



**Czech  
Hydrometeorological  
Institute**

# ADCP regatta

5.–7. 5. 2025, Vranov nad Dyjí, Czech Republic



**Protokol z porovnávacího měření č. ADCP-ČHMÚ-2025-1(ENG)**

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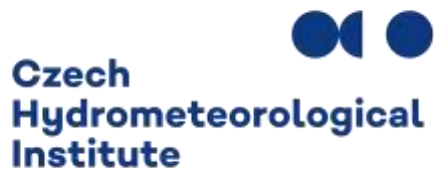
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**Pictures:**

shared database of event photos available at: <https://photos.app.goo.gl/K7zBBZam3XFeo75a7>

Event organization:



Participants:



**Bundesamt  
für Wasserwirtschaft**



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# Abstract

The ADCP Regatta organized by the Czech Hydrometeorological Institute (CHMI) took place at the traditional location in Vranov nad Dyjí from May 5 to 7, 2025. This time, experts in suspended sediments were also invited to the event, as they use ADCPs to monitor sediment transport in rivers. In addition to 45 CHMI staff members, 33 participants from partner institutions in the Czech Republic (Povodí Moravy, Povodí Ohře) and abroad (Slovakia, Poland, Austria), attended the event. A highlight of the event was the presentation of new developments by representatives of manufacturers (Xylem Sontek, TRDI, SEBA). In the pleasant surroundings of the Vranov reservoir and during a sunny field measurement day by the river, participants learned about the latest trends, deepened their knowledge of discharge measurements, and established valuable international contacts. The workshop's main goal—certification of both instruments and users—was successfully achieved at a high standard, as demonstrated by the measured discharge values and subsequent analyses.

For the purposes of metrological records of CHMI, this document is marked as:

Protokol z porovnávacího měření č. ADCP-ČHMÚ-2025-1(ENG)

# 1. Introduction and objectives

The acronym ADCP (Acoustic Doppler Current Profiler) expresses the name for flow measurement instruments that have undergone considerable technological development in the last two decades and thus contributed to the refinement of primary hydrological data not only within the CHMI but also globally. CHMI, specifically the Department of Applied Hydrology (OAH) in Jablonec nad Nisou, has the task of implementing new technologies into hydrometric practice and, thanks to the experience and investments over the last 15 years, the hydrometric equipment of the institute can be considered to be comparable to the world's top (USA, Canada, France). Since 2015, the staff of the CHMI measuring with ADCP instruments has been meeting regularly in Vranov nad Dyjí, where the practical workshop introduces not only the basics of the measurement but also the innovations in the field of hydrometry, evaluation software, and other practical experience associated with this method of flow measurement.

The principle of comparative field measurements (ADCP regattas) is to find a suitable river reach where it is possible to measure a wide range of ADCP instruments (i.e., where flow is uniform and steady). Comparison of the measurement results by individual instruments from the overall average of all measurement results, while respecting uniform settings and handling, leads to the detection of significant deviations, which may indicate a failure of the instrument. Comparative measurements of many ADCP instruments conducted in this way are sufficiently accurate, cost-effective, and above all a more accessible form of instrument verification compared to those in certified laboratories.

The organization of the event follows internationally recognized practice, which has already been documented and is expected to be published as WMO Guidance later this year. Certification of users and instruments is required to clarify and manage CHMI's extensive instrument base, which new staff members at regional branches are gradually becoming acquainted with. Their training and familiarization with both the method and colleagues are among the most significant outcomes of the entire event.

The floods that occurred in Czechia in September 2024 clearly demonstrated the valuable capability of CHMI technicians to perform discharge measurements under extremely challenging conditions. The data collected during these floods represent an unprecedented quantity and quality of observations during such extreme events in overall history. The experience gained by staff in measuring flood discharges should be transferrable to other team members, same as the limitations of ADCPs in extreme flows. Once the safety thresholds for ADCP operation were exceeded, the non-contact LSPIV technique proved to have considerable potential for future use. The progress in this area is also reflected in the results presented within the ADCP regatta.

## 1.1 Review of previous inter-laboratory experiments

In the framework of the CHMI instrumentation, the first attempts to compare ADCP measurements can be dated back to 2013, when it was mostly about joint measurements near chosen gauging station and mutual exchange of experience of individual users. The measurement parameters were not closely compared and as a sufficient output the collection of flow data with a uniform setting of all instruments was considered. In the following years, a suitable measurement location was sought for a sufficiently high-quality flow measurement with TRDI devices (StreamPro, RioGrande), which were supplemented by SonTek devices in 2015. In the same year, the measurement cross-section at Vranov gauging station was determined to be optimal not only with respect to the channel and flow parameters, but also thanks to the possibility of constant (steady) flow from the above-mentioned dam and the available background for the event.

For the needs of the CHMI hydrometric group, a deviation of  $\pm 5\%$  of the overall average of the measured flow rates was determined as a sufficient verification of instrument accuracy. With the development of evaluation tools, it is possible to better specify the individual deviations and biases, but the 5% rule remains a supporting pillar not only within the ADCP regattas, but also a similar meeting and comparison of other flow measuring instruments such as classical current meters, dilution method probes or surface velocity radars. A list of all the events organized by CHMI over the last decade is given in the table.

**Table 1 Previous inter-comparisons in Czechia**

Experiment	Devices	Mean Discharge (m <sup>3</sup> /s)	Number of teams (devices)
Želiv, 2013	ADCP, Flowtracker	4.737	18
Lipno, 2014	ADCP, Flowtracker, propeller	11.8	14
Paseky, 2015	ADCP, Flowtracker, propeller	various	7
Vranov, 2015	ADCP	14.6	16
Šachov, 2016	current meters	0.856	11
Vranov, 2016	ADCP	14.8	21
Skalná, 2017	current meters	0.641	17
Vranov, 2017	ADCP	15.0	19
Rýmařov, 2018	current meters	0.589	18
Vranov, 2019	ADCP	15.2	29
Osečná, 2019	current meters	0.488	20
Borovnice, 2020	current meters	1.463	10
Vranov, 2021	ADCP	15.2	30
Kazdovna, 2021	current meters, ADCP, radar, dilution method	0.888	20
Vranov, 2022	ADCP, radar, LSPIV	14.9	35
Kapraluv mlyn, 2022	current meters, dilution method	0.051	28
Vranov, 2022	ADCP	14.1	32
Troskovice, 2023	current meters, dilution method	0.185	22
Vranov, 2024	ADCP, radar, LSPIV	15,6	36
Orlické Záhří	current meters, radar, ADCP	0,459	21

## 1.2 Objectives

The objectives of this study include:

- Comparing discharge measurements, search for outliers
- Comparing sources of bias
- Sharing techniques and experiences,
- Estimating the uncertainty by evaluation in QRame
- Evaluating the site selection impact on discharge measurement,
- Evaluating the impact of extrapolation coefficients,
- Comparing different kinds of methods to measure the discharge

Instruments that show deviation beyond tolerance or bias without clear justification are subjected to further verification. Afterwards if the error is not detected and corrected, the instrument is sent to the manufacturer for repair or is taken out of normal operation.

The event also includes verification of the measurement technique of individual users, who must demonstrate sufficient knowledge of the measurement technique, data collection and distribution of results.

## 2. The experimental design

This chapter describes the participants and ADCPs gathered during the experiment and some logistical aspects.

### 2.1 Participants

In the hospitable area of Penzion M, directly at the Vranov Dam, a total of 78 participants from 8 European countries, representing 5 National Hydrological Services, met in the period 5–7 May 2025. For the purposes of successful comparison measurements, the maximum capacity of 50 ADCP devices that could operate on five defined transverse profiles (A-E) was determined on the basis of previous regattas in this location. Individual participants were thus distributed in the final 36 teams of 2 to 5 members, whose task was to perform the highest quality measurement of the flow in the defined profile according to the prescribed settings (Appendix C) for individual ADCP devices. 45 employees from CHMI participated, who not only actively participated in the flow measurement, but also helped with the organization. Logos are mentioned at the beginning of the document; full name descriptions are involved in Annex B. Table 2 below summarizes all the participant teams and the ADCP type deployed.

The organizing team was made up of CHMI representatives who were in charge of preparing location, installing support equipment and coordinating the measurement schedule.

Evaluation of the results, data analysis and generation of the final report were mainly handled by representatives from the Jablonec and Prague branches.

**Tab. 2 Participant teams. (ADCP devices are further described in Tab. 3)**

Nr.	ADCP team name	Device	Boat
1	CHMU BR	SonTek M9	torrent board
2	CHMU BR	TRDI RiverPro	trimaran
3	CHMU BR	SonTek RS5	TBX
4	CHMU BR OMPM	TRDI StreamPro	trimaran
5	CHMU CB	SonTek M9	torrent board
6	CHMU CB	SonTek RS5	TBX
7	CHMU HK	SonTek M9	torrent board
8	CHMU HK	SonTek RS5	TBX
9	CHMU JBC	SonTek M9	torrent board

10	CHMU JBC	TRDI StreamPro	trimaran
11	CHMU OS	SonTek M9	torrent board
12	CHMU OS	TRDI StreamPro	trimaran
13	CHMU PL	SonTek RS5	TBX
14	CHMU PL	SonTek M9	torrent board
15	CHMU PR	SonTek M9	torrent board
16	CHMU PR	SonTek RS5	TBX
17	CHMU PR OJV	TRDI RiverPro	trimaran
18	CHMU PR OJV	TRDI StreamPro	trimaran
19	CHMU UL	TRDI StreamPro	trimaran
20	CHMU UL	TRDI StreamPro	trimaran
21	SHMU BB	TRDI StreamPro	trimaran
22	SHMU BA	TRDI RiverPro	trimaran
23	SHMU BA	TRDI StreamPro	trimaran
24	SHMU BB	TRDI RiverPro	trimaran
25	SHMU BB	TRDI RioPro	trimaran
26	SHMU KE	TRDI StreamPro	trimaran
27	SHMU KE	TRDI RiverPro	trimaran
28	SHMU ZA	TRDI RiverRay	trimaran
29	SHMU ZA	TRDI StreamPro	trimaran
30	IMGW KRA	SonTek M9	torrent board
31	IMGW WAR	SonTek M9	torrent board
32	IMGW WIS	TRDI RiverPro	trimaran
33	IMGW WRO	TRDI StreamPro	trimaran
34	IMGW WRO	TRDI RiverPro	trimaran
35	IMGW WRO	SonTek M9	torrent board
36	HydroDienst	SonTek M9	torrent board
37	HydroDienst	SonTek RS5	HydroBoard II Micro
38	BAW	SonTek RS5	TBX
39	BAW	TRDI StreamPro	trimaran
40	BOKU	TRDI RioGrande	trimaran
41	BOKU	TRDI StreamPro	trimaran
42	Aquamonitoring	SonTek RS5	TBX

43	PMO	TRDI RiverPro	trimaran
44	NARW	SonTek M9	HydroBoard
45	SEBA	TRDI StreamPro	big trimaran
46	TRDI	TRDI RiverPro	trimaran

## 2.2 Equipment

### 2.2.1 ADCPs and tethered boats

Seven kinds of ADCPs were used, from two different manufacturers: M9 and RS5 from SonTek manufacturer and StreamPro, RiverPro, RiverRay, RioGrande and RioPro from TeledyneRDI. Table 3 summaries the different ADCP types and deployment platforms (boats).

**Tab. 3 ADCP types and info**

ADCP	Manufacturer	Number of ADCPs	Number of transducers	Echosounder Frequency	Boat
M9	SonTek	12	9	1 MHz, 3 MHz	torrent board, rQPOD
RS5	SonTek	8	4	3 MHz	TBX float
StreamPro	Teledyne RDI	14	4	2 MHz	small trimaran
RiverPro	Teledyne RDI	9	4	1.2 MHz	trimaran
RioRay	Teledyne RDI	1	1	0,6 MHz	trimaran
RioGrande	Teledyne RDI	1	4	1,2 MHz	trimaran
RioPro	Teledyne RDI	1	5	1,2 MHz	trimaran

### 2.2.2 Software and firmware

The ADCP acquisition software required was: WinRiver II 2.21 (or newer) for Teledyne RDI ADCPs, RiverSurveyorLive 4.1 (or newer) for SonTek M9 ADCPs and RSQ 3.1 (or newer) for SonTek RS5 ADCPs. All measurements were post-processed with QRevInt ver.1.28, resp. QRevInt 1.37 for QRame analyses, (<https://www.genesishydrotech.com/qrevint>) to provide consistent discharge computations and settings between the different teams and ADCP types. Additional analyses were processed with QRame ver.0.1.

The ADCP firmware required was: 31.16 (or newer) for TRDI StreamPro, 56.07 (or newer) for TRDI RiverPro and 4.10 (or newer) for SonTek M9, 1.25 for SonTek RS5.

## 2.3 Logistics

The event commenced with an internal meeting of the CHMI Hydrology Section, which focused primarily on the evaluation of the 2024 flood events. As part of the program, a company specializing in automatic sediment sampling was introduced. Once the meeting was opened to external participants, a necessary briefing was held to explain the coordination of measurements planned for the following day. Participants were informed about the required instrument settings, the measurement schedule, and the format of the output data files. This was followed by presentations from representatives of TRDI, Aquamonitoring (SonTek), and SEBA, which featured newly introduced instruments on the market and their potential applications.

The following day, a full day was dedicated to field measurements of discharge in the river Thaya.

Wednesday 7.5. was devoted in the morning to a brief evaluation of the raw data from the previous day's measurements. The LSPIV method and the data evaluation process were also brought closer. At the end, there was a discussion on various topics.

### 2.3.1 Field safety

The tests were conducted downstream of the Vranov dam. Both banks along the measured section can be considered as safe and stable. The use of a life jacket is not required, but extra caution against slipping or falling into the stream is required. Every team must ensure their own safety while measuring discharge next to the water course: CHMI takes no responsibility for that. To achieve the measurements, everyone is requested to wear suitable shoes, since the ground is uneven and slippery when rainy. At least two operators are requested to conduct a measurement.

Four members of the coordinating team were dedicated to ensuring smooth and safe operations from the bank. Communication was maintained between dam managers and measurement day leader Jan Jirák from CHMI.

No incidents or injuries were registered during the experiments.

Note: for safety and logistical reasons, the number of registered teams was limited to 46.

## 2.4 Site presentation

The inter-laboratory experiments were conducted on the Thaya River (right hand side tributary of the Morava River), downstream of E-ON-operated Vranov Dam, in Vranov nad Dyjí town, Jihomoravský kraj, Czechia (Fig. 1, <https://goo.gl/maps/SPZsWLLSaqetRgo6>).

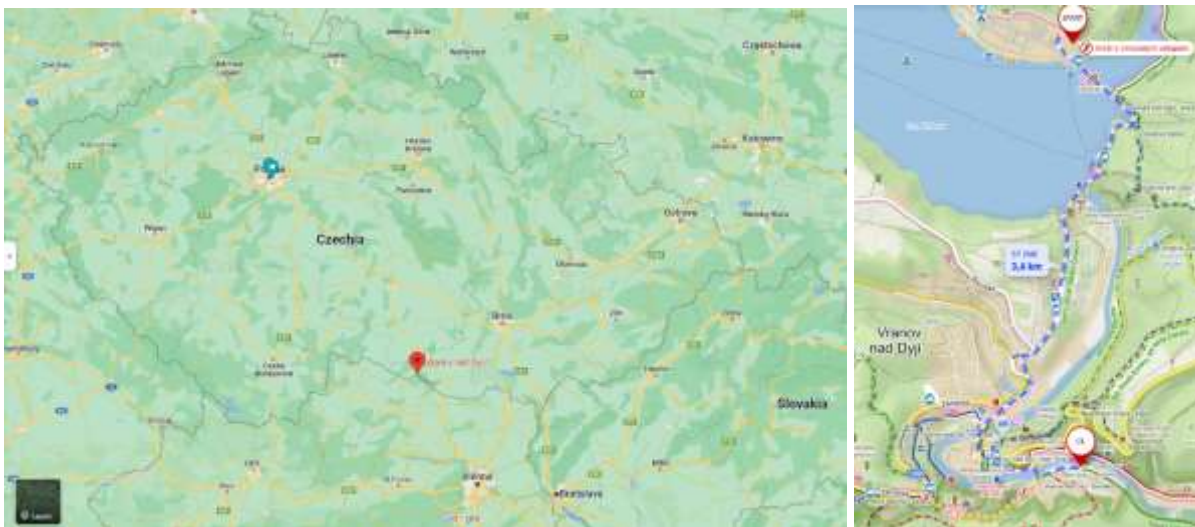


Fig. 1 Location map

Approximately in the middle of the channel reach designated for measurement, the gauging station Vranov Hamry (CHMI Nr. 434000) is located on the left bank. Tents have been installed on the right bank to shelter from the rain and as an organization team headquarter.

### 2.4.1 Cross-sections

Within the 100 m long, straight and uniform reach of the Thaya River, a total of 5 flow measurement cross-sections were defined. 3 of them (B, C, E) were fitted with manual cable way, cross-section A was released for movement with remote controlled deployments and on cross-section D there was installed electric cable way guaranteeing continuous movement of constant speed.



**Fig. 2 Defined cross-sections**

The hydraulic parameters of the individual cross-sections were more or less uniform, with only slight turbulence occurring locally due to isolated cobbles. On average, all cross-sections were approximately 33 m wide with an average depth of about 0.8 m. The depth at the right bank was greater than at the left bank and both banks were triangular in shape.



**Fig. 3** River reach with installed cable ways

## 2.5 Evaluation of the cross-section quality

Generally, all cross-sections are considered suitable for measurement with ADCPs of all types. Sufficient depth across the entire width of the profile allowed to achieve measured discharge ( $Q$ ) above 50% of the total discharge, and for smaller devices even above 70%. The shape of the channel and flow parameters were uniform for all cross-sections. The depth at both banks was sufficient for measurement of at least 2 bins and at the same time the interpolated bank discharge was minimal in relation to the entire transect.



Fig. 4 Upstream view



Fig. 5 Downstream view

## **2.6 Measurements**

### **2.6.1 Hydraulic conditions**

The section of the flow on which the measurements were carried out is situated approximately 3 km below the dam of Vranov and there are no major tributaries in the intermediate section. Approximately 100 m above the first cross-section there is the mouth of the channel of the upstream hydro power station, which has been decommissioned for the duration of all the measurements and all the flow went through the main channel only.

Compared to the conditions observed during previous ADCP regattas at this location, it was evident this year that the outflow from the reservoir was greater. This is confirmed by the final measured discharge values, higher water levels, and increased flow velocities. The reasons should be investigated through communication with the reservoir operator, although one possible explanation may be a larger water volume in the reservoir following the winter season.

Despite these potentially higher outflow conditions, no Moving Bed was observed at any of the designated cross-sections. Several attempts were made to perform a Moving Bed test during the measurements; however, their duration was insufficient for a full evaluation. Nevertheless, experience from this site, along with the low sediment load in the water originating from the reservoir bottom, can be considered sufficient justification for the absence of a Moving Bed.

### **2.6.2 Water-level monitoring and additional measurements**

Water level control was monitored in the hydrometric station located on the left bank in the middle of the exposed river reach. The station consists of a staff gauge and two independent pressure sensors set up to read the level once per minute. By applying a stage-discharge relation (or rating-curve), water level recorded was converted into discharge.



**Fig. 7 Gauging station Vranov Hamry (Nr. 434000) on river Thaya**

In order to best determine the surface velocity of the flow, additional measurements were made using Ott C31 propeller and LSPIV (Large Scale Particle Image Velocimetry) video using a drone. The surface velocity information will help to determine the velocity and discharge extrapolation of the upper unmeasured layer in the ADCP cross-section. Point velocity measurement improves the data collection quality according to the metrological demands.

The site for point-velocity measurement was selected approximately 350 meters downstream of the station, where it was possible to safely wade the river and stretch a measuring tape. The cross-section is divided by a small island into two parts, which together account for the total discharge. Unfortunately, no illustrative photograph of the site conditions was taken during the measurement.



**Fig. 8 Ott C31 propeller and location of the measurement**

A time interval toward the end of the measurement program was selected for the LSPIV method, during which all ADCP units were brought to shore for several minutes to avoid interference with the video analysis. Due to the lack of natural floating material, biodegradable corn-starch chips were distributed into the stream. A drone-mounted camera at three cross-sections captured their movement along the reach, where concurrent measurements were carried out using a remote-controlled ADCP to obtain the most accurate possible channel geometry. Simultaneously, the movement of the chips was also recorded from an elevated viewpoint using a standard smartphone.



**Fig. 9 View on the reach from the viewpoint**

## 3. Results

### 3.1 Stage time series

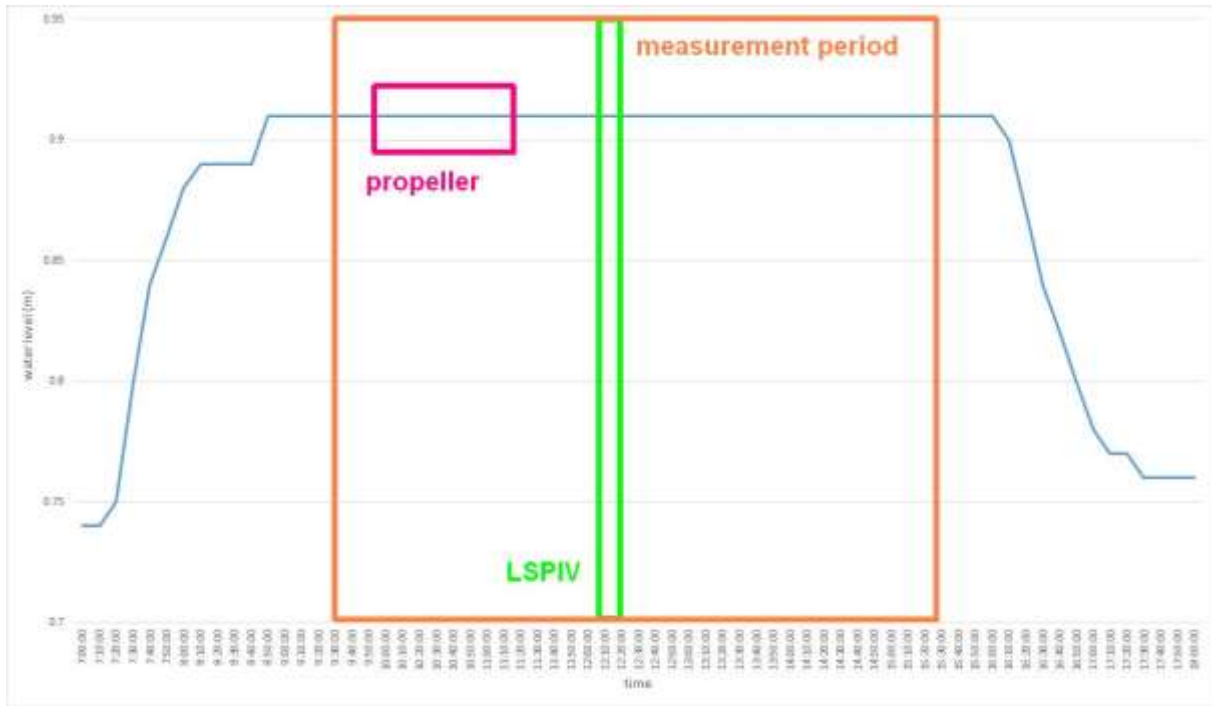


Fig. 10 Monitored (floating 10 min interval) water level graph from Vranov Hamry station

The water level, monitored at the nearby station Vranov Hamry (ID 434000), remained stable at 91 cm throughout the entire discharge measurement. The upstream small hydropower plant was out of operation. The water release from the Vranov reservoir was carried out as agreed, but compared to previous events at this location, the water level was approximately 2 cm higher, which was also reflected in the measured discharges. This could be due to a change in the outlet control or a result of higher reservoir levels following a preceding period of heavy rainfall.

### 3.2 Independent discharge measurements

#### 3.2.1 Propeller point measurement

Not only for metrological purposes regarding instrument traceability, but also as a means of comparing measurement techniques, a point velocity method was employed. The measurement site had to be selected further downstream, where both the channel depth and flow velocity were lower than in the section used for the ADCP, due to the stream being divided into two branches below the weir. The final discharge value is therefore the sum of two measurements. The measurement was carried out by representatives from the Brno branch, Stanislav Lejska and Karel Kovář, using a calibrated Ott C 31 current meter (serial no. 135152), and the total discharge amounted to **16.327 m<sup>3</sup>.s<sup>-1</sup>**.

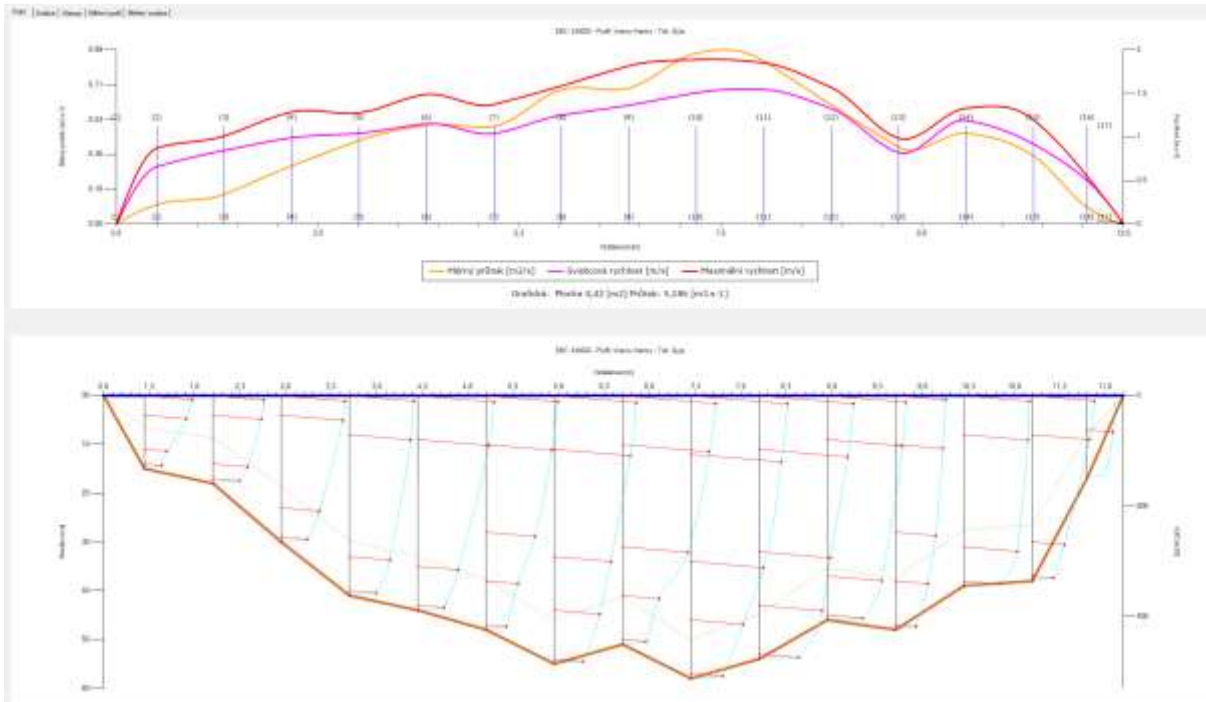


Fig. 11. Field 1 point measurement  $5.186 \text{ m}^3 \cdot \text{s}^{-1}$ , (Expanded uncertainty (95%) = 5.78%)

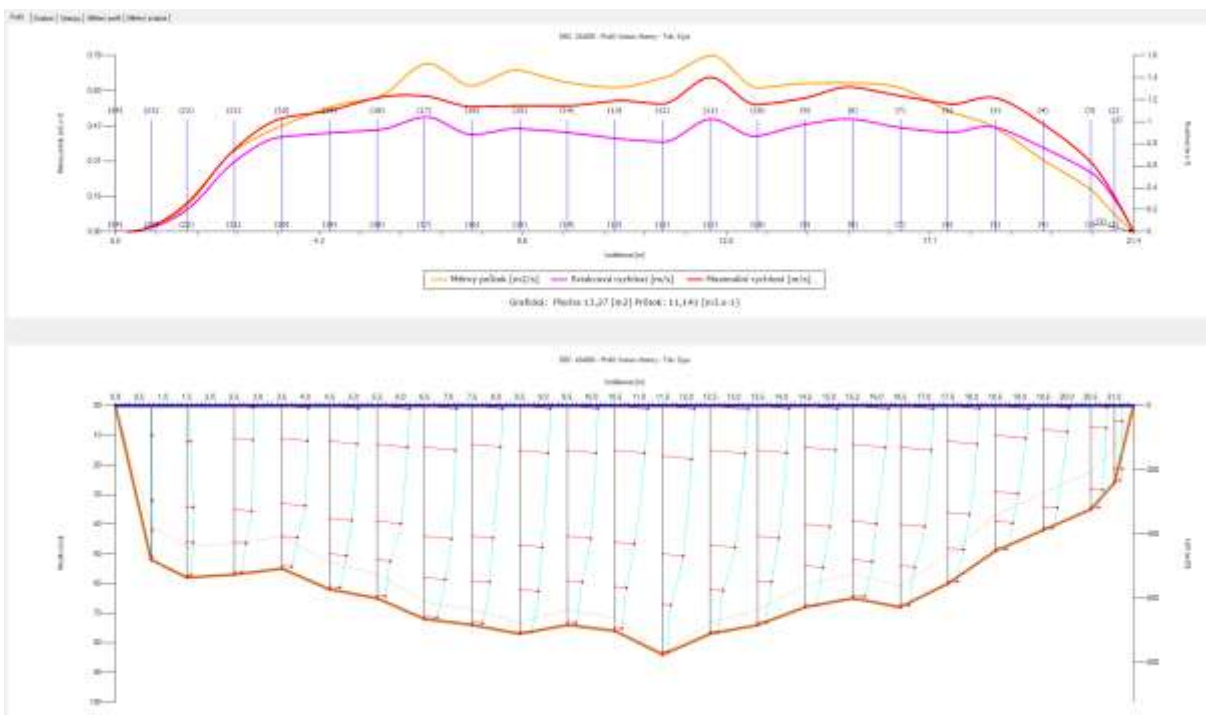


Fig. 12 Field 2 point measurement  $11.141 \text{ m}^3 \cdot \text{s}^{-1}$ , (Expanded uncertainty (95%) = 4.33%)

The result obtained using the point velocity method closely matches the overall average of all ADCP measurements and thus meets the general requirement of falling within a  $\pm 5\%$  range from the average. The point method has proven to be sufficiently accurate even under such complex conditions, as

confirmed by the overall measurement uncertainty. On the other hand, this method requires operator endurance and stability, along with a significantly longer time needed to complete the measurement.

### 3.2.2 LSPIV measurements

Based on experience from previous LSPIV attempts at this site, auxiliary floating markers were used this time in the form of environmentally degradable corn chips, with a total volume of 400 liters. The ADCP operators were instructed to position their boats close to the riverbank to avoid interfering with the tracking and evaluation of the floating objects. The corn chips were distributed across the full width of the stream approximately 100 meters upstream from the first ADCP profile (Profile A).



Fig. 13 Aerial view of LSPIV measurements.

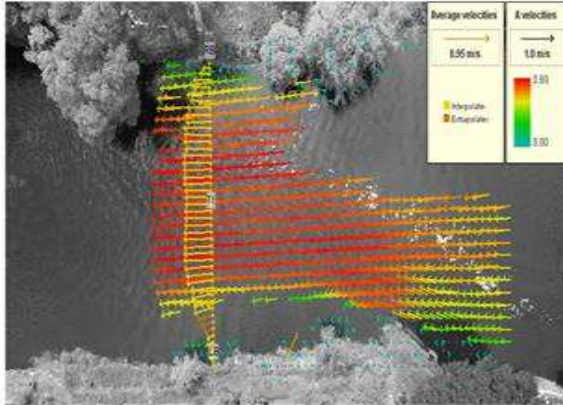
For overhead imaging, a DJI drone operated by the Brno branch was used. A supplementary video was recorded from a viewpoint above the river using a standard Samsung smartphone. To ensure the most accurate discharge assessment, three selected cross-sections were scanned using a remotely operated SonTek M9 ADCP mounted on an rQPOD. This allowed the assignment of corresponding cross-sectional areas to the surface velocities. Black-and-white targets measuring 20×20 cm were placed along the riverbanks at surveyed intervals to enable high-quality orthorectification.

The drone video was processed using the open-source Fudaa-LSPIV 1.11.3 software. Discharge was computed using 3 cross-sectional profiles extracted from 4 ADCP processed in each profile. The velocity coefficient alpha used to convert surface velocities to depth-averaged velocities was set to 0.85 by default.

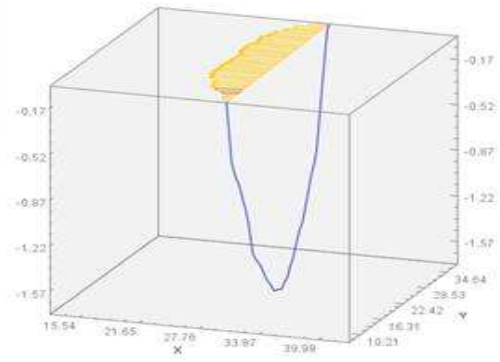
The discharges evaluated from drone footage show very consistent values, with an average of **17.543 m<sup>3</sup>.s<sup>-1</sup>**. Among the three profiles, the lower profile appears to be the most suitable for evaluation, as evident from the attached image showing a relatively uniform distribution of surface flow lines and less disturbed flow in the bank zones.

The evaluation from the viewpoint position (**15,745 m<sup>3</sup>.s<sup>-1</sup>**) serves as an illustration of the discharge estimation using commonly available equipment from a safe and elevated location with a clear view of the river reach. Although this value differs from the overall average by more than 1 m<sup>3</sup>.s<sup>-1</sup>, it would still be considered sufficiently accurate in flood situations or when no other measurement method is feasible.

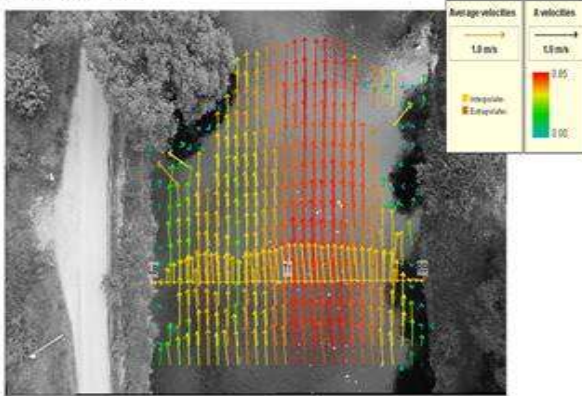
2D view - Real space



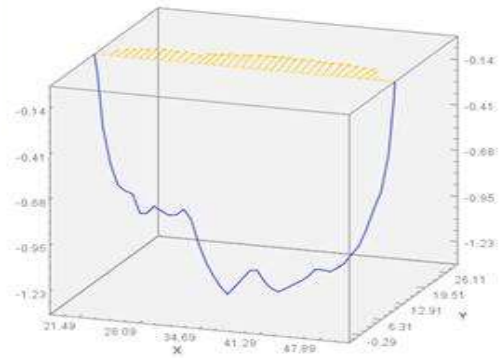
3D view



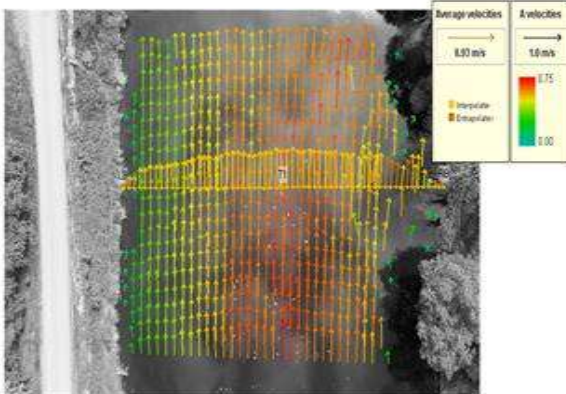
2D view - Real space



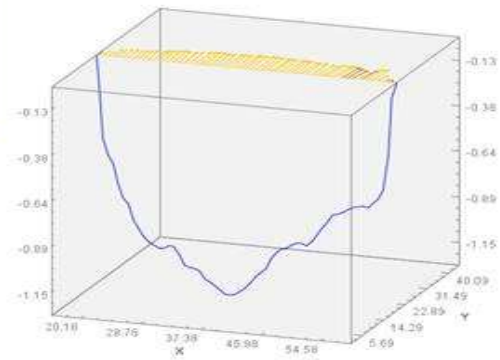
3D view



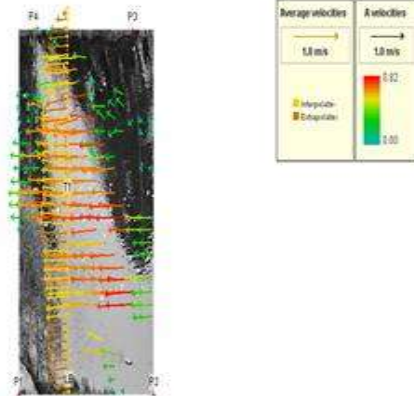
2D view - Real space



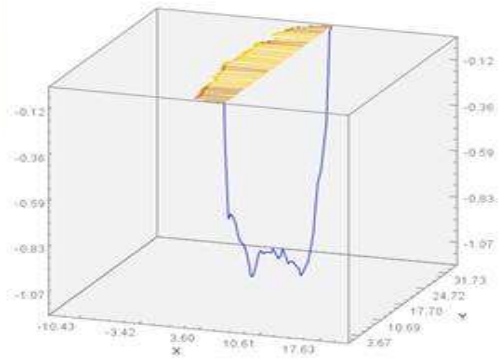
3D view



2D view - Real space



3D view



**Fig. 14 Graphical results of Fudaa-LSPIV processing of a drone video during the Vranov regatta (gray-scale ortho-image, surface velocity field, and depth-average velocities interpolated along 4 cross-sectional profiles extracted from ADCP measurements).**

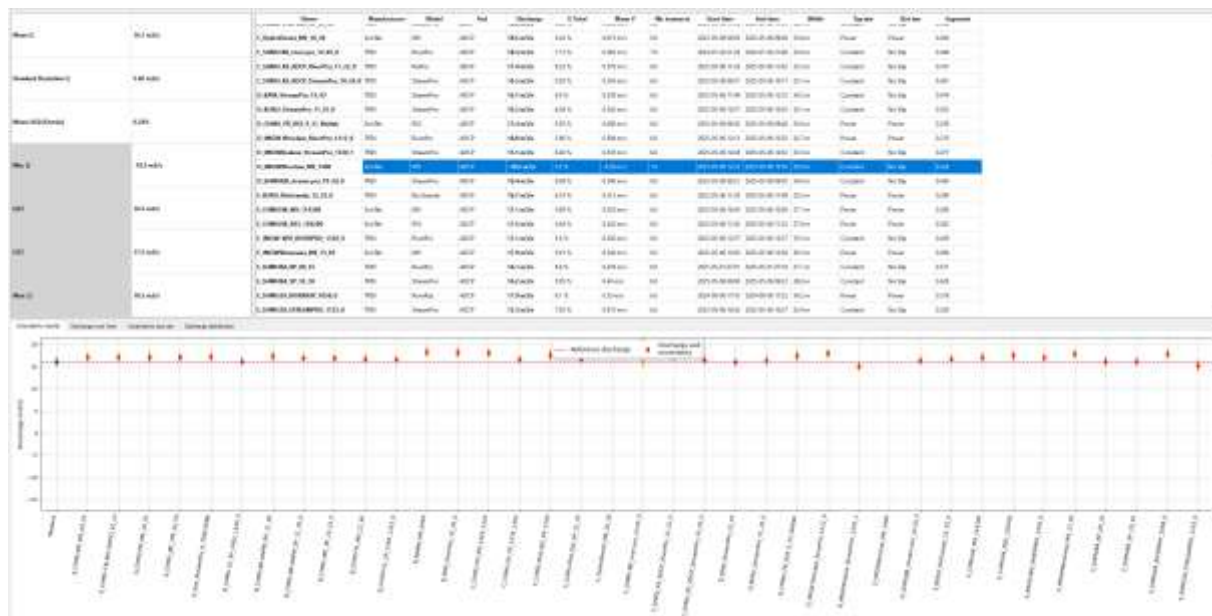
The results are summarized in the next table.

Location	Velocity coef.	Total Q (m <sup>3</sup> /s)	Wetted area (m <sup>2</sup> )	Mean velocity (m/s)	Measured Q / Total Q (%)
upper profile	0.85	17.304	35.289	0.49	97.7
middle profile	0.85	17.818	33.356	0.534	100
lower profile	0.85	17.507	39.511	0.443	95.2
viewpoint profile	0.85	15.745	30.421	0.518	72.5

**Tab. 4 Summary of discharge estimates calculated using Fudaa-LSPIV for the Vranov regatta.**

### 3.3 ADCP measurement results

Only raw measurement results were collected from all participating teams in a standardized format, allowing for consistent evaluation using the QRevInt (v. 1.28) and Qrame (v. 1.26) software tools. When visualizing the raw data in a graph, it becomes apparent that some measurements require adjustments to settings (such as time, bank assignment, or file name), and in some cases, complete exclusion from the dataset due to significant deficiencies. Despite this, the overall average discharge value (**16.1 m<sup>3</sup>.s<sup>-1</sup>**) derived from the raw data remains relatively representative, as high-quality measurements dominate the dataset (Q StdDev = 5.82 m<sup>3</sup>.s<sup>-1</sup>; Mean U Oursin = 6.24%). Compared to previous events, the number of deviations, errors, and incorrect settings has decreased, which reflects the growing experience of participants and the increased emphasis on pre-measurement briefings.



**Fig. 15 Raw ADCP data evaluation in Qrame**

Following analyses described below reflect different purposes and can be used for the needs of individual organizations. The first method (CHMI) of evaluation can be considered as a basic, where the individual measured values are related to the overall average with an envelope 5% interval. The second method (QRame) of evaluation already contains additional metadata about the quality of individual measurements and their uncertainty. The third subchapter includes CHMI instruments only which are evaluated according to the metrological purposes of the organization.

## 4. Analyses

### 4.1 CHMI Analysis

To assess the consistency of measurements collected during the ADCP regatta, each discharge value is compared to the overall average discharge obtained from all devices involved. For the 2025 campaign, the overall average was  $17.3 \text{ m}^3\cdot\text{s}^{-1}$ , and an acceptable tolerance range of  $\pm 5\%$  was defined, resulting in the interval  $16.44 \text{ m}^3\cdot\text{s}^{-1}$  to  $18.17 \text{ m}^3\cdot\text{s}^{-1}$ . All measurements falling within this envelope are considered consistent with the group. Measurements slightly outside this range may still be acceptable if supported by corresponding metadata that confirm high measurement quality (e.g., low coefficient of variation, high percentage of measured discharge, stable boat track, or appropriate extrapolation method). Measurements with more significant deviations are individually reviewed, particularly with respect to contextual metadata such as river cross-section characteristics, platform stability, operator performance, and unmeasured zone ratios. In justified cases, minor corrections may be proposed (e.g. adjusted extrapolation parameters), though these typically result in changes below one percent. If no clear explanation is found and the deviation remains substantial, such measurements are marked as outliers and excluded from aggregate analyses to maintain integrity of the overall result set. The dataset obtained in 2025 demonstrated high internal consistency, with only a few instruments outside the tolerance band, often due to known or identifiable issues

ADCP inter comparison, Vranov-Hamry (434000), river Dyje, 6.5. 2025													
team	ADCP	SrNr	Cross section	Start [CET]	End [CET]	Q [ $\text{m}^3/\text{s}$ ]	$\Delta Q$ [%]	COV [%]	Uncertainty [%]	Qm [%]	B [m]	v [m/s]	A [ $\text{m}^2$ ]
CHMU CB	RS5	2340004	C	08:10	08:40	17.3	0.2%	0.5%	4.4%	73.4%	33.6	0.60	28.9
CHMU BR	M9	7823	A	08:22	08:38	17.2	0.8%	1.4%	4.6%	55.1%	31.9	0.53	32.3
CHMU PR	RS5	2340006	D	08:31	08:46	17.4	0.3%	1.1%	5.9%	73.6%	33.6	0.61	28.7
CHMU BR	RS5	2340002	C	08:49	09:05	17.4	0.3%	0.9%	4.4%	72.4%	33.7	0.60	28.9
HydroDienst	RS5	221004	D	08:54	10:20	18.1	4.4%	0.9%	5.9%	74.0%	33.7	0.61	29.6
SHMU-BA	RiverPro	1509	E	08:54	09:12	17.1	1.4%	1.0%	6.8%	67.8%	37.2	0.51	33.7
CHMU PR	M9	5148	A	09:01	09:15	17.1	1.4%	1.3%	4.6%	53.0%	33.2	0.52	33.2
SHMU-BA	StreamPro	1668	E	09:20	09:34	17.0	2.0%	1.4%	6.4%	70.0%	36.8	0.51	33.1
SHMU BB	StreamPro	2134	D	09:21	09:45	17.3	0.2%	1.4%	6.5%	68.2%	34.0	0.58	30.1
CHMU CB	M9	6592	A	09:22	09:35	17.1	1.4%	2.0%	4.8%	56.0%	31.9	0.52	32.6
HydroDienst	M9	8191	C	09:29	09:49	18.0	3.8%	1.0%	4.5%	53.3%	33.6	0.61	29.6
Aquamonit.	RS5	2350001	B	09:31	09:49	17.2	0.8%	1.3%	4.5%	73.3%	33.3	0.53	32.7
CHMU JBC	M9	6073	A	09:50	10:07	17.1	1.4%	1.9%	4.7%	55.4%	31.6	0.53	32.1
SHMU-BB	RioPro	1510	D	09:50	10:12	17.0	2.0%	12.0%	31.6%	49.4%	33.7	0.56	30.5
SHMU-KE	StreamPro	1669	C	09:57	10:17	17.1	1.4%	1.4%	4.1%	68.4%	33.0	0.58	29.6
SHMU-ZA	RiverRay	670339	E	09:58	10:10	17.9	3.2%	1.3%	6.1%	50.8%	34.2	0.55	32.5
<b>NARW</b>	<b>M9</b>	<b>4911</b>	<b>B</b>	<b>09:59</b>	<b>10:22</b>	<b>18.4</b>	<b>6.1%</b>	<b>0.6%</b>	<b>4.7%</b>	<b>57.1%</b>	<b>33.5</b>	<b>0.53</b>	<b>34.3</b>
CHMU BR	RiverPro	1561	B	10:03	10:22	17.6	1.5%	2.0%	4.9%	52.8%	34.1	0.51	34.9
BOKU	StreamPro	2297	D	10:25	10:44	17.4	0.3%	1.2%	6.6%	68.4%	34.1	0.58	30.2

PMO	RiverPro	1064	B	10:26	10:43	18.2	4.9%	1.8%	4.9%	51.9%	33.2	0.52	34.9
<b>SHMU-ZA</b>	<b>StreamPro</b>	<b>2136</b>	<b>E</b>	<b>10:26</b>	<b>10:38</b>	<b>16.3</b>	<b>6.0%</b>	<b>3.3%</b>	<b>7.8%</b>	<b>69.3%</b>	<b>35.4</b>	<b>0.50</b>	<b>32.5</b>
OMPM	StreamPro	514	B	10:28	10:51	16.9	2.5%	1.2%	4.9%	74.6%	34.2	0.49	34.3
CHMU HK	M9	5108	E	10:43	10:58	17.1	1.4%	1.5%	5.9%	52.3%	37.1	0.54	31.9
CHMU PL	RS5	2340003	B	10:53	11:17	17.6	1.5%	1.0%	4.4%	72.2%	33.0	0.53	33.0
CHMU HK	RS5	2042007	E	11:02	11:22	17.5	0.9%	1.7%	5.6%	74.9%	37.0	0.54	32.3
CHMU PR OJV	RiverPro	2490	C	11:05	11:25	17.6	1.5%	0.8%	4.8%	66.5%	33.7	0.59	29.6
BAW	RS5	2410003	D	11:06	11:25	17.2	0.8%	0.9%	5.9%	73.3%	33.2	0.58	29.4
SHMU-KE	RiverPro	1512	C	11:24	11:42	17.4	0.3%	1.3%	4.9%	47.1%	33.5	0.58	30.0
CHMU PR OJV	StreamPro	443	C	11:34	11:55	17.5	0.9%	0.2%	5.3%	69.1%	34.7	0.56	31.0
SEBA	StreamPro	426	A	11:35	11:57	17.3	0.2%	1.6%	4.8%	75.7%	32.2	0.50	34.9
BOKU	RioGrande	20541	E	11:35	11:55	16.7	3.7%	1.8%	6.2%	49.8%	35.5	0.51	32.5
CHMU PL	M9	6594	B	11:42	12:01	16.7	3.7%	0.8%	4.6%	57.2%	33.3	0.51	32.7
BAW	StreamPro	2554	D	11:43	12:16	17.0	2.0%	1.2%	6.4%	68.2%	34.2	0.57	29.9
CHMU OS	M9	5117	C	12:00	12:23	18.0	3.8%	1.0%	5.0%	54.3%	33.5	0.60	30.1
CHMU UL	StreamPro	2165	B	12:05	12:34	16.9	2.5%	1.7%	5.0%	74.0%	33.5	0.49	34.8
IMGW War	M9	6623	E	12:05	12:38	17.9	3.2%	1.1%	5.6%	54.0%	36.4	0.54	33.0
IMGW Wro	RiverPro	20321	D	12:13	12:35	18.0	3.8%	1.2%	5.7%	66.1%	34.7	0.59	30.3
CHMU OS	StreamPro	461	C	12:34	12:56	17.5	0.9%	1.1%	4.2%	68.6%	34.0	0.58	29.9
<b>TRDI</b>	<b>RiverPro</b>	<b>2330</b>	<b>A</b>	<b>12:35</b>	<b>12:50</b>	<b>15.9</b>	<b>8.3%</b>	<b>14.8%</b>	<b>17.3%</b>	<b>49.9%</b>	<b>31.3</b>	<b>0.48</b>	<b>33.2</b>
<b>IMGW Wro</b>	<b>StreamPro</b>	<b>2419</b>	<b>D</b>	<b>12:35</b>	<b>12:45</b>	<b>16.0</b>	<b>7.7%</b>	<b>2.1%</b>	<b>6.5%</b>	<b>73.1%</b>	<b>33.5</b>	<b>0.57</b>	<b>28.2</b>
CHMU UL	StreamPro	1994	B	12:40	13:03	17.3	0.0%	1.8%	4.6%	71.9%	33.5	0.50	34.8
IMGW Kra	M9	6621	D	12:45	13:00	18.0	3.8%	0.9%	5.6%	52.8%	34.3	0.59	30.5
IMGW Wis	RiverPro	20337	E	12:57	13:27	17.1	1.4%	0.9%	5.6%	69.6%	35.5	0.53	32.4
<b>SHMU-BB</b>	<b>RiverPro</b>	<b>1510</b>	<b>C</b>	<b>13:05</b>	<b>13:25</b>	<b>18.5</b>	<b>6.7%</b>	<b>3.2%</b>	<b>10.0%</b>	<b>63.8%</b>	<b>33.8</b>	<b>0.60</b>	<b>30.6</b>
CHMU JBC	StreamPro	1096	B	13:10	13:23	16.9	2.5%	1.8%	5.1%	75.1%	33.1	0.49	34.4
IMGW Wro	M9	3450	D	14:00	14:15	18.0	3.8%	0.2%	5.7%	53.5%	34.4	0.59	30.5
<b>AVG</b>						<b>17.3</b>	2.4%	1.8%	6.3%	63.5%			

**Tab. 5 Raw data statistics used in CHMI**

Six measurements (NARW, SHMU-ZA, TRDI, IMGW Wro, SHMU-BB) were outlying the 5% interval. None of these instruments is implemented in the everyday use of CHMI. The reason for the shortage is a combination of insufficient device settings, the smoothness of the crossings, and probably also the age and wear of some units.

The average uncertainty value (6.3%), and even more so the average uncertainty excluding outliers (5.3%), demonstrates the high quality of all measurements and the mutual comparability of the recorded discharge values. A detailed overview and comparison within individual cross-sections is provided in the following table.

team	ADCP	SrNr	Cross section	Start [CET]	End [CET]	Q [m <sup>3</sup> /s]	ΔQ [%]	COV [%]	Uncertainty [%]	Qm [%]	B [m]	v [m/s]	A [m <sup>2</sup> ]
CHMU BR	M9	7823	A	08:22	08:38	17.2	0.2%	1.4%	4.6%	55.1%	31.9	0.53	32.3
CHMU PR	M9	5148	A	09:01	09:15	17.1	0.3%	1.3%	4.6%	53.0%	33.2	0.52	33.2
CHMU CB	M9	6592	A	09:22	09:35	17.1	0.3%	2.0%	4.8%	56.0%	31.9	0.52	32.6
CHMU JBC	M9	6073	A	09:50	10:07	17.1	0.3%	1.9%	4.7%	55.4%	31.6	0.53	32.1
SEBA	StreamPro	426	A	11:35	11:57	17.3	0.8%	1.6%	4.8%	75.7%	32.2	0.50	34.9
			<b>A</b>			<b>17.2</b>	<b>0.0%</b>	<b>1.6%</b>	<b>4.7%</b>	<b>59.0%</b>	<b>32.1</b>	<b>0.52</b>	<b>33.0</b>
Aquamonit.	RS5	2350001	B	09:31	09:49	17.2	0.3%	1.3%	4.5%	73.3%	33.3	0.53	32.7
CHMU BR	RiverPro	1561	B	10:03	10:22	17.6	2.0%	2.0%	4.9%	52.8%	34.1	0.51	34.9
PMO	RiverPro	1064	B	10:26	10:43	18.2	5.4%	1.8%	4.9%	51.9%	33.2	0.52	34.9
OMPM	StreamPro	514	B	10:28	10:51	16.9	2.1%	1.2%	4.9%	74.6%	34.2	0.49	34.3
CHMU PL	RS5	2340003	B	10:53	11:17	17.6	2.0%	1.0%	4.4%	72.2%	33.0	0.53	33.0

CHMU PL	M9	6594	B	11:42	12:01	16.7	3.2%	0.8%	4.6%	57.2%	33.3	0.51	32.7
CHMU UL	StreamPro	2165	B	12:05	12:34	16.9	2.1%	1.7%	5.0%	74.0%	33.5	0.49	34.8
CHMU UL	StreamPro	1994	B	12:40	13:03	17.3	0.5%	1.8%	4.6%	71.9%	33.5	0.50	34.8
CHMU JBC	StreamPro	1096	B	13:10	13:23	16.9	2.1%	1.8%	5.1%	75.1%	33.1	0.49	34.4
			<b>B</b>			<b>17.3</b>	<b>0.0%</b>	<b>1.5%</b>	<b>4.8%</b>	<b>67.0%</b>	<b>33.5</b>	<b>0.51</b>	<b>34.2</b>
CHMU CB	RS5	2340004	C	08:10	08:40	17.3	1.3%	0.5%	4.4%	73.4%	33.6	0.60	28.9
CHMU BR	RS5	2340002	C	08:49	09:05	17.4	0.8%	0.9%	4.4%	72.4%	33.7	0.60	28.9
HydroDienst	M9	8191	C	09:29	09:49	18.0	2.7%	1.0%	4.5%	53.3%	33.6	0.61	29.6
SHMU-KE	StreamPro	1669	C	09:57	10:17	17.1	2.5%	1.4%	4.1%	68.4%	33.0	0.58	29.6
CHMU PR OJV	RiverPro	2490	C	11:05	11:25	17.6	0.4%	0.8%	4.8%	66.5%	33.7	0.59	29.6
SHMU-KE	RiverPro	1512	C	11:24	11:42	17.4	0.8%	1.3%	4.9%	47.1%	33.5	0.58	30.0
CHMU PR OJV	StreamPro	443	C	11:34	11:55	17.5	0.2%	0.2%	5.3%	69.1%	34.7	0.56	31.0
CHMU OS	M9	5117	C	12:00	12:23	18.0	2.7%	1.0%	5.0%	54.3%	33.5	0.60	30.1
CHMU OS	StreamPro	461	C	12:34	12:56	17.5	0.2%	1.1%	4.2%	68.6%	34.0	0.58	29.9
			<b>C</b>			<b>17.5</b>	<b>0.0%</b>	<b>0.9%</b>	<b>4.6%</b>	<b>63.7%</b>	<b>33.7</b>	<b>0.59</b>	<b>29.7</b>
CHMU PR	RS5	2340006	D	08:31	08:46	17.4	1.1%	1.1%	5.9%	73.6%	33.6	0.61	28.7
HydroDienst	RS5	221004	D	08:54	00:00	18.1	2.8%	0.9%	5.9%	74.0%	33.7	0.61	29.6
SHMU BB	StreamPro	2134	D	09:21	09:45	17.3	1.7%	1.4%	6.5%	68.2%	34.0	0.58	30.1
BOKU	StreamPro	2297	D	10:25	10:44	17.4	1.1%	1.2%	6.6%	68.4%	34.1	0.58	30.2
BAW	RS5	2410003	D	11:06	11:25	17.2	2.3%	0.9%	5.9%	73.3%	33.2	0.58	29.4
BAW	StreamPro	2554	D	11:43	12:16	17.0	3.4%	1.2%	6.4%	68.2%	34.2	0.57	29.9
IMGW Wro	RiverPro	20321	D	12:13	12:35	18.0	2.3%	1.2%	5.7%	66.1%	34.7	0.59	30.3
IMGW Kra	M9	6621	D	12:45	13:00	18.0	2.3%	0.9%	5.6%	52.8%	34.3	0.59	30.5
IMGW Wro	M9	3450	D	14:00	14:15	18.0	2.3%	0.2%	5.7%	53.5%	34.4	0.59	30.5
			<b>D</b>			<b>17.6</b>	<b>0.0%</b>	<b>1.0%</b>	<b>6.0%</b>	<b>66.5%</b>	<b>34.0</b>	<b>0.59</b>	<b>29.9</b>
SHMU-BA	RiverPro	1509	E	08:54	09:12	17.1	1.1%	1.0%	6.8%	67.8%	37.2	0.51	33.7
SHMU-BA	StreamPro	1668	E	09:20	09:34	17.0	1.7%	1.4%	6.4%	70.0%	36.8	0.51	33.1
SHMU-ZA	RiverRay	670339	E	09:58	10:10	17.9	3.5%	1.3%	6.1%	50.8%	34.2	0.55	32.5
CHMU HK	M9	5108	E	10:43	10:58	17.1	1.1%	1.5%	5.9%	52.3%	37.1	0.54	31.9
CHMU HK	RS5	2042007	E	11:02	11:22	17.5	1.2%	1.7%	5.6%	74.9%	37.0	0.54	32.3
BOKU	RioGrande	20541	E	11:35	11:55	16.7	3.4%	1.8%	6.2%	49.8%	35.5	0.51	32.5
IMGW War	M9	6623	E	12:05	12:38	17.9	3.5%	1.1%	5.6%	54.0%	36.4	0.54	33.0
IMGW Wis	RiverPro	20337	E	12:57	13:27	17.1	1.1%	0.9%	5.6%	69.6%	35.5	0.53	32.4
			<b>E</b>			<b>17.3</b>	<b>0.0%</b>	<b>1.3%</b>	<b>6.0%</b>	<b>61.1%</b>	<b>36.2</b>	<b>0.53</b>	<b>32.7</b>
<b>AVG (A,B,C,D,E)</b>						<b>17.4</b>		<b>1.3%</b>	<b>5.2%</b>	<b>63.5%</b>			

**Tab. 6 Raw data statistics according to cross-sections**

Looking at the results in the context of individual routes, it can be stated that all cross sections were of sufficient quality for ADCP measurements and did not show significant negative effects. The exposed locations do not differ much in terms of their properties, and the biggest differences are in width, resp. area. They arose at an unmeasured distance near the left bank, where there were only minimal flow velocities that did not significantly affect the resulting flow. The uniformity of the cross sections is best demonstrated by the average flow speed, which is close to the value of  $0.5 \text{ m}\cdot\text{s}^{-1}$  at all locations. It is also worth mentioning the high percentage of measured discharge  $Q_m$  (63%), which exceeded 50% for almost all ADCPs. The highest measured portion was surprisingly achieved by the StreamPro operated by OAH JBC (75.1%), closely followed primarily by the RS5 devices.

## 4.2 QRame Analysis

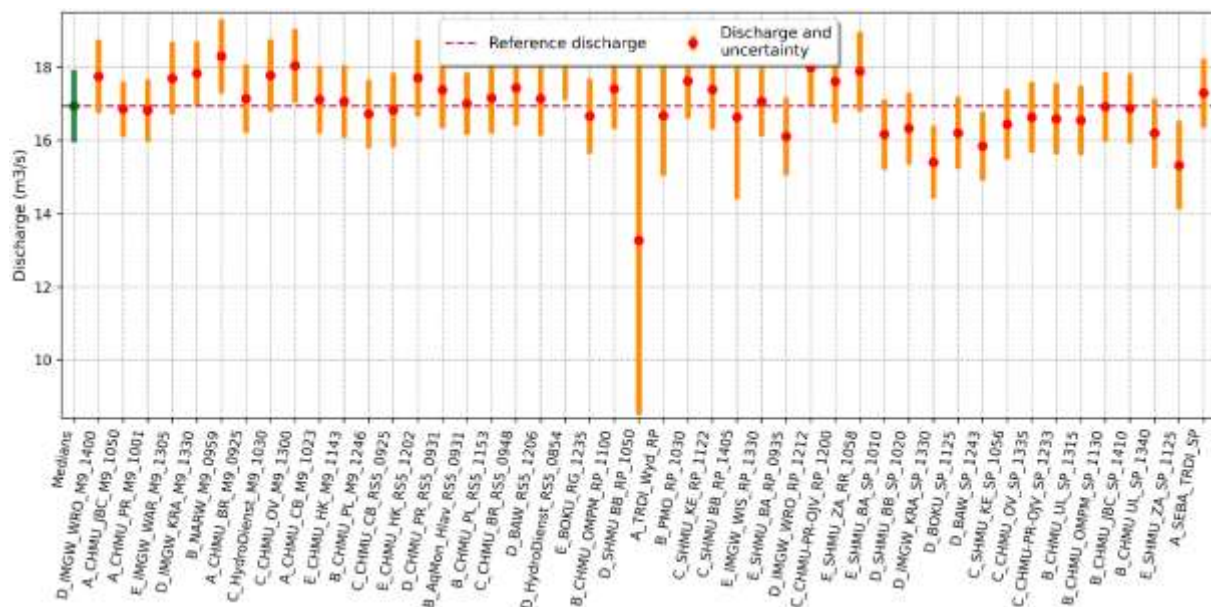
Evaluation using the QRame tool, developed by the French research institute INRAE and available as open-source software, has proven to be an optimal aid for intercomparison events. It supports both

detailed data analysis and clear visualization of all supplementary information, thereby facilitating the interpretation of event results. For the 2025 campaign, the latest version QRame 1.27 was used, which—besides offering an extended range of graphical outputs—also allows manual editing of measurement timestamps and more specific settings for extrapolation parameters.

Mean Q	Standard Deviation Q	Mean U (Q) Oursin	Min Q	Q25	Q75	Max Q
16.9 m <sup>3</sup> ·s <sup>-1</sup>	0.878 m <sup>3</sup> ·s <sup>-1</sup>	6.74%	13.3 m <sup>3</sup> ·s <sup>-1</sup>	16.6 m <sup>3</sup> ·s <sup>-1</sup>	17.6 m <sup>3</sup> ·s <sup>-1</sup>	18.3 m <sup>3</sup> ·s <sup>-1</sup>

**Tab. 7 QRame statistics**

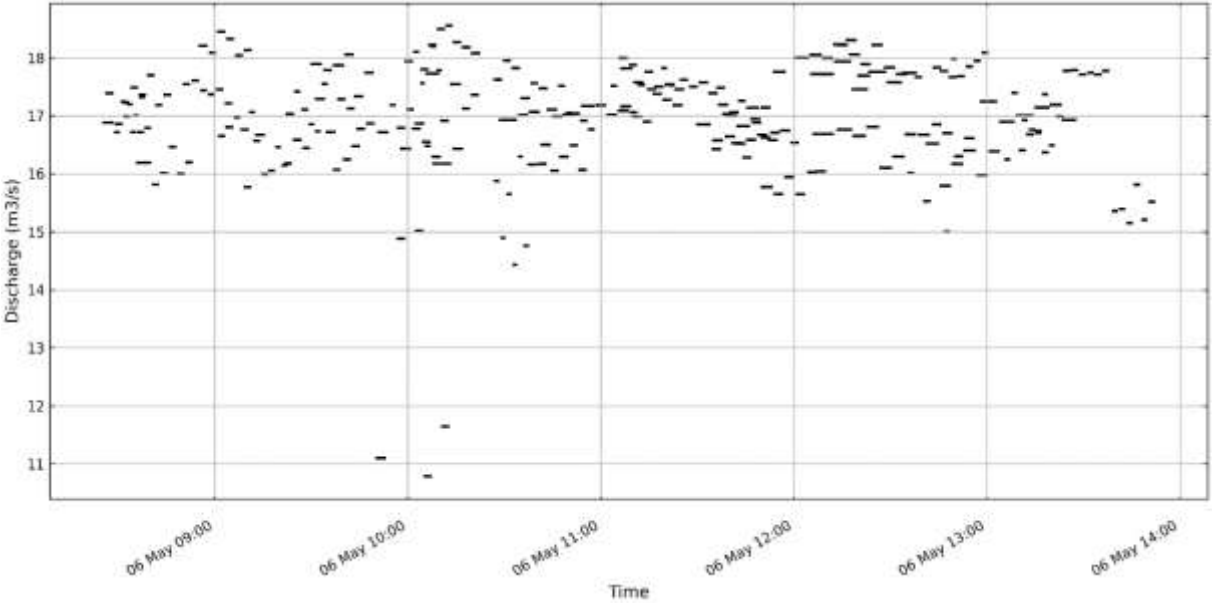
Already the initial visualization of the measured data, after filtering out the most significant deficiencies, demonstrates a high consistency of values, with only a few outliers that require closer inspection or potential exclusion from the dataset. The complete dataset includes 46 individual measurements, corresponding to the number stated in the previous subsection. For comparison purposes, the overall mean value of **16.9 m<sup>3</sup>·s<sup>-1</sup>** from this dataset can be used, complemented by additional statistical outputs and an uncertainty estimate.



**Fig. 16 Initial analyses and outputs from QRame**

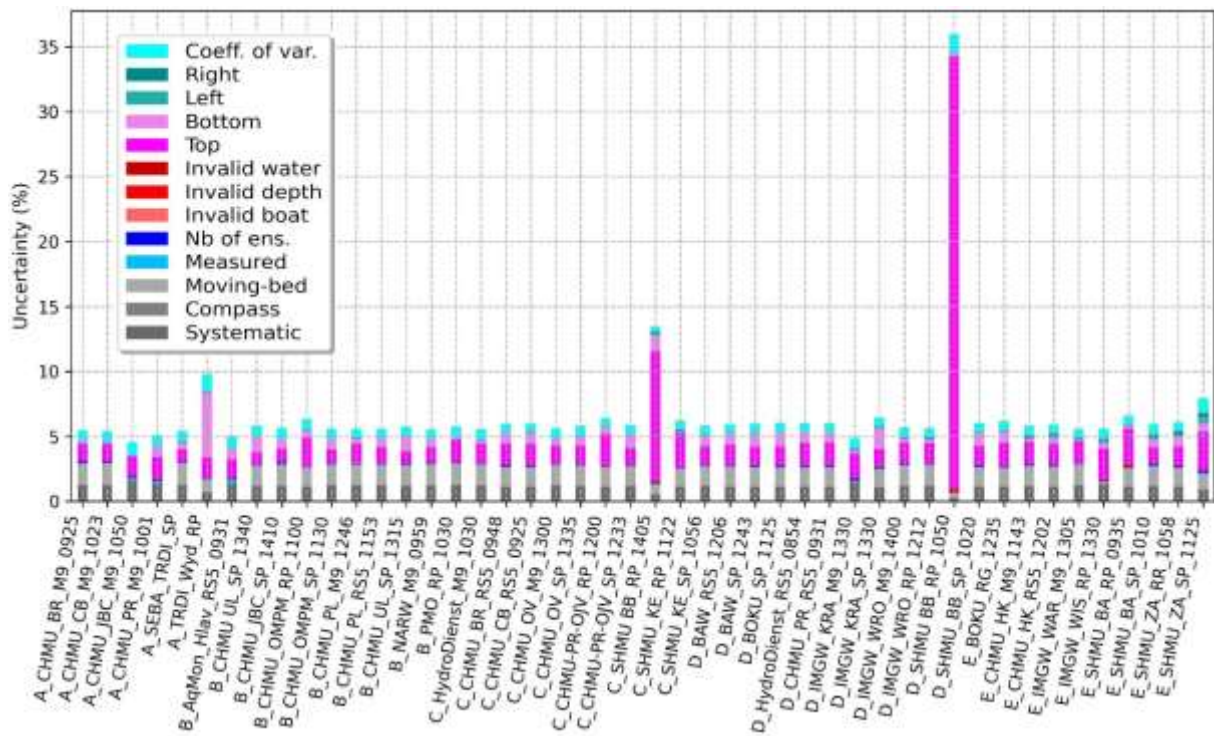
The new features in QRame allow for a more refined assessment of the influence of extrapolation in unmeasured zones. The chart above displays measurements ranked by the optimal extrapolation method, whether assigned automatically or selected manually. On the left side of the graph, it is apparent that the Power/Power method is predominantly used with SonTek instruments (M9; RS5), which logically also yield above-average discharge values. When applying this exponential extrapolation rule uniformly—using optimized coefficient values—the overall mean discharge rises to 17.4 m<sup>3</sup>·s<sup>-1</sup>. In contrast, the Constant/No slip method, visible on the right side of the graph, is typical for StreamPro ADCPs and tends to result in below-average discharge values. Applying this extrapolation method uniformly to all measurements yields a mean discharge of 16.8 m<sup>3</sup>·s<sup>-1</sup>. Compared to the original average, this corresponds to a difference of +3% and -0.6%, respectively, which highlights extrapolation as a significant factor influencing the total discharge. However, these differences still fall within the generally accepted tolerance envelope of ±5%.

The graph (Fig. 17) displaying individual transects along the time axis confirms the consistency of the measured data, with only a few notable deviations. These deviations are reflected in the assigned uncertainty of the discharge measurements. As previously mentioned, data homogeneity over time is a key prerequisite for a meaningful comparison, and QRame enables at least partial revision of potential timing inconsistencies. This temporal homogeneity of discharge values corresponds well with the observed stability in water level throughout the measurement campaign, which showed no signs of trend or fluctuation during the measurement window



**Fig. 17** Transect distribution in time

Results from previous and international intercomparison events confirm that the largest differences in discharge measurements typically arise from the extrapolated flow in the top layer. QRame enables a clear visualization of uncertainty contributions across individual measurement attributes, where the dark pink color representing the TopLayer uncertainty clearly dominates.



**Fig. 18 TopLayer uncertainty distribution**

The majority of instruments exhibited total uncertainties (U Total) in the range of 4.5–6.5 %, with top-layer extrapolation uncertainty (U Top Q) contributing approximately 20–30 % to the total. This proportion is consistent with previous regatta evaluations and aligns with expectations for uniform cross-sections and consistent flow conditions.

The 2025 ADCP regatta confirmed that QRame has matured into a key tool for quality control and comparative analysis in hydrometric campaigns. Its strength lies not only in standardized uncertainty calculations, but also in its ability to make measurement structure and metadata visually interpretable—even for complex inter-laboratory datasets. By integrating automated and manual extrapolation methods, QRame bridges the gap between raw data and expert judgement, allowing deeper insights without compromising methodological transparency.

### 4.3 CHMI metrological purposes

For the purposes of metrological documentation within the hydrology section of CHMI, it is necessary to compile a protocol on the intercomparison of ADCP systems. This protocol serves as a certification record for selected ADCP units, which can then be used in routine hydrometric practice or for contract-based measurements. The protocol for these purposes is prepared in Czech and the following text contains its results.

From the full dataset of participating ADCP measurements, only those instruments owned by CHMI and requiring certification for operational use were selected and evaluated in QRame. The assessment of these instruments follows a team-based approach: each CHMI branch is represented by a group of staff members with clearly defined roles—such as ADCP operation, software handling, or tagline management. The objective is to obtain the highest possible quality of discharge measurement in a designated profile.

Throughout the measurement process, representatives from the Applied Hydrology Department in Jablonec (OAH) are available on site to provide consultation and guidance. This ensures that each participant has the opportunity to access relevant support and apply best practices in real time. This approach not only guarantees proper verification of the ADCP instruments themselves but also serves as hands-on training for the field teams. The participating staff gain practical experience that can be further shared with colleagues at their respective branches, reinforcing institutional expertise and measurement consistency across the CHMI network.

Name	Manufacturer	Model	Serial Number	Discharge	Deviation to ref.	U Total	Mean V	Nb. transects	Start time	End time	Width	Area
C_CHMU_CB_RSS_9925	SonTek	R55	R552140004	16.8 m <sup>3</sup> /s	-1.57 %	5.1 %	0.182 m/s	6.0	2025-05-06 08:21	2025-05-06 09:40	13.7 m	20.9 m <sup>2</sup>
A_CHMU_BR_M9_9925	SonTek	M9	7823	17.1 m <sup>3</sup> /s	0.29 %	4.69 %	0.131 m/s	6.0	2025-05-06 08:28	2025-05-06 09:36	11.9 m	32.3 m <sup>2</sup>
D_CHMU_PR_RSS_9931	SonTek	R55	R552140008	17.4 m <sup>3</sup> /s	1.7 %	3.31 %	0.085 m/s	6.0	2025-05-06 08:30	2025-05-06 09:46	13.5 m	28.7 m <sup>2</sup>
C_CHMU_BR_RSS_0948	SonTek	R55	R552140002	17.4 m <sup>3</sup> /s	2.0 %	1.27 %	0.087 m/s	6.0	2025-05-06 08:49	2025-05-06 09:01	13.8 m	29.0 m <sup>2</sup>
A_CHMU_PR_M9_1001	SonTek	M9	3148	16.8 m <sup>3</sup> /s	-1.62 %	5.1 %	0.108 m/s	6.0	2025-05-06 09:01	2025-05-06 09:13	12.7 m	32.5 m <sup>2</sup>
A_CHMU_CB_M9_1023	SonTek	M9	6992	17.1 m <sup>3</sup> /s	0.188 %	4.64 %	0.134 m/s	6.0	2025-05-06 09:22	2025-05-06 09:39	11.9 m	32.7 m <sup>2</sup>
A_CHMU_BR_M9_1050	SonTek	M9	6073	16.9 m <sup>3</sup> /s	-1.35 %	4.54 %	0.133 m/s	6.0	2025-05-06 09:30	2025-05-06 10:07	10.8 m	31.6 m <sup>2</sup>
B_CHMU_OHPM_BP_1100	TRDI	RearPro	1501	17.4 m <sup>3</sup> /s	1.88 %	5.06 %	0.499 m/s	6.0	2025-05-06 10:01	2025-05-06 10:22	14.1 m	34.9 m <sup>2</sup>
B_CHMU_OHPM_SP_1130	TRDI	StreamPro	514	16.9 m <sup>3</sup> /s	-1.03 %	4.81 %	0.484 m/s	6.0	2025-05-06 10:28	2025-05-06 10:51	13.2 m	34.2 m <sup>2</sup>
E_CHMU_BR_M9_1143	SonTek	M9	1100	17.1 m <sup>3</sup> /s	-0.173 %	1.12 %	0.125 m/s	6.0	2025-05-06 10:41	2025-05-06 10:58	17.1 m	31.9 m <sup>2</sup>
B_CHMU_PL_RSS_1153	SonTek	R55	R552140003	17.2 m <sup>3</sup> /s	0.383 %	4.84 %	0.121 m/s	6.0	2025-05-06 10:53	2025-05-06 11:17	12.8 m	33.0 m <sup>2</sup>
E_CHMU_BR_RSS_1202	SonTek	R55	R552042007	17.7 m <sup>3</sup> /s	3.6 %	3.22 %	0.146 m/s	6.0	2025-05-06 11:02	2025-05-06 11:22	17.0 m	32.4 m <sup>2</sup>
C_CHMU_PR_OIV_BP_1200	TRDI	RearPro	2490	17.0 m <sup>3</sup> /s	2.0 %	1.76 %	0.194 m/s	6.0	2025-05-06 11:03	2025-05-06 11:25	13.7 m	29.6 m <sup>2</sup>
C_CHMU_PR_OIV_SP_1233	TRDI	StreamPro	443	16.6 m <sup>3</sup> /s	-2.62 %	5.13 %	0.136 m/s	6.0	2025-05-06 11:34	2025-05-06 11:53	14.7 m	31.0 m <sup>2</sup>
B_CHMU_PL_M9_1246	SonTek	M9	6994	16.7 m <sup>3</sup> /s	-2.14 %	4.81 %	0.112 m/s	6.0	2025-05-06 11:42	2025-05-06 12:01	13.3 m	32.7 m <sup>2</sup>
C_CHMU_OV_M9_1300	SonTek	M9	3117	18.0 m <sup>3</sup> /s	5.24 %	4.84 %	0.197 m/s	6.0	2025-05-06 12:00	2025-05-06 12:23	13.3 m	30.1 m <sup>2</sup>
B_CHMU_UL_SP_1315	TRDI	StreamPro	2193	16.6 m <sup>3</sup> /s	-3.19 %	5.01 %	0.475 m/s	6.0	2025-05-06 12:05	2025-05-06 12:34	13.3 m	34.6 m <sup>2</sup>
C_CHMU_OV_SP_1335	TRDI	StreamPro	461	16.6 m <sup>3</sup> /s	-2.68 %	5.07 %	0.156 m/s	6.0	2025-05-06 12:34	2025-05-06 12:56	14.0 m	29.9 m <sup>2</sup>
B_CHMU_UL_SP_1340	TRDI	StreamPro	1904	17.1 m <sup>3</sup> /s	-0.238 %	5.21 %	0.488 m/s	6.0	2025-05-06 12:40	2025-05-06 13:03	12.8 m	34.2 m <sup>2</sup>
B_CHMU_BR_SP_1410	TRDI	StreamPro	1046	16.9 m <sup>3</sup> /s	-1.28 %	4.81 %	0.48 m/s	6.0	2025-05-06 13:10	2025-05-06 13:23	13.1 m	34.4 m <sup>2</sup>

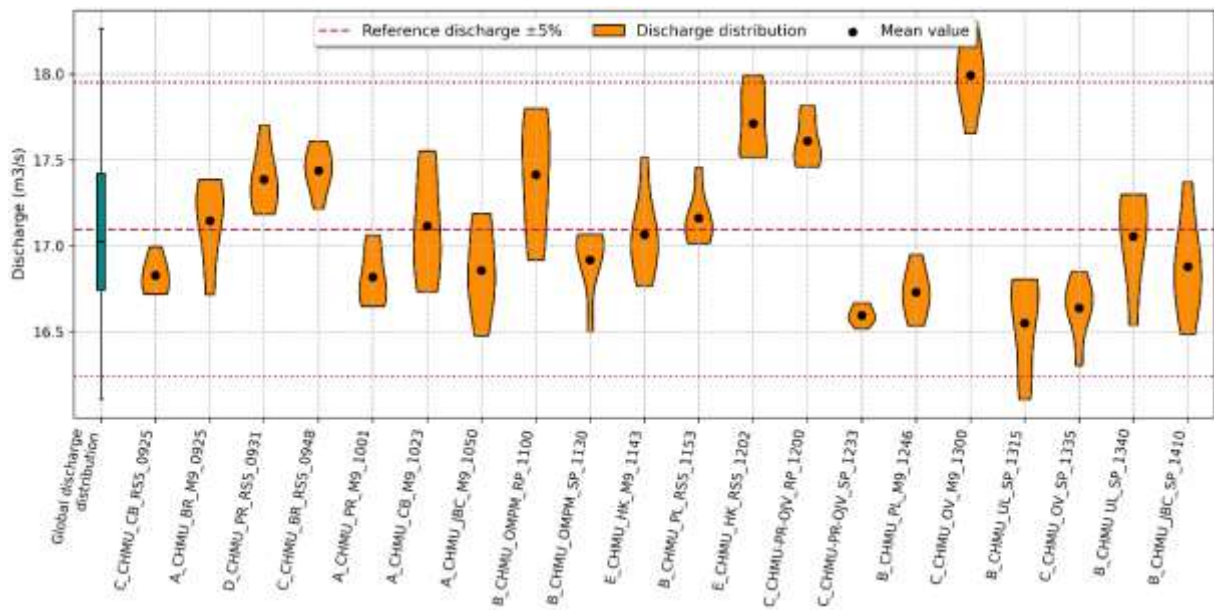
Fig. 19 CHMI devices and their discharge

The evaluation of individual ADCP measurements was carried out using QRevInt version 1.28. The outputs from QRevInt were subsequently processed in QRame version 1.26, which applied the input parameters to assess extrapolation in unmeasured zones near the bed and the surface. Within the river reach used for measurements, no evidence of a moving bed effect was observed.

Mean Q	Standard Deviation Q	Mean U (Q) Oursin	Min Q	Q25	Q75	Max Q
17.1 m <sup>3</sup> ·s <sup>-1</sup>	0.383 m <sup>3</sup> ·s <sup>-1</sup>	5.06%	16.6 m <sup>3</sup> ·s <sup>-1</sup>	16.8 m <sup>3</sup> ·s <sup>-1</sup>	17.4 m <sup>3</sup> ·s <sup>-1</sup>	18.0 m <sup>3</sup> ·s <sup>-1</sup>

Tab. 8. QRame statistics

The dashed line in the figure below indicates the  $\pm 5\%$  envelope around the overall mean discharge, which is 17.1 m<sup>3</sup>·s<sup>-1</sup>. Overall, all measurements can be considered sufficiently accurate and consistent, as were the measurement conditions—no fluctuations were observed in the water level at the nearby gauging station during the measurement period. The SonTek M9 unit (serial number 5117) from the Ostrava branch slightly exceeds the 5% threshold. However, given its proximity to the limit, the overall quality of the measurement, and the resulting uncertainty, this measurement is considered acceptable. A follow-up intercomparison campaign of ADCP instruments at the branch level is recommended to further investigate the cause of this deviation.



**Fig. 19 CHMI devices distribution within  $\pm 5\%$  envelope**

All instruments met the accuracy requirements specified in the methodological guideline “SOP pro kalibrace přístrojů používaných na PV”. All devices fulfilled the required verification criteria, and the measured values did not exceed the 5% deviation limit from the overall mean, or lay very close to this threshold.

## 5. Conclusions and perspectives

The overall course of the event can be considered highly successful. This is confirmed not only by the measured discharge values, which show strong internal consistency, but also by the stable hydrological conditions during the measurement period and, last but not least, the minimal number of operational issues on the part of the ADCP operators. The results of the ADCP Regatta 2025 represent a valuable dataset that can be further analyzed not only in terms of comparing different methods, but also to gain deeper insight into specific parameters and associated metadata. Particular attention should be given to the velocity values near the water surface and the extrapolated discharge in the top unmeasured layer, which consistently account for the largest differences between individual ADCP measurements.

Method	Mean Q	Uncertainty (%)	Deviation from CHMI ADCP mean (%)
only CHMI ADCP	17.1 m <sup>3</sup> .s <sup>-1</sup>	5.06	0
all ADCP	16.1 m <sup>3</sup> .s <sup>-1</sup>	6.24	-5.8
LSPIV (drone)	17.5 m <sup>3</sup> .s <sup>-1</sup>	NA	2.3
LSPIV (viewpoint)	15.7 m <sup>3</sup> .s <sup>-1</sup>	NA	-8.2
point velocity (Ott C31)	16.3 m <sup>3</sup> .s <sup>-1</sup>	4.33	4.7

**Tab. 9 Individual methods and techniques results**

The site at Vranov nad Dyjí has long proven to be an optimal river reach for organizing events of this type. Its stable cross-section geometry, the possibility of controlled flow release from the reservoir, and

the available infrastructure allow for efficient organization, repeatability, and methodological continuity. Experience from this and previous editions of the regatta contributes to the implementation of new measurement techniques, validation of software tools, and development of methodological standards.

The benefit of the event lies not only in comparing measured data against established procedures, but also in the active exchange of experience among technicians from various branches and institutions. Presentations from instrument manufacturers and immediate feedback from users create a dynamic environment for technological development. The international dimension is also important—Vranov’s accessibility facilitates participation by colleagues from Austria, Slovakia, Poland, and Hungary, further fostering collaboration and methodological harmonization.

Cooperation not only with WMO but also with other European organizers of similar intercomparison campaigns continues to deepen. The outcome includes standardized instructions published under the WMO umbrella, which aim to provide globally applicable procedures for verifying hydrometric instruments. In this sense, the experience gained in Vranov contributes to the global advancement of cost-effective, reliable, and methodologically sound verification approaches.

Raw ADCP datasets are available and free to use via this link:

<https://ecloud.chmi.cz/s/TpctoA4fHdBsFPk>



See you next year in Vranov ☺

Libor and Jan