Overview of

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- Antiprotons at FAIR
- PANDA Overview
- Selected PANDA Systems
- Schedule and Conclusions

Antiprotons at FAIR

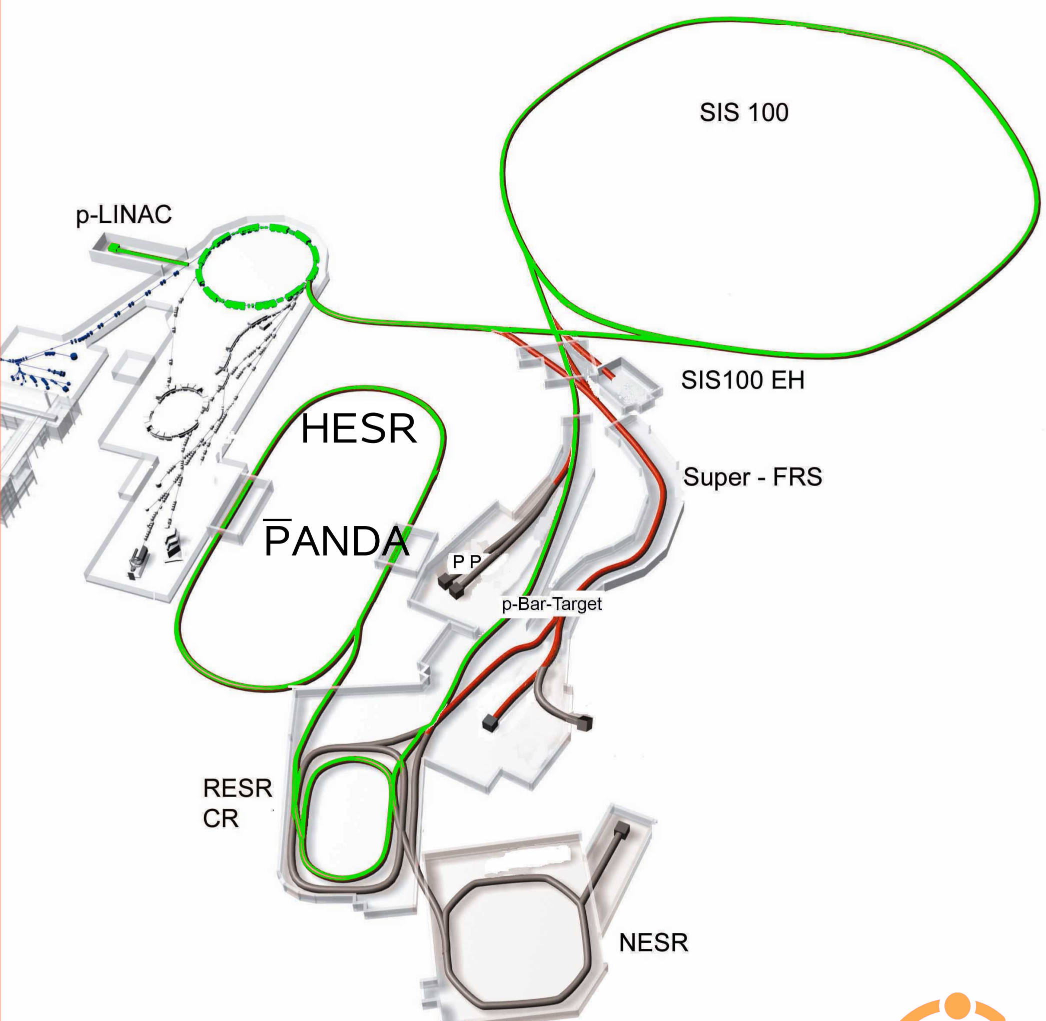
Antiproton production

- Proton Linac 70 MeV
- Accelerate p in SIS18 / 100
- Produce $\bar{p}$ on Ni/Cu target

- Collection in CR, fast cooling
- *Full FAIR*: Accumulation in RESR, slow cooling
- Storage in HESR and usage in $\overline{\text{P}}$ANDA at < 2×10^{32} $cm^{-2}s^{-1}$

Modularised Start Version

- RESR is postponed (Mod. 4)
- Accumulation in HESR
- 10x lower luminosity: 10^{31} $cm^{-2}s^{-1}$



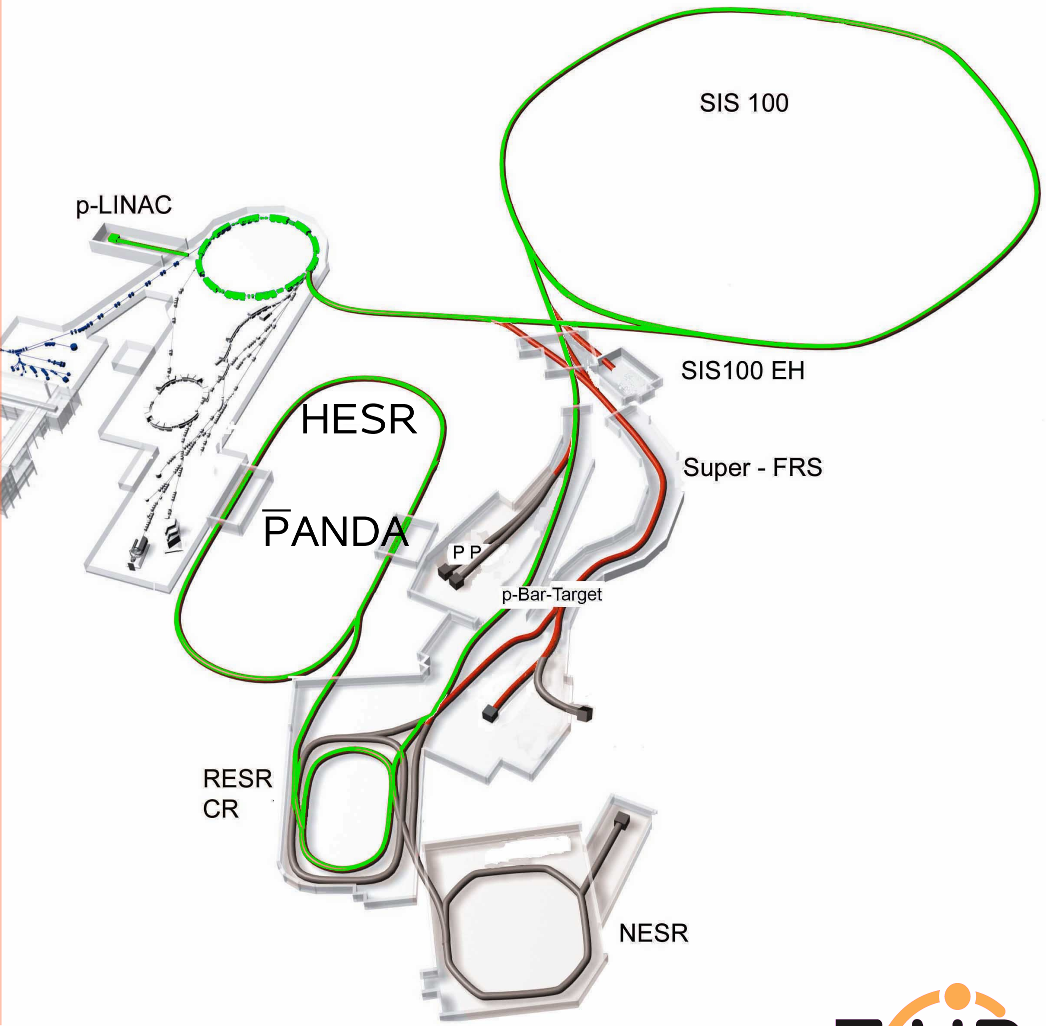
Antiprotons at FAIR

Antiprotons are unique:

- New dimension at FAIR wrt GSI
- Hadron physics bridges nuclear and HI physics to basic QCD
- No other $\bar{p}$ facility worldwide
- Successful predecessors have demonstrated the large potential

Unique precision at HESR:

- Stochastic beam cooling
  - ➔ $\Delta E \sim 50$ keV
  - ➔ Tune E_{CM} to scan resonances
- Annihilation at threshold



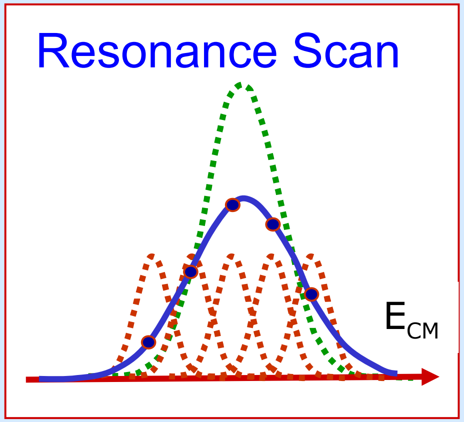
High Energy Storage Ring

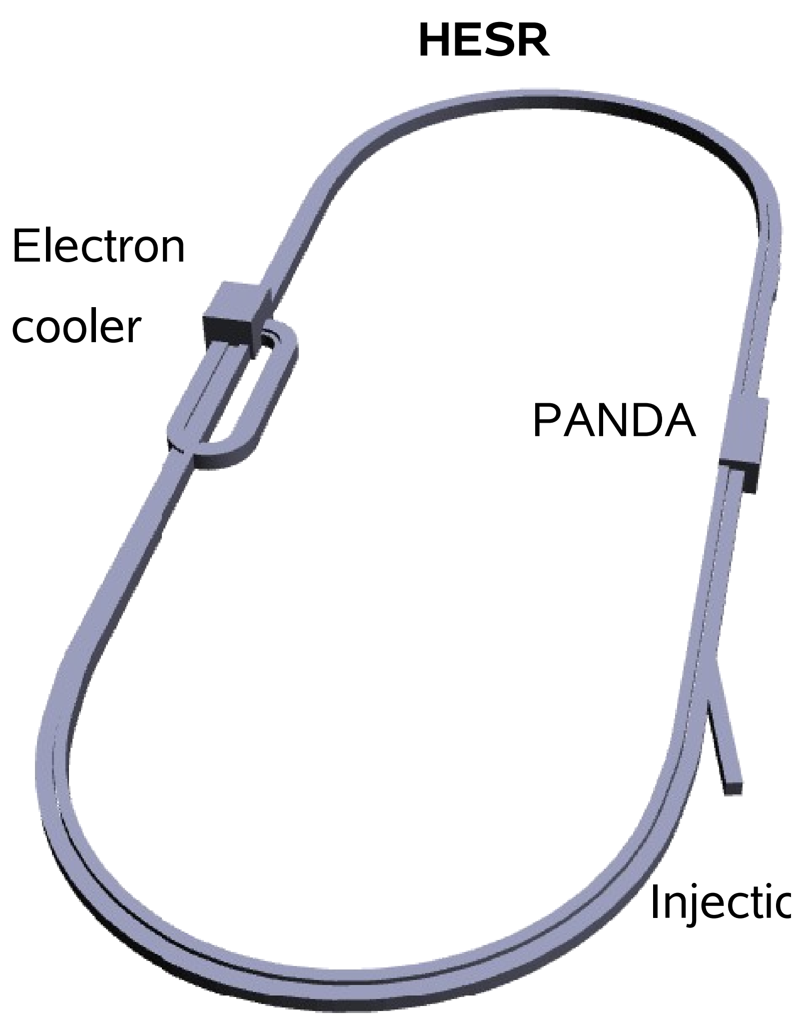
HESR Parameters

- Storage ring for internal target
- Initially also used for accumulation
- Injection of $\bar{p}$ at 3.7 GeV/c
- Slow synchrotron (1.5-15 GeV/c)
- Luminosity up to L~ $2x10^{32}$ $cm^{-2}s^{-1}$

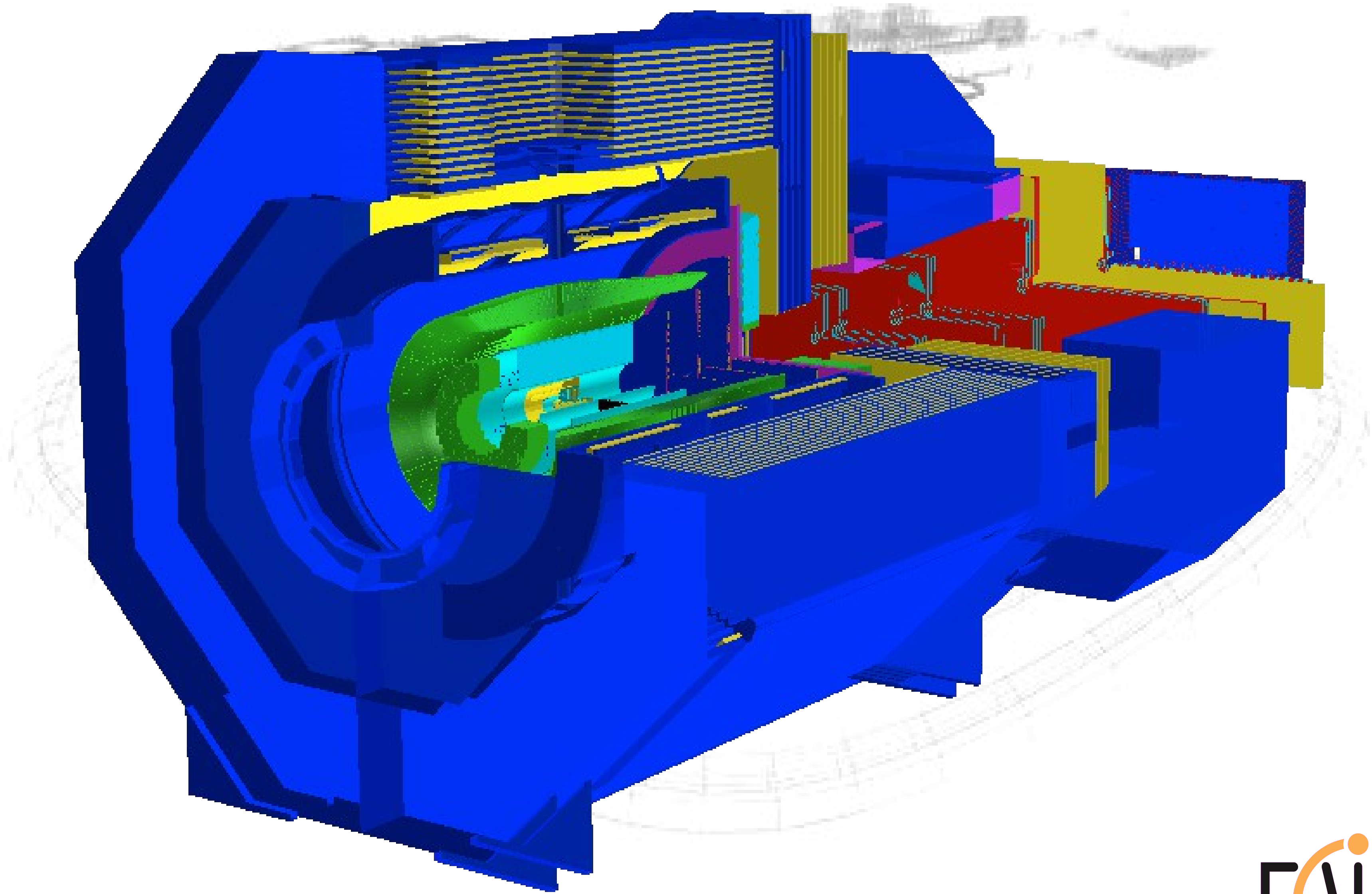
Mode	High luminosity (HL)	High resolution (HR)
$\Delta p/p$	$\sim 10^{-4}$	$\sim 4x10^{-5}$
L ($cm^{-2}s^{-1}$)	$2x10^{32}$	$2x10^{31}$
Stored $\bar{p}$	10^{11}	10^{10}

- Stochastic & electron cooling
- Resolution ~50 keV
- Tune E_{CM} to probe resonance
- Get precise m and Γ





$\overline{\text{P}}$ANDA Overview



PANDA Physics Objectives

HEP: interference of coupled channels

Spectroscopy

New narrow XYZ:
Search for partner states

Production of exotic QCD states:
Glueballs & hybrids

HEP: underlying elementary processes

Nucleon Structure

Generalized parton distributions:
Orbital angular momentum

Drell Yan process:
Transverse structure, valence anti-quarks

Timelike formfactors:
Low and high E, e and μ pairs

Bound States of Strong Interaction

Astro physics:
Strange n-stars

Strangeness

Strange baryons:
Spectroscopy
Polarisation

HI collisions:
comparing QGP to elementary reactions

Nuclear Physics

Hypernuclear physics:
Double Λ hypernuclei
Hyperon interaction

Hadrons in nuclei:
Charm and strangeness in the medium

Nuclear physics:
Hypernuclear spectroscopy

Physics Goals of $\bar{P}$ANDA

Hadron Spectroscopy

Experimental Goals: *mass, width & quantum numbers J^{PC} of resonances*

***Charm Hadrons**: charmonia, D-mesons, charm baryons*

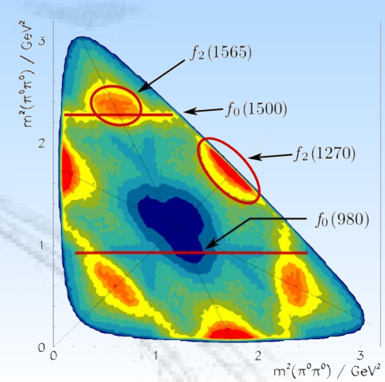
➔ Understand new XYZ states, $D_s(2317)$ and others

***Exotic QCD States**: glueballs, hybrids, multi-quarks*

Spectroscopy with Antiprotons:

Production of states of all quantum numbers

Resonance scanning with high resolution



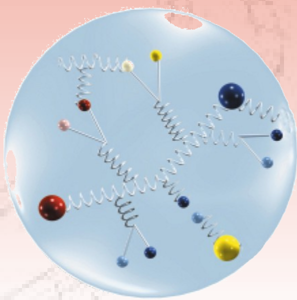
Hadron Structure

Generalized Parton Distributions

➔ Formfactors and structure functions, L_q

Timelike Nucleon Formfactors

Drell-Yan Process

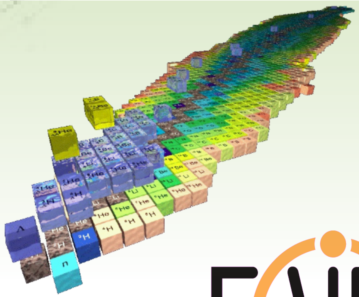


Nuclear Physics

***Hypernuclei**: Production of double Λ-hypernuclei*

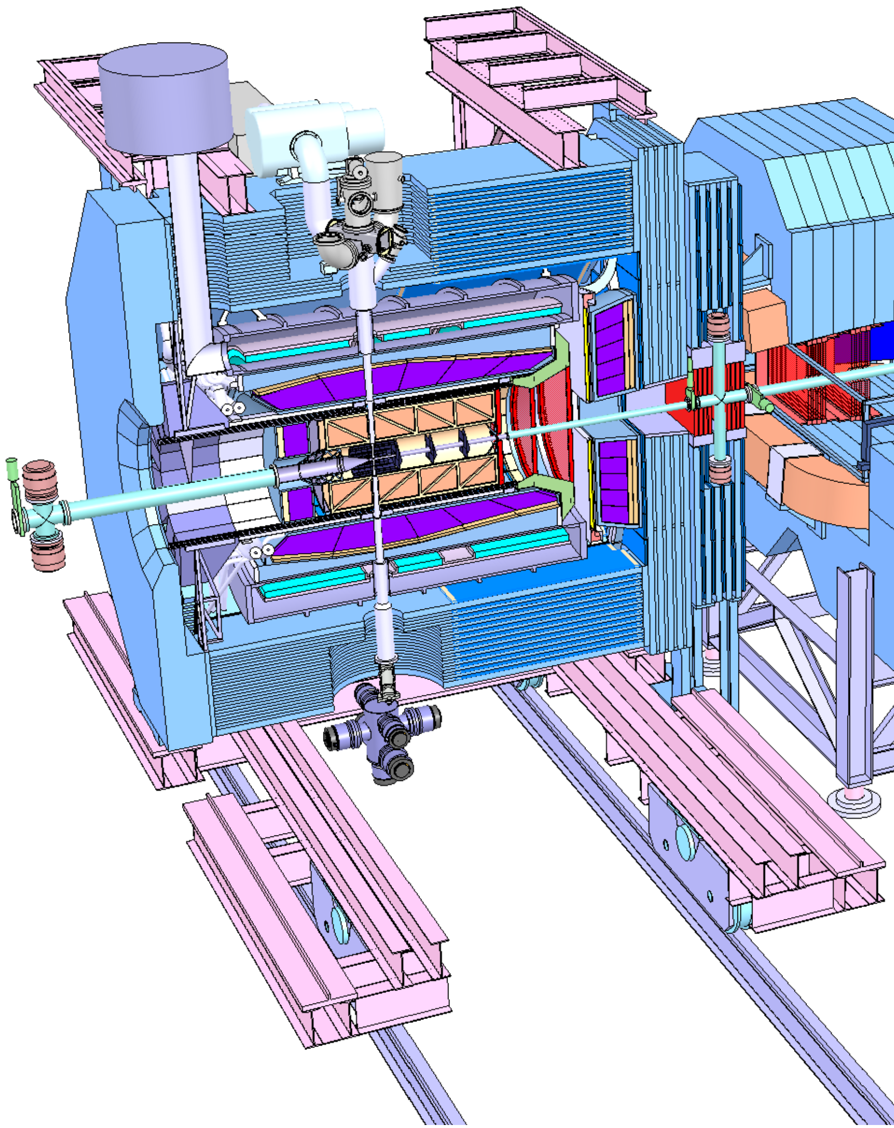
➔ γ-spectroscopy of hypernuclei, YY interaction

Hadrons in Nuclear Medium



FAIR

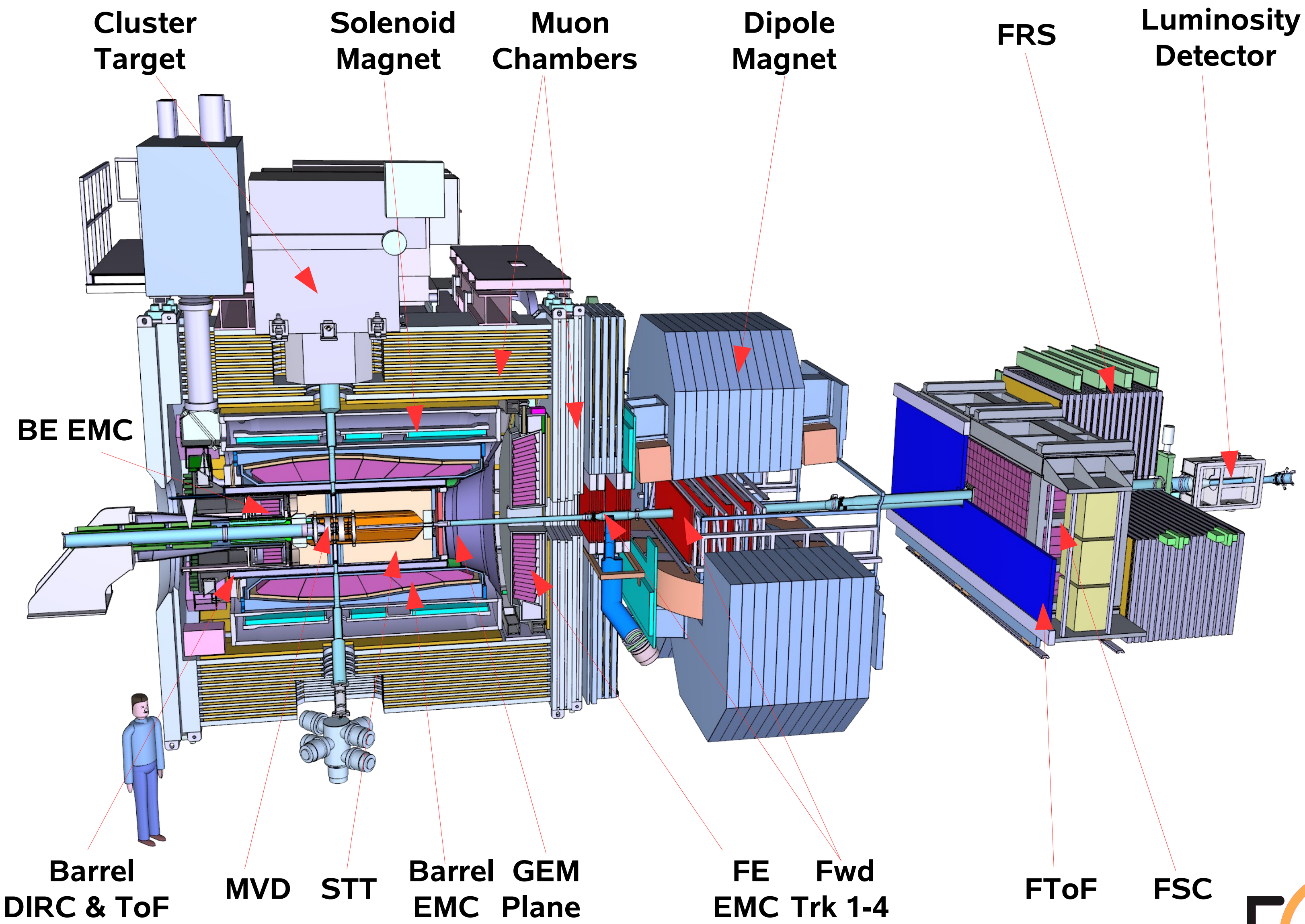
PANDA Spectrometer



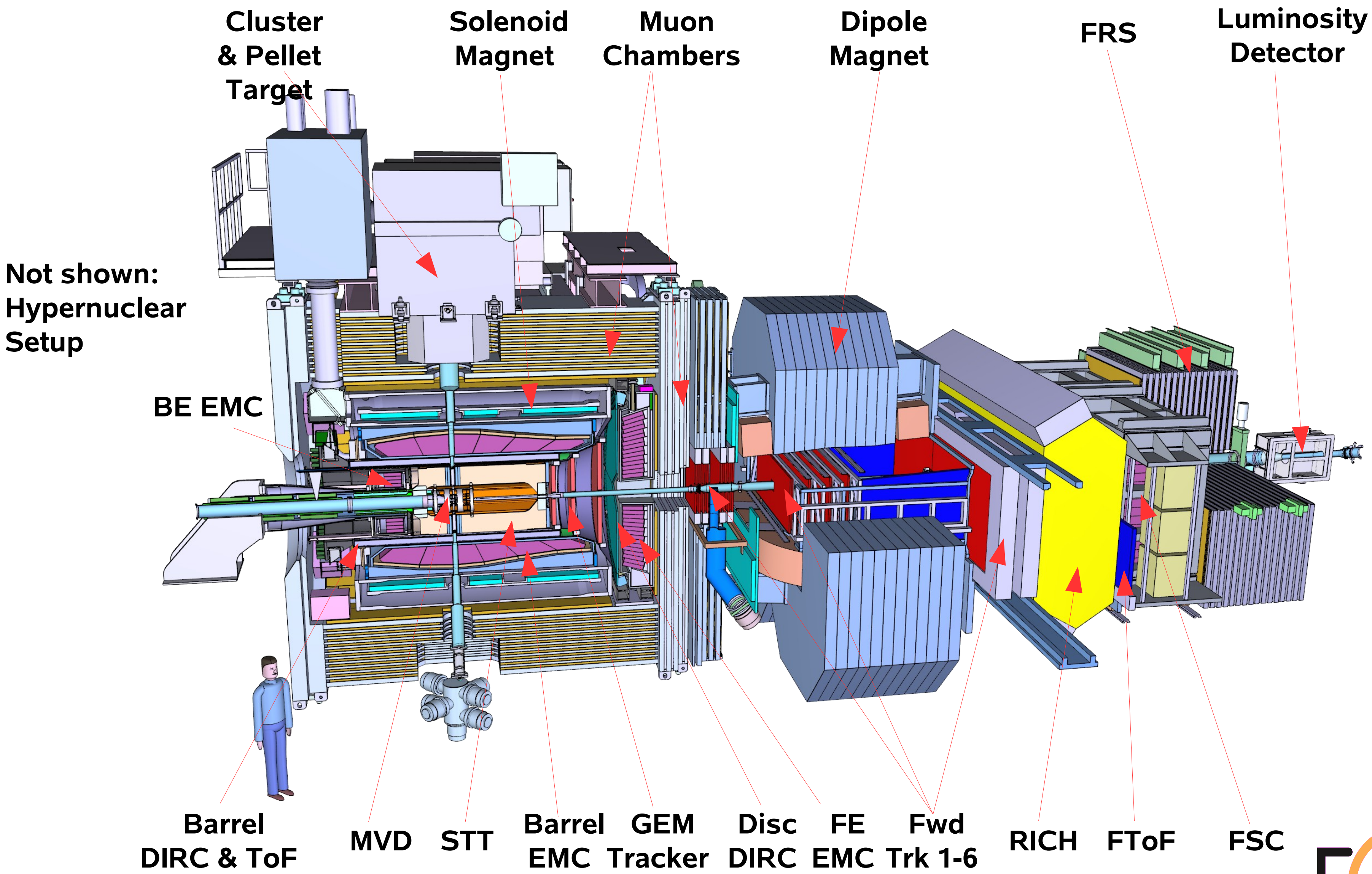
Detector requirements:

- 4π acceptance
- High rate capability:
  $2 \times 10^{7}\ s^{-1}$ interactions
- Efficient event selection
- *Continuous acquisition*
- Momentum resolution ~1%
- Vertex info for D, K^0_S, Y
  (cτ = 317 μm for $D^{\pm}$)
- *Good tracking*
- Good PID (γ, e, μ, π, K, p)
- *Cherenkov, ToF, dE/dx*
- γ-detection 1 MeV – 10 GeV
- *Crystal Calorimeter*

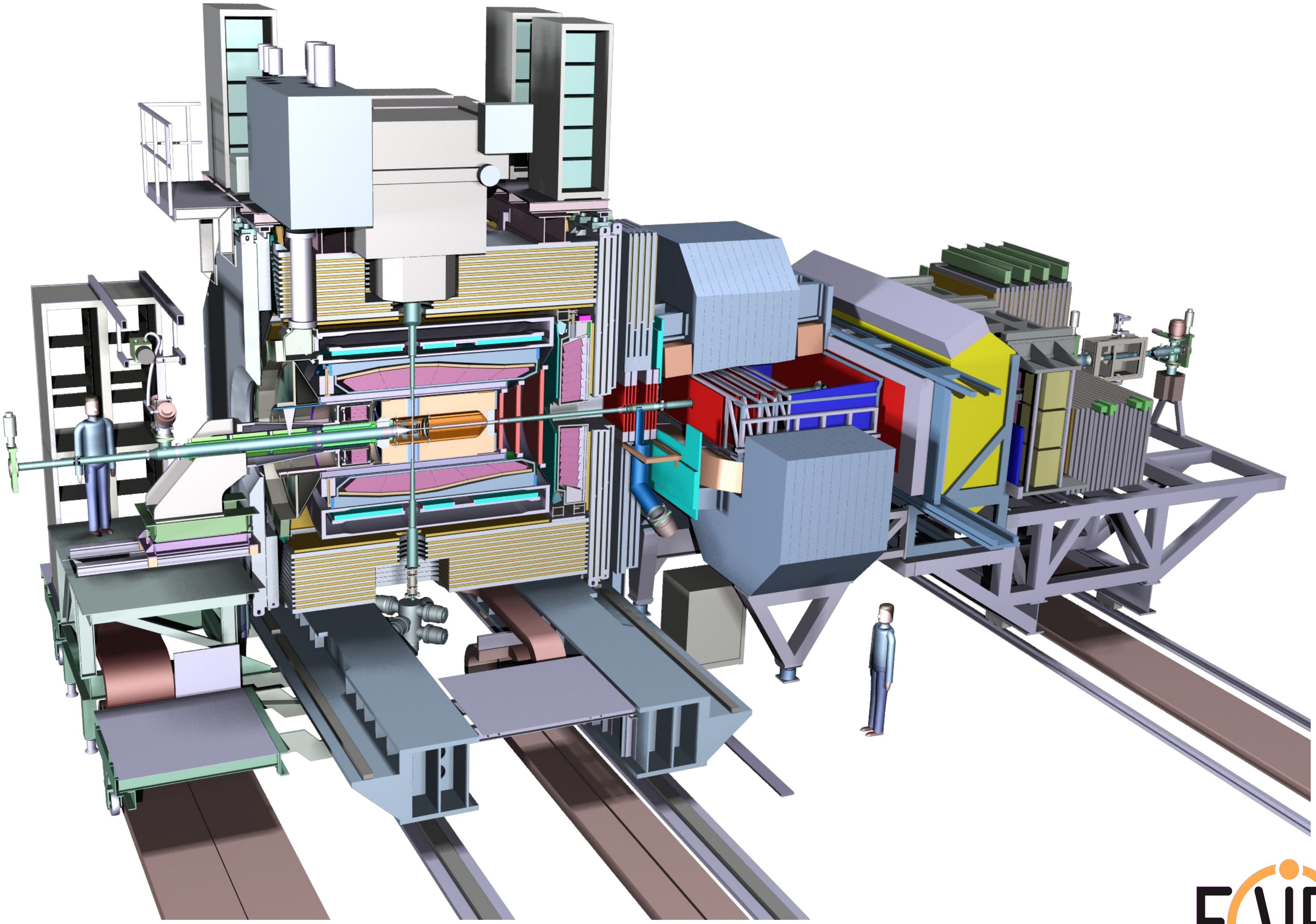
$\overline{\text{P}}$ANDA Start Setup



$\overline{\text{P}}$ANDA Full Setup



Selected $\overline{\text{P}}$ANDA Systems

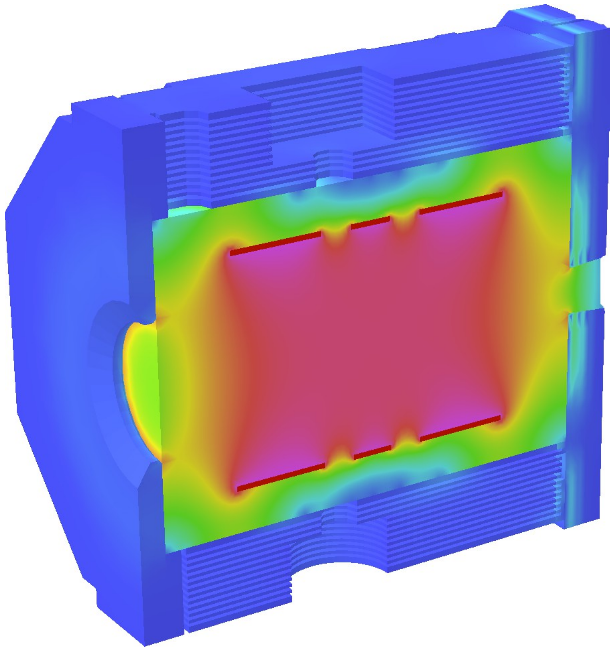


Magnets

Solenoid Magnet

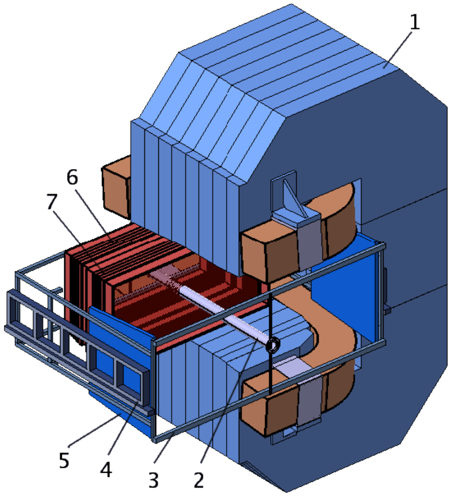
- Super conducting coil
- 2 T central field
- Segmented coil for target
- Instrumented iron yoke
- Doors for installation and maintenance
- ***Status of design:***

  - Cooperation with CERN for cold mass
  - Conductor optimized, close to tender
  - Yoke design complete
- Contract with BINP started



Dipole Magnet

- Normal conducting racetrack design
- Dipole also bends the beam
- → HESR component



PANDA Targets

Luminosity Considerations

- Goal: 2×10^{32} cm^{-2}s^{-1} (HL mode)
- With 10^{11} stored $\bar{p}$ and 50 mb: 4×10^{15} cm^{-2} target density

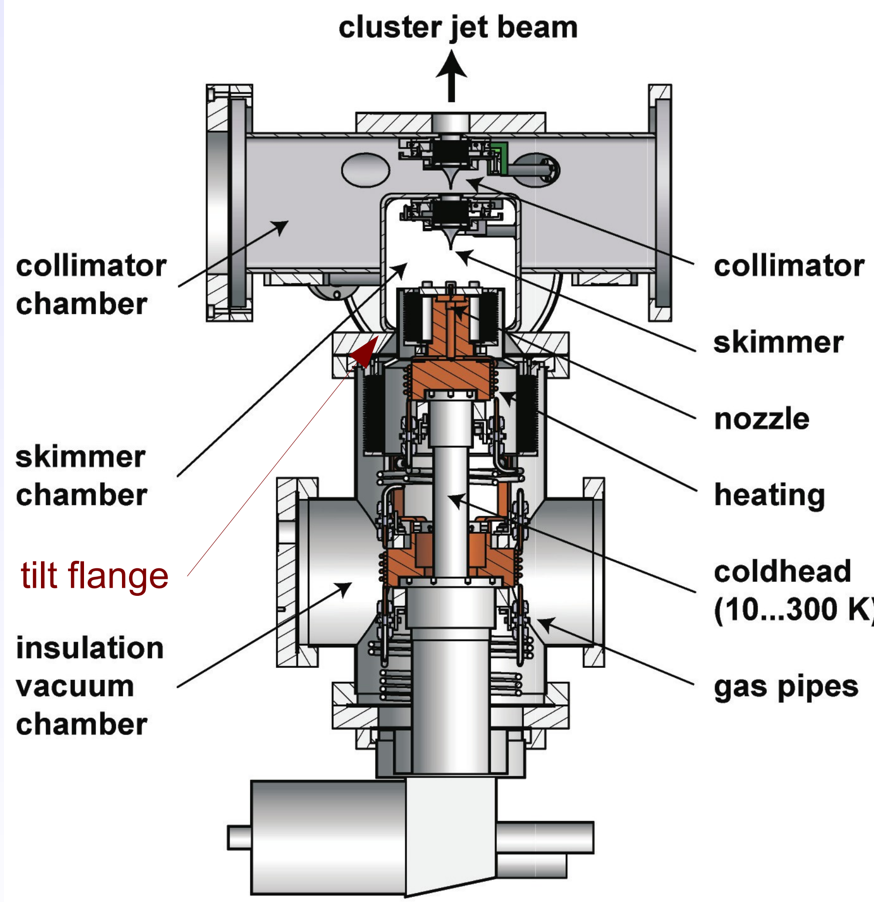
Cluster Jet Target

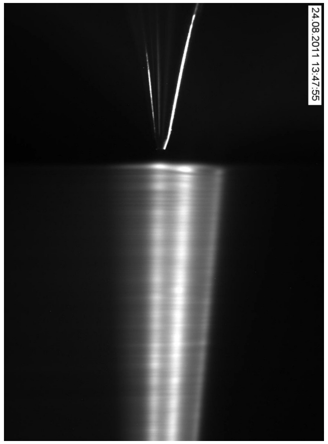
- Continuous development
  - Nozzle improvement
  - Better alignment by tilt device
  - Record 2×10^{15} cm^{-2} reached
- TDR approved

Pellet Target

- $>4 \times 10^{15}$ cm^{-2} feasible
- Prototype under way
- Pellet tracking prototype
- Second TDR part 2017

Latest version of the cluster jet target





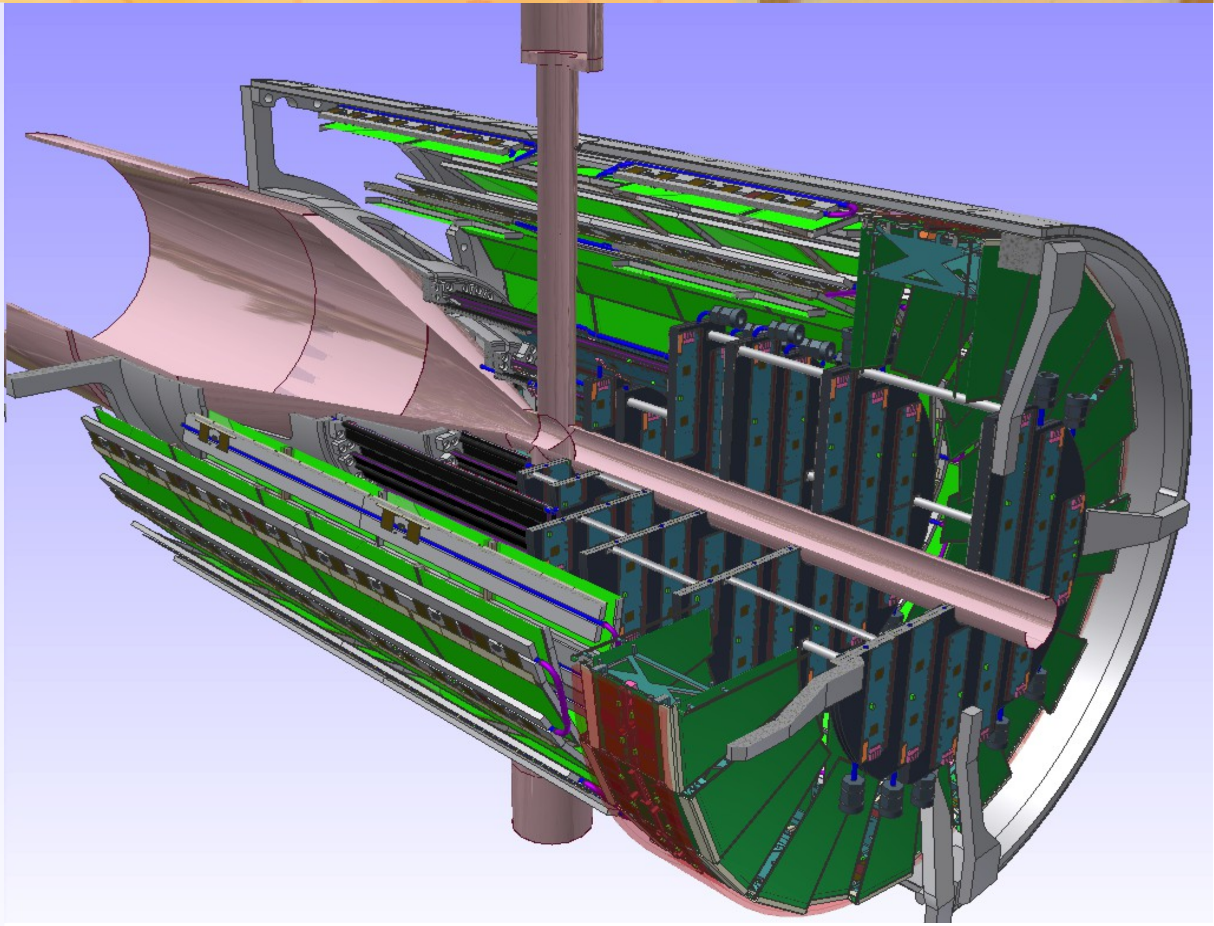
Micro Vertex Detector

Design of the MVD

- 4 barrels and 6 disks
- Continuous readout
- Hybrid pixels (100x100 μm^2)
  - *ToPiX* chip, 0.13μm CMOS
  - Thinned sensor wafers
- Double sided strips
  - Rectangles & trapezoids
  - 64 ch ASIC *PASTA*
- Mixed forward disks (pixel/strips)

Status:

- PASTA 1st version ready
- ToPix full functional prototype V4
- Detailed service planning



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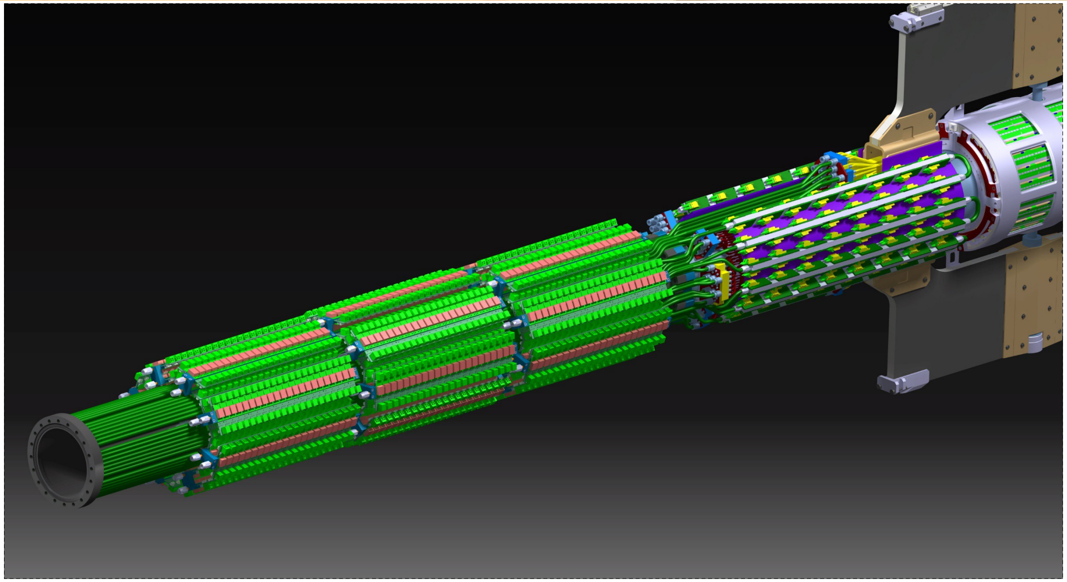
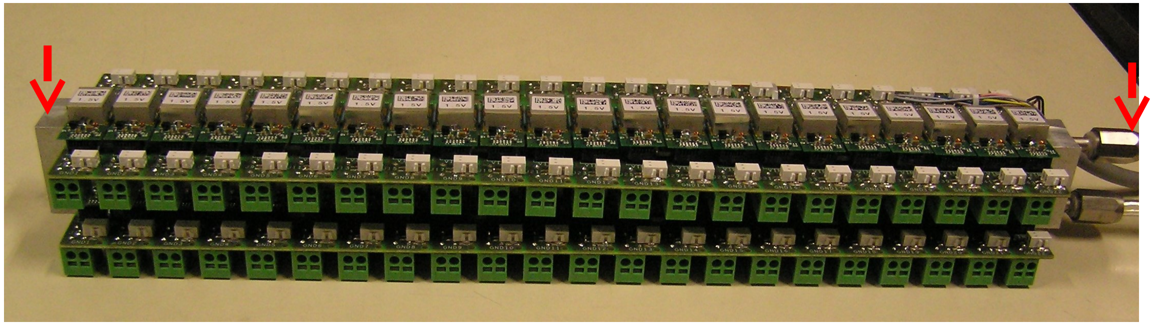


DC-DC converters and GBTx boards without cables



DC-DC converters: 24 pieces a 88 converters,

Each piece 1.3 kg, 455 x 85 x 63 mm^3

Straw Tube Tracker

Detector Layout

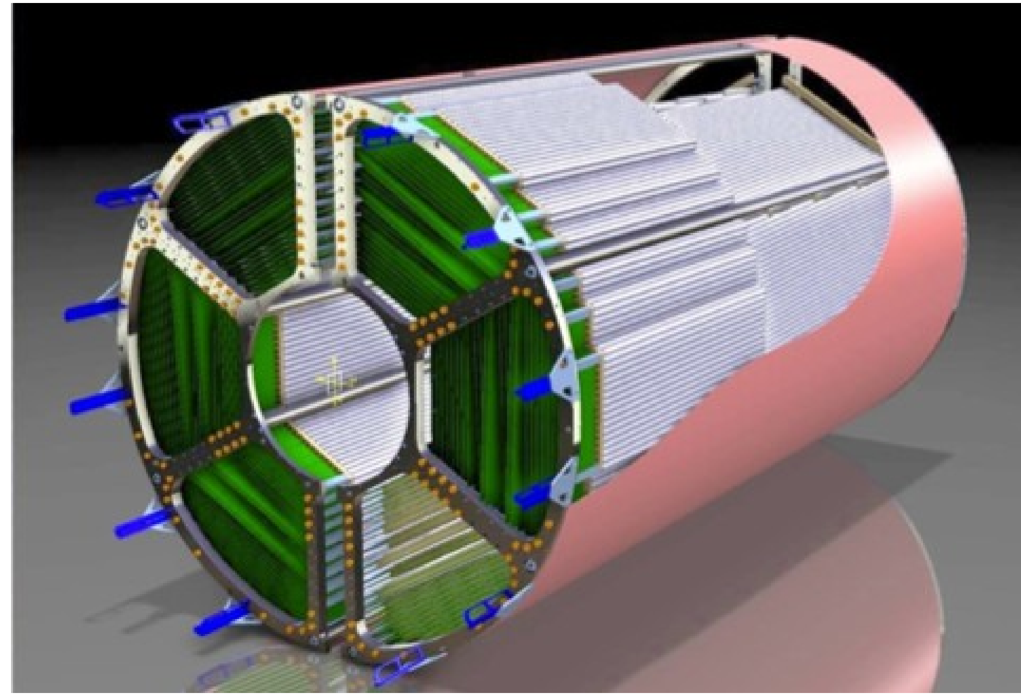
- 4600 straws in 21-27 layers, of which 8 layers skewed at ~3°
- Tube made of 27 μm thin Al-mylar, Ø=1cm
- R_{in}= 150 mm, R_{out}= 420 mm, l=1500 mm
- **Self-supporting straw double layers at γ 1 bar overpressure (Ar/CO_2)**
- Readout with ASIC+TDC or FADC

Material Budget

- Max. 26 layers,
- 0.05 % X/X_0 per layer
- **Total 1.3% X/X_0**

Project Status

- Readout prototypes & beam tests
- Ageing tests: up to 1.2 C/cm^2
- Straw series production ongoing: 3000 straws produced till end 2015



Straw Tube Tracker Developments

Mechanics status

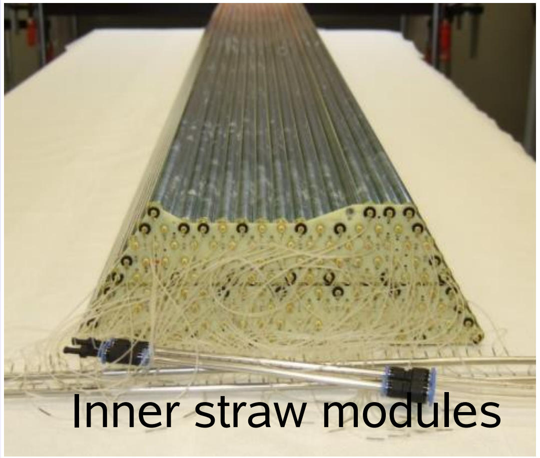
- Prototype frame installed
- Assembly scheme
- Frontend layout CAD

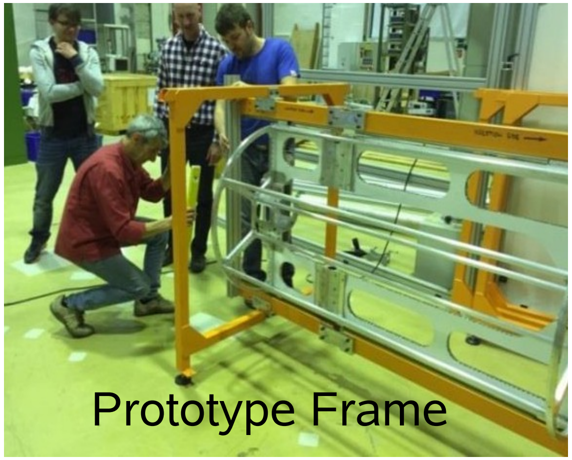
Electronics Status

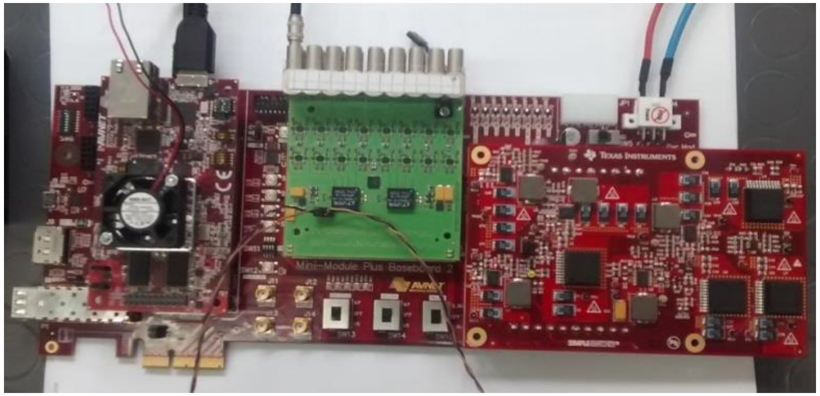
- New PASSTREC ASIC
- New 125 MSPS FADC,
  no FEE at detector side

Testbeam campaign

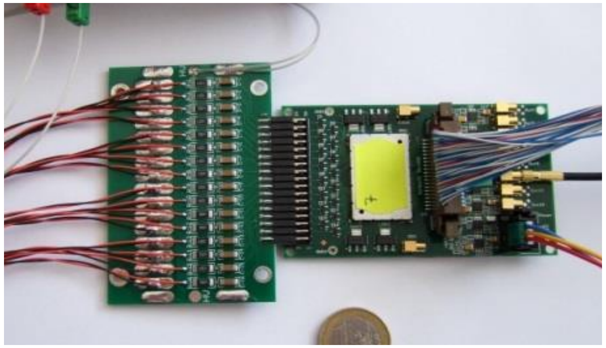
- 5 energies between 0.6 and 3.0 GeV
- Both types of electronics:
  - PASTTREC ASIC + TRB3 TDC
  - FADC (240 MHz & 125 MHz)
- Goal to fully characterise readout
- Final selection: cost/performance in 2018







ADC card

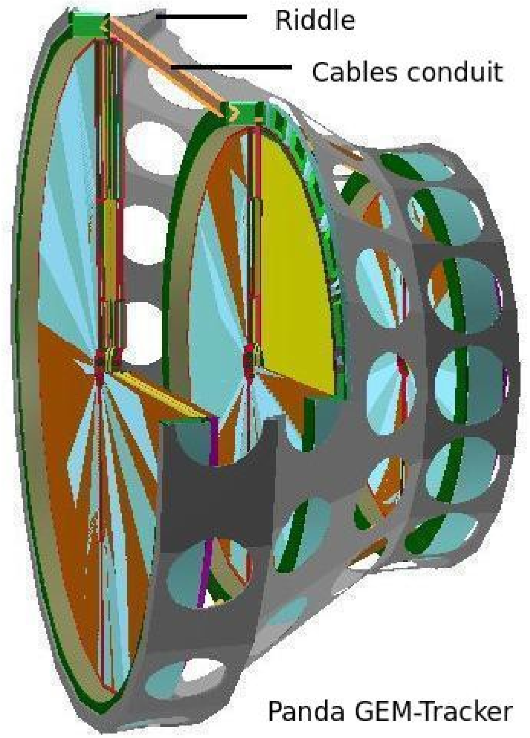


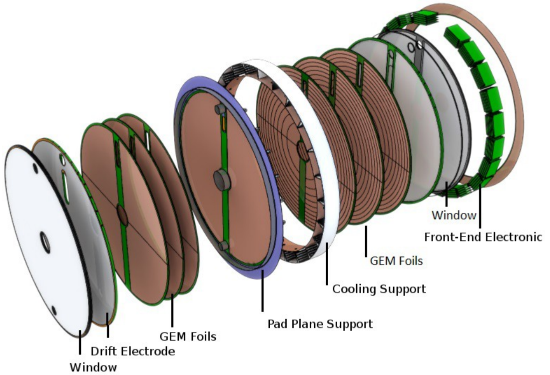
PASTTREC card

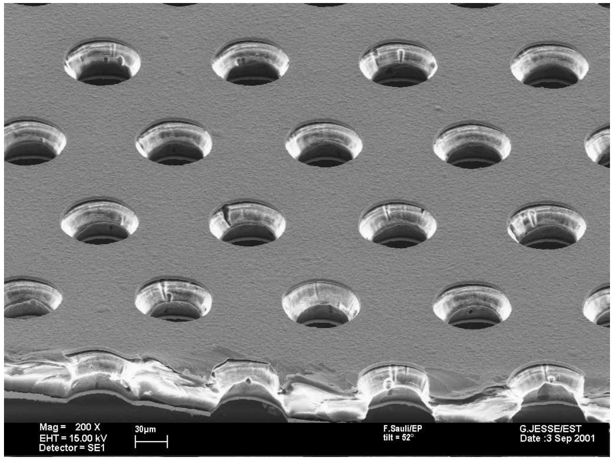
Forward GEM Tracker

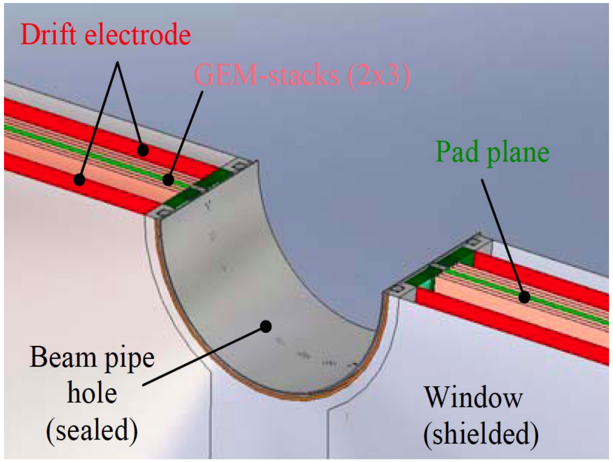
Forward Tracking inside Solenoid

- 3 stations with 4 projections each
  - ➔ Radial, concentric, x, y
- Central readout plane for 2 GEM stacks
- Large area GEM foils developed at CERN (50μm Kapton, 2-5μm copper coating)
- ADC readout for cluster centroids
  - ➔ Approx. 35000 channels total
- Challenge to minimize material









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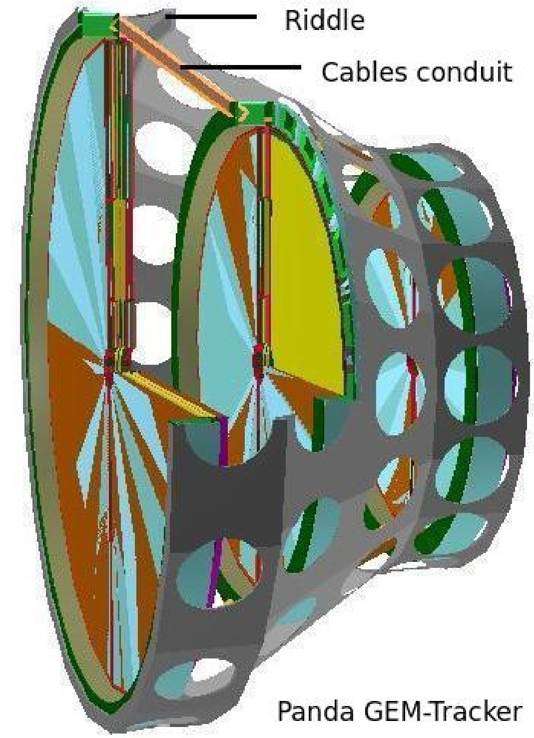
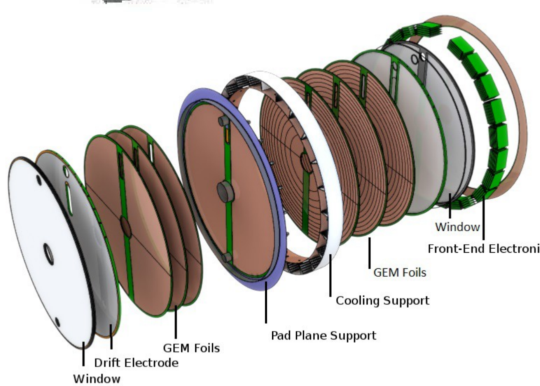
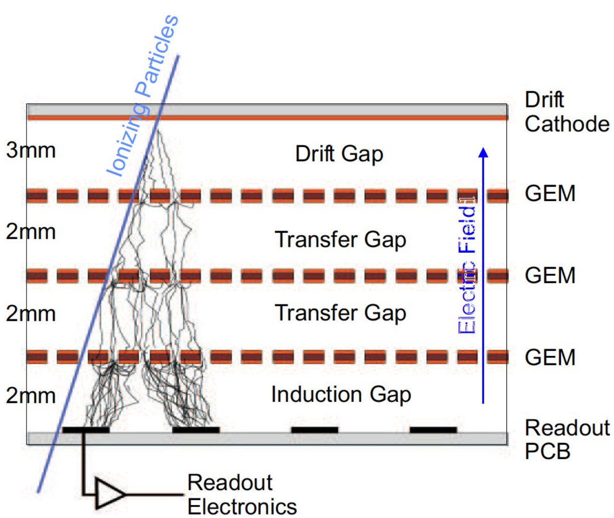
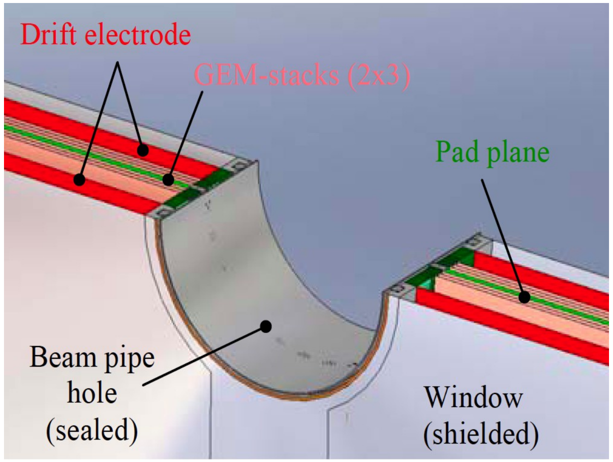








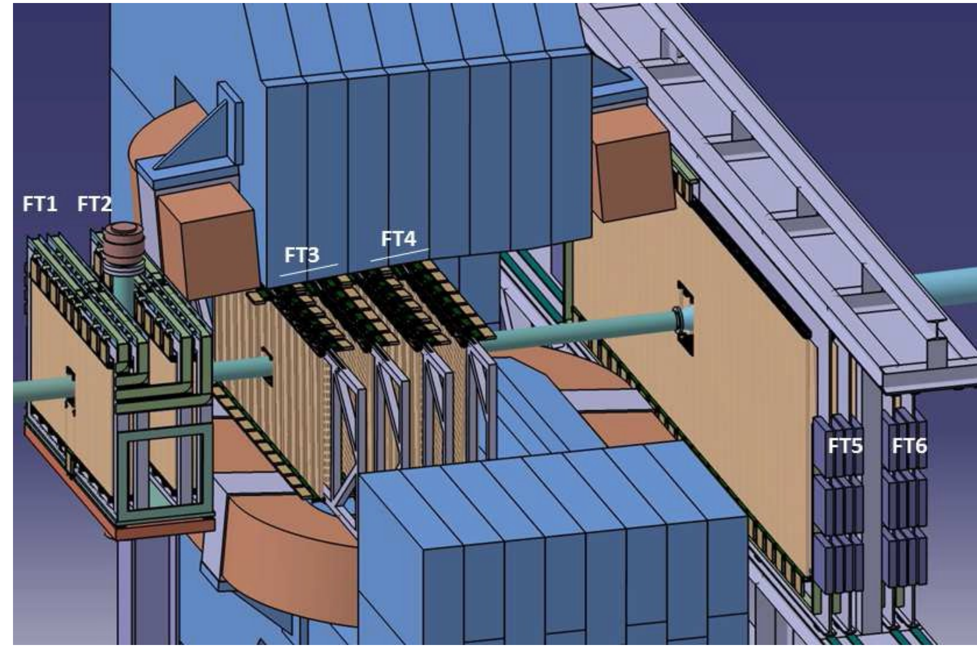
Forward Tracking

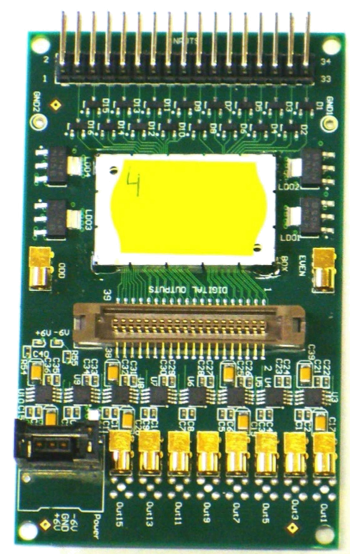
Tracking in Forward Spectrometer

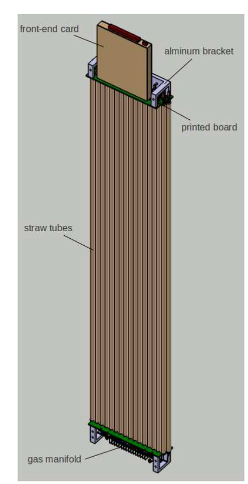
- 3 stations with 2 chambers each
  - FT1&2 : between solenoid and dipole
  - FT3&4 : in the dipole gap
  - FT5&6 : large chambers behind dipole
- Straw tubes arranged in double layers
  - 27 µm thin mylar tubes, 1 cm Ø
  - Stability by 1 bar overpressure
- 4 projections 0°/±5°/0° per chamber

Present status

- Optimisation of setup: FT6 before RICH
- Final simulation ongoing
- Preparation of half plane of FT5
- Preparations for PANDA Phase 0 @HADES based on FT3 & FT5 modules







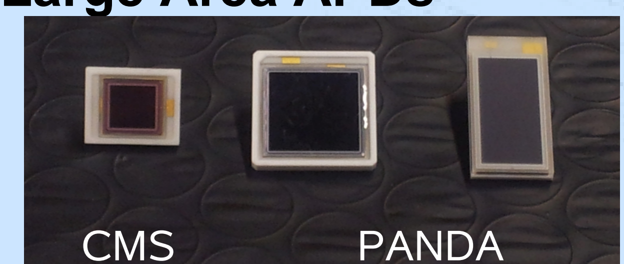
Modular layout

Target Spectrometer EMC

$\overline{\text{P}}$ANDA PWO Crystals

- PWO is dense and fast
- Low γ threshold is a challenge
- Increase light yield:
  - improved PWO II (2xCMS)
  - operation at -25°C (4xCMS)
- Challenges:
  - temperature stable to 0.1°C
  - control radiation damage
  - low noise electronics
- New producer CRYTUR

Large Area APDs



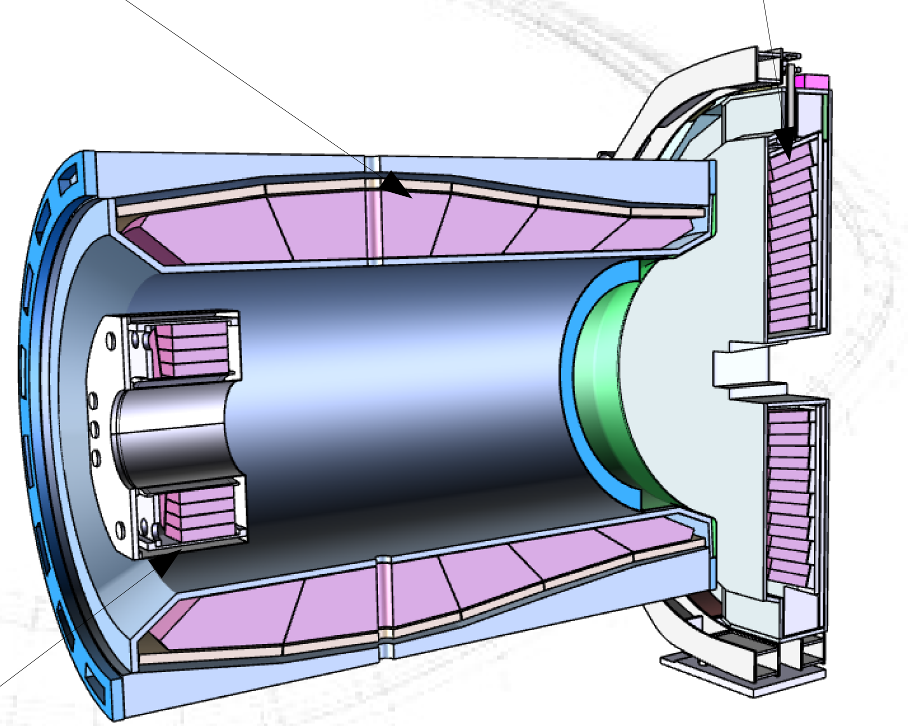
$5x5\ mm^2$ $10x10\ mm^2$ and $7x14\ mm^2$

Barrel Calorimeter

- 11000 PWO Crystals
- LAAPD readout, $2x1 cm^2$
- $\sigma(E)/E \sim 1.5\%/\sqrt{E}$ + const.

Forward Endcap

- 4000 PWO crystals
- High occupancy in center
- LA APD and VPTT



Backward Endcap for hermeticity,
530 PWO crystals

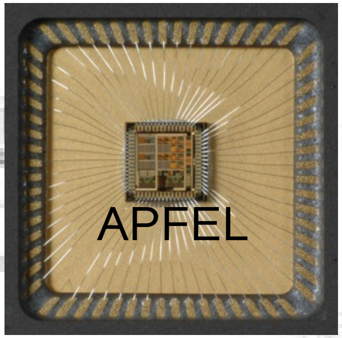
EMC Status (1)

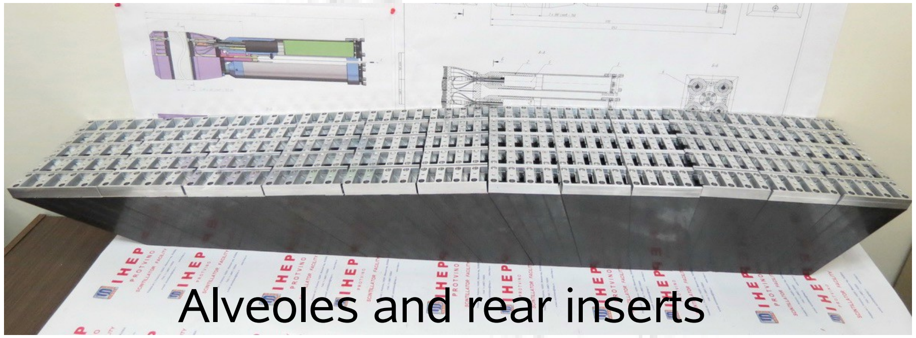
PWO Crystal Production
- New producer Crytur
- Test production in 2016 (~100 pc)
- EoI to fund remaining crystals

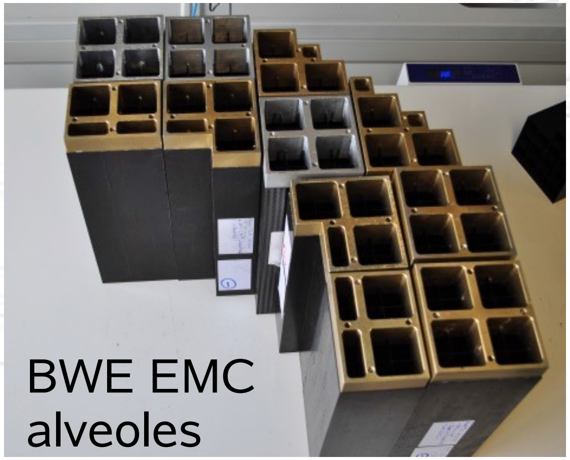
APD Screening
- Screening of 30000 APDs at GSI
- Facility in full shift operation

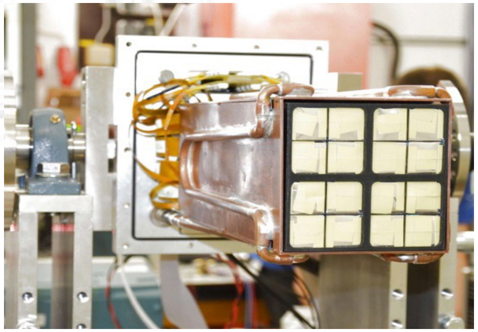
Barrel progress
- All alveoles produced
- APD readout ASIC produced
- Tests with depolished crystals
- First slice in construction

Backward Endcap
- Prototype tests successful
- Layout of alveoles
- Service planning ongoing





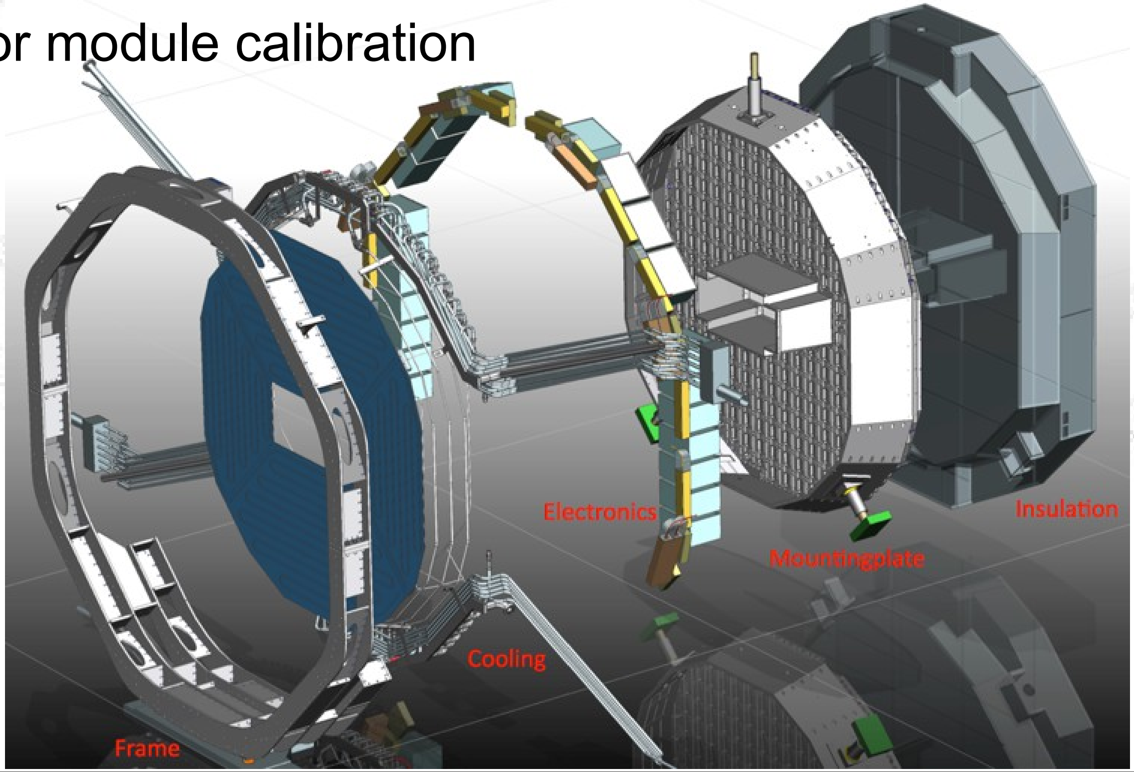


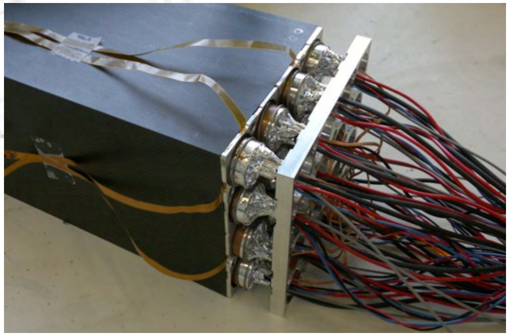


EMC Status (2)

Forward Endcap

- Assembly of full sub-system till 2018
- VPTT all characterised
- APDs in preparation
- Module assembly ongoing
- Cooling system available, work on controls
- Test stand for module calibration



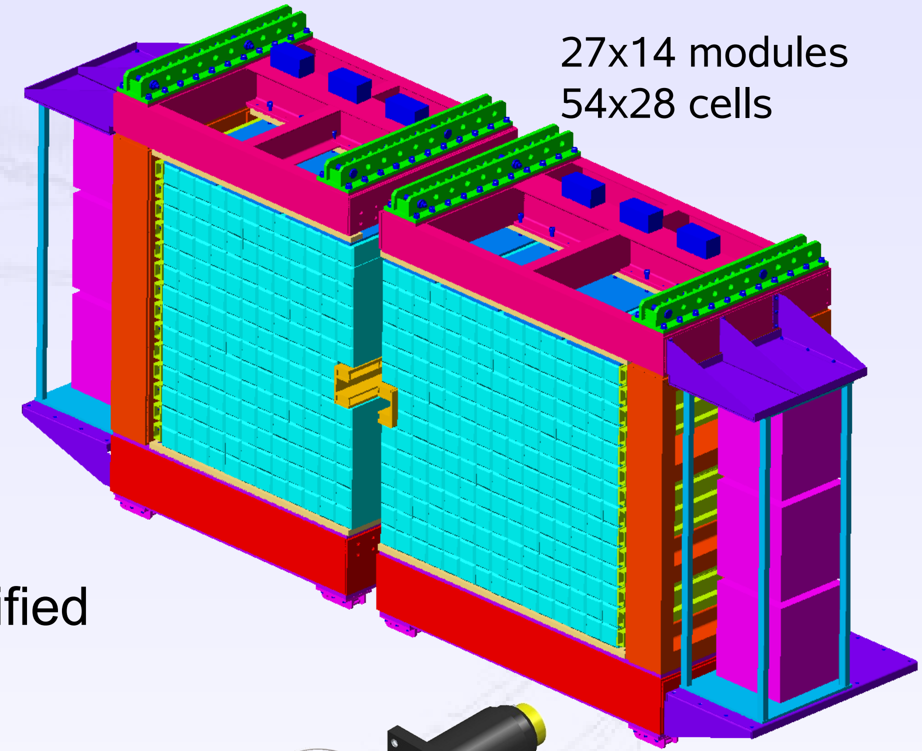


Forward Spectrometer Calorimeter

Forward electromagnetic calorimeter:

- Interleaved scintillator and absorber
- WLS fibres for light collection
- PMTs for photon readout
- FADCs for digitization
- Active area size 297x154 cm^2

27x14 modules
54x28 cells



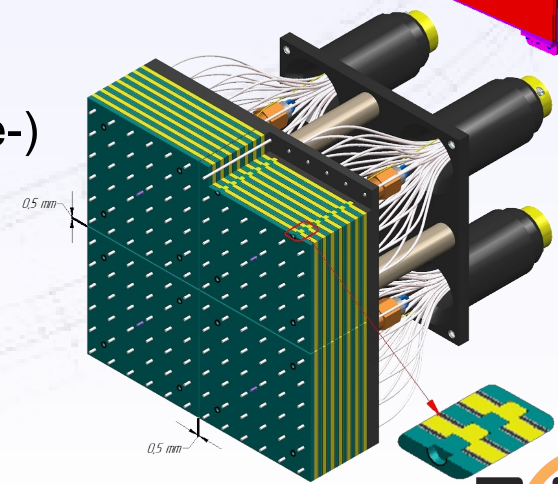
System status:

- Module design 2x2 cells of 5.5x5.5 cm^2 verified
- Tests with electrons and tagged photons:
- → **Energy resolution:**

  $\sigma_E / E = 5.6/E \oplus 2.4/\sqrt{E}$ [GeV] $\oplus$ 1.3 [%] (1-19 GeV e-)

  $\sigma_E / E = 3.7/\sqrt{E}$ [GeV] $\oplus$ 4.3 [%] (50-400 MeV ph)

- **Time resolution:** 100 ps/$\sqrt{E}$ [GeV]
- **TDR approved in Mar 2016**



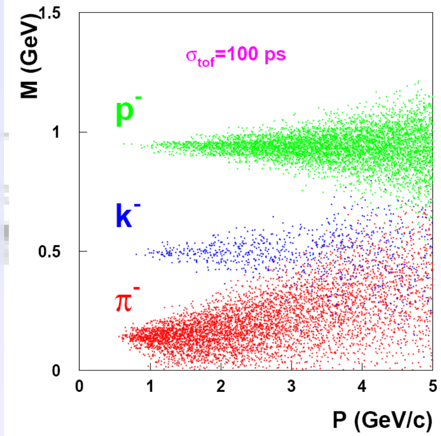
Forward Time of Flight

Forward Spectrometer PID

- Time-of-Flight essential
- No start detector
- Relative timing to Barrel

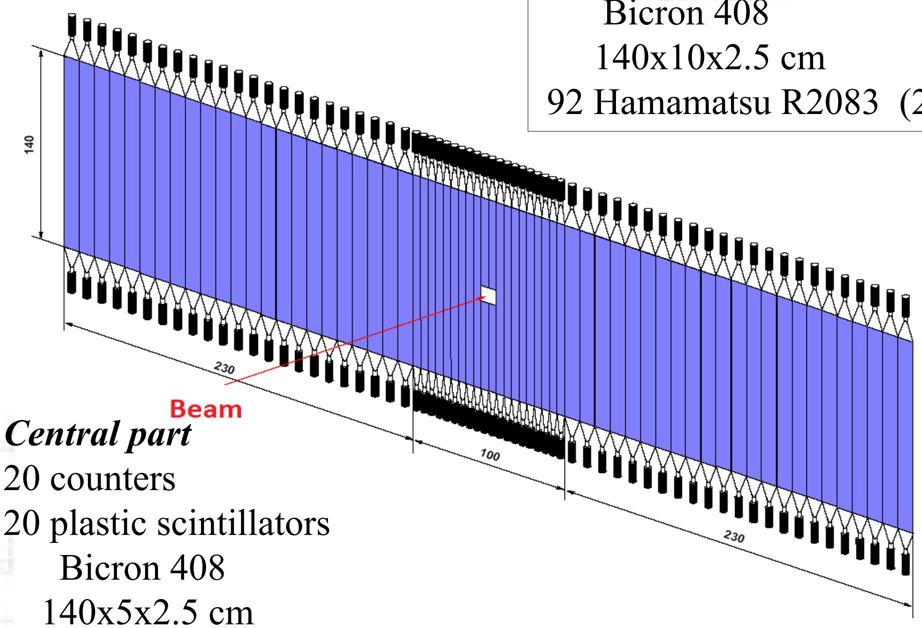
Detector layout:

- Scintillator wall at z=7.5m made of 140 cm long slabs
- Bicron 408 scintillator
- PMT readout on both ends
- 10 cm slabs on the sides, 5 cm slabs in the center
- TRB TDC readout
- **Later addition:** Side panels in dipole for low momentum tracks (not part of initial TDR)
- **TDR close to submission**



Goal: Time-of-flight with σ(t) better than 100 ps

Side parts
2x23 counters
46 plastic scintillators
Bicron 408
140x10x2.5 cm
92 Hamamatsu R2083 (2")

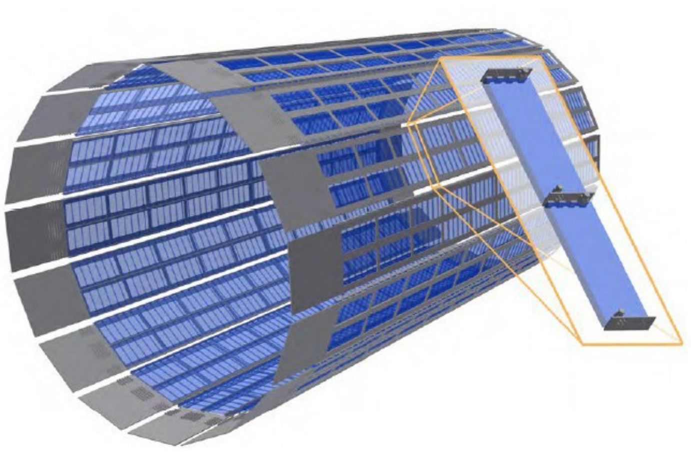


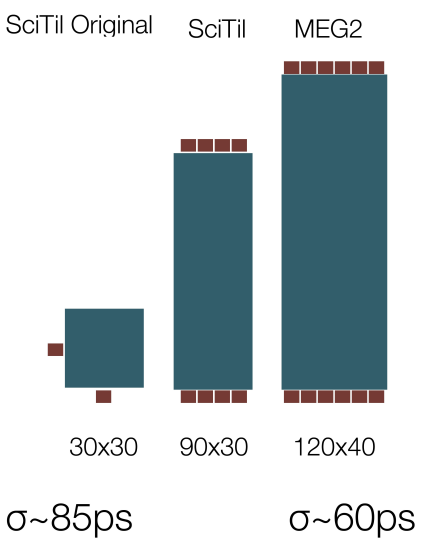
Central part
20 counters
20 plastic scintillators
Bicron 408
140x5x2.5 cm
40 Hamamatsu R4998 (1")

Scintillator Tile Hodoscope

Detector for ToF and event timing

- Scintillator tiles 5 mm thick
  - BC404, BC408 or BC420
  - Space points with precision timing
  - Lowest possible material budget
- Photon readout with SiPMs (3x3 mm^2)
  - High PDE, time resolution, rate capability
  - Work in B-fields, small, robust, low bias
  - *High intrinsic noise*
  - *Temperature dependence*
  - Evaluation of rad. hardness
- System time resolution: <100 ps
- ToFPET ASIC for SiPM readout
- Layout optimsation:
  - Serial readout, more SiPM
  - Multilayer PCB for transmission
- **TDR submitted to FAIR**





very first result
σ<75ps

$\overline{\text{P}}$ANDA Barrel DIRC

Baseline design

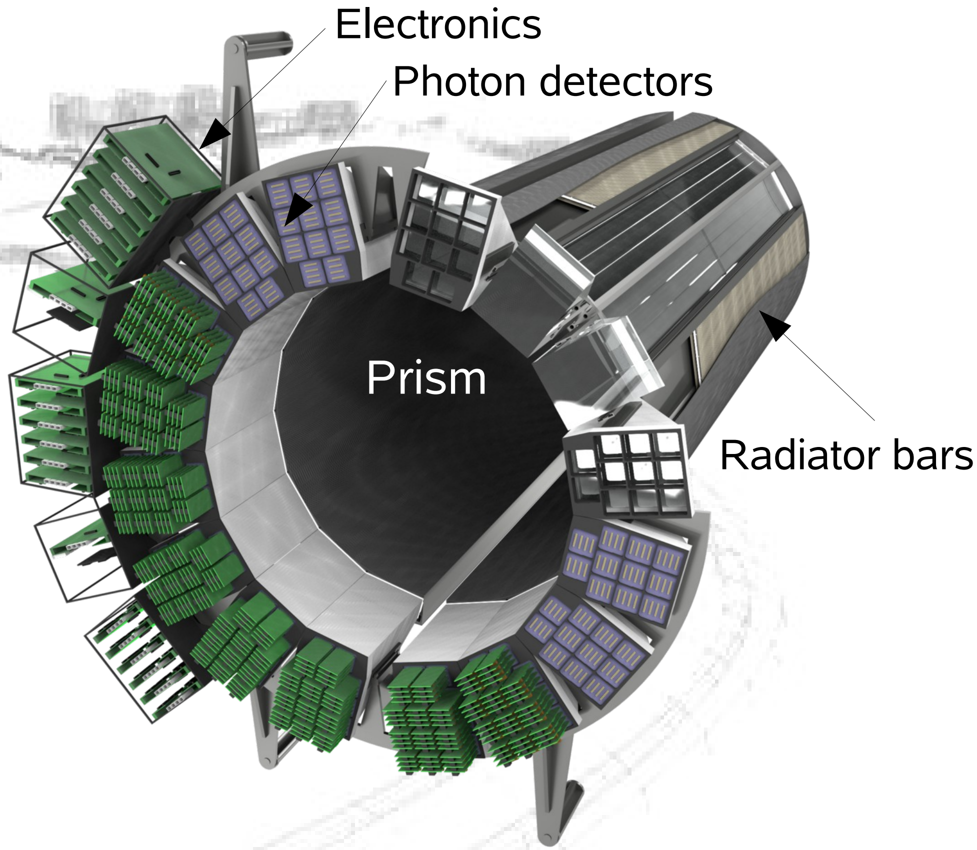
- DIRC: Detection of Internally Reflected Cherenkov light pioneered by BaBar
- Cherenkov detector with SiO_2 radiator
- Detected patterns give β of particles

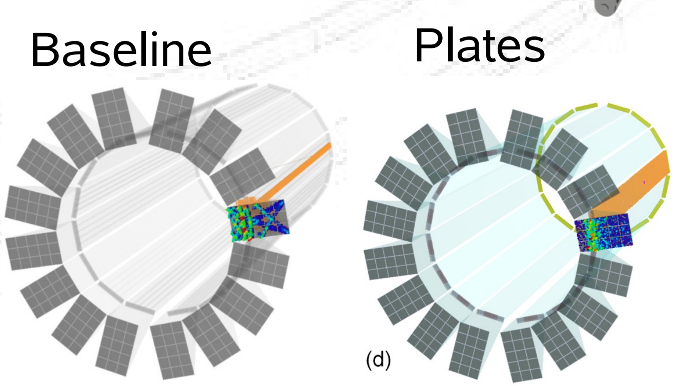
Optimization and challenges

- Focusing by lenses/mirrors
- More compact design
- Magnetic field → MCP PMT
- Fast readout to suppress BG
- Plates as more economic radiator

Project status

- Baseline design verified
- **TDR submitted to FAIR**

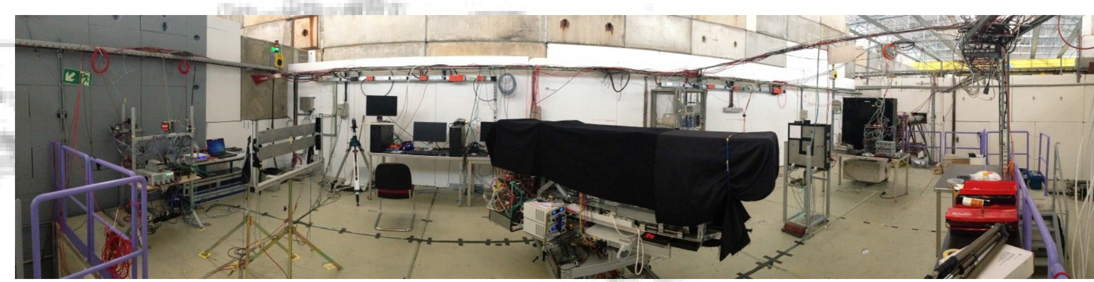




$\bar{\text{P}}$ANDA Barrel DIRC: Recent Results

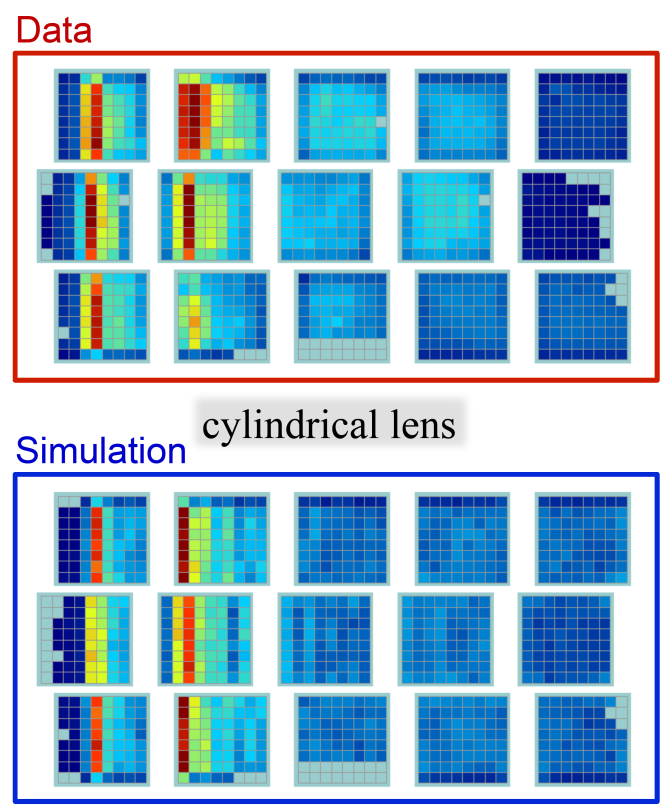
Testbeam campaign at CERN T9

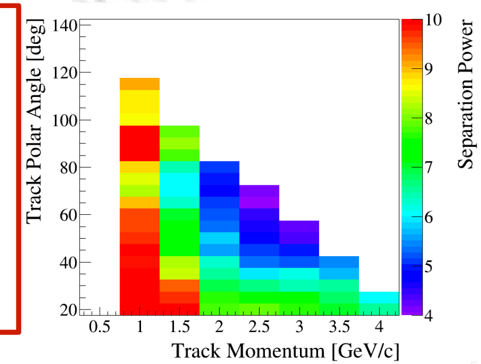
- 2 periods: 3+2 weeks May-July
- ToF ref. at multi-hadron beam
- Readout with TRB3/PADIWA



Measurement program

- Focusing by various lenses
- Prism as expansion volume
- Bars as baseline radiator
- Plate radiator as alternative



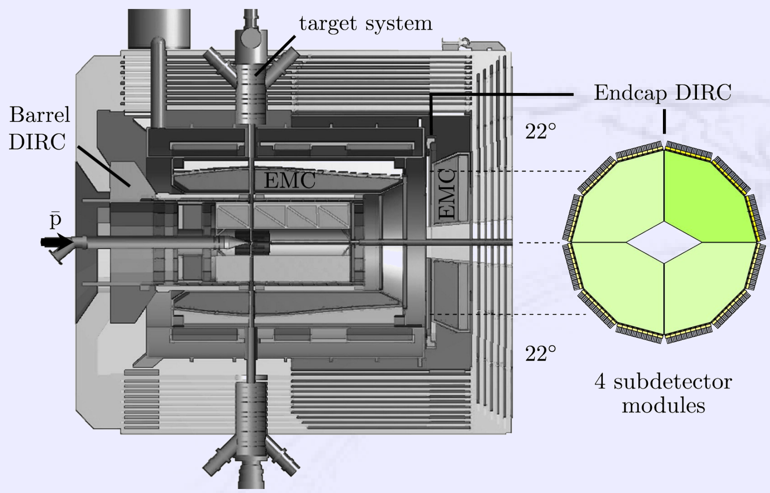


Simulated separation of π/p at testbeam

Outlook

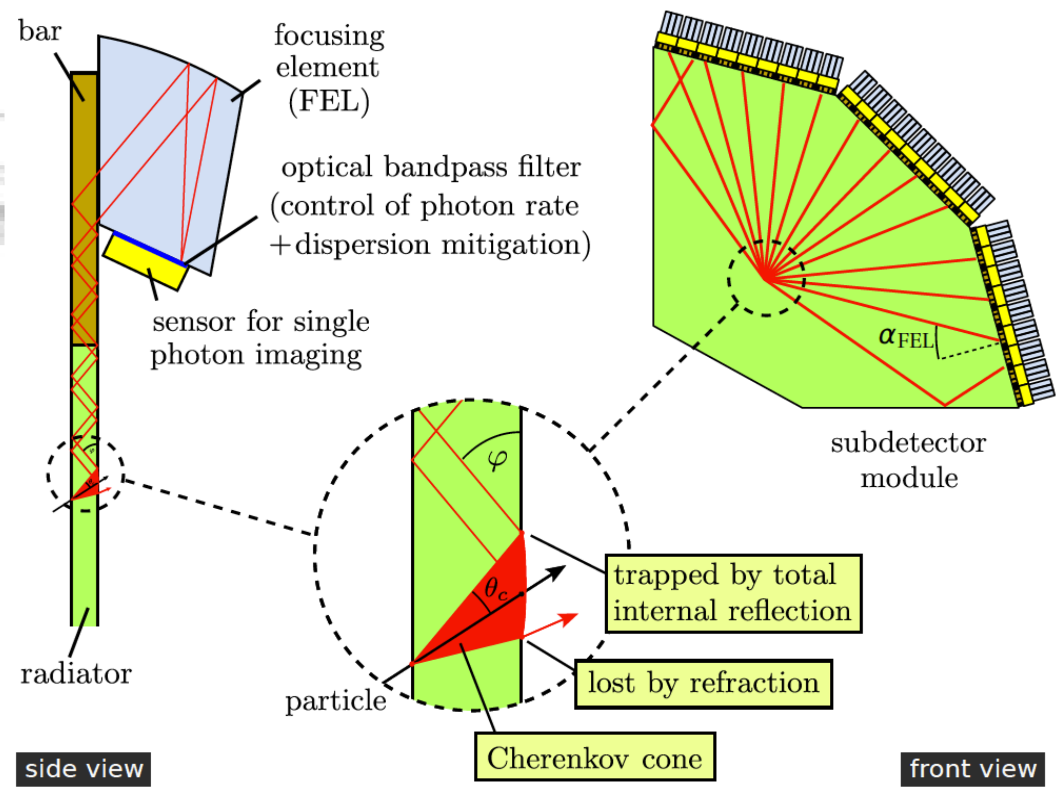
- Data analysis ongoing:
  Expect results for design choice
- TDR submitted to FAIR

P̄ANDA Disc DIRC



Novel concept for forward PID
- Based on DIRC principle
- Disc shaped radiator
- Readout at the disc rim

Project status:
- Advanced design, first tests
- Review with external experts
- Next: full quarter disc prototype



Basic components:
- SiO_2 radiator disc
- Focusing element
- Optical bandpass filter
- MCP PMT for photon readout in magnetic field
- ASIC for electronic readout

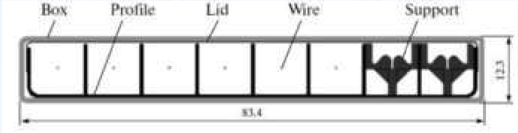
Muon Detector System

Muon system rationale:

- Low momenta, high BG of pions
- → Multi-layer range system

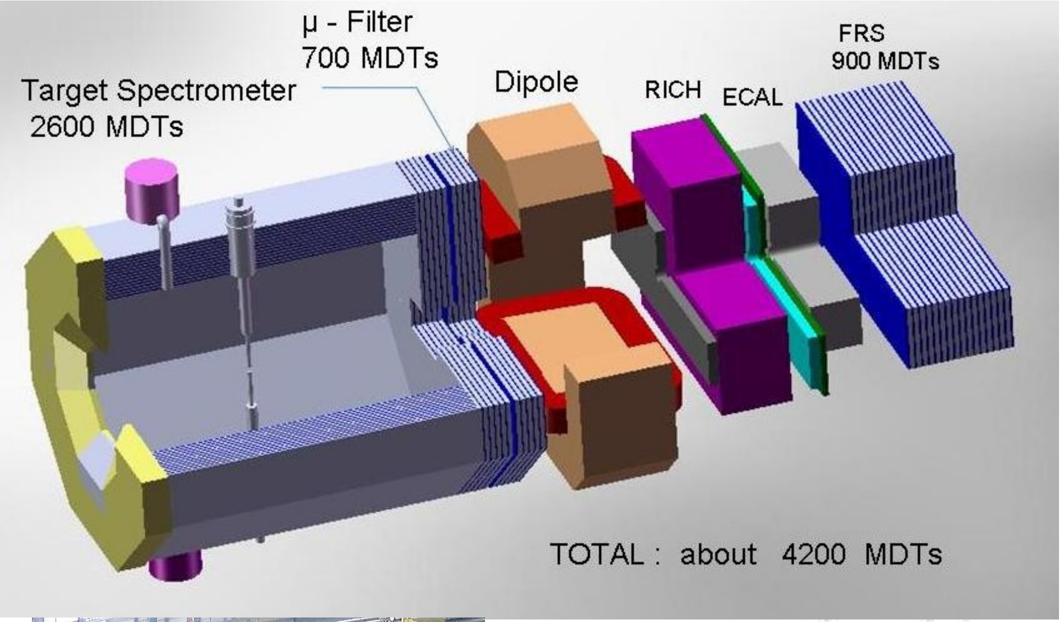
Muon system layout:

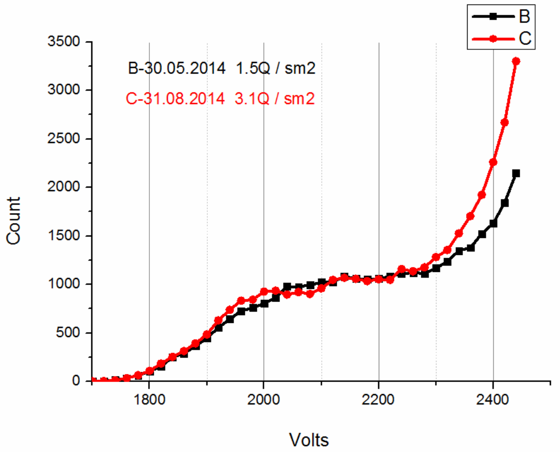
- *Barrel*: 12+2 layers in yoke
- *Endcap*: 5+2 layers
- *Muon Filter*: 4 layers
- *Fw Range System*: 16+2 layers
- *Detectors:* Drift tubes with wire & cathode strip readout



System status

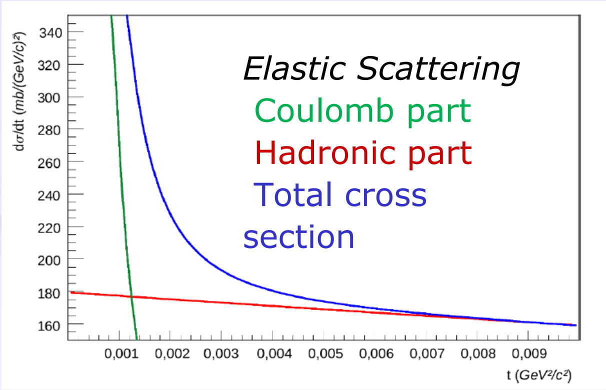
- Range system tests at CERN
- Aging tests up to $3C/cm^2$
- Digital r/o design based on Artix7





FAIR

Luminosity Detector

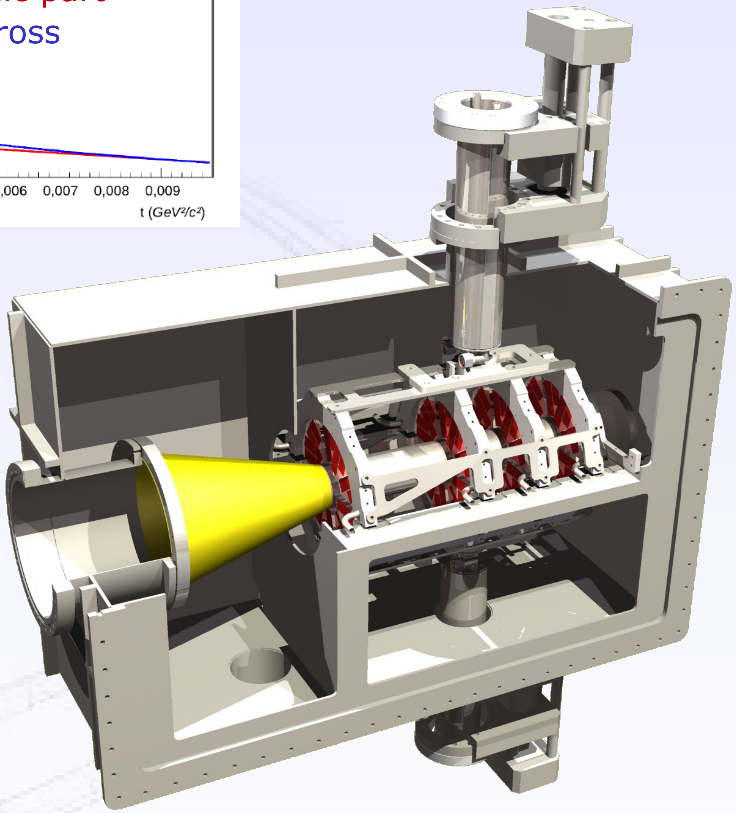


Elastic scattering:

- Coulomb part calculable
- Scattering of $\bar{p}$ at low t
- Precision tracking of scattered $\bar{p}$
- Acceptance 3-8 mrad

Detector layout:

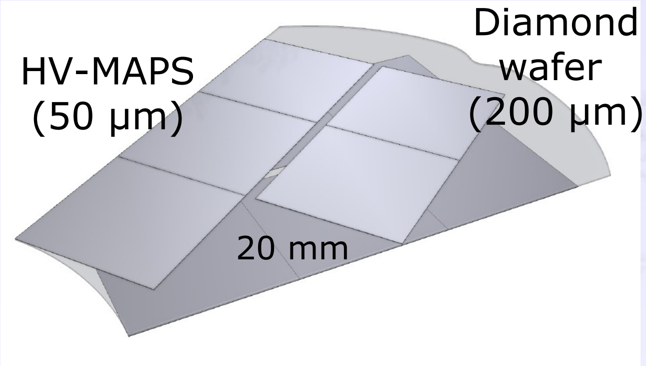
- Roman pot system at z=11 m
- Silicon pixels (80x80 μm^2):
  4 layers of HV MAPS (50 μm thick)
- CVD diamond supports (200 μm)
- Retractable half planes in sec. vacuum

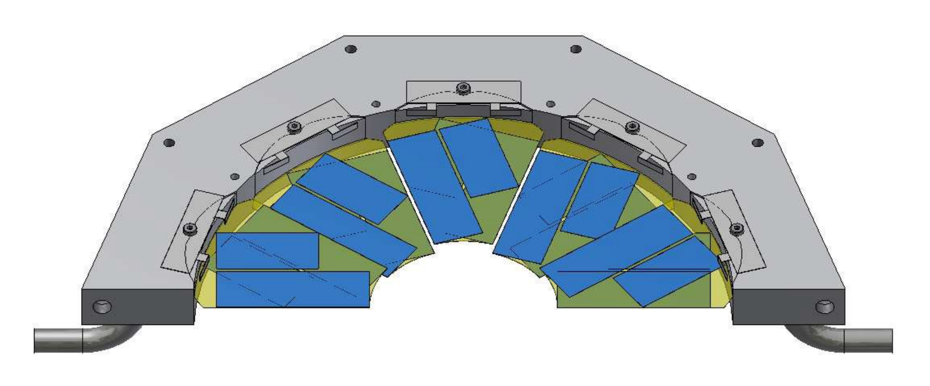


HV MAPS:

- Development for Mu3e Experiment at PSI
- Active pixel sensor in HV CMOS: faster and more rad. hard
- Digital processing on chip
- Testbeam results: S/N ~ 20, Efficiency ~99.5%

Luminosity Detector





Project status:

- Cooling system prototype tested
- Mechanical vessel and vacuum system prototype tested
- CVD diamond supports available
- TDR was reviewed internally with external experts
- ➔ Recommendations: implement more testbeam results, further simulations, material tests
- HV MAPS concept adopted for ATLAS upgrade
- Radiation test results from ATLAS

- **TDR submitted to FAIR**

Hypernuclear Setup

Principle:

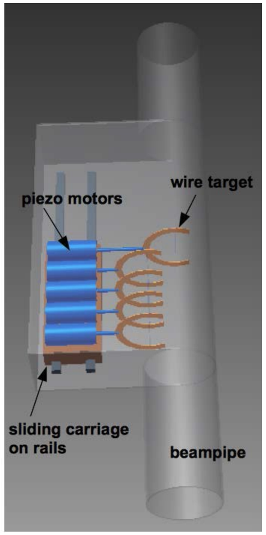
- Produce hypernuclei from captured Ξ

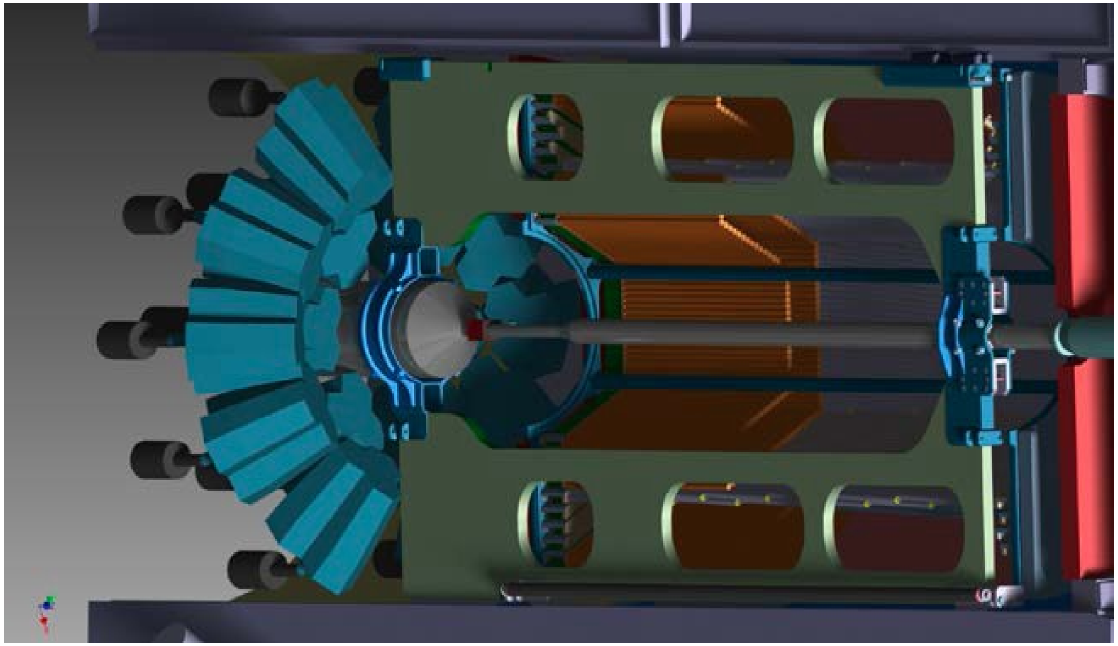
Modified Setup:

- Primary retractable wire/foil target
- Secondary active target to capture Ξ and track products with Si strips
- HP Ge detector for γ-spectroscopy

Primary Target:

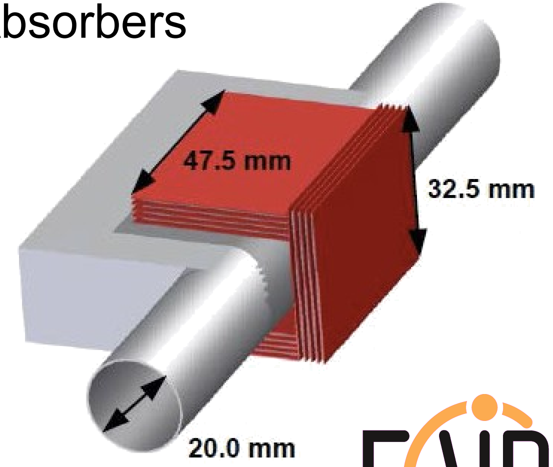
- Diamond wire
- Piezo motored wire holder





Active Secondary Target:

- Silicon microstrips
- Absorbers



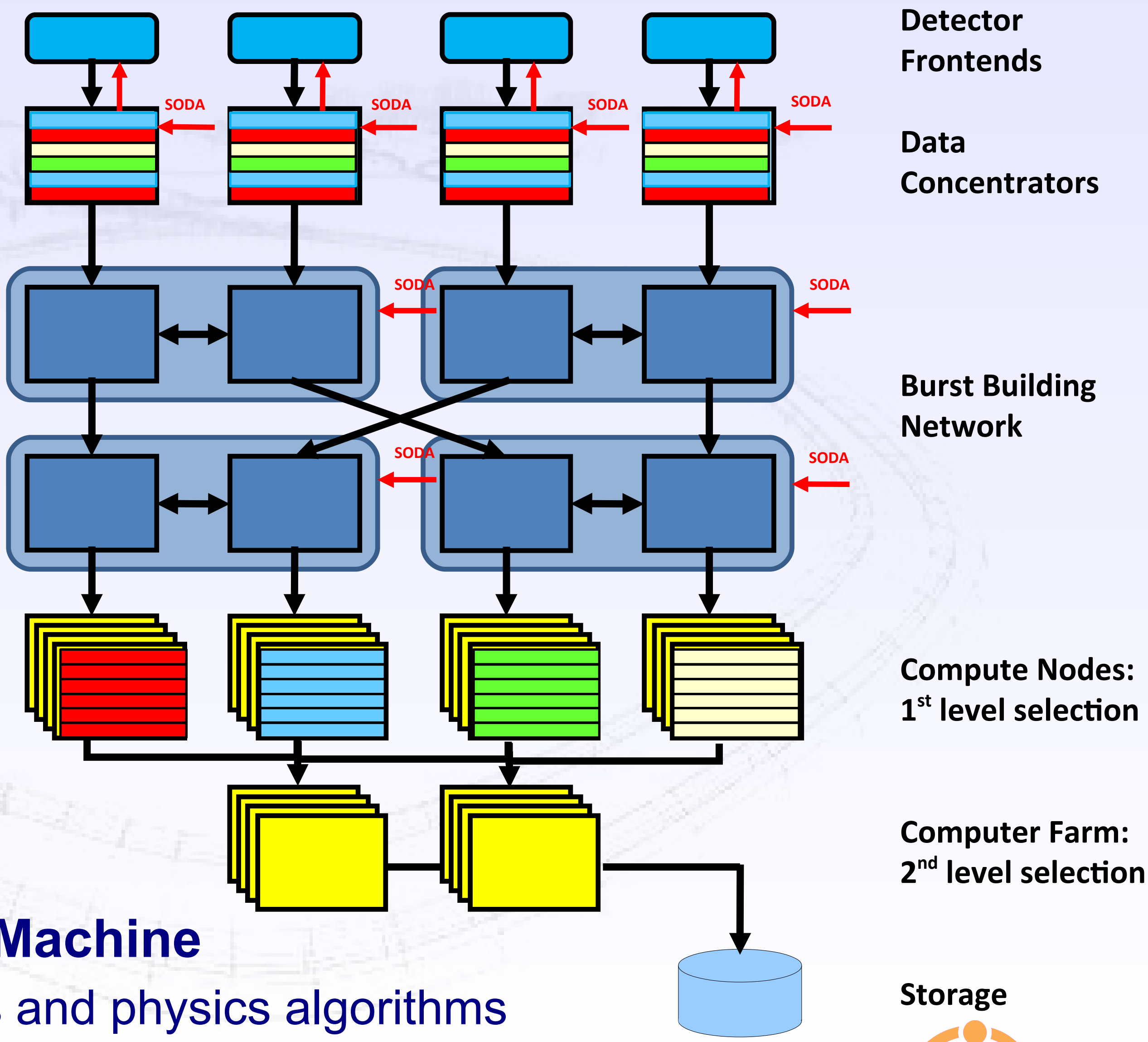
P̄ANDA Data Acquisition

Self triggered readout

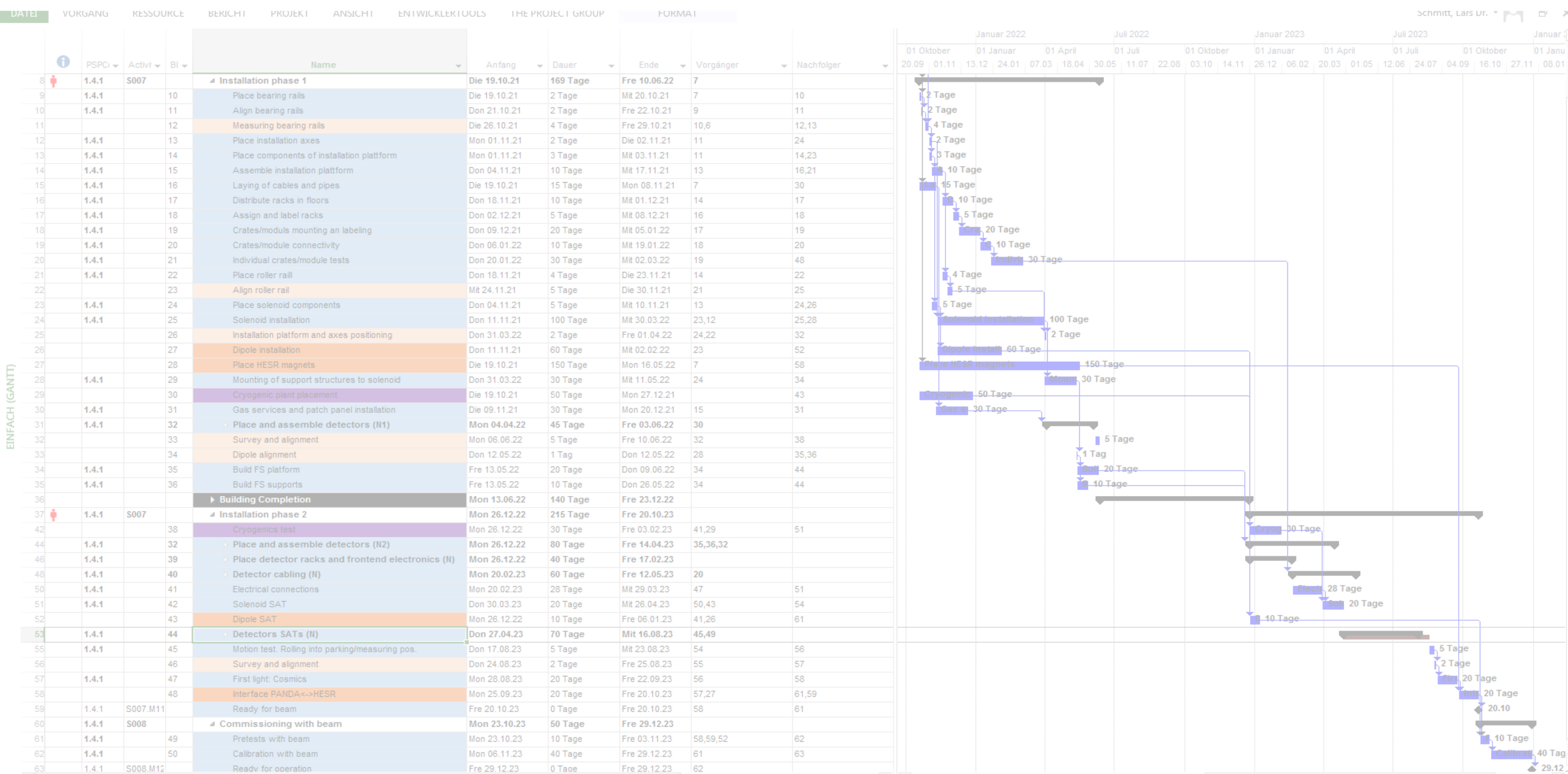
- Components:
  - Time distribution: SODA
  - Intelligent frontends
  - Powerful compute nodes
  - High speed network
- Data Flow:
  - Data reduction
  - Local feature extraction
  - Data burst building
  - Event selection
  - Data logging after online reconstruction

➔ **Programmable Physics Machine**

Online selection schemes and physics algorithms are a key for successful measurements

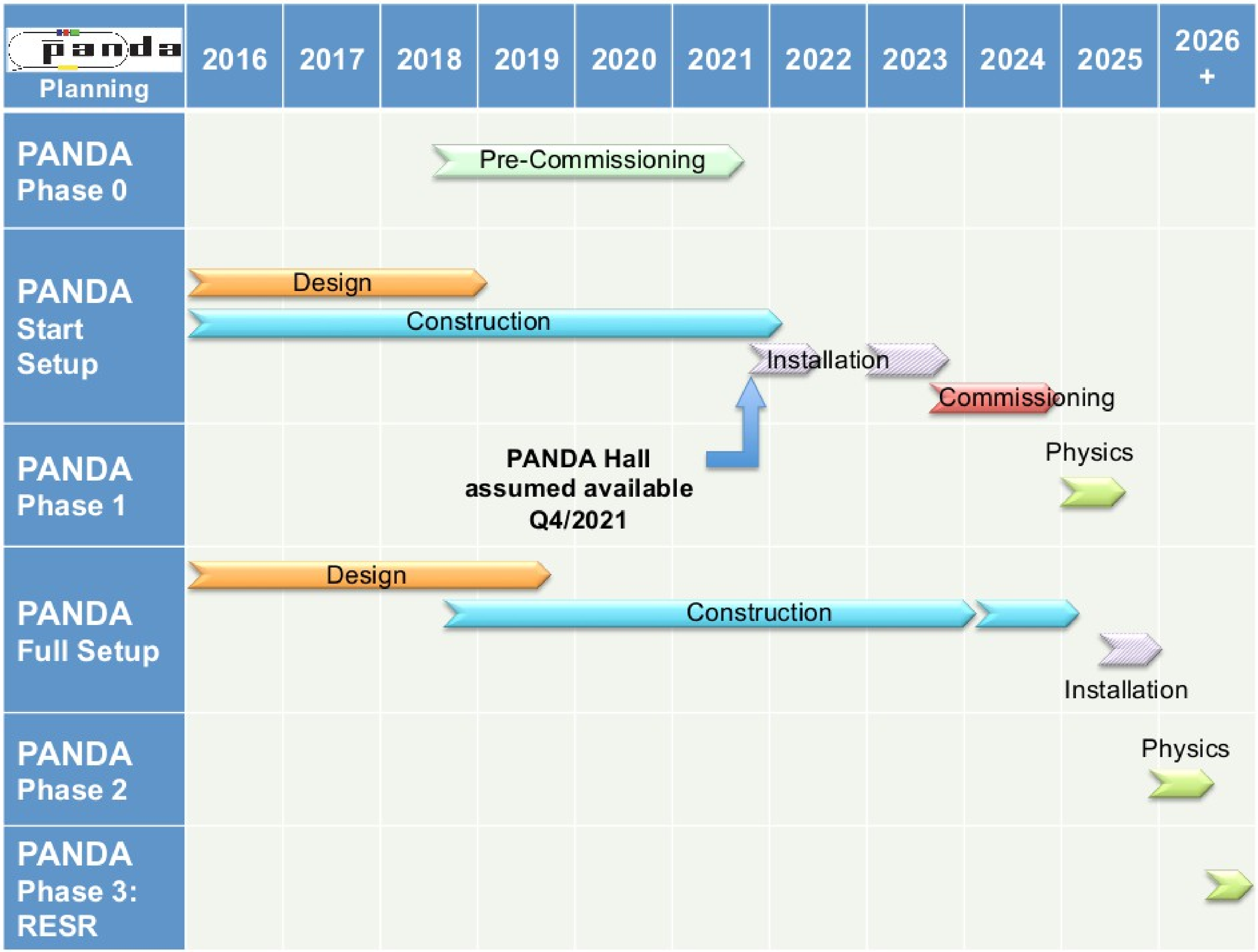


Schedule and Summary



	PSPCode	Activity	BI	Name	Anfang	Dauer	Ende	Vorgänger	Nachfolger
8	1.4.1	S007		Installation phase 1	Die 19.10.21	169 Tage	Fre 10.06.22	7	
9	1.4.1		10	Place bearing rails	Die 19.10.21	2 Tage	Mit 20.10.21	7	10
10	1.4.1		11	Align bearing rails	Don 21.10.21	2 Tage	Fre 22.10.21	9	11
11			12	Measuring bearing rails	Die 26.10.21	4 Tage	Fre 29.10.21	10,6	12,13
12	1.4.1		13	Place installation axes	Mon 01.11.21	2 Tage	Die 02.11.21	11	24
13	1.4.1		14	Place components of installation plattform	Mon 01.11.21	3 Tage	Mit 03.11.21	11	14,23
14	1.4.1		15	Assemble installation plattform	Don 04.11.21	10 Tage	Mit 17.11.21	13	16,21
15	1.4.1		16	Laying of cables and pipes	Die 19.10.21	15 Tage	Mon 08.11.21	7	30
16	1.4.1		17	Distribute racks in floors	Don 18.11.21	10 Tage	Mit 01.12.21	14	17
17	1.4.1		18	Assign and label racks	Don 02.12.21	5 Tage	Mit 08.12.21	16	18
18	1.4.1		19	Crates/moduls mounting an labeling	Don 09.12.21	20 Tage	Mit 05.01.22	17	19
19	1.4.1		20	Crates/module connectivity	Don 06.01.22	10 Tage	Mit 19.01.22	18	20
20	1.4.1		21	Individual crates/module tests	Don 20.01.22	30 Tage	Mit 02.03.22	19	48
21	1.4.1		22	Place roller raill	Don 18.11.21	4 Tage	Die 23.11.21	14	22
22			23	Align roller rail	Mit 24.11.21	5 Tage	Die 30.11.21	21	25
23	1.4.1		24	Place solenoid components	Don 04.11.21	5 Tage	Mit 10.11.21	13	24,26
24	1.4.1		25	Solenoid installation	Don 11.11.21	100 Tage	Mit 30.03.22	23,12	25,28
25			26	Installation platform and axes positioning	Don 31.03.22	2 Tage	Fre 01.04.22	24,22	32
26			27	Dipole installation	Don 11.11.21	60 Tage	Mit 02.02.22	23	52
27			28	Place HESR magnets	Die 19.10.21	150 Tage	Mon 16.05.22	7	58
28	1.4.1		29	Mounting of support structures to solenoid	Don 31.03.22	30 Tage	Mit 11.05.22	24	34
29			30	Cryogenic plant placement	Die 19.10.21	50 Tage	Mon 27.12.21		43
30	1.4.1		31	Gas services and patch panel installation	Die 09.11.21	30 Tage	Mon 20.12.21	15	31
31	1.4.1		32	Place and assemble detectors (N1)	Mon 04.04.22	45 Tage	Fre 03.06.22	30	
32			33	Survey and alignment	Mon 06.06.22	5 Tage	Fre 10.06.22	32	38
33			34	Dipole alignment	Don 12.05.22	1 Tag	Don 12.05.22	28	35,36
34	1.4.1		35	Build FS platform	Fre 13.05.22	20 Tage	Don 09.06.22	34	44
35	1.4.1		36	Build FS supports	Fre 13.05.22	10 Tage	Don 26.05.22	34	44
36				Building Completion	Mon 13.06.22	140 Tage	Fre 23.12.22		
37	1.4.1	S007		Installation phase 2	Mon 26.12.22	215 Tage	Fre 20.10.23		
42			38	Cryogenics test	Mon 26.12.22	30 Tage	Fre 03.02.23	41,29	51
44	1.4.1		32	Place and assemble detectors (N2)	Mon 26.12.22	80 Tage	Fre 14.04.23	35,36,32	
46	1.4.1		39	Place detector racks and frontend electronics (N)	Mon 26.12.22	40 Tage	Fre 17.02.23		
48	1.4.1		40	Detector cabling (N)	Mon 20.02.23	60 Tage	Fre 12.05.23	20	
50	1.4.1		41	Electrical connections	Mon 20.02.23	28 Tage	Mit 29.03.23	47	51
51	1.4.1		42	Solenoid SAT	Don 30.03.23	20 Tage	Mit 26.04.23	50,43	54
52			43	Dipole SAT	Mon 26.12.22	10 Tage	Fre 06.01.23	41,26	61
53	1.4.1		44	Detectors SATs (N)	Don 27.04.23	70 Tage	Mit 16.08.23	45,49	
55	1.4.1		45	Motion test. Rolling into parking/measuring pos.	Don 17.08.23	5 Tage	Mit 23.08.23	54	56
56			46	Survey and alignment	Don 24.08.23	2 Tage	Fre 25.08.23	55	57
57	1.4.1		47	First light: Cosmics	Mon 28.08.23	20 Tage	Fre 22.09.23	56	58
58			48	Interface PANDA<->HESR	Mon 25.09.23	20 Tage	Fre 20.10.23	57,27	61,59
59	1.4.1	S007.M11		Ready for beam	Fre 20.10.23	0 Tage	Fre 20.10.23	58	61
60	1.4.1	S008		Commissioning with beam	Mon 23.10.23	50 Tage	Fre 29.12.23		
61	1.4.1		49	Pretests with beam	Mon 23.10.23	10 Tage	Fre 03.11.23	58,59,52	62
62	1.4.1		50	Calibration with beam	Mon 06.11.23	40 Tage	Fre 29.12.23	61	63
63	1.4.1	S008.M12		Ready for operation	Fre 29.12.23	0 Tage	Fre 29.12.23	62	

P̄ANDA Schedule Overview



P̄ANDA TDR Schedule

Submission 2017:
- Luminosity Detector
- Barrel Time of Flight
- Forward Time of Flight
- Forward Tracking

Submission 2018/19:
- GEM Tracker
- Detector Controls
- DAQ and Computing

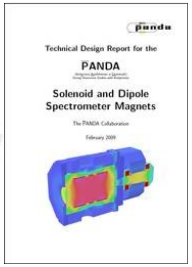
Phase 2:
- Hypernuclear Setup
- Pellet Target
- Disc DIRC
- Forward RICH

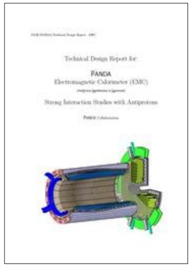
System	Submission *ExpectedSubmis*	*(Approval) Expected M3*
PANDA PHASE 1		
Target Spectrometer EMC		08/08/2008
Solenoid		05/21/2009
Dipole		05/21/2009
Micro Vertex Detector (MVD)		02/26/2013
Straw Tube Tracker (STT)		01/29/2013
Cluster Jet Target		08/28/2013
Muon System		09/22/2014
Forward Shashlyk Calorimeter		03/03/2016
Barrel DIRC	22/9/2016	*9/2017*
Luminosity Detector	30/3/2017	*12/2017*
Barrel Time of Flight (TOF)	11/4/2017	*12/2017*
Forward TOF	*6/2017*	*12/2017*
Forward Tracking	*10/2017*	*5/2018*
Controls	*12/2017*	*9/2018*
DAQ	*12/2018*	*6/2019*
Planar GEM Trackers	*12/2018*	*6/2019*
PANDA PHASE 2		
Endcap Disc DIRC	*9/2017*	*3/2018*
Forward RICH	*12/2017*	*6/2018*
Pellet Target	*12/2017*	*6/2018*
Hypernuclear Setup	*9/2018*	*3/2019*

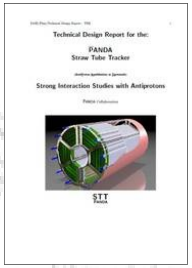
Status 11/04/2017

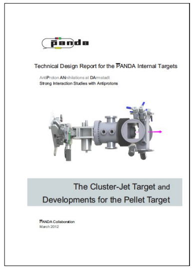
For the items “Interaction Region”, “Supports” and “Supplies” no TDRs are planned, only specification documents.

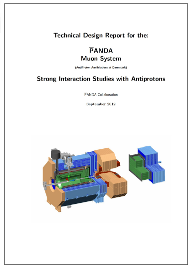
Computing TDR together with FAIR Computing TDR:
FAIR Computing CDR mid of 2018











Summary

Present Status of $\overline{\mathrm{P}}$ANDA

- Most Phase 1 detector TDRs complete in 2017
- Preparation for Construction MoU ongoing
- Sharpened physics focus and detector start sequence

Timeline of $\overline{\mathrm{P}}$ANDA

- All TDRs of Phase 1 to be complete by 2018
- Start of construction in 2014 for some systems
- Ready for mounting at FAIR from 2021
- Installation takes 2 years

$\overline{\mathrm{P}}$ANDA & FAIR start in hadron physics with $\bar{p}$ from 2025

- Versatile physics machine with full detection capabilities
- $\overline{\mathrm{P}}$ANDA will shed light on many of today's QCD puzzles

The $\overline{\text{P}}$ANDA Collaboration

More than 450 physicists from 70 institutions in 19 countries

Aligarh Muslim University
U Basel
IHEP Beijing
U Bochum
Magadh U, Bodh Gaya
BARC Mumbai
IIT Bombay
U Bonn
IFIN-HH Bucharest
U & INFN Brescia
U & INFN Catania
NIT, Chandigarh
AGH UST Cracow
JU Cracow
U Cracow
IFJ PAN Cracow
GSI Darmstadt

Karnatak U, Dharwad
TU Dresden
JINR Dubna
U Edinburgh
U Erlangen
NWU Evanston
U & INFN Ferrara
FIAS Frankfurt
LNF-INFN Frascati
U & INFN Genova
U Glasgow
U Gießen
Birla IT&S, Goa
KVI Groningen
Sadar Patel U, Gujart
Gauhati U, Guwahati
IIT Guwahati
Jülich CHP

Saha INP, Kolkata
U Katowice
IMP Lanzhou
INFN Legnaro
U Lund
HI Mainz
U Mainz
U Minsk
ITEP Moscow
MPEI Moscow
U Münster
BINP Novosibirsk
Novosibirsk State U
IPN Orsay
U & INFN Pavia
Charles U, Prague
Czech TU, Prague
IHEP Protvino

PNPI St. Petersburg
U of Sidney
U of Silesia
U Stockholm
KTH Stockholm
Suranree University
South Gujarat U, Surat
U & INFN Torino
Politecnico di Torino
U & INFN Trieste
U Tübingen
TSL Uppsala
U Uppsala
U Valencia
SMI Vienna
SINS Warsaw
TU Warsaw