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# The relationship between the Vietnam national coordinate reference system (**VN-2000**) and **ITRS, WGS84 and PZ-90**

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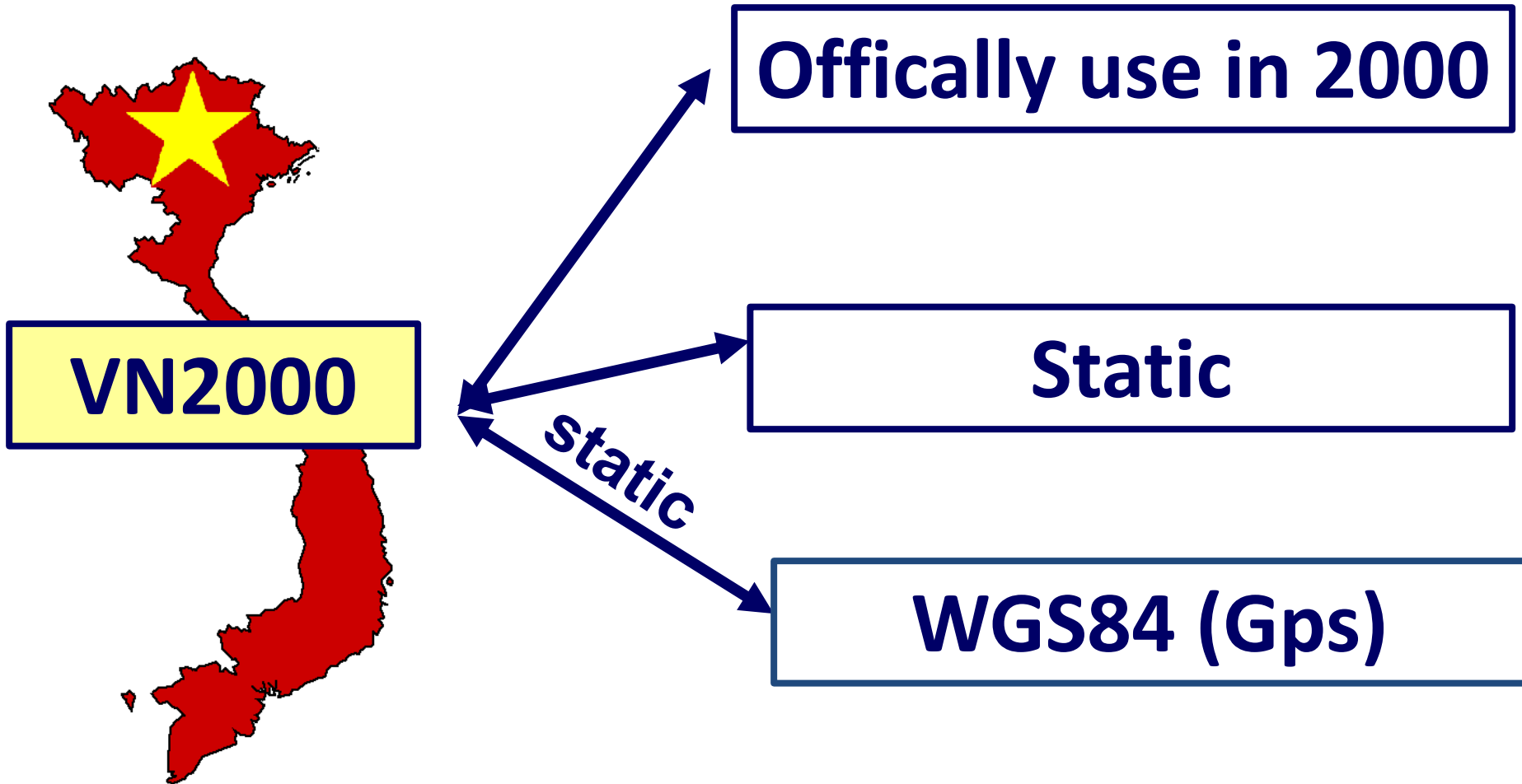
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- 4. Results and discussion**
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**1.**

# **Introduction**

# Introduction



**ITRS**

**ITRF1988**

**ITRF1989**

**ITRF1990**

**ITRF1991**

**ITRF1992**

**ITRF1996**

**ITRF1997**

**ITRF2000**

**ITRF2005**

**ITRF2008**

**ITRF2014**

**WGS84**

**WGS84 (origin)**

**WGS84 (G730)**

**WGS84 (G1150)**

**WGS84 (G1674)**

**WGS84 (G1762)**



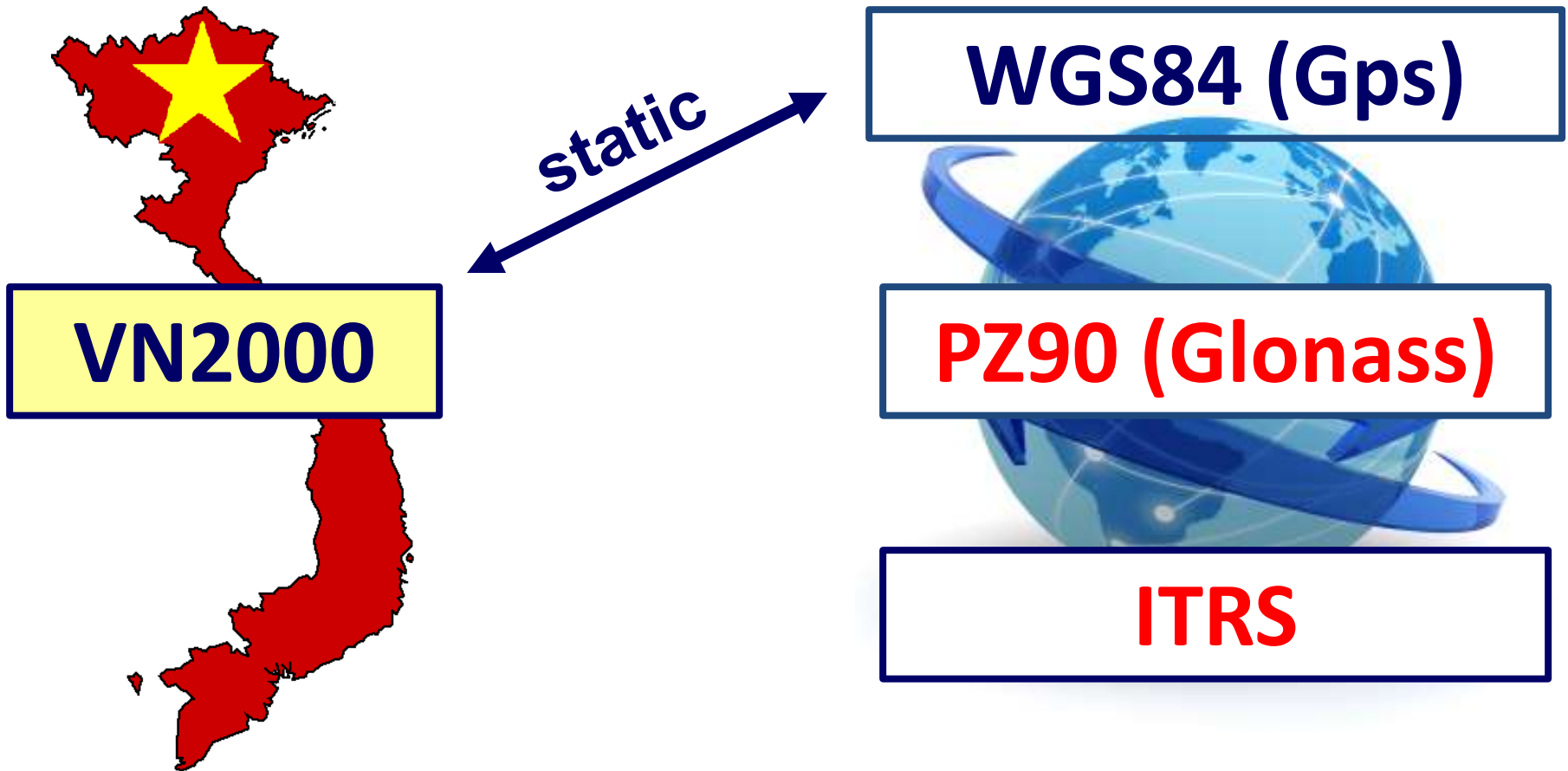
**PZ90**

**PZ90.00**

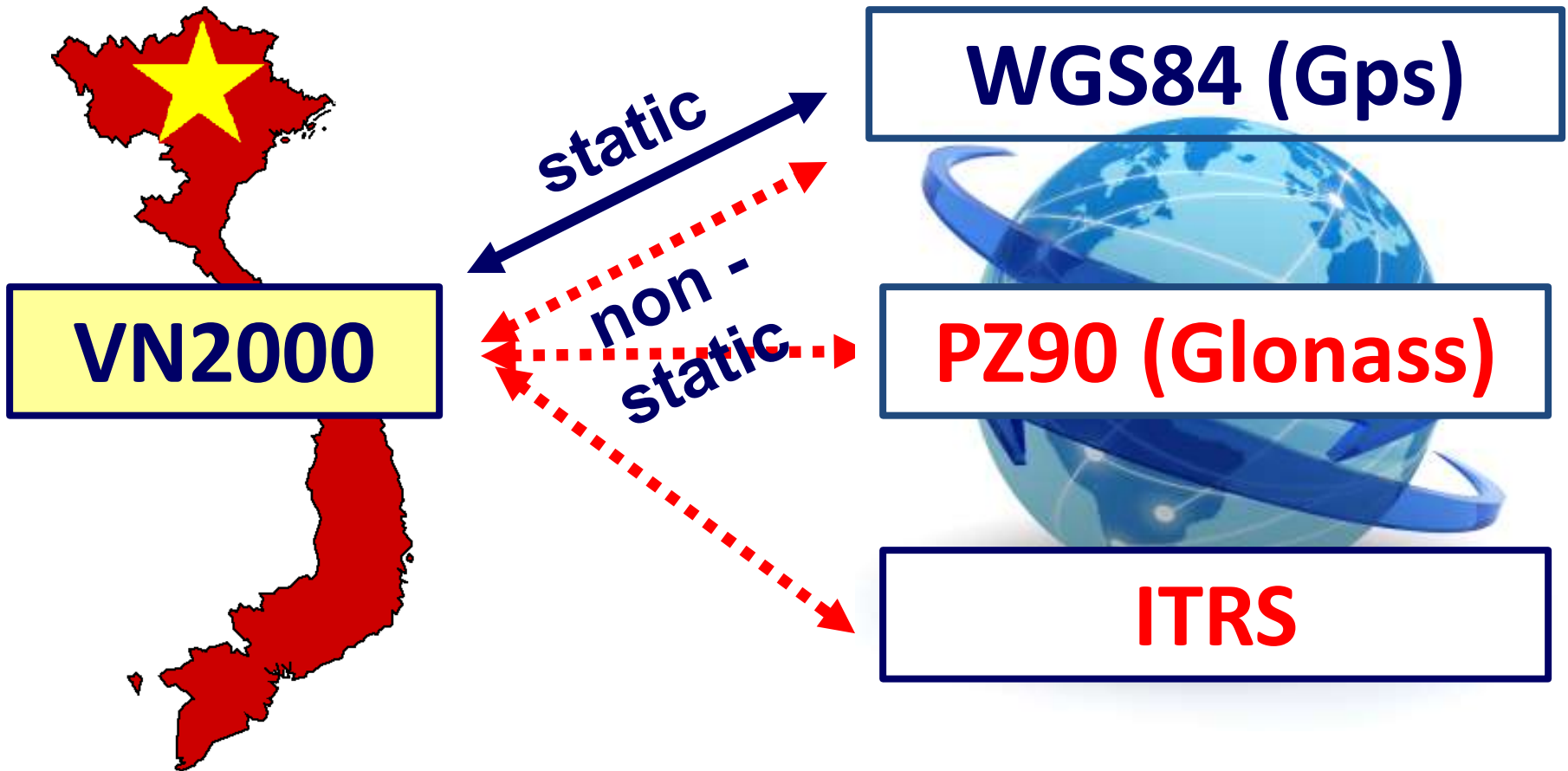
**PZ90.02**

**PZ90.11**

# Introduction



# Introduction



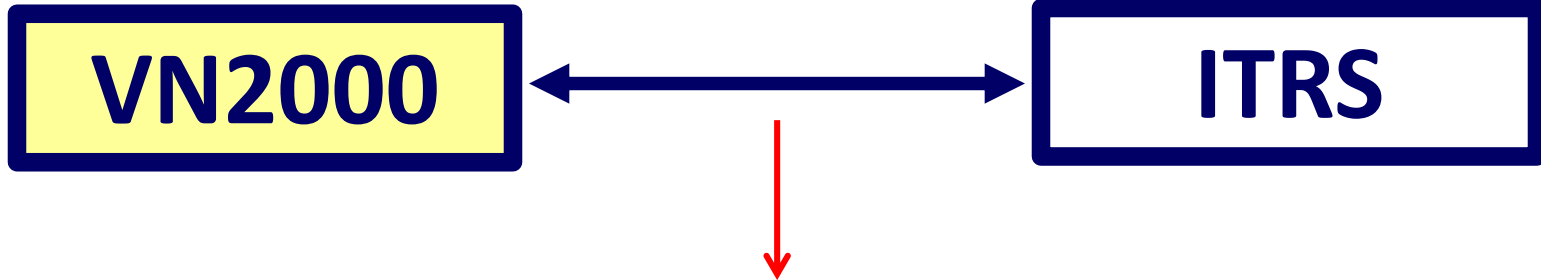
**2.**

# **Theory and Method**



# Theory and Method

1



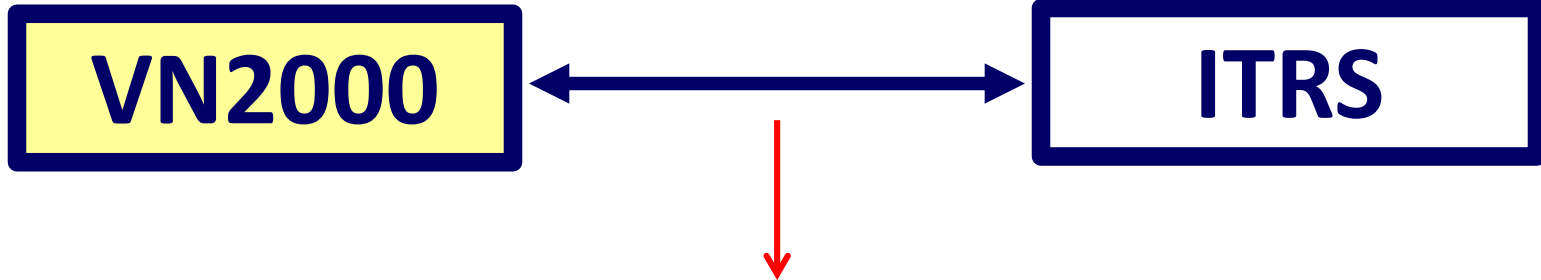
2

$$\text{VN2000} \rightarrow \text{WGS84} =$$
$$(\text{VN2000} \rightarrow \text{ITRS}) + (\text{ITRS} \rightarrow \text{WGS84})$$

$$\text{VN2000} \rightarrow \text{PZ-90} =$$
$$(\text{VN2000} \rightarrow \text{ITRS}) + (\text{ITRS} \rightarrow \text{PZ-90})$$

# Theory and Method

1



2

$$\text{VN2000} \rightarrow \text{WGS84} = (\text{VN2000} \rightarrow \text{ITRS}) + (\text{ITRS} \rightarrow \text{WGS84})$$

$$\text{VN2000} \rightarrow \text{PZ-90} = (\text{VN2000} \rightarrow \text{ITRS}) + (\text{ITRS} \rightarrow \text{PZ-90})$$

**VN2000****7+7 = 14 parameters****ITRS**

$$X_2 = X_1 + A\theta \quad \theta = [T_1, T_2, T_3, D, R_1, R_2, R_3] \quad \mathbf{7}$$

$$\dot{X}_2 = \dot{X}_1 + A\dot{\theta} \quad \dot{\theta} = [\dot{T}_1, \dot{T}_2, \dot{T}_3, \dot{D}, \dot{R}_1, \dot{R}_2, \dot{R}_3] \quad \mathbf{7}$$

## The least squares solutions :

$$\theta = (A^T P_x A)^{-1} A^T P_x (X_2 - X_1)$$

$$\dot{\theta} = (A^T P_v A)^{-1} A^T P_v (\dot{X}_2 - \dot{X}_1)$$

$$s_{0X}^2 = ((A^T P_x - (X_2 - X_1))^{-1} \cdot (A^T P_x - (X_2 - X_1))^{-1}) / n$$

**3.**

**Input solution datasets**

# Input solution datasets

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## The annual Asia Pacific Regional Geodetic Project (APRGP) GPS campaign

- 10 points
- 7-day observation sessions over a period of 4 years (2011–2015)
- ITRF2008-based coordinates and velocities; VN2000 coordinate

## Vietnamese GNSS marine network

- 11 points
- 7-day observation sessions in 2016
- ITRF2005-based coordinates at epoch 2016.764 and VN-2000 coordinate values.

# 21 stations in the two networks



4.

# Results and dicussion

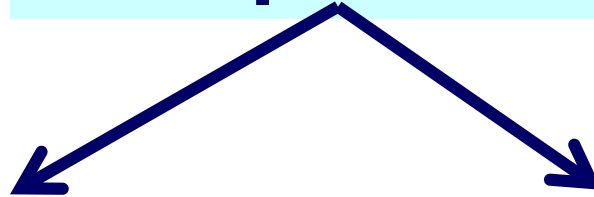
**VN2000**



**7+7 = 14 parameters**

**ITRS**

**21 points**



**10 points**

for determining  
parameter  
transformation

**11 points**

for evaluating the  
performance  
of parameter transformation



**VN2000**

**ITRS**

**7+7 = 14 parameters**

**determining parameter transformation**

**Data (10 points)**

**1. ITRS coordinates:**

- ITRF08,  $t = 2011.7$
- ITRF08,  $t = 2015.7$

**2. VN2000 coordinates**

**Steps**

**ITRF08 to VN2000**

**ITRF<sub>xy</sub> to VN2000**

$$\begin{aligned} &ITRF_{xy} \text{ to VN2000} = \\ &(ITRF_{xy} \text{ to ITRF2008}) + (ITRF2008 \text{ to VN2000}) \end{aligned}$$

**VN2000**

**7+7 = 14 parameters**

**ITRS**

Parameters	$T_1$ mm	$T_2$ mm	$T_3$ mm	D $10^{-9}$	$R_1$ mas	$R_2$ Mas	$R_3$ mas	Epoch
	$\dot{T}_1$ mm/n	$\dot{T}_2$ mm/n	$\dot{T}_3$ mm/n	$\dot{D}$ $10^{-9}/n$	$\dot{R}_1$ mas/n	$\dot{R}_2$ mas/n	$\dot{R}_3$ mas/n	
ITRF2014								2015.0
	193.9227	37.5110	110.6343	-7.51	-7.11	+20.08	+37.35	
	-0.0790	-0.0360	0.0188	0.16	-0.85	+1.33	-3.52	
ITRF2008								2015.0
	193.9211	37.5091	110.6319	-7.54	-7.11	+20.08	+37.35	
	-0.0790	-0.0360	0.0189	0.16	-0.85	+1.33	-3.52	
ITRF2005								2015.0
	193.9186	37.5100	110.6366	-8.48	-7.11	+20.08	+37.35	
	-0.0793	-0.0360	0.0189	0.16	-0.85	+1.33	-3.52	
ITRF2000								2015.0
	193.9215	37.5093	110.6694	-10.08	-7.11	+20.08	+37.35	
	-0.0791	-0.0361	0.0207	0.08	-0.85	+1.33	-3.52	
.....	.....	.....	.....	.....	.....	.....	.....	.....
ITRF88								2015.0
	193,8983	37.5065	110,7571	-17,95	-7,21	20,08	37,29	
	-0,0791	-0,0355	0,0221	0,07	-0,85	1,33	-3,54	

**VN2000**

**ITRS**

**7+7 = 14 parameters**

## Parameter Assessment

**11  
points**

**ITRS coordinates**  
- ITRF05 at t= 2016.764

**transfer**

**VN2000 coordinates**  
(known)

**VN2000 coordinates**

**Compare**

**VN2000**

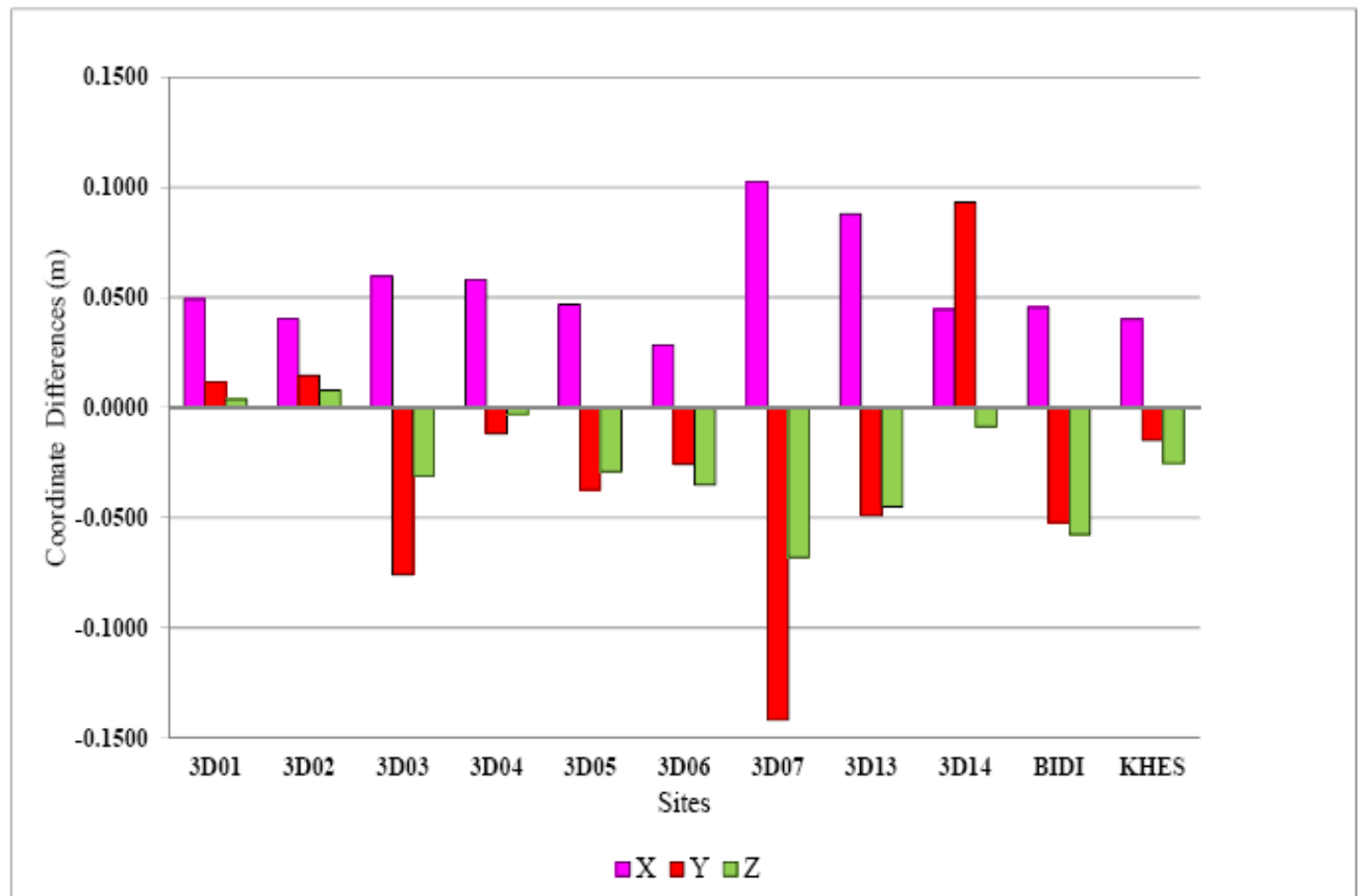


**ITRS**

**7+7 = 14 parameters**

## The performance of parameters

**Coordinate  
Differences**



**VN2000**



**WGS84**

**determining parameter transformation**

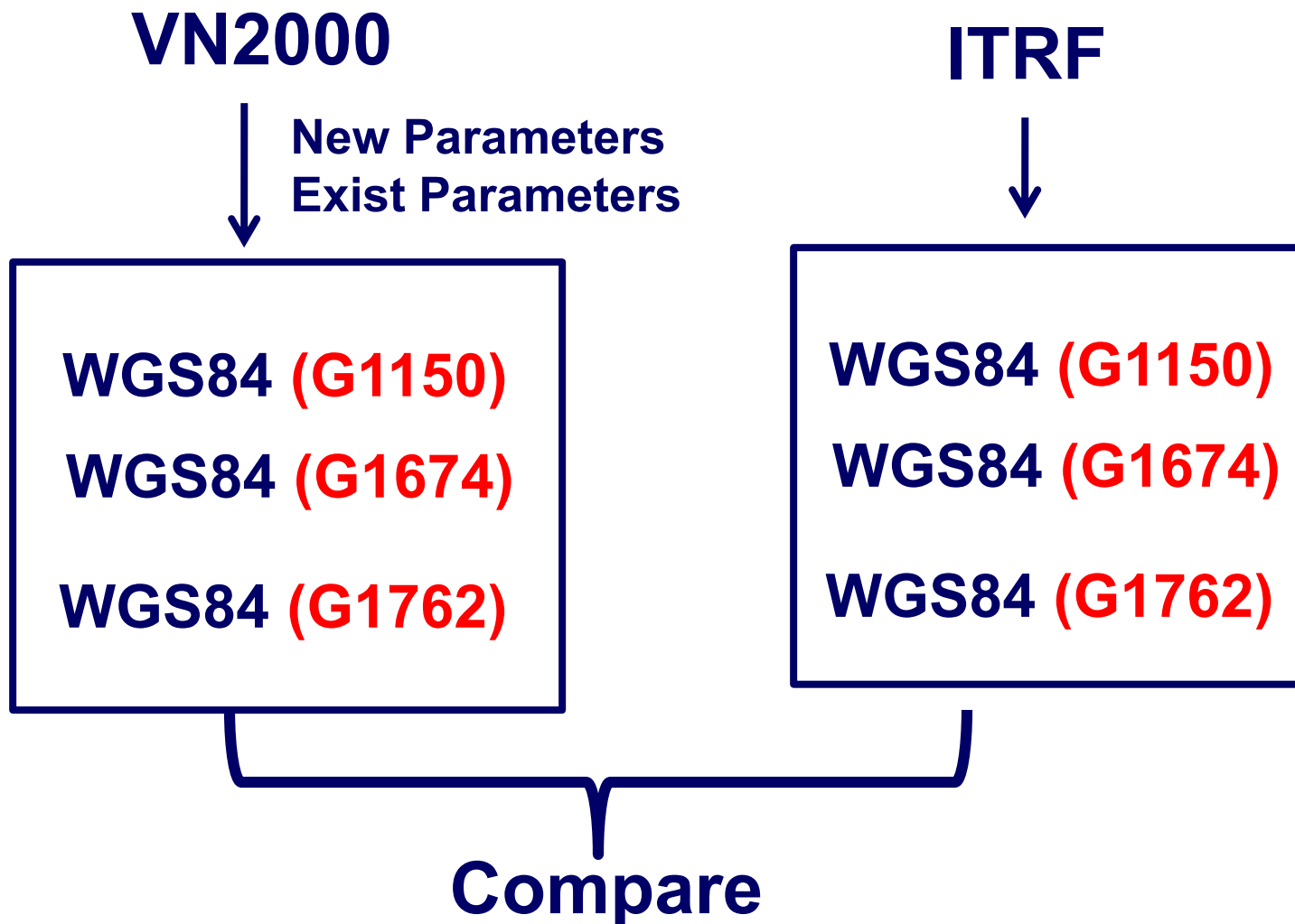
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**VN2000 → PZ90 =**

**(VN2000 → ITRS) + (ITRS → WGS84)**

**VN2000****WGS84**

$T_1$	$T_2$	$T_3$	D	$R_1$	$R_2$	$R_3$
(mm)	(mm)	(mm)	( $10^{-9}$ )	(mas)	(mas)	(mas)
VN2000 to WGS84 (G1762), epoch 2005.0						
194,7154	37,8661	110,4386	-2,2172	1,0920	7,0395	72,1838
VN2000 to WGS84 (1674), epoch 2005.0						
194,7114	37,8691	110,4426	-9,1172	1,3620	6,7695	72,5638
VN2000 to WGS84 (G1150), epoch 2001.0						
195,0293	38,01471	110,3792	-11,1682	4,7517	1,4456	86,6502
VN2000 to WGS84 (G873), epoch 1997.0						
195,3391	38,15302	110,3148	-13,0293	8,1414	-3,8783	100,7366
VN2000 to WGS84 (G730), epoch 1994.0						
195,5565	38,24353	110,2624	-13,9225	10,6837	-7,8713	111,3614
VN2000 to WGS84 (origin), epoch 1984						
196,2898	39,11956	110,2802	-96,1000	0,8579	-20,8810	139,7773

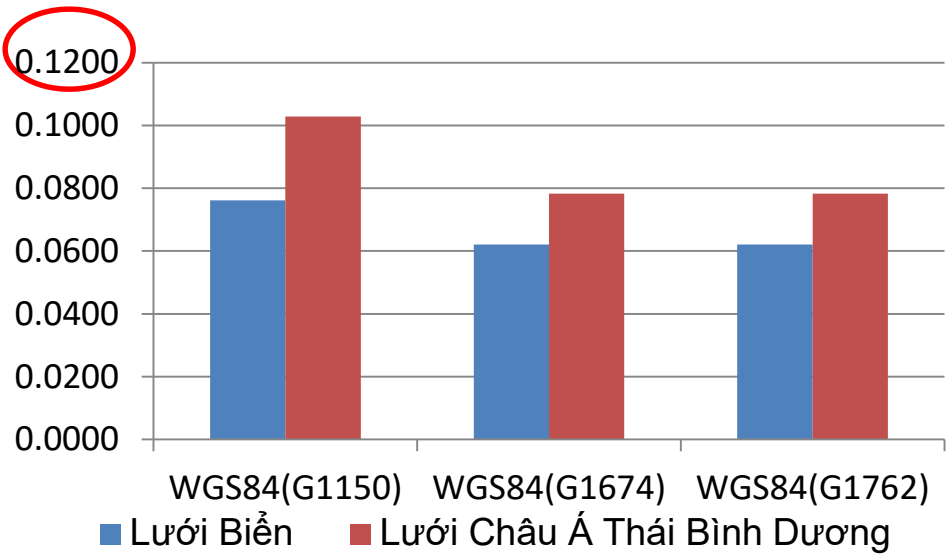


**VN2000**

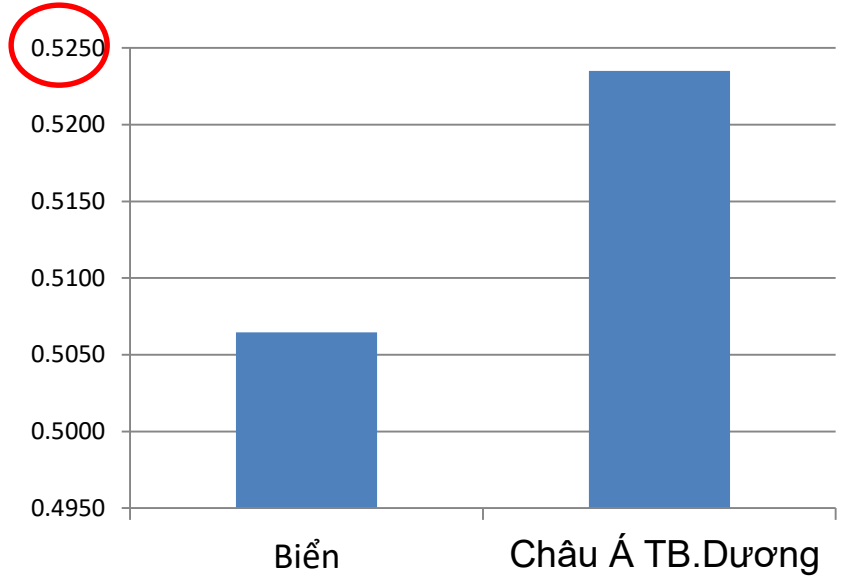


**WGS84**

## The performance of parameters



**New parameters**



**Exist parameters**





**determining parameter transformation**

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**VN2000 → PZ90 =**

**(VN2000 → ITRS) + (ITRS → PZ90)**



determining parameter transformation

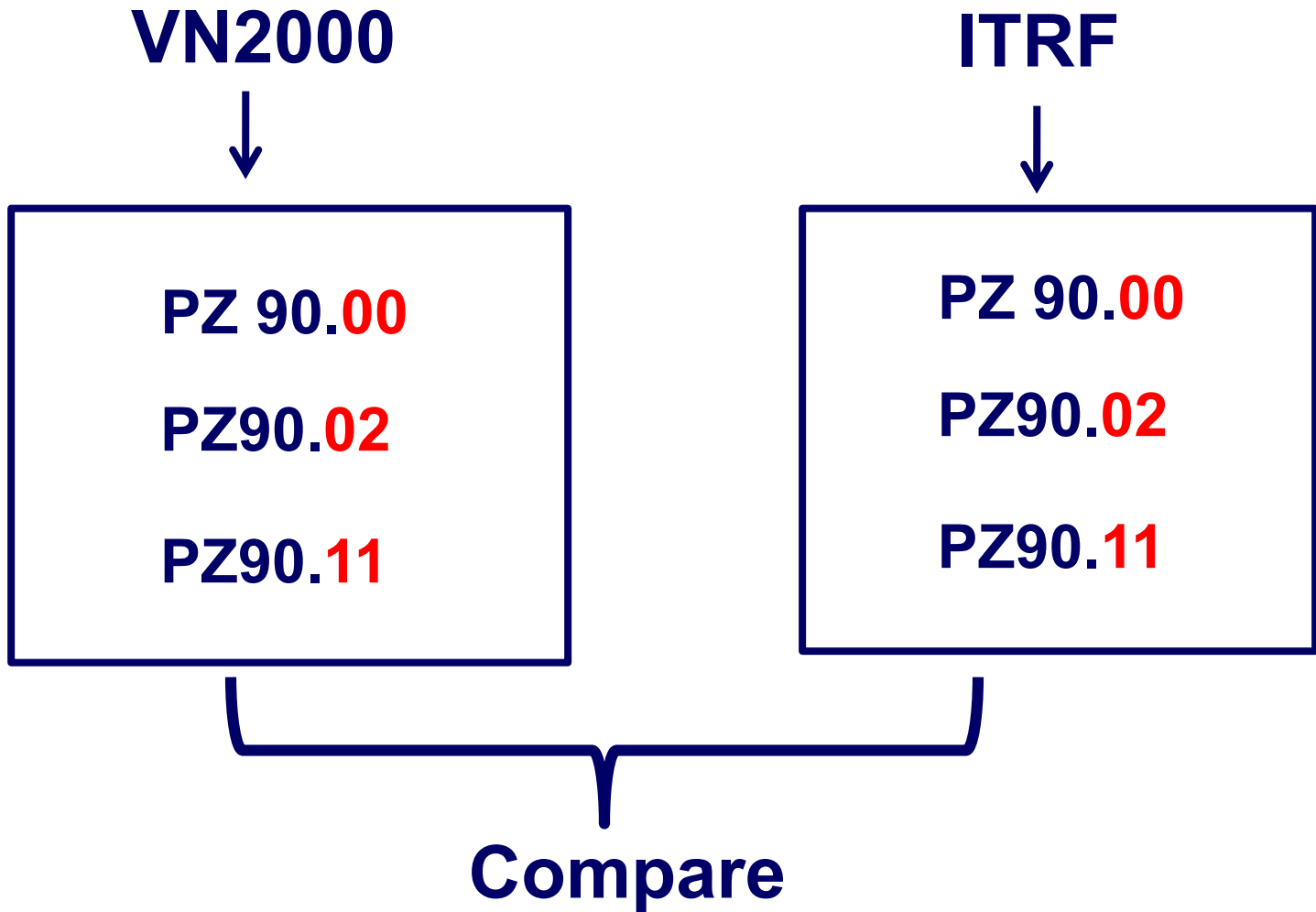
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**VN2000 → PZ90 =**

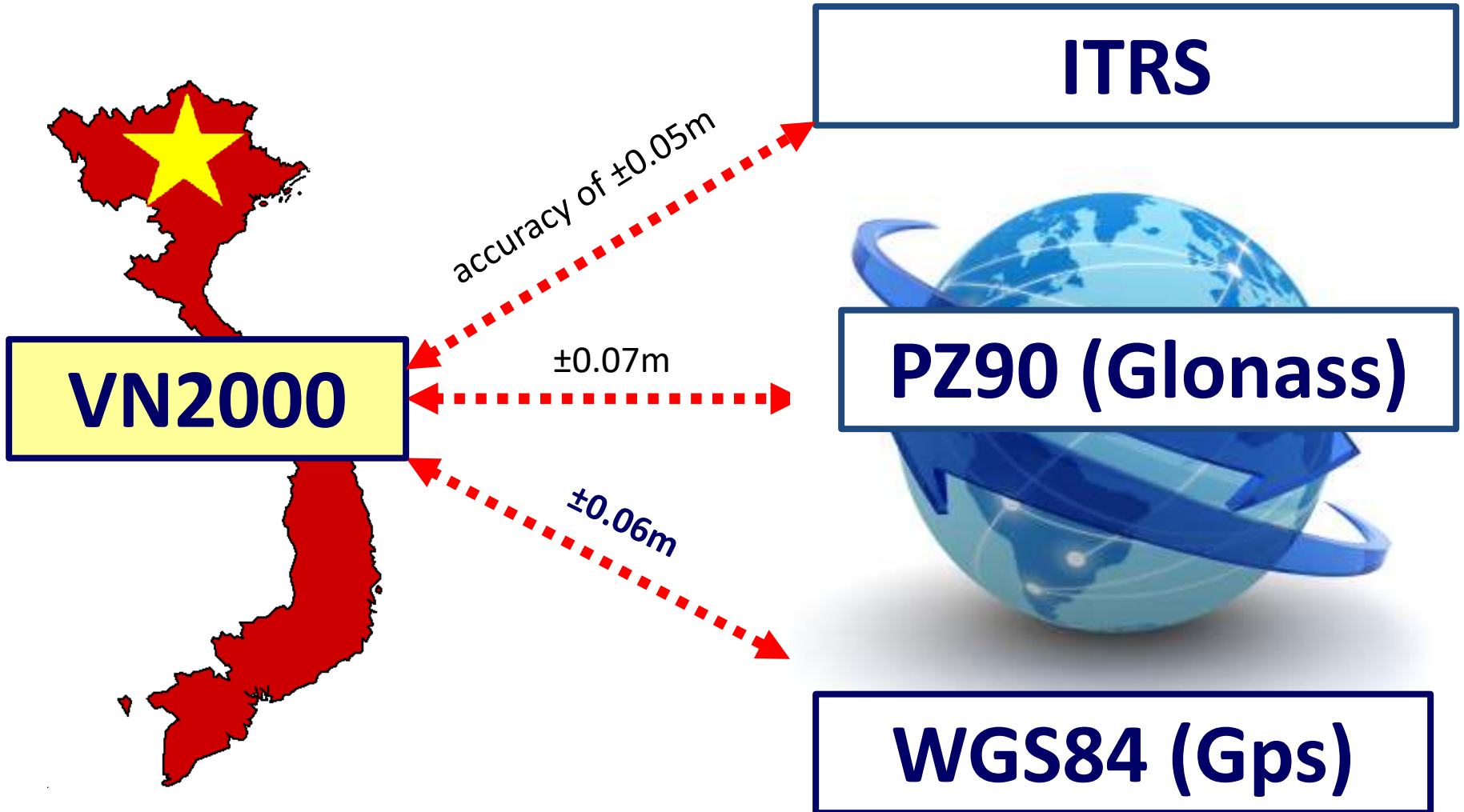
**(VN2000 → ITRS) + (ITRS → PZ90)**

**VN2000****PZ90**

$T_1$ (mm)	$T_2$ (mm)	$T_3$ (mm)	D ( $10^{-9}$ )	$R_1$ (mas)	$R_2$ (mas)	$R_3$ (mas)
<b>PZ 90.11, epoch 2010.0</b>						
<b>194,3132</b>	<b>37,6881</b>	<b>110,5373</b>	<b>-8,3285</b>	<b>-2,8942</b>	<b>13,4664</b>	<b>54,9538</b>
<b>PZ 90.02, epoch 2010.0</b>						
<b>193,9402</b>	<b>37,8741</b>	<b>110,7393</b>	<b>-16,3285</b>	<b>-0,5942</b>	<b>9,9264</b>	<b>59,1638</b>
<b>PZ 90.00, epoch 2002.0</b>						
<b>193,5202</b>	<b>38,0286</b>	<b>110,6000</b>	<b>-231,0905</b>	<b>3,9042</b>	<b>2,7766</b>	<b>213,1286</b>



# Conclusion



# Conclusion

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**New** parameters is

**seven times** better

than the **existing** one.

# Thank you for your listening

