The Elettra Virtual Collaboratory: a CSCW System for Scientific Experiments with Ultra-Bright Light Sources

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Abstract. This paper reports the first results of an on-going project aimed at developing a Web-based CSCW system to support scientific collaboration in experiments with ultra-bright light sources (from UV to X-rays), called the *Elettra Virtual Collaboratory*, and currently being extensively tested in three real-world experimental stations at the Elettra Synchrotron facility.

1 Introduction

This paper reports the first results of an on-going project aimed at developing a CSCW system to support scientific collaboration in experiments with ultra-bright light sources (from UV to X-rays).

This kind of system is typically called *collaboratory*, a term coined by William Wulf by merging the words *collaboration* and *laboratory*, and defined as "... center without walls, in which researchers can perform their research without regard to geographical location - interacting with colleagues, accessing instrumentation, sharing data and computational resource, and accessing information in digital libraries" [1].

Scientific collaborations currently rely heavily on face-to-face interactions, group meetings, individual action, and hands-on experimentation [2]. The creation and introduction of effective CSCW systems aims at bringing the following main advantages: first, to provide remote access to expensive and hard-to-duplicate equipment (and thus reduce travel costs of research groups); second, to increase the effectiveness of the experimental activity, since more experts can participate to experiments, give useful hints and solve problems; third, to facilitate multi-institutional consortia collaborations on large-scale projects.

In the following, we present a prototype of a Web-based collaboratory system called *Elettra Virtual Collaboratory* (*EVC*), that is currently being extensively tested in three real-world experimental stations at the Elettra Synchrotron facility.

The paper is structured as follows: Section 2 briefly discusses some CSCW issues and results in the domain of scientific experiments; Section 3 illustrates the EVC system. Section 4 concludes the paper, and mentions future work.

2 Motivations

The need for a distributed scientific laboratory is mostly motivated by research and industrial projects that require the use of scarcely available facilities (e.g., large electron microscopes, synchrotron light sources, various types of particle accelerators, etc.) and by the geographic distribution of collaborators and industrial partners at several different institutions.

Although the experiments tools vary considerably at the different facilities, some issues in the experimental activity with ultra-bright light sources are quite common:

- expensive, hard-to-duplicate and hard-to-use equipment for experimental data collection. The expensive and unique nature of the equipment means that the facilities are in high demand by scientists world-wide; the operation of the equipment is not generally well-known, and newcomers are regularly in and out of the facility. Moreover, since the equipment can be used only for a limited amount of time (e.g. a time slot of 30 hours), human errors due to stress conditions are not uncommon.
- multiple person and multiple specialties needed for carrying out experiments. The necessary expertise to know how to design an experiment, how to run the equipment, how to get the most out of it, is typically distributed by itself among several kind of professional figures, such as researchers, technicians and computer science people.
- collaborators are, in many cases, already geographically distributed.

To facilitate scientific work, collaboratory systems must support the (secure) sharing of experimental data, analysis, instruments, and interaction spaces. Several systems incorporate some of these basic features. Early collaboratories focused mostly on the sharing of large, expensive instruments such as astronomical telescopes, particle accelerators, oceanographic instruments, atmospheric observatories, and space research applications [2]. For example, the Upper Atmospheric Research Collaboratory [3] provides access to instruments in Greenland for solar wind observation, and collaborators can exchange and archive multimedia information from the instruments and the measurements analysis. More recently, collaboratory systems (e.g., [4,5]), besides providing remote sharing of experimental equipment, data and computing power, are focusing also on communication tools (e.g. videoconference, whiteboards) and on *electronic notebooks*, i.e., electronic versions of a traditional paper laboratory notebook. The goal of electronic notebooks is to provide distributed access to data, as well as automated data entry, searching, and other information processing not possible in a paper notebook.

3 The EVC system

The aim of the EVC system is to provide tools that help researches to collaborate in all the typical phases of an experiment with ultra-bright light sources (i.e., experiment set-up, data collection, data analysis, and publication/storage of results).

We chose a Web-based interface for the EVC, since we did not want to force the user to download and install any client software (besides a Web browser and a Java Virtual Machine). Consequently, the system is composed by a Web server, through which users access the different services (e.g. set-up experiments, see experimental data, run scientific programs). The Web server performs the required services by communicating with other computing equipment at Elettra (e.g., data collection workstations, data processing workstations), and translating user requests into proper commands, which are in turn executed by scripts running on specific machines. In this way, most of the UNIX commands that are needed to set-up and carry out an experiment (which may vary from one computer to another) are no longer needed by the user, that can concentrate only on the experimental activity.

The EVC interface (see Figure 1) resembles a Web portal that can be accessed by different categories of users (visitors, researchers, experiment leaders, staff personnel of the experimental stations), which are offered different sets of possible actions, depending on their user category and expertise level (for example, an experiment leader can add and remove collaborators from a specific experiment, while a normal user has not this possibility).

Any experiment supported by the EVC is divided into three phases: *data collection*, in which collaborators can access the experimental station equipment (both physically and through the EVC), *data analysis*, in which collaborators can share experimental data and run scientific programs to analyze those data, and *experiment standby*, in which only sharing of data is allowed. Depending on the availability and scheduling choices for the experimental equipment and computing resources, the EVC automatically sets the current status of every experiment.

Collaboration teams are led by an experiment leader (which typically, for security and safety reasons, is the one who physically carries out the experiment at the experimental station) which is able to add and remove collaborators at any time. Besides that, the EVC does not force any particular collaboration protocol, leaving to users the freedom to establish a suitable collaboration strategy (this was fundamental for the acceptance of the system).

At any phase of an experiment, collaborators can communicate both textually and visually using a chat, which allows, besides typical messaging facilities, pasting of images (obtained from the data collection equipment) and drawing on a shared canvas. Researches can thus see the same image and discuss about it with the possibility of drawing arrows, signs, or text on it, and have the others see what one is doing. Moreover, they can share experimental data by using a file browser tool (see Figure 2), which performs also some basic processing of the experimental data (this allows remote users to quickly estimate the suitability of the experimental parameters). Finally, access to scientific resources (such as the Protein Data Bank) is integrated in the EVC interface.

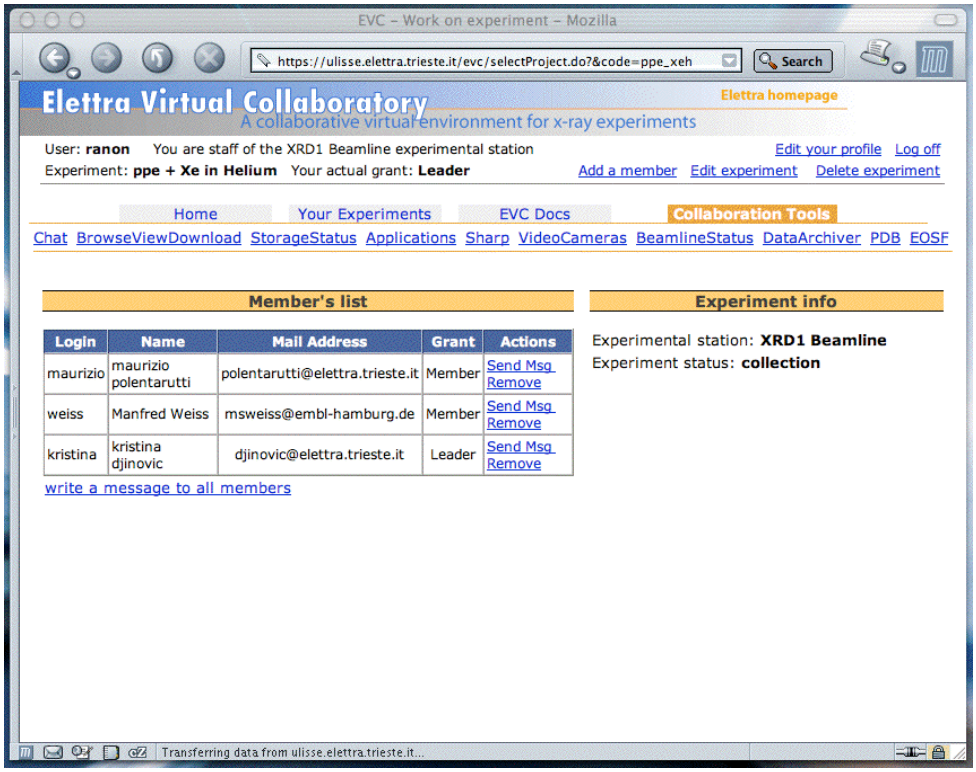

Figure 1. The EVC page for a specific experiment.

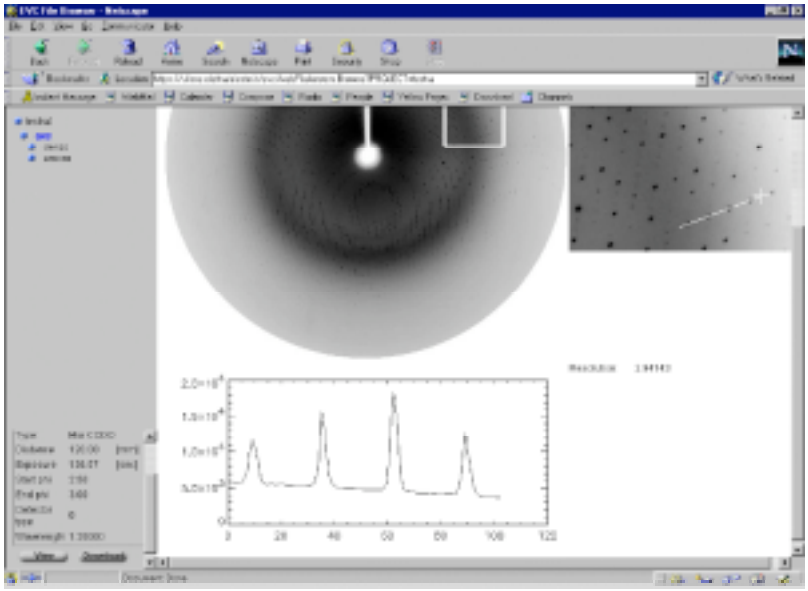

Figure 2. The scientific file browser showing a diffraction image.

During the *data collection* phase, collaborators have also the possibility of monitoring the experimental equipment both through video cameras and by a synoptic view of the equipment which is being used.

In the *data analysis* phase, collaborators can run scientific applications using the computing resources at Elettra. Since these applications are typically X-Window based, they can be remotely accessed using *VNC* (Virtual Network Computing), which provides a remote graphical interface to the computing servers. This solution has the additional advantage of not requiring the (expert) user to learn new commands and procedures: the scientific applications that are used are typically very complex to understand and use even for an expert in that domain, and many users would probably refuse the system if forced to learn new interfaces.

4 Conclusion

Currently, the EVC is being tested (in real-world situations) on three different experimental stations at Elettra. Currently, we are implementing an electronic notebook to store texts and images (which are automatically indexed and hence easily searchable), and the possibility of partially accessing the system via WAP enabled mobile phones.

Acknowledgements

The authors would like to thank Kristina Djinovic Carugo, all the people of the Structural Biology Laboratory and of the Instrumentation and Measurement Software Area of Elettra for helpful discussions and encouragement.

References

1. Cerf, V. G. et al., National Collaboratories: Applying Information Technologies for Scientific Research, National Academy Press: Washington, D.C., 1993.
2. Kouzes, R. T., Myers, J,. D. and Wulf, A. W. 1996. Collaboratories: Doing Science on the Internet,.IEEE Computers, Volume 29, Number 8.
3. Olson, G. M., Atkins, D. E., Clauer, R., Finholt, T. A., Jahanian, F., Killeen T. L. , Prakash, P., and Weymouth, T. 1998. The Upper Atmospheric Research Collaboratory (UARC). Interactions, Volume 5, Issue 3
4. The Spectro-Microscopy Collaboratory at the Advanced Light Source, http://www-itg.lbl.gov/BL7Collab/
5. Stanford Collaboratory for Macromolecular Crystallography, http://smb.slac.stanford.edu/collaboratory/