



Closing remarks

Hermann Schmickler

Adapting to sanitary conditions of Covid we have changed the venue and also the dates to 25.September - 8.October 2021

Everness Hotel in Chavannes de Bogis

ktu
kauno technologijos universitetas
1922

#5.2021

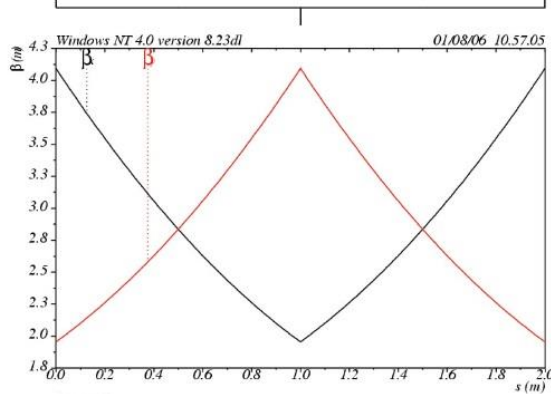


The “minimum takeaway”

- **Transverse and longitudinal beam dynamics**
 - trajectory, closed orbit, synchronous particle
 - horizontal and vertical phase/trace-space, preserved action
 - Twiss-parameters: Beta-function, Phase advance, tunes (H+V+synchrotron)
 - Dispersion-function, momentum compaction, slip factor
 - transverse and longitudinal focusing
 - chromaticity: origin and correction
 - transport matrix, tracking, dynamic aperture, bucket-area
- **Emittance**
 - emittance = average action of all particles
 - Liouville Theorem
 - RMS emittance, geometrical emittance
 - adiabatic damping, radiation damping
- **Imperfections**
 - dipole displacement: OK, dipole tilt: vertical deflection
 - quadrupole offset: extra deflection; quadrupole tilt: coupling
 - sextupole offset: extra quadrupole, sextupole tilt: coupling
- **Beam instrumentation**
 - Basic BPM functionality
 - How to measure losses, profiles
 - time and frequency domain signals, tune measurement
- **Collective effects:** Head-Tail, Wakefields, Direct Space Charge, Instabilities
- **Types of accelerators:** Linacs, Cyclotrons, Synchrotrons, Colliders, Lightsources

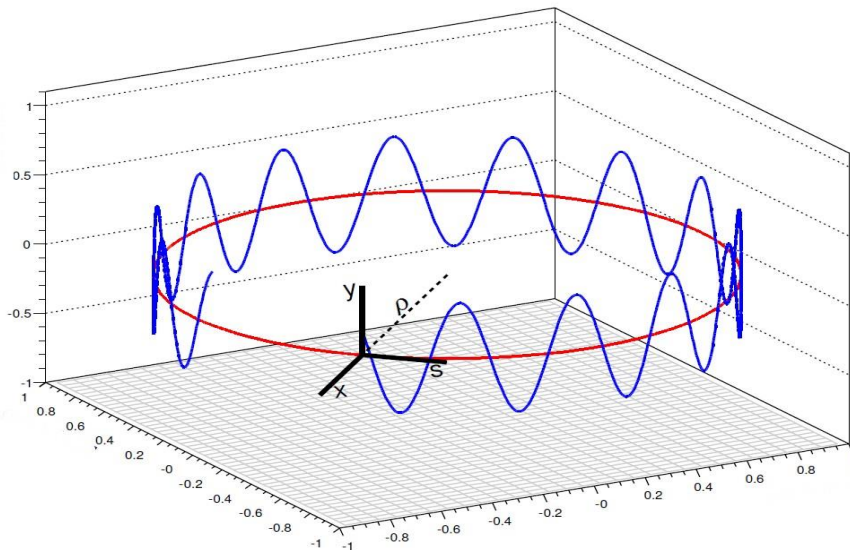
5 slides to retain

1) Horizontal and vertical beta function $\beta_{H,V}(s)$:

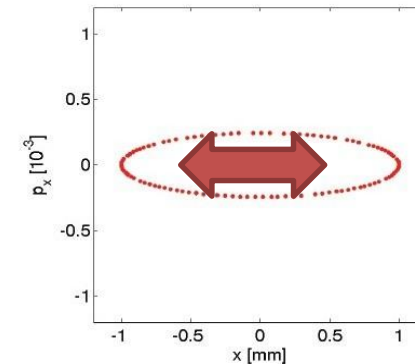


- Proportional to the square of the projection of the phase space ellipse onto the space coordinate
- Focusing quadrupole \rightarrow low beta values

Although the shape of phase space changes along s , the rotation of the particle on the phase space ellipse projected onto the space co-ordinate looks like an harmonic oscillation with variable amplitude: called **BETATRON-Oscillation**



$$x(s) = \text{const} \cdot \sqrt{\beta(s)} \cdot \cos\{\mu(s) + \varphi\}$$



Interpretation of the Twiss parameters (2/2)

2.)
$$\alpha = -\frac{1}{2} \frac{d\beta}{ds}$$

α indicates the rate of change of β along s
 α zero at the extremes of beta (waist)

3.)
$$\mu = \int_{s1}^{s2} \frac{1}{\beta} ds$$

Phase Advance: Indication how much a particle rotates in phase space when advancing in s

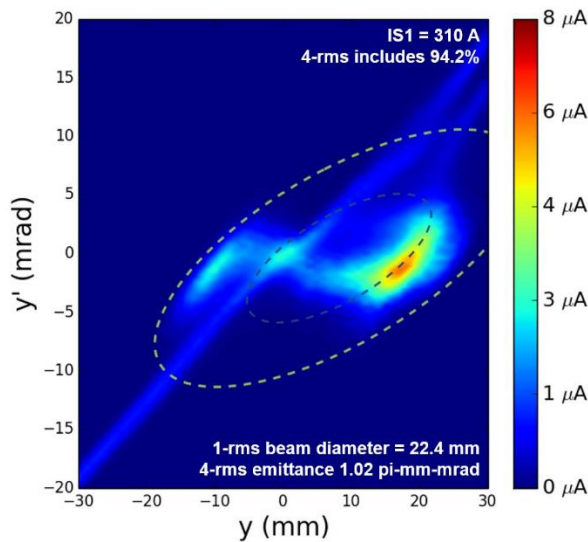
Of particular importance: Phase advance around a complete turn of a circular accelerator, called the **betatron tune Q (H,V)** of this accelerator

$$Q_{H,V} = \frac{1}{2\pi} \int_0^C \frac{1}{\beta_{H,V}} ds$$

Finally: a beam

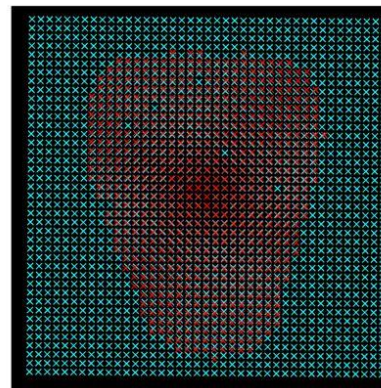
We focus on “bunched” beams, i.e. many (10^{11}) particles bunched together longitudinally

From the generation of the beams the particles have transversally a spread in their original position and momentum.

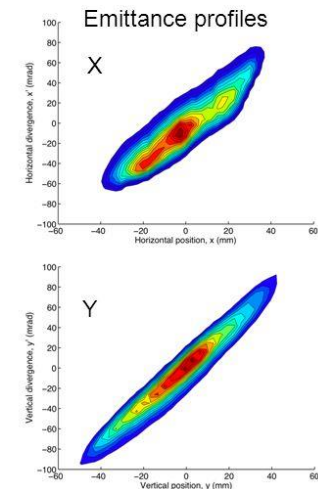


Source: ISODAR (Isotope at rest experiment)

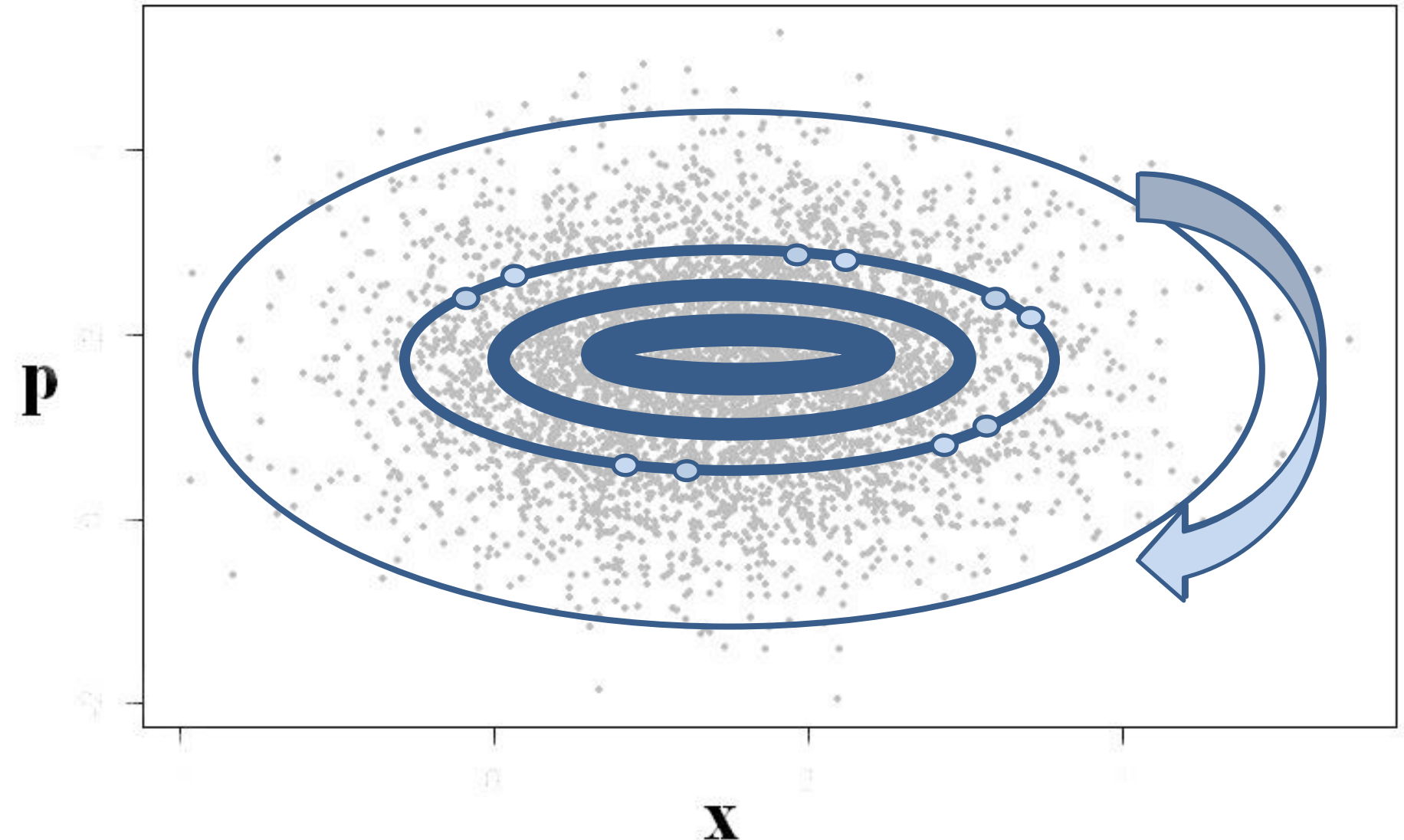
Pepperpot Emittance Extraction



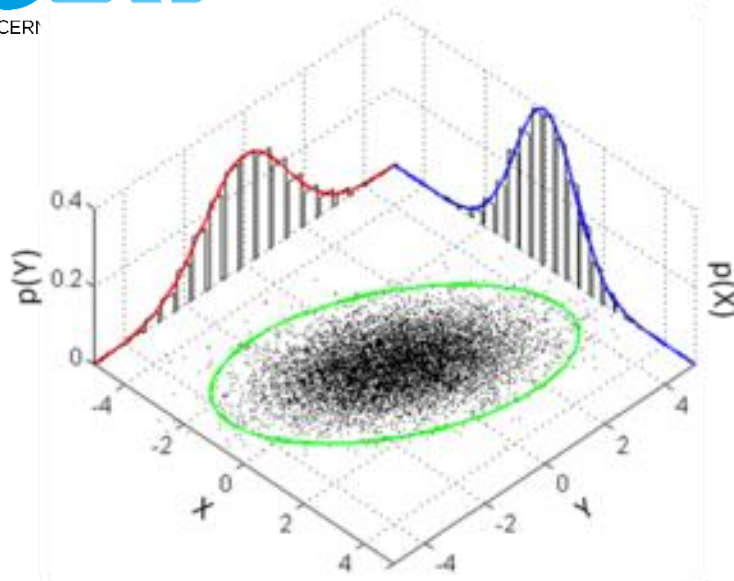
Pepperpot image spots: hole positions (blue) and beam spots (red)



Gaussian beam profile in x and p

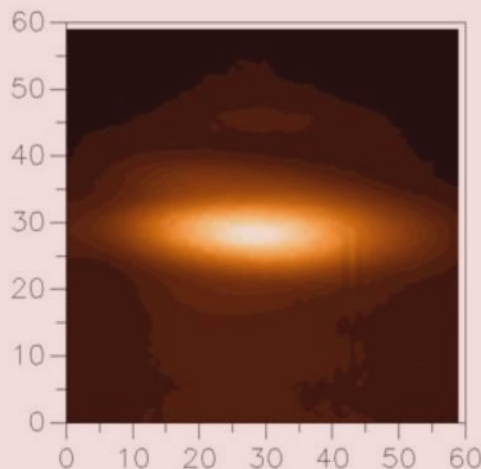


What do we normally measure from the phase-space ellipse?



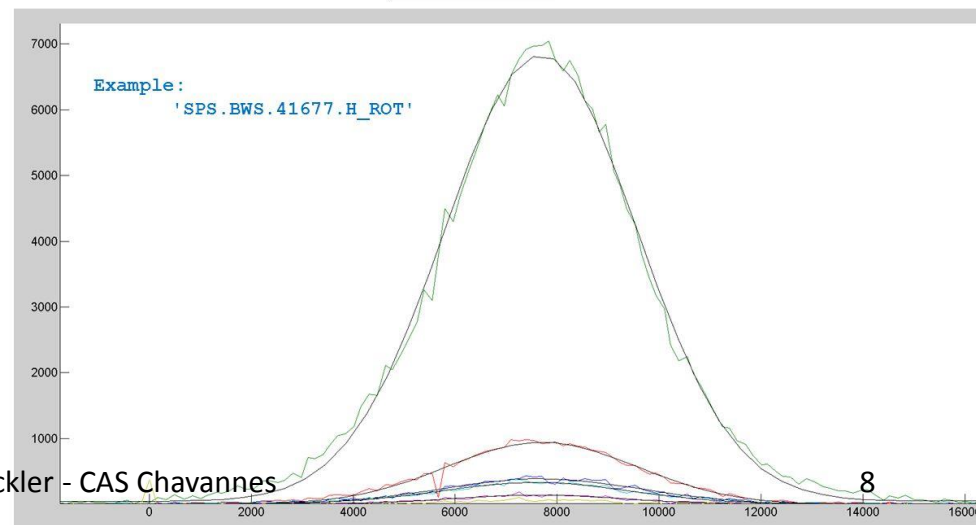
- At a given location in the accelerator we can measure the position of the particles, normally it is difficult to measure the angle...so we measure the projection of the phase space ellipse onto the space dimension:
→ called a profile monitor

Attention! The standard 2 D image of a synchrotron light based beam image is NOT a phase space measurement



Hermann Schmickler - CAS Chavannes

FITTING



Some background info

- Last course 2 years ago (High Tatras, Slovakia)
- Next course in September 2022 probably in Kaunas (Lithuania)
- Visit and choice of hotel in autumn based on Covid considerations
- Same program as two years ago, nevertheless 9 iterations of program to accommodate speaker availabilities.
- Incomplete proceedings available on the web
- Expect complete and printed copies in February/March 2022
Every participant will be asked by email for his postal address and will get (if wanted) a printed copy.

Statistics

- 68 participants
- 23 different nationalities
- Age span: 20 ... 48
- 45 males / 23 females

Feedback Discussion

- Comments to the program
- Balance of topics
- Balance between accelerator types
- Hands-ON Courses
- Level of the lectures

Project “CAS videos”

Presently two major attempts to produce MOOC's in the field of accelerator physics:

- Nordic Accelerator School
- ARIES

CAS proposes to film its lectures and to put them onto our website including an electronic index baptized “CASopedia”

- first attempt: introductory in Budapest; no index
- now: this introductory course;
(provided we get the necessary resources)

MOOC: Massive Open Online Course


Our website: <http://cas.web.cern.ch/>

Author: Anastasiya

Our major depository of information...large effort to keep the site up to date

Sign inDirectory

Registration is open for "RF for Accelerators", 22 March – 4 April 2020 in Kaunas, Lithuania




The CERN Accelerator School

HomeAboutUpcoming schoolsPrevious schoolsFrequently asked questionsPhoto galleryContact

Welcome to the CERN Accelerator School!

The CERN Accelerator School holds training courses on accelerator physics and associated technologies for physicists, engineers, technicians and students. The courses take place in different member states of CERN and consist of a programme of lectures and tutorials spread over a period of one to two weeks.

We welcome participants from all countries world-wide!



RIGHT NOW

Introduction to Accelerator Physics

ongoing until 21 September 2019 in Vysoke-Tatry, Slovakia

New registration procedure

With the upcoming advanced and then introductory general CAS courses we propose a new procedure for all student registrations external to CERN:

The registration opens 4-5 months before the course and stays open for 3 months. All students registering with payment are informed within a week about the acceptance of their application. For the first half of the payment period a price advantage of 300 CHF for the whole course is offered. Later payment will require the full sum. This also gives ample time for VISA formalities etc.

Grant students will be informed at the end of the registration period, because all grant applications will be considered together and compared to each other. For those typically a 2 months period remains for VISA formalities and travel arrangements.

For students applying as grant student AND as paying student the grant application is automatically removed.

A student, who has applied for a grant, which could not be considered for a course, can NOT apply afterwards as normal paying student.

Our CAS video on the website

<https://cas.web.cern.ch/>



Feedback

VACUUM FOR PARTICLE ACCELERATORS

6-16 June, 2017

Glumslov, Sweden

YOUR IMPRESSIONS OF THE PROGRAMME

Please mark each lecture with a number 1 to 5 in each of the three columns labelled "Level, Content and Presentation". The meaning of the numbers is as shown below. Please return this sheet to Barbara Strasser or Roger Bailey as soon as possible when completed. Your answers are confidential.

LEVEL	CONTENT	PRESENTATION
1 – Much too low	1 – Completely uninteresting	1 – Very poor
2 – Low	2 – Uninteresting	2 – Poor
3 – Just right	3 – Of some interest	3 – Fair
4 – Too high	4 – Interesting	4 – Good
5 – Much too high	5 – Very interesting	5 – Very good

TITLE	LEVEL	CONTENT	PRESENTATION
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We keep the feedback open until
Sunday this week...last chance!

- Please help us

- Very important

- For

- For

- About

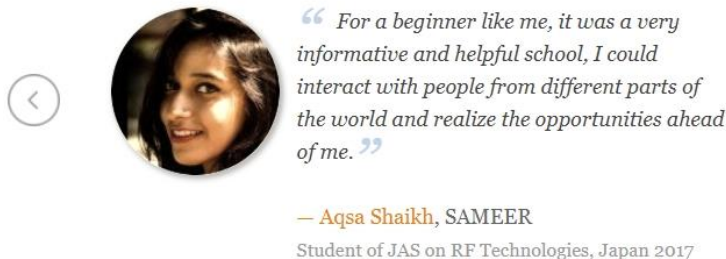
- The lectures
- The tutorials
- The place
- Anything else

Introduction to Cryogenics			
Cryopumping			
Industrial Vacuum Applications			
Beam Induced Desorption			
Beam-Gas Interaction			
Surface Characterisation			
Interactions between Beams and Vacuum System Walls			
Surface Cleaning & Finishing			
Thin-Film Coating			
Controlling Particles/Dust in Vacuum Systems			
Beam Induced Radioactivity & Radiation Hardness			
Radiation Damage and its Consequence			
Control & Diagnostic			
Vacuum Design Aspects			
Manufacturing & Assembly for Vacuum Technology			
The Real Life of Operation			
Challenges for Vacuum Technology of Future Accelerators			

“Testimonials” on the CAS website



What our students say about us



- All it needs:
 - a photo
 - name + affiliation + CAS course
 - “a sentence”

Social life during course:

- Next to the course teaching the most important aspect of the school
“ digital training cannot replace CAS courses”
- What happened:
 - people socialising (and even working) up to late in the evenings
 - lots of interactions students <-> teachers
 - cinema evening
 - excursion

Last not least:

This course would not have happened without:

- lecturers: they do all the work for “love”
- the Hands-ON courses teachers:
 - Guido, Andrea, Volker, Axel, Heiko, Alexandre, Simon
- The “souls” of the event:
 - Delphine
 - Maria
 - Michela
 - Anastasiya



• YOU