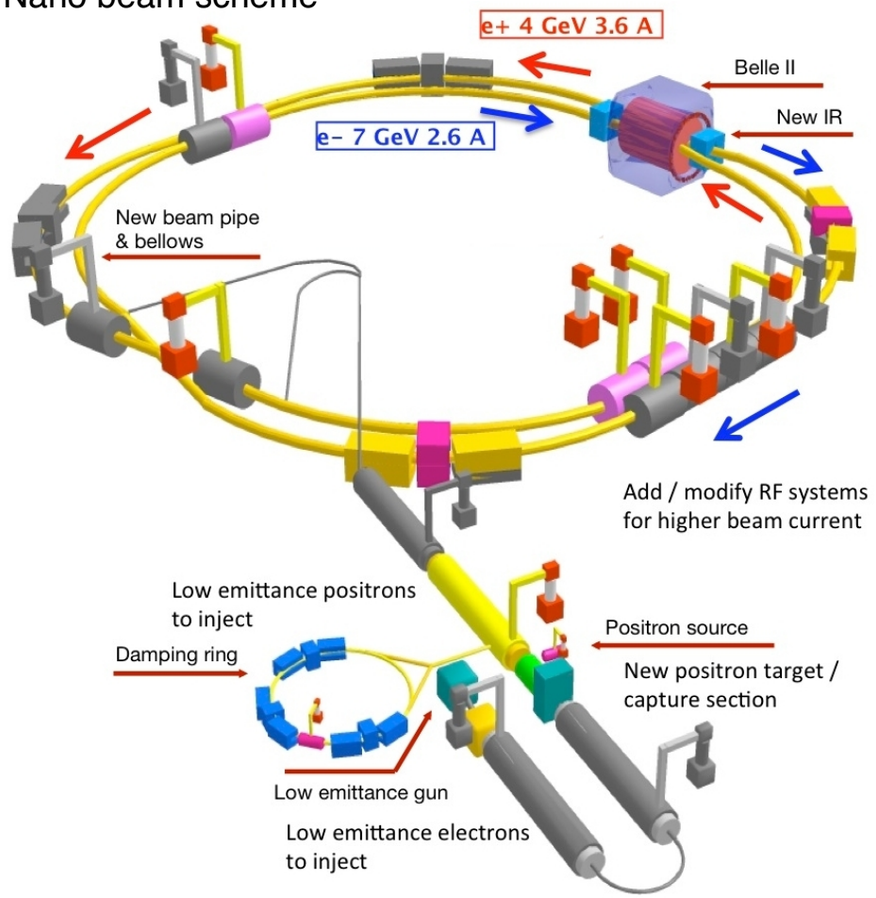
Status Report from DESY Belle II Group

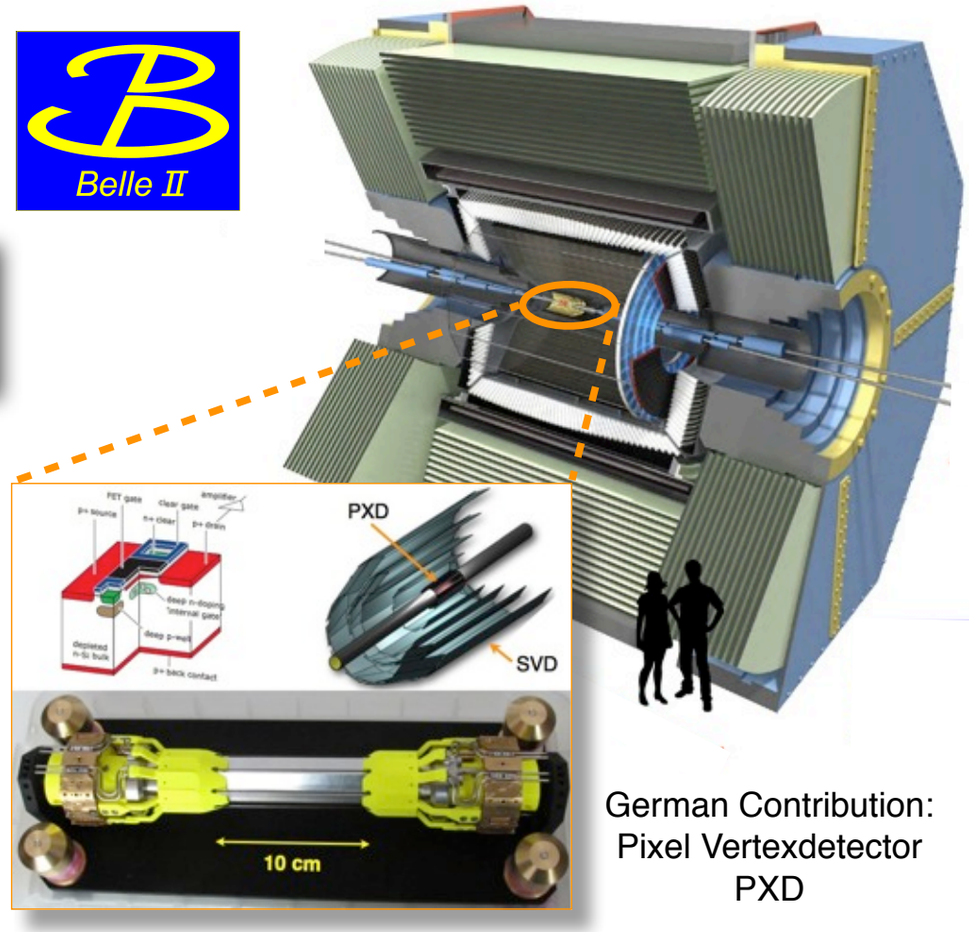
- Schedule
- DESY Contributions to Belle II Upgrade
- DESY at Belle I

SuperKEKB und Belle II in Japan

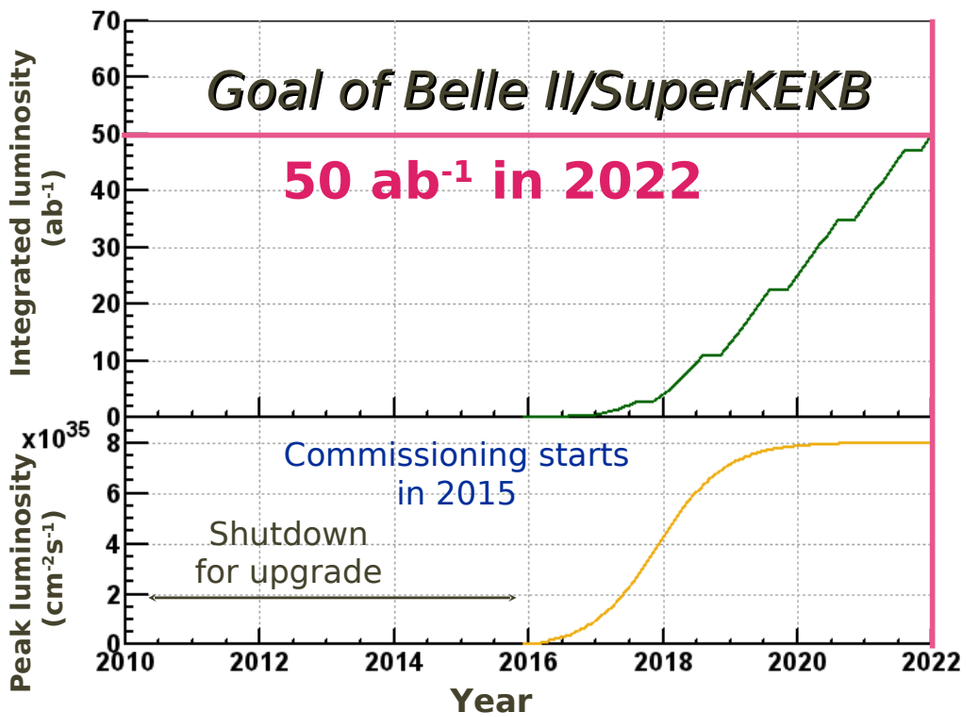
Nano beam scheme



DESY joined Belle II in November 2011

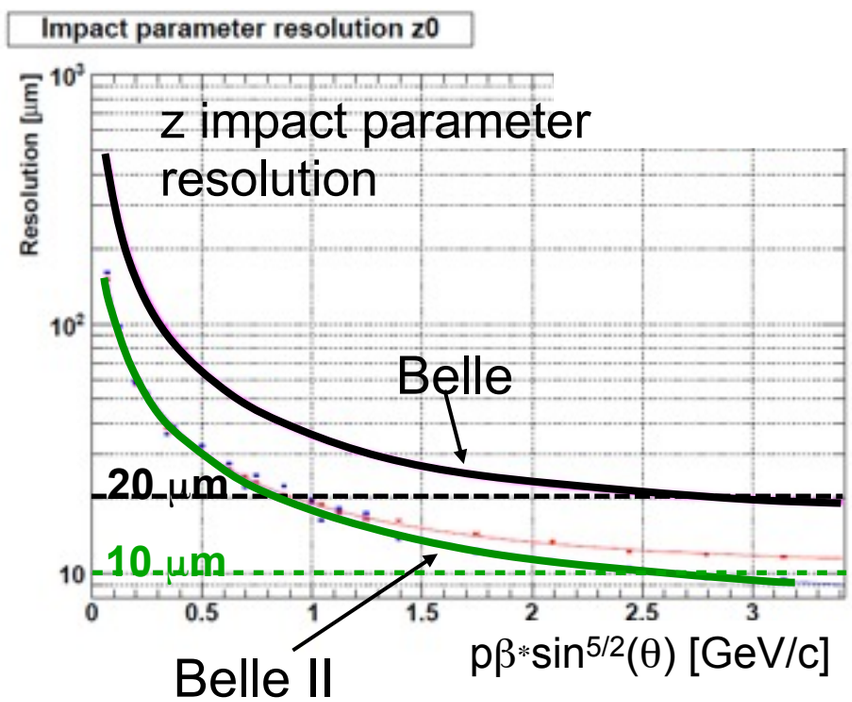


German Contribution:
Pixel Vertexdetector
PXD



Goal:

$$\int \mathcal{L}_{\mathrm{KEKB}} \cdot 50$$

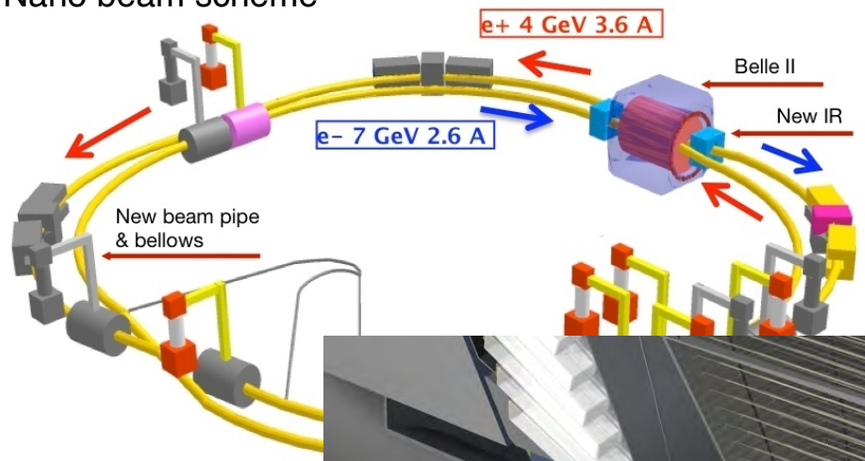


Goal:

$$\frac{\sigma_z(\mathrm{Belle})}{2}$$

SuperKEKB und Belle II in Japan

Nano beam scheme



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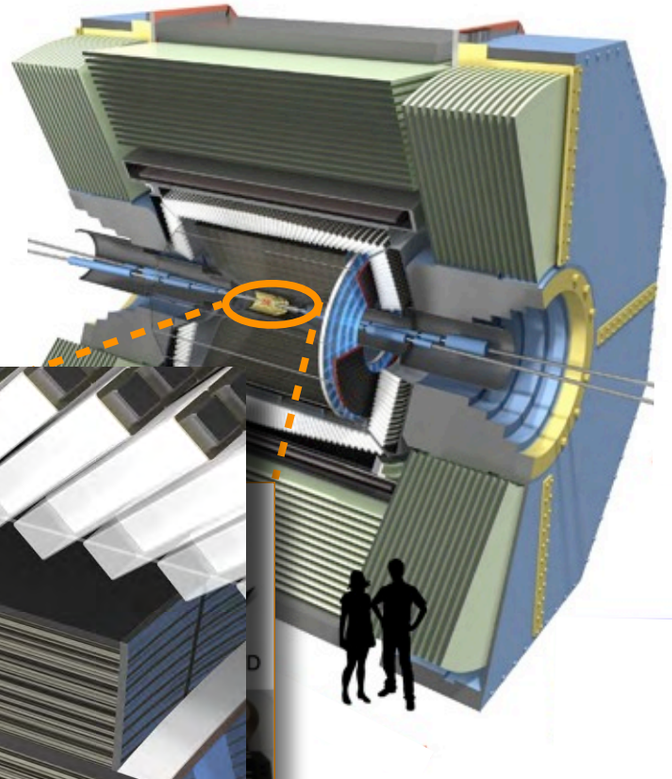

German Contribution:
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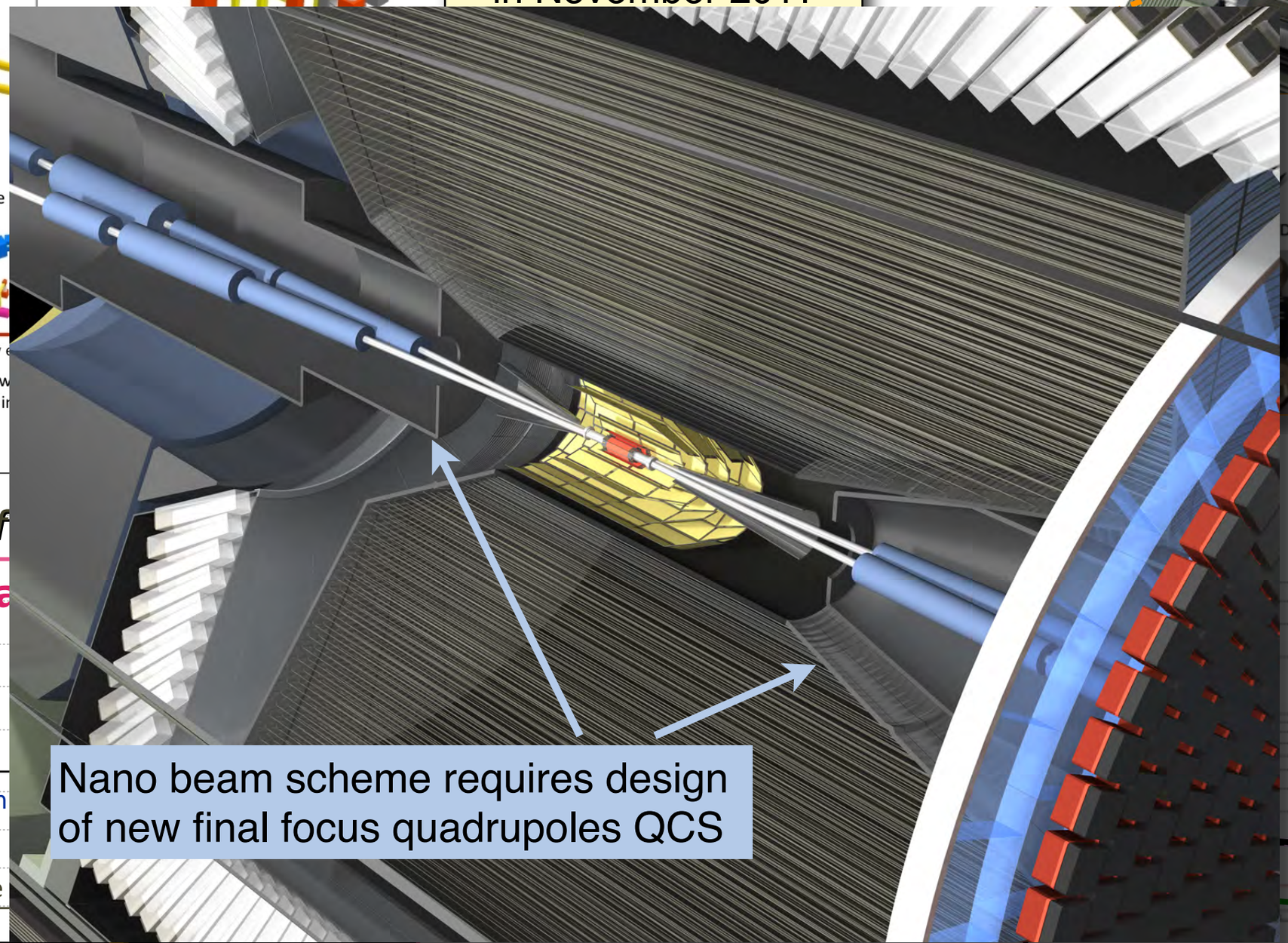
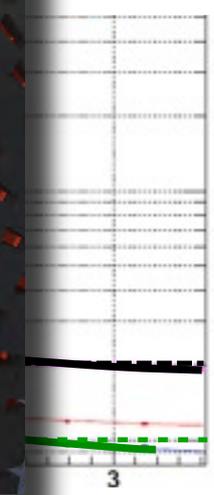


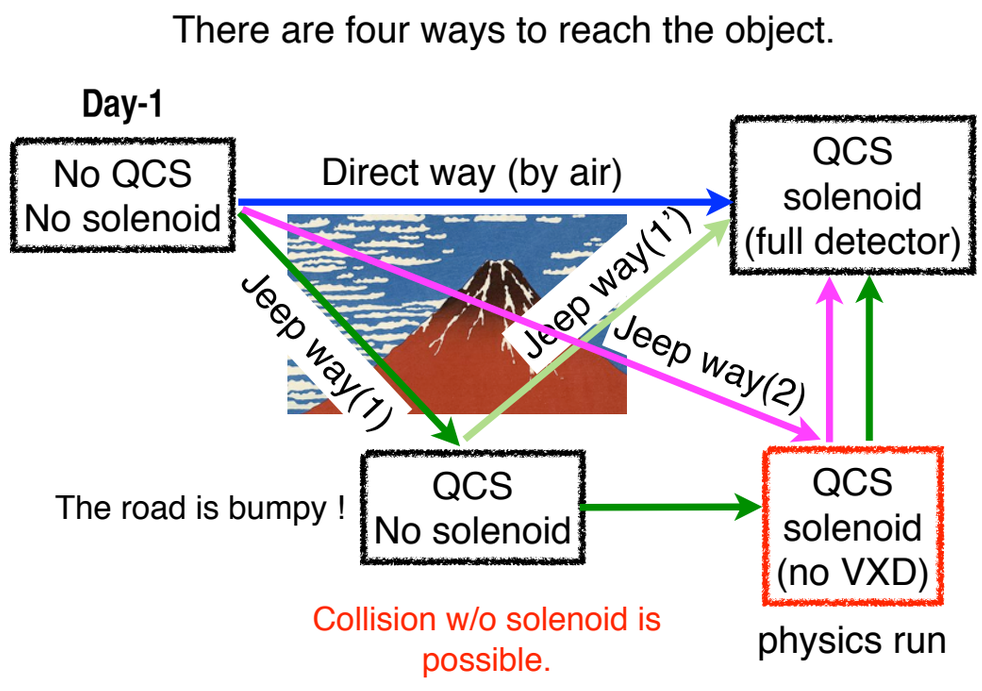


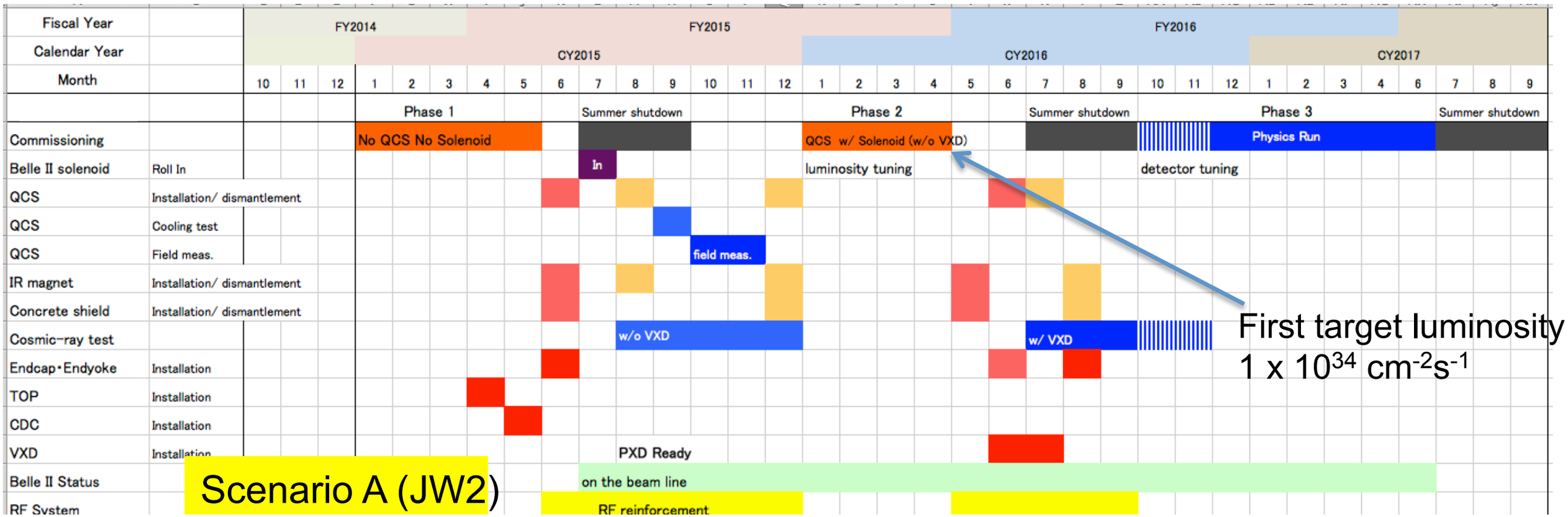
Goal:

$$\frac{\sigma_z(\mathrm{Belle})}{2}$$

Overall Schedule

- Schedule driven by readiness of QCS magnets
- Machine group clearly prefers „Jeep way(2)“ commissioning scenario
  - i.e. no attempt to make collisions without Belle II solenoid
    - no cosmic run with full detector outside beam position
  - PXD installation date independent of scenario
    - PXD installation in summer 2015
  - physics run starts in 2016

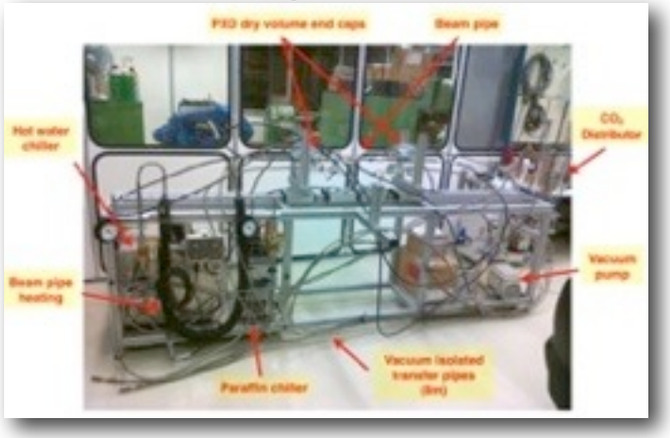




DESY Activities around Belle II PXD

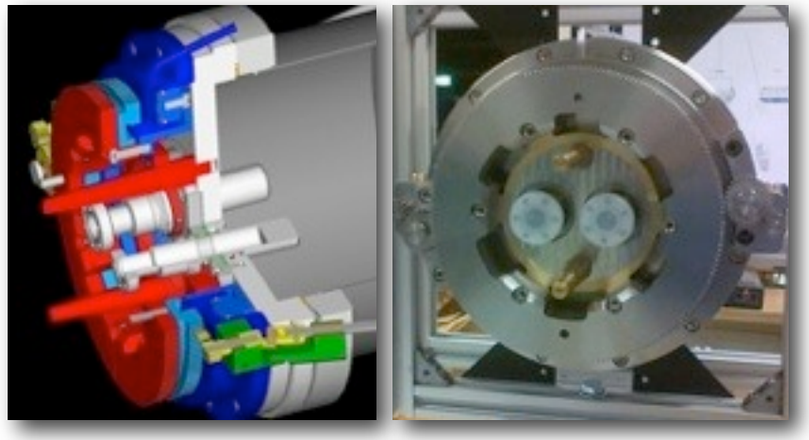
Supporting German Belle II groups by exploiting specific competencies available at DESY

Thermal Mock-up & Shield for VXD

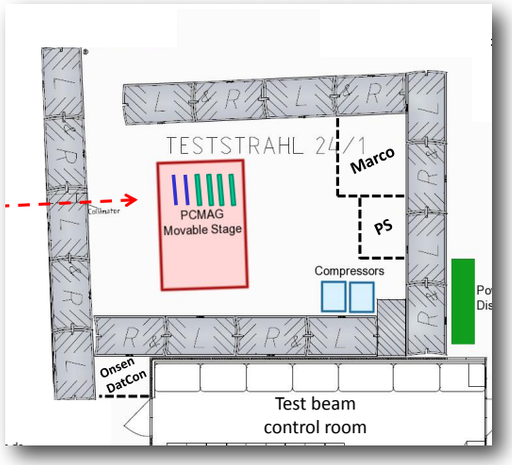


CO_2 Cooling System

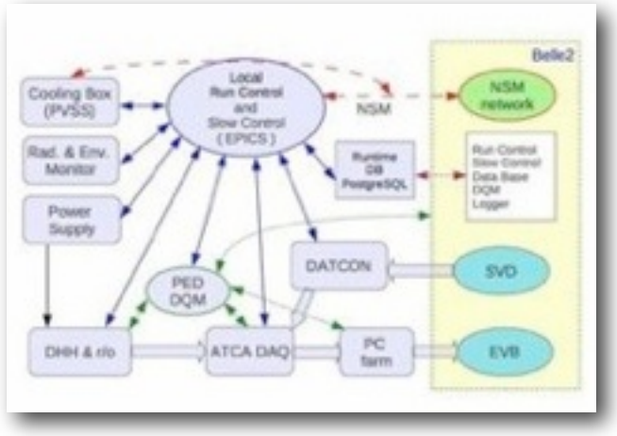
Remote Vacuum Connection



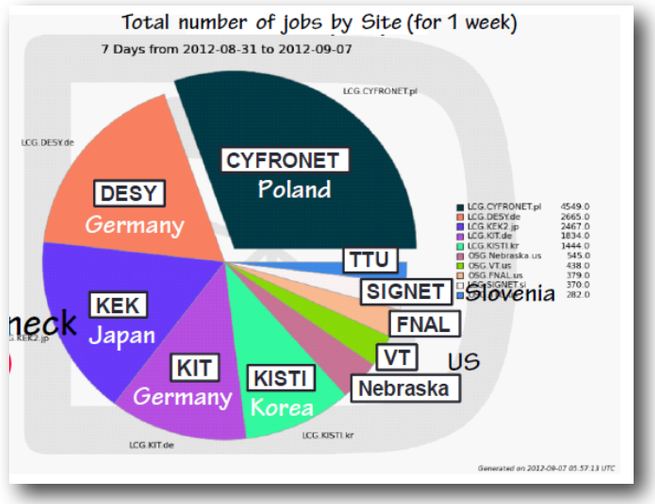
DESY Testbeam



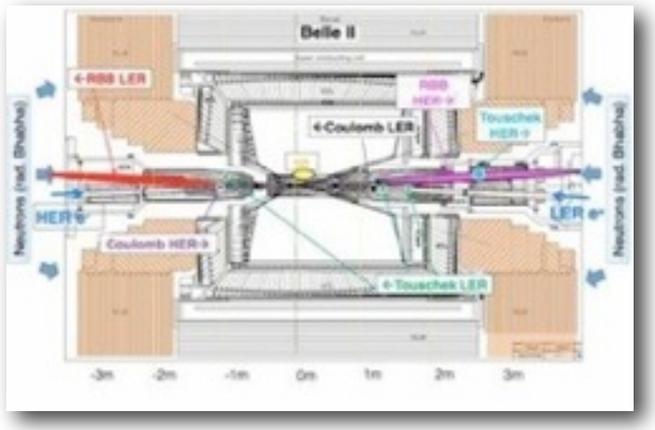
DAQ/DQM/SC Software



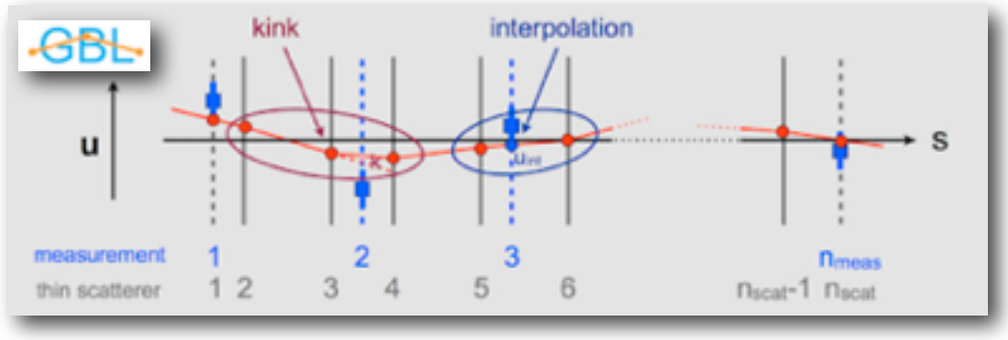
Grid/NAF/Data Preservation



SynRad Background MC



Tracker Alignment and Calibration



PXD Whitebook

The PXD Whitebook

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Marca Boronat, Daniel Esperante, Juan Fuster, Carlos Lacasta, Marcel Vos
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Karlheinz Ackermann, Laci Andricek, Vladimir Chekelian, Veronika Chobanova, Jeremy Dalseno, Christian Kiesling, Christian Koffmane, Luigi Li Gioi, Andreas Moll, Hans-Günther Moser, Felix Müller, Elena Nedelkovska, Jelena Ninkovic, Stefan Petrovics, Kolja Prothmann, Rainer Richter, Andreas Ritter, Martin Ritter, Frank Simon, Pit Vanhoefer, Andreas Wassatsch
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Charles University of Prague, Czech Republik

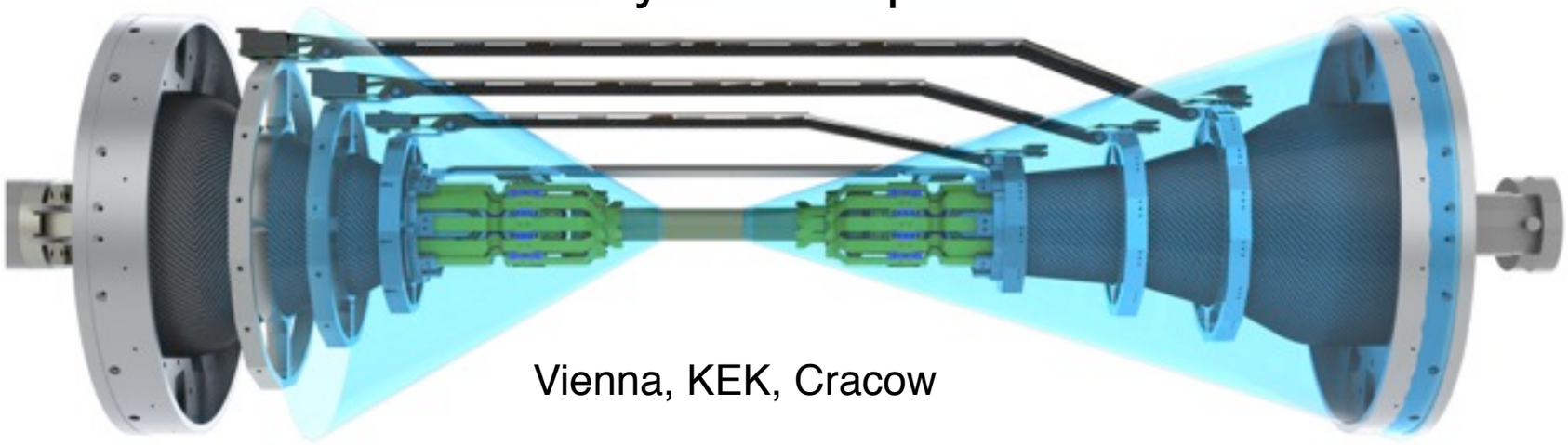
edited by Z. Dolezal, C. Kiesling, C. Lacasta & H.-G. Moser

Version 0, September 2012

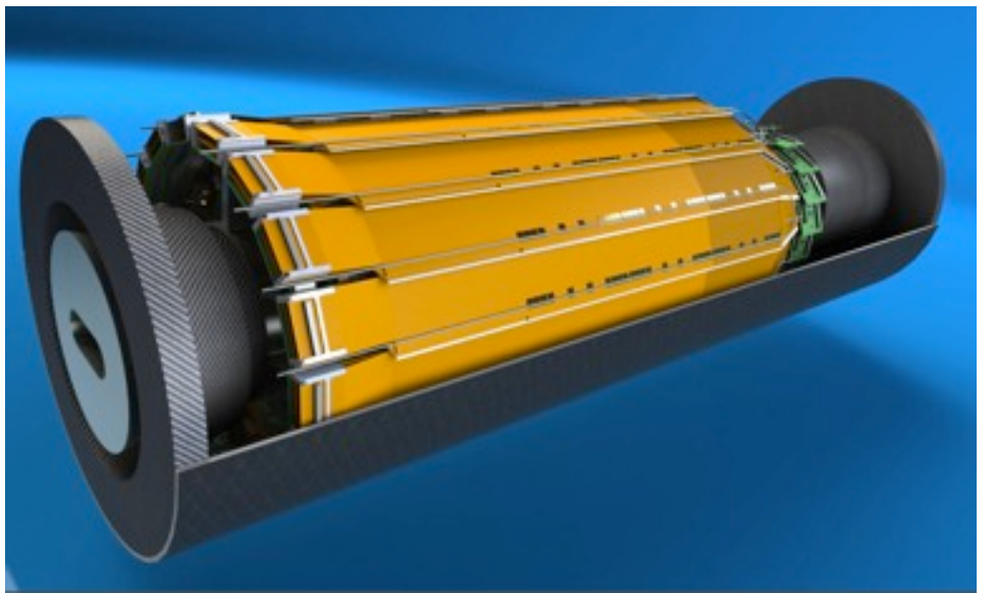
- Comprehensive PXD status report
  - serving as up-to-date reference
  - „living document“, presently 270 pages
- Substantial contributions from DESY
  - Mechanics & Cooling (ch 6)
  - DAQ Software, Slow control, Monitoring and Data Quality (ch 9)
  - Alignment and Calibration (ch 10)
  - *Installation into Belle II (ch 14, tbw)*
- Handed over to collaboration and BPAC members on Oct 1st

Common VXD Issues

SVD: 4 layer Si strip detector



Vienna, KEK, Cracow



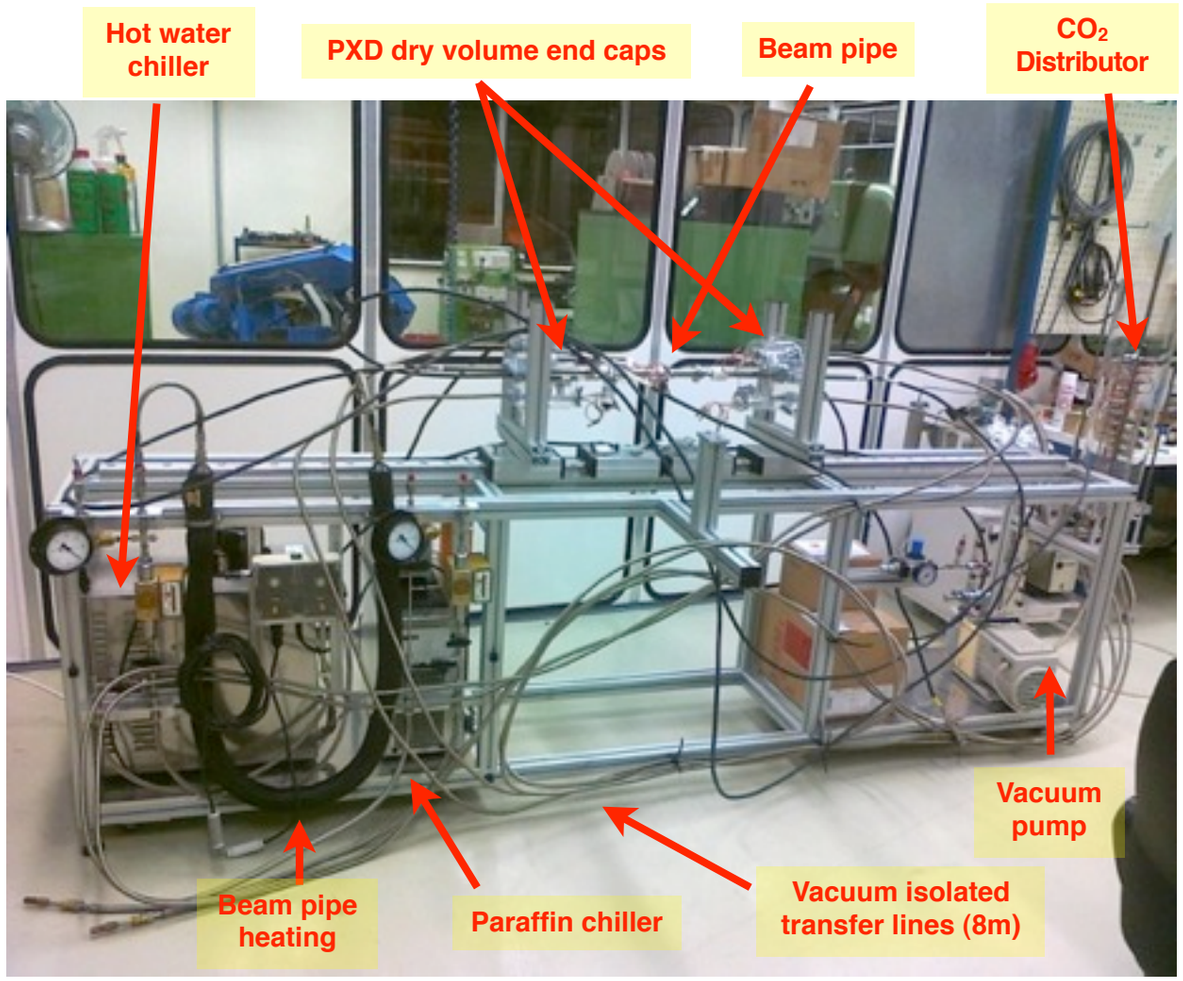
very preliminary ideas for support shell and thermal enclosure

- PXD and SVD share common VXD volume
  - extremely tight space constraints for
    - assembly, support, installation
    - cabling, cooling, ...
- In spring initiated regular „brainstorming“ mechanics meetings
  - HEPHY (Vienna), MPI (Munich), DESY
  - very important for fixing several „loose ends“
- DESY engages in design and production of support shell / thermal enclosure

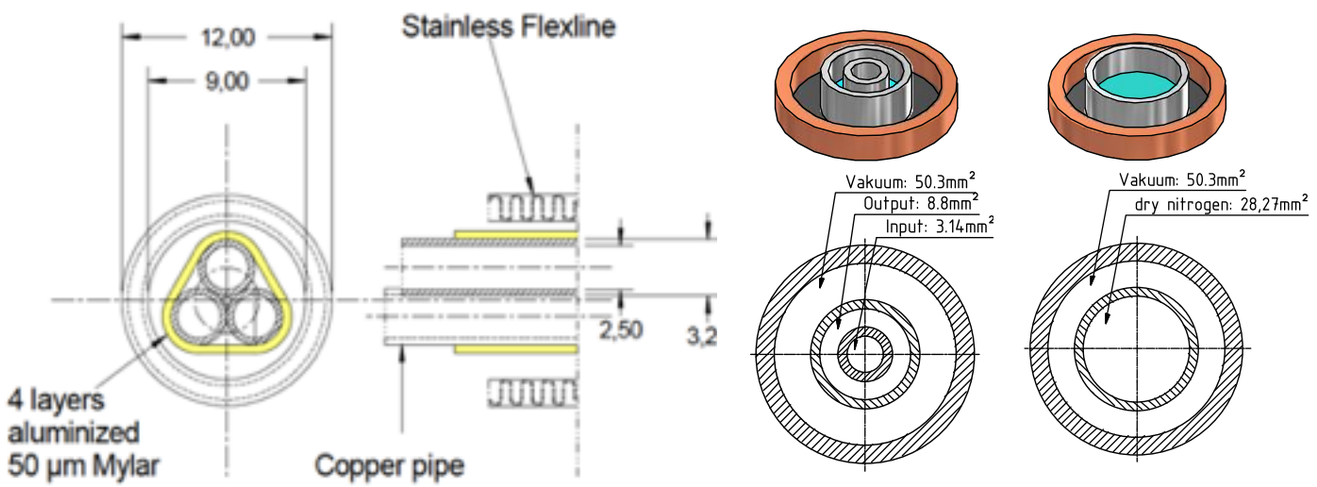
K.Gadow, R.Volkenborn, C.N.

Thermal Mock-up at DESY

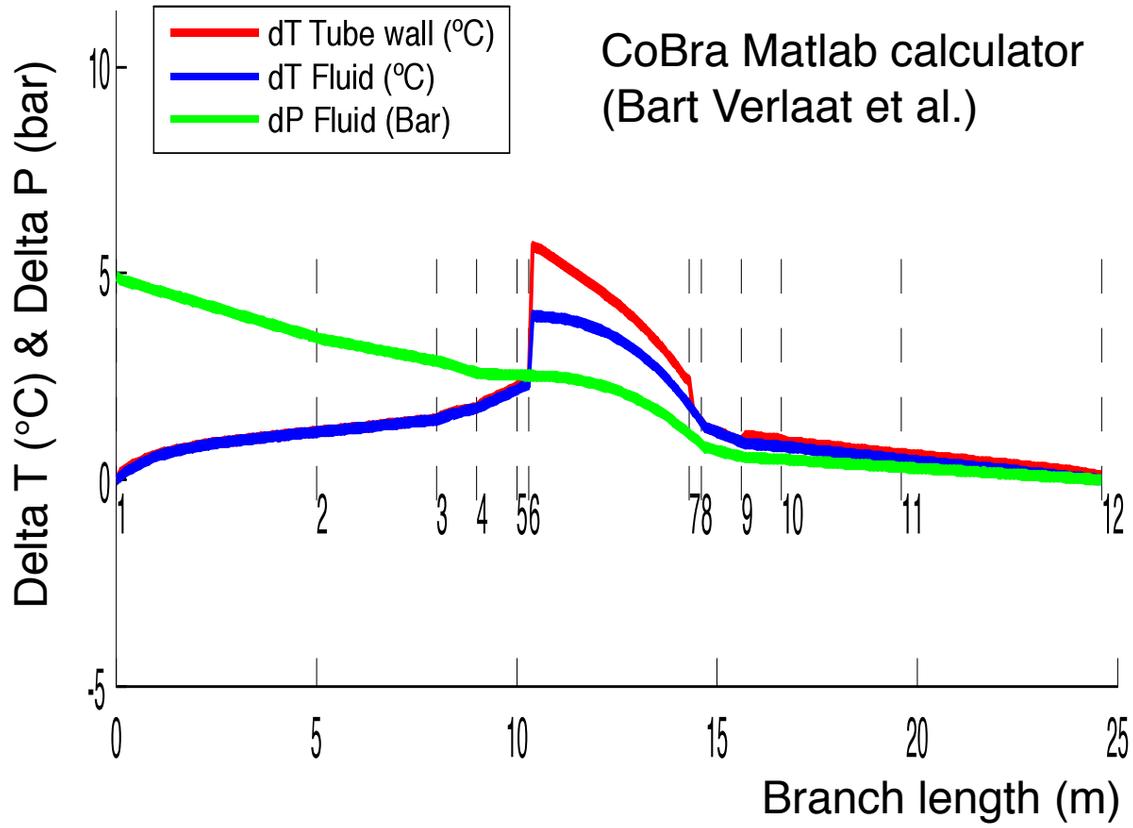
K.Gadow, C.Camien



Different options for vacuum isolated CO_2 transfer lines



Calculated Temperature and pressure profile

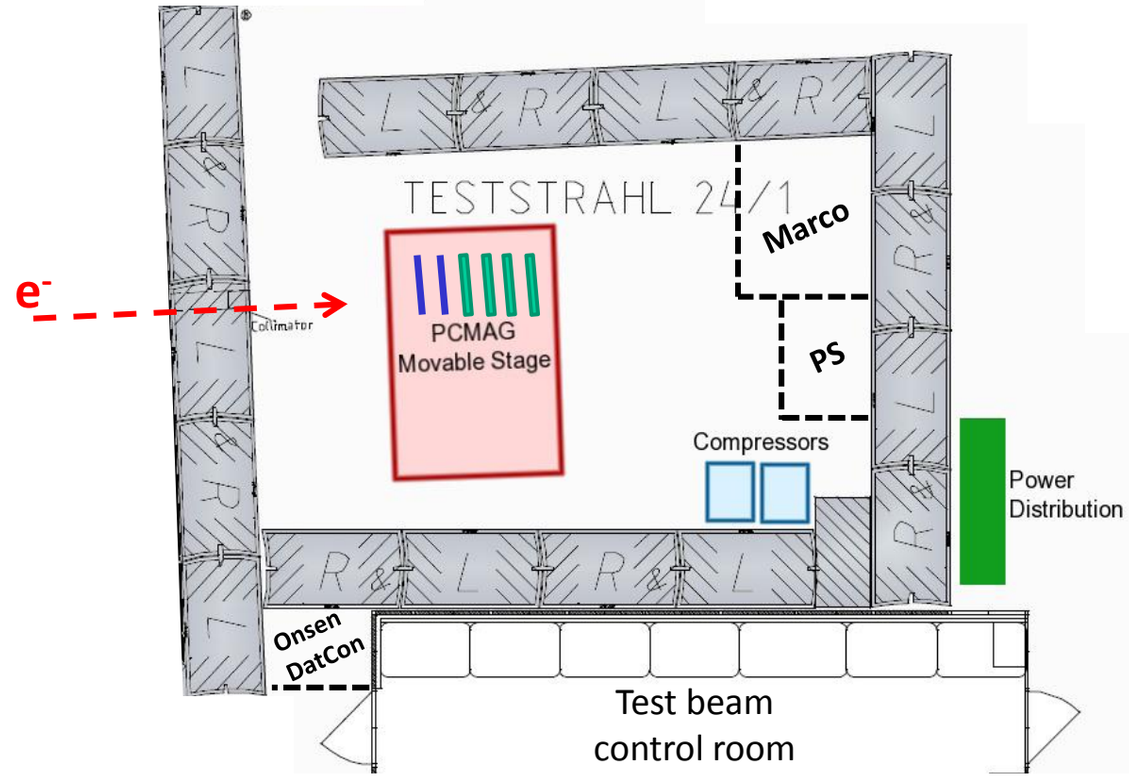


- Verify overall VXD cooling concept
- Optimize layout of transfer lines, inlet and outlet tube geometry
  - understanding of pressure drop and heat transfer extremely important for long thin evaporator branches
  - cross check with calculations concerning
    - liquid entry effects
    - dry-out prediction

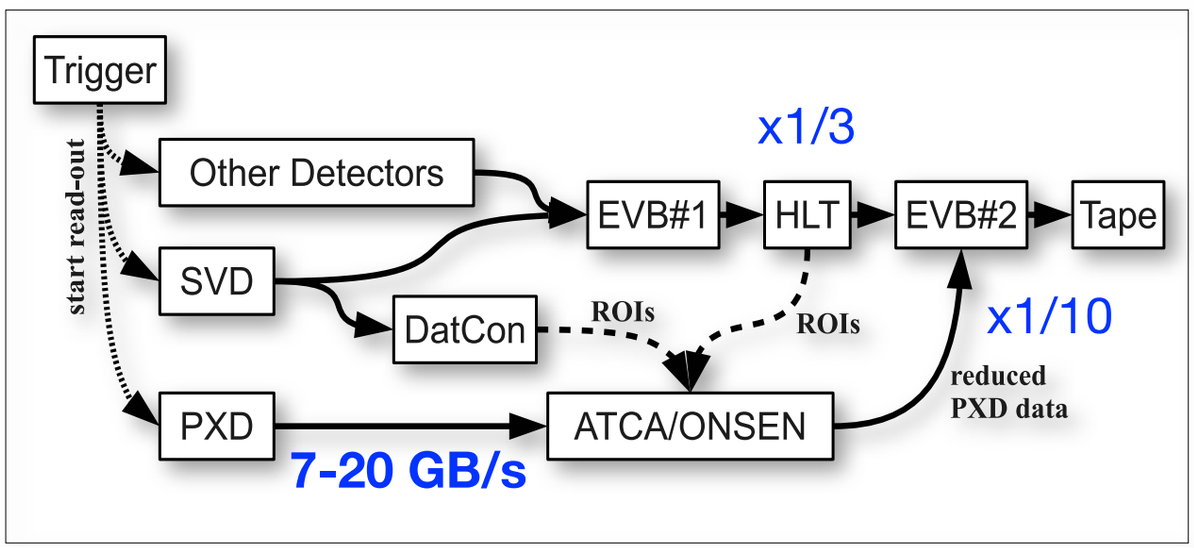
„Telescope Test“ at DESY Testbeam

- Major milestone in 2013
  - VXD slice test
  - 4 weeks requested in November 2013
- Goals
  - operate 2 PXD + 4 SVD sensors in B-field of 1T with final electronics + CO_2 cooling
  - perform full system test
    - establish data-size-reduction scheme using HLT feedback to the PXD-readout (RoI)

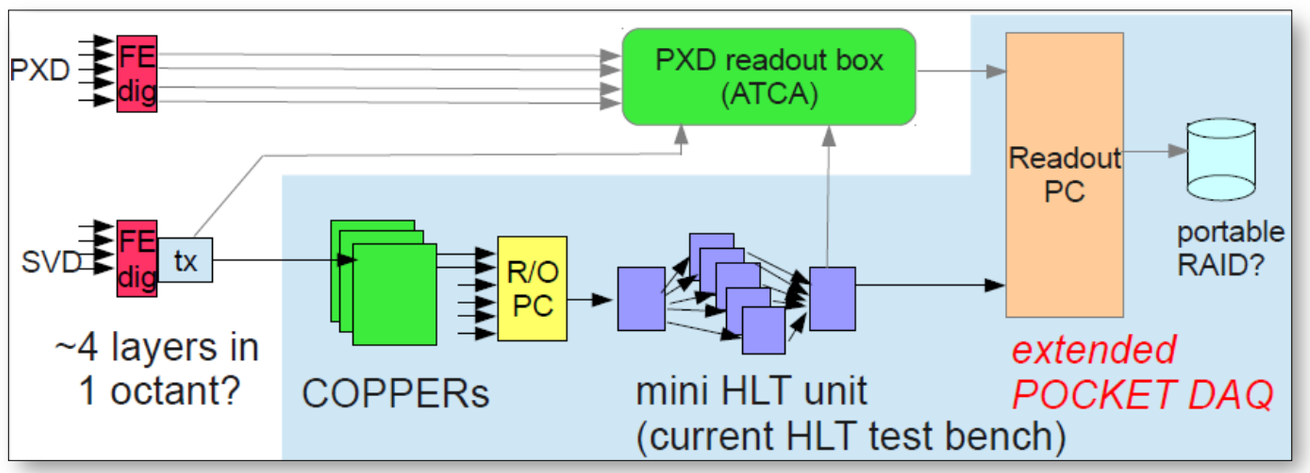
PCMAG @ TB24/1



Integration of PXD DAQ into Belle II DAQ



„Pocket“ DAQ for telescope test



Belle II PXD Detector Control and Monitoring

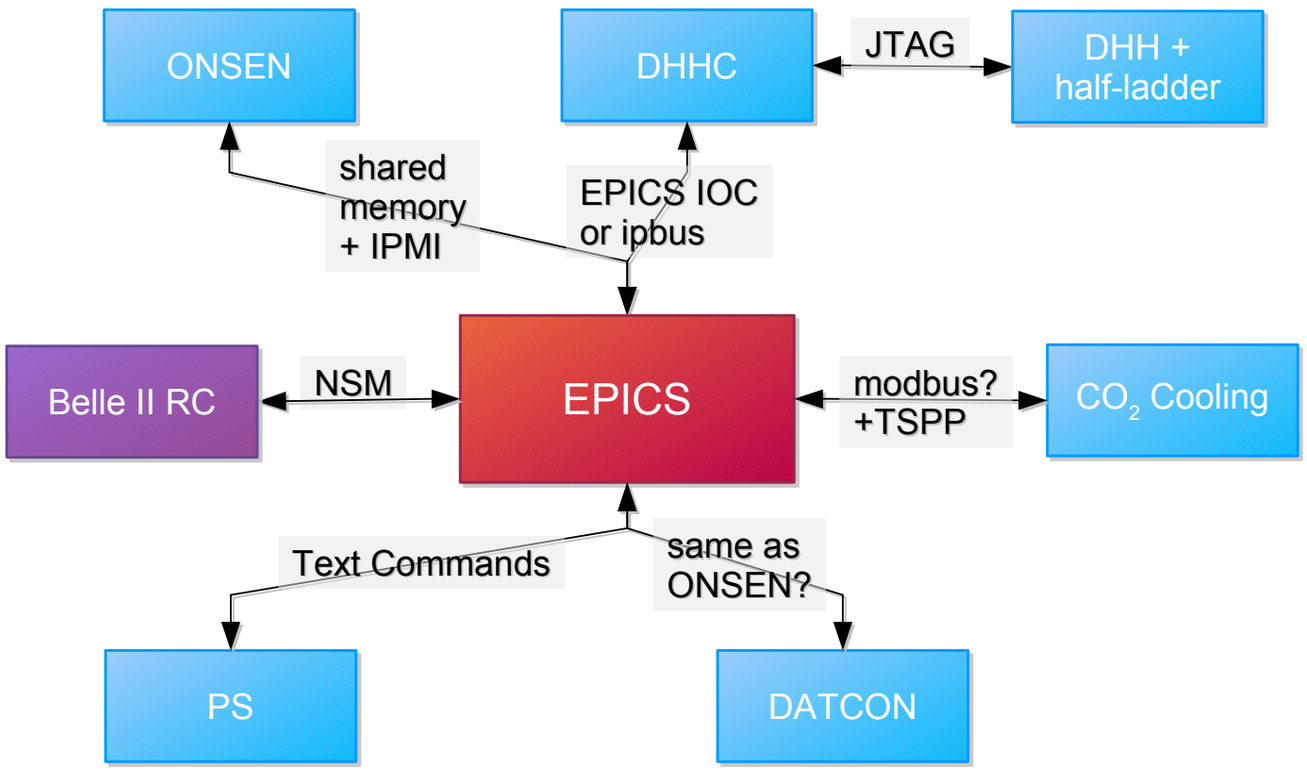
A.Campbell

- Project Organizer left end of June 2012
  - DESY temporarily takes task (until Ziti Heidelberg can take over in 2013)

- Decisions reached (Bayrischzell PXD DAQ and Belle II trigger workshop July 2012)
  - **use EPICS** (experimental physics and industrial control system) from ANL
    - mature open source control system with wide user base
    - experience in labs (DESY-cryo , superKEKB accelerator)
  - **use CSS** (control system studio) as operator interface
    - modern approach (uses Java/Eclipse)
    - initiated by UniHH/DESY, now also ORNL/BNL and in use at KEK
  - online histograms in “express reco” after event building
  - pedestal update using 1Hz full-frame events prior to top up injection

Belle II PXD Detector Control and Monitoring

A.Campbell

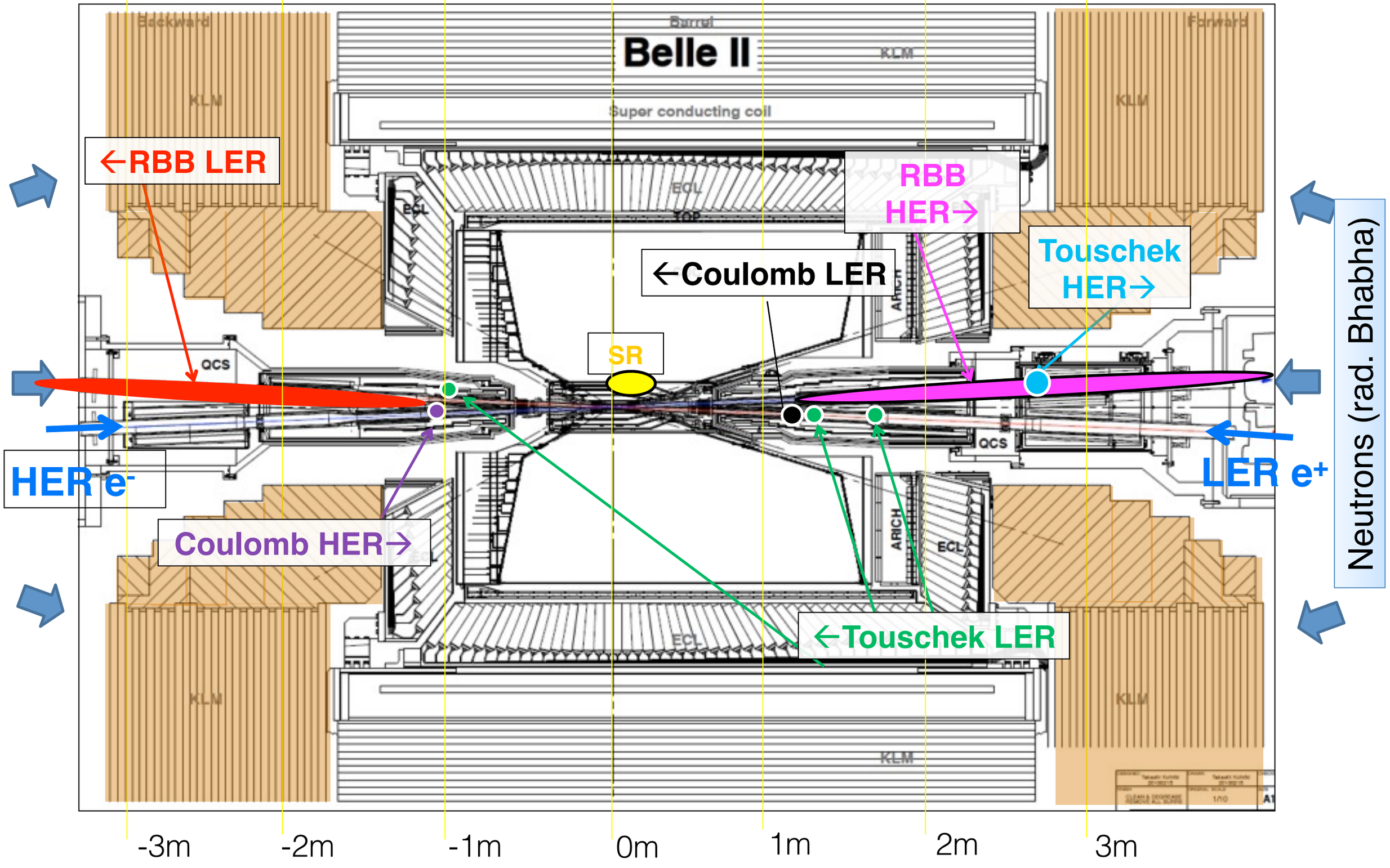


- EPICS must be interfaced to all PXD hardware
  - ASICS/FPGA/Power Supply/Cooler
- Aim: deploy at DESY telescope test in November 2013
- Personpower available is critical
  - TUM Informatics group joins
- Planning meeting at TUM Munich 8.11.12

- DHHC/DHH will use IPBUS (CMS software+firmware for control of FPGA)
  - development of EPICS-IPBUS interface started at DESY
- CO_2 cooler control: CERN meeting 10.9. identified a UNICOS-EPICS port as best solution
  - needs personpower

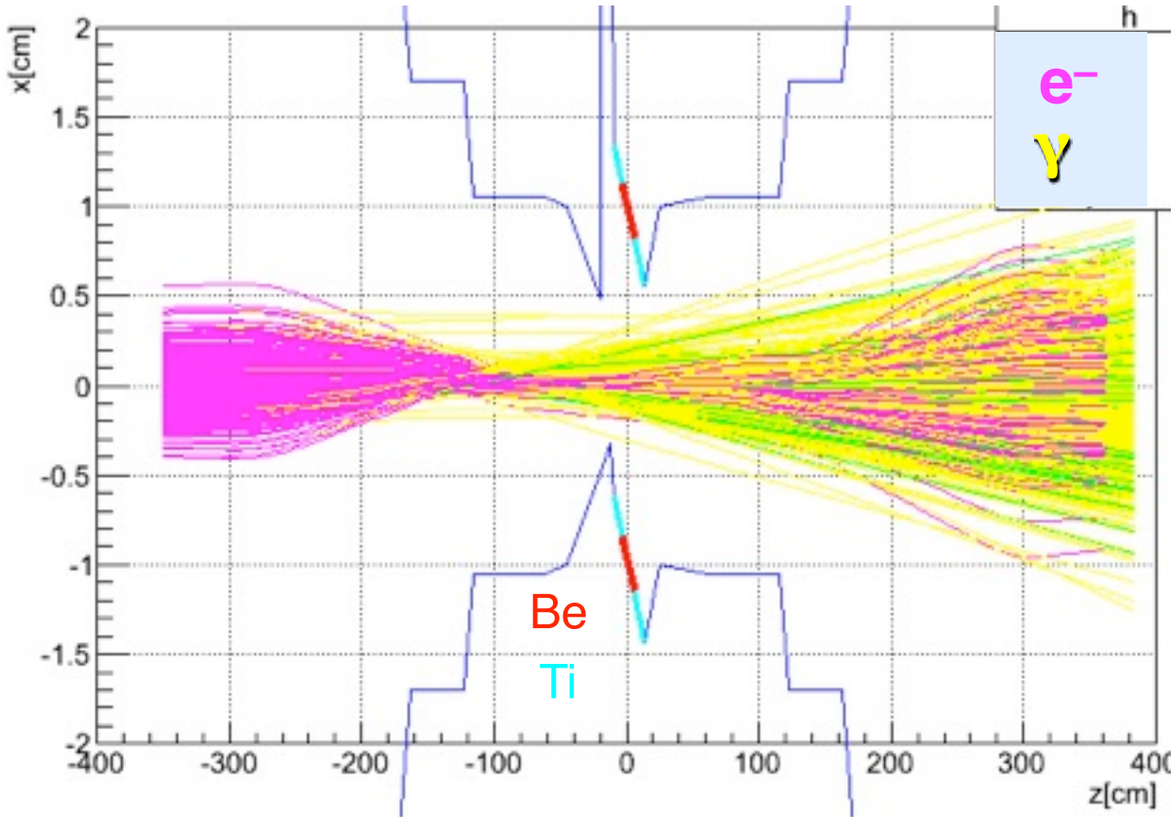
Background at SuperKEKB

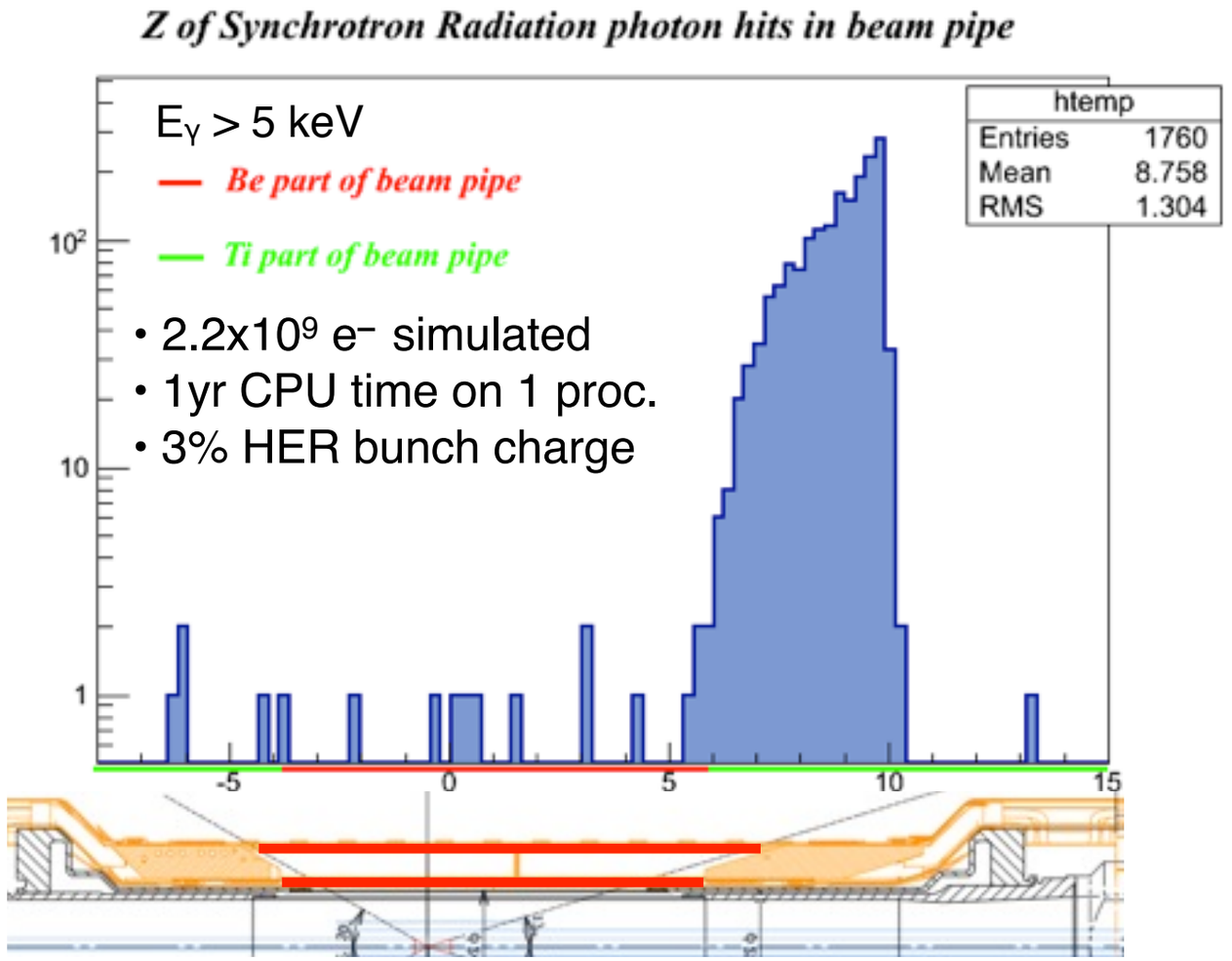
40x higher luminosity also means much higher background levels



Status of Synchrotron Radiation Simulation

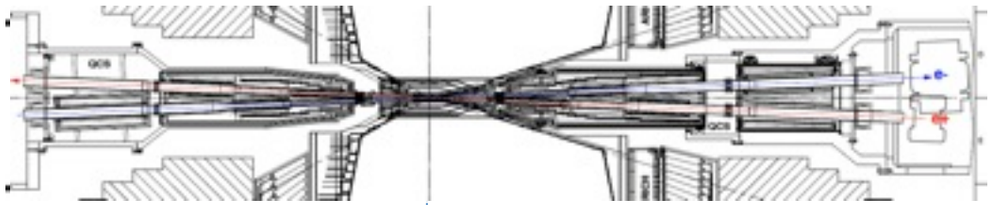
Y. Soloviev, B. Lobodzinski



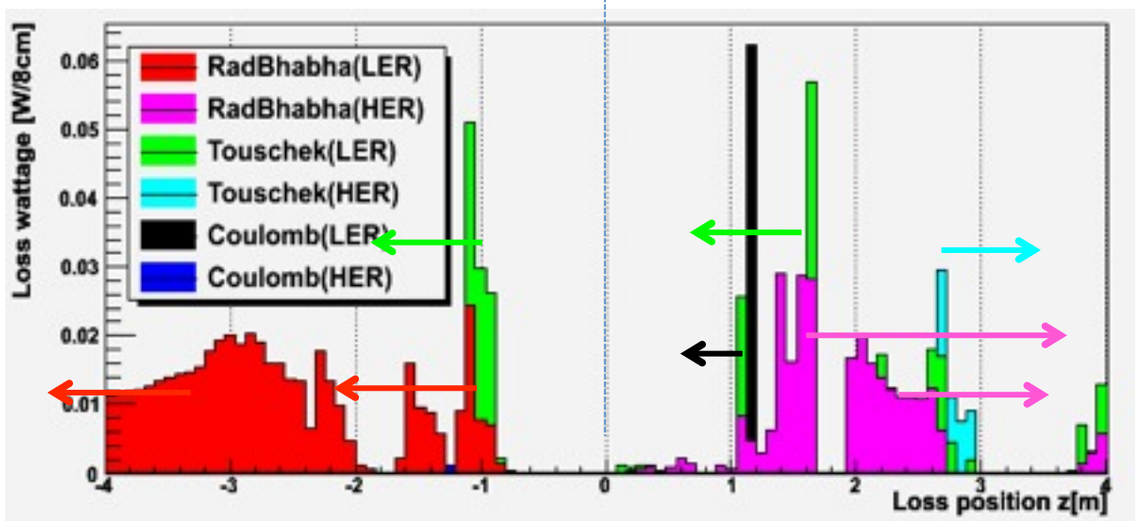


- With present statistics background level seems tolerable
- However, further studies are necessary
  - still rather limited statistics - need to further speed up simulation
  - use final optics and magnetic fields (3D)
  - estimate sensitivity to mis-alignment and orbit shifts
  - include fluorescence effect
  - estimate amount of tip-scattering

Background Simulation and QCS Design



HER (e-)

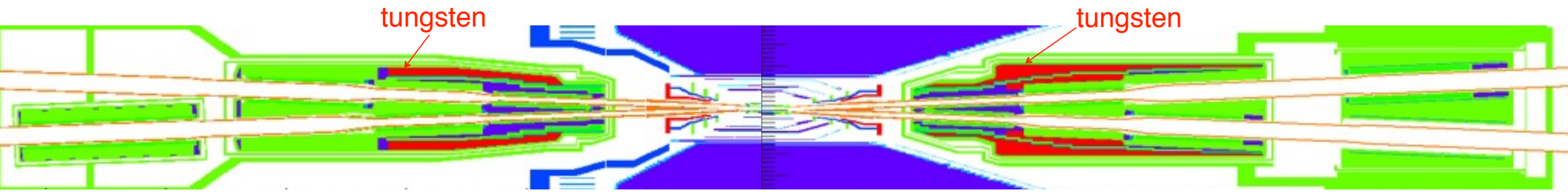


LER (e+)

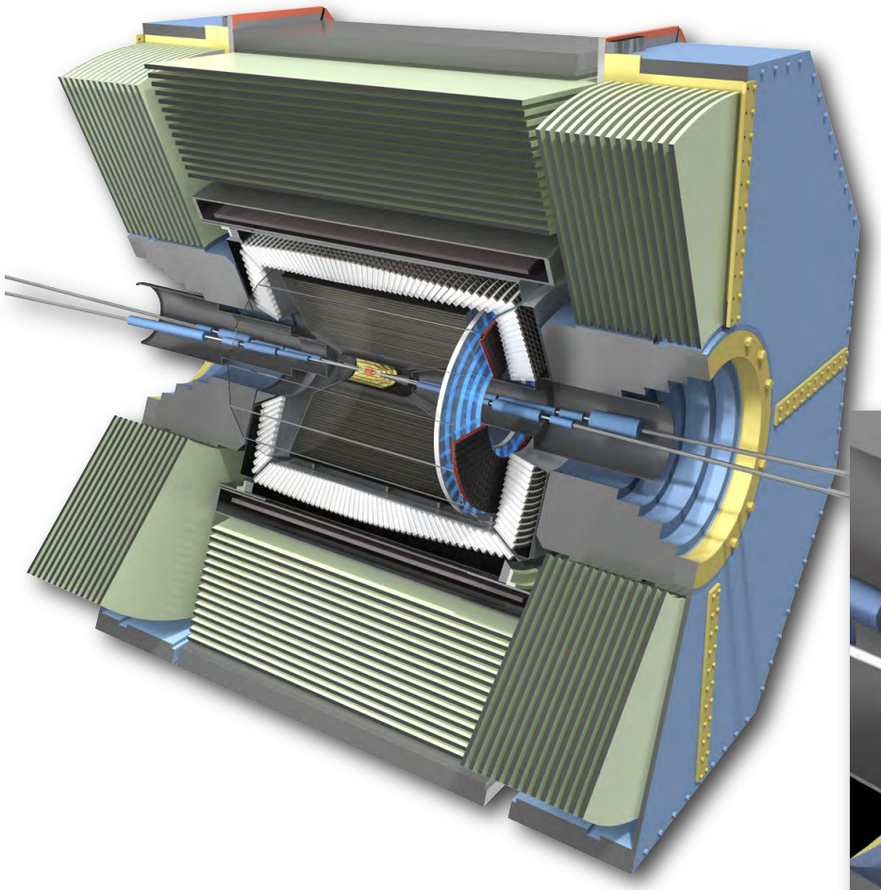
	LER (4GeV e+)	HER (7GeV e-)
Rad. Bhabha	0.45 W (eff. 0.7GHz)	0.28W (eff. 0.24GHz)
Touschek	0.16 W (0.25GHz)	0.03 W (0.03 GHz)
Coulomb	0.06 W (0.09GHz)	0.001W (0.001GHz)

1GeVx1GHz = 0.16W

- Background from Radiative Bhabha
  - wider QCS body allows more shielding
  - but less space between CDC and QCS
- Main remaining problems
  - TOP-PMT lifetime
  - ECL pile-up noise

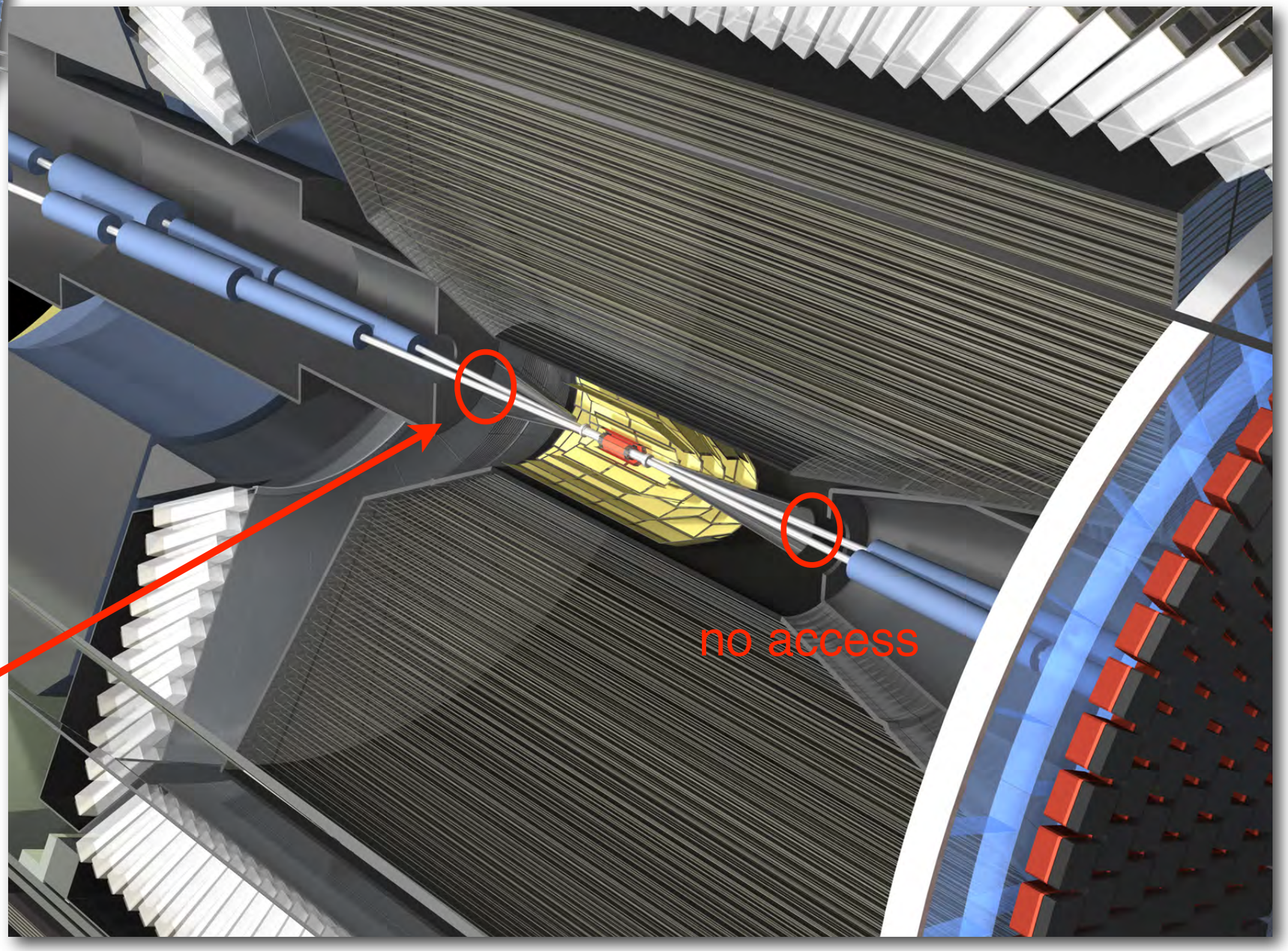


Space Constraints around IP

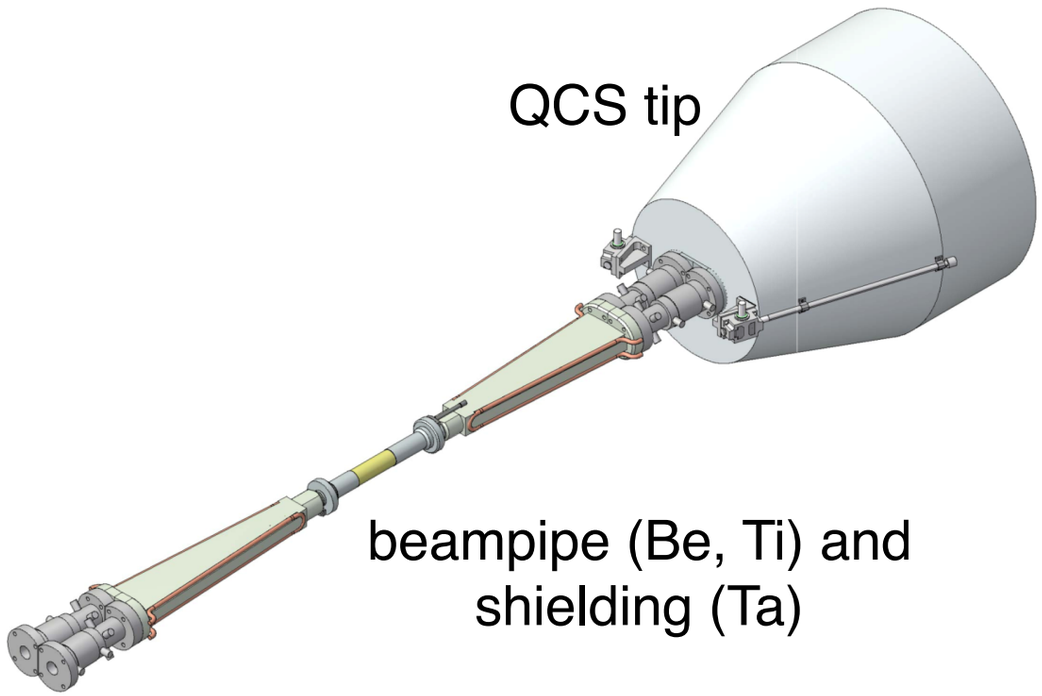


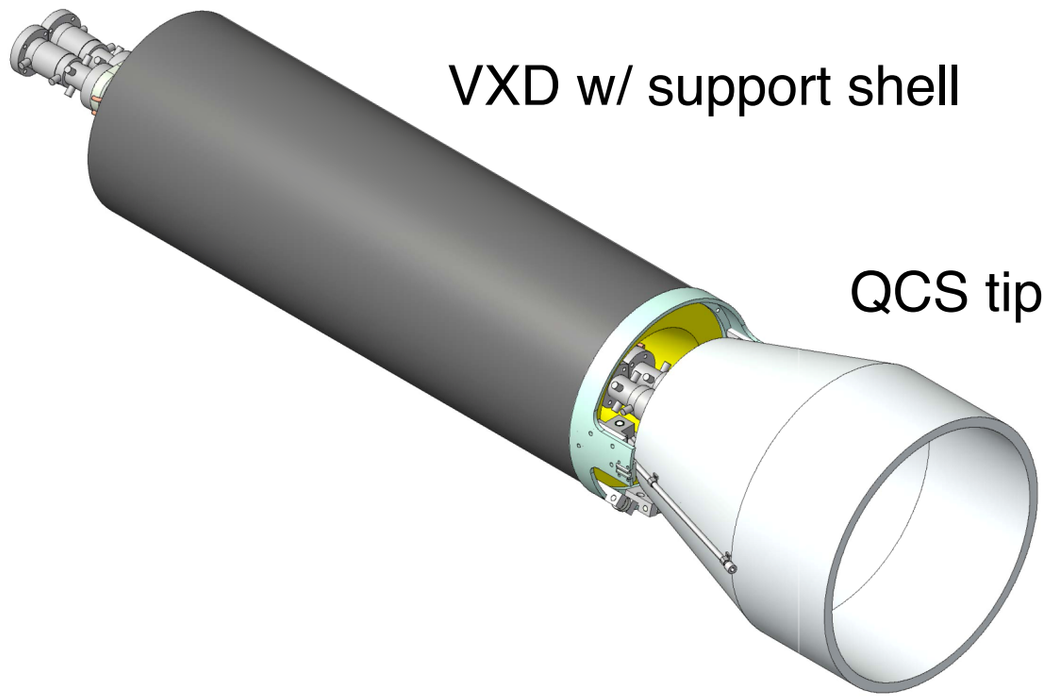
- Extremely tight space constraints around IP
  - due to crossing angle and nano beam optics
  - recent modifications of final focus quads (QCS) for background reduction

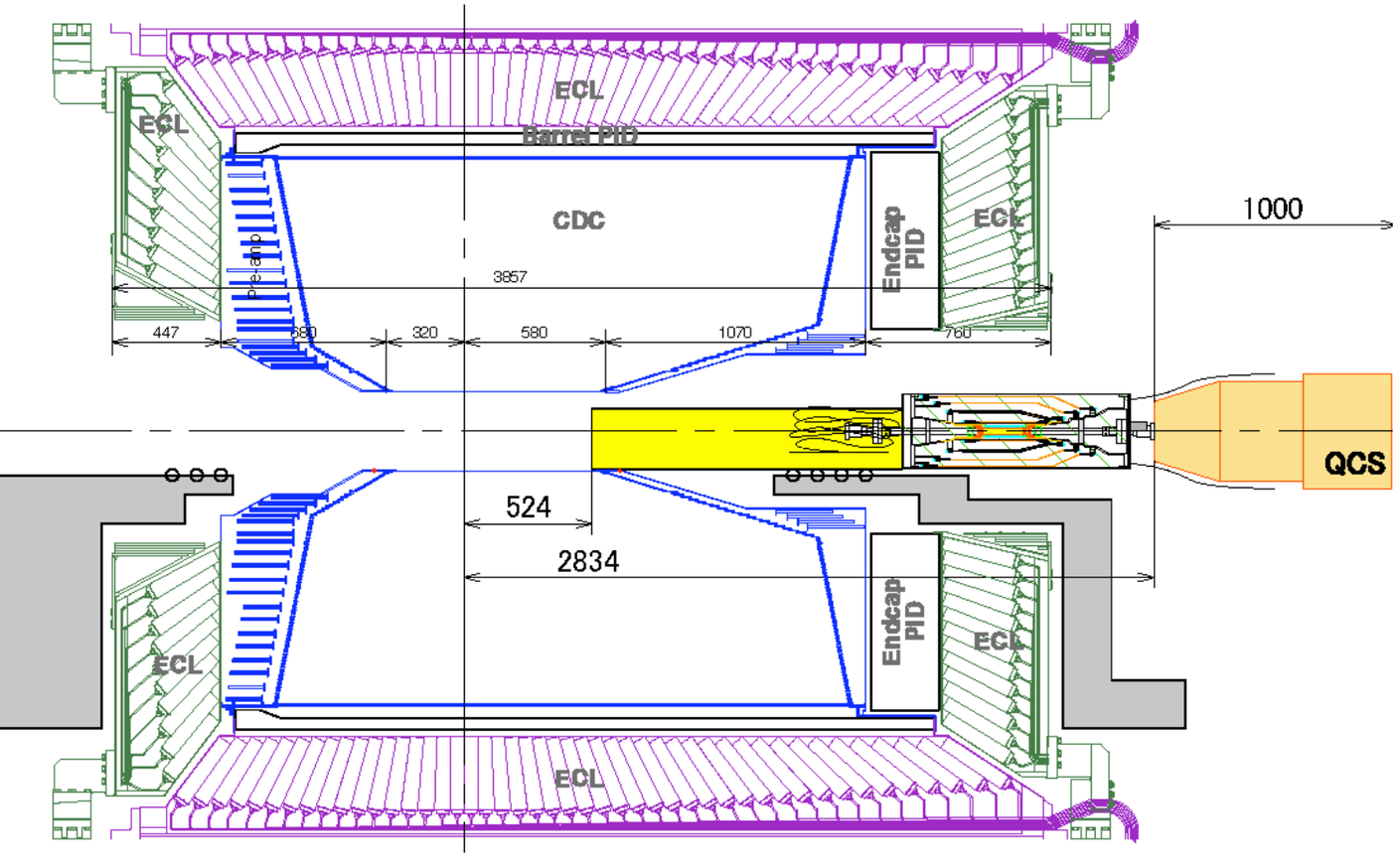
Only very limited or even no access possible to vacuum flanges between IR and QCS beam pipes on left side



Baseline VXD Installation Scenario







Remote Vacuum Connection

K. Gadow

- Recent QCS modifications prevent access to vacuum flange also on left side
- Proposal for a remote vacuum connection
  - hydraulic bayonet closure mechanism
- Detailed discussions with machine experts
- Decided to produce prototype at DESY
- Concept presented at BPAC meeting at KEK on October 1st
  - seen as essential element for VXD installation procedure
- Last components for mock-up arrived at DESY end of October

Remote Vacuum Connection

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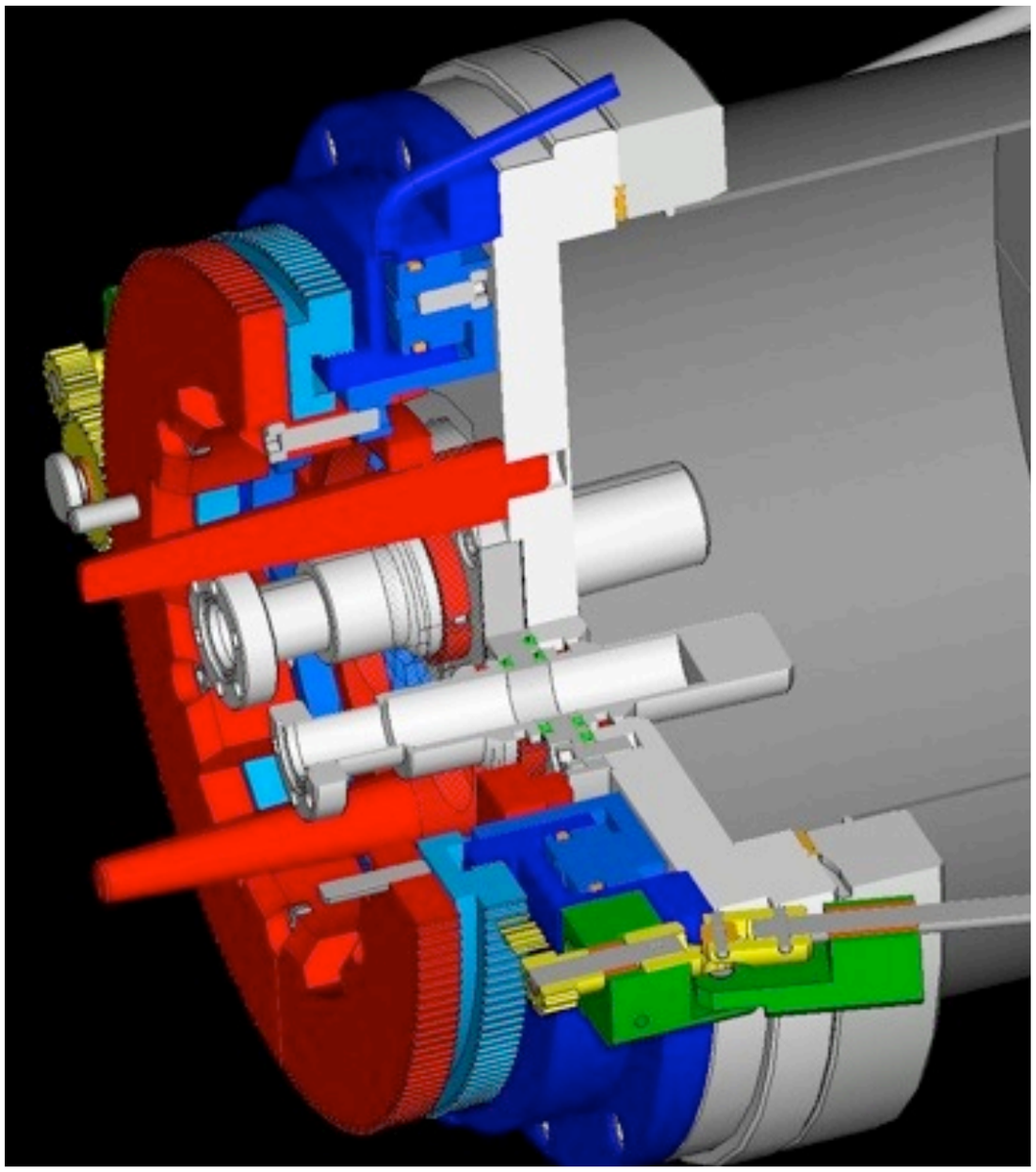

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Very critical component at interface between machine and experiment

Remote Vacuum Connection

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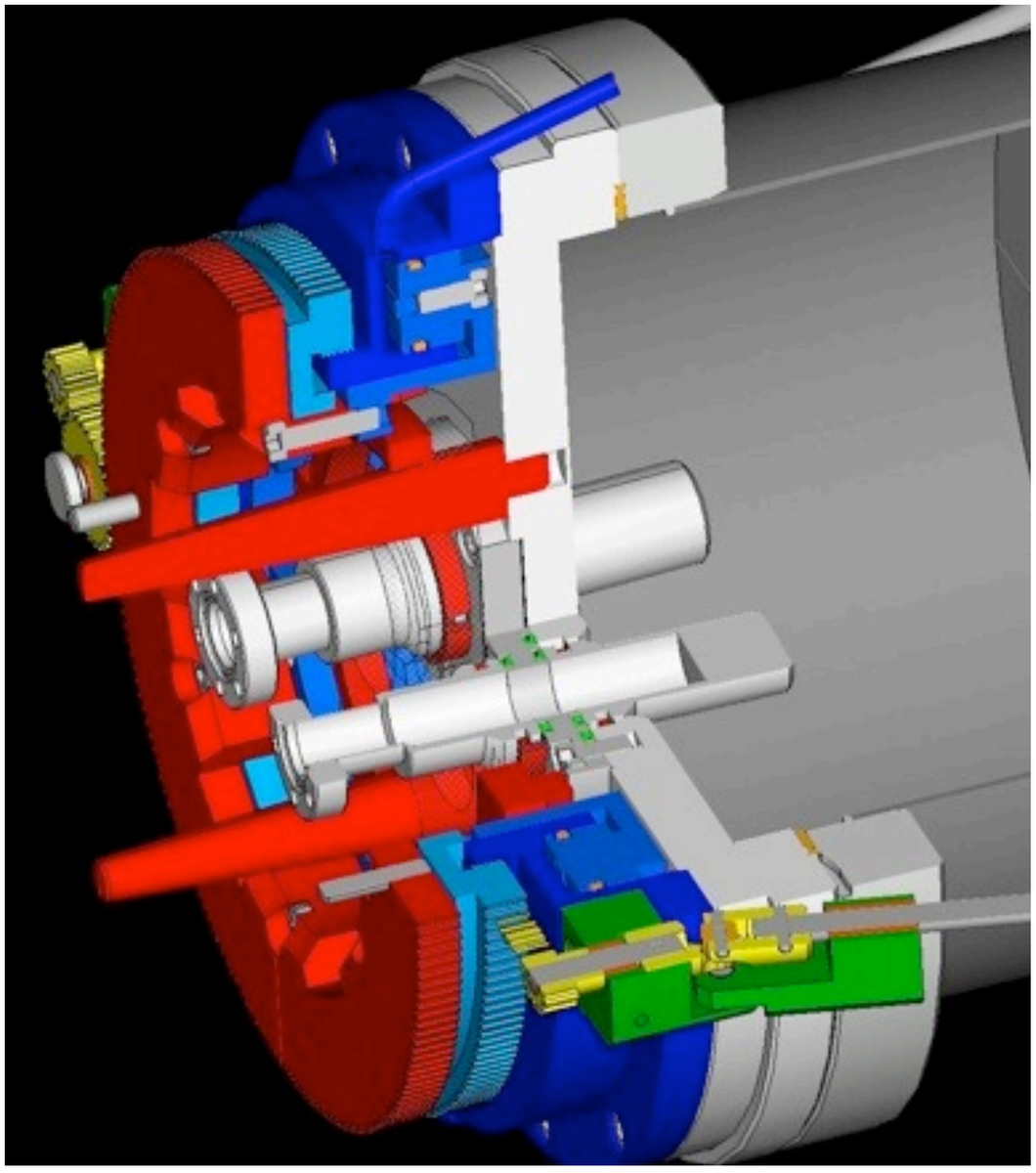
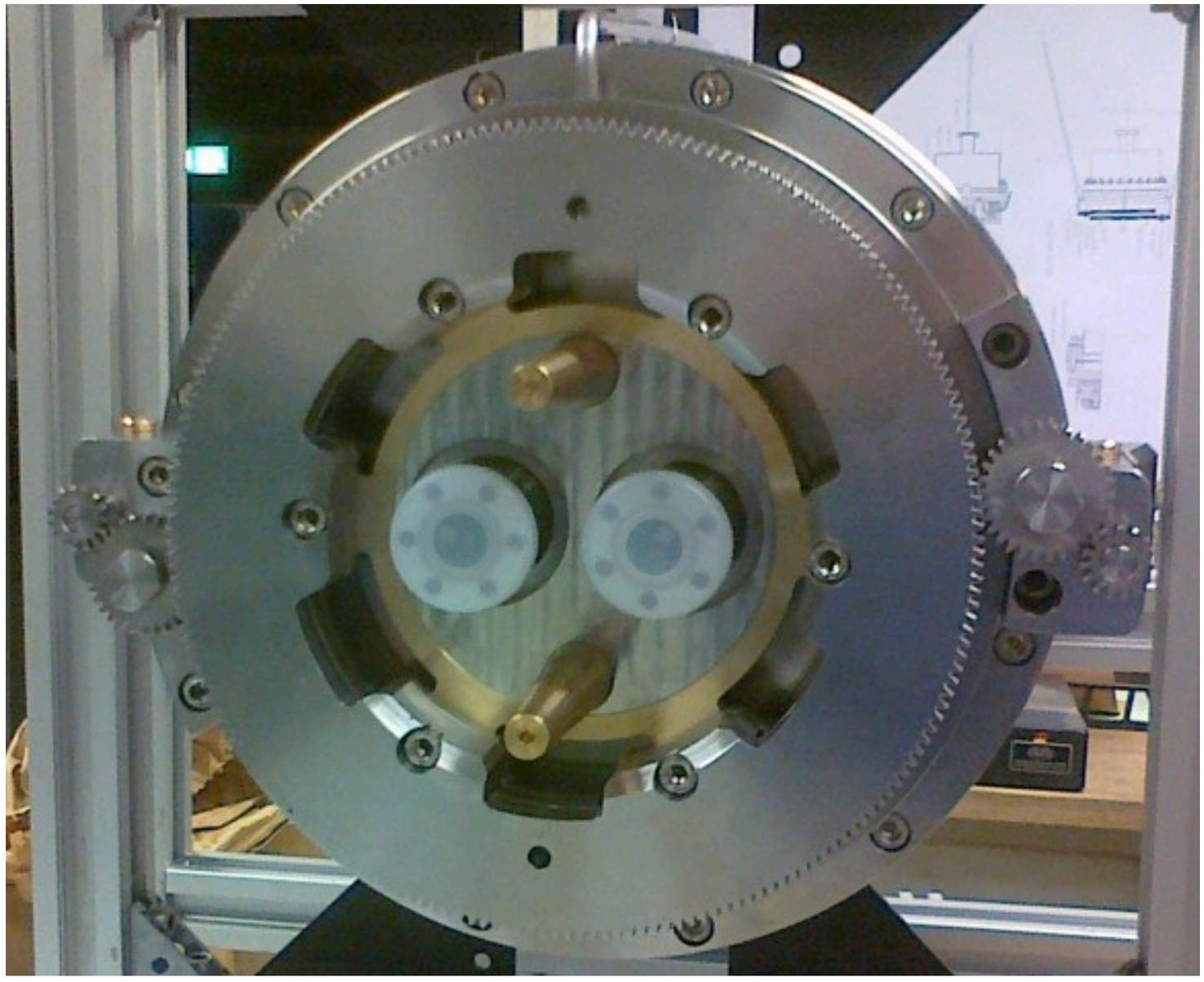




Very critical component at interface between machine and experiment

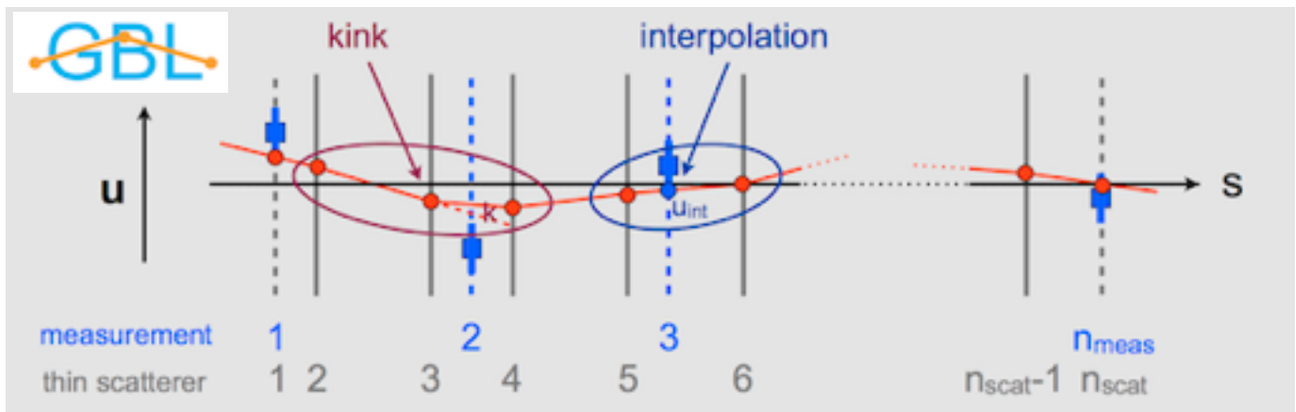
- First tests with mock-up ongoing right now
  - verify basic functionality
  - optimize design
  - demonstrate longterm reliablity

Tracker Alignment & Calibration

- Tracker alignment and calibration with MillePede using General Broken Lines interfaced via GENFIT

  C.Kleinwort, S.Yaschenko

  - track refit using GBL providing input for Millepede II MPII



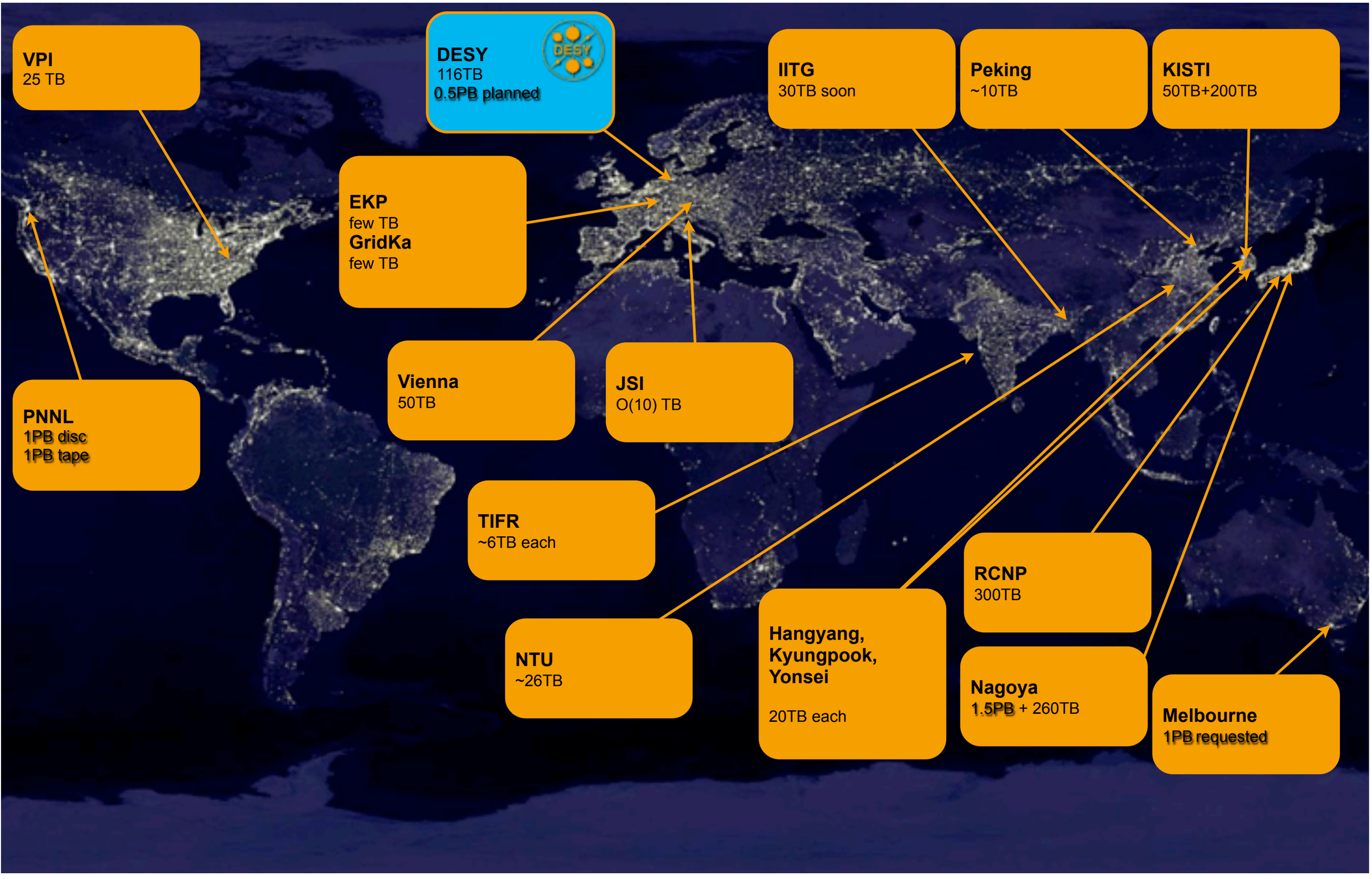
- Implementation of GBL in GENFIT almost finished - next steps:
  - study with Belle II Monte Carlo events
  - decide on common data format for both Belle I and Belle II
    - Cracow to provide Belle I data for alignment tests (SVD – CDC)
- Belle II alignment taskforce recently installed by Belle II management
  - charge
    - define which and how much data are needed for alignment. What are requirements on the design of detector hardware and trigger?
    - align detectors at least as good as Belle I was on day 1
    - develop automatic update procedure of alignment constants
  - Sergey Yaschenko agreed to lead the group

Belle Computing at DESY

M.Steder, T.Ferber

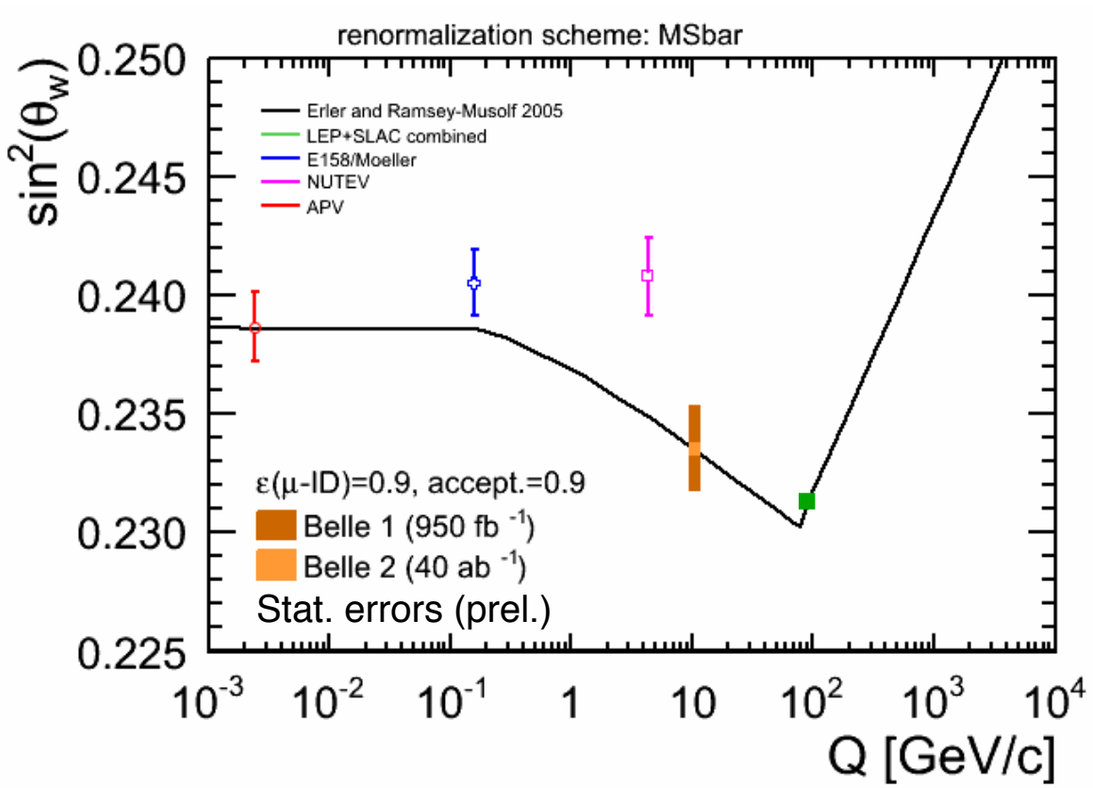
- Full local installation of Belle I & II software releases
  - accessible on all DESY computers and batch systems
  - physics analyses with Belle I data recently started at DESY
- DESY Belle group early adopter of NAF 2.0 infrastructure
  - fruitful and effective collaboration with DESY-IT
  - analysis activities strongly supported by DESY
    - workgroup servers as part of the NAF 2.0
    - access to NAF batch system
    - large scale storage to host full Belle I data set
  - NAF resources are open to all German Belle groups
- Data Preservation Activities
  - DESY was asked to participate in Belle DPWG (M.Steder)
    - DPWG installed end of August 2012, in consequence of a sizeable data loss at KEK
  - '`all-mdst`'-files will form basis of Belle DP project
    - files for 330fb^{-1} available / approx. 550fb^{-1} will have to be re-produced from raw data
    - Belle DPWG advocates duplication of data (outside of KEK)
  - DESY offered to host second copy of all Belle I '`all-mdst`'-files
    - 116TB added to DESY Grid SE, in total O(0.5PB) will be required
    - data will be accessible for local analyses (NAF 2.0)

Storage for Belle I Data Preservation (non-KEK)



Physics Analysis @ DESY

- DESY member of Belle I collaboration since July 2012
  - access to huge and high quality dataset corresponding to $\mathcal{L}_{\mathrm{int}} \approx 1\mathrm{ab}^{-1}$
  - new person power (postdoc, master student)
- As „newcomer“ DESY builds on extensive Belle analysis experience available in other German groups
  - e.g. attending „mini Belle analysis school“ recently organized by KIT, Karlsruhe
    - thanks to Anze Zupanc (charm WG convenor)
- First studies of potential analysis topics have begun
  - time-dependent analysis in charm sector (vacant Belle analysis)
    - search for D mixing/CPV in $D^0 \to K^+ \pi^- \pi^0$
  - measurement of weak mixing angle $\sin^2\theta_W$
    - challenge: reach $O(10^{-5})$ precision for A_{FB}
    - topic was presented in Tau/2Photon WG
  - detailed discussions at next weeks Belle collaboration meeting at KEK



Summary

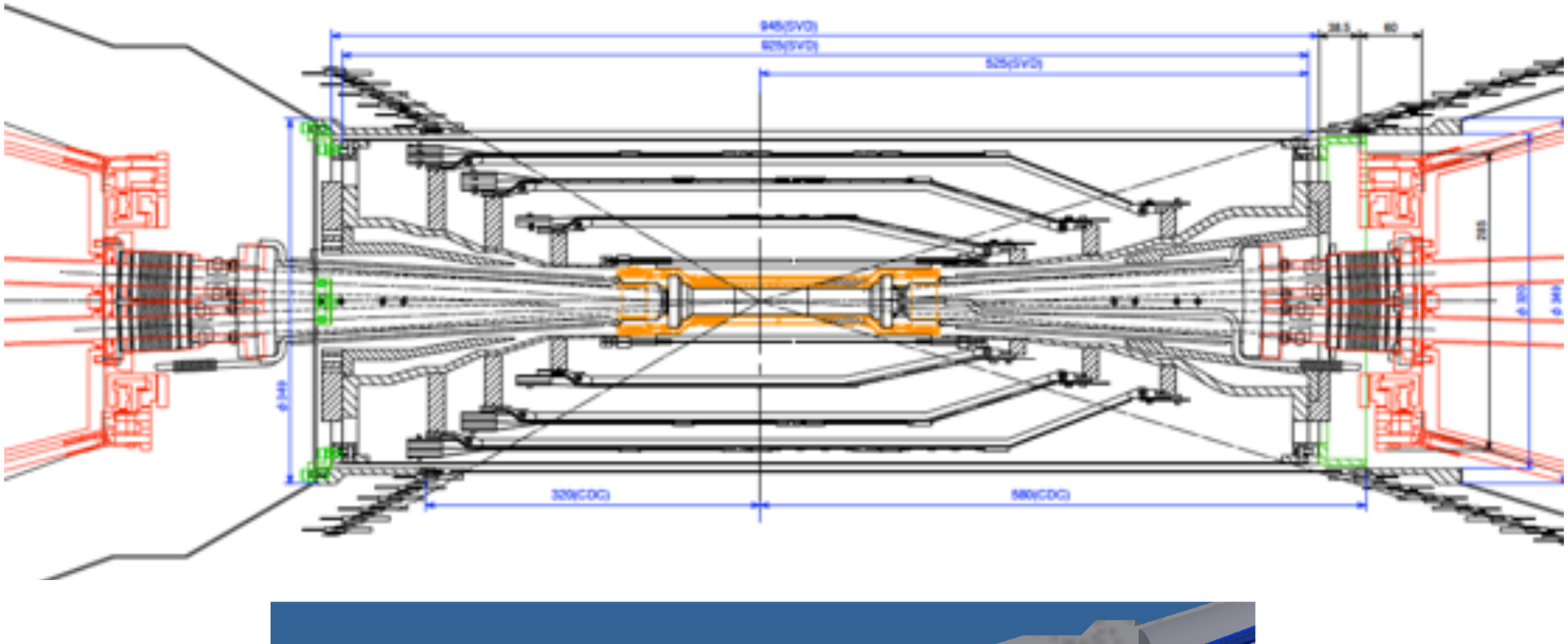
- DESY making significant contributions to Belle II upgrade
  - Hardware
    - VXD integration, **installation**, cooling
  - Software
    - DAQ / DQM / SC
    - tracker alignment and calibration
    - background simulation

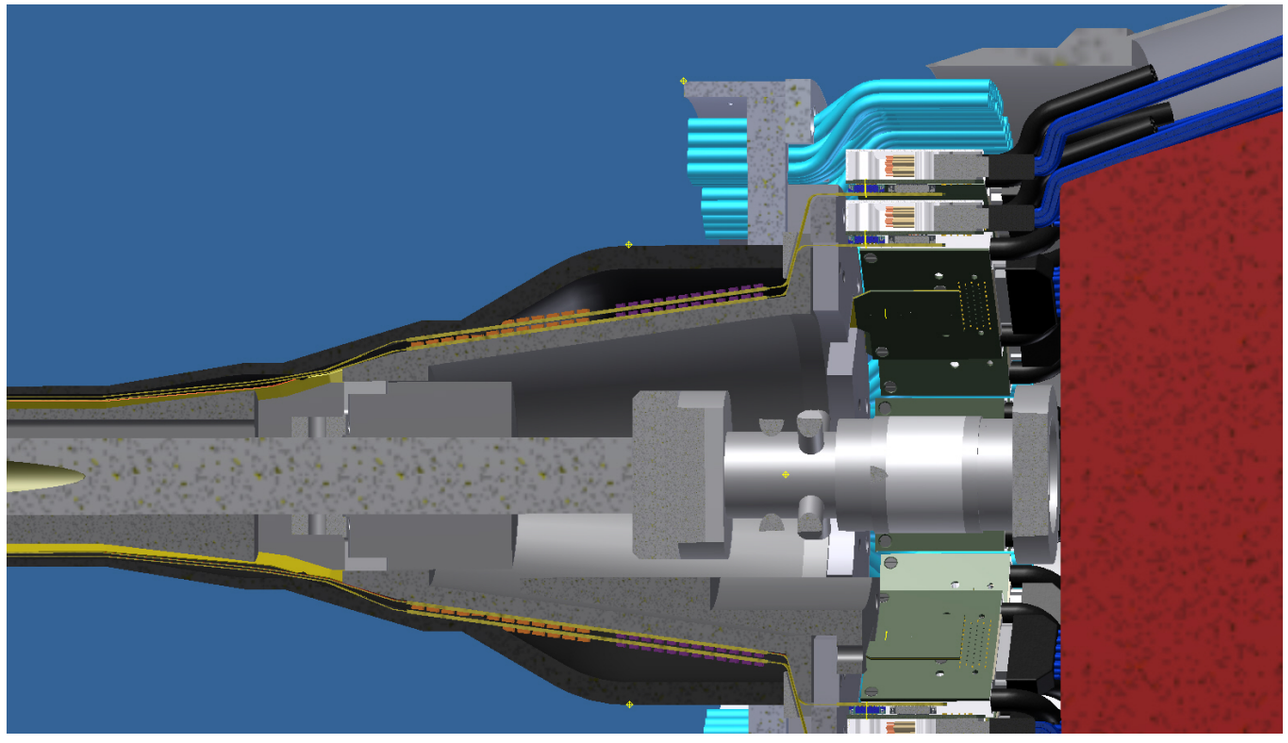
- DESY joined Belle I in July
  - providing computing support for Belle I/II
    - storage space as contribution to data preservation effort
    - GRID resources
    - NAF 2.0
  - physics analyses starting

Additional Information

Overall View of IR with RVC

top view



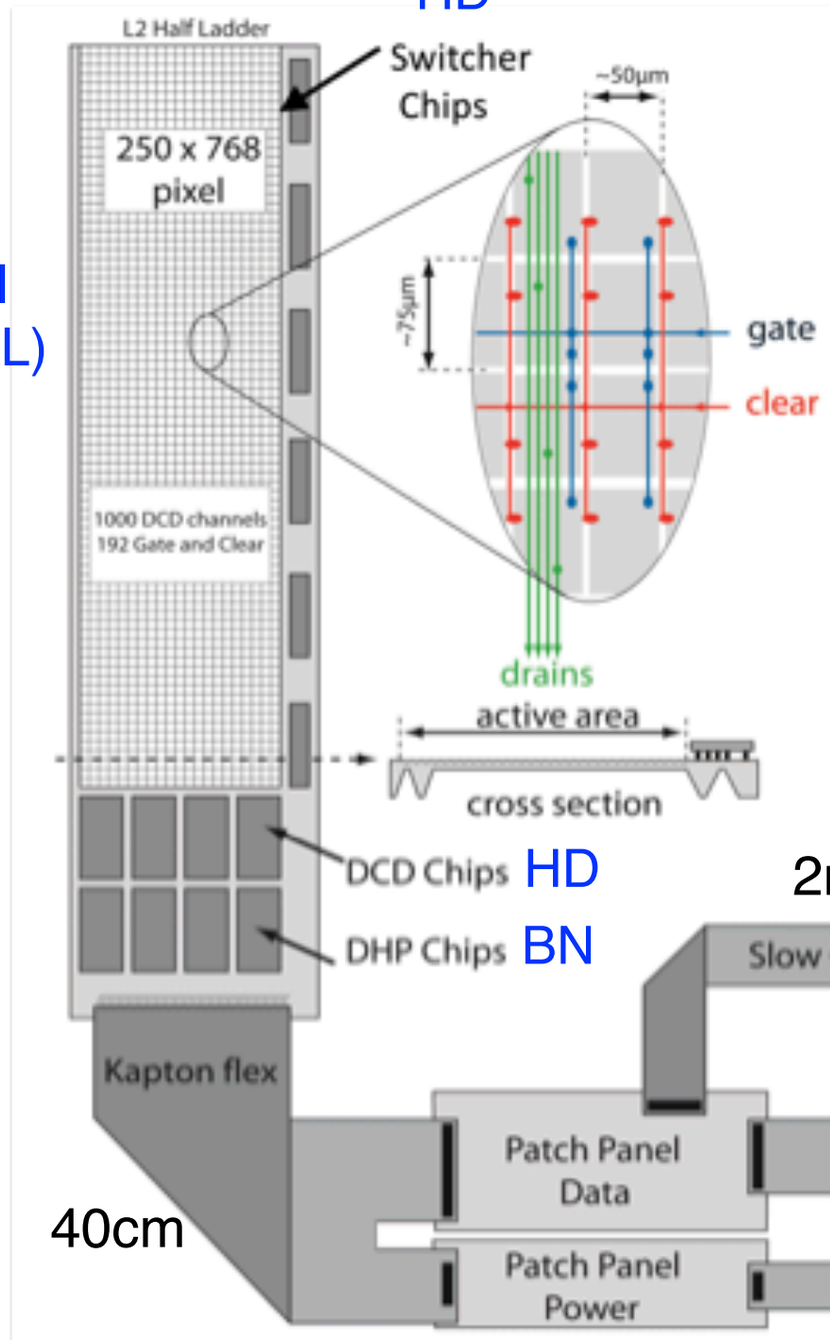


Present space conflict in forward direction with position of PXD patch panels has to be solved (MPI).

PXD System Overview

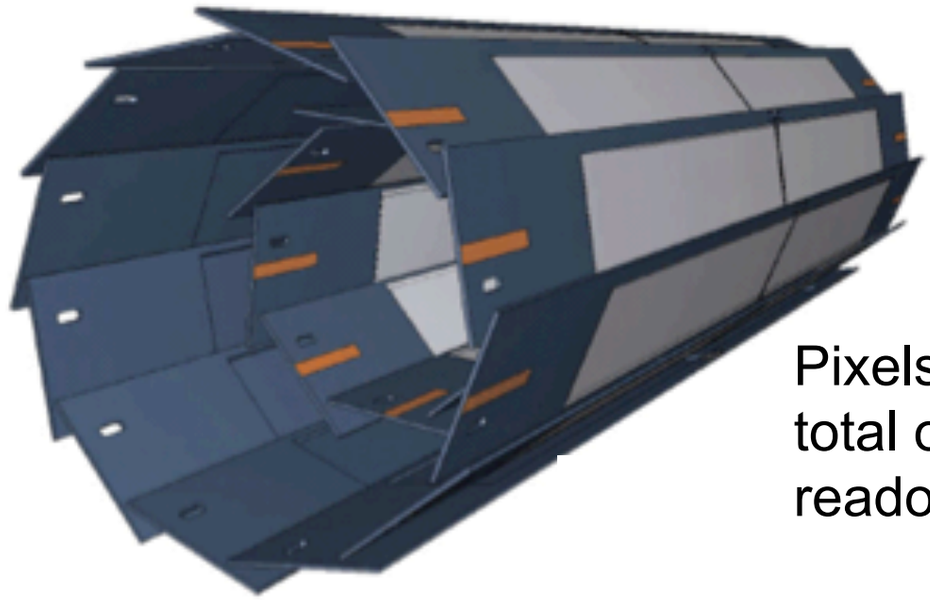
HD

MPI (HLL)



2 layers: @1.4(2.2) cm

Thickness: **75 µm, 2x0.2%X_0**



Mechanics, cooling:
DESY, MPI, IFIC

Pixels: 50 x 50(75) µm
total of 8 Mpx
readout: 20 µs

Switcher: Gate and Clear signals (rolling shutter mode: 100ns per pixel row)
DCD: Drain Current Digitizer
DHP: Data Handling Processor (common mode rejection, pedestal subtraction, zero-suppression)
DHH: Data Handling Hybrid (FPGA: clock, timming, trigger; conversion to optical; clustering)

PXD Milestones

Nr	Milestone	Deadline	ID	Status
1	ASIC prototypes available	March 2012	609	done
2	DEPFET PXD9 production start	July 2012	605	done
3	EMCM module fabricated	September 2012	626	
4	Mockups (mechanical and cooling)	December 2012	617	
5	Cable prototypes	December 2012	612	
6	Large PXD6 module available	December 2012	604	
7	PXD/SVD telescope test	October 2013	627	
8	Assembly tooling finished	December 2013	625	
9	All production ASICs available	March 2014	610	
10	Services (cables) available	March 2014	621	
11	DAQ and DHH available	March 2014	622	
12	Power supplies available	April 2014	623	
13	First production sensors available	September 2014	606	
14	Support ready	September 2014	624	
15	All sensors available	November 2014	607	
16	Ladder 0 (PXD9 prototype)	November 2014	628	
17	ATCA system at KEK	April 2015	631	
18	All ladders assembled:	May 2015	629	
19	PXD ready for integration	August 2015	631	