

An aerial photograph of a mountainous region with a large lake on the left. A circular dashed white line is overlaid on the terrain, centered on a valley. A solid blue horizontal line is positioned below the title.

ABT involvement in FCC

W. Bartmann for ABT-FCC working group
SY-FCC workshop, 4 Oct 2024

- Siting of the injector complex and design of the transfer line to collider tunnel including energy/bunch compressor
- Design and production of damping ring injection and extraction systems → no conceptual layout, nor system specification
- Layout, design and production of booster injection, extraction and dump systems
- Layout of the transfer lines between booster and collider
- Layout, design and production of collider injection and dump systems including transfer lines to the dumps
- Design and production of collider EM separators

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- Layout, design and production of collider injection and dump systems including transfer lines to the dumps
- Design and production of collider EM separators
- FCC-hh: Layout and design of injection and dump systems to a level that compatibility with FCC-ee CE design can be assessed
- FCC-hh: Layout and design of hadron transfer lines, and steering associated studies on future hadron injectors

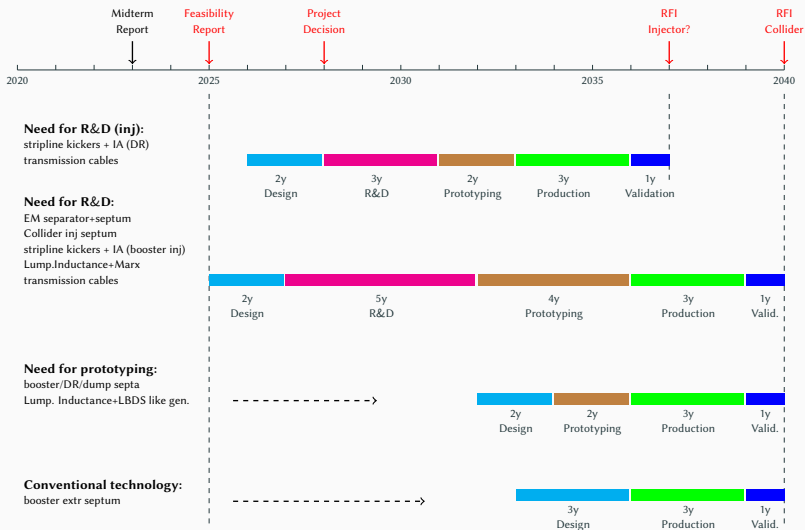
Technical challenges - ABT HW

- Chosen beam transfer HW baseline is the result of a first optimisation regarding optics design, cost, power consumption, environmental impact, integration, dose levels, machine protection, operation, beam impedance → talk by Giorgia
- HW challenges:
 - EM separators field quality and SR shielding
 - Very thin magnetic septum for collider injection
 - Striplines vs beam impedance and thermomechanical robustness
 - Transmission cables: lengths for performance and CE impact (integration of generators close enough to magnet) as well as for radiation impact
 - Validation of generator choices not yet operated at CERN for fast pulsed systems (inductive adder, marx generator)
- **most of the ABT HW requires either R&D or prototyping - no fundamental showstoppers identified so far**

- **Top-up injection** is an important conceptual challenge
 - very much inter-woven with collider beam dynamics - see Yann's talk
 - initial WG diluted due to departures of key actors - we will re-activate this one and ask for support of various domains (overall lattice design with errors, beam-beam, collimation) → seeking project support for this approach
- **Machine protection** considerations started where obvious; systematic approach to listing failure scenarios still to come, might impact design choices, eg segmentation, thus impact on space in lattice and for generators, cost and CE baseline → worth having timeline for analysis, mitigation plans, review, etc?
- **Transfer lines** from surface to collider: per se not problematic, but substantial length and integrated bending cause emittance growth and bunch lengthening; bunch compressors have likely to be added to present baseline

- Top-up injection concept
- EM separators
- Kicker transmission cables

Timeline



Timeline observations

- injector complex systems not the most complicated for us but have to be vigilant about earlier installation readiness wrt collider
- most difficult items require us to enter directly into R&D phase
- ongoing parallel CONS activities will serve a technology validation step, ie installation of inductive adder generator for one PS extraction kickers
- early prototyping will reduce the CtC and allow for spreading the required human resources
- will use the WP descriptions to detail by system timeline and budget requests for R&D/prototyping
- Do we have a deadline for those and how will we handle the approval of requests?

Collaborations, in-kind, industry

- Marx generator for FCC-hh ongoing, still to be delivered and tested, can be extended to FCC-ee,
- Collaboration with Wigner on Sushi ongoing, soon to be closed
- Inductive adder, discussed but never materialized with KIT, could easily start
- Stripline, possible collaborations with PSI, DESY,...
- Lumped inductance magnets and septa in general, prototype in-house, then produce in industry, assemble and validate in-house
- Top-up collaboration on non-linear kicker stopped, several aspects suitable for collaboration like beam-beam, collimation, etc
- TL energy compressor - collaboration not particularly effective
- EM separator, ongoing collaboration with Uni Tartu on SR induced sparking and HV phenomena under vacuum
- EM separator is also used as target for AI assisted HW conception in collaboration with Physics X - allocated DOCT to this activity, can we start the hiring?

- since end of 2023 ramped up group internal staff ressources - remarkable how the step up from paper allocation to real activity happened - a lot of engagement and motivation for the project
- even with additional ressources (1 Staff, 1 DOCT, 1 GRAD) we can't alleviate on inital group efforts in the next years until project decision
- while at CERN we are used to work for machine operation the pedal to the metal, we chose to take ressources away from operational efforts - do we have support for this?
- when can DOCTs and GRADs be hired? first replacement of present FELL position need to be published, need response from project on these requests to avoid discontinuities in the various work packages and allow for planning ahead
- top-up injection (or other inj/extr layouts) will be suffering from 2nd staff request not being allocated - will have to work out plan on how to reach feasible design for pre-TDR

Organisational aspects - ABT internal

- Since end of last year have an ABT internal WG dedicated on FCC, 15 active people meeting bi-weekly, chaired by Yann Dutheil
- We have one representative for ATDC, Optics, TI, Integration, MPP meetings reporting back to WG
- main purpose is info exchange from various FCC committees and aligned approach to documentation like MTR, FS, environmental report, cost estimate, risk register,...
- Already inside this small group realized that keeping track of beam parameters and HW specifications is a challenge

Organisational aspects - suggestions

a few suggestions for discussion...

- establish parameter table and HW specifications which are centrally stored, version controlled and changes require approval, eg from optics meeting chair
- FS is setting a baseline: establish process for changing baseline, eg ÉCR light
- with ongoing WP definition will have clear list of FCC core activities - ensure deliverables have a responsible unit behind in addition to a person
- Decision making not always clear, and not sure what is the role of the committees in this (Optics meeting, ATDC, TI, Integration, MPP, RWG, CHART...) or how the inter-committee communication/reporting happens → clarify/establish transparent decision making process and committee organigram

Conclusions

- A lot of work is happening - we are enjoying one of the most interesting project phases
- several suggestions to smooth workflow and communication to keep the motivation at its high level and efficiently integrate the incoming resources
- technically we have interesting challenges - for some we need to jump imminently from first design into R&D to leverage some of our doubts
- a lot of potential for continued and new collaborations