

# THE BEAMLINE EXPERIMENTS SCHEDULING SOFTWARE



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# ABSTRACT

Scheduling the experiments to the beamlines of the synchrotron at the Canadian Light Source (CLS) is a manual procedure so far. Once every

# SOFTWARE IMPLEMENTATION

The experiment schedule on the web calendar

	Previous task for cycle id(22) is finished!
Cycle	Colored Descellance (add 10 1)

Facility

Autom

six months, the beamline scientists discuss before a whiteboard to schedule as many approved experiments as possible. In the Canarie funded project Science Studio, we are building *an automatic scheduling module*. After the synchrotron users submit their proposals via Web UI, the automatic scheduling module can find an optimal scheduling solution that satisfies all the constraints modelled, if such a solution exists, and display the results on a *Web calendar*. We present our contributions on design and implementation of the scheduling module and our study on automatic scheduling of synchrotron experiments.

#### THE SYSTEM ARCHITECTURE OF USER OFFICE

The Science Studio platform is a large J2EE enabled Web application. Figure 1 shows its system architecture. The core of the system architecture is the application tier composed by the User Interface (UI) services, the User Office, and the beamline services. The major functions of the User Office are proposal management (PM) and scheduling (SCH). The proposal management module accepts user inputs and manages the proposal review process. The schedule module gets proposal information and outputs the scheduling results on a Web calendar.



(Display Calendar)	Close Calendar (Ner	w Scheduling Task					
Hours	Su	Mo	т	w	Th	F	s
Troata	00	inty.				1-January	2-January
00:00 - 08:00							
08:00 - 16:00							
16:00 - 24:00							
	3-January	4-January	5-January	6-January	7-January	8-January	9-January
00:00 - 08:00	,	,	,	,	Proposal #71	Proposal #17	Proposal #34
08:00 - 16:00				Proposal #71	Proposal #17	Proposal #34	Proposal #34
16:00 - 24:00				Proposal #71	Proposal #17	Proposal #34	Proposal #34
	10-January	11-January	12-January	13-January	14-January	15-January	16-January
00:00 - 08:00	Proposal #78	Proposal #78	Proposal #78	Proposal #78	Proposal #78	Proposal #45	Proposal #45
08:00 - 16:00	Proposal #78	Proposal #78	Proposal #78	Proposal #78	Proposal #78	Proposal #45	Proposal #45
16:00 - 24:00	Proposal #78	Proposal #78	Proposal #78	Proposal #78	Proposal #78	Proposal #45	Proposal #45
	17-January	18-January	19-January	20-January	21-January	22-January	23-January
00:00 - 08:00	Proposal #45	Proposal #45	Proposal #45	Proposal #40	Proposal #40	Proposal #40	Proposal #40
08:00 - 16:00	Proposal #45	Proposal #45	Proposal #45	Proposal #40	Proposal #40	Proposal #40	Proposal #40
16:00 - 24:00	Proposal #45	Proposal #45	Proposal #45	Proposal #40	Proposal #40	Proposal #40	Proposal #40
	24-January	25-January	26-January	27-January	28-January	29-January	30-January
00:00 - 08:00	Proposal #40	Proposal #44	Proposal #44	Proposal #44	Proposal #44	Proposal #44	Proposal #31
08:00 - 16:00	Proposal #40	Proposal M44	Proposal #44	Proposal #44	Proposal #44	Proposal #44	Proposal #31
16:00 - 24:00	Proposal #40	Proposal #44	Proposal #44	Proposal #44	Proposal #44	Proposal #44	Proposal #31
	31-January	1-February	2-February	3-February	4-February	5-February	6-February
00:00 - 08:00	Proposal #31	Proposal #31	Proposal #31	Proposal #31	Proposal #107	Proposal #107	Proposal #10
08:00 - 16:00	Proposal #31	Proposal #31	Proposal #31	Proposal #31	Proposal #107	Proposal #107	Proposal #10
16:00 - 24:00	Proposal #31	Proposal #31	Proposal #31	Proposal #31	Proposal #107	Proposal #107	Proposal #10
	7-February	8-February	9-February	10-February	11-February	12-February	13-February
00:00 - 08:00	Proposal #107	Proposal #107	Proposal #118	Proposal #118	Proposal #118	Proposal #118	Proposal #11
08:00 - 16:00	Proposal #107	Proposal #107	Proposal #118	Proposal #118	Proposal #118	Proposal #118	Proposal #11
16:00 - 24:00	Proposal #107	Proposal #107	Proposal #118	Proposal #118	Proposal #118	Proposal #118	Proposal #11
	14-February	15-February	16-February	17-February	18-February	19-February	20-February
00:00 - 08:00	Proposal #118	Proposal #118			Proposal #75	Proposal #75	Proposal #75
08:00 - 16:00	Proposal #118	Proposal #118			Proposal #75	Proposal #75	<ul> <li>Proposal #75</li> </ul>
16:00 - 24:00	Proposal #118	Proposal #118		Proposal #75	Proposal #75	Proposal #75	Proposal #75

Figure 2: Example screen shot showing a calendar with schedule results



Figure 1: The system architecture for Science Studio.

## **MODELING THE SCHEDULING PROBLEM**

The experiment scheduling problem is modelled as an integer programming model. We consider various constraints of the experiments, such as preferred starting time, unacceptable time intervals beamline operating modes, and experiment priorities. The objective is to minimize the total weighted lateness which is defined as the sum of time differences between the preferred end time of an experiment and its actual finish time. ILOG is the scheduler we use. Figure 3: Users can manually edit the schedule on the calendar.

## Testing with the real world data

We use the CLS proposals data for the first cycle of 2010 for testing the scheduling functions. A summary of these proposals is in Table 1. Totally 141 proposals are scheduled. The time points and intervals are converted to nature numbers in the format as shown in Figure 4.

7,122,14,1	7,110,42,6	7,106, 98,9	7,123,189,6
7,118,17,3	7,111,48,6	7,102,107,9	7,113,203,9
7,100,20,3	7,112,54,6	7,96,116,10	7,108,212,9
7,103,23,3	7,116,60,6	7,119,126,12	7,107,221,15
7,109,26,3	7,105,66,8	7,125,138,2	7,121,236,6
7,124,29,3	7,126,74,8	7,127,144,15	7,101,521,6
7, 97,32,4	7,114,82,8	7,98,159,18	7,104,527,6
7,120,36,6	7, 99,90,8	7,115,177,6	7,117,533,9

Figure 5: Part of the scheduling results from the ILOG for beamline SGM in the format of [index of beamline, index of proposal, start time, processing time]

Table 1: General user							
proposal summary							
Beamline	Total	Total Shift					
	Requests	Request					
01B1-1 (Mid IR)	5	77					
02B1-1 (Far IR)	15	258					
06B1-1 (SXRMB)	9	72					
06ID-1 (HXMA)	25	211					
07B2-1 (VESPERS)	5	60					
10ID-1 (SM)	36	343					
11ID-1 (SGM)	32	228					
11ID-2 (PGM)	14	120					
Total	141	1369					

