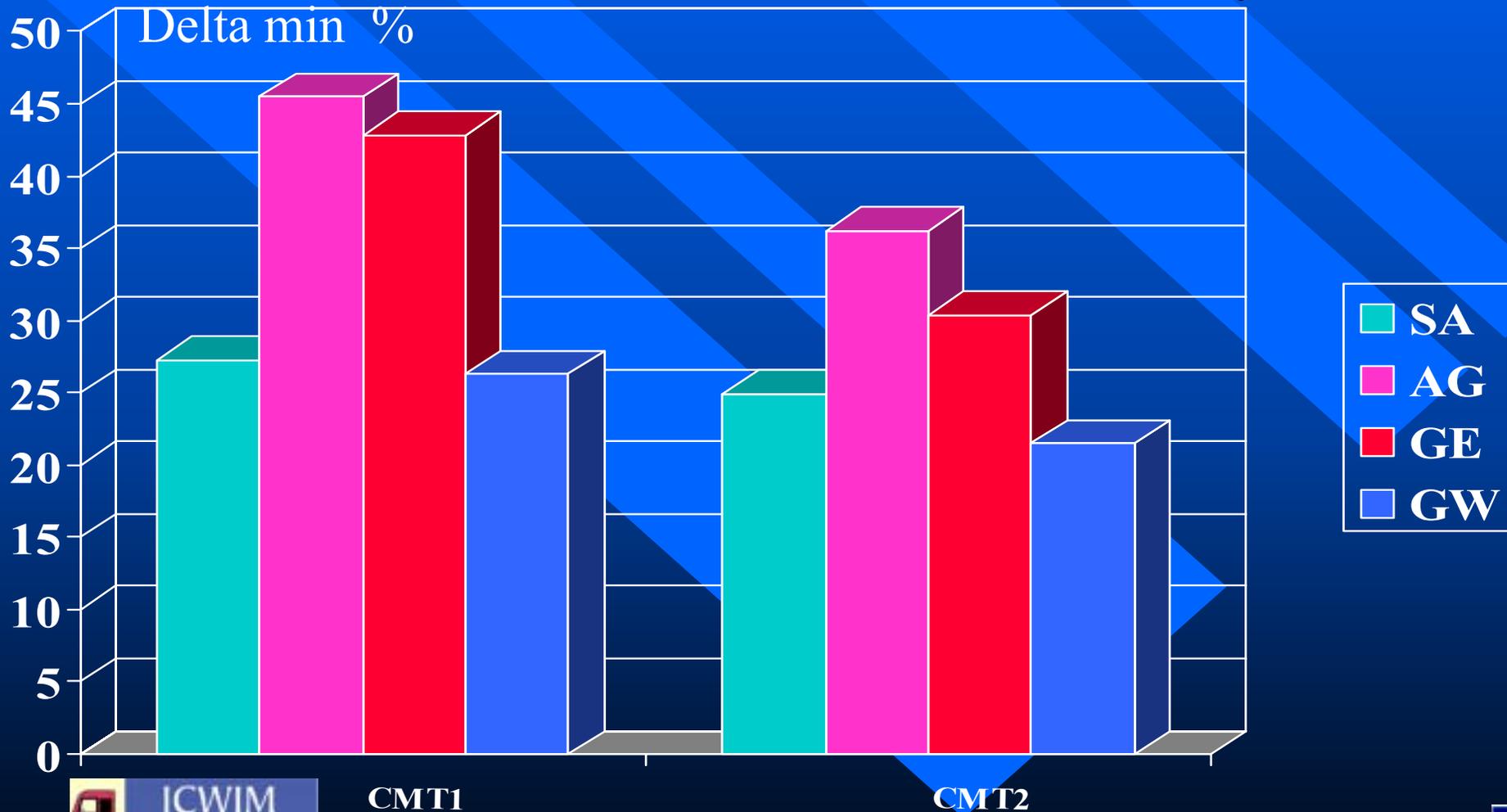
CMT1

CMT2



# MSI1/ECM - 2 Piezo-polymer ribbons

## CMT2 with modification value of calibration by axle ranks



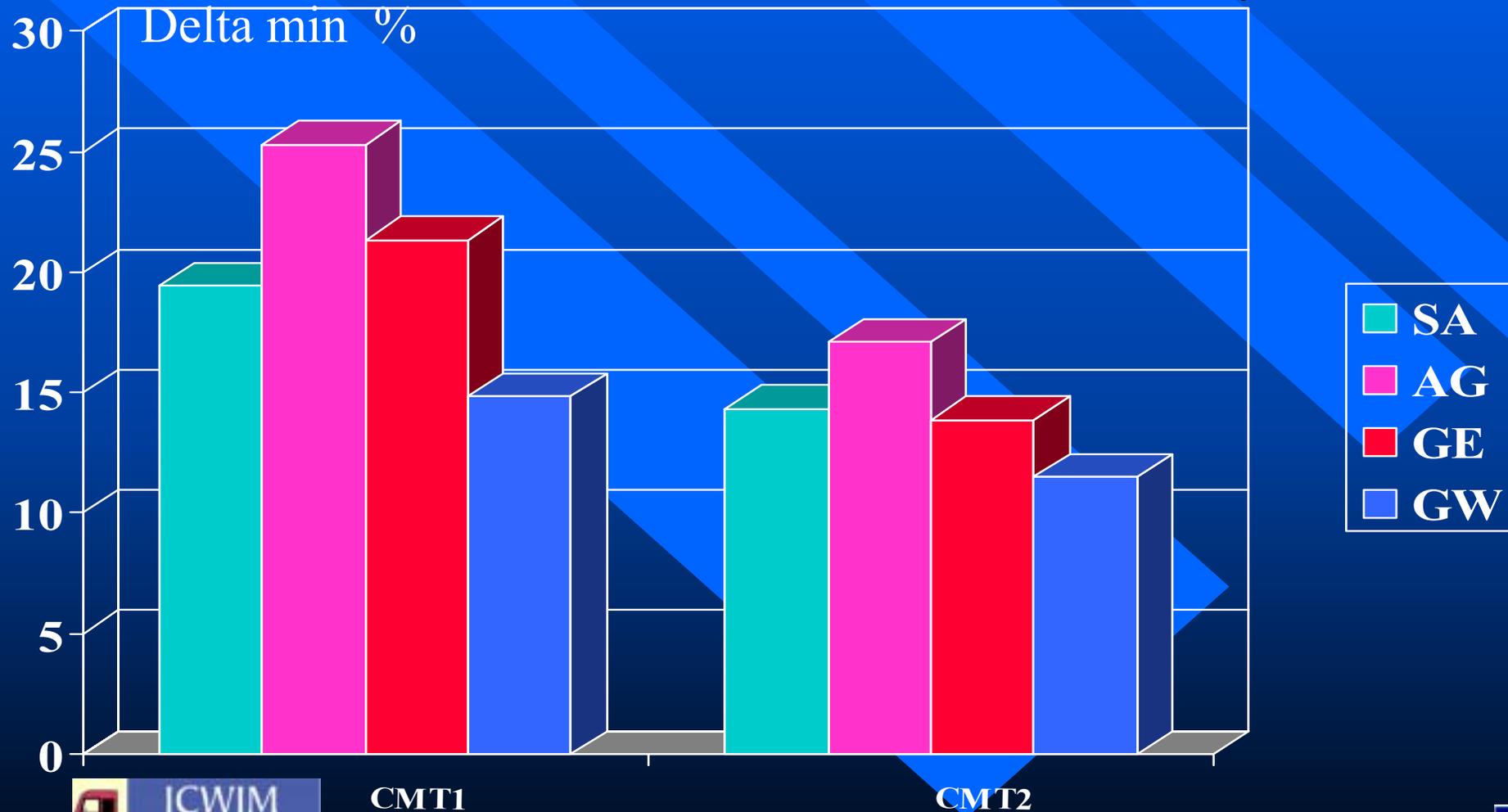
CMT1

CMT2

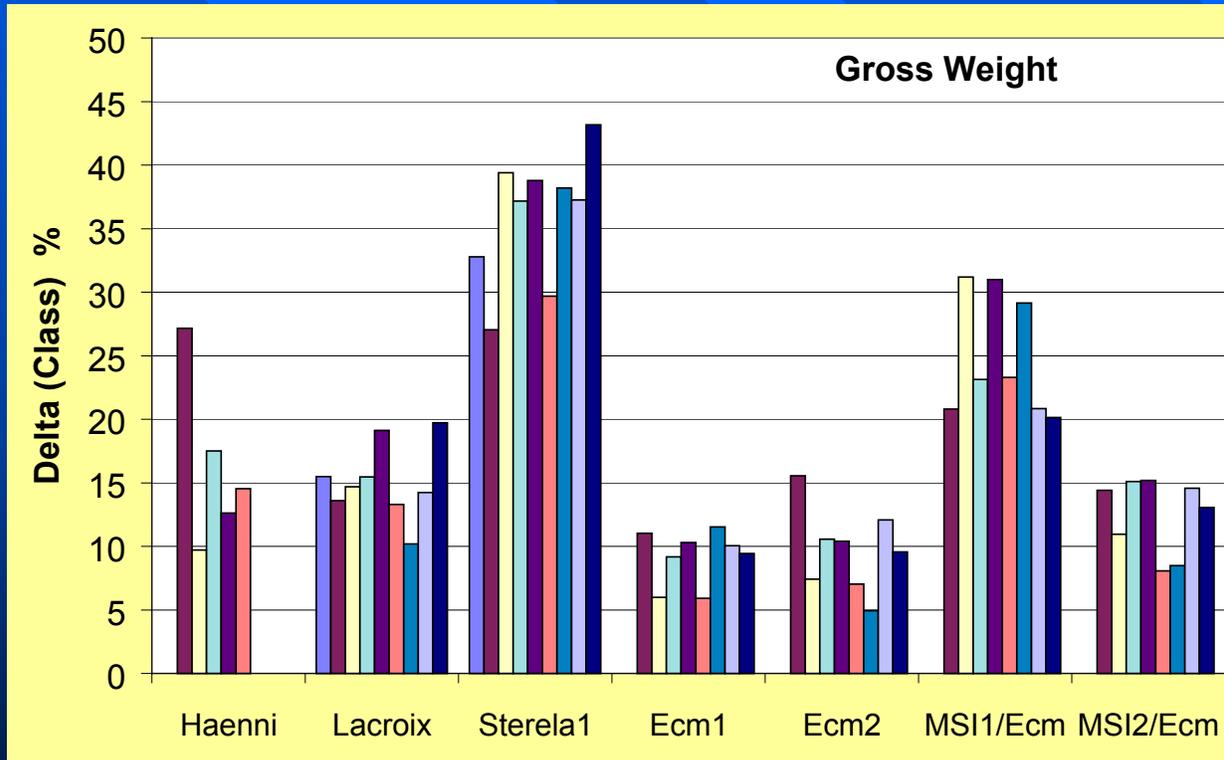


# MSI2/ECM - 2 Piezo-polymer bars

CMT2 with modification value of calibration by axle ranks



# ACCURACY Condition (R2), Environment I



- ◆ ECM1 ,MSI2 systems  
var max  $\delta_{\min}$  7.2%
- ◆ LACROIX, ECM2,  
MSI2 systems  
var max  $\delta_{\min}$  11.1%
- ◆ STERELA, HAENNI  
systems  
var max  $\delta_{\min}$  17.5%



# CMT2 - CONCLUSIONS

- ◆ result presented a total of 281 lorries (traffic flow) (CMT1 684 lorries)
- ◆ HAENNI - new capacitive mat - lost 3 accuracy classes between CMT1 and CMT2 - B(10) to D(25)
- ◆ LACROIX - 1 piezo-ceramic bar - no modification between CMT1 and CMT2 - result stable - C(15) for 2 tests ( 981 HGV)
- ◆ STERELA - 1 piezo-ceramic nude - 8 mm - no modifications between CMT1 and CMT2 - lost 1 accuracy class between CMT1 and CMT2 - E(30) to E(35) - very large bias (-15,64 )



# CMT2 - CONCLUSIONS

- ◆ ECM1 and ECM2 - 2 piezo-ceramic bars - New values of the calibration by axle ranks - improve the quality measurement - ECM1 C(15) to B(10) - ECM2 B(10) for 2 tests
- ◆ SMI1/ECM (2 piezo-polymer ribbons) and SMI2/ECM (2 piezo-polymer bars) - New values of the calibration by axle ranks - improve the quality measurement - SMI1/ECM E(40) to E(30) - SMI2/ECM D+(20) to C(15)

