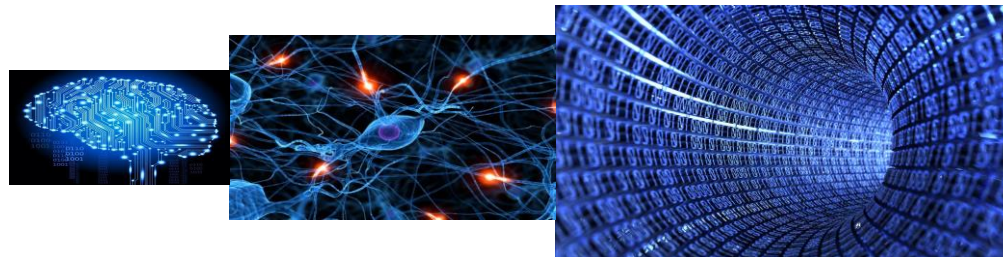




# Machine Learning CWP

**Sergei V. Gleyzer**

**University of Florida**



**CWP Workshop Annecy**

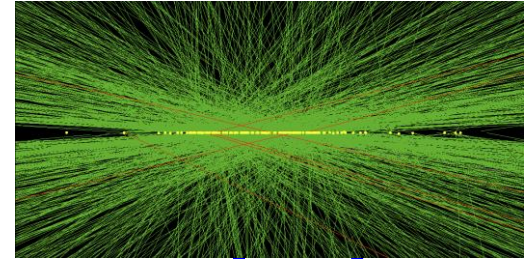
**June 26, 2017**

# WG Charge

**Scope:** Machine Learning algorithms play an important role in many facets of today's HEP data analysis, data-processing and detector applications. Machine-learning tools already form an important part of HEP software. To overcome the challenges related to data-processing and analysis of upcoming very large HEP data-sets, it is important to plan ahead for how HEP machine-learning software and tools develop. **This group will work on both identifying the challenges related to machine-learning software in HEP and proposing possible solutions and a community roadmap towards better HEP-ML software.**

# Challenges

- **Rare physics signals**
- **High backgrounds**
- **High-pileup and event complexity**

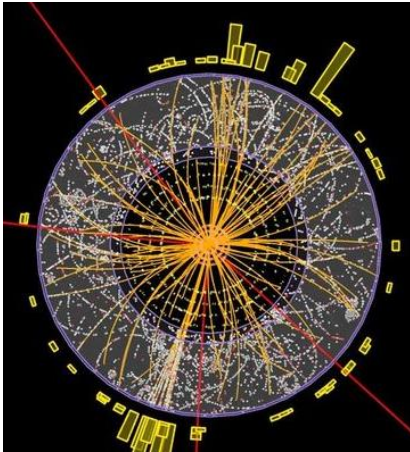


**Under these conditions ML algorithms out-perform traditional approaches**

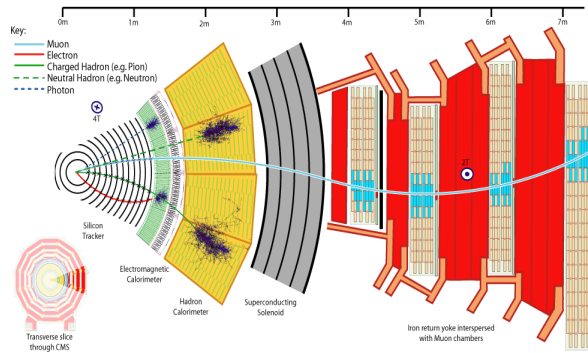
# R&D Investment

- **More powerful, easier to use tools**
- **Much more flexible and integrated eco-system that exploits best data formats, algorithms and hardware**
- **Ability to apply algorithms in real-time environments**
- **Training the community**

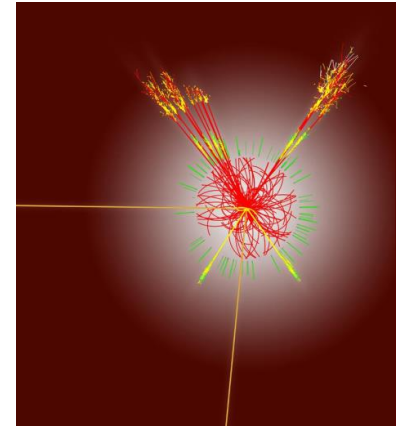
# Interesting areas



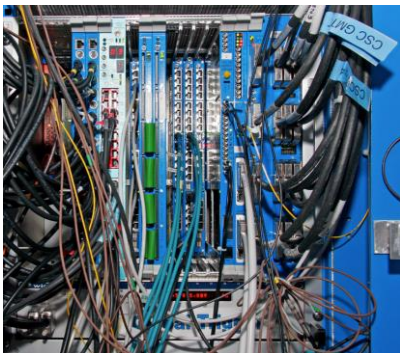
**Particle Tracking**



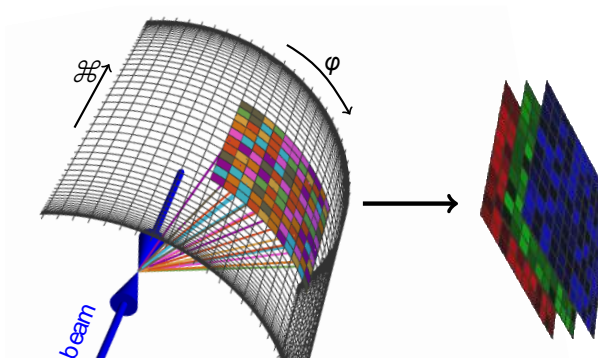
**Fast Simulation**



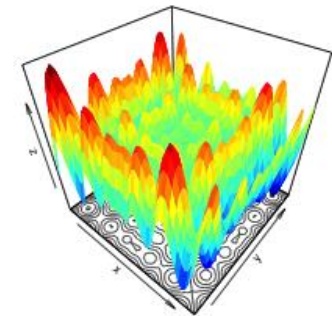
**Object Identification**



**Trigger**



**Imaging Calorimetry**



**Simulation**

- **Fast Detector Simulation**
- **Deep learning applications**
- **Pattern Recognition in Tracking and Trigger**
- **Imaging techniques for physics**
  - **Calorimetry, physics object and event identification and reconstruction**
- **Feature extraction and unsupervised learning**
- **Regression**

- **Editing in progress**

## **CWP-ML**

- **Key ideas in place**
  - Review which parts are more broad to HEP
  - Expect to have a first draft by end of workshop

- **A lot of cross-experimental benefit and progress from ML software and tools**
- **Leveraging external tools and algorithms developed outside of HEP an important component**



# Topics

- A. External and Internal ML Tools**
- B. New applications of ML and R&D**
- C. Resources and related: Interactive, HPC, Cloud, GPUs, Storage**
- D. Bridges to other communities**
- E. Training the Community**

## Naturally cross-cutting topic:

- **Event reconstruction**
- **Software and trigger**
- **Generators**
- **Data analysis**
- **Visualization**
- **Training**

# Primary Activities

- **HSF Workshop in January**
- **IML Workshop in April**
- **DS@HEP Workshop in May**
- **HSF Annecy Workshop**

# Primary Organizers

**Sergei Gleyzer (CMS)**

**Steven Schramm, Mathew Feichert  
(ATLAS)**

**Paul Seyfert (LHCb)**

**Fernanda Psihas (NOvA)**

**Many individual contributors**

- Aaron Sauers
- Aashrita Mangu (CS)
- Adam Aurisano (NOvA)
- Adrian Bevan (ATLAS)
- Alessandra Forti (ATLAS)
- Alexander Kurepin (ALICE)
- Alexander Radovic (NOvA)
- Alexei Klimentov (ATLAS)
- Amir Farbin (ATLAS)
- Andrey Ustyuzhanin (Yandex, LHCb)
- Antonio Limosani (ATLAS)
- Ariel Schwartzman (ATLAS)
- Attilio Picazio
- Aurelius Rinkevicius (CMS)
- Ben Hooberman (ATLAS)
- Benedikt Hegner (SFT)
- Bob Stienen
- Claire David (ATLAS)
- Daniele Bonacorsi (not only as CMS in this)
- David Rousseau (ATLAS)
- Dick Greenwood
- Dorian Kcira
- Douglas Davis
- Dustin Anderson (CMS)
- Elias Coniavitis
- Elias Coniavitis
- Federico Carminati (SFT)
- Fernanda Psihas (NOvA)
- Filip Siroky
- Gabriel Perdue (MINERvA)
- Giles Strong (CMS)
- Gilles Louppe (ATLAS)
- Gordon Watts (ATLAS)
- Graeme Stewart
- Hans Pabst (Intel)
- Harvey Newman (CMS)
- Helge Meinhard
- Horst Severini
- Ian Stockdale
- Igor Lakomov (ALICE)
- Ilija Vukotic (ATLAS)
- Jamal Rorie (CMS)
- Javier Duarte (CMS)
- Jean-Roch Vlimant
- Jim Kowalkowski
- Jim Pivarski (CMS)
- Jochen Gemmler (Belle2)
- Johannes Junggeburth
- John Harvey (SFT)
- Jonas Eschle (LHCb)
- Jonas Graw
- Jordi Garra-Tico (LHCb)
- Juan Pedro Araque Espinosa (ATLAS)
- Karen Tomko
- Kevin Lannon (CMS)
- Kim Albertsson (ATLAS)
- Konstantin Kanishchev (AMS-02)
- Konstantin Skazytkin (ALICE)
- Kyle Cranmer (ATLAS)
- Laurent Basara
- Lindsey Gray (CMS)
- Lorenzo Moneta (ROOT)
- Louis Capps
- Lukas Heinrich (ATLAS)
- Luke Kreczko
- Maria Girone (CERN openlab)
- Mario Campanelli (ATLAS)
- Mario Lassnig (ATLAS)
- Mark Neubauer (ATLAS)
- Martin Vala
- Matthew Feickert (ATLAS)
- Mauro Verzetti (CMS)
- Meghan Kane (SoundCloud, formerly @M)
- Michael Andrews (CMS)
- Michael Kagan (ATLAS)
- Michael Williams (LHCb)
- Michela Paganini (ATLAS)
- Michele Floris (ALICE)
- Mike Sokoloff (LHCb)
- Nicolas Köhler
- Nuno Filipe Castro (ATLAS)
- Paolo Calafiura (ATLAS)
- Paul Glaysher (ATLAS)
- Paul Seyfert (LHCb)
- Pere Mato (SFT)
- Piero Altoe (NVIDIA)
- Przemyslaw Karpiński (CERN openlab)
- Rob Kutschke
- Ryan Reece (ATLAS)
- Savannah Thais
- Sean-Jiun Wang (CMS)
- Sergei Gleyzer (CMS)
- Seth Moortgat (CMS)
- Sofia Vallecorsa (SFT)
- Stefan Wunsch (CMS)
- Steven Schramm (ATLAS)
- Taylor Childers (ATLAS)
- Thomas Keck (Belle2)
- Tom Hacker
- Uzziel Perez (CMS)
- Valentin Kuznetsov (CMS)
- Vladimir Gligorov (LHCb)
- Wahid Bhijmi (Daya-Bay)
- Wenjing Wu
- Xavier Vilasis-Cardona
- Omar Zapata (<http://oproject.org>)