
Particle Physics at PSI

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9 The intensity frontier of particle physics uses intense particle beams to perform precision
10 tests of the Standard Model (SM) and to search for rare processes forbidden in the SM. This
11 approach is complementary to the energy frontier. The proton accelerator facility at the Paul
12 Scherrer Institute (PSI), with its ring cyclotron [1] generates high-intensity beams of pions,
13 muons and ultracold neutrons. In this special SciPost volume, a collection of articles describes
14 past, present and future experiments using these beams at the intensity frontier, as well as a
15 description of the facility. Ideas for future facility upgrades or completely new experimental
16 efforts are not included here, but we are ready to extend this volume in the years to come.

17 PSI is the largest federal research institute in Switzerland. It belongs to the ETH domain
18 and serves as a national laboratory to provide large-scale research infrastructure, such as ac-
19 celerators, that are beyond the means of a single university. PSI was formed in 1988 by the
20 merger of two predecessor institutions: EIR (Eidgenössisches Institut für Reaktorforschung)
21 and SIN (Schweizer Institut für Nuklearforschung). SIN was founded to host Switzerland's
22 “pion factory”, a high-intensity proton accelerator complex with target stations and secondary
23 beam lines. We use the term “PSI” to include facilities and activities at both SIN and PSI.

24 The proton accelerator facility at PSI produced its first pions shortly after it went into oper-
25 ation in 1974. The design of the high-intensity ring cyclotron was novel and innovative, aiming
26 at a proton current of 100 μA at a kinetic energy of 590 MeV. The accelerator has been contin-
27 uously improved and upgraded and has far outperformed these design goals. It is currently
28 among the world's most powerful proton accelerators, producing an average beam power of
29 up to 1.4 MW, with a beam current of over 2 mA. Several low-momentum beams of pions and
30 muons are produced with the highest intensities available [2]. In the last 10 years, a dedicated
31 neutron spallation target has been added, which serves as a high-intensity source of ultracold
32 neutrons [3]. As new experiments need even higher intensities to reach their ambitious goals,
33 plans to further upgrade the facility are under discussion.

34 Many of the particle physics experiments performed at PSI use the high beam fluxes to
35 precisely measure the parameters of the SM, or to search for the possible existence of physics
36 beyond the SM with improved sensitivity. While the results from these studies have been pub-
37 lished in many articles and journals over the years, there has been no review to date collecting
38 all of these in one volume. This SciPost Volume aims to fill that void.

39 Peter Truöl¹ published a monograph in 2007 [4] entitled *Myonen und Pionen in Teilchen-*
40 *physik und Anwendungen – 30 Jahre experimentelle Forschung an der Schweizer Mesonenfabrik*

¹Peter Truöl (1939-2020) was professor of experimental particle physics at the University of Zurich and chair-
man of the particle physics advisory committee at PSI for ten years, 1993-2002, after which one of the volume
editors (CMH) took over this duty for another long period, 2002-2014.

43 *in Villigen*. This was, unfortunately, only available in German, and was meant for a different
44 audience than this volume. Peter Truöl, together with one of the editors of this volume (KK),
45 wanted to update and extend this nice booklet into a major review article aimed at an inter-
46 national audience of interested particle physicists. While that project was never realized, the
47 present editors teamed up to assemble this special volume. We distributed much of the work to
48 the many colleagues who are actually much better able to write individual parts of this review,
49 reporting on their own work. We are grateful to all of the authors who accepted our request,
50 and contributed their articles.

51 When we started this project some time ago, we asked two very dear colleagues, Claude
52 Petijean and Manfred Daum, to serve as guinea pigs. They wrote several example contribu-
53 tions, which were discussed and used to help fix the instructions and templates for the other
54 authors. Claude and Manfred also wrote several final contributions and served as critical re-
55 viewers for many other papers. In addition, many other authors and colleagues served as
56 anonymous referees for the contributions to this special volume. We give a huge “thank you”
57 to all those who helped!

58 We hope that this volume will remain as a reference for the achievements in particle physics
59 at PSI, and expect that many future contributions will extend this collection.

60 Klaus Kirch, Adrian Signer, Cy Hoffman

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