ACC OPERATIONS

GSI Helmholtzzentrum für Schwerionenforschung GmbH

Some Aspects for ESR Operation

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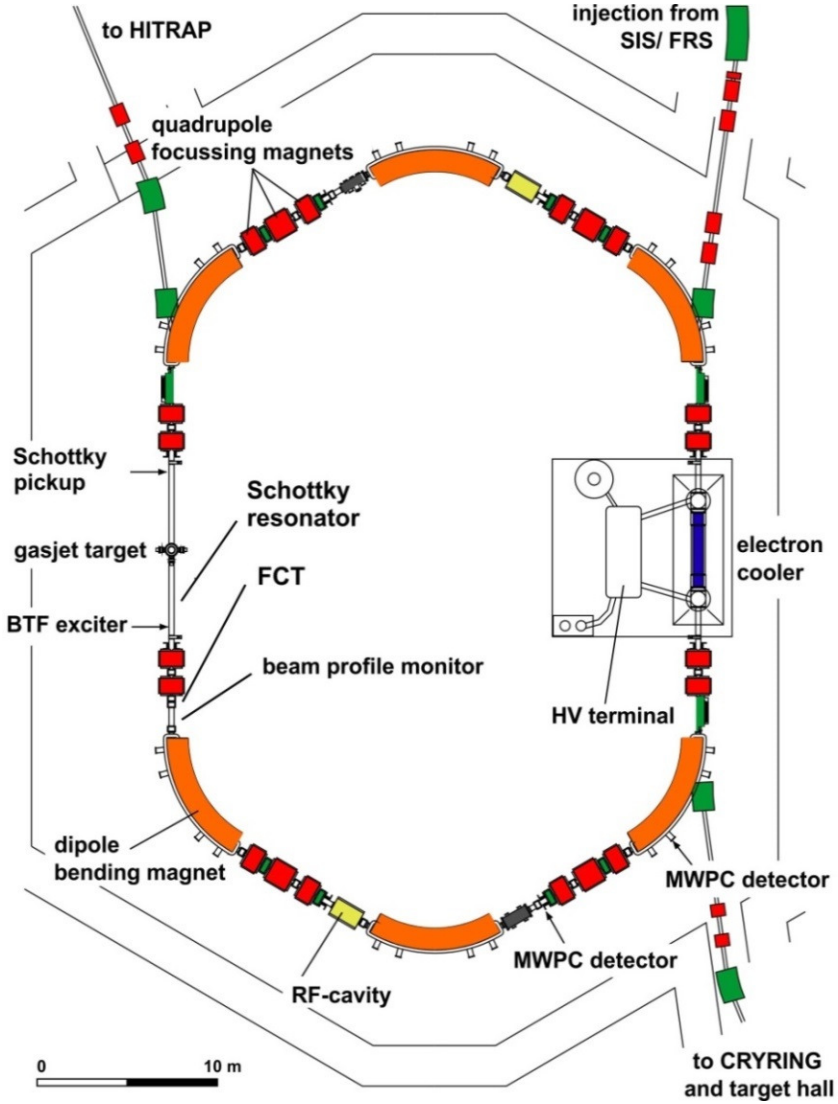
The Heavy Ion Storage Ring ESR



- Fast injection (stable ions / RIBs)
- Stochastic cooling (≥ 400 MeV/u)
- Electron cooling (3 - 430 MeV/u)
- Laser cooling (C^{3+} 120 MeV/u)
- Internal gas jet target
- Deceleration (down to 3 MeV/u)
- Fast extraction (HITRAP/CRYRING)
- Slow (resonant) extraction
- Ultraslow extraction (charge change)
- Beam accumulation
- Multi charge state operation
- Schottky mass spectrometry of RIBs
- Isochronous mode (TOF detector)

⇒ **no standard cycle**

ESR Operation in 2016

very reliable and well established hardware

downtime during 2016 beamtime (36 days) was less than 2 hours

additional support by technical departments was on the order of a few hours

control system was obsolete, but matched by operational staff

flexibility was sufficient for the requested operation

efficiency of operation might be increased with new control system in the long run

beam was delivered according to schedule and requirements

faithful cooperation between accelerator staff and experimentalists

ESR Shutdown Activities 2016-2018

repair of vacuum chamber in one dipole magnet (bellow)

installation of barrier bucket rf system in May 2018

possibility of installation of second Schottky resonator (UHV compatibility?)

modification of laser diagnostics chamber in target section

plans for modification of internal target gas inlet

repair of electron cooler drift tubes was postponed due to the presence of hazardous material, doubts about time schedule for the repair

modernization of main control room, console for experiments disappeared

modernization of beam diagnostics and stochastic cooling system

modernization of control system hardware (SCUs for SEs)

preparation of new software and timing system (relevant for experiments)

ESR Shutdown Activities 2016-2018

Main Control Room has changed

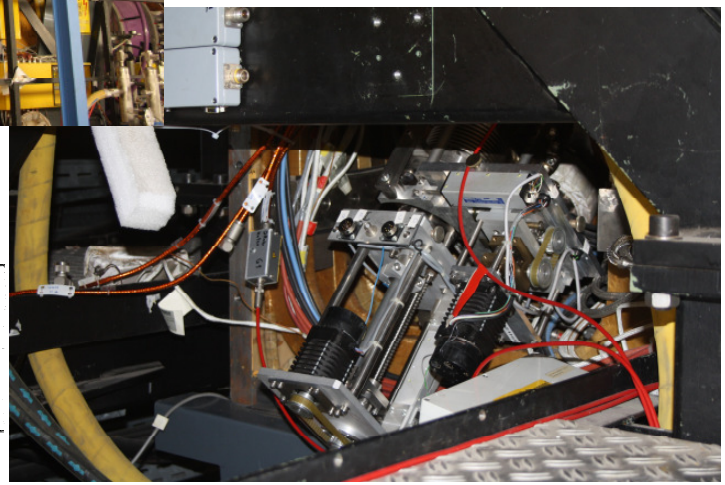
ESR experiment console disappeared

ESR measurement equipment rearranged (half of old consoles houses measurement equipment)

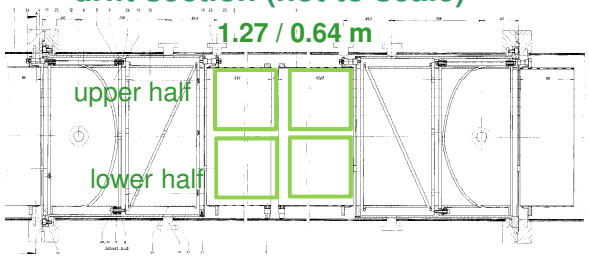
Repair of Electron Cooler Drift Tubes

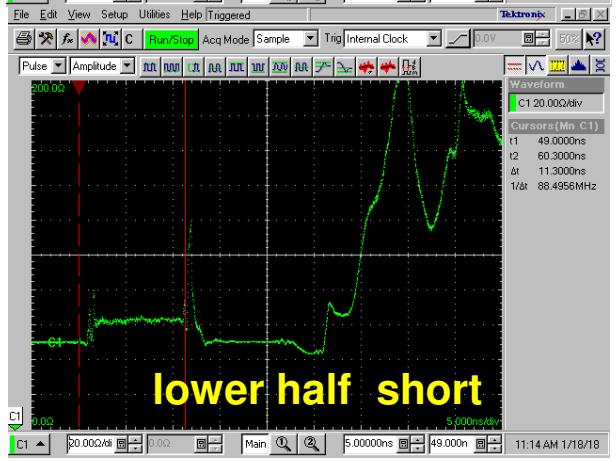
drift tubes are needed for experiments which need a fast variation of the electron energy, mainly dielectronic recombination

the performance of cooling is not compromised

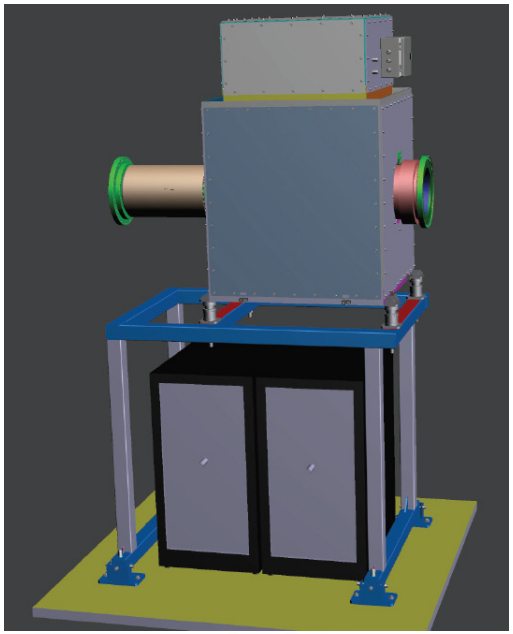


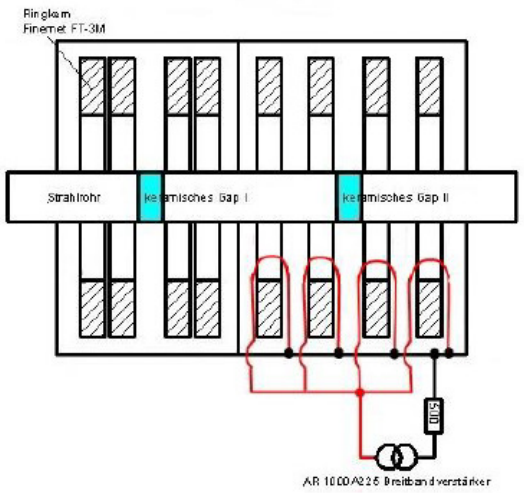
drift section (not to scale)





New ESR Barrier Bucket Cavity





tasks: 1) accumulation in combination with cooling
2) bunching of the beam for fast extraction at low energy

Technical Parameters

frequency	0.25 - 5 MHz
maximum voltage	1 kV
rf power (at 5 MHz)	850 W

air cooling
two gaps
eight magnetic alloy rings

installation in the ESR in May 2018

Recommissioning Steps

electron beam generation

tuning of magnets
tuning of high voltage devices
tuning of global parameters
electron current switch control
interlock control
cathode heating, vacuum reading
drift tube high voltage stepping

ramping of magnets

local orbit change
global orbit change
change of tune and chromaiticity

ramping of electron cooler

ramping of magnets
ramping of hv devices

estimated number of shifts to establish old performance

≈ 120

(assuming reasonably experienced operators)

conclusion:
priorities for recommissioning depend on scheduled experiments

ion beam storage

kick matrix measurement
matrix response measurement
dispersion function measurement
tuning of dispersion in target and cooler section
tuning of isochronous mode
control of particle detecor pockets

control of beam line magnets and diagnostics

fast beam extraction

kicker timing
kicker control
orbit control for extraction (CRYRING + HITRAP)
timing controlled beam line operation
bunching and rf synchronization

ramping of rf

rf stacking (frquency and amplitude variation)
varation of beam energy/orbit
changing of harmonic number
matching rf and electron cooling

recommissioning stochastic cooling

commissioning beam profile monitor (low energy operation)

Commissioning for E121

electron beam generation

- tuning of magnets
- tuning of high voltage devices
- tuning of global parameters
- electron current switch control
- interlock control
- cathode heating, vacuum reading
- drift tube high voltage stepping
- ramped operation

ion beam storage

- ring magnet commissioning and tuning
- synchronization of kickers (SIS, ESR)
- synchronization of pulsed injection septum
- bunching
- measurement of closed orbit
- tuning of electron cooler magnets
- tuning of electron cooling
- control of Schottky/BTF devices
- measurement of tune, chromaticity, dispersion
- commissioning of diagnostics; DCT, FCT, profile monitor
- variation of beam momentum for optics measurements
- local orbit bumps implemetation and check
- kick matrix measurement
- matrix response measurement
- dispersion function measurement
- tuning of dispersion in target and cooler section
- tuning of isochronous mode
- control of particle detecor pockets

ramping of rf

- rf stacking (frquency and amplitude variation)
- varation of beam energy/orbit
- changing of harmonic number
- matching rf and electron cooling

ramping of magnets

- local orbit change
- global orbit change
- change of tune and chromaiticity

ramping of electron cooler

- ramping of magnets
- ramping of hv devices
- timing controlled electron current operation

timing control of devices

- timing triggered motion of actuators
- timing for beam diagnostics measurements

acceleration/deceleration

- synchronized ramping of magnets, rf, electon cooler
- beam parameter measurements during ramping
- tuning of parameters for beam deceleration

slow beam extraction

- UHV septum
- septum position
- electrostatic septum control
- control of beam line magnets and diagnostics

fast beam extraction

- kicker timing
- kicker control
- orbit control for extraction (CRYRING + HITRAP)
- timing controlled beam line operation
- bunching and rf synchronization

recommissioning stochastic cooling

commissioning beam profile monitor (low energy operation)

Σ= 40 shifts

Commissioning for CRYRING

electron beam generation

- tuning of magnets
- tuning of high voltage devices
- tuning of global parameters
- electron current switch control
- interlock control
- cathode heating, vacuum reading
- drift tube high voltage stepping
- ramped operation

ion beam storage

- ring magnet commissioning and tuning
- synchronization of kickers (SIS, ESR)
- synchronization of pulsed injection septum
- bunching
- measurement of closed orbit
- tuning of electron cooler magnets
- tuning of electron cooling
- control of Schottky/BTF devices
- measurement of tune, chromaticity, dispersion
- commissioning of diagnostics; DCT, FCT, profile monitor
- variation of beam momentum for optics measurements
- local orbit bumps implemetation and check
- kick matrix measurement
- matrix response measurement
- dispersion function measurement
- tuning of dispersion in target and cooler section
- tuning of isochronous mode
- control of particle detecor pockets

ramping of rf

- rf stacking (frquency and amplitude variation)
- varation of beam energy/orbit
- changing of harmonic number
- matching rf and electron cooling

ramping of magnets

- local orbit change
- global orbit change
- change of tune and chromaiticity

ramping of electron cooler

- ramping of magnets
- ramping of hv devices
- timing controlled electron current operation

timing control of devices

- timing triggered motion of actuators
- timing for beam diagnostics measurements

acceleration/deceleration

- synchronized ramping of magnets, rf, electon cooler
- beam parameter measurements during ramping
- tuning of parameters for beam deceleration

Σ= 85 shifts

slow beam extraction

- UHV septum
- septum position
- electrostatic septum control
- control of beam line magnets and diagnostics

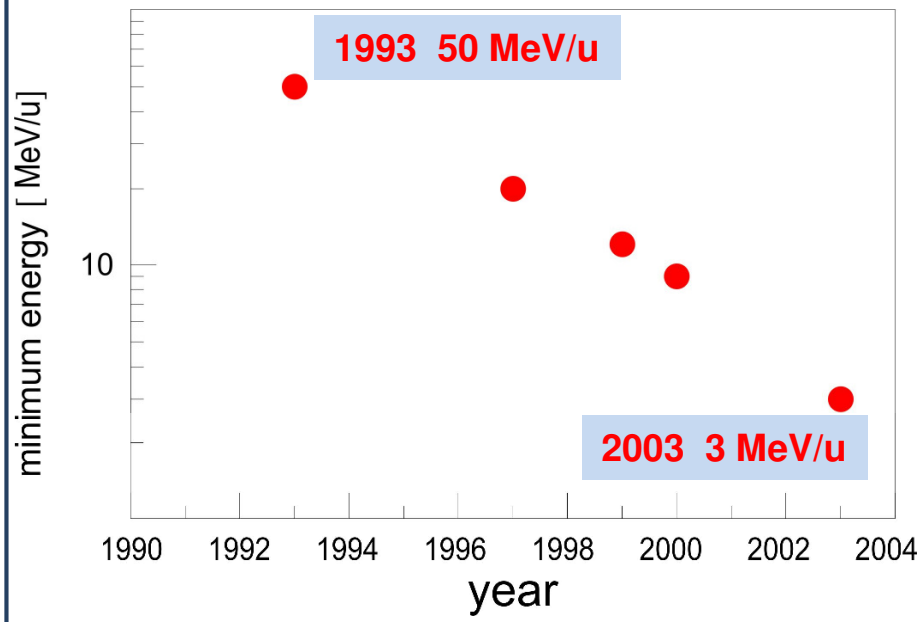
fast beam extraction

- kicker timing
- kicker control
- orbit control for extraction (CRYRING + HITRAP)
- timing controlled beam line operation
- bunching and rf synchronization

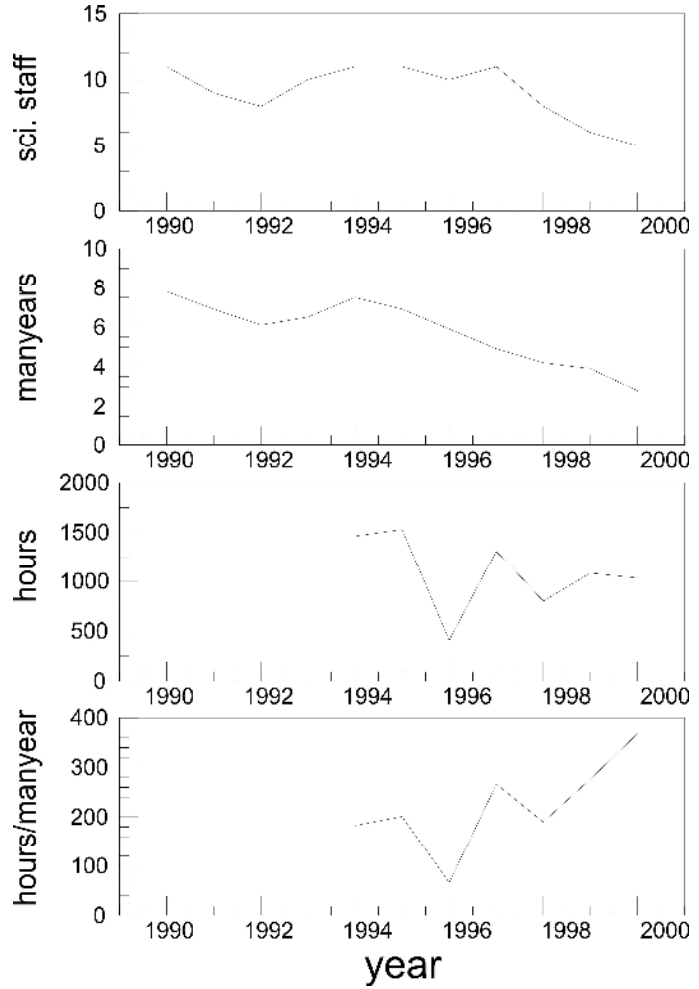
- recommissioning stochastic cooling

- commissioning beam profile monitor (low energy operation)

History of Deceleration in the ESR

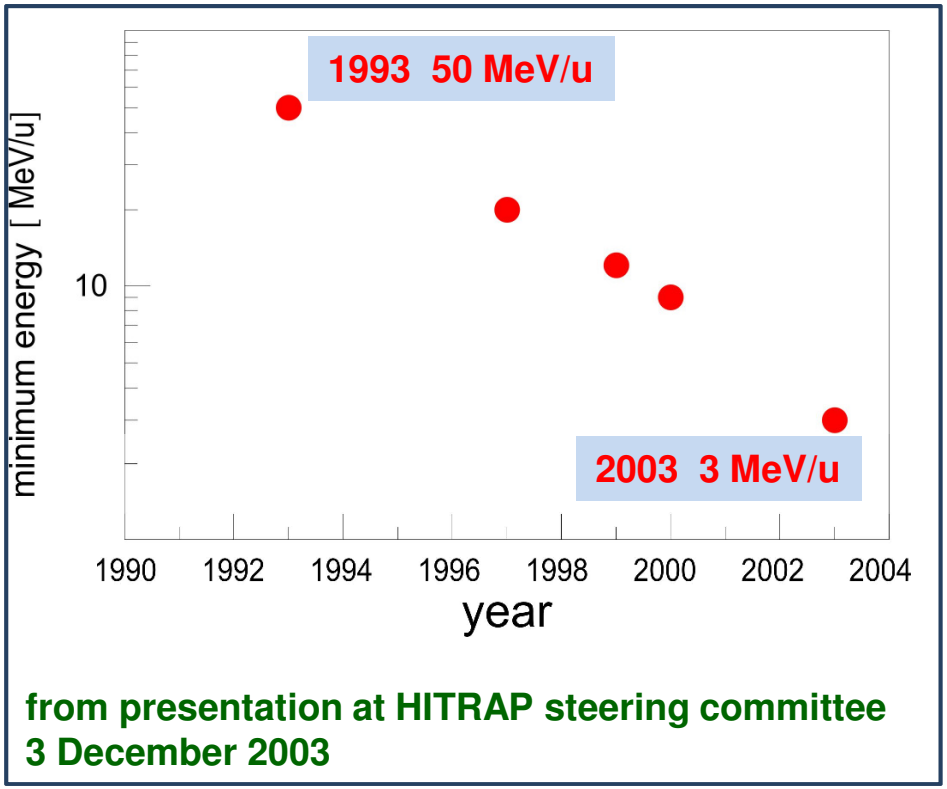


from presentation at HITRAP steering committee
3 December 2003



from presentation at atomic physics seminar
May 2001

Future of Deceleration in the ESR



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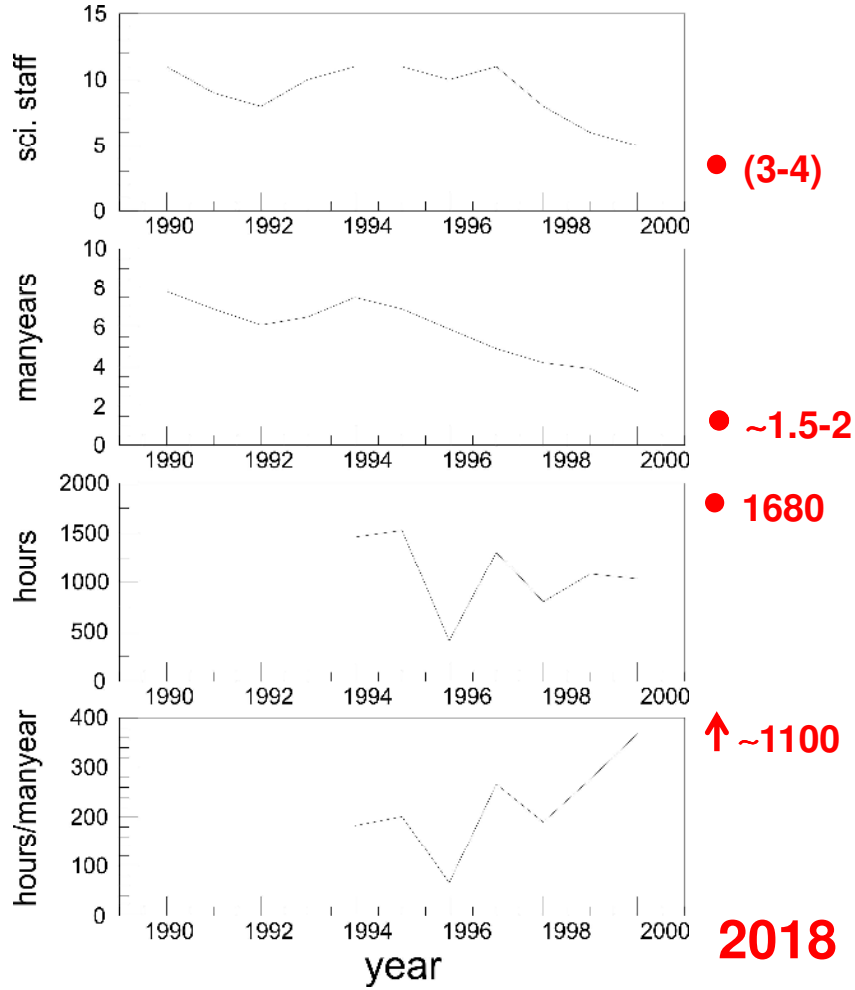

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Issues for Beam Transfer to CRYRING

ultrahigh vacuum is crucial, low 10^{-11} mbar required, little compromises possible
⇒ consequences for the installation of experimental set-ups

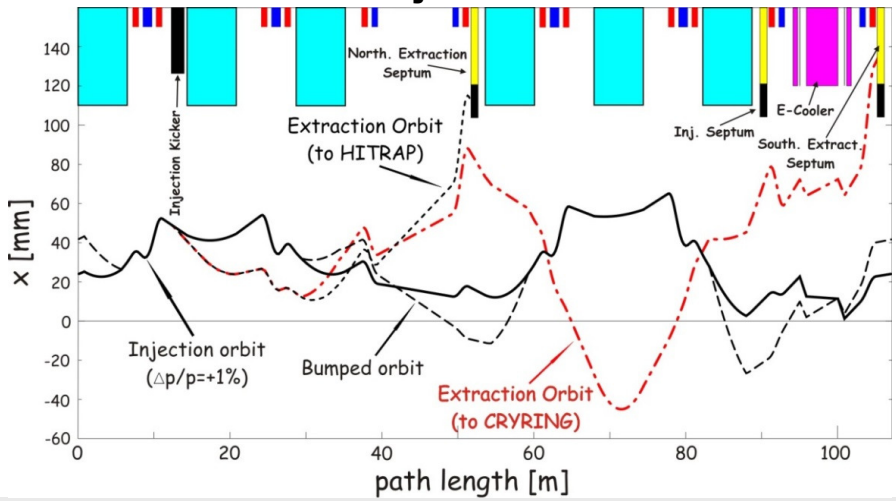
no FAIR solution for synchronization is presently available,
SIS-ESR synchronization uses 30 years old gear,
ESR-CRYRING transfer is an open issue

shorter ESR deceleration cycles require extensive machine development, maybe also hardware modification

a fast extraction scheme from ESR has been demonstrated
It still has to be demonstrated that it is suitable for injection into CRYRING

no cooling right before extraction

no immediate fall back position in case of failure



ESR Operation in 2018

- hardware should be disposable with the established performance
- quality of global alignment is uncertain (ESR ring should be ok)
- all software must be new, no fall back to old VMS system based software
- this also affects all experiments, no previously used software is available
- new timing system, old triggers for experiments will be affected
- staffing of operating team is an open issue
- the beam recommissioning will require significant support by technical departments, particularly controls and beam diagnostics, to achieve good performance of the installed new equipment for the control of devices
- migration to new control system and to fresh staff will require devoted efforts and a lot of patience

ESR Operation beyond 2018

recommissioning and development of control system will continue
first goal: establish old performance
second goal: improvement of performance,
e.g. beam transfer to CRYRING,
shorter deceleration cycle
high intensity operation

integrate new barrier bucket cavity into operation
for: accumulation of exotic beams
single bunch generation for CRYRING and HITRAP

establish a team of experts for ESR operation during FAIR phase 0
which will be able to continue the faithful cooperation with experiments

requirements for ESR modifications for new experiments beyond the existing set-up need to be discussed in due time