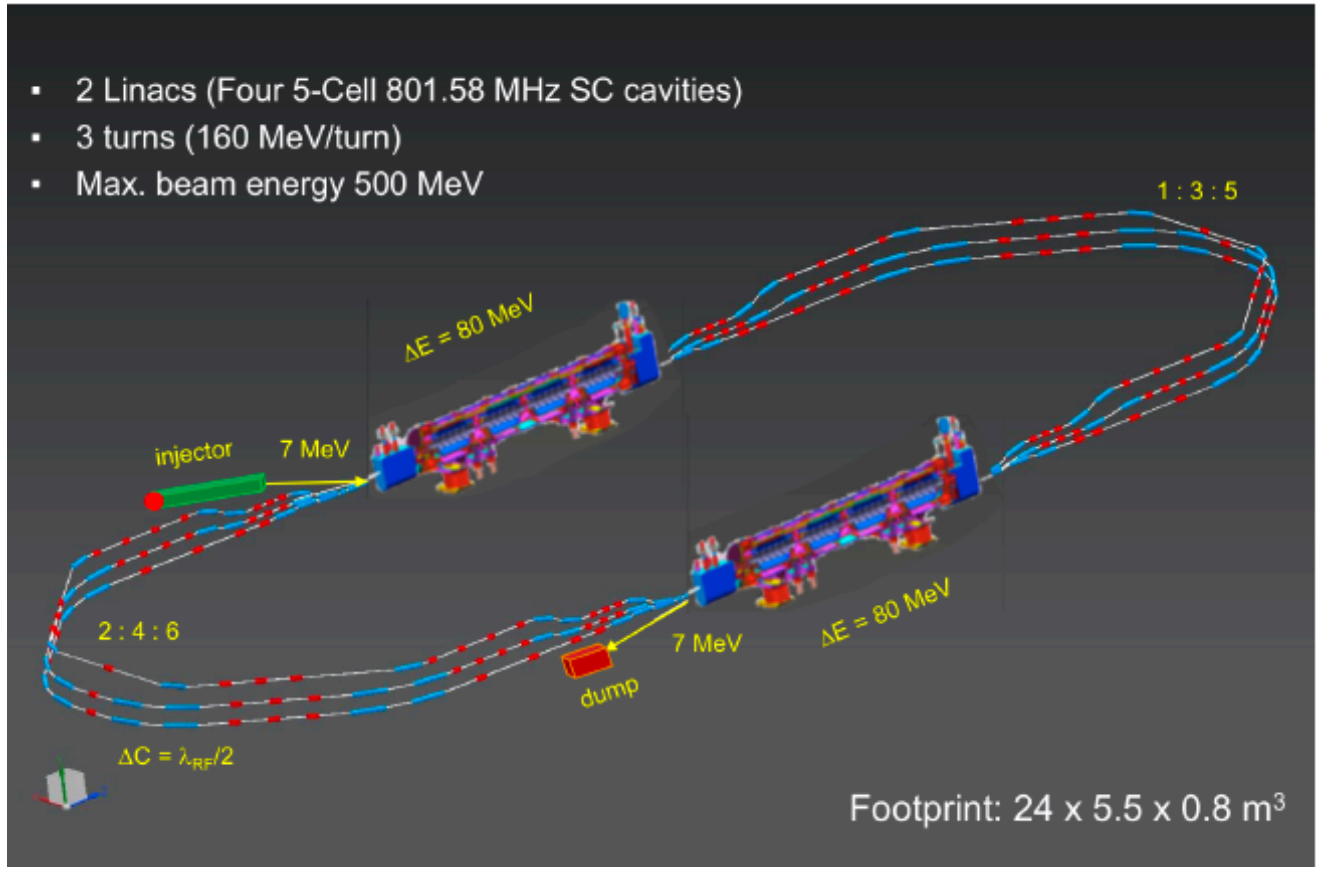
Thoughts about the TDR and Beyond

PERLE at IJCL

PERLE (colour code) fits to IJC'

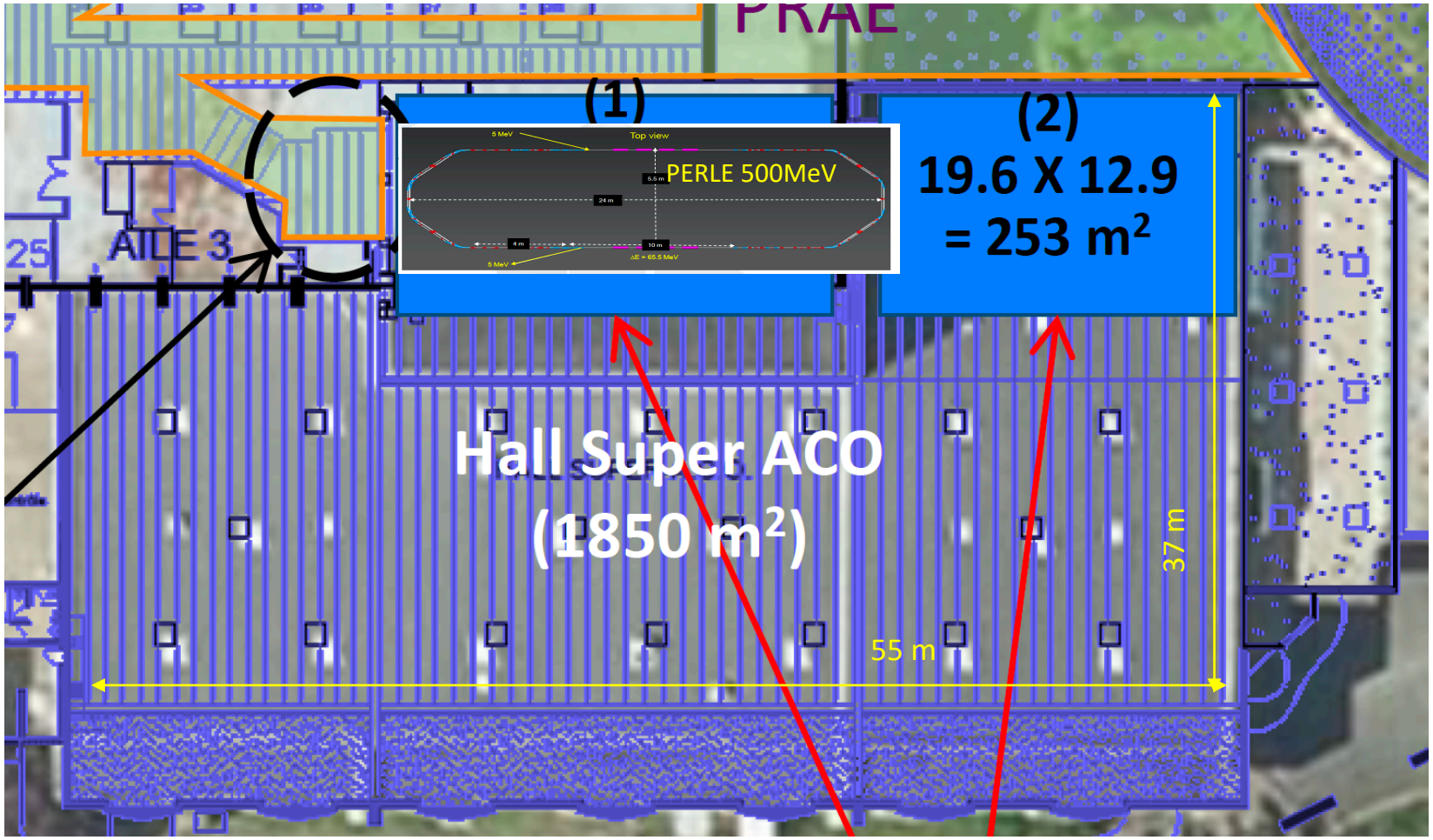
From here (24.2.2017) to there →



Max Klein (U. Liverpool)

Talk presented at the end of the June 20 PERLE Collaboration Meeting, 5.6.2020, in lock away status

Site



- 500 MeV footprint hardly fits to (1) extension to (2) possible but narrow
- Need to add >=3m on each side to Alex' footprint for shielding, monitors and access
- Experiments need space
- Add +10m in z in case of going to the 1 GeV PERLE in the 30ies

The TDR needs the Super ACO Hall (even (1) + (2) look too small (Bob Rimmer in February 2017)

→ Its re-enforcement better be started

Sebastien Bousson

Lessons

1. **You need courageous Directors**
   merci a Achille, Sebastien, Walid
   and the leaders in collaborating institutes.

2. **The timing has to be not too wrong**

   IN2P3 Strategy for Accelerators just released

Sebastien Bousson

13 RECOMMENDATIONS have been issued, and among them:
ERL is a very promising technology for future electron accelerators.
The ambitious PERLE@Orsay initiative should be strongly supported, provided that an adequate international participation to the project can be settled.

European Strategy expected to highly value ERL

3. **ERL Projects seriously struggle with priority, technology and mundane problems too**

Major progress with projects (here presented CBETA, sD, MESA)

however: funding limited duration of CBETA, sD fights with 2 turn ERL, both have very small currents, MESA new building, KEK re-opened, BERLINPro in priority trouble, the scars of DD..

→ serious indications that we deal with a very complex project

4. **Complexity and Recognition**
   best met with strong Collaboration

Open to other institutes. Network with other facilities which are not directly in PERLE-C

PERLE Collaboration Agreement
Draft 30.5.2020

Sign in Summer 20
Achille Stocchi

5. **PERLE to be embedded in PP+NP Strategy**

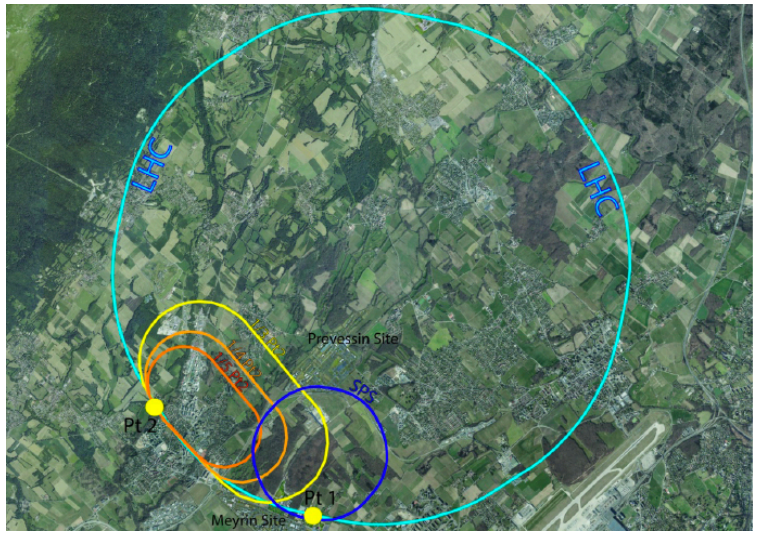
HIGH IMPACT PROJECTS FOR ACCELERATOR SCIENCE AT IN2P3
In addition, the GT07 working group has identified projects which best address the objectives of the IN2P3 research programs on accelerator science and recommends to:
· engage IN2P3 resources to develop high-visibility Very Large Research Infrastructures providing leadership in accelerator-based science;
1. Completion of the construction & commissioning of SPIRAL2 phase 1 and associated R&D on the production of radioactive ions.
2. Design of the FCC and associated R&D on next-generation HEP colliders, including ERL options (with PERLE@Orsay as a possible demo).
…

Sebastien Bousson

ERL: Accelerator Energy Frontier

CERN-ACC-Note-2020-0002
Version v1.0
Geneva, June 2, 2020

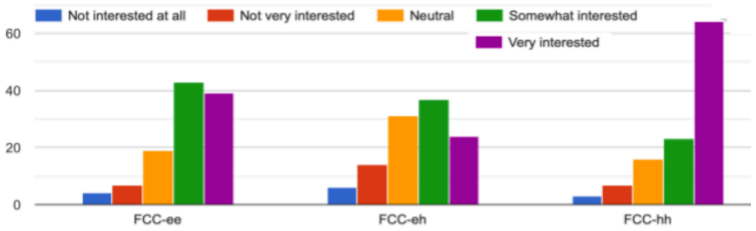
400 pages update of 2012 CDR - to appear



50 GeV to limit cost [1/4 or 1/5 of U(LHC)]
Three pass ERL, two ~800m long linacs
I_e=20mA for 10^{34} luminosity, f=801.58 MHz
(Erk at Daresbury 16, Frank M at Orsay 18)
Operation concurrent to LHC (+dedicated)

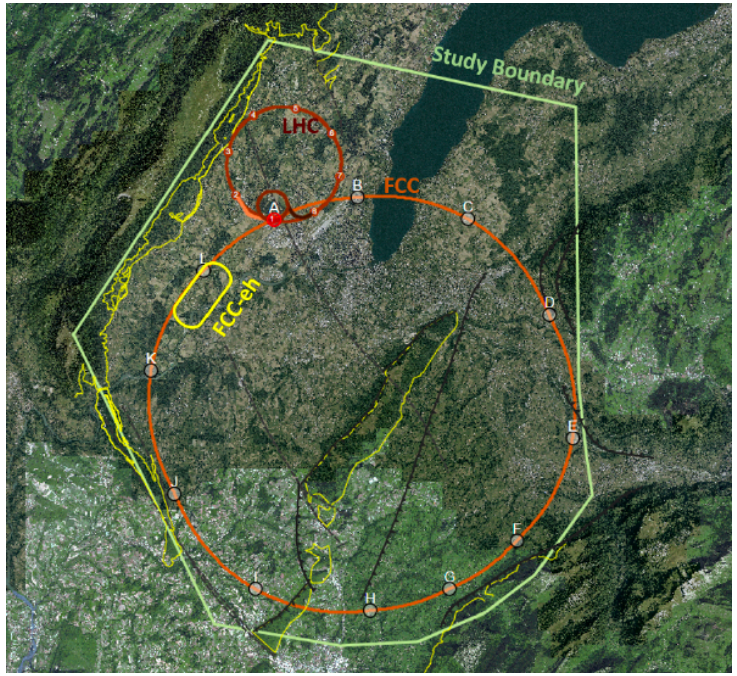
(when) will that happen.? We don't know
I met Abhay Deshpande in Snowmass 2001,
when he presented the EIC, not for the 1st time

HL-LHC dominates all of PP,
Its programme will extend to 2040

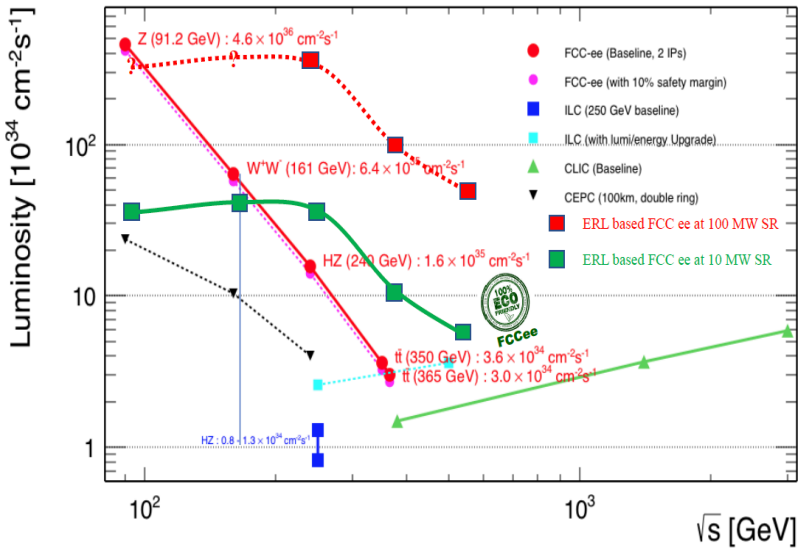


ECFA: Interest of young scientists 2002.02837

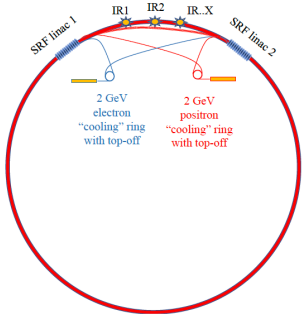
60 GeV ERL design applied to FCC-he



FCC-ee



Vladimir Litvinenko et al, 1909.04437



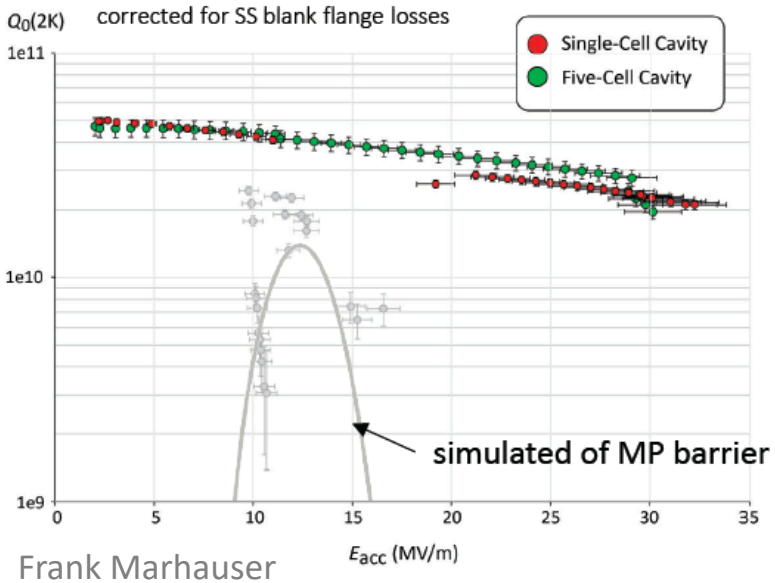
4-6 turns

E/linac = $M_{Z,..HH}/(2 * N_{turn})$

EIC: Polarised eh Collider at BNL
IBS: emittance growth: needs ERL 100mA (!)
CW e beam cooling of p/A beam (for CBETA)
cf e.g. F Willeke APS talk, April 2018

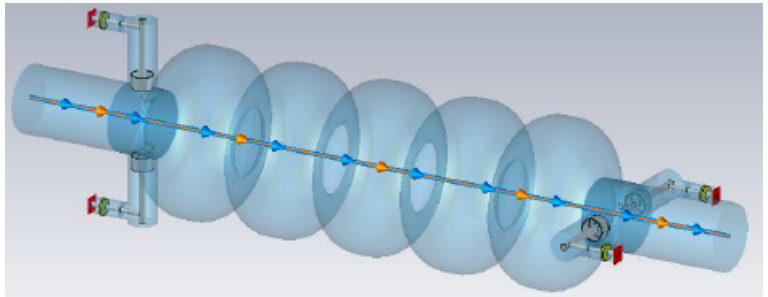
Coherent Electron Cooling
V.N. Litvinenko, Y.S. Derbenev, *PRL* **102**, 114801, 2009

Cavity and CryoModule - HOMs

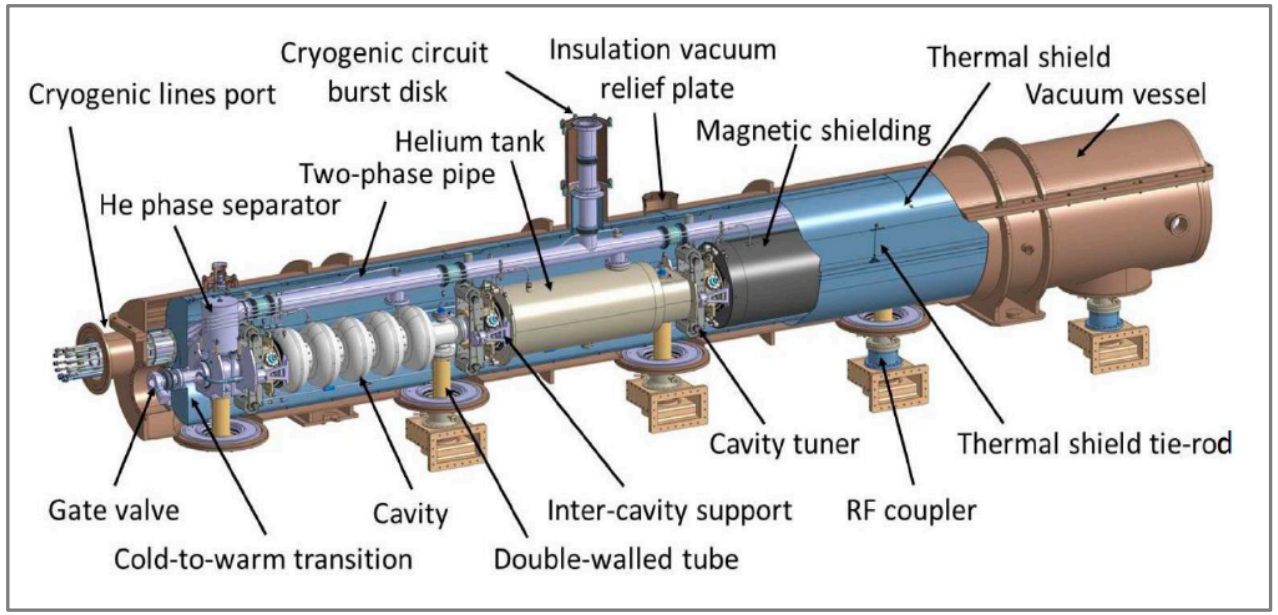


Frank Marhauser

- **Beam dynamics to determine damping requirements**
- Go beyond Rostock study?
- ”Finish” HOM coupler concept.
- Collaboration has remarkable expertise, should use it
- Equip CRN5 for real measurements (HOM, Q_0..) → TDR
- Prepare for dressed cavity production thereafter
- When is the best time to order 4 cavities from Jlab?
- We still want to hear from Fermilab about N treatment

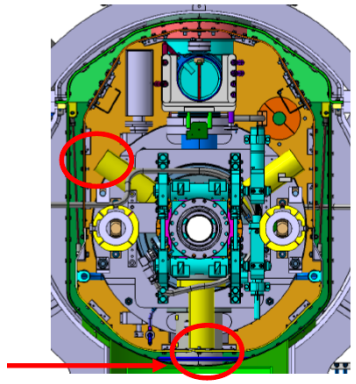


Ningyuan Hu



Test area for CM at Orsay (Patxi)

In kind from CERN



Gilles Olivier

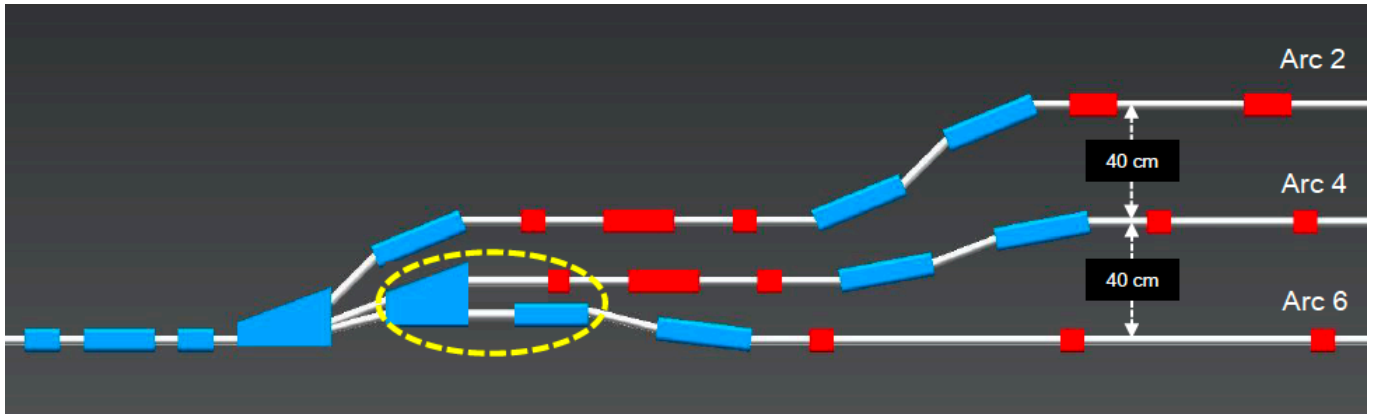
The adaptation of the SPL cryomodule (design and fabricated components) is possible but depends on the number, the type, the size, the location and the cooling system of the HOM couplers

The SPL cryomodule sets constraints on the HOM couplers.
Using this module is obviously critical for cost and time schedule reasons
Needed for credible TDR in 2022, + commence design dedicated cryomodule

Lattice and Magnets

- Smaller bend angle of individual dipoles (30^0 vs 45^0)
  - Alleviates strong edge focusing effects of the bends
  - Results in a better balanced optics with smaller alphas
- Optics more resilient to CSR (micro bunching)
  - Larger number of periods (3 vs 2) – Smaller M_{56} variance.
  - Lattices with smaller variation in M_{56} generate lower CSR gain*, ideally, lattices that are composed of multiple super-periods, each period being achromatic and isochronous.

Alex Bogacz



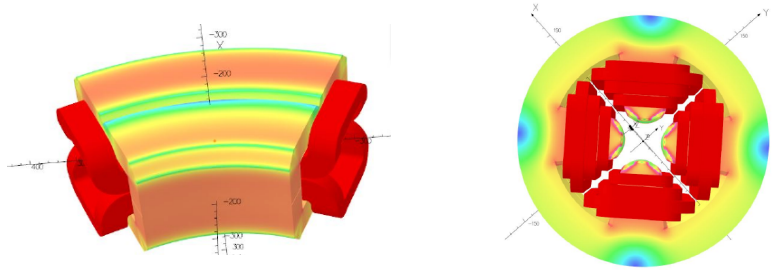
New lattice : See Alex Bogacz presentation

6 dipoles/arc (30° vs 45°)

2B-Com magnets

196 magnets without sextupole and octupole magnets

Cynthia Vallerand



- Need tolerance specification, finish design

- Then decide on prototype (if yes → for TDR)

- Fix lattice (sextupoles, octupoles)?

- Include injector magnets

BINP, CERN, IJC – strong magnet collaboration

New: 6 dipole bend, curved dipole, two B comb in spreader. Single step → 100T/m – is that a real problem vs less sync radiation

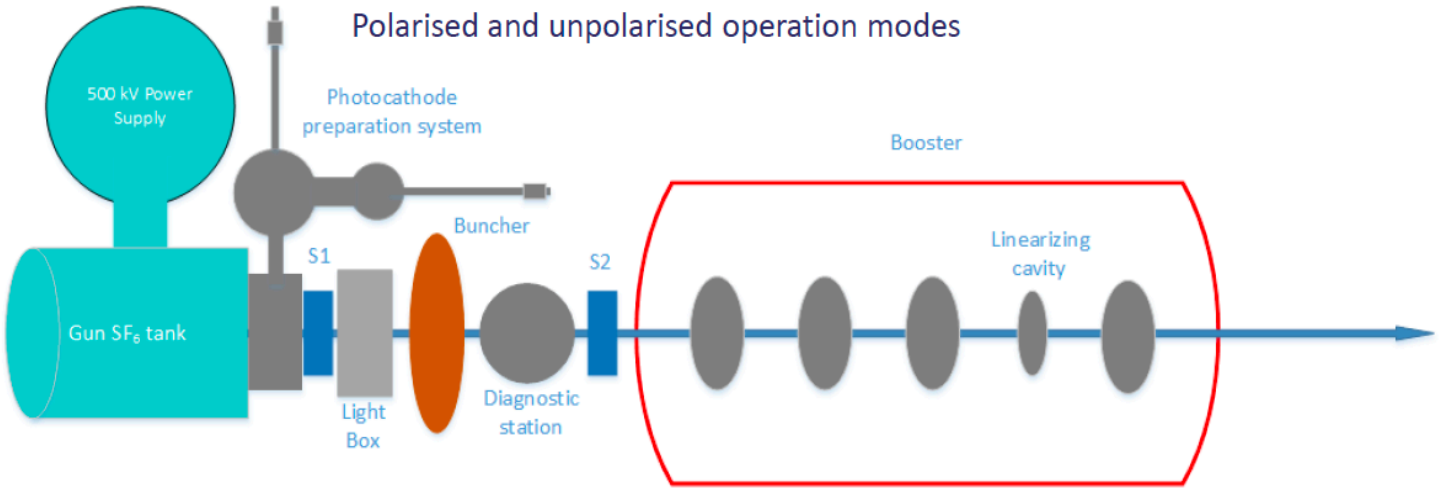
Innovation

- Innovation leads to support and to progress. PERLE is a pioneering facility -

Two examples presented to this meeting

High current, high polarization new PERLE electron beam source+injector

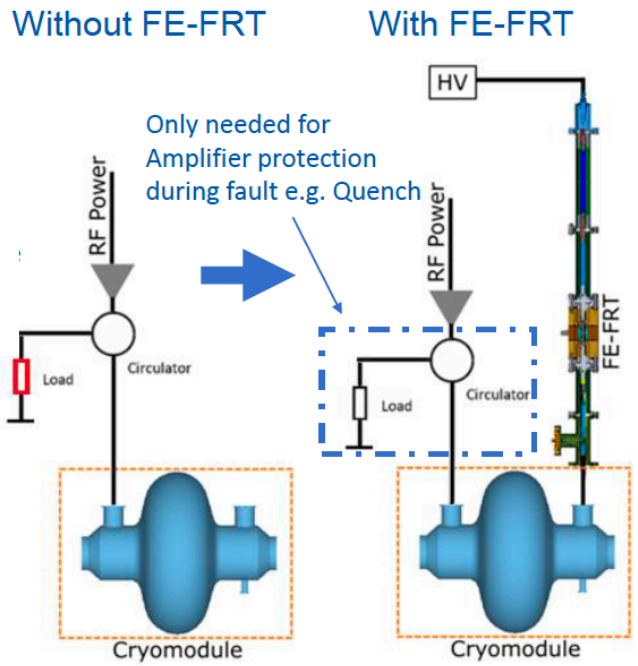
ALICE gun upgraded and operates with GaAs photocathodes activated in the photocathode preparation system or with CsK_2Sb photocathodes prepared in the dedicated preparation facility.
Polarised and unpolarised operation modes



Boris L. Militsyn

Baseline to start with (when): ALICE (Daresbury) gun, now at Orsay
Develop and build new source within the PERLE Collaboration
Suggest to have both described in the TDR, including booster

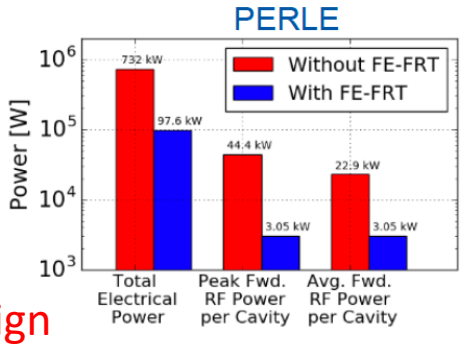
Ferro Electric Fast Reactive Tuner

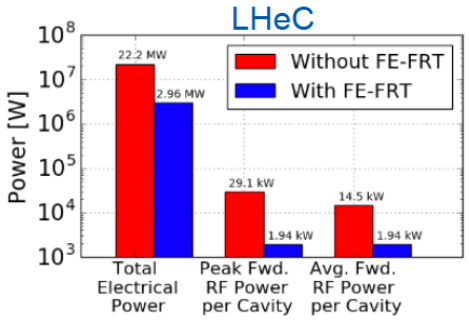


Nick Shipman

Highly overcoupled: Almost all RF power dissipated in load

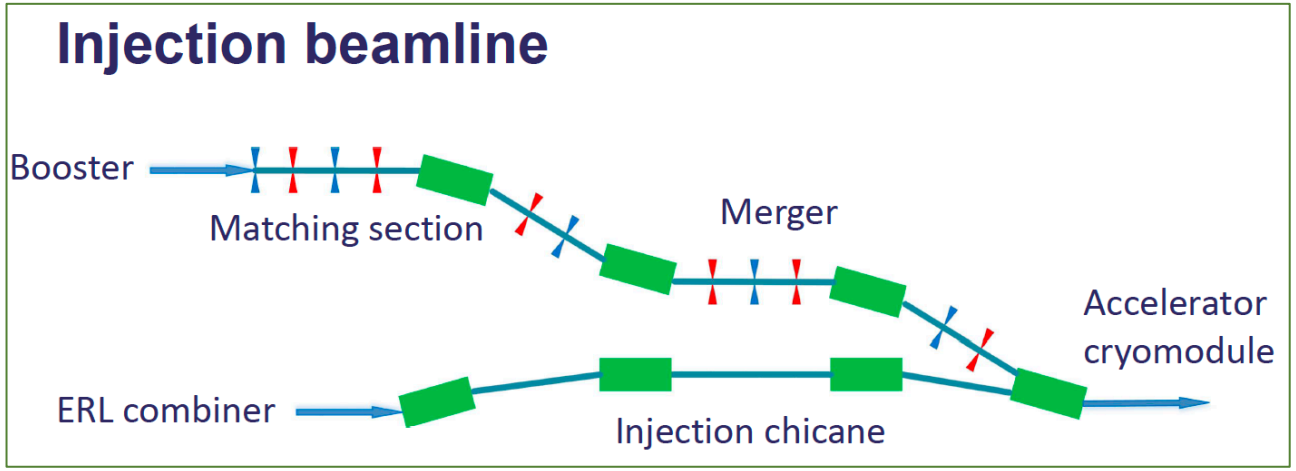
Critically coupled: Reduced RF power, not dissipated in load





ERL with FRT: the "greenest" of all →
Integrate in dedicated CM + HOM design

Systems being and to be designed



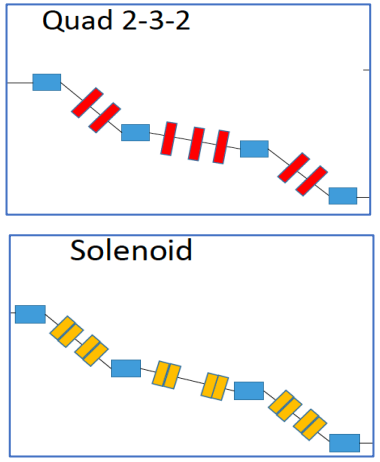
Boris Militsyn

Cryogenics

- Conceptual design
  - Analyse the different possible architectures for the system
  - Define and analyse the operating modes
  - Assess as much as possible the transient states (dynamic simulation
  - Involve industry as much as possible at this stage
  - Include the commissioning operations in this design.
- Involve cyogenist task force asap (at early stage)

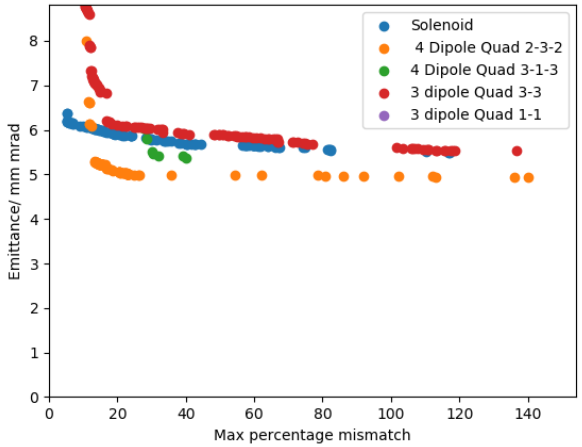
1/3 of ESS, 10x larger than IJC liquifier cooling capacity

Merger Design

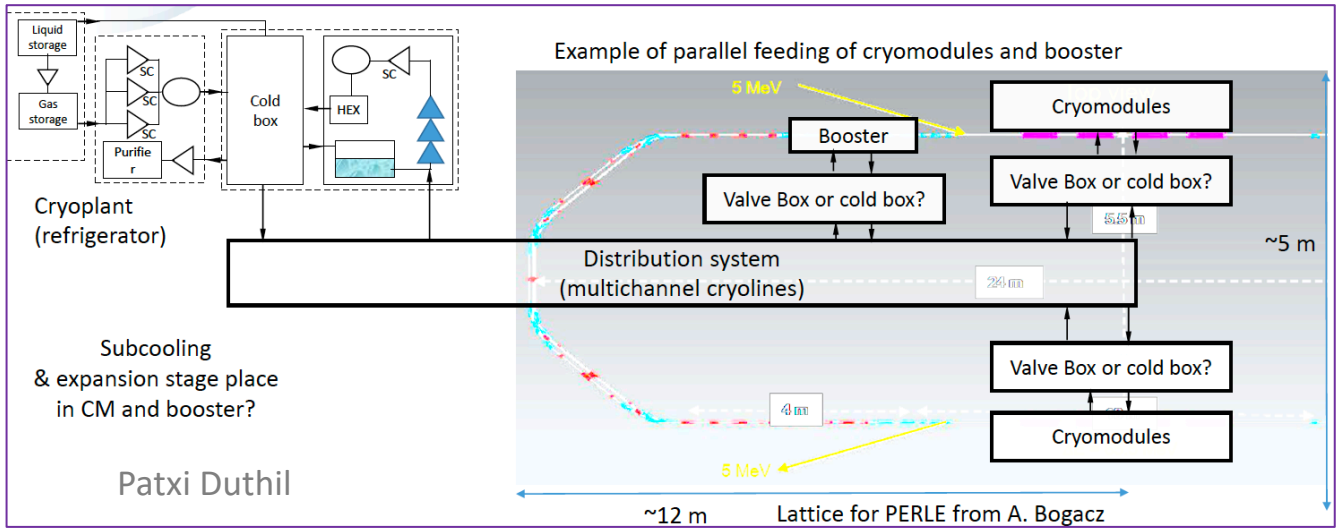


Ben Hounsell

Pareto fronts



Update to 3.6.



Patxi Duthil

And many others: power, monitoring, beam dump, data acquisition, operation control, …

Main Axes of Collaboration

Walid Kaabi

TASK 1: Lattice and optics

- T 1-1: Linear lattice optimization Initial magnet specs
- T 1-2: Momentum acceptance and longitudinal match
- T 1-3: Correction of nonlinear aberrations with multipole magnets
- T 1-4: Final magnet specs
- T 1-5: Repository and data base with version control

TASK 2: Beam Dynamics

- T 2-1: Start-to-End simulation with CSR & micro-bunching
- T 2-2: BBU studies
- T 2-3: Space-charge studies at injection
- T 2-4: Multi-particle tracking studies, error effects and halo formation
- T2-5: Impedance analysis and wakefield effect mitigation

TASK 3: Electron source and injection

- T 3-1: DC Gun upgrade
- T 3-2: Photocathode fabrication and load lock system design
- T 3-3: Buncher design
- T 3-4: Booster studies and design
- T 3-5: Laser system
- T 3-6: Merger design

TASK 4: SRF Cavity and cryomodule

- T 4-1: RF cavity design
- T 4-2: Fabrication & tests
- T 4-3: HOM study
- T 4-4: Power coupler design and study
- T 4-5: Cryomodule design

TASK 5: Magnets & power supplies

- T 5-1: Arc magnets design
- T 5-2: Spreaders & combiners magnets design
- T 5-3: Injection and extraction magnets design
- T 5-4: Multipole magnets design

TASK 6: Beam instrumentations

- T 6-1: Charge measurements
- T 6-2: Beam position measurements
- T 6-3: Transverse profile measurements including halo
- T 6-4: Longitudinal measurements including profile and sub-structures (CSR, CTR…)
- T 6-5: Losses
- T 6-6: Polarisation measurements

TASK 7: Beam dumps

- T 7-1: Setup dump
- T 7-2: Transfer line

TASK 8: LLRF

- T 8-1: Synchronisation
- T 8-2: Feedbacks

TASK 9: Safety and radioprotection

- T 9-1: Site Shielding
- T 9-2: Personal Protection System
- T 9-3: Machine Protection System

TASK 10: RF Power sources

TASK 11: Cryogenic equipment

TASK 12: Physics Experiments - selections and preparations

- T 12-1: Photo-nuclear physics
- T 12-2: e- probe on Self-Confining Radioactive Ion Target
- T 12-3: ep scattering, dark photon detection, proton radius, weak interaction

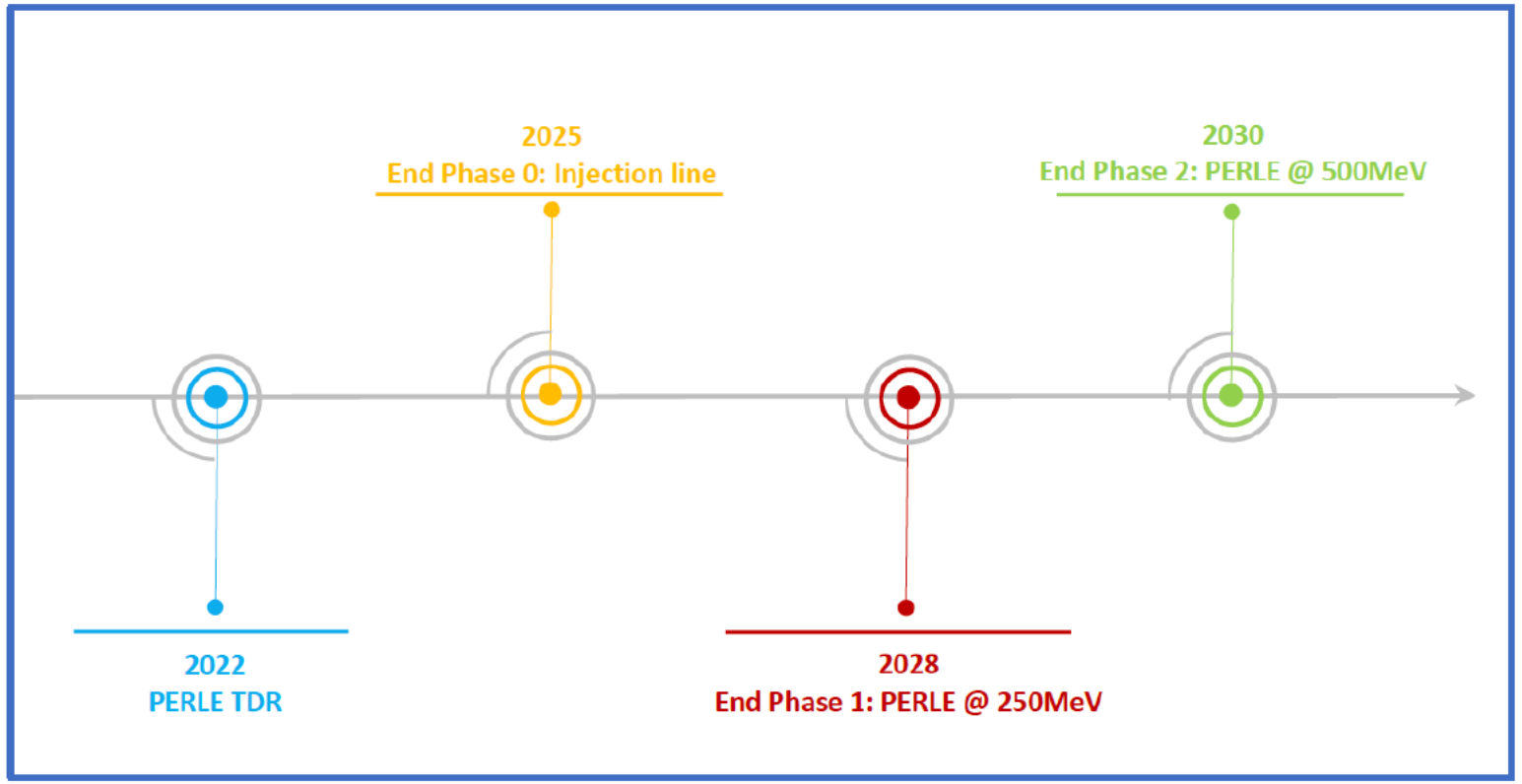
We shall establish/continue working groups to succeed

Collaboration Board to endorse the Collaboration + its Management

Time Schedule

The Collaboration will develop a detailed **time schedule**. Currently it is foreseen to complete the TDR by 2022, Phase 0 by 2025, Phase 1 by 2028 and Phase 2 by 2030. A scheme of milestones will be worked out and agreed upon with emphasis on the accelerator but including a timeline for future experiments.

From the Collaboration draft Agreement



Questions

- Is this too conservative or not?
- Where do these cornerstones matter?
- Especially, can the adapted SPL cryomodule be filled with 4 cavities earlier than for 2028?
- Isn't the ring possible to have closer in time to Phase 0?
  (CBETA had 1 year between 0 and 1)
- Can one think about a different phasing e.g. Phase 1 with full single ring?
- Are there interesting experiments for the 7 MeV injector phase? (sDALINAC has some) Would we have time to pursue them?
- Is two years too near for Phase 1→ 2?
- Can we establish a PhD@PERLE programme to advance optimally?
- Who receives the TDR?
- … [it requires time to think]

→ We need to work out a more detailed milestone schedule and then revisit the timeline. Note that PERLE is not alone.

Thanks to all (up to 57) participants.

Thanks to all speakers and colleagues with them.

Remercier les trois mousquetaires de ijc.

Good luck to all current projects and future plans.

May France understand: PERLE@Orsay is no nuclear danger.
(merci Jean Michel)

We plan a next meeting for the fall.

In between, and for the TDR, it is vital that we hold to our own promises and hopes.

May you all stay healthy and safe.


The 2 zones are not completely separate
(1)
(2)