

# The VISPA internet-platform in deep learning applications

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**Abstract.** Latest developments in many research fields indicate that deep learning methods have the potential to significantly improve physics analyses. They not only enhance the performance of existing algorithms but also pave the way for new measurement techniques that are not possible with conventional methods. As the computation is highly resource-intensive both dedicated hardware and software are required to obtain results in a reasonable time which poses a substantial entry barrier. We provide direct access to this technology after a revision of the internet platform VISPA to serve the needs of researches as well as students. VISPA equips its users with working conditions on remote computing resources comparable to a local computer through a standard web browser. For providing the required hardware resources for deep learning applications we extend the CPU infrastructure with a GPU cluster consisting of 10 nodes with each 2 GeForce GTX 1080 cards. Direct access through VISPA, preinstalled analysis software and a workload management system allowed us on one hand to support more than 100 participants in a workshop on deep learning and in corresponding university classes, and on the other hand to achieve significant progress in particle and astroparticle research. We present the setup of the system and report on the performance and achievements in the above mentioned usecases.

## 1. Introduction

The project Visual Physics Analysis (VISPA)[1, 2] implements a development environment for data analyses in a web browser. It supports the typical development cycle of designing, executing, verifying and redesigning an analysis.

For analyses using deep learning techniques the working environment consisting of hardware and software components is essential for quick turnarounds. Throughout this proceeding this working environment is called workspace. The VISPA web platform gives its users access to computing resources which is considered as a key feature. The VISPA cluster is provided as default workspace but more computing resources can be added by the user. We present the setup of the system and focus on how the interplay between VISPA platform and cluster makes analysis resources available through a web browser.

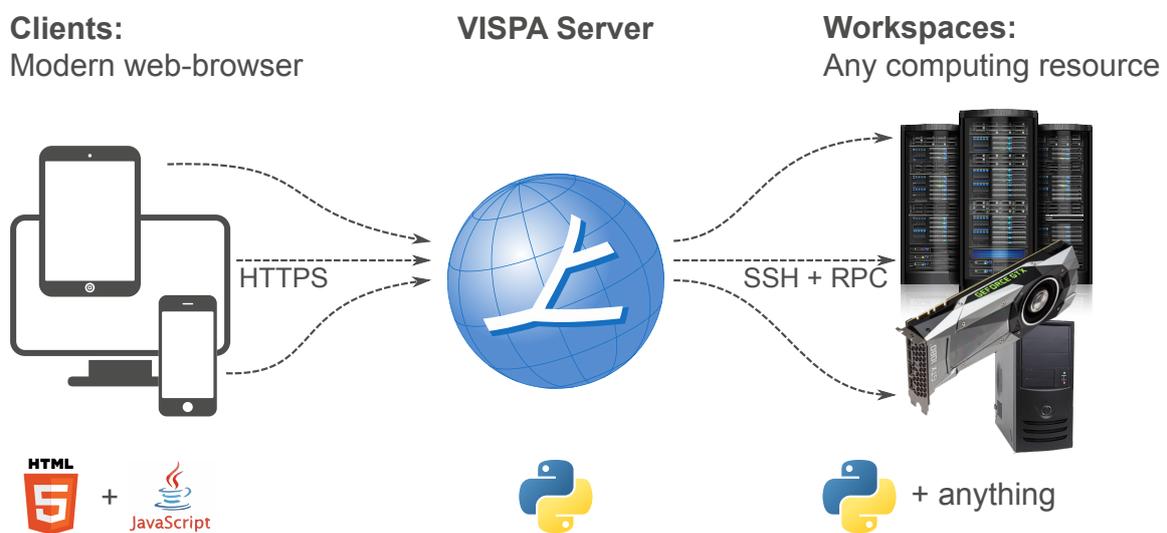
## 2. The VISPA Server

The VISPA platform allows its users to work through a web-browser on a remote computing system, see figure 1. The only requirement to use the system is a modern web browser. If the user

wants to access additional workspaces than they must be accessible via SSH. Clients connect to the VISPA server via HTTPS and the connection between the server and the computing resource is established via remote procedure call (RPC) over SSH. So the VISPA server serves as a mediator between the user and the workspace by executing commands issued from client side and by returning the feedback from workspace side to the client.

All parts of the graphical user interface are written in HTML5 and JavaScript. This allows access from many different devices like desktop computers, tablets or mobile phones. The server uses the Python web framework CherryPy [3]. Code needed on workspace side e.g. to access files is written in Python [4] and copied automatically to the computing resource upon connection.

User credentials are stored in a SQL database like MariaDB [5]. For privacy reasons passwords to workspaces are not saved.



**Figure 1.** The VISPA Server as mediator between user and computing resources.

### 3. Extensions

The VISPA server provides different functionality by extensions. Default extensions are a file manager, a terminal and a code editor with execution and image preview capabilities. Further extensions are a browser for data of the Pierre Auger Observatory [6] or a parameter scan extension [7]. The latter helps to explore high-dimensional file system structures which appear naturally when naming output files of parameter scans by their parameters. An extension helping to work with various job submission tools like LSF or CRAB is currently under development.

### 4. The VISPA Cluster

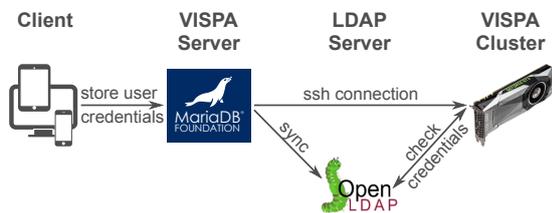
The VISPA cluster operates since 2012 and consists of multiple computing nodes with in total 212 CPU cores and 20 NVIDIA GeForce GTX 1080 graphic cards (GPU). CPU only nodes are equipped with 16 GB of RAM, nodes assembled with a GPU provide 64 GB of RAM. The latter nodes were bought in 2016 and are dedicated to teaching purposes and analyses using deep learning techniques.

User space is provided by a network file system (NFS) server where home directories are stored on SSD and thus kept small. Data is stored on HDDs on the NFS server allowing for larger file sizes. The hard disks of the local computing nodes are used to cache the network file system.

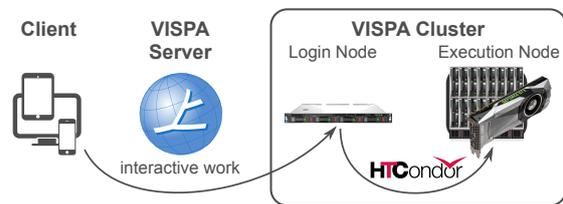
Analysis software, e.g. TensorFlow [8], is installed and managed centrally which allows users to concentrate on analysis properties.

## 5. User Authentication

To provide a default computing resource, users registered on the VISPA server are able to access the VISPA cluster without additional password. For this purpose the MariaDB database is synchronized with a LDAP [9] database. The password to login to the VISPA server will also be used as cluster password allowing for an automatic login which gives users an interactive look and feel. Note that in previous publications, i.e. [10] the user authentication was achieved via a direct lookup into the SQL database. During the automatic login a round robin procedure is used to distribute the users to different login nodes which decreases the load on each individual node.



**Figure 2.** User authentication using an OpenLDAP database synchronized to the VISPA Server database



**Figure 3.** Job scheduling: Small analyses can be executed interactively on login node, longer jobs are managed by HTCondor.

## 6. Job scheduling

Computing resources should always be distributed on a fair share basis. Due to this reason only small interactive processes are allowed on the respective login node. More expensive jobs need to be send to the batch system software HTCondor [11], see also figure 3. The submission can be done directly from the code editor which lowers the entry barrier for inexperienced users. Graphic cards are not available interactively. Using HTCondor to schedule processes allows to distribute GPU resources on a fair share and not a first come first serve basis. Note that HTCondor is able to schedule jobs on a per GPU basis and even allows to request two GPUs.

## 7. Experience

The VISPA system consisting of server and cluster is used for education, outreach and research, see [12]. In 2017 it first served as a basis for a deep learning workshop in astroparticle physics with  $\sim 70$  participants who needed a simultaneous access to the resources. Secondly, the execution of exercises of a university class on deep learning with  $\sim 90$  students lead to high load peaks. The setup of the system facilitated the realization as everyone had the required hardware and software at their hands. Furthermore, the transparent approach to hide system details helped the participants to concentrate on deep learning techniques and physics problems.

VISPA is used to develop new deep learning methods in high energy and astroparticle physics [13, 14]. It allows several users to work on the same project using the same resources which streamlines the development process.

## 8. Conclusion

The VISPA web server and the VISPA computing cluster were presented. We focused on technical steps to connect webserver and cluster to obtain a seamless access to deep learning

infrastructure. User authentication and distribution of resources are revealed as key points to provide an interactive look and feel. We have shown that the VISPA project helps to concentrate on physics problems. This increases the learning curve for students and the productivity for scientists.

### Acknowledgments

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