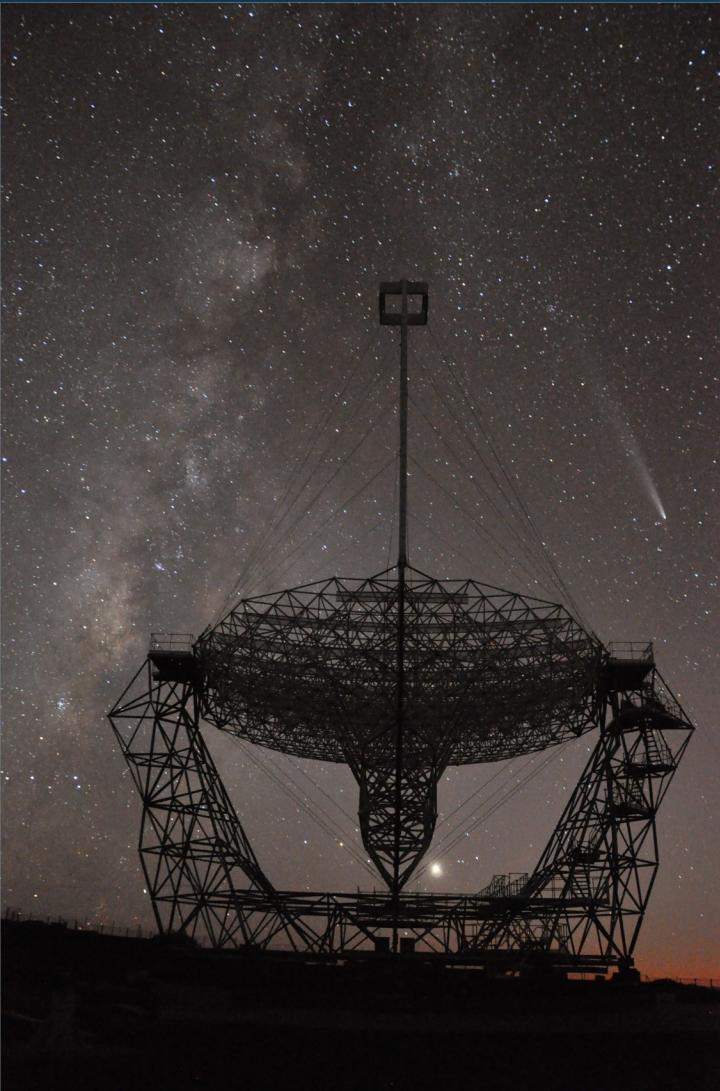




Laboratoire d'Annecy de Physique des Particules



# CTA - Large Size Telescopes

## Monitoring de la tension des haubans

Journées Online 2025  
Eric Chabanne

Automatismes  
Programmation  
Embarqué PLC Slow control Informatique industrielle DAQ  
Control systems Asservissements Traitemet du signal  
Interlocks Temps réel Régulation SCADA Eiectrotechnique  
Contrôle-commande IoT Supervision  
in2p3 Catalogue Développement Logiciel Acquisition de données

CTA / CTA-LST: présentation

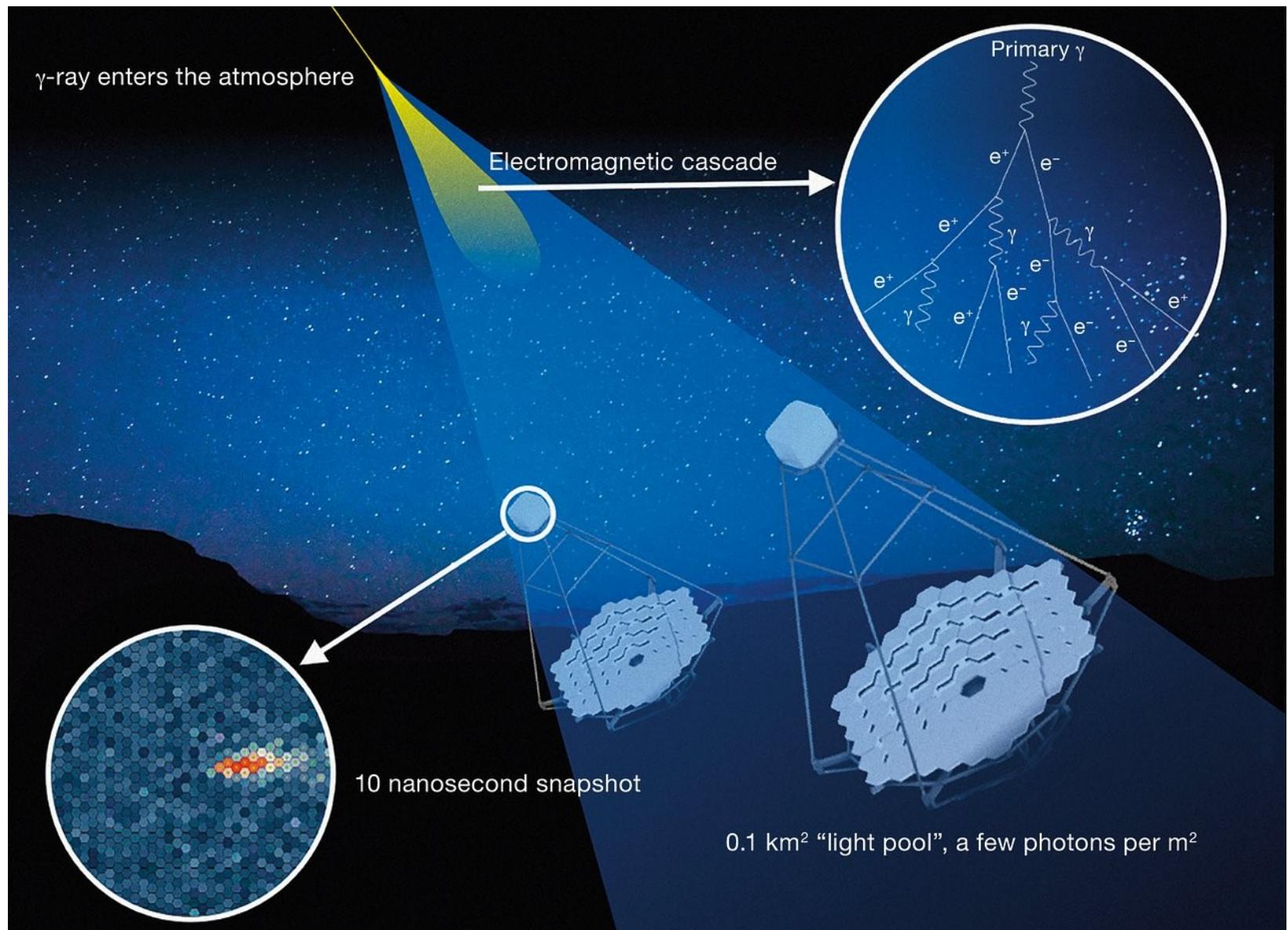
L'arche et ses haubans

L'interface de visualisation

Système de lecture prévue en opération

Système de lecture en installation

Résultats



# Large Size Telescope

Mirrors: JP

Interface plates: JP, DE, BR

Actuators: JP, CH

CMOS: JP

calibration:

IT, HR, IN, DE

Telescope  
structure: DE

Bogies: ES

Foundation: ES

Drive and main  
el. cabinet: FR

Tension cables: IT

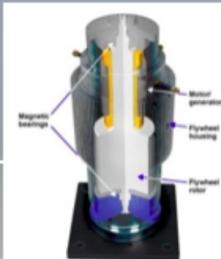
Camera Support  
Structure: FR

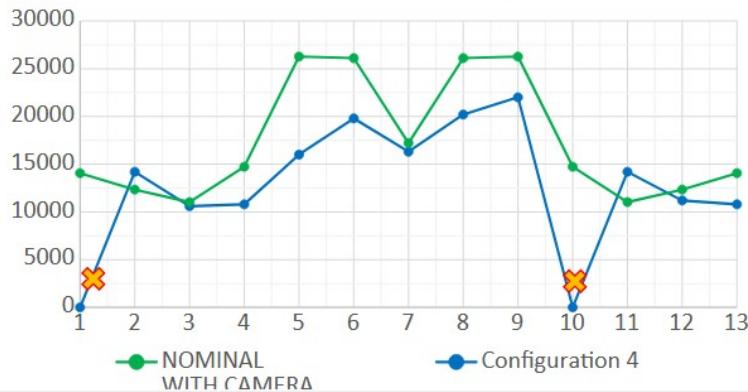
Camera electronics: JP, IT, ES  
Camera mechanics: ES  
Camera safety: FR

Rail: DE

Camera Access Tower: DE, ES

FlyWheels (2x300kW)  
energy storage and UPS: JP

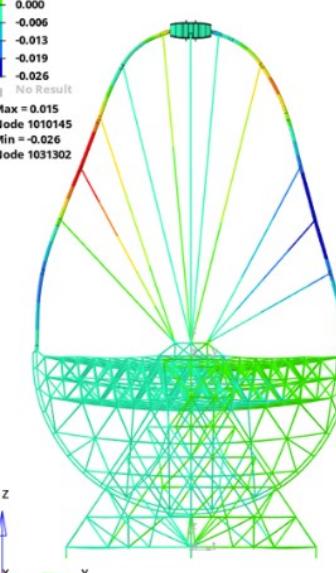




Contour Plot  
Displacement(Y)  
Analysis system

0.015  
0.012  
0.009  
0.006  
0.003  
0.000  
-0.006  
-0.013  
-0.019  
-0.026

No Result  
Max = 0.015  
Node 1010145  
Min = -0.026  
Node 1031302

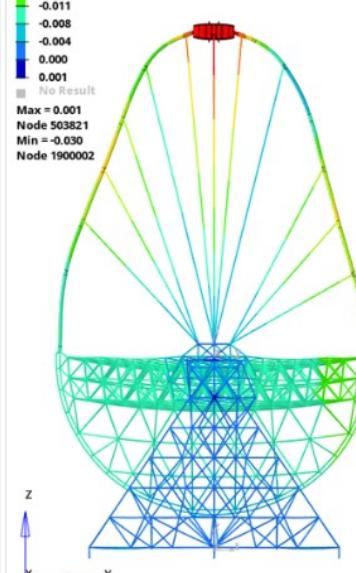


Configuration 4

Contour Plot  
Displacement(Z)  
Analysis system

-0.030  
-0.026  
-0.023  
-0.019  
-0.015  
-0.011  
-0.008  
-0.004  
0.000  
0.001

No Result  
Max = 0.001  
Node 503821  
Min = -0.030  
Node 1900002



## Coéficients de linéarisation des loadpins,

et affectation des numéros de série  
pour chaque hauban (101 → 213)

ID	Type	Coeff a	Coeff b	ID	Type	Coeff a	Coeff b	ID	Type	Coeff a	Coeff b	ID	Type	Coeff a	Coeff b
2230218	Short	5.112817e-02	-2.103011e-03	2230239	Short	5.110732e-02	-2.158237e-03	2230260	Short	4.889513e-02	-2.009129e+03	2230281	Long	4.959835e+02	-2.018653e+03
2230219	Short	5.177197e-02	-2.108040e+03	2230240	Short	4.838470e-02	-1.982433e+03	2230261	Short	4.976720e-02	-2.021798e+03	2230282	Long	5.081378e+02	-2.071505e+03
2230220	Short	4.716274e-02	-1.909145e+03	2230241	Short	4.875418e-02	-2.001349e+03	2230262	Short	4.906715e-02	-1.997389e+03	2230283	Long	4.874718e+02	-1.971812e+03
2230221	Short	5.197484e-02	-2.127845e+03	2230242	Short	4.850872e-02	-1.995232e+03	2230263	Short	4.874947e-02	-1.968926e+03	2230284	Long	4.727198e+02	-1.933621e+03
2230222	Short	5.055185e-02	-2.058143e+03	2230243	Short	4.859991e-02	-2.000513e+03	2230264	Short	4.886223e-02	-2.024744e+03	2230285	Long	4.890542e+02	-1.982326e+03
2230223	Short	5.129141e-02	-2.091305e+03	2230244	Short	5.255171e-02	-2.198396e+03	2230265	Short	4.792564e-02	-2.014445e+03	2230286	Long	4.884322e+02	-1.976520e+03
2230224	Short	5.106395e-02	-2.089147e+03	2230245	Short	4.941962e-02	-2.032241e+03	2230266	Short	4.948166e-02	-2.074830e+03	2230287	Long	4.883273e+02	-1.958891e+03
2230225	Short	5.114192e-02	-2.075400e+03	2230246	Short	5.135387e-02	-2.113395e+03	2230267	Short	4.751516e-02	-1.950471e+03	2230288	Long	5.214846e+02	-2.117803e+03
2230226	Short	4.832746e-02	-1.983044e+03	2230247	Short	5.045978e-02	-2.056829e+03	2230268	Long	4.963357e-02	-2.011753e+03	2230289	Long	4.878791e+02	-1.959040e+03
2230227	Short	5.179203e-02	-2.107192e+03	2230248	Short	4.872626e-02	-2.014205e+03	2230269	Long	5.041320e-02	-2.051453e+03	2230290	Long	5.034983e+02	-2.049850e+03
2230228	Short	5.202965e-02	-2.143099e+03	2230249	Short	4.901146e-02	-2.038874e+03	2230270	Long	5.001312e-02	-2.023530e+03	2230291	Long	4.927539e+02	-2.006633e+03
2230229	Short	5.087909e-02	-2.090624e+03	2230250	Short	4.838388e-02	-1.991115e+03	2230271	Long	5.099825e-02	-2.059365e+03	2230292	Long	4.867001e+02	-1.986159e+03
2230230	Short	5.033256e-02	-2.046430e+03	2230251	Short	4.908990e-02	-2.028013e+03	2230272	Long	5.028383e-02	-2.015755e+03	2230293	Long	4.810707e+02	-1.995626e+03
2230231	Short	5.048375e-02	-2.087651e+03	2230252	Short	4.917864e-02	-2.030177e+03	2230273	Long	4.856640e-02	-1.982043e+03	2230294	Long	4.822377e+02	-1.937003e+03
2230232	Short	4.927287e-02	-2.024304e+03	2230253	Short	4.901179e-02	-2.071389e+03	2230274	Long	5.164852e-02	-2.065067e+03	2230295	Long	4.847953e+02	-1.944153e+03
2230233	Short	5.092313e-02	-2.084756e+03	2230254	Short	4.897179e-02	-2.017835e+03	2230275	Long	4.895542e-02	-2.023032e+03	2230296	Long	4.771144e+02	-1.877167e+03
2230234	Short	5.235689e-02	-2.136097e+03	2230255	Short	4.997756e-02	-2.034862e+03	2230276	Long	5.110257e-02	-2.072352e+03	2230297	Long	4.864770e+02	-1.868322e+03
2230235	Short	5.069406e-02	-2.056576e+03	2230256	Short	4.965270e-02	-2.013819e+03	2230277	Long	4.969803e-02	-2.007900e+03	2230298	Long	4.771057e+02	-1.926146e+03
2230236	Short	5.226586e-02	-2.080410e+03	2230257	Short	4.812796e-02	-1.983282e+03	2230278	Long	4.981822e-02	-2.027475e+03	2230299	Long	4.934363e-02	-1.973304e+03
2230237	Short	5.076954e-02	-2.000971e+03	2230258	Short	4.808691e-02	-2.021746e+03	2230279	Long	5.011074e-02	-2.006556e+03	2230280	Long	4.788633e-02	-1.944700e+03
2230238	Short	4.923414e-02	-2.003514e+03	2230259	Short	4.932624e-02	-2.039950e+03	2230281	Long	4.788633e-02	-1.944700e+03				

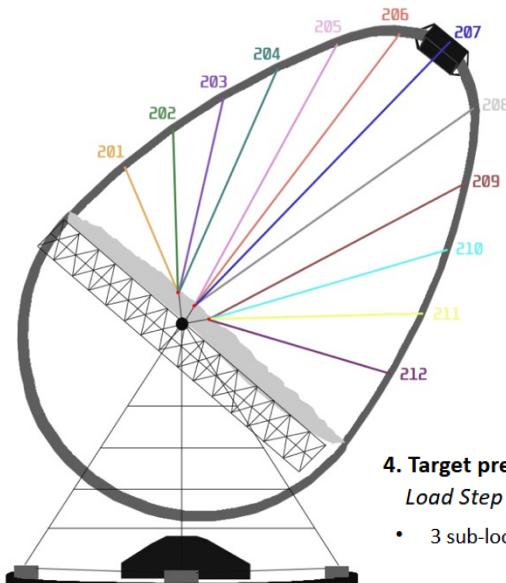
LST 3

EAST

Cable Ref	Loadpin ID	Type
101	2230250	SHORT
102	2230288	LONG
103	2230289	LONG
104	2230251	SHORT
105	2230252	SHORT
106	2230253	SHORT
107	2230290	LONG

WEST

Cable Ref	Loadpin ID	Type
201	2230258	SHORT
202	2230293	LONG
203	2230294	LONG
204	2230259	SHORT
205	2230260	SHORT
206	2230261	SHORT
207	2230295	LONG

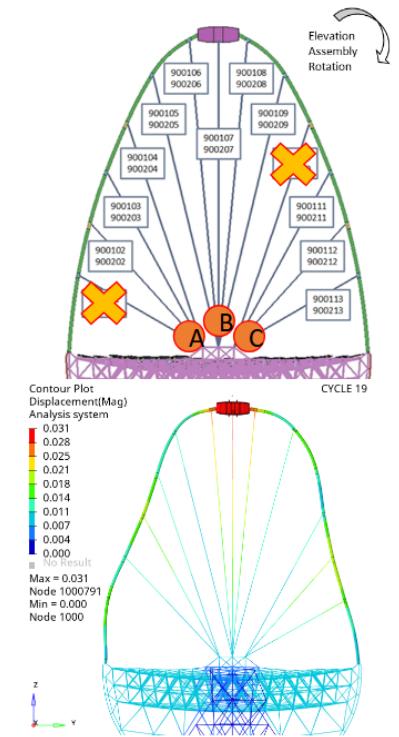


#### 4. Target pretension for configuration 4

*Load Step #4 (from 80% to 100% of the target pretension)*

- 3 sub-loops are foreseen for the load step #4, to get from 80% to 100% of the target pretension.

ID	starting tension [N]	LOOP 1																		
		Group A							Group C							Group B				
		f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12	f13	f14	f15	f16	f17	f18	f19
2	11500	11567	10520	12500	12553	11226	12500	12522	12539	12572	12656	12666	12726	12777	12786	12978	13064	13095	13105	13108
3	8500	7845	9800	8339	7822	10300	9360	9142	9154	9176	9232	9240	9280	9314	9320	9337	9393	9426	9433	9435
4	8500	9800	8837	8975	10000	8780	8868	9300	9315	9343	9413	9423	9474	9516	9524	8864	8939	8957	8968	8972
5	13000	12451	12472	12800	12367	12394	12604	12422	12451	12503	12636	12655	12750	12831	12847	14200	14362	14275	14299	14300
6	16000	16062	16231	16453	16501	16716	16859	16879	16907	16959	17114	17132	17228	17322	17337	16971	17173	17500	17515	17499
7	13000	13115	13241	13429	13520	13680	13801	13839	13865	13923	14128	14144	14250	14375	14388	14458	14549	14408	14352	14400
8	16500	16599	16687	16865	16943	17055	17170	17202	17231	17302	17505	17523	17653	17776	17792	18044	17832	17871	18000	17984
9	17500	17596	17700	17924	18000	18132	18276	18308	18390	18498	18154	18207	18405	18195	18239	18488	19200	19274	19244	19247
11	11500	11551	11612	11739	11779	11856	11938	11955	12020	11434	12800	12842	11770	12600	12635	12754	12554	12587	12604	12609
12	9000	9035	9074	9157	9184	9235	9288	9300	8657	9800	8821	8407	10500	9905	9561	9638	9743	9761	9771	9773
13	8500	8519	8540	8583	8597	8625	8652	8658	9800	9157	9266	10000	8823	8889	9500	9542	9622	9632	9636	9637





# L'interface de visualisation

Loadpins Values for Tensionning Telescope Arch

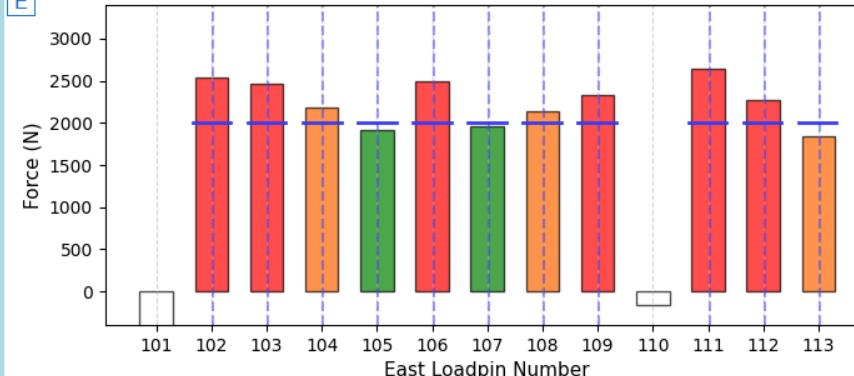
Value  Value Over Time  Target Value Conf  Loadpin Assignment  Loadpin Calibration  OPCUA Configuration

**East Side**

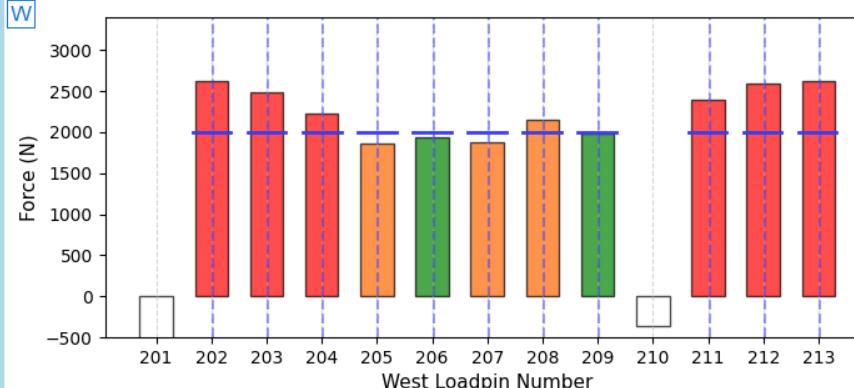
**West Side**

	Current Value	Target Value	Target Value	Current Value	
Loadpin101	-571.6 N	0.0 N	0.0 N	-671.18 N	Loadpin201
Loadpin102	2543.37 N	2000.0 N	2000.0 N	2630.12 N	Loadpin202
Loadpin103	2462.98 N	2000.0 N	2000.0 N	2484.16 N	Loadpin203
Loadpin104	2187.48 N	2000.0 N	2000.0 N	2234.05 N	Loadpin204
Loadpin105	1911.15 N	2000.0 N	2000.0 N	1855.38 N	Loadpin205
Loadpin106	2487.49 N	2000.0 N	2000.0 N	1938.22 N	Loadpin206
Loadpin107	1957.77 N	2000.0 N	2000.0 N	1872.07 N	Loadpin207
Loadpin108	2131.02 N	2000.0 N	2000.0 N	2151.76 N	Loadpin208
Loadpin109	2332.17 N	2000.0 N	2000.0 N	1988.76 N	Loadpin209
Loadpin110	-166.77 N	0.0 N	0.0 N	-357.57 N	Loadpin210
Loadpin111	2643.69 N	2000.0 N	2000.0 N	2389.24 N	Loadpin211
Loadpin112	2279.06 N	2000.0 N	2000.0 N	2600.15 N	Loadpin212
Loadpin113	1841.47 N	2000.0 N	2000.0 N	2620.23 N	Loadpin213

E



W



Loadpin configuration assignment :

Step target value configuration to use :

E East OPCUA Server Connected

W West OPCUA Server Connected

LST 4

Loadpins Values for Tensionning Telescope Arch

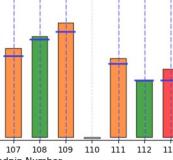
Value  Value Over Time  Target Value Conf  Loadpin Assignment  Loadpin Calibration  OPCUA Configuration

**East Side**

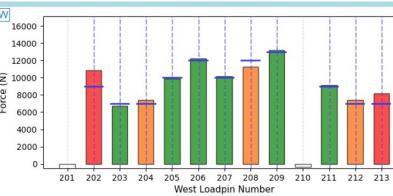
**West Side**

	Current Value	Target Value	Target Value	Current Value	
Loadpin101	-577.2 N	0.0 N	0.0 N	-642.89 N	Loadpin201
Loadpin102	1082.32 N	9000.0 N	9000.0 N	10812.22 N	Loadpin202
Loadpin103	1497.95 N	7000.0 N	7000.0 N	10700.0 N	Loadpin203
Loadpin104	1082.27 N	7000.0 N	7000.0 N	7795.04 N	Loadpin204
Loadpin105	10800.9 N	10000.0 N	10000.0 N	10700.0 N	Loadpin205
Loadpin106	10814.65 N	12000.0 N	12000.0 N	12000.0 N	Loadpin206
Loadpin107	10935.08 N	10000.0 N	10000.0 N	10812.11 N	Loadpin207
Loadpin108	14039.87 N	13000.0 N	13000.0 N	12000.0 N	Loadpin208
Loadpin109	-172.52 N	0.0 N	0.0 N	366.05 N	Loadpin209
Loadpin110	9672.85 N	9000.0 N	9000.0 N	9719.87 N	Loadpin210
Loadpin111	5871.04 N	7000.0 N	7000.0 N	7419.87 N	Loadpin211
Loadpin112	8395.01 N	7000.0 N	7000.0 N	6983.82 N	Loadpin212

E



W



Loadpins Values for Tensionning Telescope Arch

Value  Value Over Time  Target Value Conf  Loadpin Assignment  Loadpin Calibration  OPCUA Configuration

**East Side**

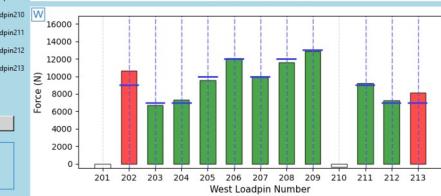
**West Side**

	Current Value	Target Value	Target Value	Current Value	
Loadpin101	-554.8 N	0.0 N	0.0 N	-602.7 N	Loadpin201
Loadpin102	10326.11 N	9000.0 N	9000.0 N	10692.51 N	Loadpin202
Loadpin103	7502.7 N	7000.0 N	7000.0 N	7000.0 N	Loadpin203
Loadpin104	5911.22 N	10000.0 N	10000.0 N	5348.9 N	Loadpin204
Loadpin105	9811.22 N	10000.0 N	10000.0 N	9850.0 N	Loadpin205
Loadpin106	10201.75 N	12000.0 N	12000.0 N	10200.0 N	Loadpin206
Loadpin107	10818.53 N	10000.0 N	10000.0 N	10800.0 N	Loadpin207
Loadpin108	12721.59 N	12000.0 N	12000.0 N	11547.59 N	Loadpin208
Loadpin109	13883.69 N	13000.0 N	13000.0 N	13800.0 N	Loadpin209
Loadpin110	-172.52 N	0.0 N	0.0 N	-329.3 N	Loadpin210
Loadpin111	8691.96 N	9000.0 N	9000.0 N	8690.0 N	Loadpin211
Loadpin112	5871.04 N	7000.0 N	7000.0 N	5225.82 N	Loadpin212
Loadpin113	8548.19 N	7000.0 N	7000.0 N	8163.31 N	Loadpin213

E



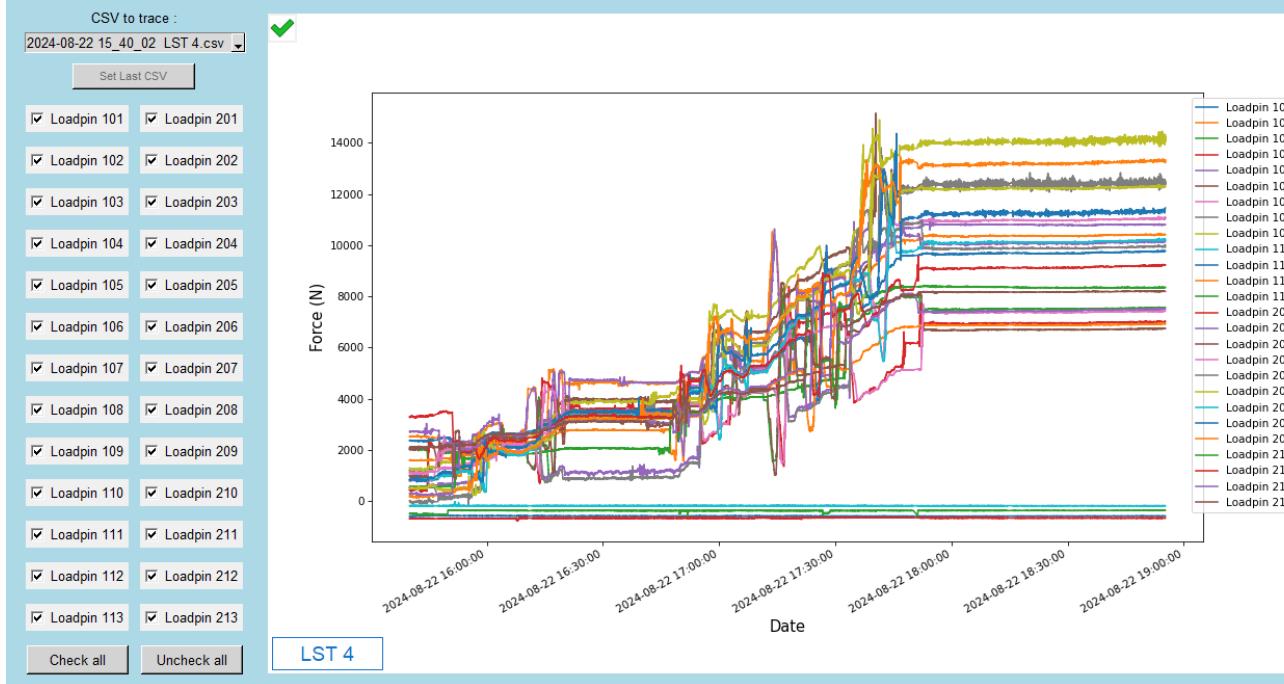
W



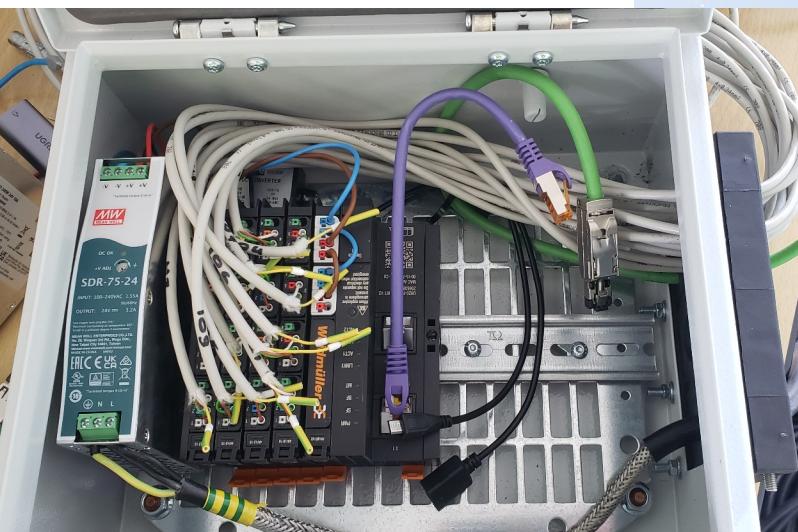
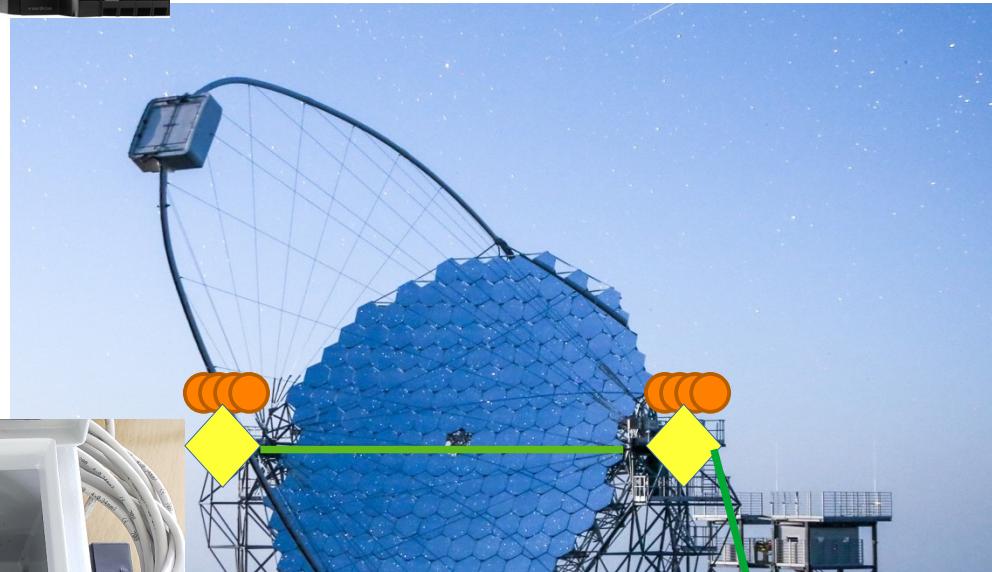


Loadpins Values for Tensionning Telescope Arch

Value | Value Over Time | Target Value Conf | Loadpin Assignment | Loadpin Calibration | OPCUA Configuration



LoadPins ————— Remote IO ————— PLC ————— CTA DRIVE CTRL  
4-20 mA



## LoadPins



## Remote IO

4-20 mA

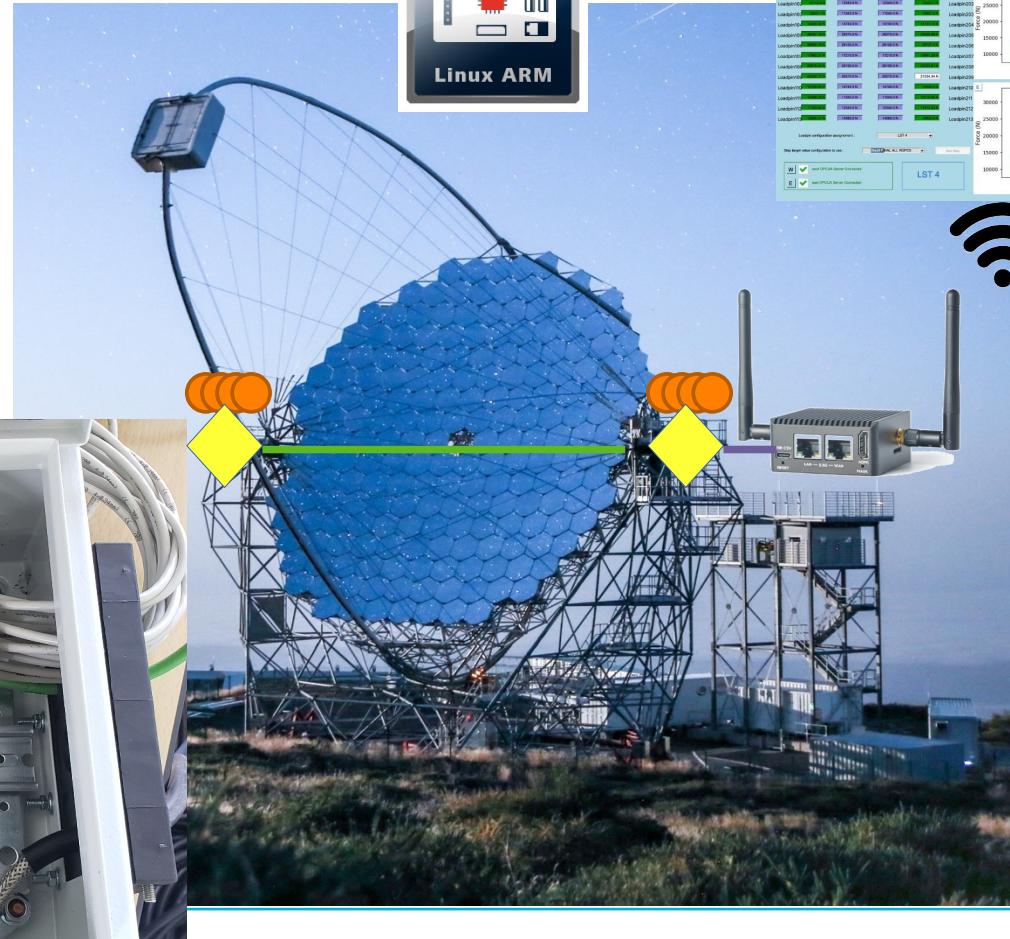


**PROFI**  
**NET**

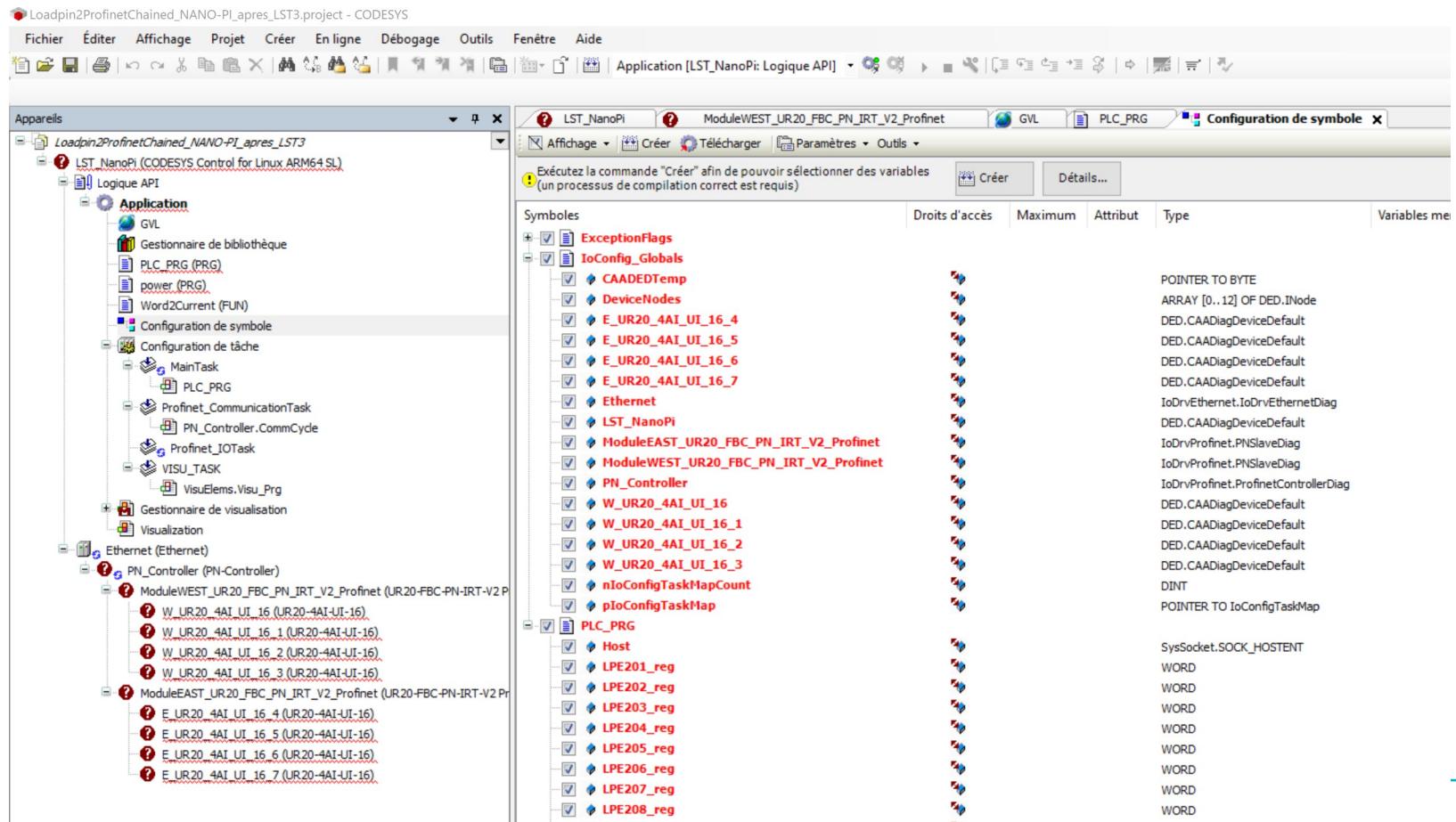
odesys / NanoPI



## — IHM Custom



Environnement de développement Automatisme portable sur différentes plateformes (ici : Linux /ARM)  
Prise en charge des bus de terrain (Profinet)  
Et serveur OPCUA exposant les variables du programme et des objets déclarés dans Codesys



Loadpins Values for Tensionning Telescope Arch

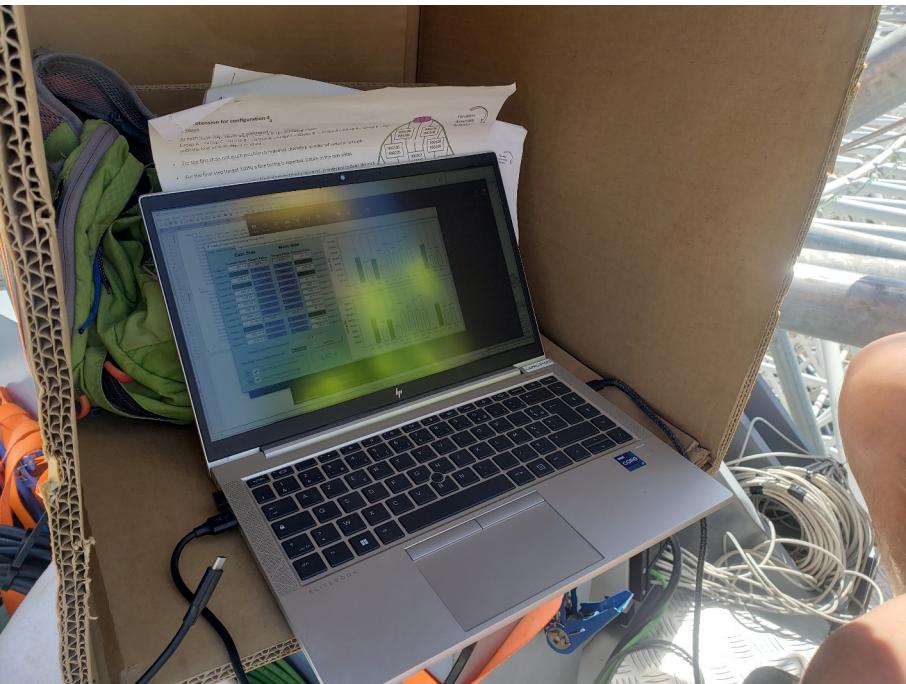
Value Value Over Time Target Value Conf Loadpin Assignment Loadpin Calibration OPCUA Configuration

**East Side**

URL of OPCUA Server :	opc.tcp://192.168.0.3:4840
Loadpin 101 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant1
Loadpin 102 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant2
Loadpin 103 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant3
Loadpin 104 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant4
Loadpin 105 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant5
Loadpin 106 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant6
Loadpin 107 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant7
Loadpin 108 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant8
Loadpin 109 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant9
Loadpin 110 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant10
Loadpin 111 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant11
Loadpin 112 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant12
Loadpin 113 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant13

**West Side**

URL of OPCUA Server :	opc.tcp://192.168.0.2:4840
Loadpin 201 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant1
Loadpin 202 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant2
Loadpin 203 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant3
Loadpin 204 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant4
Loadpin 205 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant5
Loadpin 206 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant6
Loadpin 207 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant7
Loadpin 208 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant8
Loadpin 209 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant9
Loadpin 210 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant10
Loadpin 211 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant11
Loadpin 212 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant12
Loadpin 213 Node ID :	ns=4;s= var CODESYS Control for Raspberry Pi SL.Application.PLC_PRG.courant13





## QUESTIONS ?

