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# A custom toolchain for WEST legacy LynxOS subsystems

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13TH TECHNICAL MEETING ON PLASMA CONTROL SYSTEMS, DATA  
MANAGEMENT AND REMOTE EXPERIMENTS IN FUSION RESEARCH  
5TH TO 8TH JULY 2021, CULHAM, UNITED KINGDOM

Since 2013 => **re-factoring of CODAC source code**

Goals :

- Modernize legacy implementations (C / Makefiles),
- Create a framework by main features:
  - Data Acquisition,
  - Timing Network,
  - Finite State Machine,
  - Shared Memory Network, etc.
- Cross-platform portability thanks to [CMake](#).



**Tokamak WEST**

Still in operation in 2021:

- Legacy West CODAC sub-systems,
- Based on Motorola PowerPC VME Boards,
- Running [LynxOS](#) RT OS,
- Including major functions for **Tokamak plasma control:**  
e.g. DGENE, **Poloidal Field System Monitoring and Protection.**

## VME / LynxOS :

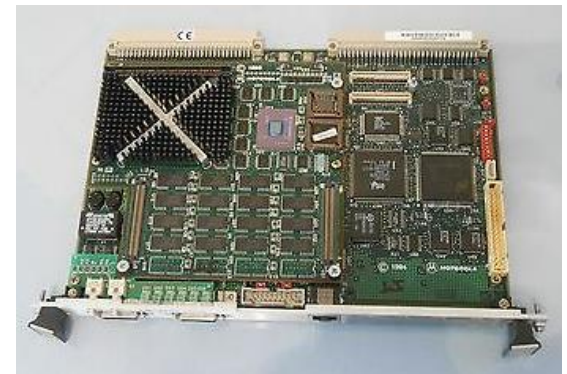
- Hardware and software Maintenance,
- Major challenge : loss of knowledge and know-how
- Deployments on targets → **30 years old native compiler !**

## Compiler Chain :

- Hardware and Software cannot be upgraded,
- Mostly frozen,
- Risk of hardware failures,
- Security issues (no SSH → telnet)

## No DevOps :

- No code versioning,
- No continuous integration,
- No code quality checks,
- No deployment workflow.

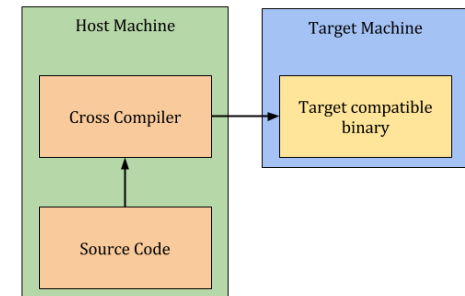


**VME CPU board**

→ **Goal : upgrade to same level of code quality and maintainability as modern CODAC**

## Software migration :

- Old implementations are monolithic (Strada),
- Client and backend components are mixed,
- Whole compilation puzzled with hand-made Makefiles,
- Depends on native compiler hardware,
- Not maintained.

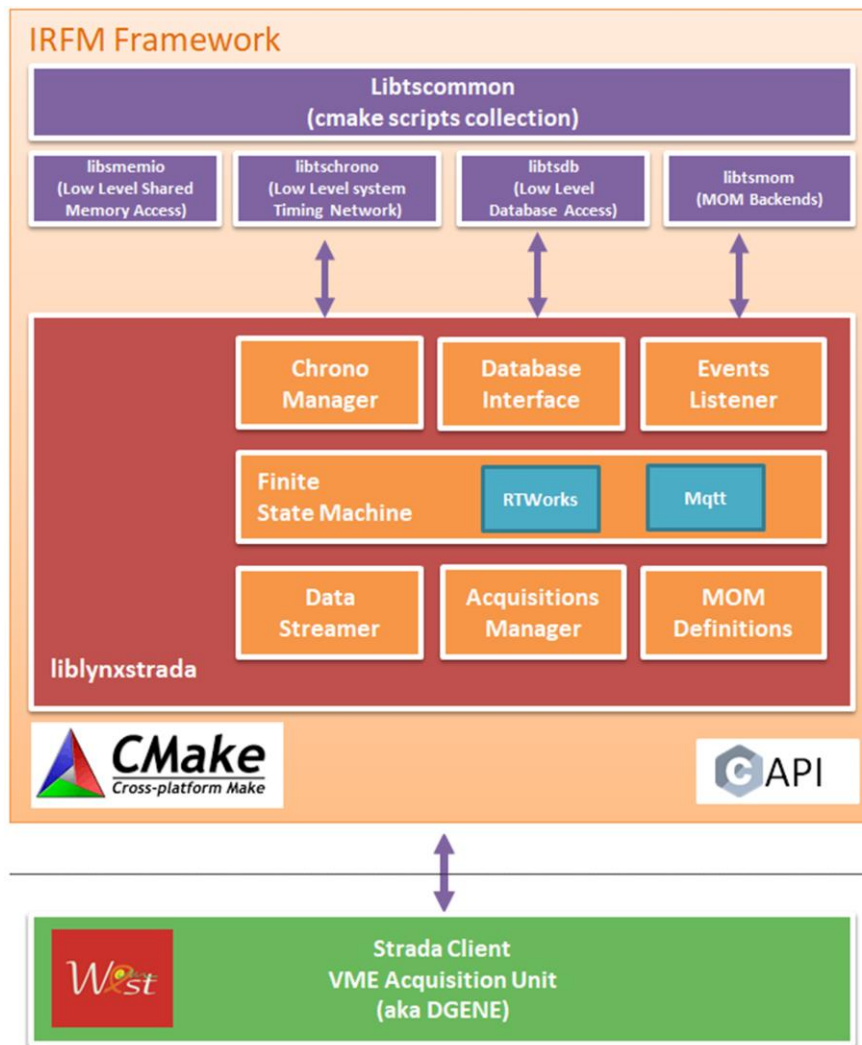


## Cross Compiler Ops

- Create a new framework component named **Liblynxstrada**:  
Based on CMake,  
Reorganizes legacy C implementations,  
Fully integrated in existing IRFM Framework architecture.
- Inherits existing features:  
Compatible with exiting low level framework components,  
Included within the continuous integration workflow,  
Compatible with modern toolchains,  
Allows using [Mqtt](#) as new Message Oriented Middleware.

➔ **Ready for cross-compilation.**

## IRFM WEST Framework Architecture For VME



## Migrating to cross-compiler:

### Native compiler:

- VCOMP3,
- One VME crate + one CPU PowerPC 2700,
- 333Mhz / 256Mb RAM / 1Gb HDD,
- Running LynxOS 3.1 with GCC 2.95.3 toolchain

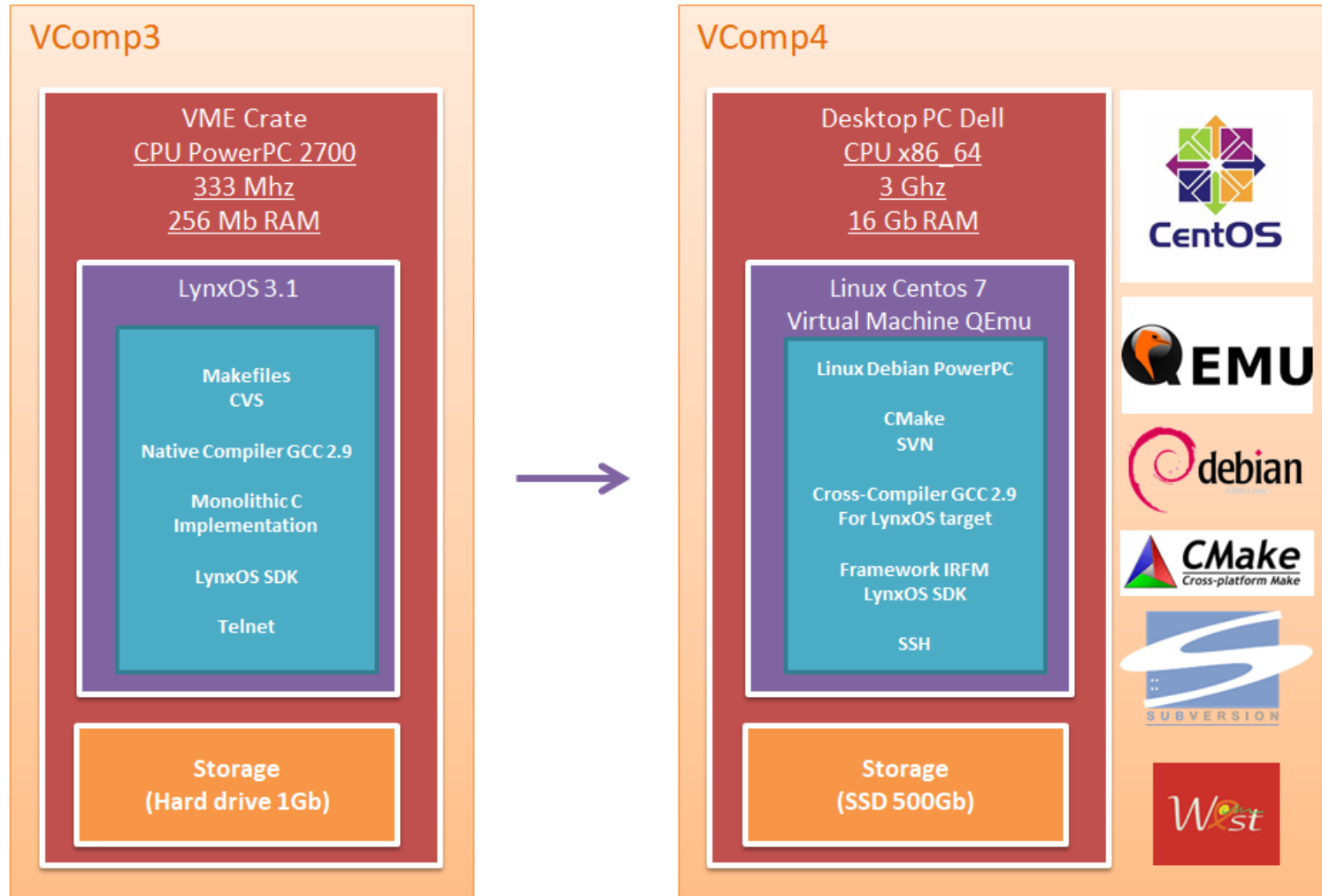


### Emulated cross-compiler:

- VCOMP4,
- Linux x86\_64 Centos standard PC,
- 3Ghz / 16 Gb RAM / 500 Gb SSD,
- Running [QEmu](#) PowerPC with Debian Wheezy,
- Customized GCC 2.95.3 + LynxOS API
- Support for Floating point operations
- Cross compile for LynxOS 3.1 targets,
- Including CMake, Subversion, SSH,
- Fully secure with backup rules,
- Fully integrated with DevOps infrastructure.



**→ Speed-up compilations (x10)**



## Comparison between VCOMP3 (native) and VCOMP4 (cross-compiler)

## Continuous Integration at IRFM / WEST :

- Processed every night on Jarvis-acq,
- Compile all IRFM CODAC codes,
- Scan codes with open-source tools:
  - [cppcheck](#) (C/C++ static analyzer),
  - [krazy](#) (code quality checker),
  - [clang-scan](#) (static analyzer while compiling).
- Run more than 500 scenarios,
- Report all detailed results on Intranet page,
- **Since 2020 : All VME checks run on VCOMP4.**

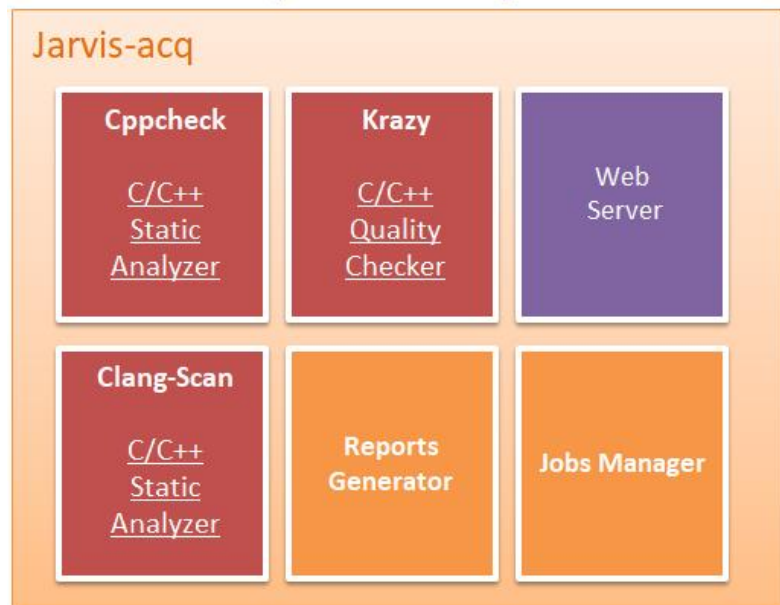
## Goals:

- Detect broken code,
- Detect broken combinations,
- Detect dubious changes from collaborators,
- Follow check histories and progress,
- Reliable deployment of code to targets.

**➔ Improve code quality over time.**



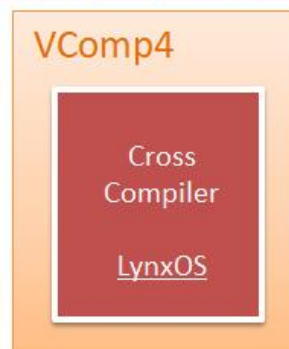




**IRFM Framework Continuous Integration Static Code Analyzers Dashboard**

Page Updated at: Wed 9 Sep 02:04:26 CEST 2020  
 Last Scan Duration: 3 hours 3 minutes 25 seconds  
 Global Configuration: [see this file](#)  
 Legend: **Green**: no warning ; **Orange**: warnings ; **Red**: error ; **Gray**: disabled ; **Bold**: compilation processed.

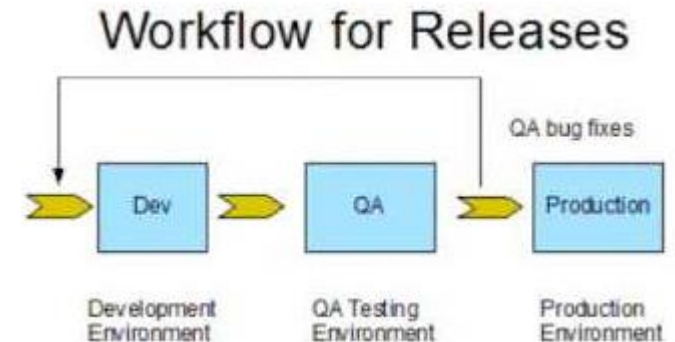
LynxOS Targets											
ID	COMPONENT NAME	SYSTEM	ANALYZER	REVISION	BRANCH	RESULT	DATE	DURATION	TRACE	HISTORIES	INSIGHT
400	libtscommon	LynxOS	Clang	496	trunk	PASSED	2020-09-09 01:53:19	0 h 0 m 3 s	log	directory	graph
401	libtsdb	LynxOS	Clang	332	trunk	PASSED	2020-09-09 01:53:25	0 h 0 m 2 s	log	directory	graph
402	liblynxchrono.10a	LynxOS	CppCheck	43	trunk	389	2020-09-09 01:53:31	0 h 0 m 4 s	log	directory	graph
403	liblynxchrono.10a	LynxOS	Krazy	43	trunk	33	2020-09-09 01:54:17	0 h 0 m 44 s	log	directory	graph
404	liblynxchrono.10a	LynxOS	Clang	43	trunk	PASSED	2020-09-09 01:54:20	0 h 0 m 0 s	log	directory	graph
405	liblynxchrono.12a	LynxOS	Clang	43	trunk	PASSED	2020-09-09 01:54:23	0 h 0 m 1 s	log	directory	graph
406	liblynxchrono.12b	LynxOS	Clang	43	trunk	PASSED	2020-09-09 01:54:26	0 h 0 m 1 s	log	directory	graph
407	liblynxchrono.mag	LynxOS	Clang	43	trunk	PASSED	2020-09-09 01:54:29	0 h 0 m 1 s	log	directory	graph
408	liblynxchrono.new	LynxOS	Clang	43	trunk	PASSED	2020-09-09 01:54:32	0 h 0 m 1 s	log	directory	graph
409	liblynxchrono.fce	LynxOS	Clang	43	trunk	PASSED	2020-09-09 01:54:35	0 h 0 m 1 s	log	directory	graph
420	libtsmom	LynxOS	Clang	731	trunk	PASSED	2020-09-09 01:54:40	0 h 0 m 3 s	log	directory	graph
430	liblynxstrada.10a	LynxOS	CppCheck	95	trunk	501	2020-09-09 01:54:59	0 h 0 m 15 s	log	directory	graph
431	liblynxstrada.10a	LynxOS	Krazy	95	trunk	67	2020-09-09 01:55:45	0 h 0 m 43 s	log	directory	graph
432	liblynxstrada.10a	LynxOS	Clang	95	trunk	PASSED	2020-09-09 01:55:50	0 h 0 m 2 s	log	directory	graph
433	liblynxstrada.12a	LynxOS	Clang	95	trunk	PASSED	2020-09-09 01:55:54	0 h 0 m 2 s	log	directory	graph
434	liblynxstrada.12b	LynxOS	Clang	95	trunk	PASSED	2020-09-09 01:55:58	0 h 0 m 1 s	log	directory	graph
435	liblynxstrada.mag	LynxOS	Clang	95	trunk	PASSED	2020-09-09 01:56:03	0 h 0 m 2 s	log	directory	graph
436	liblynxstrada.new	LynxOS	Clang	95	trunk	PASSED	2020-09-09 01:56:07	0 h 0 m 1 s	log	directory	graph
437	liblynxstrada.fce	LynxOS	Clang	95	trunk	PASSED	2020-09-09 01:56:12	0 h 0 m 2 s	log	directory	graph
450	strada_client.dvspix	LynxOS	CppCheck	61	trunk	65	2020-09-09 01:56:16	0 h 0 m 2 s	log	directory	graph
451	strada_client.dvspix	LynxOS	Krazy	61	trunk	26	2020-09-09 01:56:40	0 h 0 m 21 s	log	directory	graph
452	strada_client.dvspix	LynxOS	Clang	61	trunk	PASSED	2020-09-09 01:56:43	0 h 0 m 1 s	log	directory	graph
453	strada_client.dvece	LynxOS	CppCheck	33	trunk	67	2020-09-09 01:56:48	0 h 0 m 2 s	log	directory	graph
454	strada_client.dvece	LynxOS	Krazy	33	trunk	43	2020-09-09 01:57:24	0 h 0 m 34 s	log	directory	graph
455	strada_client.dvece	LynxOS	Clang	33	trunk	PASSED	2020-09-09 01:57:28	0 h 0 m 1 s	log	directory	graph
456	strada_client.dvix	LynxOS	CppCheck	26	trunk	10	2020-09-09 01:57:31	0 h 0 m 1 s	log	directory	graph
457	strada_client.dvix	LynxOS	Krazy	26	trunk	4	2020-09-09 01:57:39	0 h 0 m 5 s	log	directory	graph
458	strada_client.dvix	LynxOS	Clang	26	trunk	PASSED	2020-09-09 01:57:42	0 h 0 m 1 s	log	directory	graph

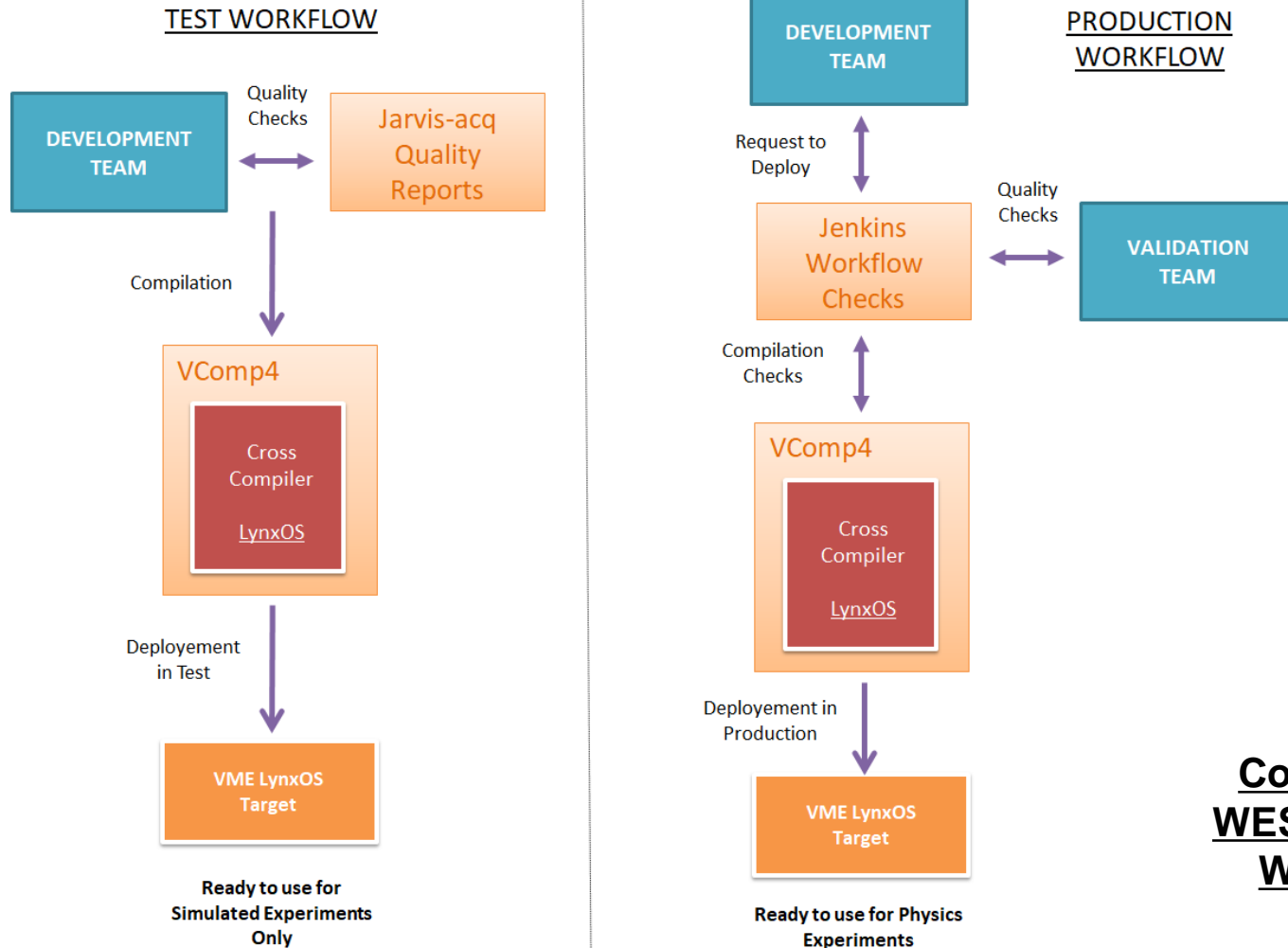


**Cross  
Compiler  
In WEST  
Continuous  
Integration**

## WEST CODAC Release Workflow:

- Deployment on targets,
  - For tests:
    - Pre-release stage,
    - Development teams,
    - Check implementations,
    - Follow quality reports.
  - For production:
    - Final stage,
    - Quality team,
    - Validate codes,
    - Ready to use while experiments.
- **VCOMP4 fully compliant with the process,**
  - **To compile all source codes for VME targets,**
  - **To deploy binaries on VME targets.**





## Cross Compiler in WEST CODAC Workflow

## Conclusion:

- VCOMP4 : Powerful cross-compiler,
- Used successfully with VME devices during C4 and C5 WEST experimental campaigns,
- Passed all tests with complex and critical DGENE unit,
- All legacy VME sub-systems still active on WEST migrated to new framework,
- Managed within the cross-compiler and continuous integration workflows.

<i>Functions</i>	<i>VME data acquisition units</i>
Toroidal Magnet Monitoring and Protection	DTORO
Poloidal Field System Monitoring and Protection	DGENE
Electron Cyclotron Emission Measurements	DVECE
Soft XRAY Measurements	DTOMOX
Visible Spectroscopy Measurements	DVIS
VUV Spectroscopy Measurements	DSIR
Doppler Reflectometry Measurements	DIFDOP
Toroidal Magnet Stain Gauge Monitoring	CTORO
Hard XRAY Measurements	DVSPX
Fixed Langmir Probes Measurements	DTURB
FEMME Laser Injector Control	DDUO

# Thank You for Your attention

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