FCCIS – The Future Circular Collider Innovation Study. This INFRADEV Research and Innovation Action project receives funding from the European Union's H2020 Framework Programme under grant agreement no. 951754.

INFN LNF Istituto Nazionale di Fisica Nucleare

HIGHLIGHTS FROM ACCELERATOR DISCUSSIONS AND NEXT STEPS

Manuela Boscolo (INFN-LNF)

MDI & IR Mockup Workshop
16-17 November 2023,
Frascati, Italy

FUTURE CIRCULAR COLLIDER Innovation Study

Mock-up of the interaction region

Goals & Motivations

- Validation of the MDI CAD drawings
- Enables better understanding of services, such as cables and pipes
- Allows a broader view of the installation sequence and potential issues
- Can help predict potential access problems to the IR
- Not a usual mockup! Real prototypes of some critical parts both for accelerator and vertex foreseen
- Outreach

Belle-II Mockup Experience

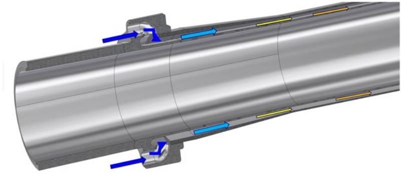
C. Niebuhr

Summary

- For the successful installation and operation of the Belle II Vertex Detector in the challenging environment of SuperKEKB, the design, construction and optimisation of various mock-ups proved to be essential
- A complete and realistic VXD thermal mock-up was used to validate the planned cooling concept
  - manufacture and installation of a number of critical components could be practised for the first time under realistic conditions
  - operating parameters could be established prior to installation of the real detector
  - operation of the mock-up helped to identify a design flaw that could be corrected
- The Remote Vacuum Connection mock-up was absolutely crucial to optimise the design and to prove that the concept was applicable to SuperKEKB

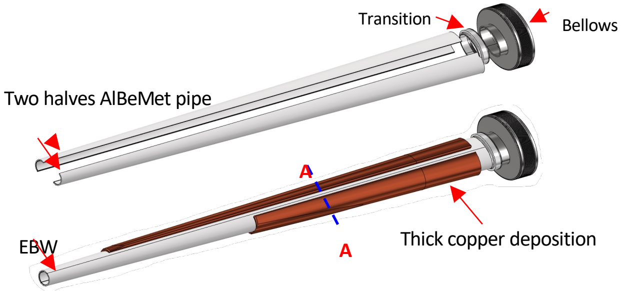
Mockup and prototypes for the vacuum chambers

F. Fransesini



Prototype / mockup Central & conical vacuum chambers:

- verify the **assembly procedure**
- test the **paraffin cooling system**
- study the **welding** process



Comment: AlBeMet availability to be confirmed

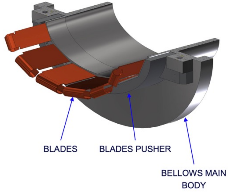
Conical chamber also:

- test thick copper deposition
- AlBeMet162- steel transition

S. Lauciani

Bellows:

- Finalize the design
- measure the loads on the central chamber
- Measure stiffness with blades
- cooling performance



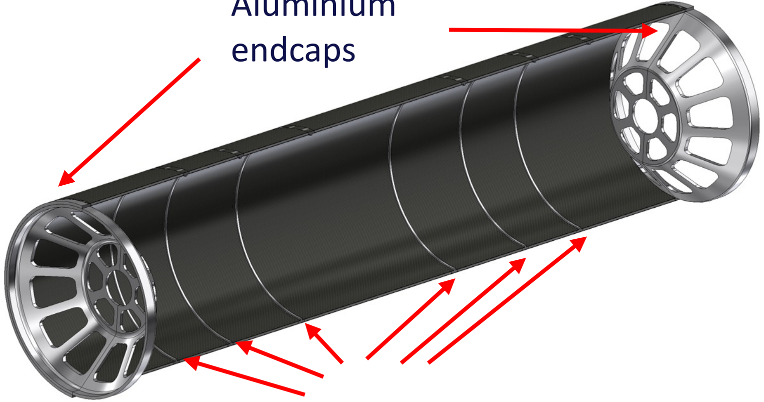
Comment:

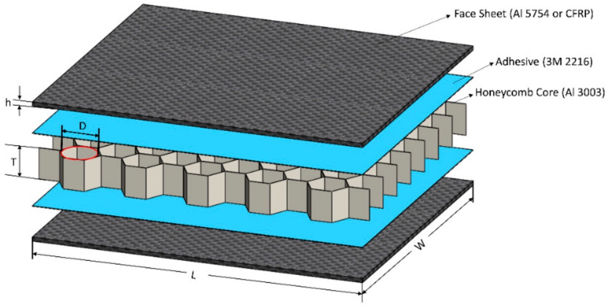
- special bellows-HOM absorbers and with cooling to be considered, as for PEP-II
- to be compared with LHC-type CERN design

Technological relevant deliverables

Mock-up of the carbon-fibre cylinder support tube with endcaps to verify

- the fiber carbon composite fabrication technology including the reinforcements for anchoring LumiCal and outer tracker
- the shape accuracy and rigidity of the structure





Lightweight carbon fiber & honeycomb tube walls

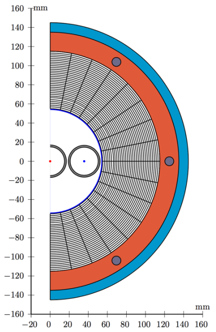
1mm CF + 4mm Al HC + 1mm CF

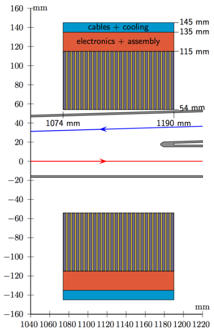
Technological relevant deliverables

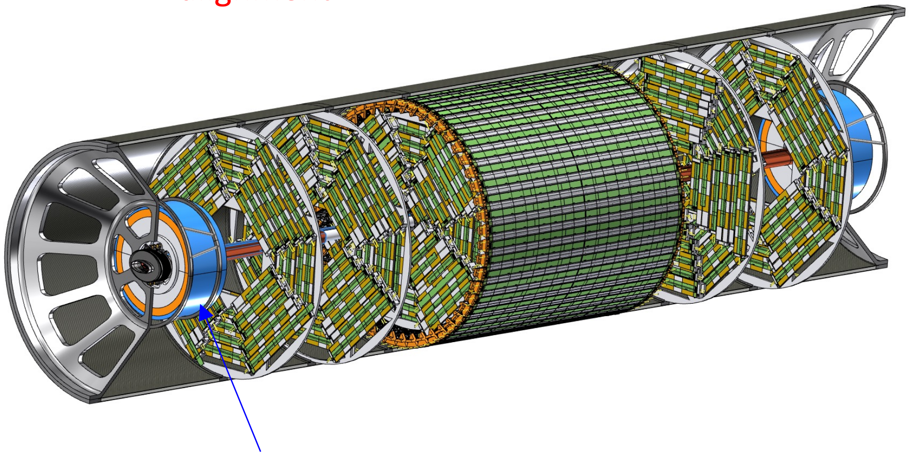
Mock-up of the Luminosity monitor (Lumical) in *lead (Pb) ?* to validate

- Structural weight analysis on the Support tube
- Installation sequence

Comment:
verify material/ dimension of the lumical mockup
study the lumical support
alignment







M. Dam presented design and requirements,
engineering of the lumical required, also to dimension the cooling system

Frascati Workshop Facility

https://autode.sk/3MF8zhK

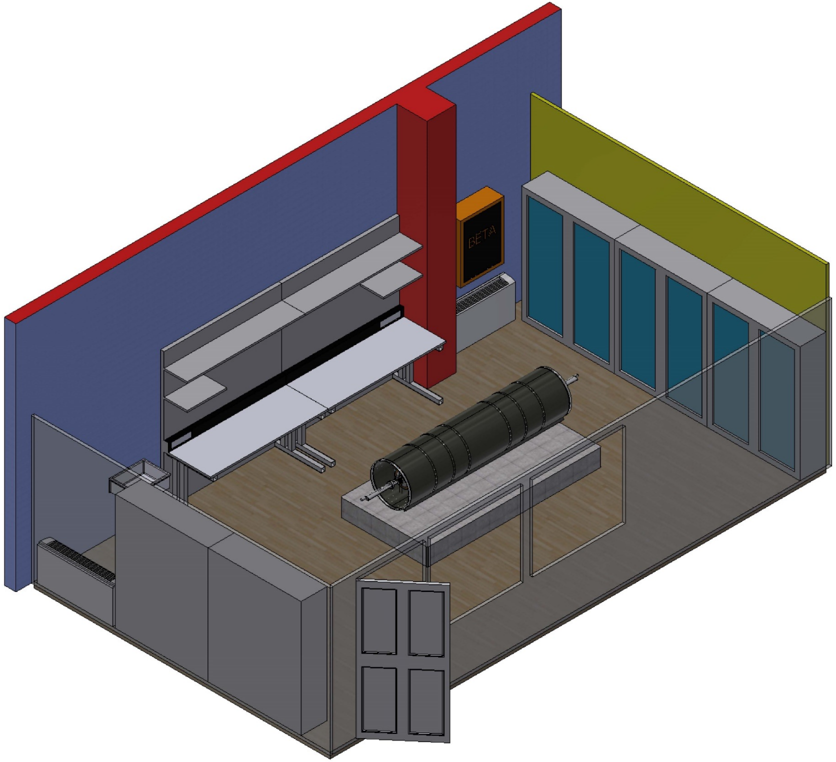
Machining equipment – Tools for handling and lifting:
workshop of the SIM is equipped with a series of machines for machining, such as

- milling cutter
- two lathes
- two electric saws
- two column drill

Electric pallet truck and a portable crane.

Systems: building 5/a is equipped with a generalized heating/cooling system.
There is a system for running water and a dry compressed air system (compressor that cools the outgoing air to -70 degrees Celsius).

Measuring instruments: the metrology laboratory is equipped with
laser tracker and portable CMM (portable measuring arms)



Tentative Milestones

1. Executive drawings vacuum chamber, bellows.
2. Executive drawings mock-up vertex.
3. Executive drawings carbon-fibre cylinder.
4. Prototypes of vacuum chambers delivered and mockup vertex.
5. Preliminary stand-alone vertex cooling studies at Pisa.
6. Mockup carbon fibre cylinder delivered, mechanical supports, mockup lumical, mechanical structures, mounting all components together on their supports, and assembly tests.
7. Test of the assembly and services (cables and cooling).

(Tentative) Goal: two years project, aim to be finished by December 2025.

IR Mechanical Design

Tight space constraints & Missing Components

- **Number of BPMs** →
- **Space for NEG pump**
- **Remote Vacuum Connection** – Magic Flange
- **Dimension of the bellows** (special-HOM absorber & with cooling)
- **Cables and services**
- **Alignment system device**

minimal number of IR BPMs:

One next to Lumical
One in front of QC1 ?
One in front of QC2

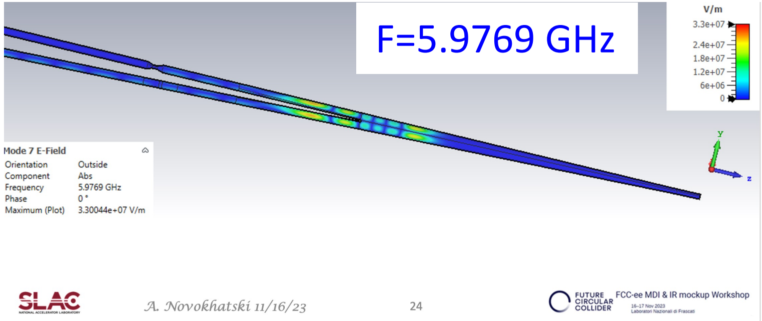
wish list:

One next to Lumical
One in front of every segment of QC1 and QC2

SR Masks

Shape (Elliptical → more inductive impedance)

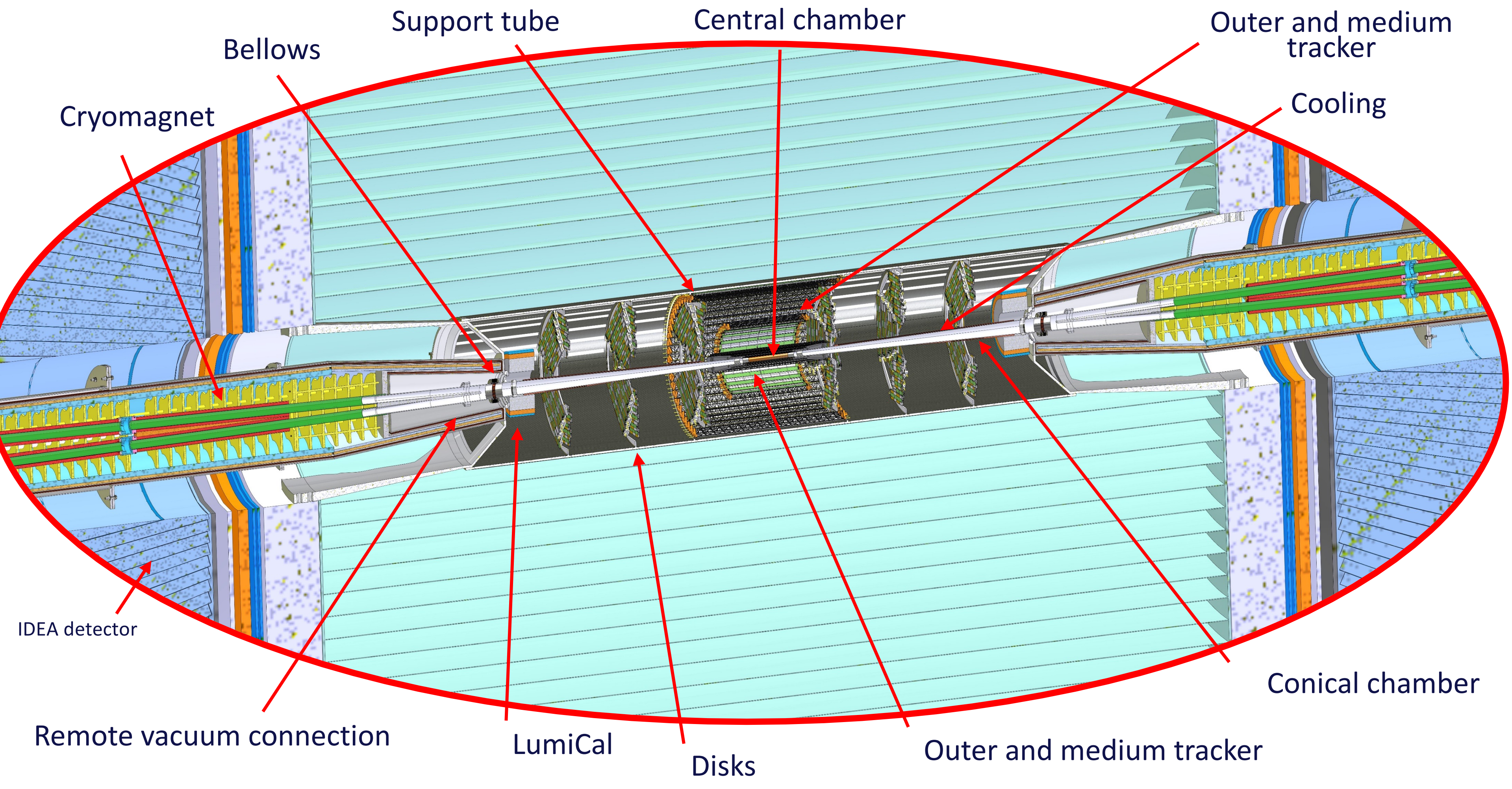
Longitudinal position



A. Novokhatski

Full model, which includes bellow, BPMs and possible new SR mask with different materials, for wakefields calculations advisable for careful calculations.

F. Fransesini



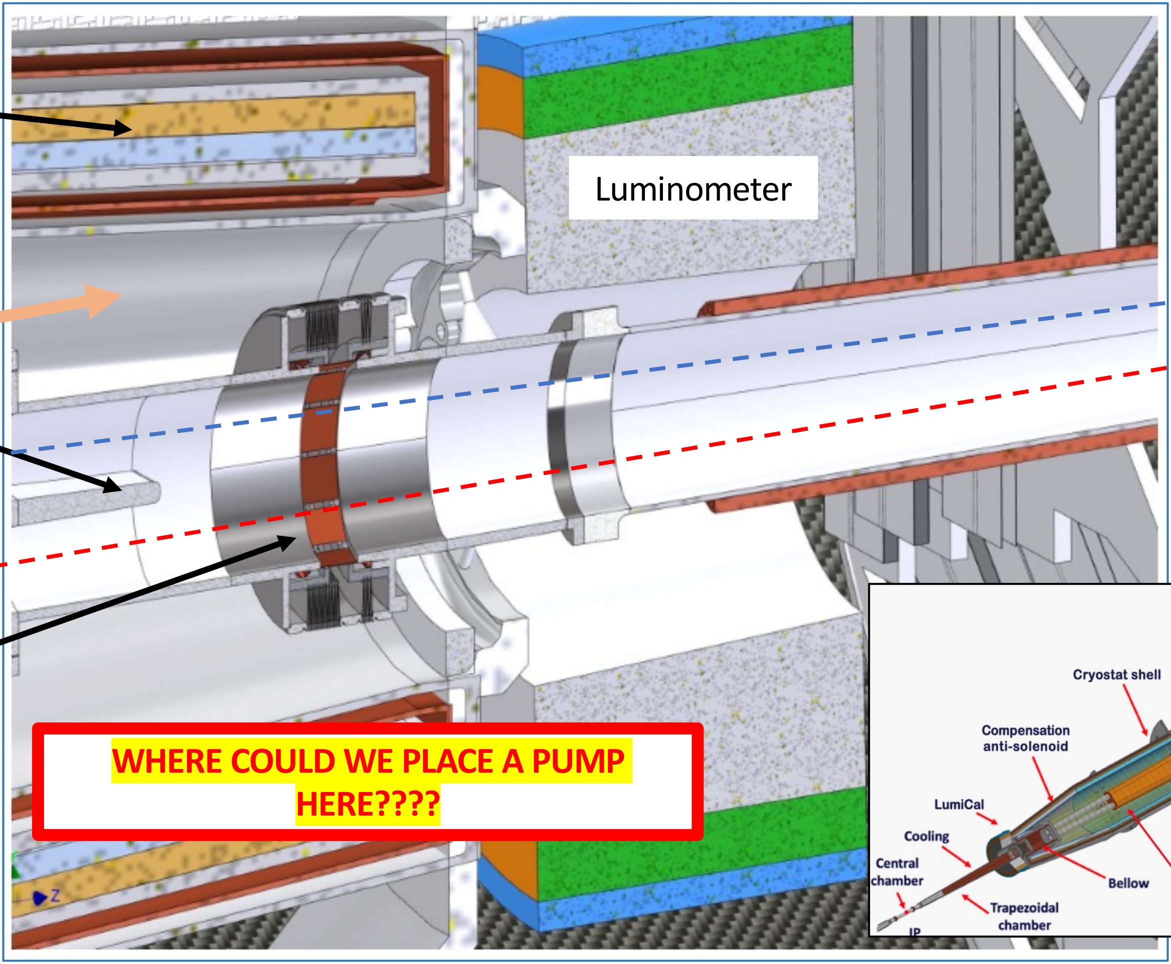
Extremely tight fabrication and alignment tolerances: accurate ray-tracing is a must

Cryostat with integrated anti-solenoid coils

SPACE RESERVATION FOR **REMOTE FLANGE CONNECTION** (SMA)

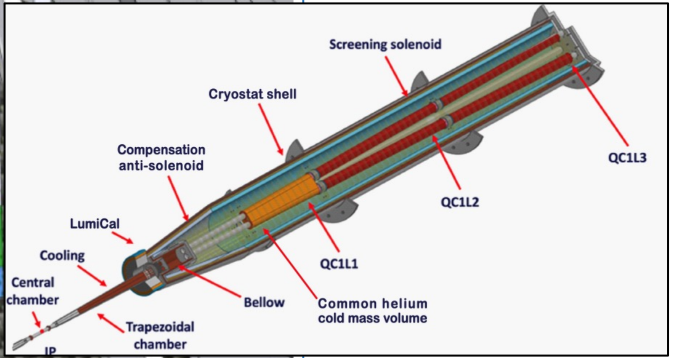
Crotch (2 beams→1)

Alignment bellow (ESRF-design)



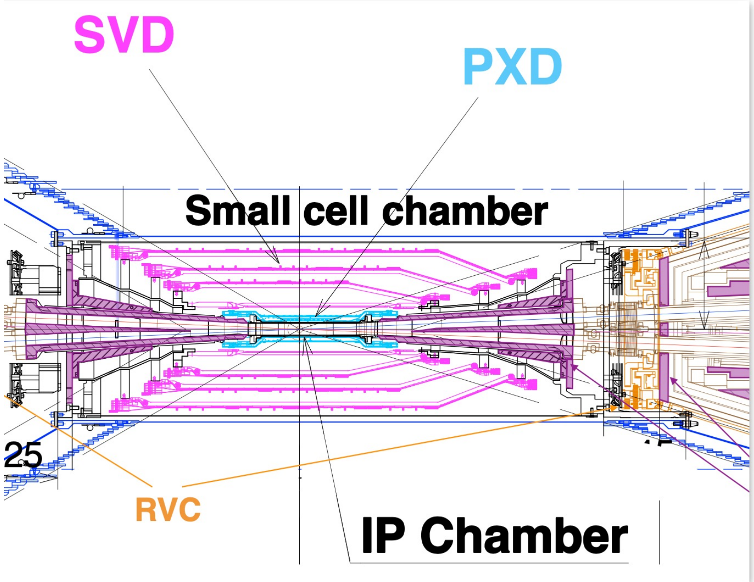
e^-

e^+

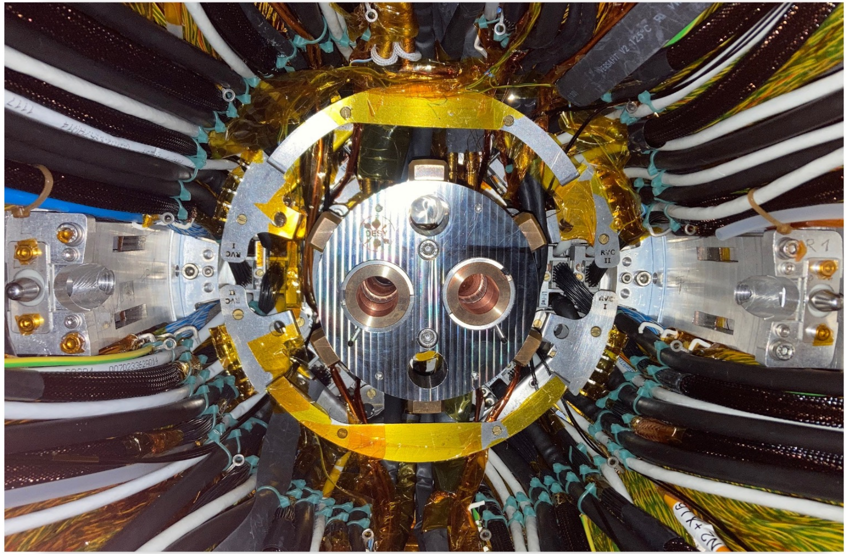


C. Niebuhr

Establishing Vacuum Connection in an inaccessible Area

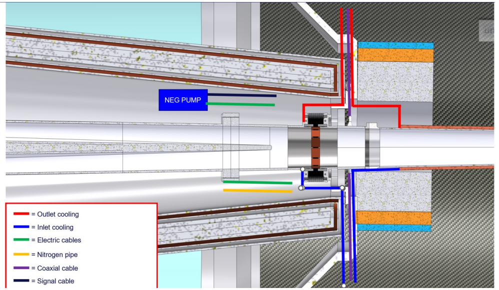


Front end flange view prior to QCS insertion



Space for services – list (only for accelerator)

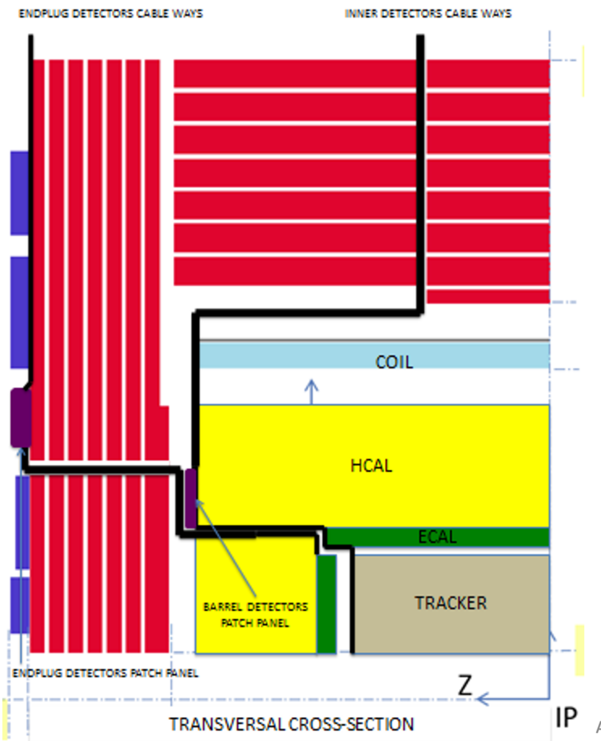
Components	Type of service	Number
Central chamber	• Inlet for paraffin • Outlet for paraffin	1 1
Bellows	• Inlet for water • Outlet for water	1 or 2 1 or 2
Conical chamber	• Inlet for water • Outlet for water	2 2
Remote vacuum connection	• Electric power for heating • Nitrogen tube • Temperature sensor	1 1 1
NEG pump	• Electric power for heating • Temperature sensor	1 1
BPM	• Coaxial cables	4



F. Fransesini

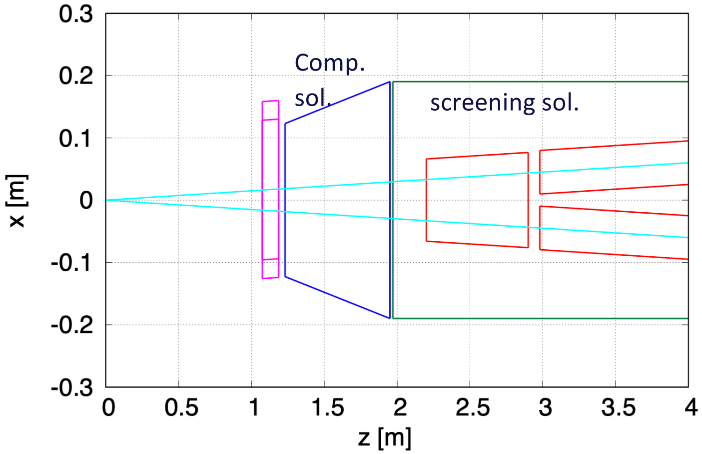
A. Gaddi

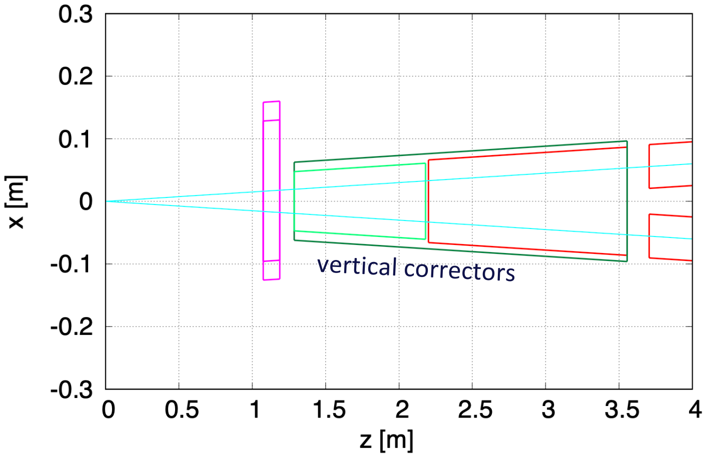
Detector Services routing



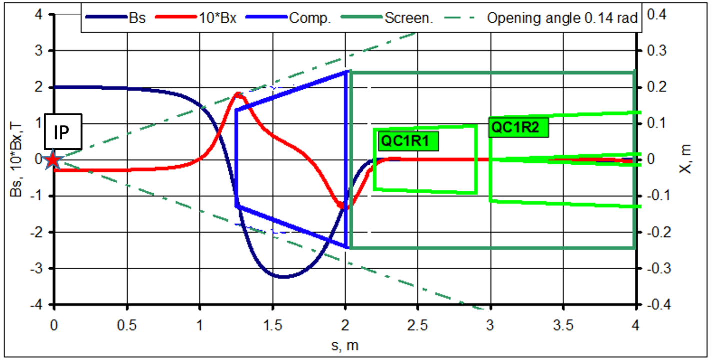
It makes a lot of difference for the available space in the central IR !

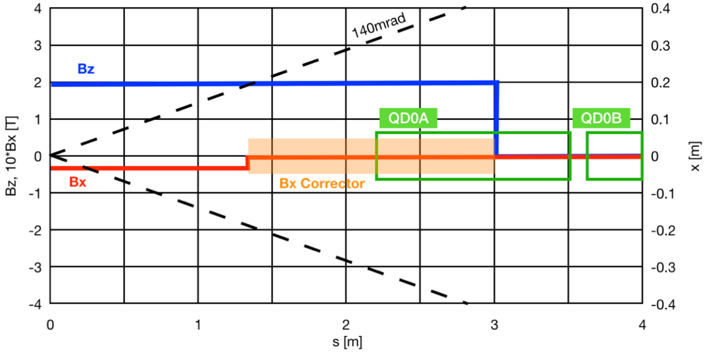
Solenoid Coupling Comp. Schemes





Field distribution along the reference trajectory





Solenoid coupling compensation scheme – *Conventional* scheme

- The detector solenoid field is compensated with **two anti-solenoids at about +/- 20 m from the IP and skew quads around the FF quads** with a relative gradient of about 2×10^{-3} at Z and 0.5×10^{-3} at ttbar.
  [This is equivalent to rotate the FF quads on the solenoid-rotated reference system].
- The horizontal crossing angle in the detector field generates vertical orbit, i.e. vertical emittance growth.
- This is coped with **weak vertical correctors** (kick of the order of **10^{-4} µrad**) placed after the crotch and next to FF quads, one per beam. This way the smooth correction generates a very small **vertical emittance growth** (about **0.04 pm**, ~4% term, about ten times less wrt the present baseline scheme) .

evaluation with MADX, see talk by A. Ciarma

- *Additionally:* machine global coupling due to residual compensating errors & chromatic coupling is four times lower if the **sign of the 2T detector solenoidal field is alternated between one IP and the next**. **Four times lower systematic errors**.
- In addition, as it will be done for the baseline scheme:
  - vert & hor correctors are needed next to QC1 and QC2 for IP orbit bumps, to correct the orbit.
  - Skew correctors next to final focus sextupoles (SDY1 and SDY2) at 200 and 400 m from the IP are needed to correct IP dispersion.

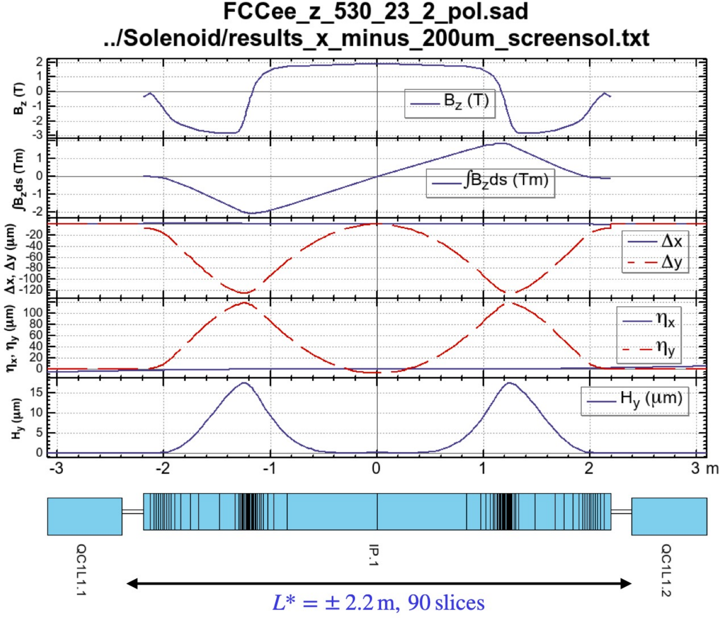
Comments:

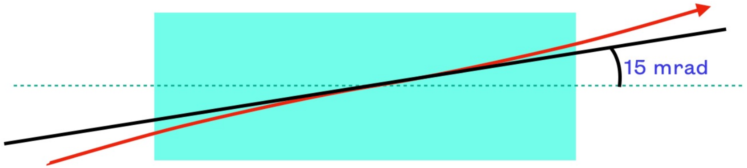
- The detector integral field is set to zero with the antisolenoid, but this is required only to preserve the longitudinal polarization. (Quads+skew quads are enough to control the solenoid induced coupling.)
- The anti-solenoid will be much cheaper and simpler of the comp. solenoid because the section beampipe in that location is about 70 mm diameter instead of 500 mm.
- SLC, LEP, DAFNE, PEP-II, … adopted this scheme, proven to be extremely effective.

Optics including a realistic solenoid (M. Koratzinos)

FUTURE CIRCULAR COLLIDER

- A realistic solenoid + multipole field given by M. Koratzinos has been included into the latest 4 IP lattice.
  - Both MAD-X and SAD can include the same solenoid field map, *independently* (H. Burkhardt, L.V. Riesen-Haupt).
- In this SAD model, the L* region (IP±2.2 m) is divided into 90 slices with *unequal thicknesses* ≧5 mm, *along the tilted straight line (±15 mrad),* not along the solenoid axis.
- No leak of vertical dispersion and x-y coupling to the outside region.
  - $\alpha, \beta,$ and hor. dispersion leak outside.
  - The leaked optics and hor. dispersion are adjusted to the no-solenoid case by tweaking several outer quads.
- The associated vertical emittance is 0.43 pm at Z.
- The highest contribution to the vertical emittance comes from the middle transition ($s \sim \pm 1.2$ m) of B_z.





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The beam optics shown here and later are not the latest ones in details.

Nov. 16, 2023, K. Oide

It will be repeated by KO for comparison with the *conventional* scheme.

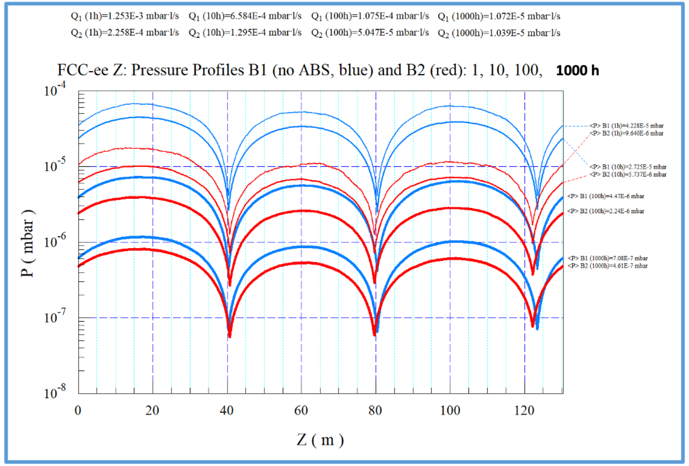
R. Kersevan

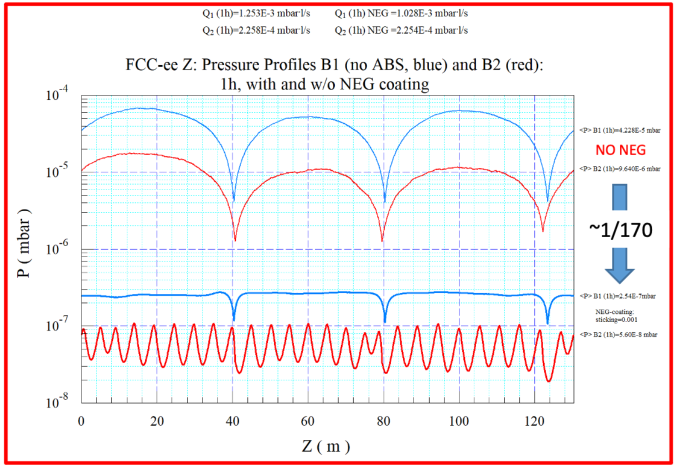
Vacuum System in the MDI region

Pressure profiles

Can be used for beam-gas background simulations

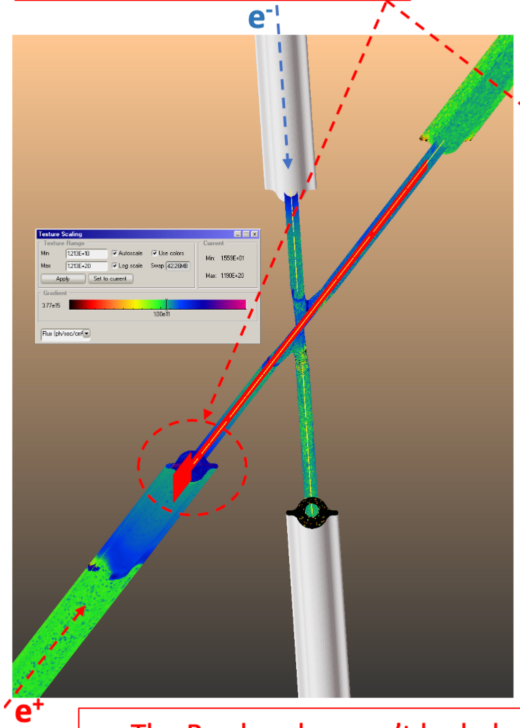
- We have calculated the PSD pressure profiles for 4 different beam doses, corresponding to times of 1 h, 10 h, 100 h, 1000 h at nominal current (1270 mA); Simulated gas: CO
- On the left the case with 3x 100 (l/s) lumped pumps/beam, and no NEG-coating
- On the right, the case with NEG-coating with some residual sticking (*s*=0.001) for 1h case

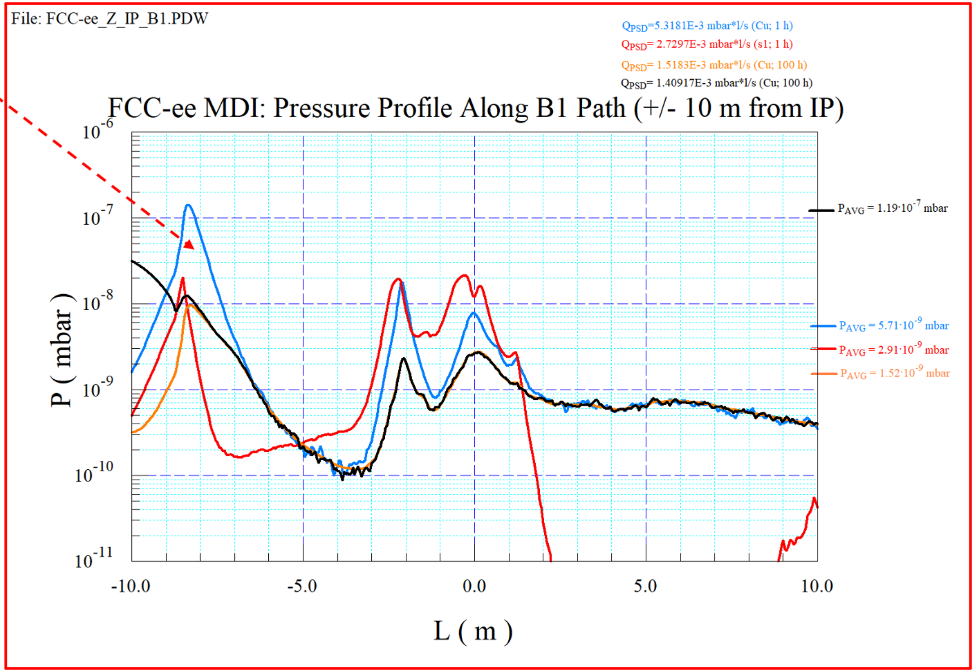




This area needs optimization of pumping and trapping of SR-induced desorption by rectangular absorber: e.g. **sawtooth design**?

Same as previous one but for the +/- 10 m to/from IP
Cu-like desorption yield with s=0.008 NEG sticking coeff. and NO NEG before IP; H_2 gas

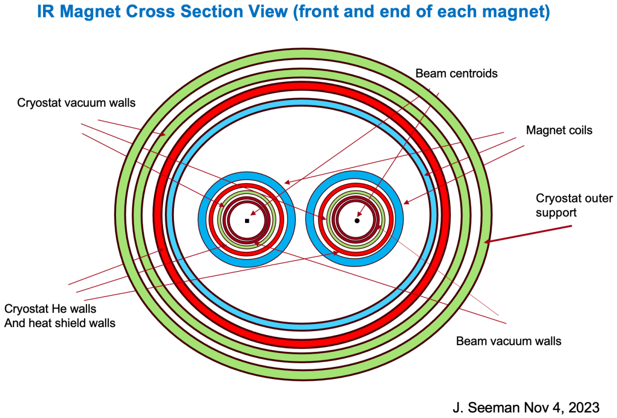


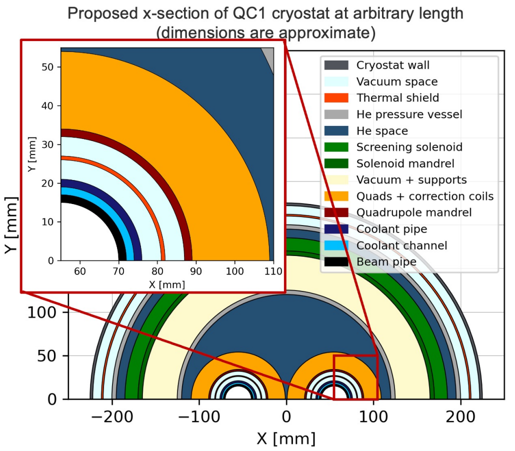


- The Be chamber can't be baked at ~180 C that would be needed for activating the NEG-coating;
- We'd like to find (at least) one place ON EACH SIDE OF THE DETECTOR where a small NEG pump could be located

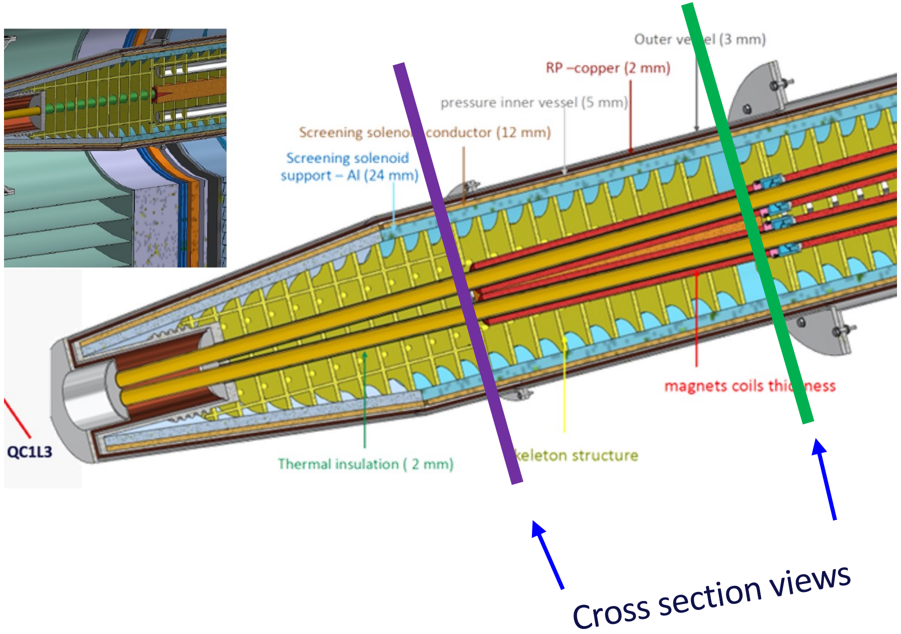
J. Seeman

Discussion on QC1-QC2 positions and cryostat options





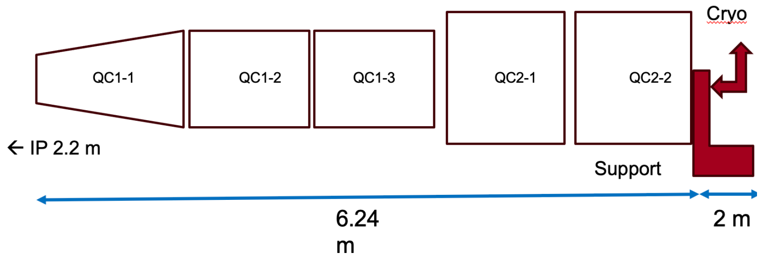
P. Borges de Sousa



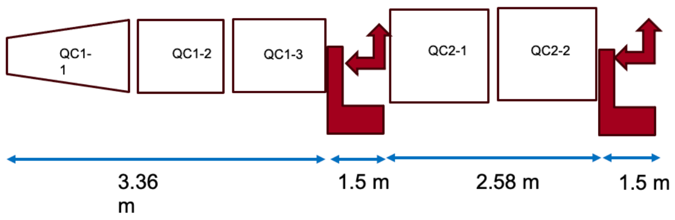
Cryogenic engineer to look into the magnet cross section

Discussion on QC1-QC2 positions and cryostat options

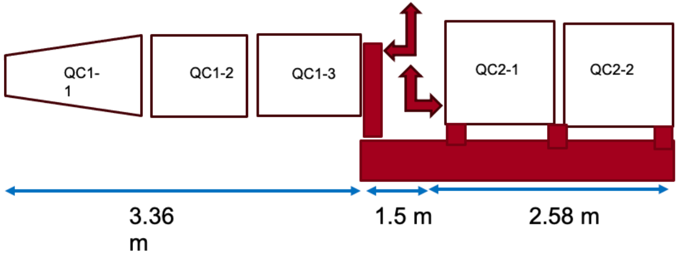
Option 1: IR QC1 and QC2 in one cryostat and raft (not to scale)



Option 2: IR QC1 and QC2 in different cryostats and rafts (not to scale)



Option 3: IR QC1 and QC2 in different cryostats but one integrated raft (not to scale)



Extra space needed between QC1- QC2 needed to split in 2 cryostats

P. Borges de Sousa

Comparison of cooling options

1.9 K in He II

- ✓ Stable *T* environment with extremely low vibration levels
- ✓ Allows for highest *T* margin
- ✓ Extremely high heat extraction capability
- ✗ Requires large free x-section for He II in cold mass, not flexible if heat load increases
- ✗ Creates need for He II cryoplant, cold compressors underground
- ✗ Higher cost
- ✗ Higher underground cavern footprint

NB: COP^{-1} at refrigerator I/F ≈ 960 W_{el}/W_{cool}

4.5-5 K in sc or LHe

- ✓ Pool boiling provides stable *T* but difficult to ensure filling; requires exhaust
- ✓ Forced He flow at 3-4 bara can be implemented in small annular space around coils/pipes embedded in former
- ✓ Same *T* level as usually required by detectors, can share same cryoplant if appropriately sized
- ✓ Smaller distribution line required
- ✗ Temperature gradient O(0.5-1 K) along length of cold mass
- ✗ Turbulent flow in annular space or pipes may cause small vibrations

NB: COP^{-1} at refrigerator I/F ≈ 240 W_{el}/W_{cool}

10-20 K He gas

- ✓ Forced He flow at 3-20 bara can be implemented in small annular space around coils/pipes embedded in former
- ✓ Higher *T* means lower overall power consumption for cryo
- ✓ Smaller distribution line required
- ✗ Temperature gradient O(5-10 K) along length of cold mass
- ✗ Turbulent flow in annular space or pipes may cause small vibrations

NB: COP^{-1} at refrigerator I/F ≈ 50 W_{el}/W_{cool}

Cryogenic approaches for superconducting magnets in the FCC-ee IR

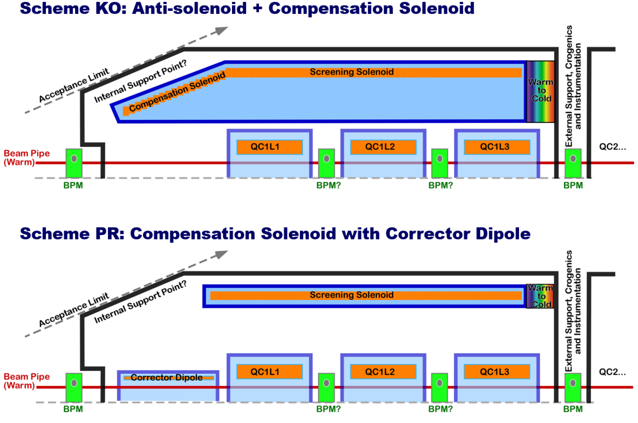
- A preliminary assessment of **local heat extraction** options for the IR magnet QC1 has been carried out, for present **level of heat load O(100 W)** there are **no showstoppers at either 1.9 K, 4.5-5 K or 10-20 K**
- Aside from local heat extraction, the choice of operating temperature will have a **profound impact on the overall MDI/IR zone** → if unavoidable, operation at **1.9 K needs to be justified**
  - **1.9 K** operation is **4x more power consuming than at 4.5 K**, 20x more than at 10-20 K
  - **Cryo distribution line in the tunnel is larger for 1.9 K** operation due to pumping line
  - **Underground cavern space** for cold compressors is a necessity for **1.9 K**
- **Integration** in the MDI/IR is challenging, would be facilitated by having common temperature levels between different magnets and using cold BPMs
- **Static heat loads** can add up to a significant percentage of the radiation-induced load, once design has matured an estimation should be planned
- We need clear **functional specifications** for both the IR magnets and detector, input is required for cryogenic infrastructure design → impact on costing, availability, integration

Open questions – Operational aspects

- **Order of magnitude of heat loads at each temperature level** for the MDI and for the experiments
- Can detector **solenoid and MDI cryogenic requirements be combined** into a single cryoplant? Can we get a list of cryo operational requirements?
- FCC week discussions considered possibility of **cold beam pipe in the MDI** region? If so, what would the temp. level and heat loads be?
- Are all 4 IP **MDIs going to have the same (cryo) design**? Is each MDI symmetric w.r.t. the IP?
- Is there any allocated **tunnel space for a cryogenic distribution line**? What about shaft space?

Efficiency of the IR quadrupole magnets and potential prototype

Two IR Optics Schemes Currently Under Consideration



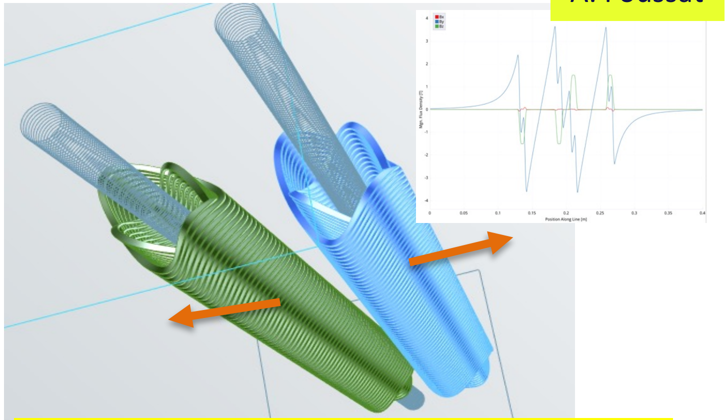
- For **BPM access** and cryogenic flexibility, it is **useful to separate individual cold masses** within main cryostat.
- Best practice says to provide **inner and outer heat shields** and more space for containment and support.
- Also, preliminary study suggests that some coils likely need **protection** from energy deposition at Z running.
- Thus, both inner and coil radii should increase, but this is not possible for all coils (e.g. QC1R/L1).
- Solutions: higher performance superconductors, lower temperatures, new coil geometries and magnetic yokes.

1. **We must finalize functional requirements for each magnet at every operating point asap in order to develop individual magnetic design solutions (e.g. QC1R1 @ tt is different than QC2R1 @ Z).**
2. **Much of the required R&D is pushing state of the art (e.g. if we need Nb_3Sn or HTS coils) so it is important to integrate magnet prototyping and testing into the project (approval???) schedule.**

FCC-ee FFQ IR magnet design options

A. Foussat

Features	LTS (Baseline)	HTS tape
Nb conductor in groove / layer	4 SC wires	5 tapes (Rebco Fujikura FESC)
Operating temperature (K)	4.5 / 1.9 K	4.5 / 20 K
Nb strand / tape / turn	4 str (0.85mm)	5 tapes (4 x 0.97 mm)
Peak field (T)	2.4	2.4
Maximum gradient (T/m)	**45 (Z-pole)**	**90**
Nominal current (A)	**350 (Z), 650 max**	305
Temperature margin (K) min /max	Min 1.1 / 3.7 5.3 /6.3	Min 37 / max 57 23/41
Max Force density (N/mm3)	2500	2500
R_in FFQ bore (mm)	**24**	**24**
Spar thick (mm)	1	1
Groove depth (mm)	4	4



Max. QC1.1 in-plane resultant force of 4.5 kN

[option1 ref]: round HTS wire:
DOI 10.1088/1361-6668/aaebe8

Need to be updated with thermal shield space, final ID bore.

Prototype and open requirements

A. Foussat

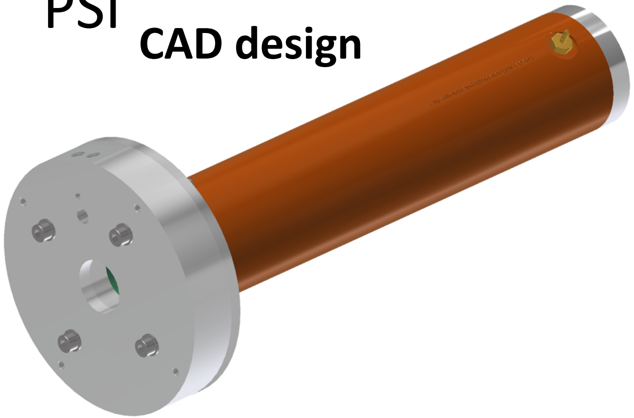
- **CERN and BNL magnet groups propose to built a first FF QC1 magnet demonstrator as placeholder of combined technology**
  A. **WP1-Demonstrator Canted cos theta FF quadrupole and Direct correction coils winding. [Q1-2024 Q4-2026]. Project scope complete**
     - fast track to capitalize on built-up LTS technology and test a best practice model to check several manufacture aspects
     - compact design adaptable incl. correction coils set.
  B. **WP2- Integrated prototype magnet (tbd):** Optics layout selection with an integrated cryostat, FFQ magnets with support, QC1L1 design magnet cooling scheme, required services (instrumentation, BPM…).
     A. **A representative in-cryostat magnet system prototype shall be constructed to validate main integration, heat loads, field quality features. (FFQ + correction + anti solenoids placeholder ?)**
- **CERN-BNL collaboration pre-agreement & resource plan expected within** FCC (off MoU) to start **WP1 IR demo magnet** detail design.

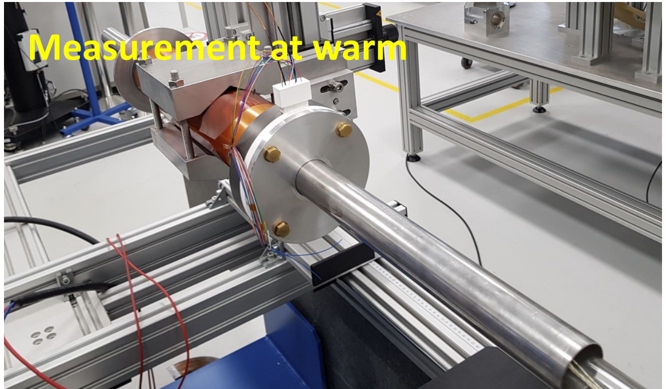
M. Koratzinos

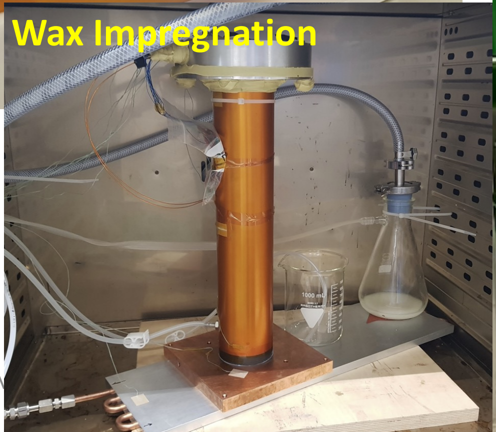
The history of SPMQMEM000-00000007

Designed, manufactured, wound, tested at CERN; impregnated at PSI

CAD design



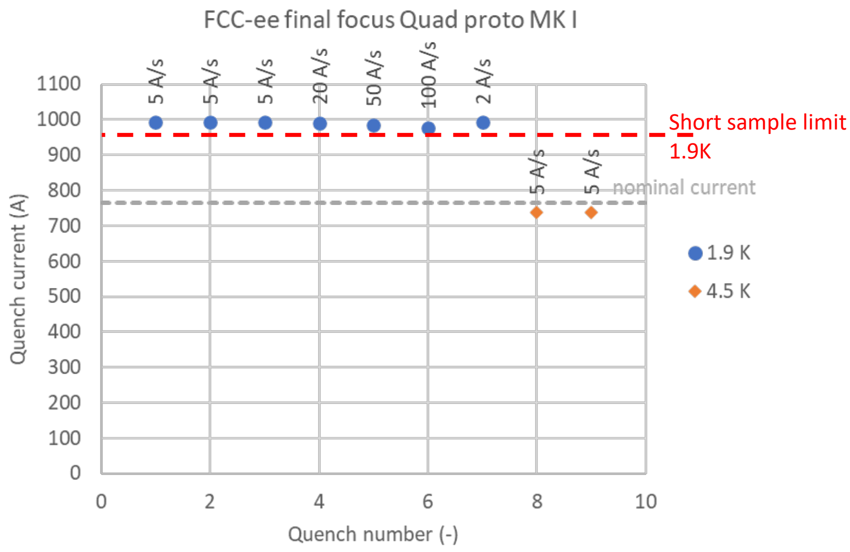




M. Koratzinos

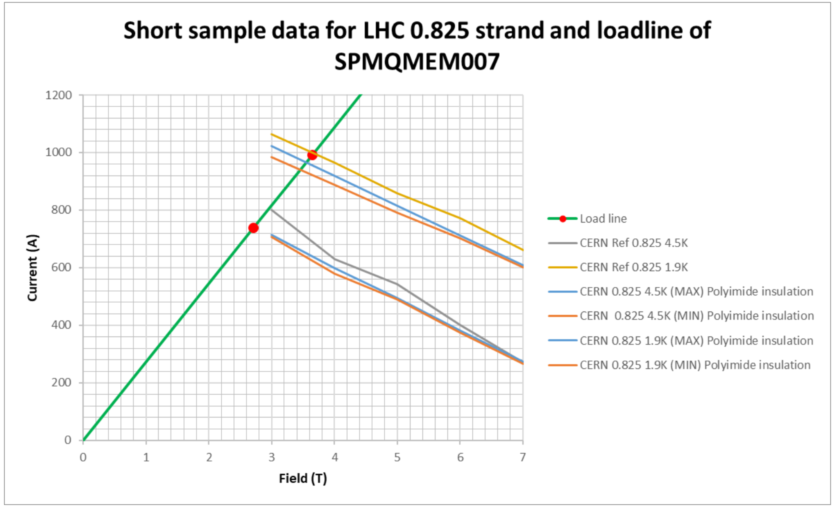
SM18 Test results Oct 27-31 - Training

Test report EDMS https://edms.cern.ch/document/2976492/1
Gerard Willering, Jerome Feuvrier for TE-MSC-TM



No training quenches were seen up to short sample limit
No degradation was seen for quenches at short sample limit

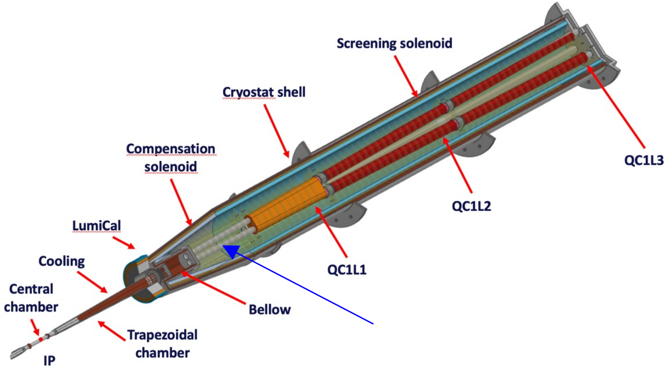
1.9 K: reached 991 A, peak field on conductor is 3.65 T
4.5 K: reached 738 A, peak field on conductor is 2.71 T



Field quality: work ongoing but less than one unit in 10^{-4} of multipole errors (Carlo Petrone, Melvin Liebsch TE/MSC/TM)

P. Raimondi

New IR quadrupoles asymmetric layout option



MOTIVATION

- Enhance luminosity by squeezing the beam at IP → horizontal and vertical beam sizes decrease by ~ 30%
- Left Final Focus chromaticity and sextupoles are reduced up to 40%
- Sextupoles strength and tolerances scale accordingly (weaker by ~30%-40%) → smaller FF emittance contribution, better dyn. ap.
- FF Left Right sides asymmetries better match the requirements in terms of synchrotron radiation in the IR, because smaller BSC and masking on left side

- E_c ~ 130 keV from last dipoles upstream the IP
- **Chromatic correction sextupoles can be normal conducting** (890 T/m^2, L=0.60 m)

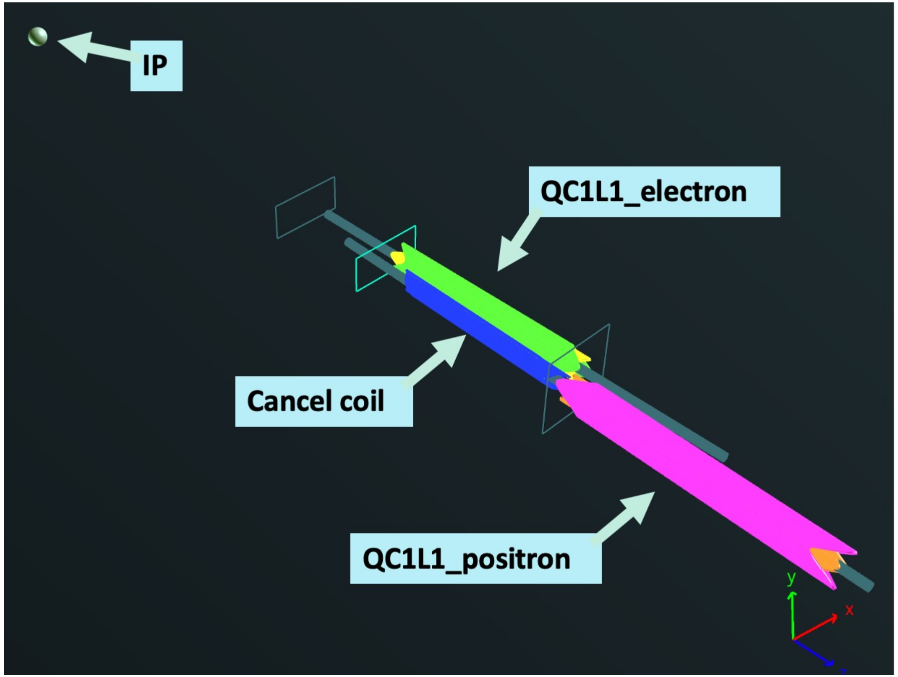
HOW IT CAN BE DONE

- QC1L1 located closer to the IP, as close as possible i.e. up to the crotch, (shorter L* for the incoming beam to the IP), and stronger (~ 130 T/m) → shorter incoming beam sizes and larger stay clear.
- QC1L&R will be interleaved – challenge to compensate the quads magnetic field leakage on the other beam.
- QC1R/L effectively independent.

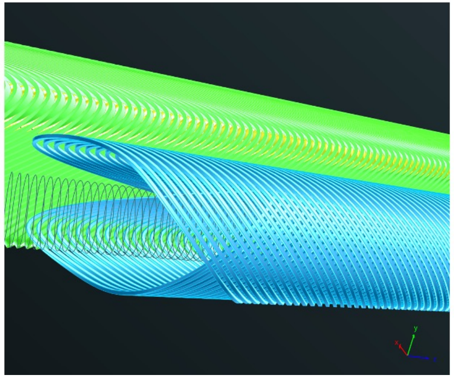
M. Koratzinos

Asymmetric design

- An asymmetric design, with e^+ quad L*=1.6m, e^- quad L*=2.2m was developed, following a request by P. Raimondi



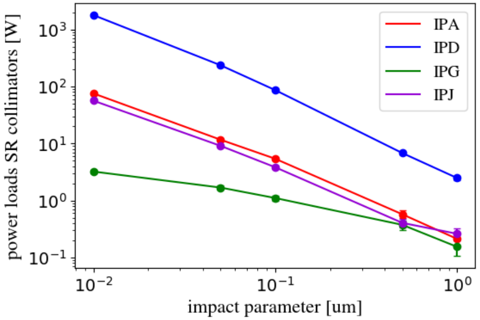
- This necessitates the use to 'cancel coils' (like SuperKEKb) [here in blue] which are very thin but necessary.
- Current design uses NbTi single 0.825mm wire (LHC strand)
- Operating temperature will have to be 4.5K or below

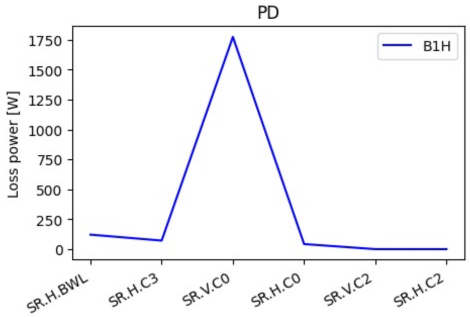


IR beam losses and beam halo collimation

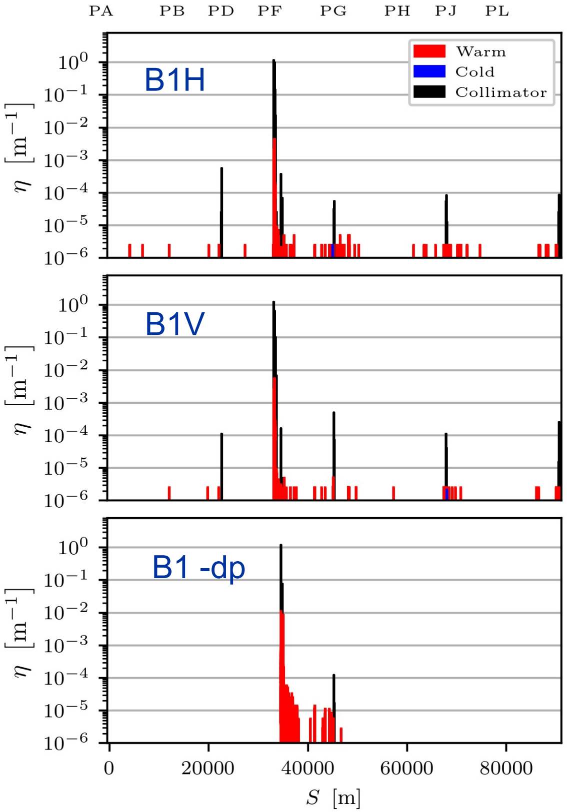
G. Broggi

- **The beam collimation system shows significant loss suppression**
  - ➢ More than 99.98% of losses contained within the collimation insertion
  - ➢ Minimal losses on superconducting elements
- **SR collimators intercept beam losses in all cases**
  - ➢ Vertical SR collimator C0 is the most exposed
  - ➢ Highest power load on SR.C0.V upstream of IPD: 2.6 W
  - ➢ Power loads on SR collimators increase at smaller impact parameters on primary halo collimators: up to kW level





- ➢ Investigate further and study possible mitigation



Z mode betatron and off-momentum halo loss maps

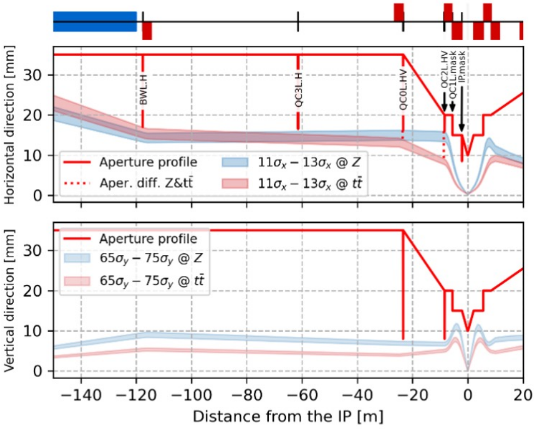
SR Studies and Mask Design

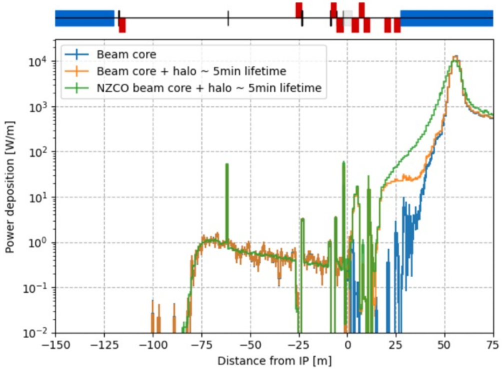
The SR collimation for **Z** and **tt** operation modes including transverse tails and non-zero closed orbit is effective.

Tens of watts deposited on the mask, cooling ?

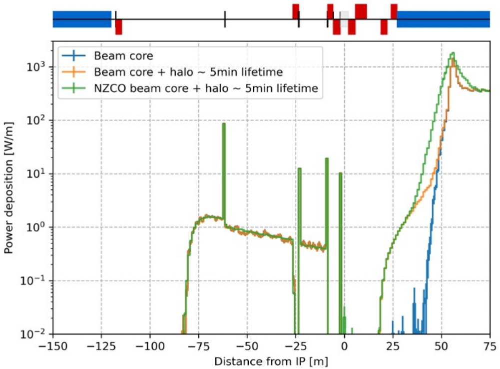
The first studies of the V23 lattice and optics designs prove to produce less SR power deposition around the IP.

Name	s_{end} [m]	HGAP [mm]	N sigma	plane
BWL.**H**	-117.5	17	$14\sigma^{Z}\|13\sigma^{tt}$	H
QC3L.**H**	-61.37	16.5	$13\sigma^{Z}\|14\sigma^{tt}$	H
QC0L.**H**	-23.25	16.2→14	$13\sigma^{Z}\|13\sigma^{tt}$	H
QC0L.**V**	-23.35	8	$81\sigma^{Z}\|139\sigma^{tt}$	V
PQC2LE.**H**	-8.45	16→9.1	$13\sigma^{Z}\|13\sigma^{tt}$	H
PQC2LE.**V**	-8.55	8	$83\sigma^{Z}\|111\sigma^{tt}$	V
MSK.QC2L	-5.58	R = 15	$20\sigma^{Z}\|38\sigma^{tt}$	H&V
MSK.QC1L	-2.10	7	$41\sigma^{Z}\|70\sigma^{tt}$	H





Power deposition from synchrotron radiation at Z



Power deposition from synchrotron radiation at tt

H. Burkhardt

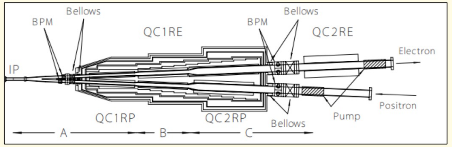
Tungsten Shielding in the MDI and Muon Background

Motivation

SuperKEKB

Hiroyuki Nakayama Oct. 2023 Int. Circ. Collider "CEPC" workshop

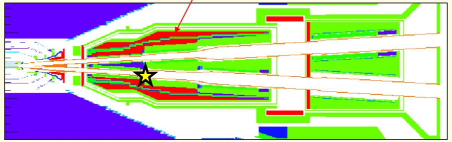
TDR(2010)



- TDR is prepared just after the change of SuperKEKB design concept ("High current " → "Nano-beam")
- Therefore, at that time, no beam background estimation was available for the "Nano-beam" optics
- No shield considered inside the cryostat

Final design

thick tungsten layers



- As background simulation developed, we found a significant beam loss inside the final focus magnet
- I made a strong request to put as much heavy-metal shield as possible inside the cryostat
- It required major modification on the already-started cryostat fabrication process

Takeaway message: Reserve enough space for the BG shields between detectors and beam pipes!

Good strategy confirmed by LEP measurements

1) **minimize background at the source**
2) **collimate halo far from IP ; do not reduce lifetime**
3) **off-momentum collimation end of arc each IP**

further beam-gas / thermal photon / collimation & IR modeling studies

SuperKEKB : HER 7 GeV e- LER 4 GeV e+

To which extend do we need that for the FCC-ee IR ?

Pay attention to add shielding: it can be a source of background if not properly studied!

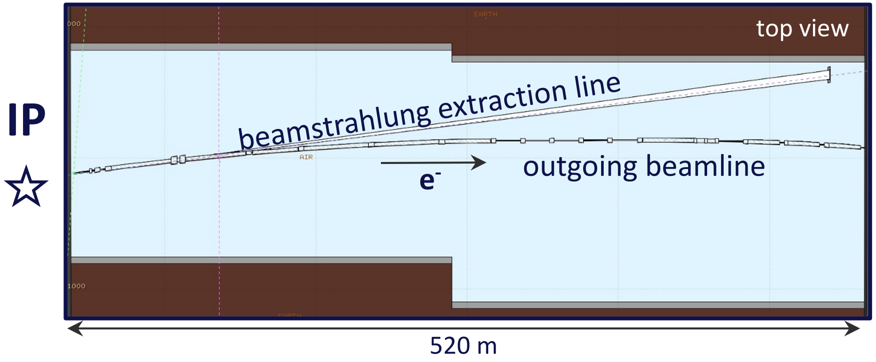
Probably additional collimators in the IR need to be added

FLUKA studies of the FCC-ee IR

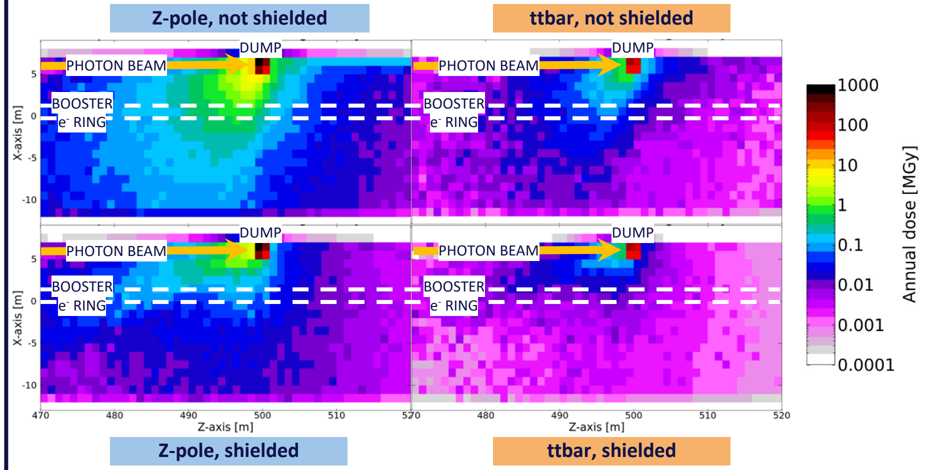
FLUKA model to estimate the radiation levels in the FCC-ee tunnel in the experimental IR

- beamstrahlung dump and synchrotron radiation outgoing from the IP investigated
- no SR absorbers included
- radiation studies for the detector and FFQ to be addressed soon (including beamline incoming to the IP)

FLUKA MODEL

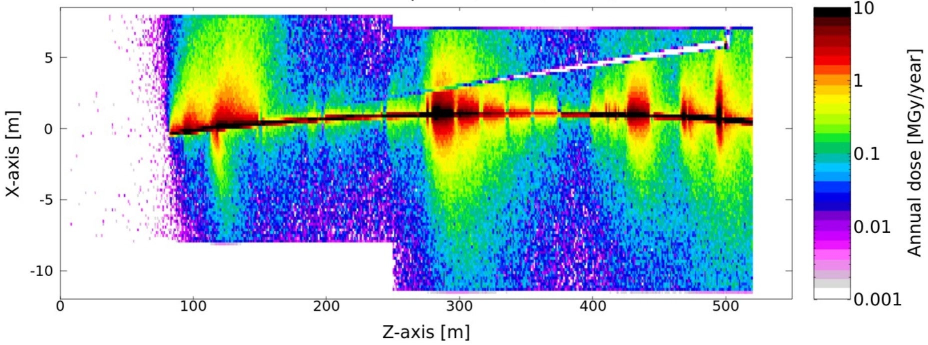


ANNUAL DOSE FROM BEAMSTRAHLUNG DUMP



ANNUAL DOSE FROM SR @ttbar

ttbar - horizontal plane (-20cm, 20cm)



Accelerator Constraints for the FCC-ee IR

Near Primary MDI IR Issues (Part 1)

SLAC

1. Cryostat layers, dimensions, and contraction allowances.
2. BPM installed between magnets (e.g. QC1a and QC1b, etc): three per side per ring are "relatively easy".
3. Magic flanges: remote vacuum connections (FCCee three per side?)
4. Supports for anti-solenoid.
5. Solenoid compensation (anti-solenoid vs. skew quadrupoles).
6. Magnet support and vibration control.
7. Space behind lumi-cal for other utilities (cables, diagnostics).
8. Explicit IP chamber design to divide from one to two chambers.
9. Most efficient quadrupole design (minimal radial space needed).
10. Cables and routing for vertex chamber.

Near Primary MDI IR Issues (Part 2)

SLAC

11) Needed magnetic trim coils.
12) Magnetic lengths versus physical lengths of QC1-A-B-C and QC2-A-B.
13) Detector shielding to include in cryostat and cone between 100 and 150 mrad.
14) Deposition of beam energy (~100 W) in magnets, shielding, cryostat.
15) How would the Raimondi lattice affect the IR design.
16) NEG coating: deposition, activation, longevity.
17) IP bellows design (needed compliance, cooling, HOM damping).
18) Assembly of cryostats with all the individual components.

Thank you !