K. Androsov (Pisa): INFN Fellow presentation

flash talk

Past activities

Projects

- $HH \rightarrow bb\tau\tau$ analysis
- Pixel Phase 1 R&D and production
- Service work for tracking algorithms
- R&D: Tau L1 pixel trigger for Phase 2

Affiliations

- Dec. 2015 – Dec. 2017 INFN Fellowship for foreign students
- Dec. 2012 – Dec. 2015 PhD at the University of Siena

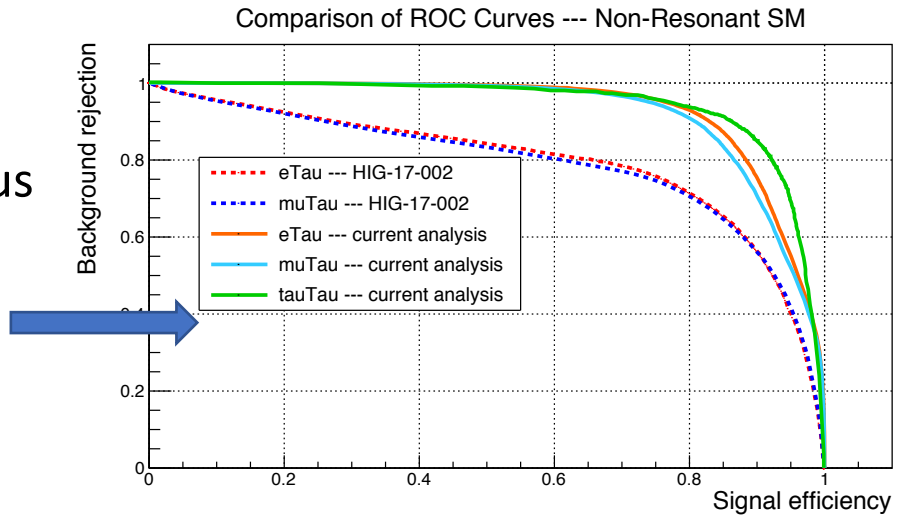
Current projects (Dec. 2017 - Now)

- Machine Learning in HEP:
  - Deep Tau ID and beyond
  - Data analysis
- Advanced pixel detector simulations for Phase 2 using GPU
- *Possible involvement in HPC tests at Cineca (under discussion)*

Machine Learning in HEP

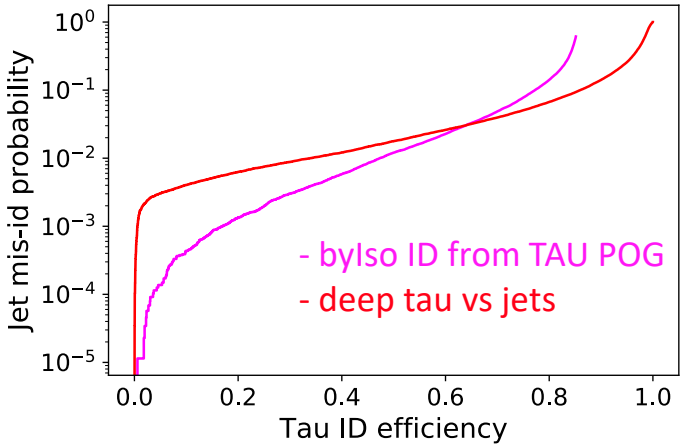
- What is the best way to apply Deep Learning in HEP?
- Can we afford “Zero Deep Learning” (without any human knowledge)?
  - This requires huge statistics, while full event simulations are CPU costly...

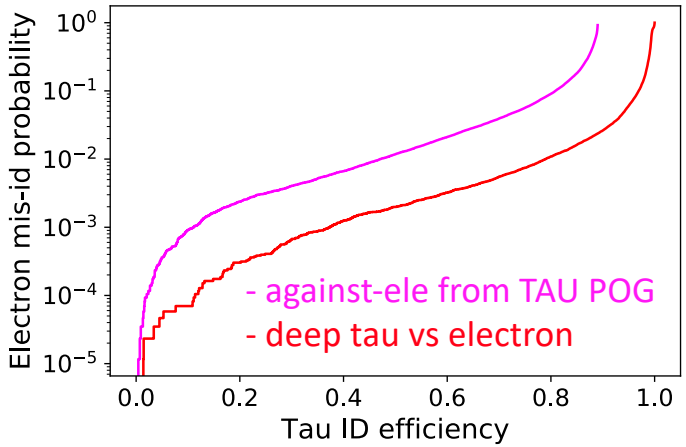
- How to pass our knowledge without adding significant bias?
  - Select relatively small set of discriminant variables based on mathematical algorithms from an extensive set of variables provided by “human experts”
  - Use those variables to pre-train inner layers of Deep NN or as an input of BDT
- We (me, A. Giraldi et al.) implemented an algorithm based on Jensen Shannon Divergence and Mutual Information measure that selects the most discriminating variables
- As a first try, this algorithm was applied to $HH \rightarrow bb\tau\tau$ analysis, keeping the same learner (BDT from TMVA) as in the previous version of the analysis:
  - Significant improvements wrt to the ”human expert” variable choice
  - The final expected limits for SM $HH \rightarrow bb\tau\tau$ improvement by almost a **factor 2**

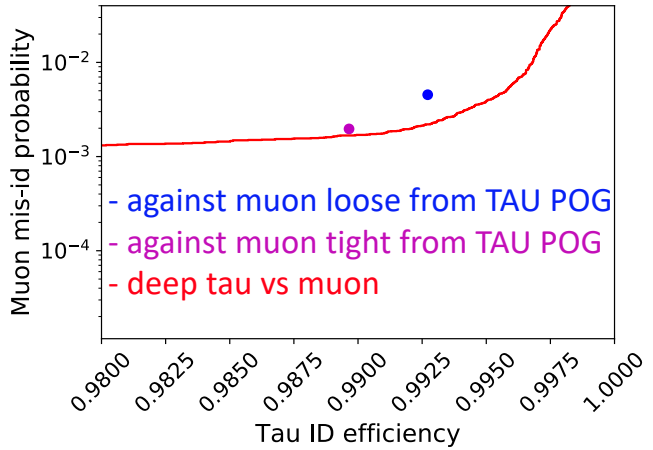


Deep Tau ID

- Physics objects reconstruction and identification is an excellent task for DL
- As the inputs, we can use a low level variables to not loose any information
- As the first target, the taus were chosen:
  - Current tau ID has 3 separate discriminators (against electron, muons and jets)
  - With DL I plan to introduce an unique multi-class discriminator
  - In the future, I plan to do full Deep Tau reconstruction
- To improve convergence (without introducing bias) we plan to pre-train the inner layers of the NN graph using algorithm described in the previous slide
- The full framework is in a very early stages of development, but first very preliminary results results of Deep Tau ID looks promising







Advanced pixel detector simulations for Phase 2 using GPU

- For Phase 2, the advances in the frontend design require sensors with smaller pixel cells and thinner active thickness
- R&D of such pixel detectors require detailed simulation to obtain reliable results. Within R&D we need to:
  - Find optimal pixel technologies and geometrical layouts
  - Test validity of the various radiation models
- 3D device modeling are very computational demanding
  - Licenses for simulation soft are very expensive and number of CPU is limited by 4 per license
  - On the other hand, simulation software allows to implement custom models as plugins
  - Most of the simulation algorithms are parallelizable => GPU isideal candidate to perform part of the calculation
- Within Pisa group, I'm starting to work on implementation of a plugin with GPU support for Sentaurus Device simulation TCAD.