

Welcome to Liverpool !



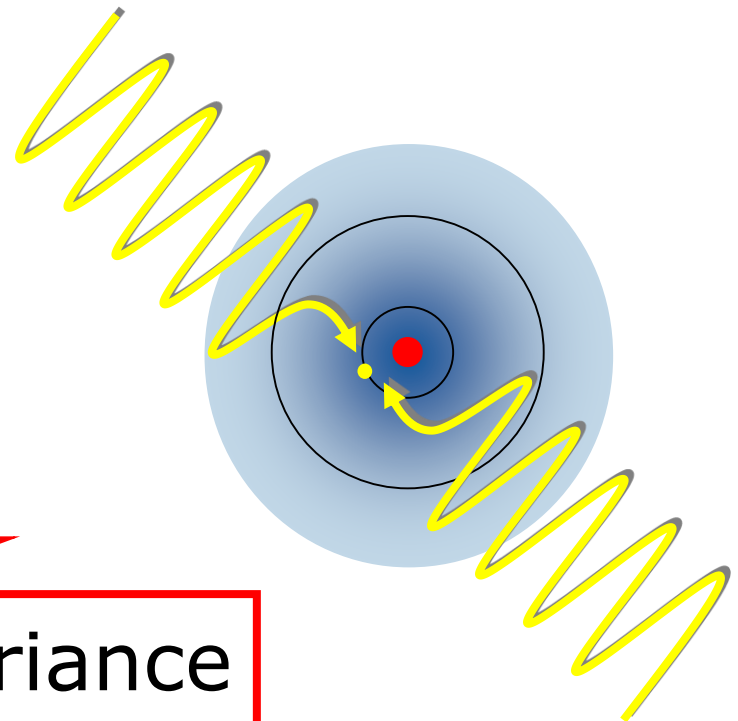
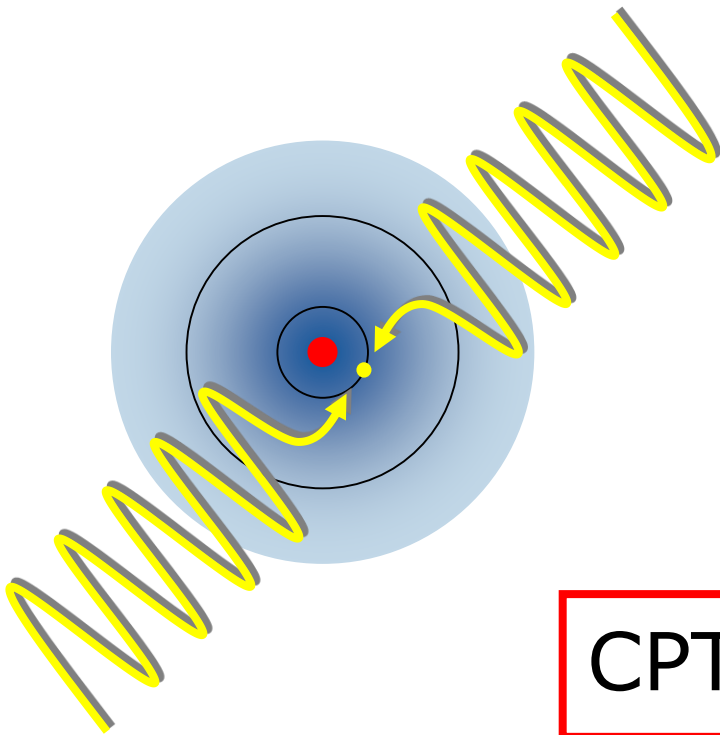
Overview

- Project Background
- Liverpool group and members
- HLLHC-UK Project – status
- Highlights in 2017

Same Structure ?

Hydrogen

Anti-Hydrogen



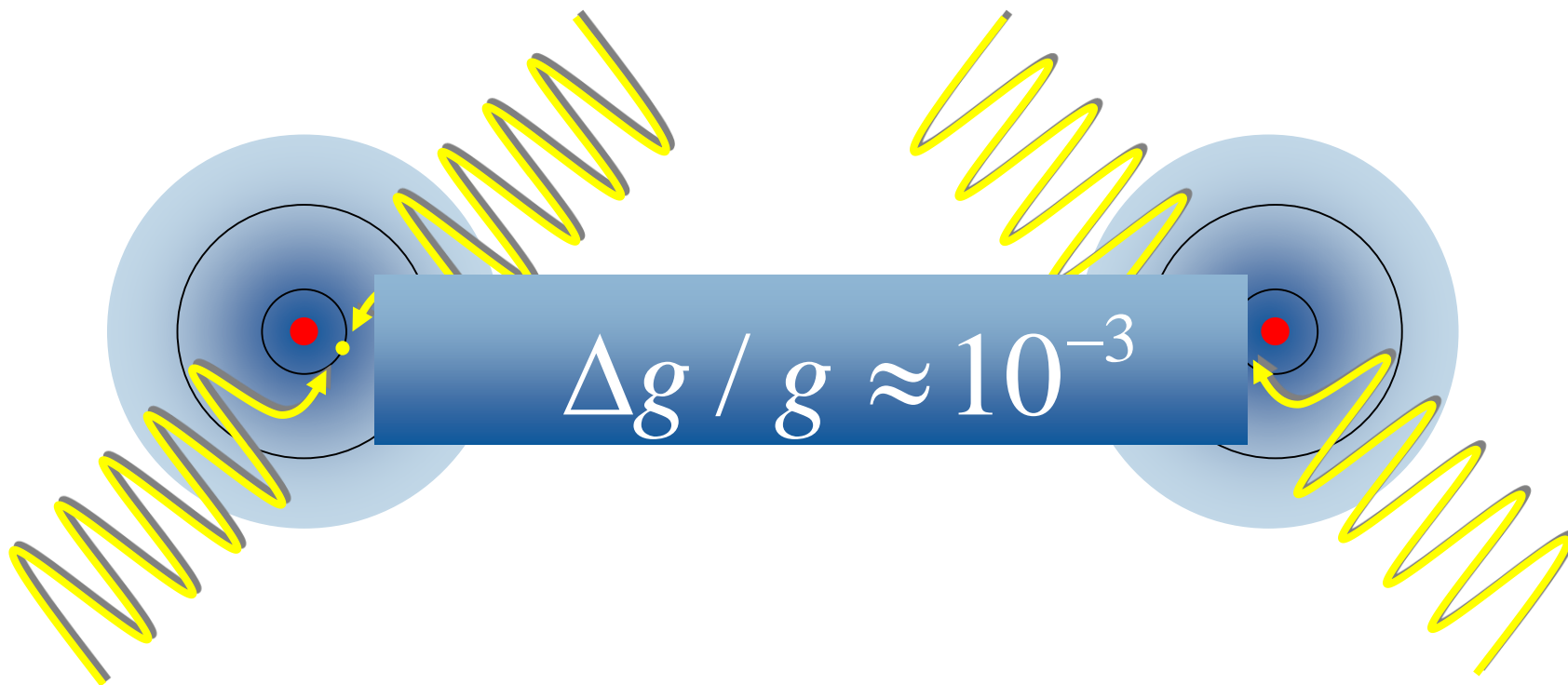
CPT Invariance

$$\Delta E / E \approx 10^{-14} \dots 10^{-18}$$

Same Weight ?

Hydrogen

Anti-Hydrogen

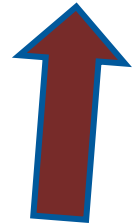
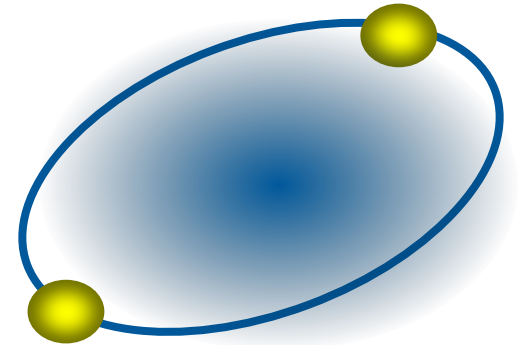


The task:

Few-body problem: Interaction with "clean" projectile.

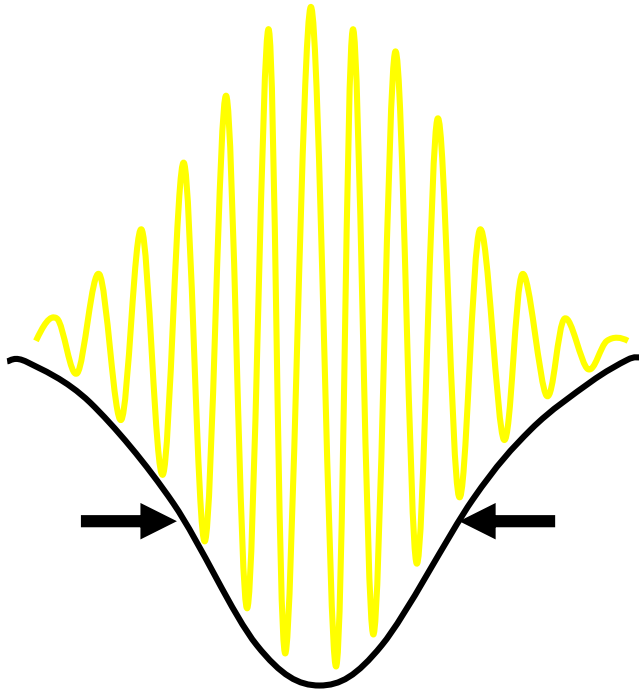
Important:

- No (or only few) add. reaction channels,
- Possibility to control perturbation strength Z/v ,
- Variation of interaction time between as \Rightarrow fs.

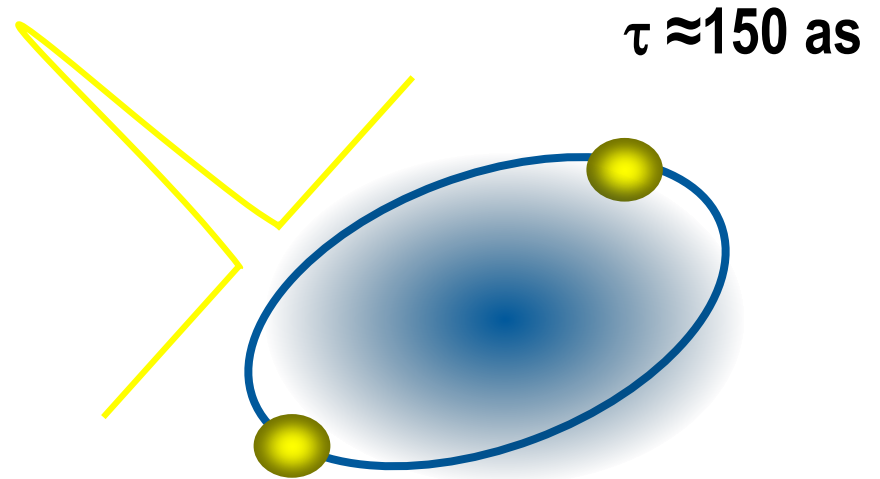


Why Antiprotons ?

~~Laser~~



$t = 30 \dots 6 \dots 3.5 \text{ fs}$

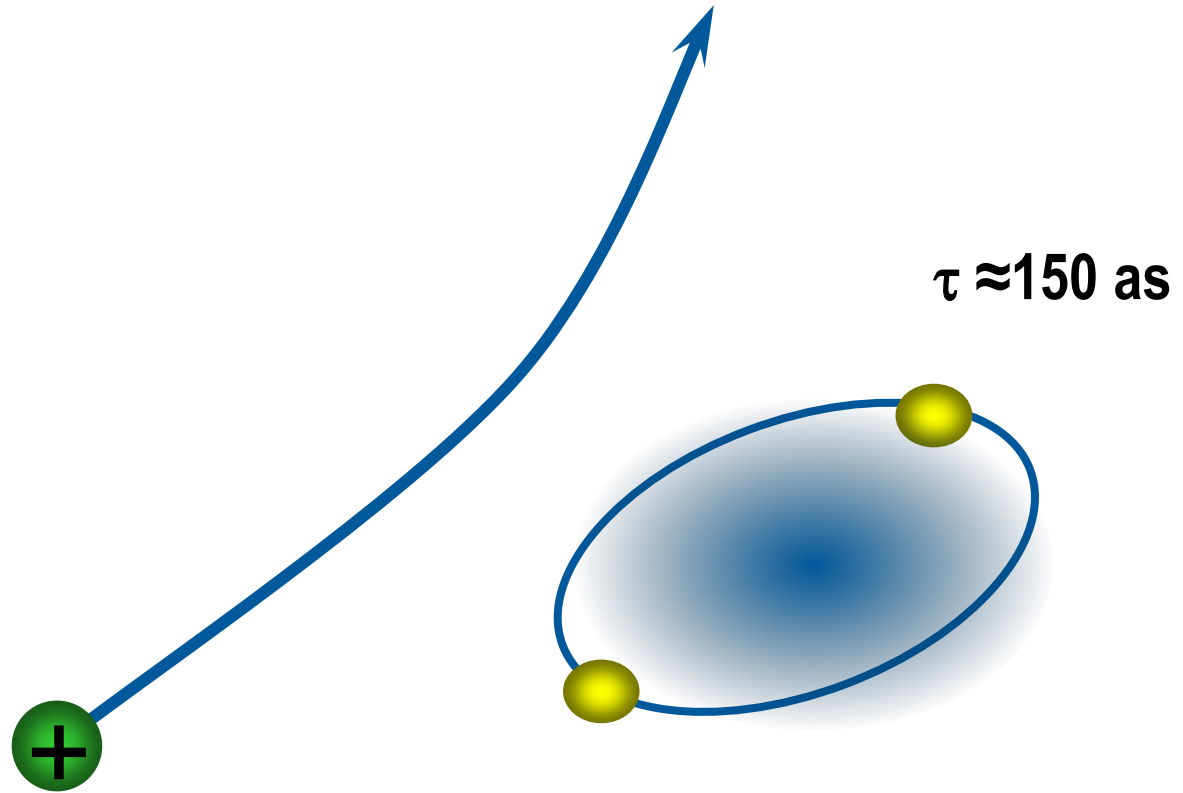


$I \geq 10^{15} \text{ W/cm}^2$

Why Antiprotons ?

~~Laser~~

~~Pos. Ions~~



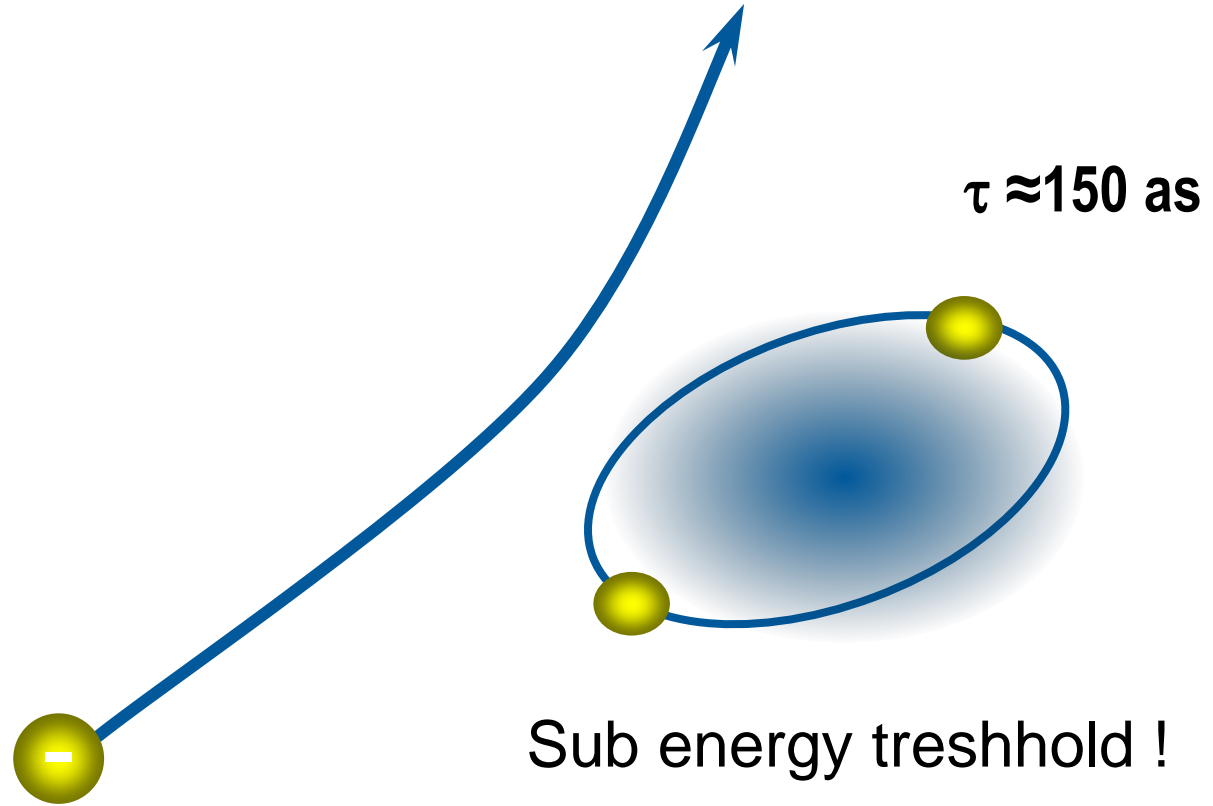
Dominated by capture !

Why Antiprotons ?

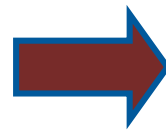
~~Laser~~

~~Pos. Ions~~

~~Electrons~~

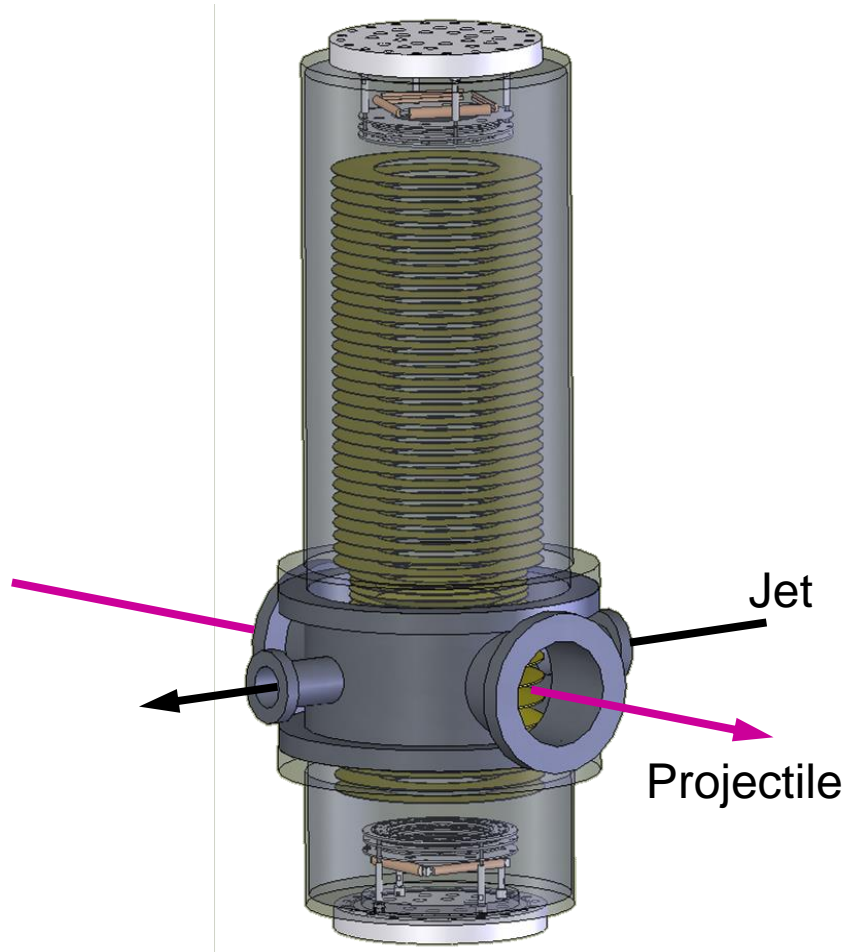


Sub energy treshhold !



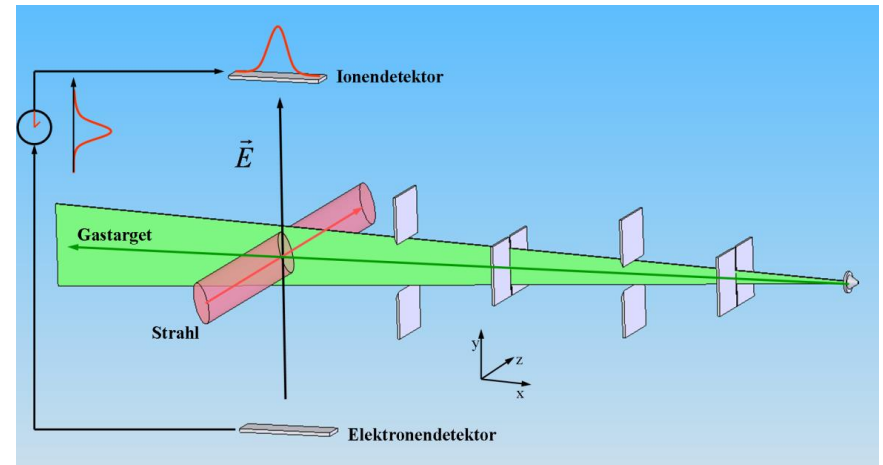
Antiprotons !!!

USR – Subprojects in QUASAR Group



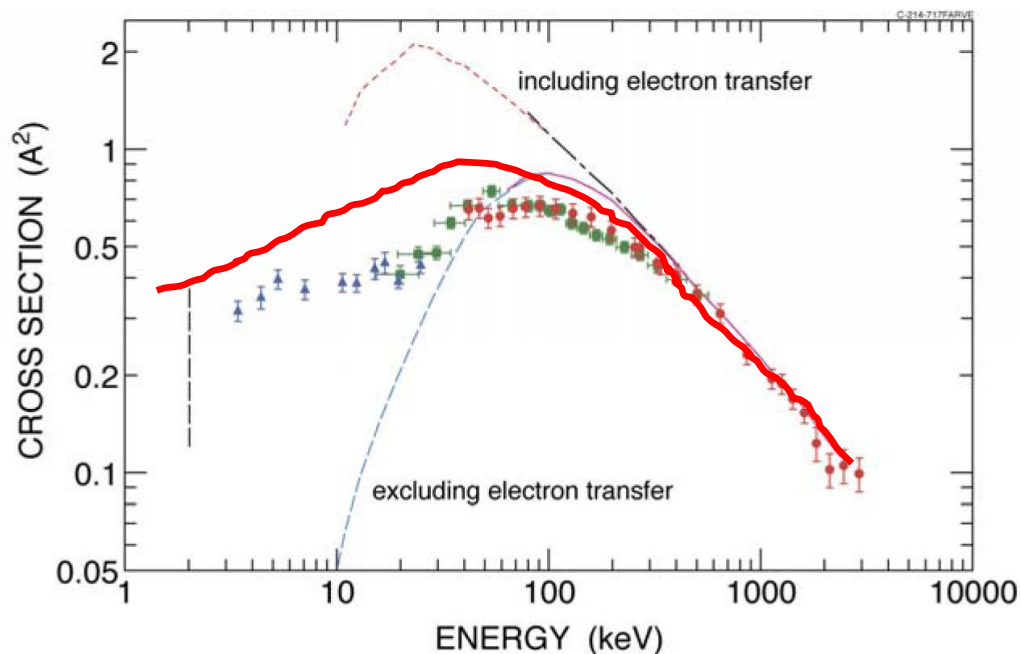
In-ring Reaction Microscope

Design of the experiment.



Ionization Cross Sections

- Can be exotic, e.g. single ionization of helium by antiproton impact – but why not protons ???



H. Knudsen, *Hyperfine Interactions* **109** (1997) 133–143
 H. Knudsen, *Journal of Physics:Conf. Series* **194** (2009) 012040

$$\#_{\text{Events}} = \frac{\#_{\text{ions}}}{C} \cdot v \cdot \sigma(E) \cdot \rho_{\text{target}} \cdot W_{\text{target}}$$

QUASAR Group research

■ Frontier Accelerators

- Particle Colliders (e.g. LHC and its upgrades), Antimatter Facilities R&D, next-generation light sources:

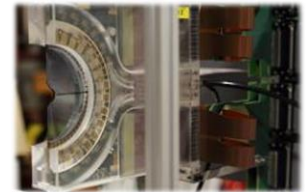
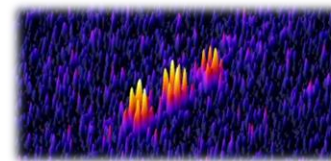
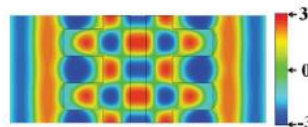
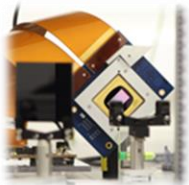
Design, optimization and R&D into underpinning technologies

■ Novel Accelerators

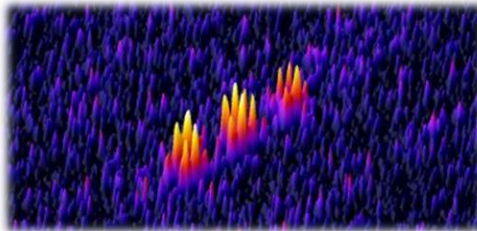
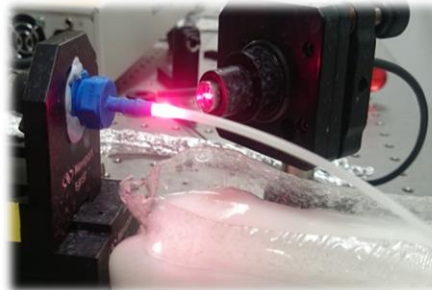
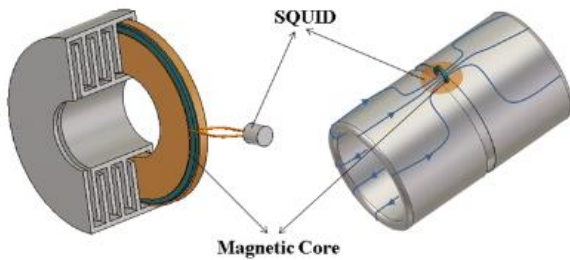
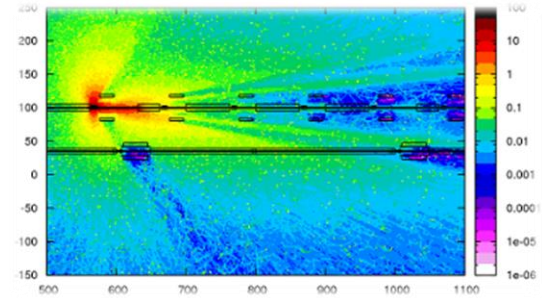
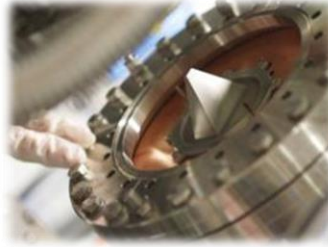
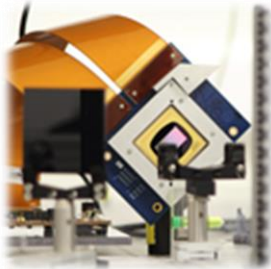
- Plasma wakefield accelerators, ultra-compact dielectric laser accelerators: Numerical studies and advanced diagnostics R&D

■ Accelerator Applications

- Medical Applications, commercialization of research: Imaging, treatment and simulations



Our Diagnostics R&D (examples)



@ CI, CERN, RIKEN, Australian Synchrotron, ESS, CCC, etc.
Benefit from lab infrastructure

Project Status

- Start date was 01/14/16 (*awarded later*)
- STFC new money awarded 1.56M, mainly for equipment - award delayed by UK spending review;
- UK institute ring-fenced money not awarded but highly likely – later in 2017;
- CERN contract final, signature still (!) pending.
- HLLHC-UK collaboration working well.

Finance Data: STFC

	Authorised FEC (£)			RC Contribution (£)			% FEC
	net	Indexation	Total	net	Indexation	Total	
DI - Staff	51,564	840	52,404	41,251	672	41,923	80
DI - T&S	15,188	310	15,498	12,150	248	12,398	80
DI - Other Costs	115,250	2,353	117,603	92,200	1,882	94,082	80
Total Value of Award	182,002	3,503	185,504	145,601	2,802	148,404	

Start Date	End Date	Duration	FTE Percent	Name or Post Identifier	Summary Fund Heading	Authorised Cost (Excluding Indexation)
1 April 2018	31 March 2019	36	50	Technician	Directly Incurred	51564.27

Finance Data: CERN

- **WP2:** 1 PDRA for 36 months incl. 21 months LTA and some travel money;
- Started 1 September 2016: Fanouria Antoniou
- However, has now LD contract; position reopened.

- **WP3:** 1 PDRA for 36 months incl. 9 months LTA and some travel money;
- Started 1 April 2017: Hao Zhang
- Hardware budget: 180k – includes everything !

Targets: CERN

- To develop a non-invasive measurement of the HL-LHC beam profile using a supersonic gas-jet, building on existing work at the University of Liverpool.
- To optimise the gas-jet beam monitoring scheme, via simulation of the layout and investigate and optimize monitor resolution.
- To deliver a prototype gas-jet beam monitor for a primary beam monitor and electron beam monitor.

■ From proposal *(6 months added following late start)*

M3.4	Installation of a gas-jet monitor on the e-beam test stand	Liverpool	Jan 2017
M3.5	Design of a gas-beam monitor for HL-LHC	Liverpool	Jun 2018
M3.6	Delivery of a prototype gas-jet monitor	Liverpool	Jun 2019

Deliverables and Milestones

D3.6	Availability of a gas-jet monitor		Hardware	Jan 2017
D3.7	Design report for a final gas-jet for HL-LHC		Report	June 2018
D3.8	Full prototype adapted for testing in the LHC		Hardware	June 2019

WP3

Dates	Deliverables	Amount
Apr-16	Start of project	20%
Apr -17	Completion of D3.1, D3.2 and D3.6	25%
Apr -18	Completion of D3.3 and D3.7	25%
Apr -19	Completion of D3.4	20%
Apr -20	Completion of D3.5 and D3.8	10%

Current Status

- Contracts being finalized – *there is hope !*
- We now have a new (bigger) lab at CI;
- Opportunity to operate **three jets** in parallel.
- **PhD students:** Edward Martin just started, Amir Salehilashkajani will start in October
- **Challenges:** Contract delays, value of pound, lab move, HoD, new starters, BIF integration, FZP jet, scanning.

Highlights 2017

- Lab move successfully completed;
- Design of second monitor (almost) done – final quotations available;
- Recruitment of all team members completed;
- Phys Rev AB article just published;
- Excellent feedback at IPAC, etc – demand for monitor type seems high (ELENA, pEDM, ESS, etc.)
- Very good and open discussions with CERN and GSI within WP3 !



U N I V E R S I T Y O F

L I V E R P O O L

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