DIGITAL INTERVAL PHOTOGRAPHY IN KULOGORSKAYA CAVE SYSTEM

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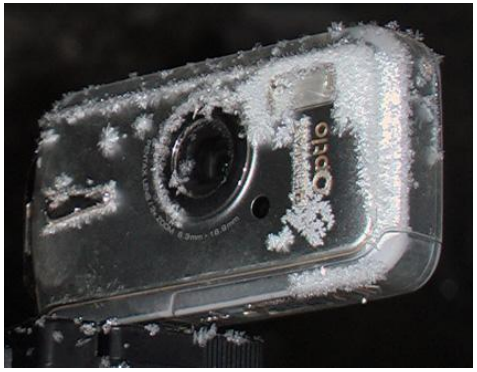
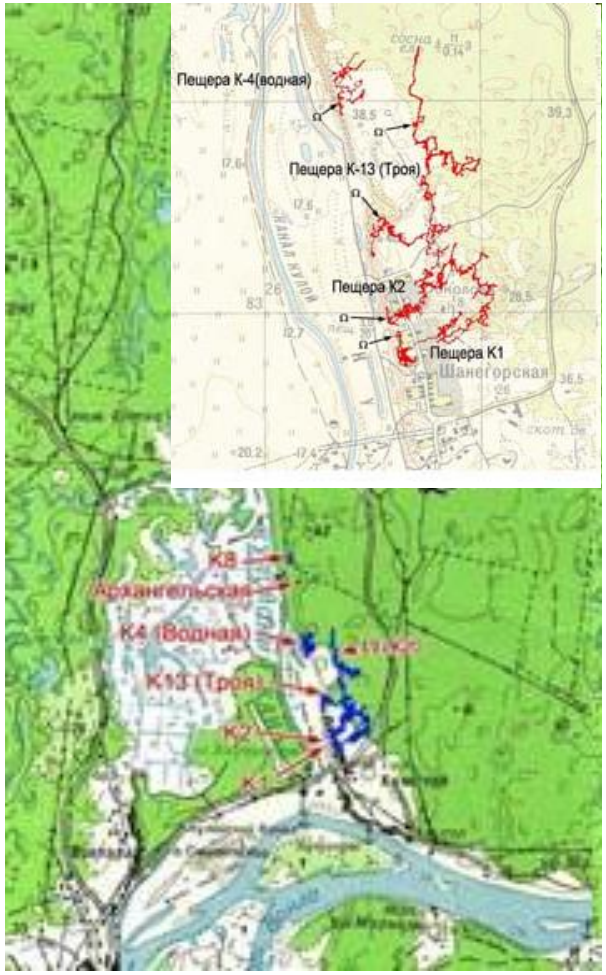


Interval Photography
Интервальная фотография



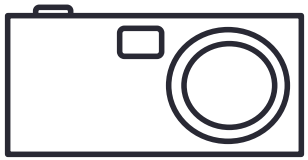
Kulogorskaya cave system is situated in Pinega district, Archangelsk region. Seven horizontal caves are currently known at the section.

Since 2008 we use digital interval photography for hydrological and other observations. This report will focus on technology used, obtained results and problems we encountered.

Digital camera with interval photography function
Цифровая камера с функцией интервальной съемки

- Limitations
  - Number of images: Limited by built-in battery 100…200
  - Maximal interval between frames: limited by camera software, 99 minutes for Pentax Optio
  - Duration: 100 images x 99 min ≈ 7 days

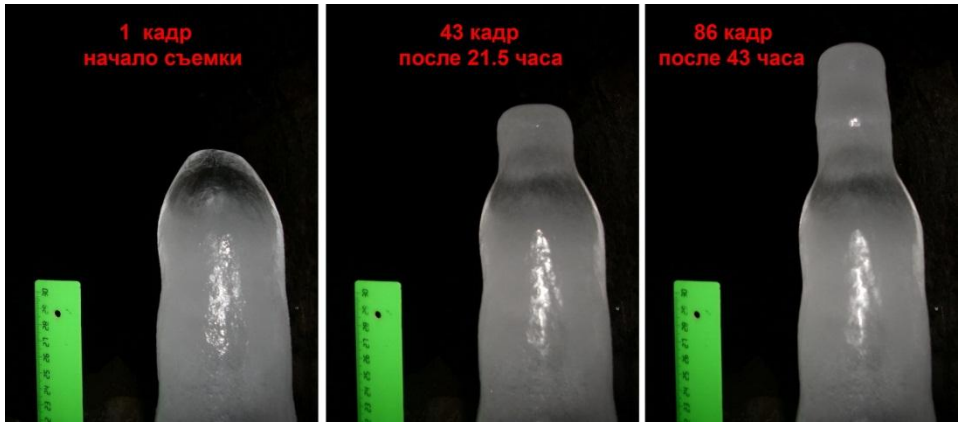
- Standard camera without extra equipment can be used for interval photography of short duration.



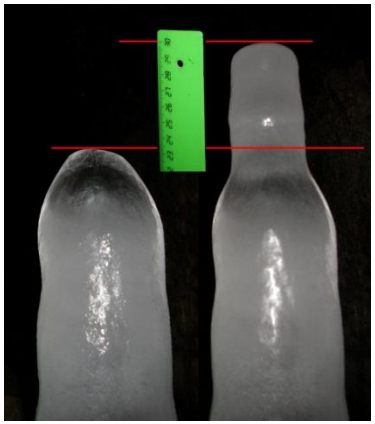
Ice stalagmite growth observations in K-2, Jan 2008. Наблюдения за ледяным сталагмитом

Ice stalagmite growth observations:

- *first frame;*
- *after 21.5 hours;*
- *after 43 hours (last frame).*

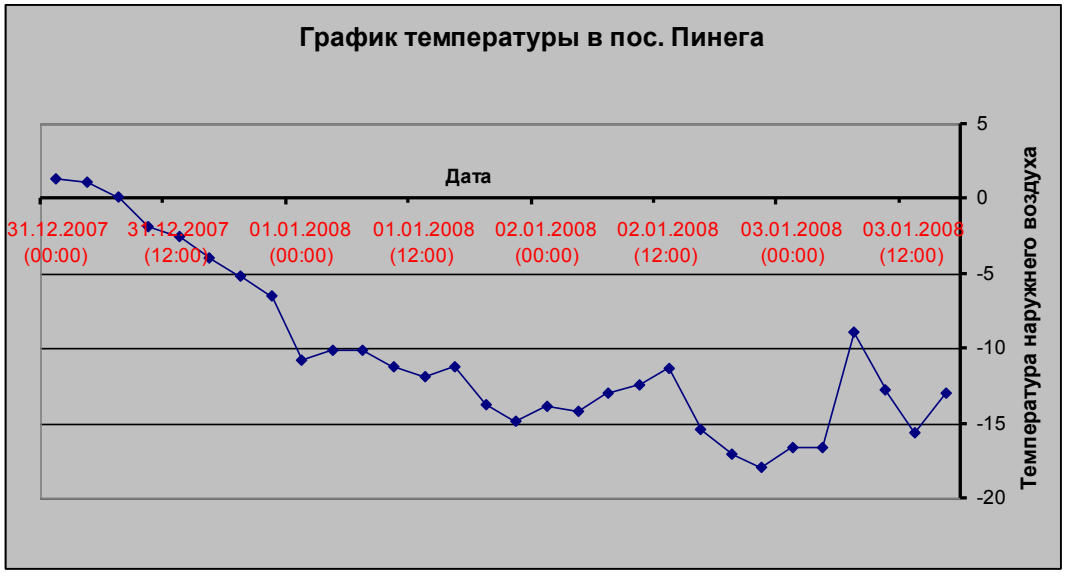


- We use Pentax Optio W10;
- Interval between frames – 30 minutes;
- Stalagmite growth 68 mm (average growth rate - 16 mm/hour).



Ice stalagmite growth video, К-2 cave
Видео процесса, пещера К-2

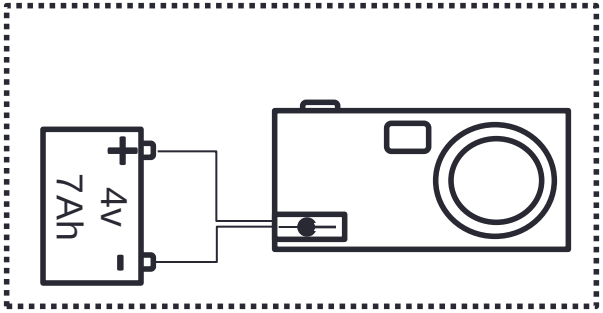
Weather change during photography session, Jan 2008
Изменение погоды во время съемки, январь 2008



- High growth rate was conditioned by fast cooling of external air entering the cave. During photography session air temperature dropped from +2°C to -18°C, as shown on graph above.
- The cold air began to flow rapidly into the cave and zero horizon temperature in the cave started to rise quickly to the ceiling.

Camera with external power
Камера с внешним питанием

- Limitations
  - Number of frames: limited by camera software, 1000 frames for Pentax Optio.
  - Duration: 1000 frames x 99 min ≈ 3 month
- Connecting external power breaks camera sealing, external sealed box required.
- Image degradation due to
  - Condensate on box glass
  - Flash reflection from the box glass



Spring flood 2008. Cave K-4.
Весенний паводок 2008. Пещера К-4.

а) б) в)

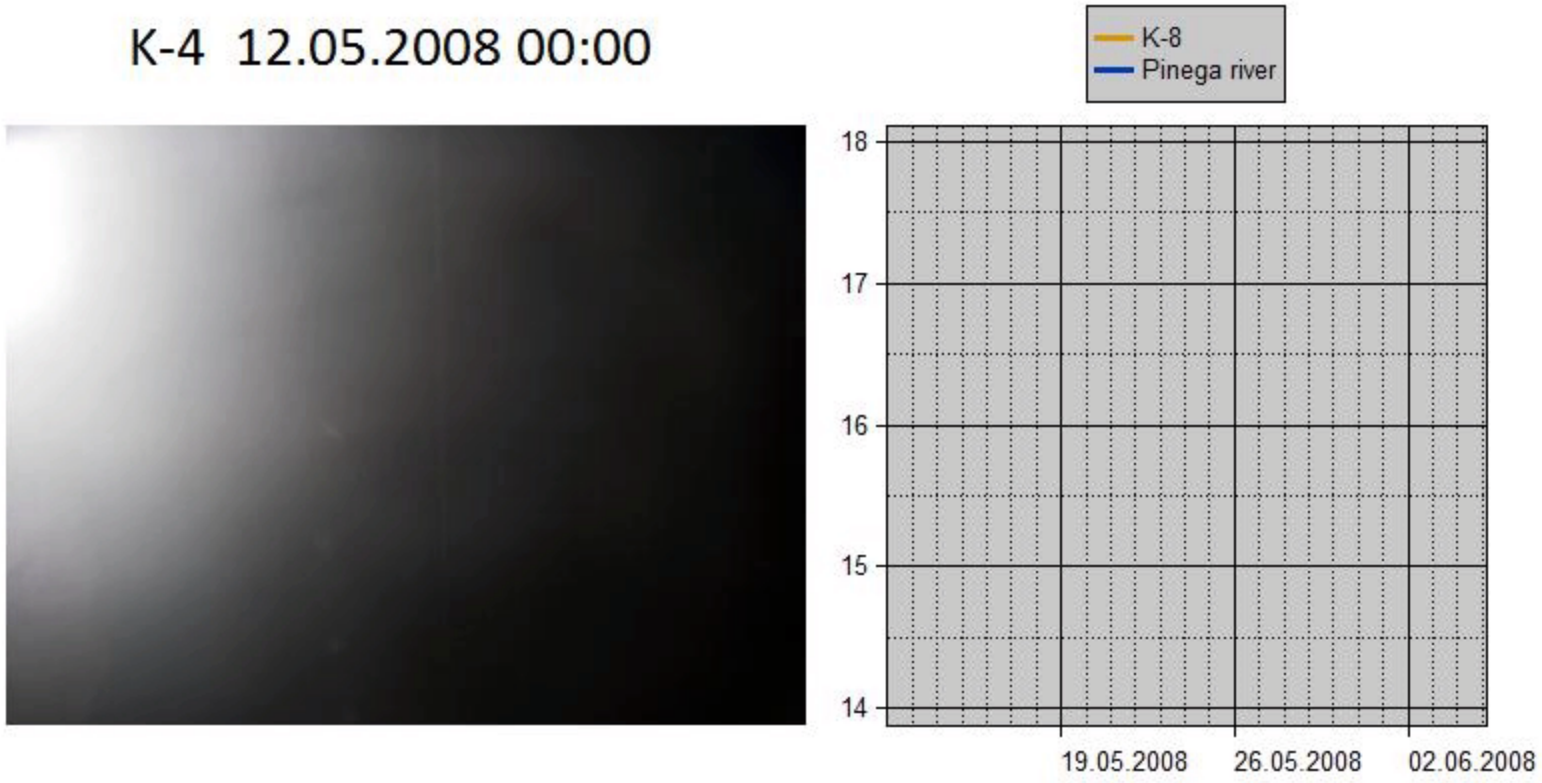
а) box with camera; б) first frame – April 3;
в) Last frame – July 5.

Equipment used:

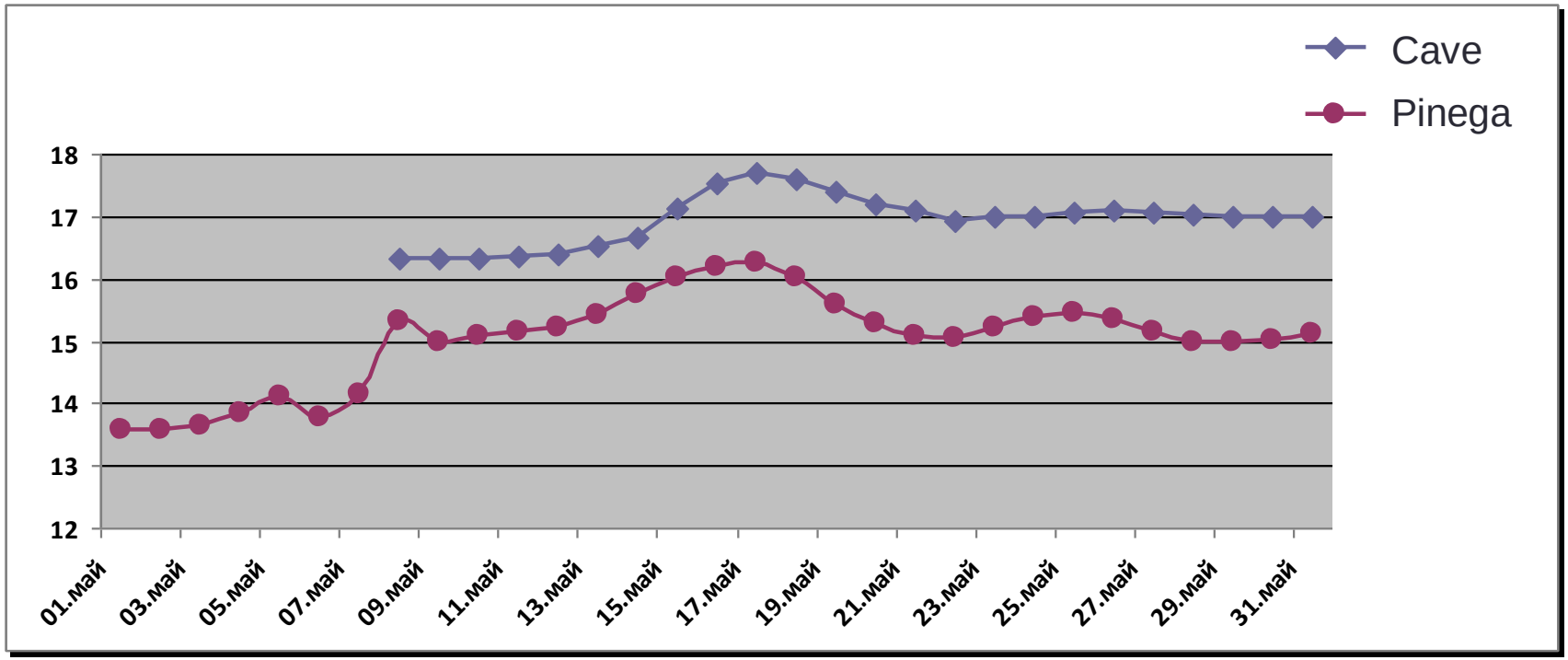
• External power: 2 sealed lead-acid batteries 2V 7Ah connected directly to Pentax W10 power jack;
• Sealed plastic box (а);
• Vertical ruler and floats (б,в).

Image quality was low because of condensate and flash reflection from box glass and cave walls.

Spring flood 2008, Cave К-4.
Весенний паводок 2008, пещера К-4.



Spring flood 2008 hydrograph
Гидрограф паводка 2008 года

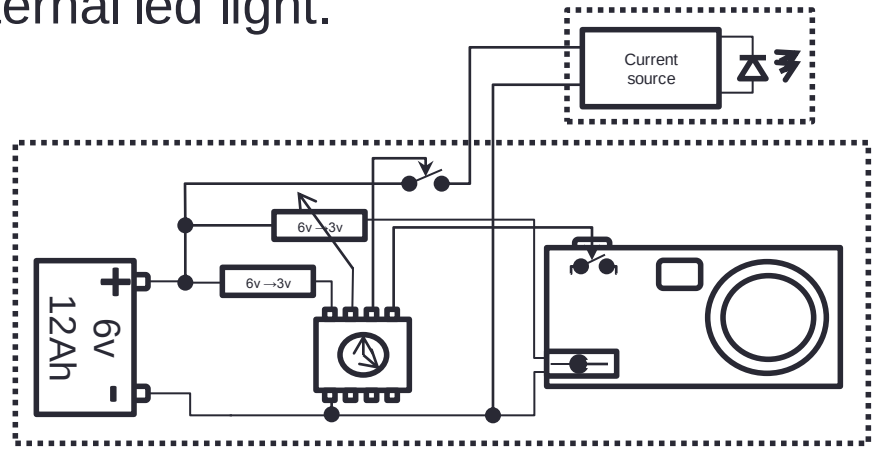


Problems with external battery setup
Проблемы с которыми мы столкнулись

- Duration is still not enough for our needs
  - Since it is limited by camera software we need to replace camera
- Low image quality
  - Flash reflection from box glass
    - Use external light source, so that reflection will not reach camera lens
  - Condensate
    - Use “anti-fog” sprays/specially coated plastic

Canon camera with CHDK and Microcontroller
Камера Canon с CHDK и микроконтроллером

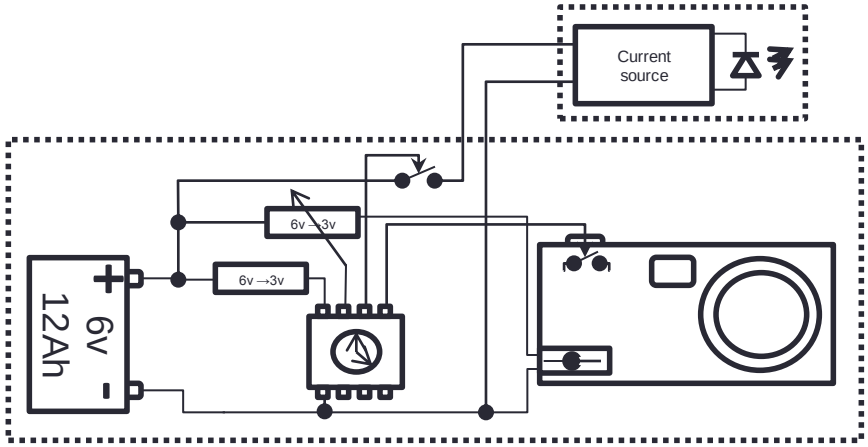
- CHDK is a third-party firmware available for many Canon cameras, which allow full camera control, including possibility for user to write program to control camera.
- Many interval photography programs are available for CHDK, the only problem is power consumption, since it is not possible to turn camera power off between frames using CHDK.
- It is than required to add external microcontroller which will turn camera on at preset interval. The in-camera program will be run at startup, set focus distance, turn off camera flash and made a shot.
- Microcontroller will also turn on/off external led light.
- Camera modification required –wires for external on/off switch should be soldered.



Canon camera with CHDK and Microcontroller
Камера Canon с CHDK и микроконтроллером

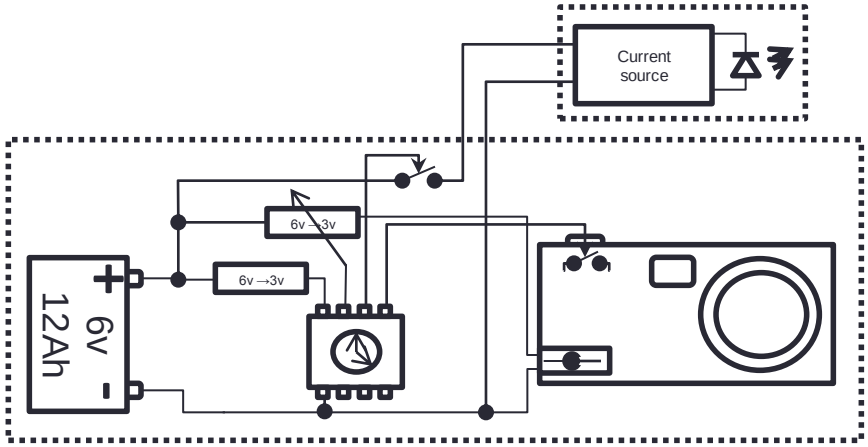
- Limitations
  - Number of frames: limited only by flash card size
  - Duration: limited only by available external power

- Image quality issues
  - Problem with flash reflection fixed
  - Problem with condensate remains, chemical means not effective



Spring flood 2009, Cave K-4.
Весенний паводок 2009, пещера К-4.

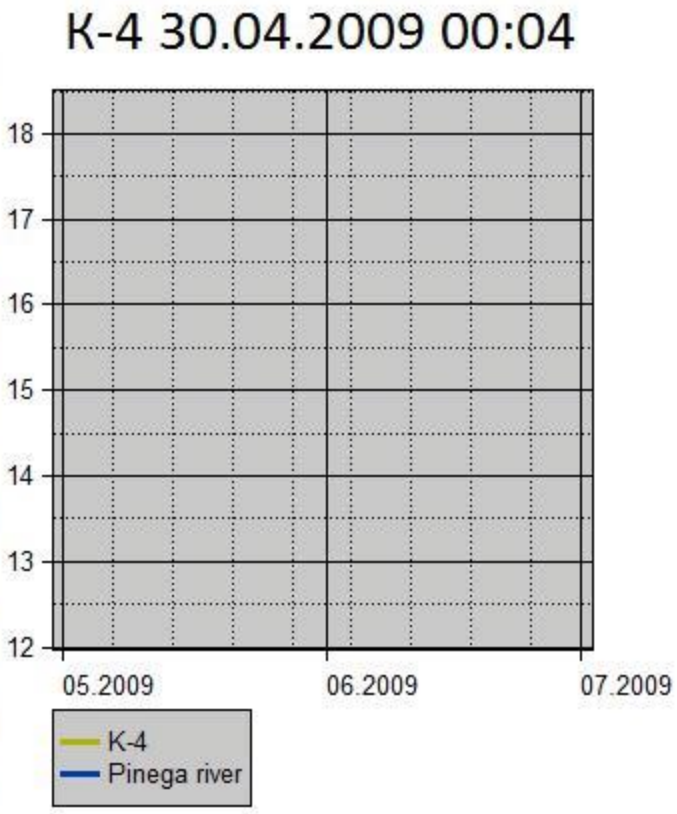
- We have used Canon A460 with CHDK software;
- Camera power and external light controlled with Texas Instruments MSP430F2001 microcontroller;
- 6V 12Ah sealed lead-acid battery;
- Single 3W led light source;
- We have used fluorescent labels on ruler and floats to improve visibility even in heavy condensate conditions.



Spring flood 2009, Cave К-4.
Весенний паводок 2009, пещера К-4

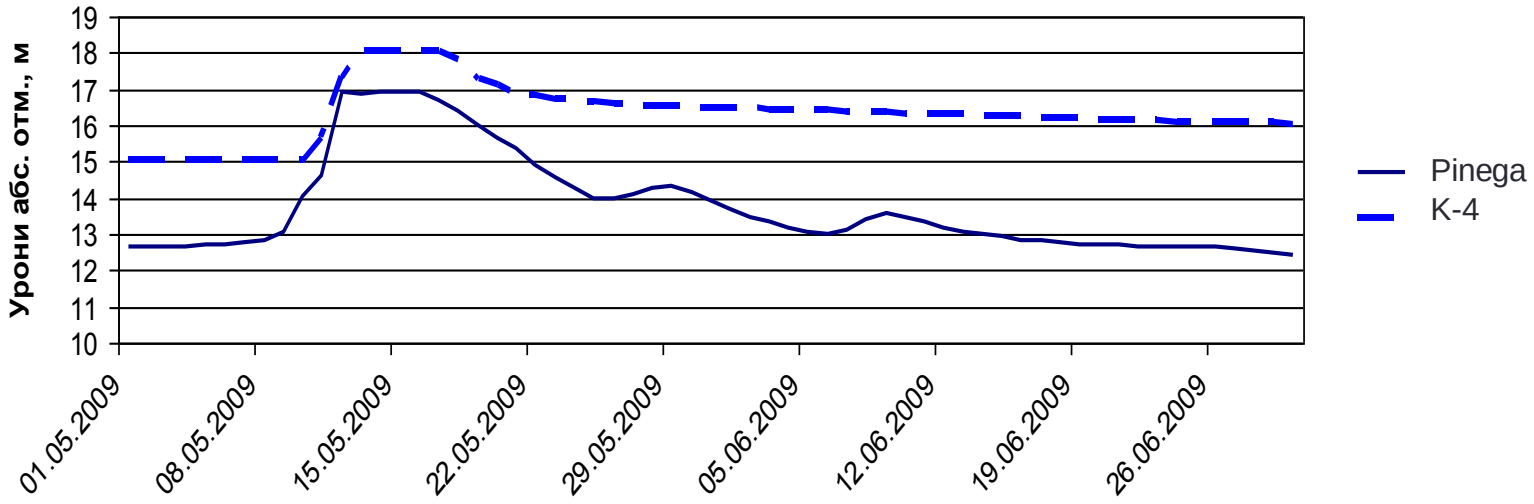
First frame March, 25	Flood started May 12, 00:00	 May, 12, 21:00	Water rises above camera May, 13, 13:00
			
May, 19, 13:00	**May, 21, 3:00**	**May, 29, 18:00**	**Jun, 10, 9:00**
			

Spring flood 2009, Cave К-4.
Весенний паводок 2009, пещера К-4.

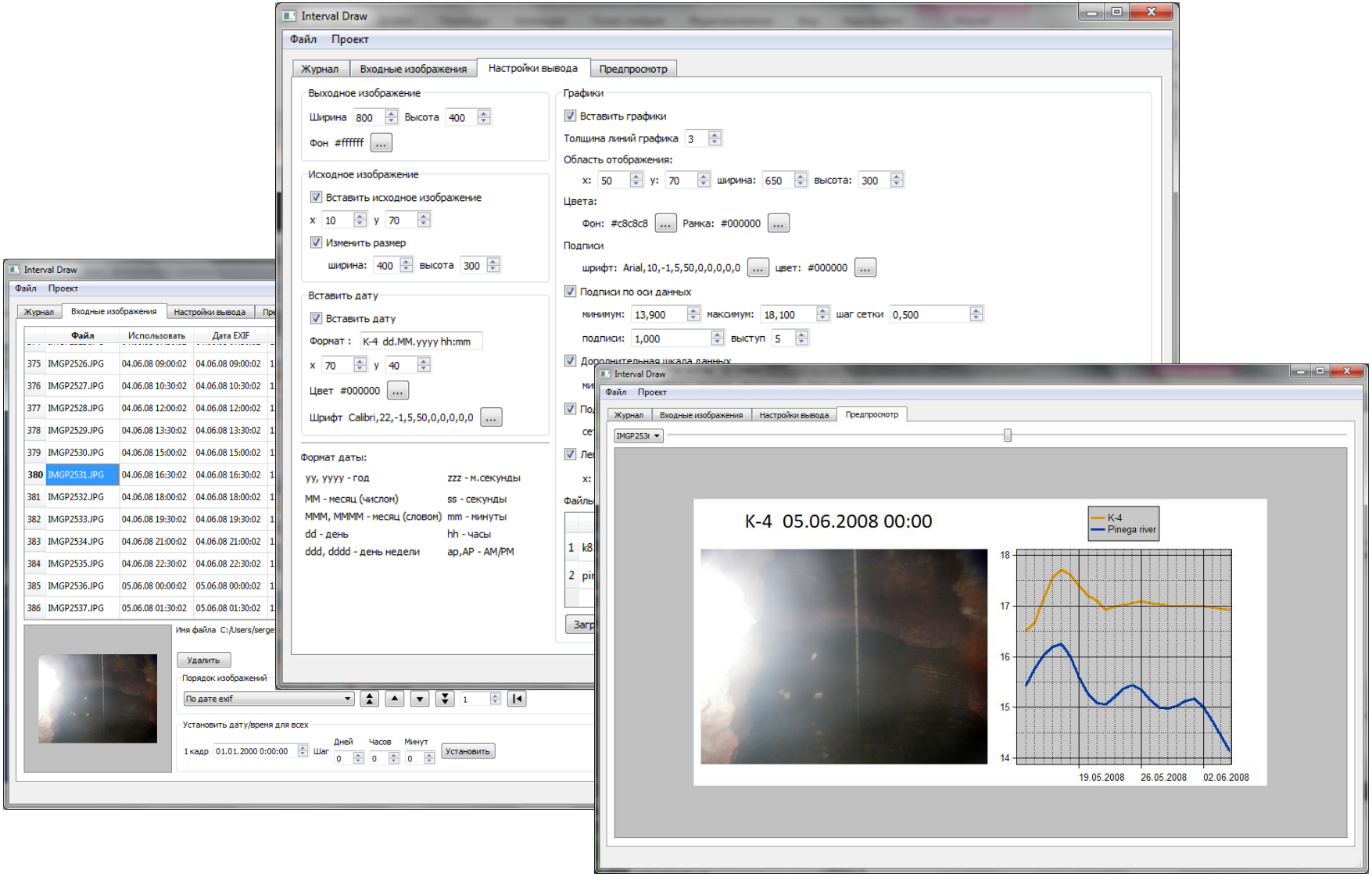


Spring flood 2009 hydrograph.
Гидрограф весеннего паводка 2009 г.

- Camera installed on March, 25.
- Water rise started in cave at May, 12;
- Decrease started at May, 18;
- Camera works successfully till removed at august.



Software for film creation
Программа для создания фильмов



Conclusions
Выводы

Digital interval photography allows to organize regular visual observation of hydrological and other processes in cases when the caves are inaccessible for humans or no permanent staff.

For more informative photography it is appropriate to place the various indicators in the frame. For example such indicators can be used to measure the water level and flow direction. To improve indicator visibility one can use reflective markers. Additional data can be obtaining by placing temperature or other loggers close to camera.

Conclusions
Выводы

Interval photography technology

		Camera with interval photography mode	Camera with external power	External MCU timer + Canon camera with CHDK
Limitations	Number of frames	Camera battery 100…200	Camera software 1000	Flash card / external battery
	Duration	1-2 weeks	3 month	> 6 month
Image quality problems	Condensate	±	+	+
	Flash reflection	-	+	-
Recommended for		Short duration		Long duration

Conclusions
Выводы

How to prevent condensate ?

- **Chemical means**
  - Plastic from anti-fog glasses
  - Anti-fog sprays

Nothing we try works ☹

Conclusions
Выводы

How to prevent condensate ?

- **Heating**

  Will require 4 times more energy than used for camera. We are going to try it, camera with heater will be installed this evening.