

Welcome to ESC15

the Seventh INFN International School on

**“Architectures, tools and methodologies for
developing efficient large scale scientific
computing applications”**

Oct. 21-26 2013

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On behalf of:

- ◆ **The Italian Institute for Nuclear Physics (INFN)**
 - × Bologna, CNAF, Padova sites
 - × providing most of the support
- ◆ **The University of Bologna, Department of Physics**
- ◆ **The lecturers, the tutors**
 - × and their Institutions/Companies

The site



Bertinoro and hospitality

Bertinoro is a nice medieval village, famous for its **hospitality** and therefore quite well suited as a location for a center like CeUB

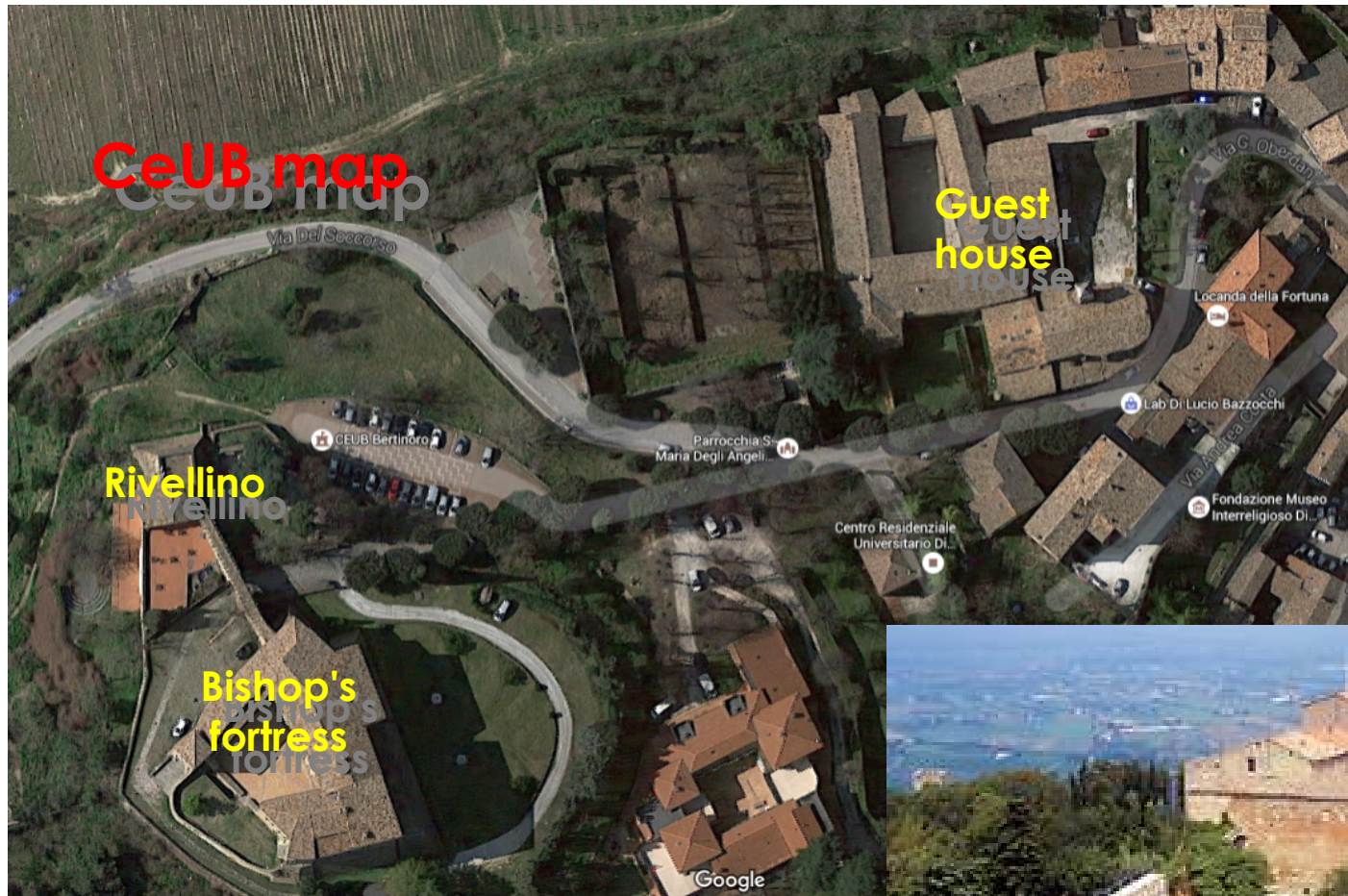
- x the name most likely comes from **"Castrum Brittinori"** (XIth century) and it is probably due to the frequent stops pilgrims coming from Britain, in their way to Rome, used to take in the quiet surroundings of Bertinoro.
- x one of the monument in Bertinoro known as **Colonna delle Anelle** ("Column of the Rings" or "Column of hospitality") is a column in white stone with 12 rings erected in 1300 by the noble families to express **their commitment to hospitality**.
 - ◆ Each one of the rings corresponded to one family;
foreigners arriving in town, could select the family to be hosted, by **tying** the horse bridles to the corresponding ring



but still today...

- ✕ Bertinoro still hosts a "**Hospitality Festival**". Held in the first weekend of September, it foresees an entire night of music, dances and events (between Friday and Saturday), some historic commemorations and the final Hospitality Rite (Sunday late morning).
- ✕ In this ceremony **anyone can be hosted** for lunch by a family in the town simply **taking one of the envelopes** tied to the rings of the Hospitality column (which inside has the name of the hosting family).
- ✕ you will not get this opportunity this week, but I'm sure you will at least enjoy the **good food and wine** that Bertinoro will offer to you while you are staying here

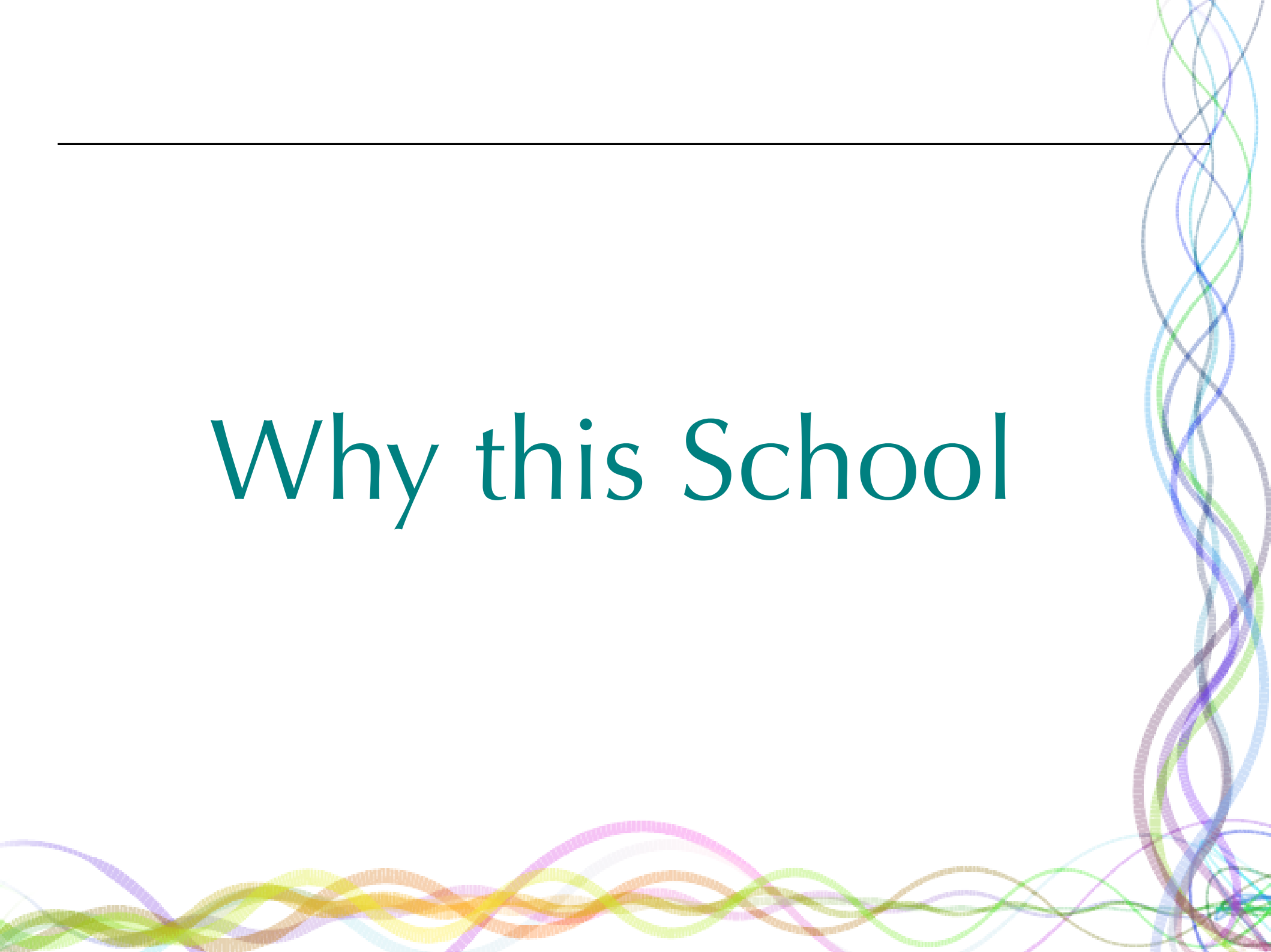
CeUB: University Residential Center of Bertinoro



CeUB: the facilities

- ◆ the Center was brought back in use with renovation work that started in 1991 in the fortress and in the guest house, followed by integration of additional buildings
- ◆ today the Center offers:
 - × **14 lecturing/meeting rooms** inside the Bishop's Fortress, the Rivellino, St. Sylvester church and the Theatre;
 - × **2 computer labs**, 20 and 50 seats;
 - × **86 bedrooms** (single, twin, double), for a total amount of 130 beds;
 - × a **canteen with 200 seats** for breakfast, lunch and gala dinners.
- ◆ **120+ events** per year
- ◆ up to **30.000** daily presences per year

Why this School

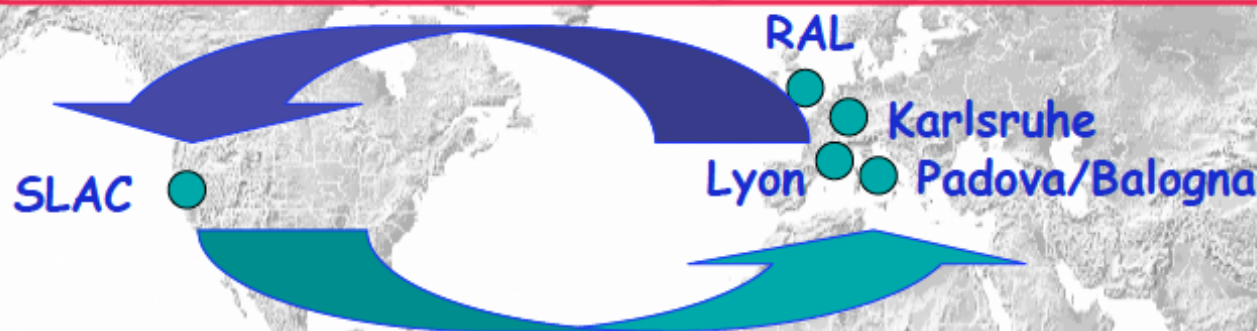


The context

- ◆ High Energy Physics has been **heavily relying** on computing since long
 - ✗ for many years the scale of resources needed by HEP experiments was such that the computing centers of the hosting lab **were copying well** with the core computing data processing needs
 - ✗ the UA1/2 experiments that discovered the Z and W bosons at CERN were good examples
- ◆ the model started to break at the end of the last century when experiments, like the BaBar experiment at the SLAC B-factory, had to deal with a **huge amount of data** and the computing power had to be scaled up by more than one order of magnitude w.r.t. **the initial estimates**
 - ✗ the investment needed started to grow very significant
 - ✗ for the first time it was felt necessary to distribute the processing of the data stored on tape to an external center

Babar distributed reconstruction

Tier A centers in calibration and reconstruction



- o **Fast calibration pass at SLAC**
- o **Data sent via network to Padova for reconstruction**
- o **Data reconstructed and returned via network to SLAC**

Additional challenges

- ◆ BaBar was also the first large experiment that make the fearless step of wiping away **40 years of experience with Fortran** to fully embrace the new emerging **OO paradigm and the C++ language**
- ◆ a generational shift took place as a consequence
 - ✗ some experienced programmers did not manage to re-learn how to write code
 - ◆ with them also an attitude to take into consideration **performance issues**, built up when dealing with tight CPU constraints, was lost
 - ✗ the collaboration had to count more on younger people that learned to program somehow without guidance from the previous generation and the community
 - ◆ on the other hand, this was supported by homegrown and commercial courses on C and object oriented analysis and design

The outcome of all this

- ◆ the fact HEP collaborations started to get quite big (600 physicists in BaBar) implied also that critical code had to be written by **many “general-purpose” physicists** rather than a **small group of experts**
- ◆ not surprisingly, for all these reasons applications turned out to not **being particularly efficient** in the way they were using computing power
 - ✗ this was clear, e.g. in BaBar when, years later, significant improvements were achieved by a review of the code performed by experienced programmers

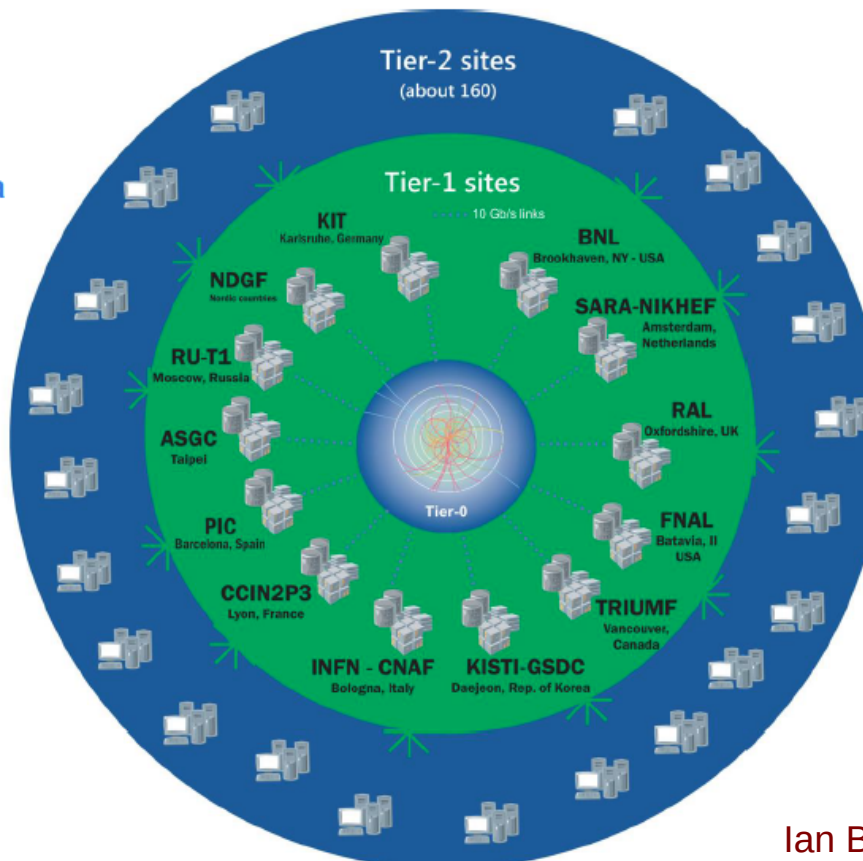
The current size of the problem

The Worldwide LHC Computing Grid

Tier-0 (CERN): data recording, reconstruction and distribution

Tier-1: permanent storage, re-processing, analysis

Tier-2: Simulation, end-user analysis



nearly 170 sites,
40 countries

~350'000 cores

500 PB of storage

> 2 million jobs/day

10-100 Gb links

WLCG:

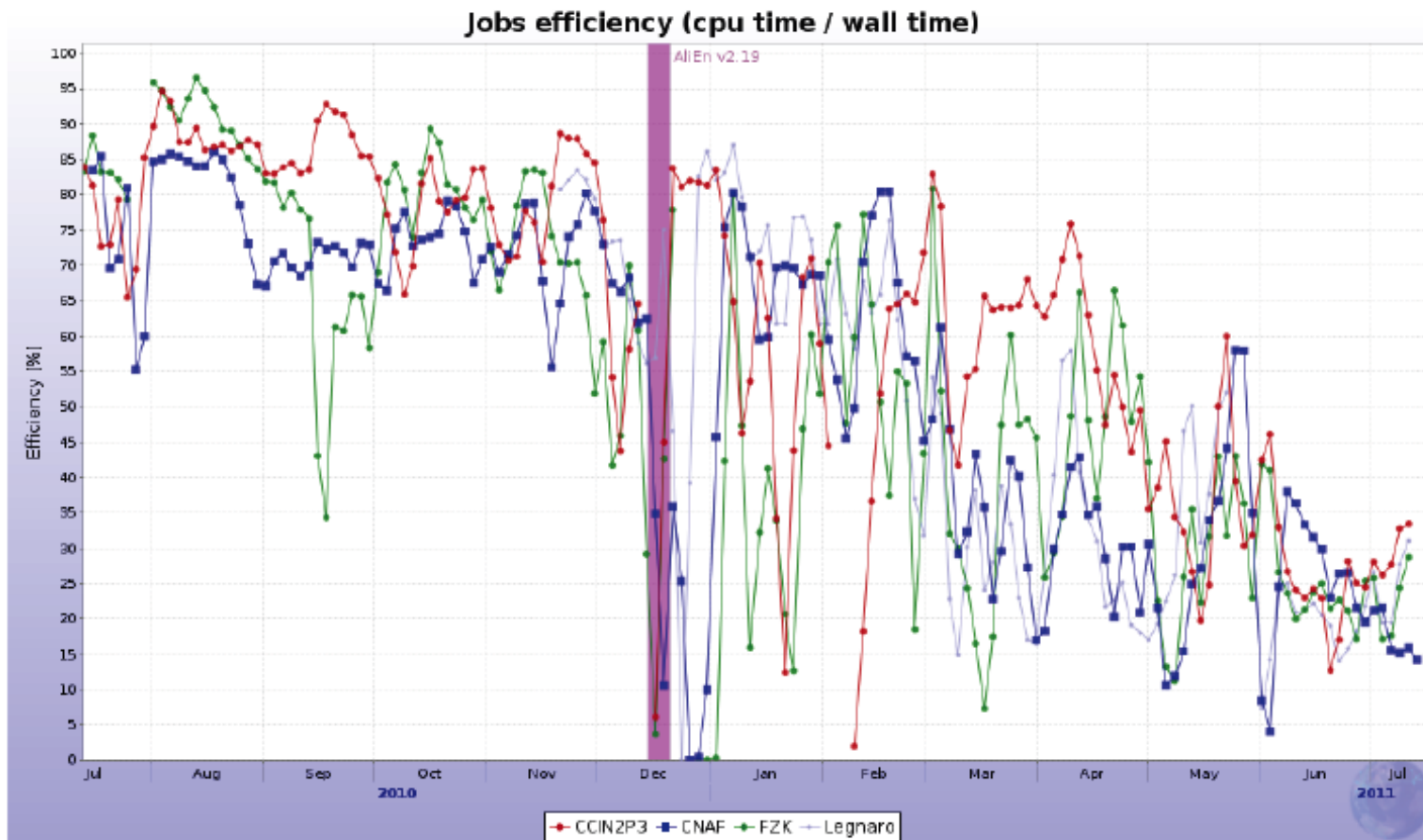
An International collaboration to distribute and analyse LHC data

Ian Bird - **NEC'2015**

Integrates computer centres worldwide that provide computing and storage resource into a single infrastructure accessible by all LHC physicists

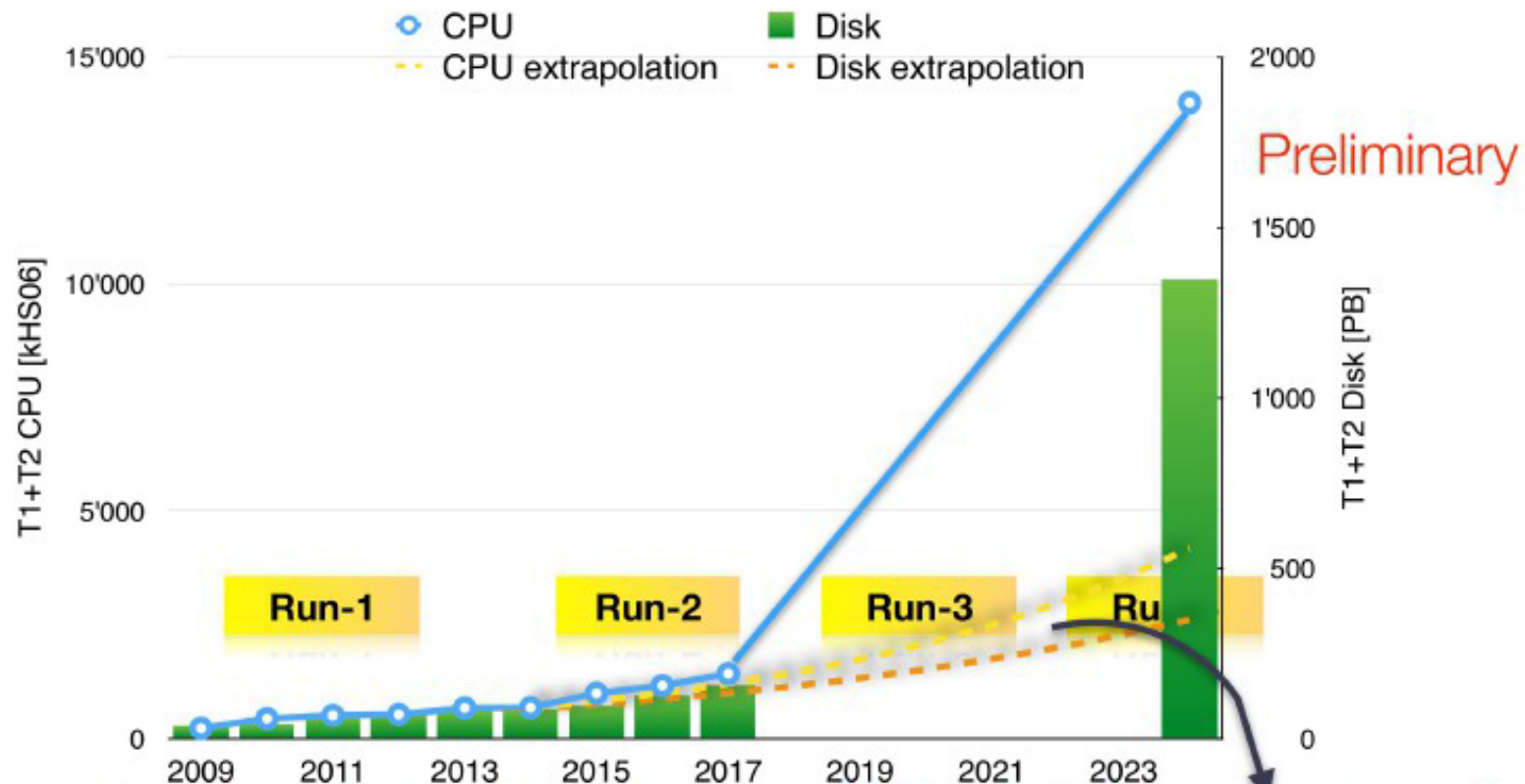
more recent experience

- ✗ an example from a LHC experiment of how CPU efficiency may drop when real data come in



Future may be even more challenging

ATLAS resource needs at T1s & T2s



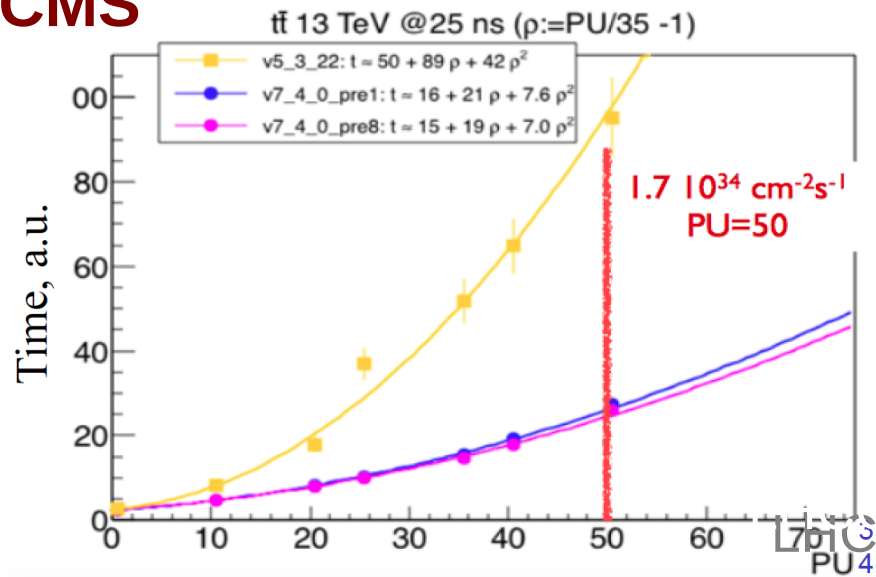
Extrapolation from 2014 (Moore law)



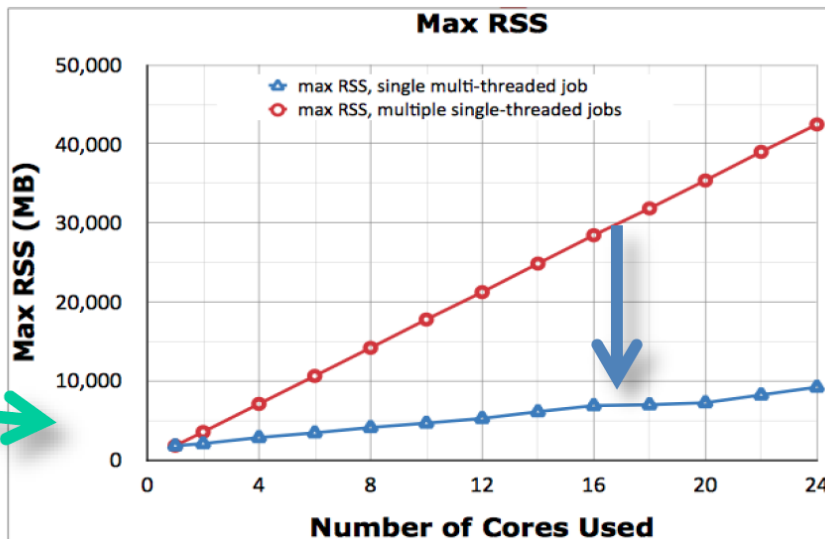
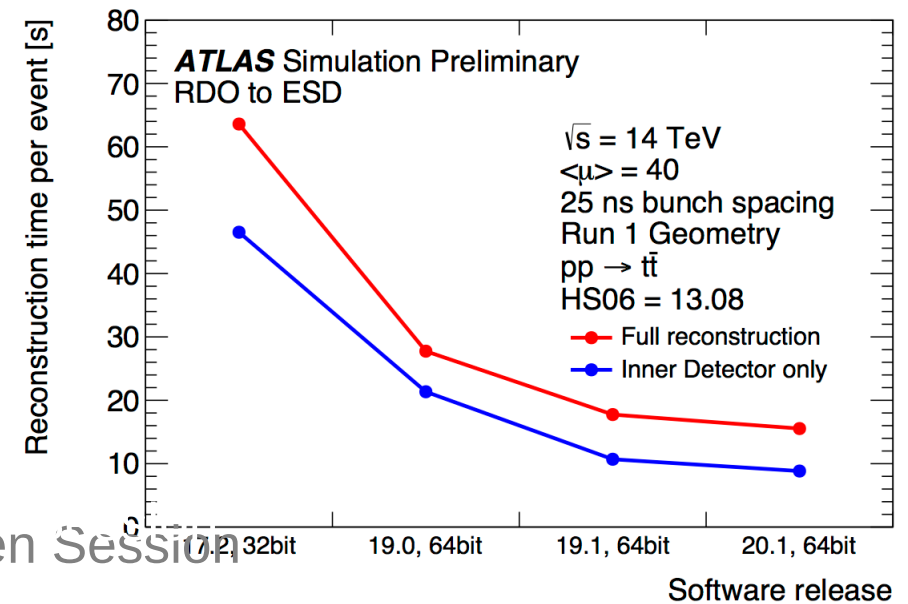
Eric Lançon on behalf of the ATLAS collaboration

the pay off: recent achievements at LHC

CMS

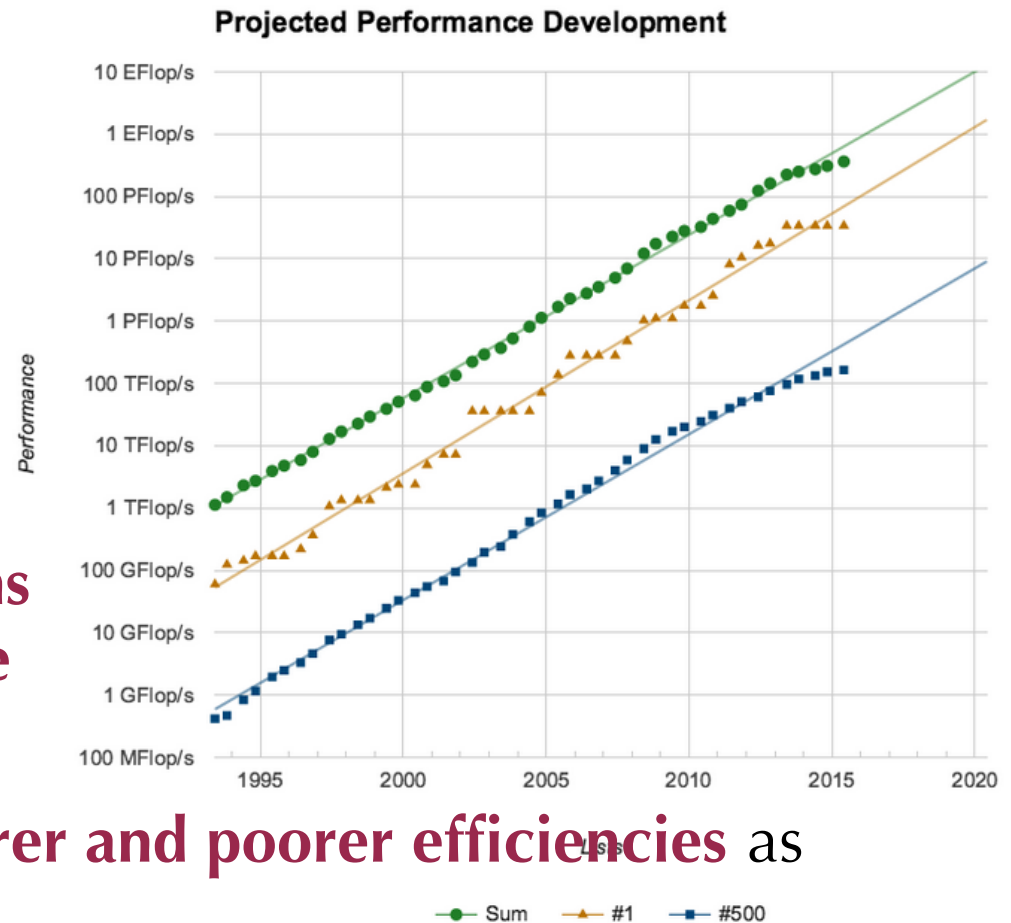


ATLAS



a look at HPC computing

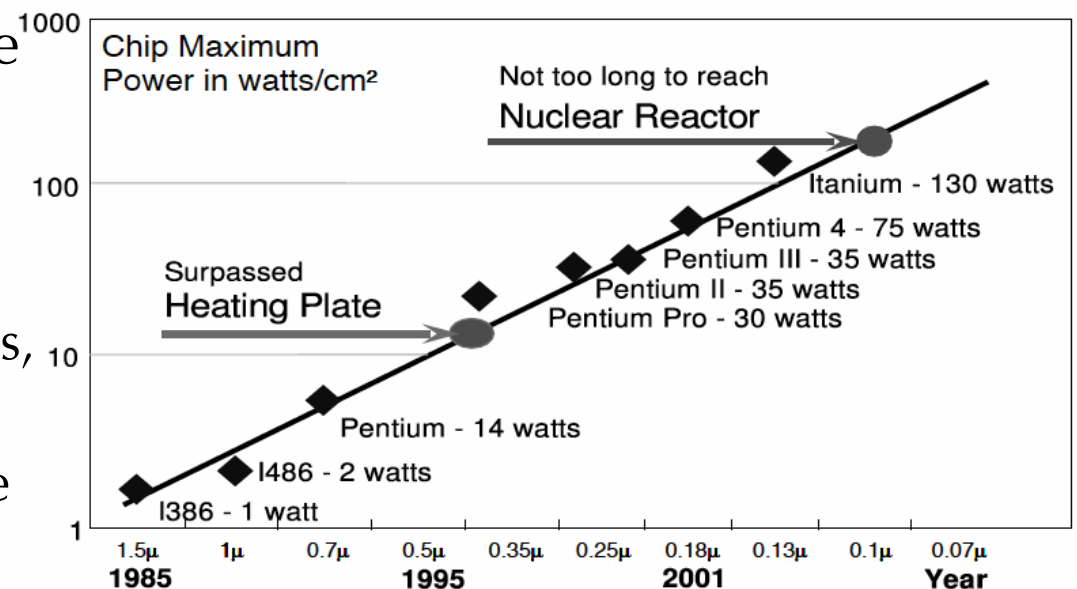
- ◆ the next big milestones for HPC systems is Exascale computing
 - × 1000 PFlops, 1000 PBytes
- ◆ we are progressing towards the goal, although at reduced pace
- ◆ however, **no supercomputer runs real applications faster than five percent of its design speed**
- ◆ the natural trend is towards **poorer and poorer efficiencies** as systems scale out to Exascale
- ◆ “it is not **power** or **reliability** that are the **exascale challenges**: it’s **programmability of complex memory hierarchies**”



Supinski - ISC HPC '15 - Frankfurt Conference and Exhibition in Frankfurt in July.

Why a School about “efficiency”

- ◆ The conception of this school was motivated by the awareness that **efficient usage of computing resources** in our field:
 - ✗ **had to be taken seriously**, given the level of computing investment now required
 - ✗ in the past was not always well understood and taken into proper consideration
 - ✗ **was becoming more and more challenging** due in particular to the physical constraints in increasing scalar performance and the attempts to exploit anyway Moore's law with new processor architectures
 - ◆ ... many cores, co-processors, GPU, vector units, etc
 - ◆ memory access getting more and more critical



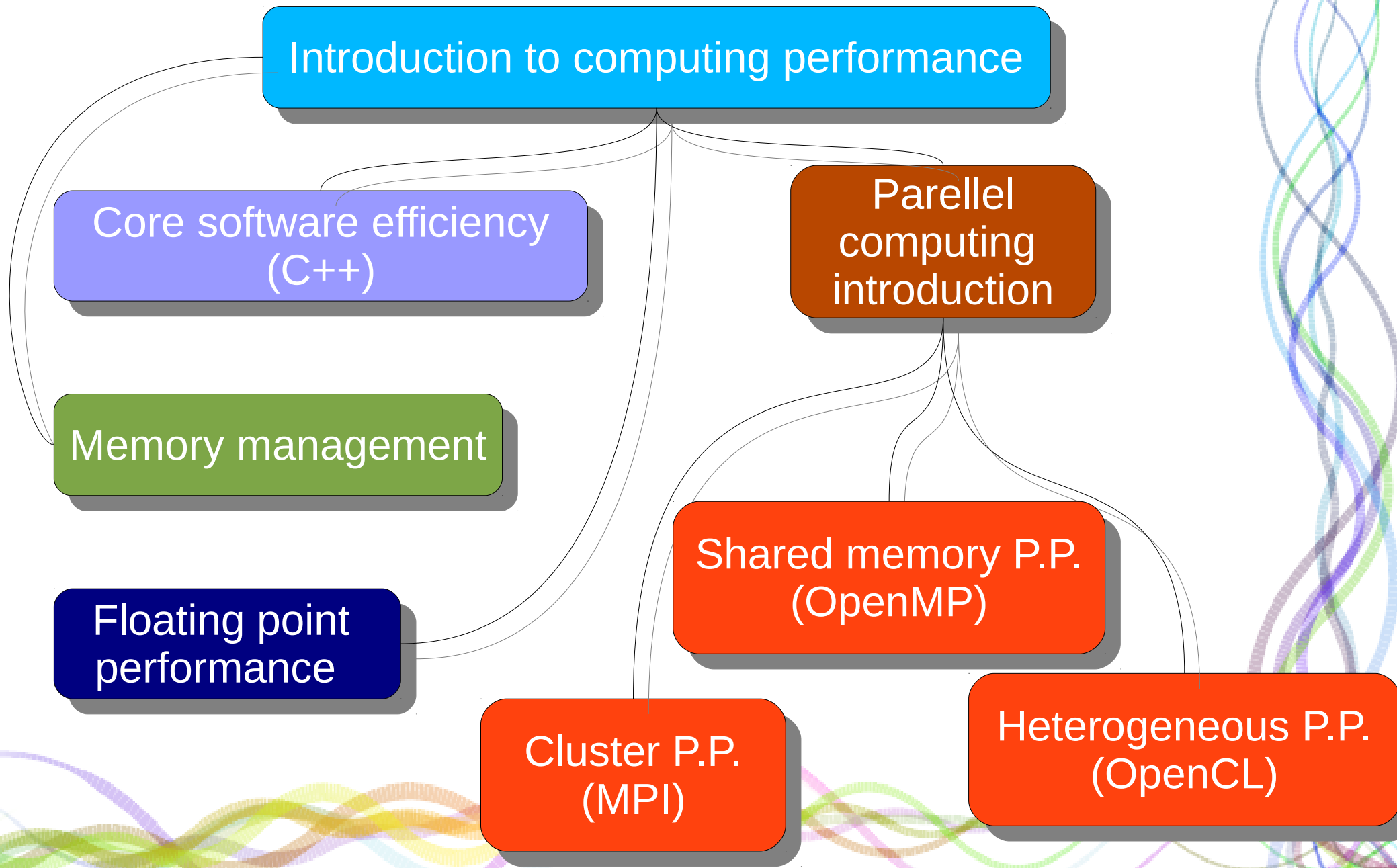
The School evolution

- ◆ In the first editions of the School we tried to embrace **several key aspects** related to the efficient usage of computing resources in scientific applications, from **exploitation of modern CPUs** to **I/O related issues**
- ◆ however we realized that the scope was too vast for a one week School
- ◆ a few years ago we decided therefore to focus the School on the area where developments looked most disruptive and challenging: **memory management** and **parallel processing**

The 2015 edition



ESC15 School lecture plan



Improving the School

- ◆ we have been striving to **improve the School** year after year
- ◆ the feedback we got from the students has always been **very useful**
- ◆ on Saturday morning we will give you an opportunity to evaluate:
 - x the **competences you have acquired**
 - ◆ a piece of information that is of course **valuable to us too**
 - x the **perceived quality** of various aspects of the School

Consolidation time

- ◆ in the last few years we have been collecting a recurring **complaint** from the students:
 - ✗ they felt they lacked **sufficient time for assimilating** what was presenting new concepts presented and to go over the proposed exercises
- ◆ therefore last year we introduced a **time slot around lunch** to let students work on their own
 - ✗ with the possibility of interacting with the lecturers
 - ✗ but it was not considered to be enough
- ◆ so this year **we have increased** these “consolidation” time slots
 - ✗ Mo.: **30'**
 - ✗ Tu.: **1h30'**
 - ✗ Wed., Thu., Fri.: **3h**

Evening lectures

- ◆ Wednesday:

- ✗ Sverre Jarpe - CERN honorary staff:

- Are we going back to the RISC era?**

- Sverre was **director** of the CERN OpenLab until last year and lectured for many years at this School*

- ◆ Thursday:

- ✗ Daniele Cesini - INFN/CNAF

- Low-power computing with System-on-Chips**

- ◆ Friday:

- ✗ Tim Mattson - Intel

- Big Data: What happens when data actually gets big?**

Social life

- ◆ last year we introduced the **students' lightning talks** on Mo. and Tue. evening, to help people at the School know each other
 - ✗ it was successful, and we are going to repeat it this year
 - ✗ we have received slides from **most participants** (~ 20)
 - ◆ please send us the the missing slides by 2 pm today
- ◆ after the lectures:
 - ✗ you **can stay here** until dinner time
- ◆ dinner: on Mon., Tue., Thur. you can organize yourself and **enjoy what local restaurants have to offer**
- ◆ after dinner, there is a **large room** in the Guest House that is available if you want to stay there together

Special events

On **Wednesday night:**

dinner with music at the Bistrot Restaurant

On **Friday night:**

social dinner at a local Restaurant



School computing infrastructure

- ◆ one of the characteristics of this School has always been the preference for the **learning-by-doing** approach
 - ✗ it is an effective way of **learning**
 - ✗ but it is also an effective way of **teaching**
 - ◆ guiding students **to discover by themselves** new notions and concepts
- ◆ therefore we have always made available a **computing infrastructure** suitable for supporting hands-on activities
 - ✗ initially relocated here for the duration of the School, now located at the Padova INFN site and accessed remotely
- ◆ **this year:**
 - ✗ each of you will get exclusive access, through a **public login gateway** (esc-gw.pd.infn.it), to a **couple of Intel dual processors (Intel E5520) Linux** servers
 - ✗ you will share the access to a server equipped with **8 Nvidia GPU (Tesla S2050)** for the OpenCL exercise

Wireless networks

- ◆ we have here two infrastructures:
 - ◆ **INFN wireless network**, available only in this room, accessed
 - x using Eduroam credentials **[eduroam SSID]**
 - x or via captive portal **[INFN-Captive SSID]**
 - ◆ you should have already the credentials
 - ◆ **Bertinoro wireless network**, available available in all rooms including the guest house **[CeUB SSID]**
 - x credentials should have been given at registration time, otherwise ask Rossana

**We wish you a very pleasant and
“efficient” week in Bertinoro**