JÜLICH
FORSCHUNGSZENTRUM

KHuK-Meeting 2016, Bad Honnef

COSY-Jülich

A Status Report

December 2, 2016 | Hans Ströher (Forschungszentrum Jülich)

COSY – Hadron Physics Era

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The legacy of the experimental hadron physics programme at COSY

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Abstract. The experimental hadronic physics programme at the COoler SYnchrotron of the Forschungszentrum Jülich terminated at the end of 2014. After describing the accelerator and the associated facilities, a review is presented of the major achievements in the field realized over the twenty years of intense research activity.

Highlights:
- Elastic pp- and pn-scattering data base (EDDA, ANKE, KOALA)
- Dibaryon state in np → d $\pi^0\pi^0$, supported by A_y in np scattering
- Evidence for η-mesic nuclei from pd → ^{3}He η
- Precision measurement of the η-mass ($\Delta p/p \sim 10^{-5}$)
- Proof-of-principle for „spin filtering“ (ERC AdG POLPBAR)
- (…)

COSY – Test Facility Era

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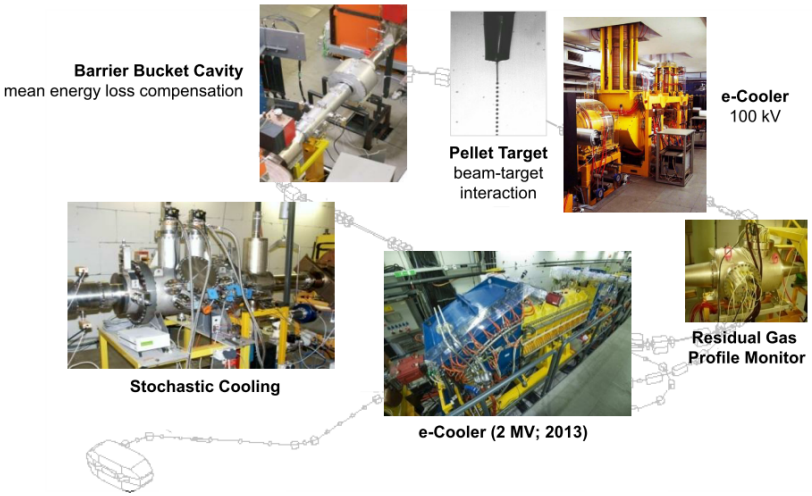
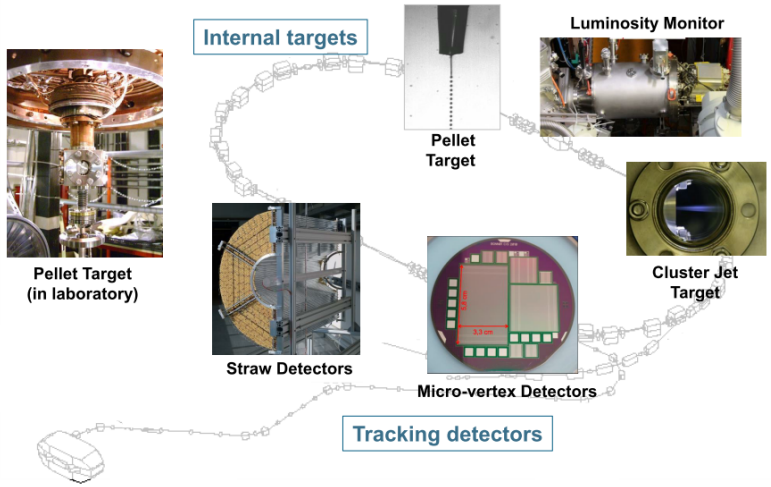
COSY Facility: Developments Related to HESR



Test bench for accelerator components and operation

COSY Facility: Developments for PANDA



Pre-assembly of major PANDA components in Jülich

CBAC recomends → beam time schedule 2016/17:

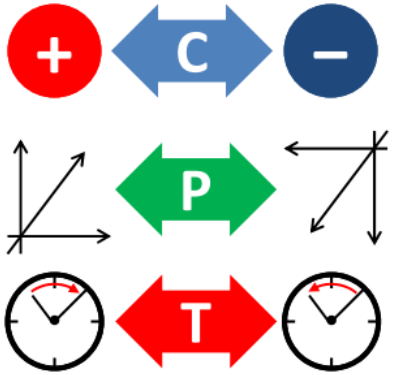
	October				November						December		
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
	03/10/16	10/10/16	17/10/16	24/10/16	31/10/16	07/11/16	14/11/16	21/11/16	28/11/16	05/12/16	12/12/16	19/12/16	26/12/16
Monday	Maintenance	COSY tunnel limitted access, cyclotron operation	MD	FAIR PANDA MVD (D001.2)	INT (D006.2) & INM (A006)	MD	JEDI Polarisation database (E004)		FAIR PANDA STT (D002.2)	MD	JEDI Polarimeter (E002.2)	COSY tunnel limitted access	Maintenance
Tuesday													
Wednesday													
Thursday													
Friday													
Saturday													
Sunday													

1st quarter of 2017

	January 2017				February							March	
Week	1	2	3	4	5	6	7	8	9	10	11	12	13
	02/01/17	09/01/17	16/01/17	23/01/17	30/01/17	06/02/17	13/02/17	20/02/17	27/02/17	06/03/17	13/03/17	20/03/17	27/03/17
Monday	COSY tunnel limitted access	Maintenance	Maintenance	Maintenance	MD	FAIR CBM (D004.2)	FAIR CBM (D004.3)	MD	stochastic cooling (A001.3)	2 MeV electron cooler (A002.3)			
Tuesday													
Wednesday													
Thursday													
Friday													
Saturday					unpolarized protons								
Sunday													

COSY – Precision Physics Era

Symmetry violations (e.g. η-decays, nuclear reactions (→ TRIC))



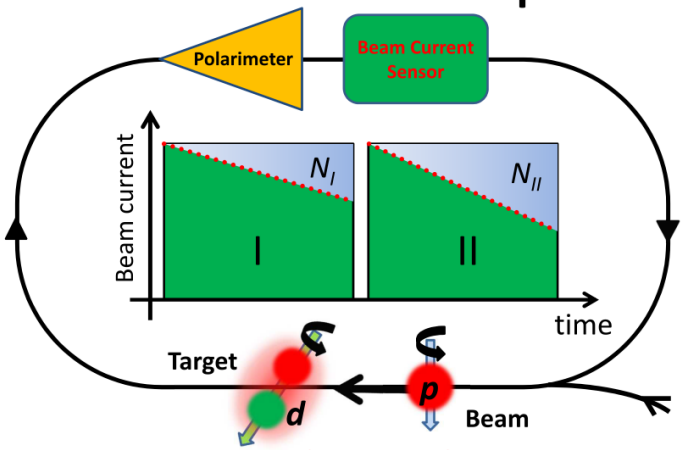
Principle of TRIC

Genuine T-violating observable in $\vec{p}\vec{d}$ scattering: $A_{\vec{p},\vec{d}}$

$$A_{\vec{p},\vec{d}} \sim \frac{N_I - N_{II}}{N_I + N_{II}} \sim \begin{cases} = 0 & \text{T conserved} \\ \neq 0 & \text{T violated} \end{cases}$$

Trick behind TRIC: T reversal via spin-flip!

Measurement Principle



Comparison of slopes for I and II

COSY – Precision Physics Era

TRIC (Time Reversal Invariance)

Associated with document Ref. Ares(2016)3472685 - 15/07/2016

[Panel: PE2, Page 1, 15072016]

Step 2 Evaluation Report

CONFIDENTIAL

Call reference	Call for proposals for ERC Starting Grant
Activity	Starting Grant
Funding scheme	ERC Starting Grant
Panel name	PE2 Fundamental Constituents of Matter
Proposal No.	715844
Acronym	TRIC
Applicant Name	[redacted]
Title	Test of Time Reversal Invariance at COSY

PANEL SCORE AND RANKING RANGE

Final panel score : A (fully meets the ERC's excellence criterion and is recommended for funding if sufficient funds are available)	Ranking range* [redacted]

* Ranking range of your proposal out of the proposals evaluated by the panel in Step 2, in percent, from 1% for the highest ranked proposals to 100% for the lowest ranked.

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HGF *Programme oriented Funding* (PoF-3, 2015-2019)

Matter and Universe (MU); *Cosmic Matter in the Laboratory* (CML)

Programme Topic 2

- The Helmholtz Institute Mainz (HIM) research in nuclear and hadron physics is clearly of considerable mutual benefit for FAIR, GSI and the Johannes Gutenberg Universität *Mainz* (JGU Mainz), and should be continued. The (super-heavy elements) SHE group at HIM has proposed a credible plan that involves research at foreign institutions and Mainz while FAIR construction continues. SHE research at HIM should be maintained during the FAIR construction period.
- The Review Panel fully supports a first phase of EDM measurements using the COSY cooler storage ring to establish by the end of PoF-3 the feasibility of a future EDM measurement.
- Given the unique future scientific opportunities in the field of ultra-relativistic (TeV-scale) heavy ion physics, it is essential that the ALICE effort be restored to the level supported in mid-PoF-2 to be able to complete the ALICE TPC detector upgrade and to continue its leading role in the ALICE experiment at LHC.

COSY – Precision Physics Era

srEDM (Electric Dipole Moments)

[Panel: PE2, Page 1, 09032016]

Ref. Ares(2016)1194155 - 09/03/2016

Step 2 Evaluation Report

CONFIDENTIAL

Call reference	ERC-2015-AdG
Activity	ERC-ADG
Funding scheme	ERC-ADG-2015
Panel name	PE2
Proposal No.	694340
Acronym	srEDM
Applicant Name	Hans STROEHER
Title	Search for electric dipole moments using storage rings

+ RWTH
+ UNIFE

PANEL SCORE AND RANKING RANGE

Final panel score : A (fully meets the ERC's excellence criterion and is recommended for funding if sufficient funds are available)	Ranking range*: 1%-37%

* Ranking range of your proposal out of the proposals evaluated by the panel in Step 2, in percent, from 1% for the highest ranked proposals to 100% for the lowest ranked.

COSY – Precision Physics Era

srEDM (Electric Dipole Moments): achievements (JEDI collaboration)

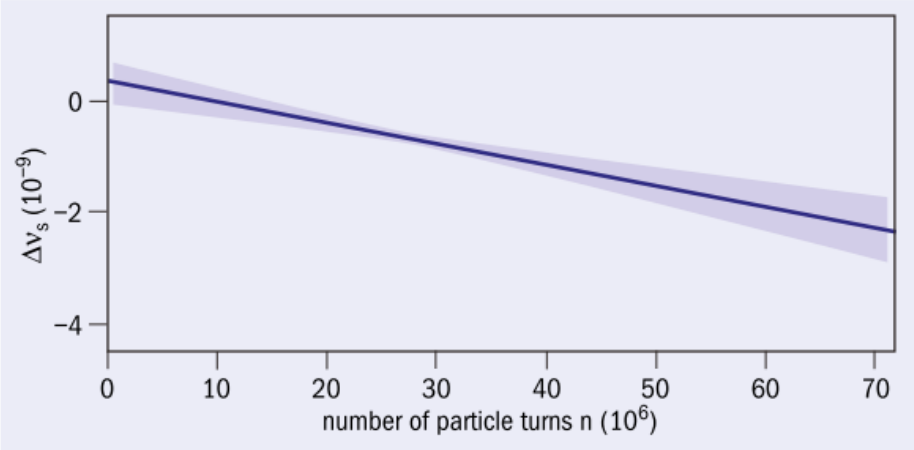

Fig. 2. Deviation of the spin tune ν_s, which is defined as the number of spin precessions per turn, as a function of the number of turns in the ring. At t = 38 s (about 28×10^6 turns), the interpolated spin tune amounts to $16097540628.3 \pm 9.7 \times 10^{-11}$, which represents the most precise measurement of this quantity ever performed. The previous best measurement, performed for the muon at the (g–2) experiment, had a precision of 3×10^{-8} per year. The higher precision achieved here is mainly attributed to the much longer measurement time of 100 s compared with 600 μs in the (g–2) experiment.

CERN Courier September 2016

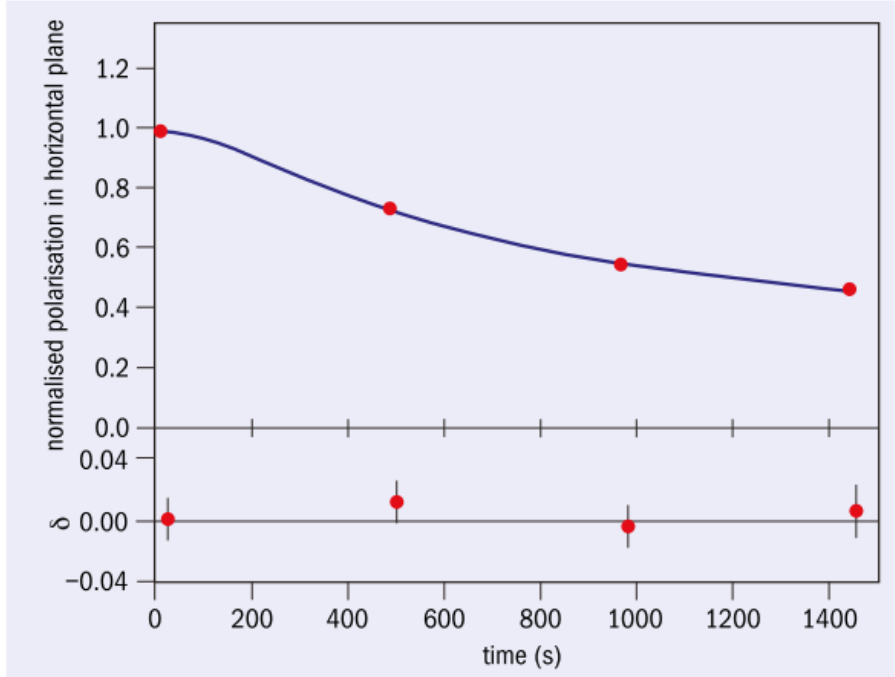

Fig. 3. One of the longest polarisation lifetimes recorded for the COSY ring. Measurements made at four separate times (to conserve beam) are matched to a depolarisation curve that assumes a Gaussian distribution of transverse oscillation amplitudes. The half-life of the polarisation is 1173±172 s, which is three orders of magnitude longer than previous results using electron beams. δ shows the difference between the model and

COSY – Precision Physics Era

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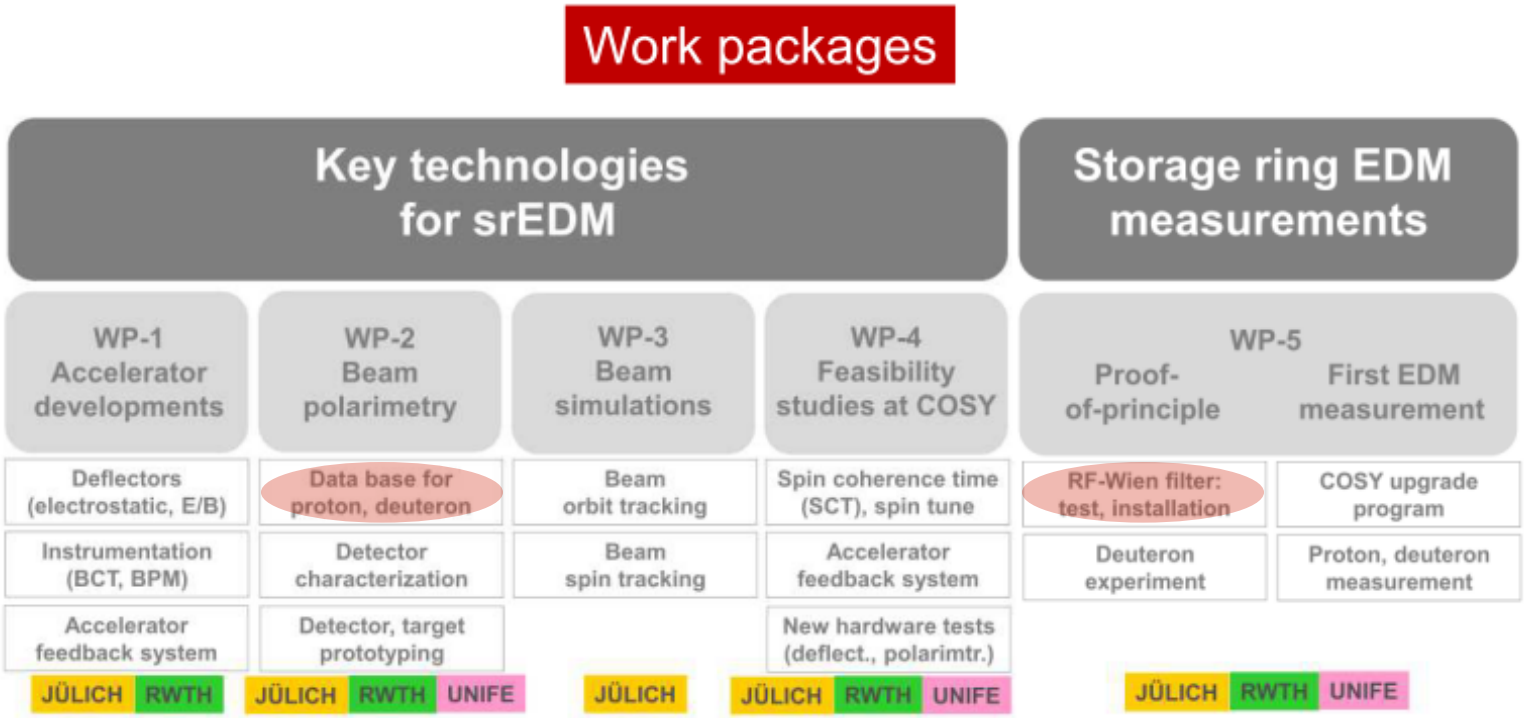
srEDM (Electric Dipole Moments): next steps



Duration srEDM: 10/2016 – 9/2021

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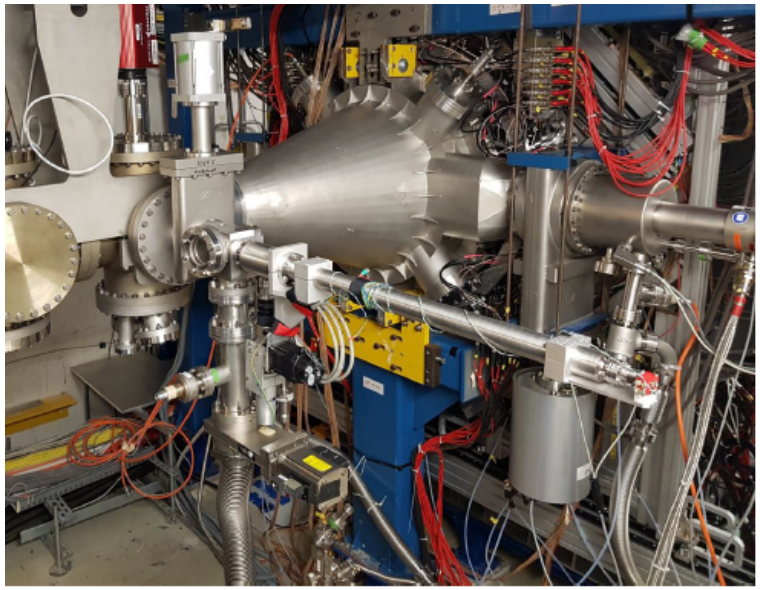
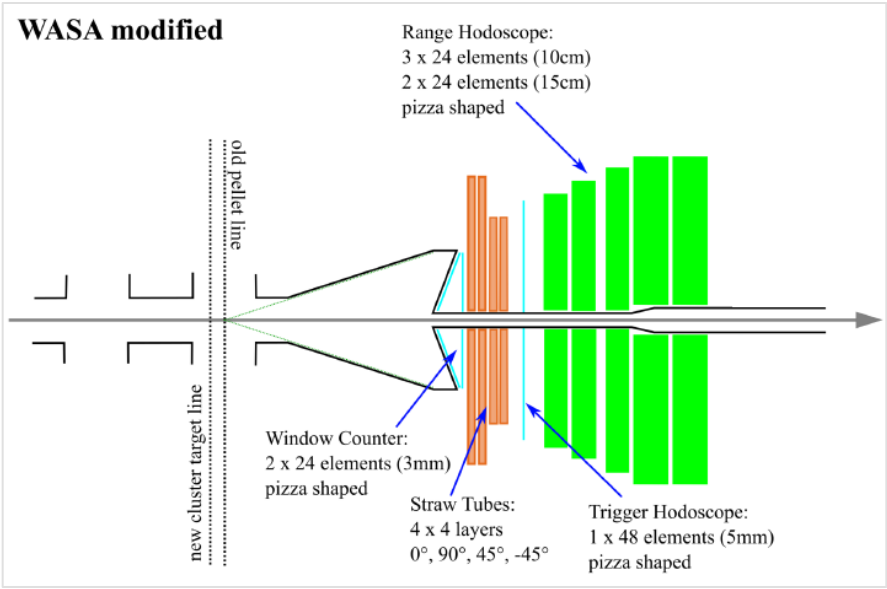
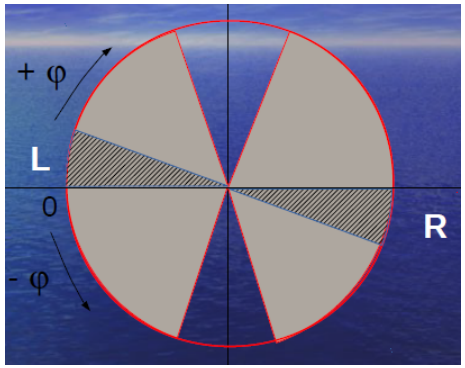
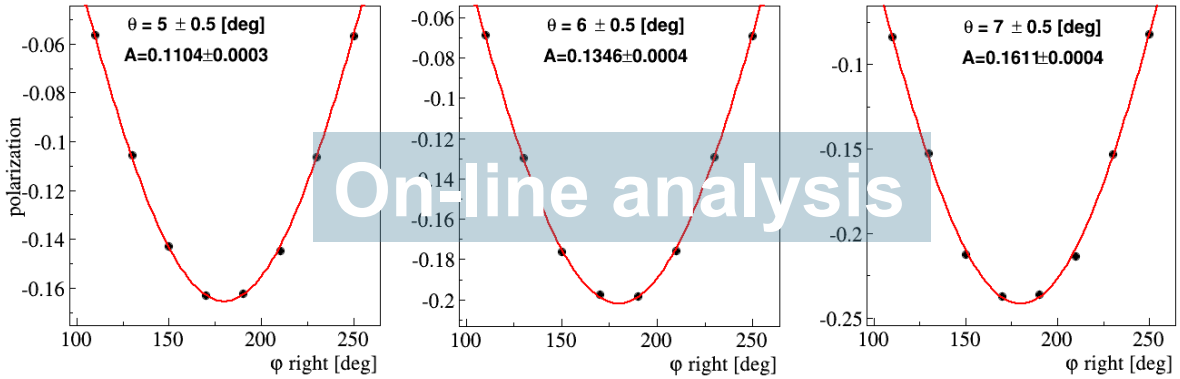
srEDM: ongoing in 2016 → data base for $\vec{d}$C elastic scattering









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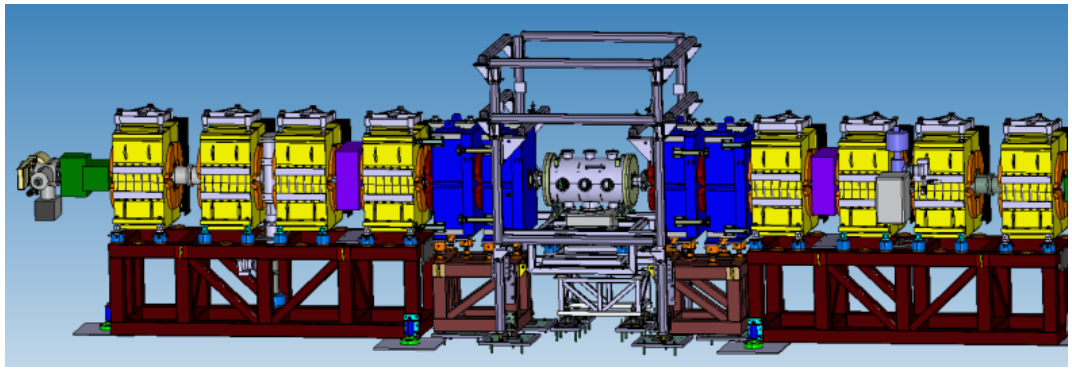
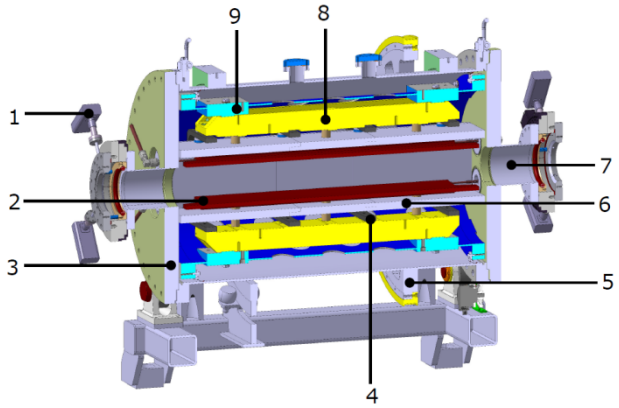
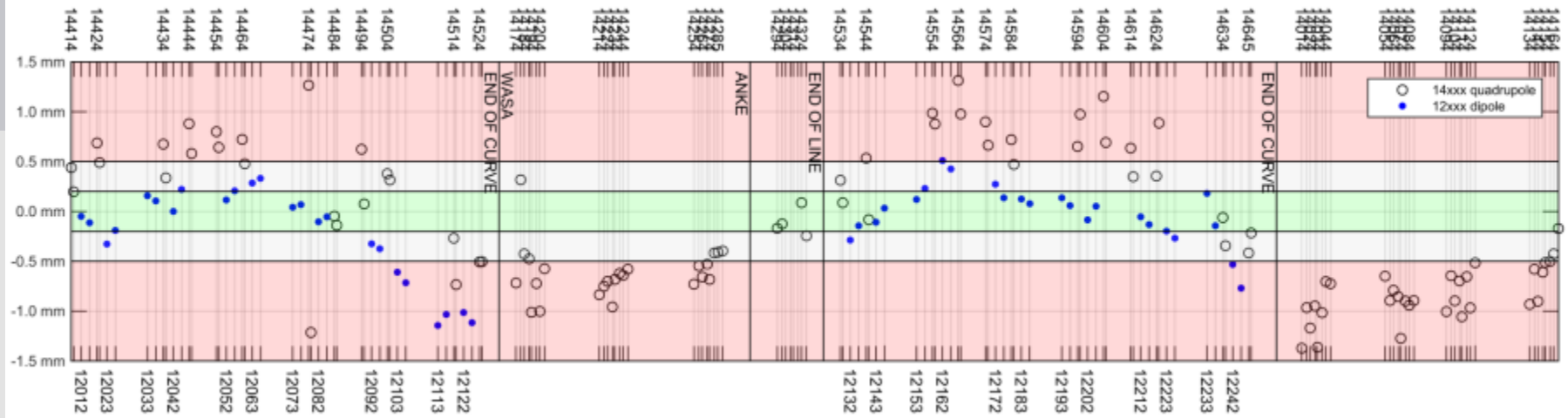
srEDM: plan for 2017 → RF-Wien filter







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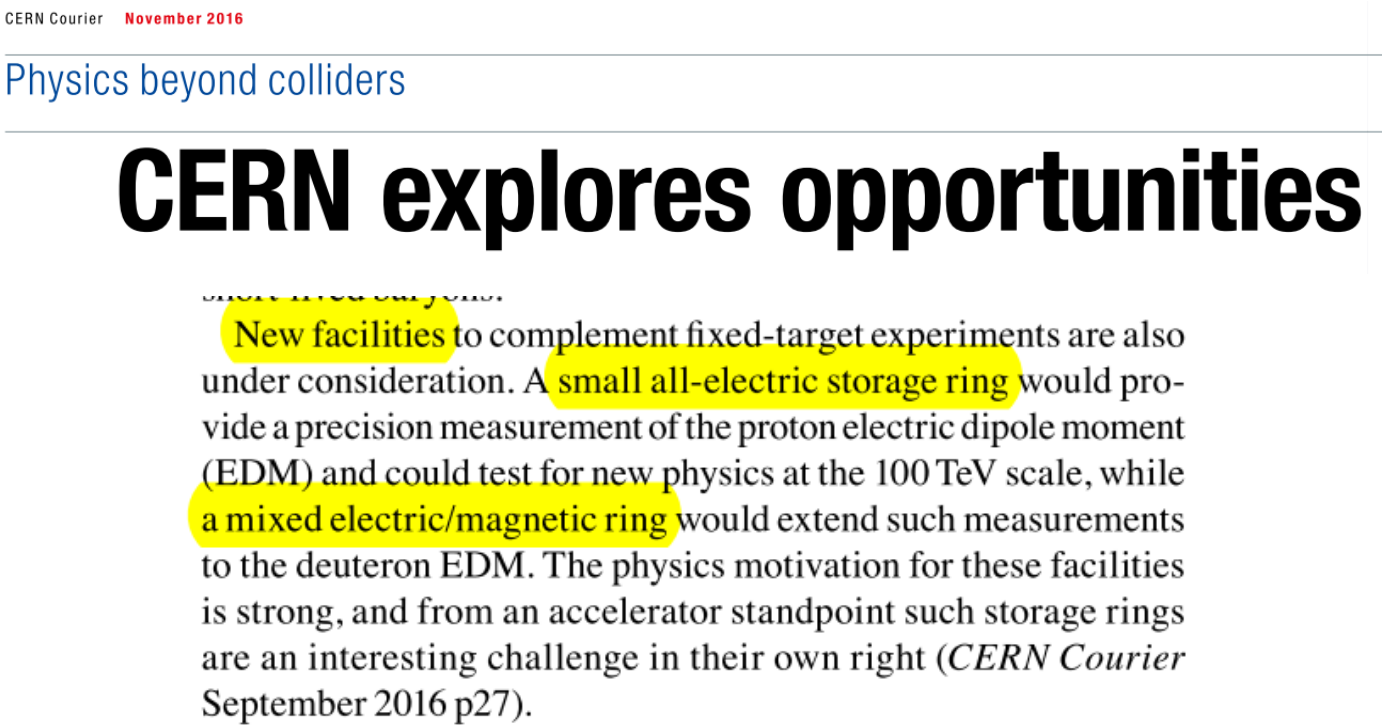
srEDM: beyond 2021



CERN Courier November 2016

Physics beyond colliders

CERN explores opportunities

New facilities to complement fixed-target experiments are also under consideration. A small all-electric storage ring would provide a precision measurement of the proton electric dipole moment (EDM) and could test for new physics at the 100 TeV scale, while a mixed electric/magnetic ring would extend such measurements to the deuteron EDM. The physics motivation for these facilities is strong, and from an accelerator standpoint such storage rings are an interesting challenge in their own right (*CERN Courier* September 2016 p27).

COSY will be extremely useful as preparation, proof-of-principle and verification machine (unique world-wide!) → precision storage ring!

COSY – IKP and FZJ Strategy

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FZJ management plans to phase-out COSY, in fact the whole IKP (no fit to new scientific portfolio):

- HESR and PANDA ←→ agreement w/ GSI/FAIR !?
- Accelerator physics ←→ service institute at FZJ !?
- EDM project ←→ continue elsewhere !
- JARA-Fame (EDM, ν) ←→ ???

Loss of know-how:

- Cyclotron and storage rings (e.g. phase-space cooling)
- Hadron physics with hadronic probes (internal experiments)
- Polarization (beams, targets, polarimetry, spin tracking)
- Electrostatic (E) and E-B deflectors

We need KHuK support for this NOT to happen!


Thank you!