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HEP software validation on ARM: status and next steps



F. Noferini, L. Anderlini, T. Boccali, C. Bozzi, L. Carminati,
L. Rinaldi, D. Spiga, M. Veltri

ICSC Italian Research Center on High-Performance Computing,
Big Data and Quantum Computing

Missione 4 • Istruzione e Ricerca

KPI and milestones

KPIs

KPI ID	Description	Acceptance threshold
KPI2.2.5.1	Software validation on ARM in the full GRID chain	50% (2/4 LHC experiments)
KPI2.2.5.2	Presentation at conferences	≥ 2
KPI2.2.5.3	Technical notes (in experiments and ICSC)	≥ 2

- Second Period (ICSC month 23-36 - aligned with MS10): test and validate the selected workflows (most probably from data reconstruction and simulation); validate the submission infrastructure and perform O(1 week) exclusive tests as needed by the validation strategy. Report the results to the experiments and in the ICSC documentation; disseminate the results at topical conferences.

ATLAS, CMS → OK
ALICE ongoing

OK

To be checked. MS11?

Internal deadline for finalizing MS10 report
→ 8/09/2025
For submission to referees 23/09/2025

Recent proceedings

SIF symposium 2024: proceedings in *Il Nuovo Cimento*

Comunicazione

Simposio sul Supercalcolo

Uso di nodi ARM nella fisica delle alte energie.

Noferini F., Spiga D., Boccali T., Anderlini L., Bozzi C., Rinaldi L., Carminati L., Veltri M.

Validation of HEP software on ARM-based architectures

L. ANDERLINI⁽¹⁾, T. BOCCALI⁽²⁾, C. BOZZI⁽³⁾, L. CARMINATI⁽⁴⁾⁽⁵⁾, F. NOFERINI⁽⁶⁾,
L. RINALDI⁽⁷⁾⁽⁶⁾, D. SPIGA⁽⁸⁾ and M. VELTRI⁽⁹⁾⁽¹⁾

⁽¹⁾ INFN, Sezione di Firenze - Firenze, Italy

⁽²⁾ INFN, Sezione di Pisa - Pisa, Italy

⁽³⁾ INFN, Sezione di Ferrara - Ferrara, Italy

⁽⁴⁾ Università degli studi di Milano - Milano, Italy

⁽⁵⁾ INFN, Sezione di Milano - Milano, Italy

⁽⁶⁾ INFN, Sezione di Bologna - Bologna, Italy

⁽⁷⁾ Università degli studi di Bologna - Bologna, Italy

⁽⁸⁾ INFN, Sezione di Perugia - Perugia, Italy

⁽⁹⁾ Università degli studi di Urbino - Urbino, Italy

Review done → accepted

And INFN-CCR 2024 workshop (Palau), L. Rinaldi et al., ["Utilizzo di risorse con architetture ARM negli esperimenti di LHC"](#)

CHEP24: proceedings on *EPJ Web of Conferences (EPJ WoC)*

Heterogeneous computing at INFN-T1

Andrea Chierici^{1,*}, Diego Michelotto^{1,**}, Giusy Sergi^{1,***}, Alessandro Pascolini^{1,****}, and Daniele Lattanzio^{1,†}

¹INFN-CNAF

general production. In this article we will describe all the activities that were necessary to enable users to run on ARM and RISC-V and will give some figures on performance, compared to x86_64 counterpart. In the end we will try

 Paper

Accepted on 7 May 2025 by Bruno Heinrich Hoeft

Review done → [accepted](#)

Previous update

The plan in view of MS8 (end of phase I)

- First period (tentatively month 13-22 - aligned with MS8): procure and configure ARM machines in order to provide access to the experiment software and storage via a production infrastructure; select and document workflows to be benchmarked from the most representatives; **prepare a validation strategy agreed with the experiments.**



A specific document was provided with MS8 report

ARM validation strategy (TAR2.15)

The goal of the "Validation of event reconstruction code on ARM" flagship use case is to provide the hardware and the software infrastructure to enable a validation of the software used by experiments to process data and Monte Carlo (MC), at least for two major LHC experiments, using resources from the ICSC datalake and in particular hosted at the INFN CNAF Tier-1 facility.



Describing 3 use cases
for phase II:

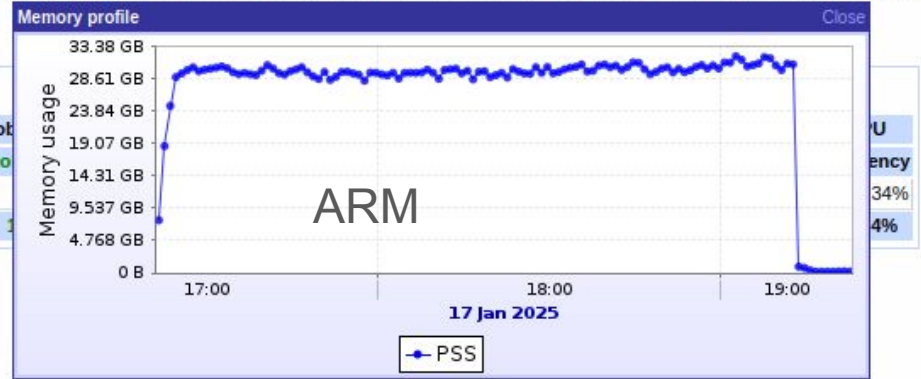
- ALICE
- CMS
- ATLAS

Mem profile

DONE (1 jobs, 100%)

3251716915 : trace | output dir, 186.7 MB PSS, No Swap PSS (1:55 running, 6m 21s saving, 51.34% CPU @ ALICE::CERN::Phoenix, max RSS: 31.48 GB, Virt: 31.48 GB)

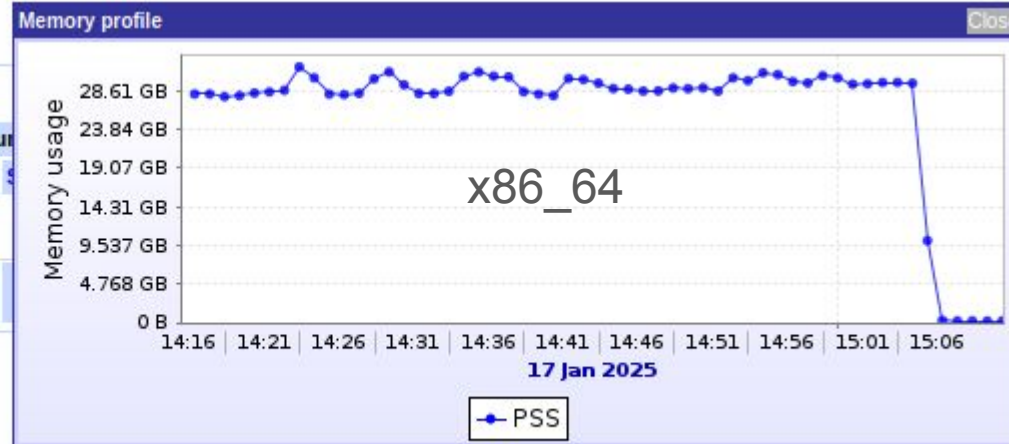
Site	Number of jobs		
	Running	Saving	Done
ALICE::CERN::Phoenix	1	0	0
1 jobs on 1 sites			



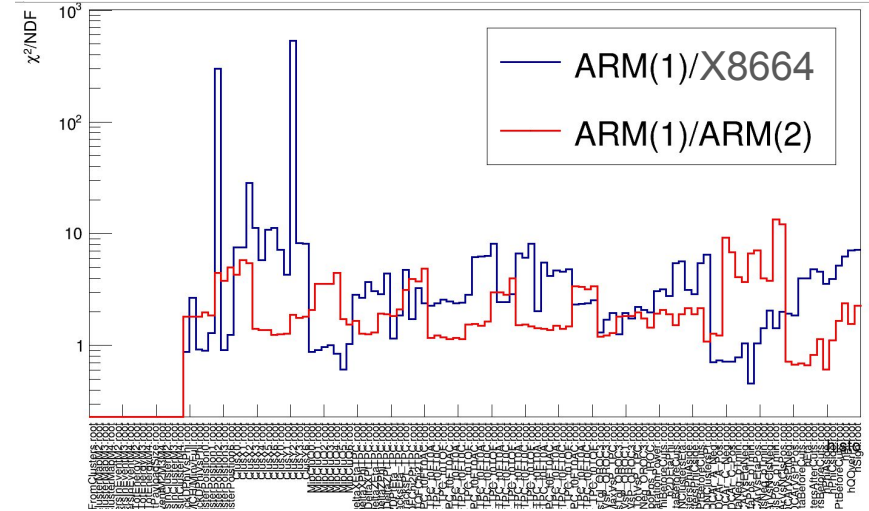
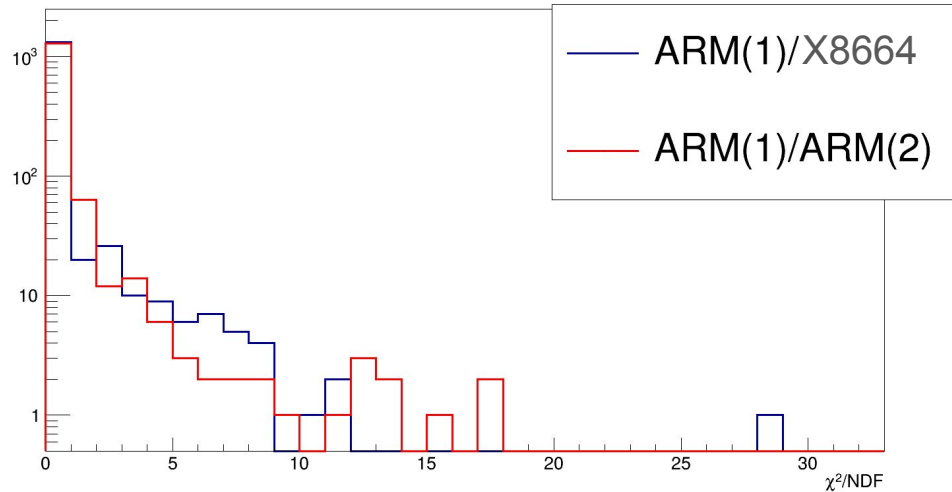
Message: similar performance in both archs

31.85 GB)

Site	Running	Saving	Done
ALICE::CERN::CERN-MIRAGE	1	0	0
1 jobs on 1 sites			



1409 objects checked



Some differences expected since tracking is not fully deterministic.
Only one external detector (non-critical) showed significant difference to be understood

Status and perspectives (ALICE)

Current limitations:

- Statistics: only 1 ctf file used since we have no more data at CNAF
- O2PDPSuite tag: only recent daily were fine (not release available for ARM)
- **MC jobs are still failing in digitization, only data reco can be tested**
 - known issue to be fixed in ROOT already notified (we are waiting for it)

Next step (agreed proposal)

We were a bit stuck here since people was busy with other activities (mainly reconstruction of Pb-Pb aPASS2... still running)

- **Since we are going to run new reco passes (March 2025), we will identify one run to be reconstructed twice on X86_64 and ARM and then run systematic checks → this could be the seed of a physics validation on ARM**
- There is now a high pressure on ALICE side to get reconstruction working on ARM

Perspective for Sept-Dec (MS11)

- KPI2.2.5.3: Technical notes (in experiments and ICSC)
 - **So far we developed a document containing the strategy and what achieved at that time with ATLAS and CMS (attached to MS8)**
 - Two proceedings approved these year
 - It would preferable for us to postpone KPI to MS11 in view of a final technical document
- A next step involves measuring electrical power consumption

backup

ARM available resources @ CNAF

- Resource procurement started in the second half of 2023 when CNAF acquired two ARM nodes allowing the experiments to login on those machines and running preliminary tests. By the end of 2023 CNAF acquired two additional nodes and setup a GRID-HTCondor queue.
- 4x 2U Dual socket ARM – Ampere Altra Max
 - 2x Ampere AltraMax M128-30 128Core 2.8Ghz 250W
 - 1TB RAM (~ 4 GB per core)
 - 2x NVMe U.3 3.84TB discs
 - 1x Dual port SFP28 ethernet

Current setting (still work in progress)

- Cvmfs available
- Network: access to external network
- Gpfs client -> now available on ARM but only with a very recent version, not yet in production at INFN-T1
- Condor/GRID -> in production

Status and perspectives (CMS)

The ARM validation, based on a bin-by-bin comparison, was completed. With strong agreement between x86_64 CPUs and ARM architectures

- The CMS Physics Data and Monte Carlo Validation (PdmV) group approved the validation results in November 2024.

The ARM resources had a key role in the CMSSW software validation process granting CMS the possibility to repeat the Data validation with 2022 and 2023 data.

As result **CMS will be able to accept pledges of ARM processing resources.**

- CMS expect a CMSSW version based on ROOT 6.34 or later (CMS is planning this upgrade for the production release expected for 2026 data taking)

Status and perspectives (ATLAS)

ATLAS has already confirmed its readiness to run on ARM

