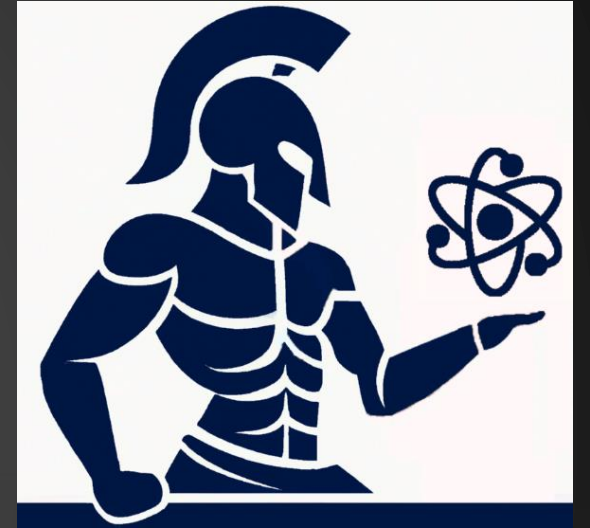


STATUS OF THE CONTROLS SYSTEM FOR 2024 CAMPAIGN

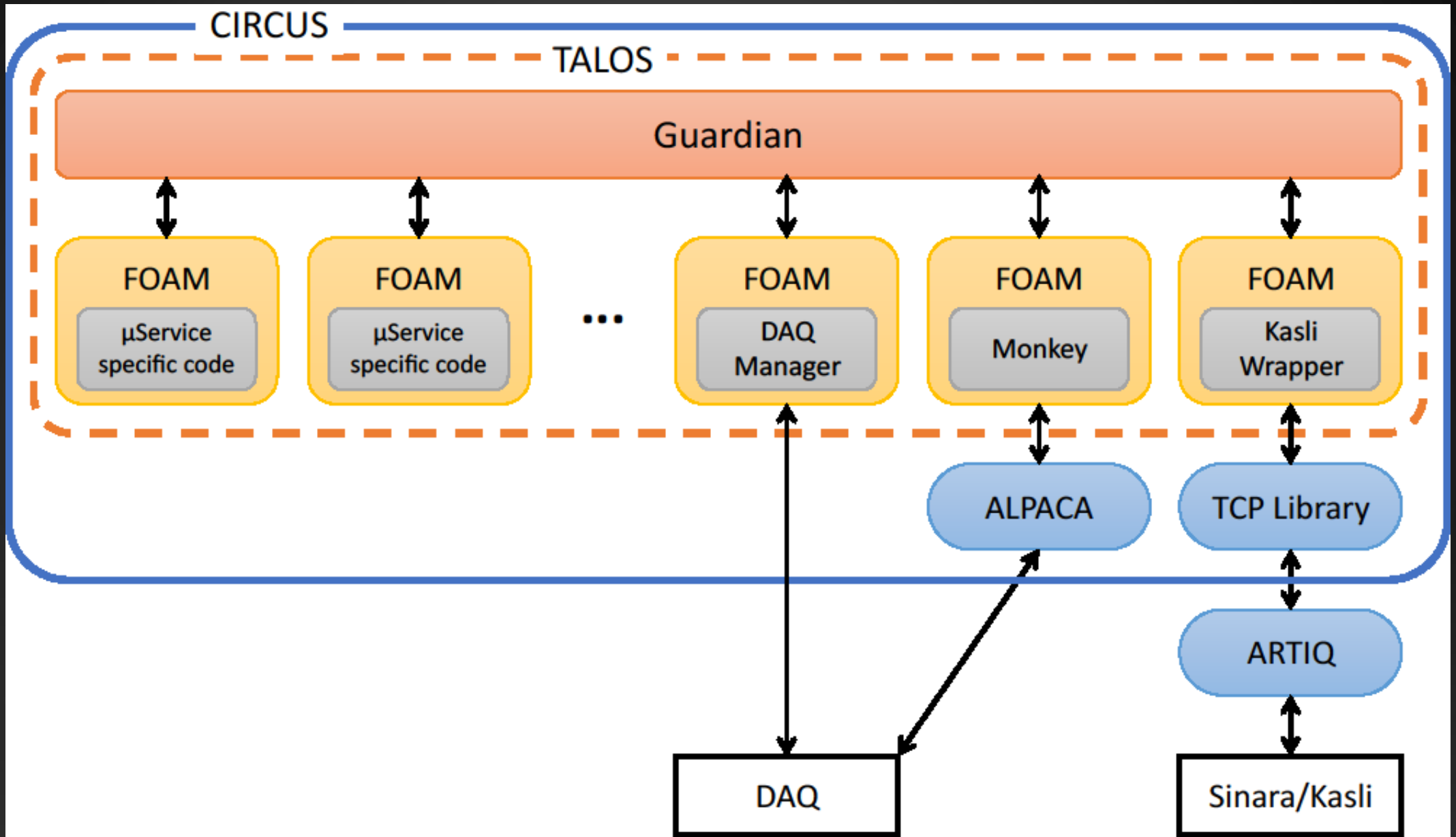
JAKUB Z., MARCO V.



A BOAT WITH TWO CAPTAINS

- TALOS does overall coordination, but it's "slow" (\sim ms)
- Sinara is used to control the fast operations (\sim ns)
- High integration:
 - TALOS controls Sinara, so no humans need to feed it experiments scripts
 - Sinara can ask TALOS to perform operations on hardware
 - In case of any error, TALOS guarantees their handling
- The helm is periodically switched between the two!

3



Size: 4	Guardians List	Size: 20	uServices Online
alex	09:19:52.133 08/10/2023	1TC1 Kasli Wrapper	09:19:52.456 08/10/2023
aegis-ekspla	09:19:52.456 08/10/2023	5TC1 Kasli Wrapper	09:19:52.789 08/10/2023
aegis-enviro3	09:19:53.204 08/10/2023	CAEN HV Manager	09:19:52.964 08/10/2023



Errors
 newtrapctrlhost Oct 08 09:19:40 Code: 7105 "

 "status": true,

 "code": 7105,

 "source": "newtrapctrlhost: ELENA Interface:

)" GUID:BB962533-4991-4FE7-8F14-05D0ED938D38

PRESS CTRL TO ARM

ABORT

RUN

400687 newtrapctrlhost

uService to show

Tamer

The TAMER

STOP

Error Details

Machine name: newtrapctrlhost
 Time: Oct 08 09:19:40
 Code: 7105
 <JSONErrorSingle_1.0>{
 status": true,
 "code": 7105,
 "source": "newtrapctrlhost: ELENA
 Interface: Beam stopper in! Retry"
)" GUID:BB962533-4991-4FE7-8F14-
 05D0ED938D38

Kasli Log

5TC1> Loading electrons ...
 5TC1> Rotating wall starting ...
 5TC1> Moving pistons ...
 5TC1> Sending:OUT to Actuator:Main
 Degradar
 5TC1> Sending:IN to Actuator:Electron Gun
 5TC1> Starting the electron loading
 procedure ...
 5TC1> Shaping the C Trap for electron
 loading ...
 5TC1> Heating up the electron gun ...
 5TC1> Ramping current ...
 5TC1> Setting E-Gun PSU voltage to 0.25 V
 5TC1> Setting E-Gun PSU current to 0.25 A
 5TC1> Setting E-Gun PSU voltage to 0.5 V
 5TC1> Setting E-Gun PSU current to 0.5 A
 5TC1> Setting E-Gun PSU voltage to 0.75 V
 5TC1> Setting E-Gun PSU current to 0.75 A
 5TC1> Setting E-Gun PSU voltage to 1.0 V
 5TC1> Setting E-Gun PSU current to 1.0 A
 5TC1> Current set to final current ...
 5TC1> Setting E-Gun PSU voltage to 1.5 V
 5TC1> Setting E-Gun PSU current to 1.15 A

Open the Debug Window

Action History

2023-10-07_16-34-13.125 Start Run
 2023-10-07_16-35-07.095 Experiment finished! Ending the script...
 2023-10-07_16-37-10.621 Start Run
 2023-10-07_16-38-24.989 Experiment finished! Ending the script...
 2023-10-07_16-40-47.933 Start Run
 2023-10-07_16-42-53.457 Experiment finished! Ending the script...
 2023-10-07_20-09-11.981 Tamer got new schedule(s)
 2023-10-07_20-09-26.592 Run init successful
 2023-10-07_20-09-26.594 Sending the schedule to Monkey
 2023-10-07_20-09-26.635 Received update from Monkey
 2023-10-07_20-09-40.883 Start Run
 2023-10-07_20-13-02.876 Sending Error Criticality (1) to Monkey
 2023-10-07_20-14-28.315 Experiment finished! Ending the script...
 2023-10-07_20-15-43.483 Quality Check to Monkey
 2023-10-07_20-15-43.500 Quality check for 5TC1 passed
 2023-10-07_20-15-43.502 Received Banana from 5TC1 (All Good)
 2023-10-07_20-15-44.514 Propagate Banana
 2023-10-07_20-15-44.515 Sending message B4N4N4 to Monkey
 2023-10-07_20-15-44.534 Received update from Monkey
 2023-10-07_20-15-44.553 Received update from Monkey
 2023-10-07_20-15-58.133 Start Run
 2023-10-07_20-17-23.908 Stop button pressed. Sending STOP!
 2023-10-07_20-17-23.911 Sending message Stop Run to

Legend:

- Pre-run init
- Working
- Finished well
- Stopped by a user
- Stopped by an error

Selector

ALL

Stop Run

Reschedule

Rerun

Reschedule - send Skipped RUNs to the Scheduler. This will overwrite the existing schedule

Rerun - send Skipped RUNs directly to Monkey and start the run.

The Cage

Monkey ID	Status	ETA	Scripts left	skipped
Monkey 1TC1	Ongoing	08/10/2023 09:21	0	0
Continuous	With DAQ?			
Current Action: Sending RUN to Kasli				
Report from previous RUNs				
Monkey 5TC1	Ongoing	08/10/2023 09:21	0	0
Continuous	With DAQ?			
Current Action: Sending RUN to Kasli				
Report from previous RUNs				



CONTROL SYSTEM UPDATES

Quality of life improvements

Size	Guardians List	Size: 17	All?	uServices Online
6	aegis-ekspla	21:47:07.442		21:47:07.713
	aegis-enviro3	21:47:07.409		21:47:07.715
	aegis-trap-ccd4	21:47:06.624		21:47:07.092



Errors

```
aegis-trap-rf2 May 05 19:26:19 Code: 5218 "<JSC
"status": true,
"code": 5218,
"source": "aegis-trap-rf2: DAQ Sender of aegi
)" GUID:8AFBFF42-D187-4E60-87A6-5D218F8A7DA
aegis-trap-rf2 May 05 19:25:32 Code: 5218 "<JSC
"status": true,
"code": 5218,
```

PRESS CTRL TO ARM

ABORT

RUN

414483 newtrapctrlhost

uService to show

Tamer

Open the Debug Window

The TAMER

Action History

```
2024-05-05_21-39-40.957 Received update from Monkey
2024-05-05_21-40-02.964 Received update from Monkey
2024-05-05_21-40-20.975 Received update from Monkey
2024-05-05_21-40-34.988 Received update from Monkey
2024-05-05_21-40-51.016 Received update from Monkey
2024-05-05_21-41-07.018 Received update from Monkey
2024-05-05_21-41-23.034 Received update from Monkey
2024-05-05_21-41-39.039 Received update from Monkey
2024-05-05_21-41-55.074 Received update from Monkey
2024-
2024-
2024-
2024-
2024-
2024-
2024-
2024-
2024-
2024-
2024-05-05_21-45-07.321 Received update from Monkey
2024-05-05_21-45-23.343 Received update from Monkey
2024-05-05_21-45-39.376 Received update from Monkey
2024-05-05_21-45-55.404 Received update from Monkey
2024-05-05_21-46-11.427 Received update from Monkey
2024-05-05_21-46-27.468 Received update from Monkey
2024-05-05_21-46-43.601 Received update from Monkey
2024-05-05_21-46-59.637 Received update from Monkey
```

Graceful flag to ensure execution of the closer function

Monkey ID	Status	ETA	Scripts left	skipped
Monkey	Paused	05/05/2024 23:53	33	0

Actions like 'paused' or 'stopped' are better indicated

Process ALL Gracefully

re-run init

Working

Finished well

Stopped by a user

Stopped by an error

Skip Run

Reschedule

Pause

Rerun

Stop Schedule

KILL

Additional actions for skipping, pausing and killing processes

Error Details

Kasli Log

```
STC1>Pbar hot storage in progress ...
STC1>Hot storage in progress ...
STC1>##### Hot storage over! #####
STC1> Ramping down slowly NegHV channel 1 ...
STC1> Ramping down NegHV channel 2 ...
STC1> Setting HV relays to low voltage ...
STC1> Opening fast HV switch ...
STC1>Starting closure procedure...
STC1> Powering down TMCP
STC1> Ramping down negative HVs ...
STC1> Opening fast HV switch ...
STC1> Opening negative HV relays ...
STC1> Setting HV relays to shutdown ...
STC1> Experiment finished!
STC1> Finalizing the Run ...
STC1> Waiting for all the uServices to properly terminate ...
STC1> Waiting for all the data to reach the DAQ and for DAQ to stop...
STC1> DAQ Stopped!
STC1> TCP connection closed. Bye!
STC1> Send a b4n4n4 to the Monkey!
Return 0
```



Guardians List		uServices Online	
Size: 7		Size: 17	<input type="checkbox"/> All?
aeis-enviro3	13:50:06.228 19/03/2024	1TC1 Kasli Wrapper	13:50:08.321 19/03/2024
aegis-trap-ccd4	13:50:05.232 19/03/2024	STC1 Kasli Wrapper	13:50:08.897 19/03/2024
aegis-trap-rt2	13:50:05.830 19/03/2024	CAEN HV Manager	13:50:09.125 19/03/2024



Errors

PRESS CTRL TO ARM

ABORT

RUN 412378 newtrapctrlhost

uService to show
Tamer

Open the Debug Window

The TAMER

Action History

2024-03-19_13-42-15.724 Tamer got new schedule(s)
 2024-03-19_13-42-15.743 Ready to Launch try #1
 2024-03-19_13-42-20.755 Ready to Launch try #2
 2024-03-19_13-42-25.901 Run init successful
 2024-03-19_13-42-26.404 Sending the schedule to Monkey
 2024-03-19_13-42-26.453 Received update from Monkey
 2024-03-19_13-42-41.482 Start Run
 2024-03-19_13-42-52.899 Experiment finished! Ending the script...

Legend:

- Pre-run init
- Working
- Finished well
- Stopped by a user
- Stopped by an error

Process: ALL Gracefully

Skip Run Reschedule

Pause Rerun

Stop Schedule **KILL**

The Stage

Monkey ID	Status
Monkey 1TC1	Finished (no errors)
Continuous With DAQ?	ETA 19/03/2024 13:42:00
Scripts left	skipped
Current Action	0 0
All the RUNs completed!	
Report from previous RUNs	
2024-03-19_13-49-22.910 0_TestScript.py finished well!	

Monkey ID	Status
Monkey 5TC1	Finished (no errors)
Continuous With DAQ?	ETA 19/03/2024 13:42:00
Scripts left	skipped
Current Action	0 0
All the RUNs completed!	
Report from previous RUNs	
2024-03-19_13-49-22.913 0_TestScript.py finished well!	

TAMER::Debug Window

Global Status Stopped

Processes Monkeys&Kaslis Replies Synced

No response Go No-Go

Guardians replies

- aegis-enviro3
- aegis-trap-ccd4
- aegis-trap-rt2
- newtrapctrlhost

uServices replies

- 1TC1 Kasli Wrapper
- 5TC1 Kasli Listener
- 5TC1 Kasli Wrapper
- 5TC1 Kasli Writer
- CAEN HV Manager
- Captorius 3 Manager
- CryoMotor Manager
- DAQ Manager

Error Details

Kasli Log

```

1TC1>-----
1TC1>NEW RUN!
1TC1>
1TC1>Configuring for 1T operation ...
1TC1>Error encountered
1TC1>Error encountered
5TC1>13:49:10.634155 Hello There
1TC1>13:49:13.458349 General Kenobi
1TC1>Done =)
1TC1>Starting closure procedure...
1TC1> Experiment finished!
1TC1> DAQ was off!
1TC1> TCP connection closed. Bye!
1TC1> Send a b4n4n4 to the Monkey!
Return 0
5TC1>Done =)
5TC1>Starting closure procedure...
5TC1> Experiment finished!
5TC1> DAQ was off!
5TC1> TCP connection closed. Bye!
5TC1> Send a b4n4n4 to the Monkey!
Return 0
  
```



GENERAL TALOS UPDATES

Framework expansion

MIGRATION OF SYSTEM SERVICES



System uServices:

- ✓ Scheduler
- ✓ Tamer
- ✓ Monkey
- ✓ Kasli Wrapper



But why?

They are essential for the main features of TALOS like:

- Scheduling
- Autonomous execution
- Kasli – LabView integration

**DEDICATED
LV PROJECT**

ADDED ABSTRACTION LEVELS TO TALOS

Defined in TALOS

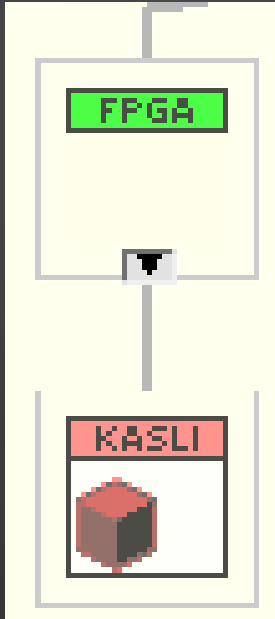
 **FPGA Interface.lvclass**

Implemented in TALOS for the
Kasli Wrapper

 **Kasli.lvclass**

Used by the Kasli Wrapper

Allows for definition of
new FPGA types as long
as they support TCP
communication



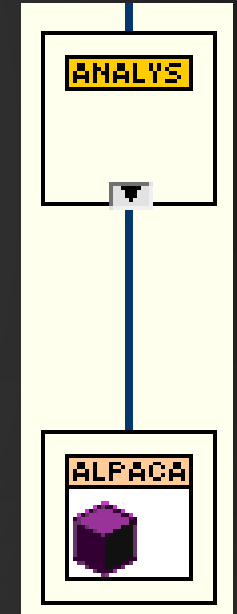
Defined in TALOS

 **Analysis Framework.lvclass**

Used by Monkey

But implemented in the AEGIS
dedicated project as the
ALPACA class

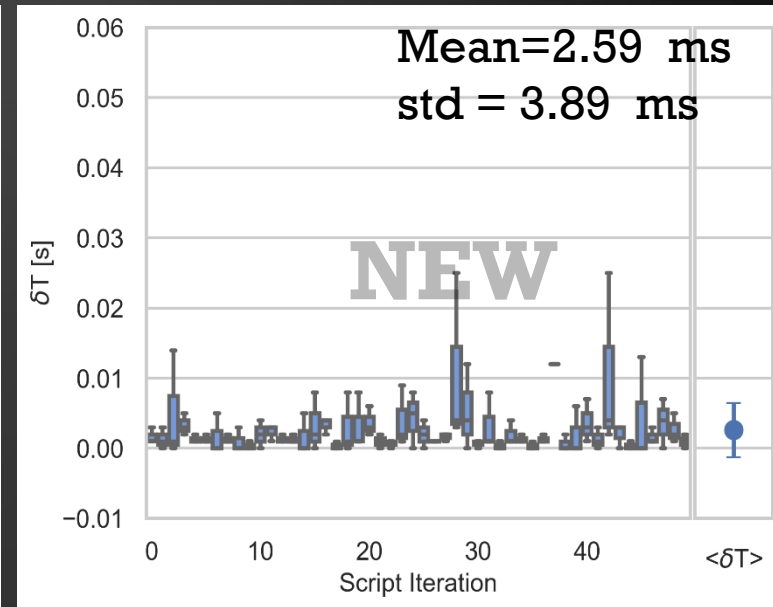
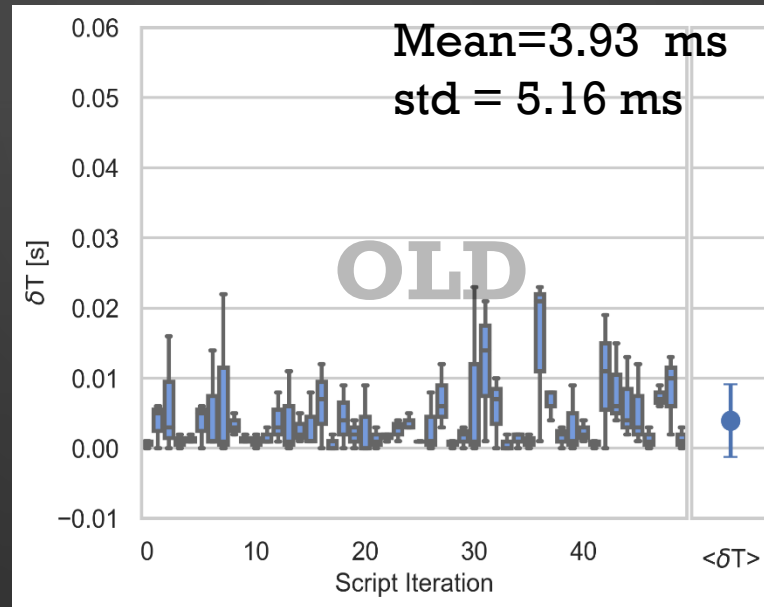
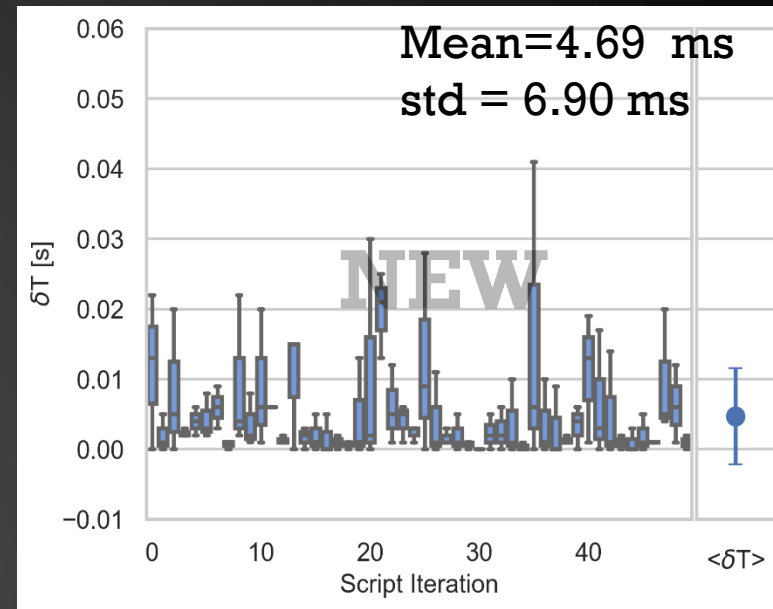
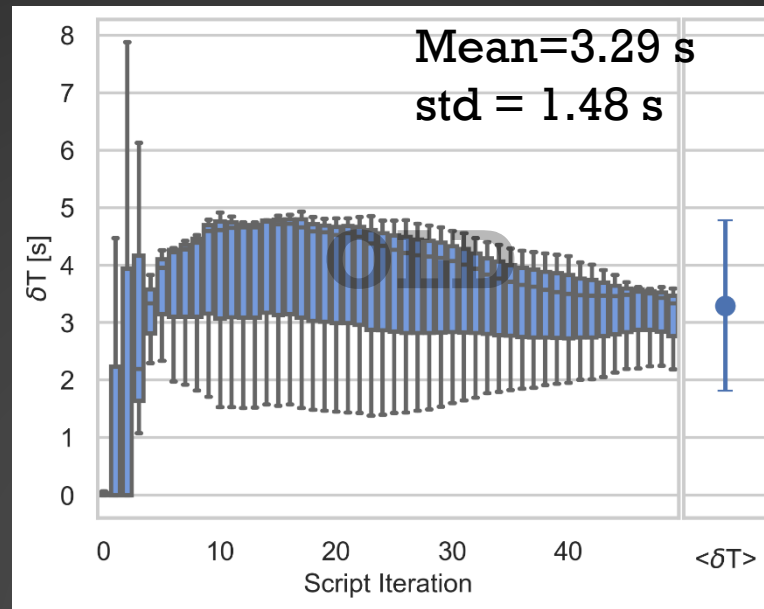
Allows TALOS to work with
any analysis framework (the
dedicated functions need to
be implemented for each
framework)



11

IMPROVED SYNCHRONISATION BETWEEN SCHEDULED SCRIPTS IN TALOS

δT is the time between the starts of the scripts of two consecutive Kaslis in a sorted array for the given script number



SOME KNOWN PROBLEMS

- ELENA Interface had a problem setting beam parameters (thanks Ruggero for finding/patching the bug)
- Communication between Monkey and ALPACA exhibits some unwanted behaviours (thanks Tassilo for looking into it)
- If you see a bug or misbehaviour or have an idea of how the system can be improved, please let us know. We appreciate all the feedback we can get

FUTURE DEVELOPMENT

**TALOS: a framework for autonomous control systems for complex experiments**

M. Volponi,^{1,2,3, a)} J. Zielinski,⁴ T. Rauschendorfer,^{1,5} S. Huck,^{1,6} R. Caravita,^{3,2} M. Auzins,^{7,1} B. Bergmann,⁸ P. Burian,⁸ R. S. Brusa,^{3,2} A. Camper,⁹ F. Castelli,^{10,11} G. Cerchiari,^{12,13} R. Ciurylo,¹⁴ G. Consolati,^{10,15} M. Doser,¹ K. Eliaszuk,⁴ A. Giszczak,⁴ L. T. Glöggler,¹ E. Graczykowski,⁴ M. Grosbart,¹ F. Guatieri,^{3,2} N. Gusakova,^{1,16} F. Gustafsson,¹ S. Haider,¹ M. A. Janik,⁴ T. Januszek,⁴ G. Kasprovicz,¹⁷ G. Khatiri,¹ Ł. Kłosowski,¹⁴ G. Kornakov,⁴ V. Krumins,^{1,7} L. Lappo,⁴ A. Linek,¹⁴ J. Malamant,^{1,9} S. Mariazzi,^{2,3} L. Nowak,¹ D. Nowicka,⁴ E. Oswald,¹ L. Penasa,^{3,2} V. Petracek,¹⁸ M. Piwiński,¹⁴ S. Pospisil,⁸ L. Povoło,^{2,3} F. Prelz,¹⁰ S. A. Rangwala,¹⁹ B. S. Rawat,^{20,21} B. Rienäcker,²⁰ V. Rodin,²⁰ O. M. Røhne,⁹ H. Sandaker,⁹ P. Smolyanskiy,⁸ T. Sowiński,²² D. Tefelski,⁴ C. P. Welsch,^{20,21} T. Wolz,¹ M. Zawada,¹⁴ and N. Zurlo^{23,24}

CIRCUS: an autonomous control system for antimatter, atomic and quantum physics experiments

Strip code and release it on GitHub (v0.1)

Clean-up the code and add abstractions

Release full final version (v1.0)

LICENCE???

WHAT UPGRADES CAN BE EXPECTED??

- Better optimiser integration
 - Using previously acquired data as the starting point of the new optimisation
- Improved response times for Monkey/Tamer (and Telegram Bot)
 - Higher synchronicity between Kaslis on the software side
- Moving away from SV Update notifications
 - No one is using them anyway – slowing transition to newer LV versions
- Eliminating last SV from TALOS engine
 - Less need of rebooting Windows if TALOS is restarted
 - ABORT needs another solution
- Updating to LV 2024 (probably at the end of the Run)
 - Better Python integration, further upgrades are easier (unique driver folder)
- Automatic skin updater
 - Based on the date, no restarts required

CONCLUSIONS

- System is more user-friendly and allows for better control of the running schedule
- The TALOS framework has been expanded to allow for higher experiment and hardware independence
- Running Parallel Schedules needs a proper stress test (still)
- The system is in the final stage of preparation for release to the public
 - Decide on the LICENSE and double-check TALOS code

THE MOST IMPORTANT METRIC

	Vis		Pixels of wires		Meters of wires*	
	2023**	2024	2023**	2024	2023**	2024
TALOS	471	939	2.7 M	5.5 M	902	1518
AEgIS LV Code	1156	801	7.7 M	5.3 M	2579	1478
Total	1627	1740	11.4 M	10.8 M	3481	2996

* Calculated using a 24" screen with Full HD resolution (1920 x 1080). Thanks Piotr Demski!

** State for 11.12.2023



THANK YOU

BACKUP SLIDES

OPEN-SOURCE LICENCES

Don't use Creative Commons but OSI-approved ~ Open Source Program Office

Permissive licences

Apache
v2

BSD

MIT

- Nobody is forced to release the source codes (theirs and ours)
- Only need to follow basic conditions (including copyright notice, etc.)

Weakly-reciprocal licences

LGPL3

LGPL2.1

MPL2

- The code of our software used needs to be released (even if not modified)
- No need to disclose their code

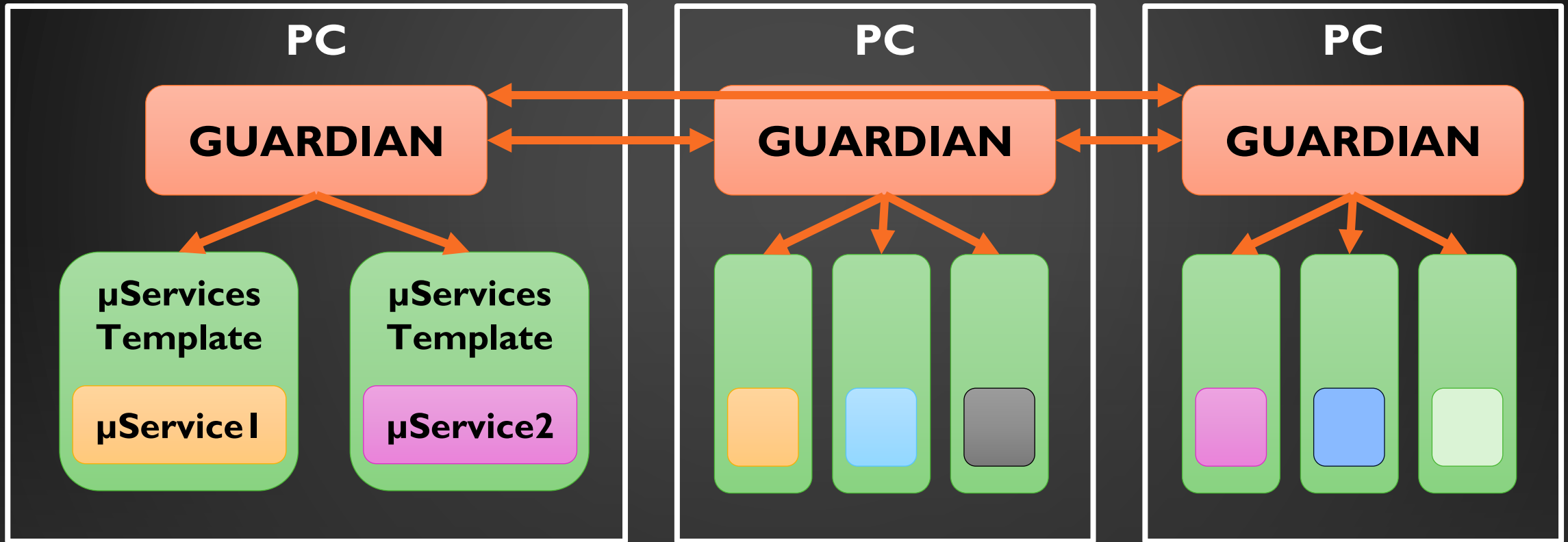
Strongly-reciprocal licences

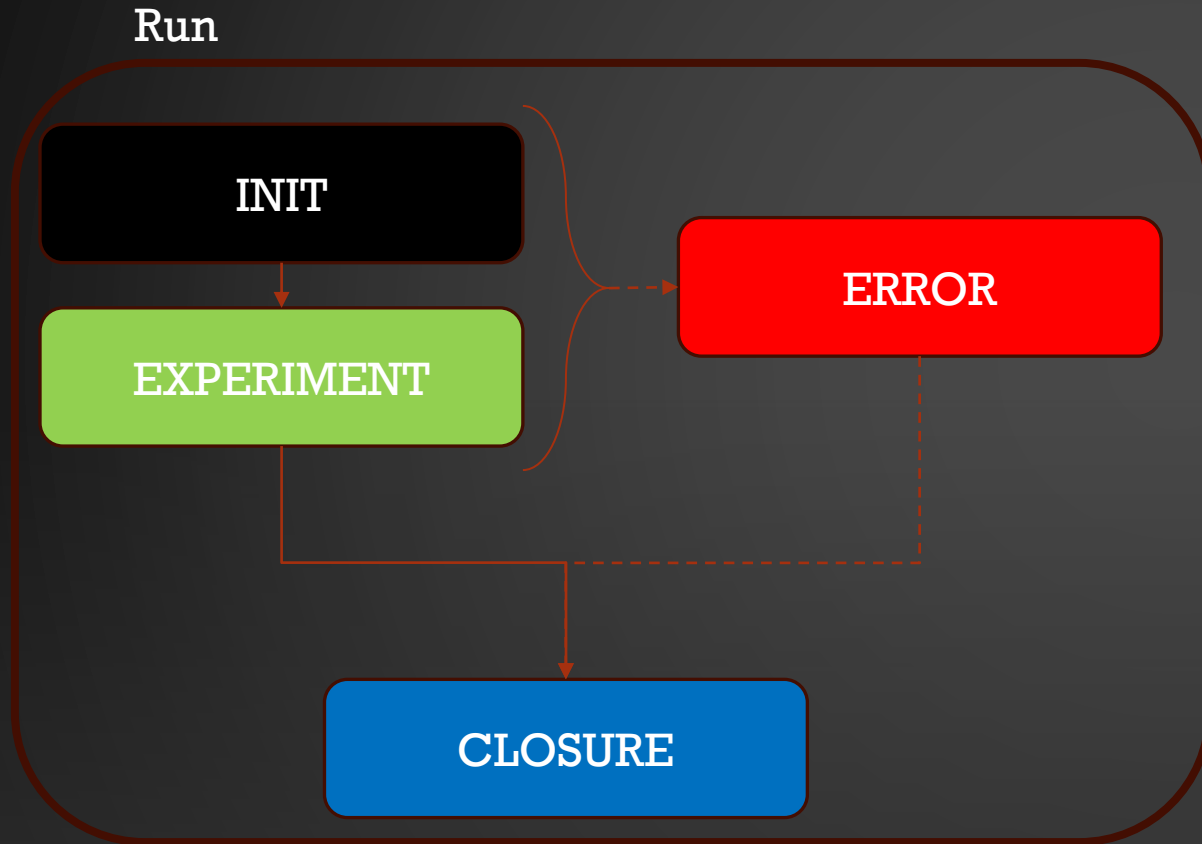
GPL3

GPL2

- All the source code needs to be released

TALOS: STRUCTURE





```
def run(self):
    try:
        # Start procedure
        self.Simplified_Init()
        self.Print("Waiting a bit before starting the run...")
        self.StartRun()
        # uService resetting where needed
        self.Simplified_Reset()
        # Experiment routine
        self.experiment()
    # Exception handling and script closure
    except Banana as error:
        self.ExceptBanana(error)
    except RTIOoverflow as error:
        self.ExceptKernelBanana(error)
    except Exception as error:
        self.ExceptException(error)
    finally:
        # Post-measurement cleanup
        print("Starting closure procedure...")
        self.closure()
        # Closing
        self.StopRun(self.RetCode)
    return
```

MACHINES TOPOLOGY

NewTrapCtrlHost	AEgIS-Trap-RT2	AEgIS-Trap-CCD4	AEgIS-EKSPLA	AEgIS-Alex	Enviro-3
Error Manager	TimingClock	ITCMOS	Avantes Spm	Alex SHG1	Environment Mngr
DAQ Manager	HV	5TCCD	TC200 UV	Alex SHG2	
ELENA Interface	5152	Captorius (2x)	TC200 IR	Alex THG1	
Kasli Wrapper (2x)	6133	Kasli UART Logger (3x)	SFG205	Alex THG2	
Telegram Bot	Rotating Wall	Degrader Ladder	HWP532	Alex VBG Rotator	
Monkey	Pulser Manager	Electron Gun	HWPI064	Alex Prism Mngr	
Scheduler			Energy Meter 2	Energy Meter 1	
Positron Reader				Moglabs MWM	
Kasli Writer (2x)					
Kasli Listener (2x)					
PMT					
CAEN HV					

Status for May
2023