LUXE

Proposal for a new experiment using a Laser and XFEL to test quantum physics in the strong-field regime

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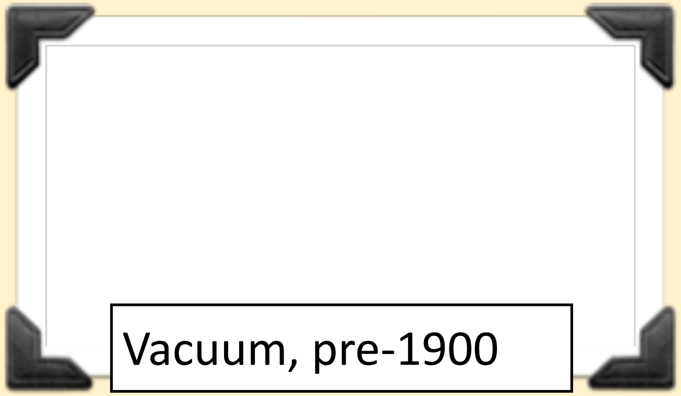
DESY PRC, November 5-6 2020

https://luxe.desy.de/

The Vacuum

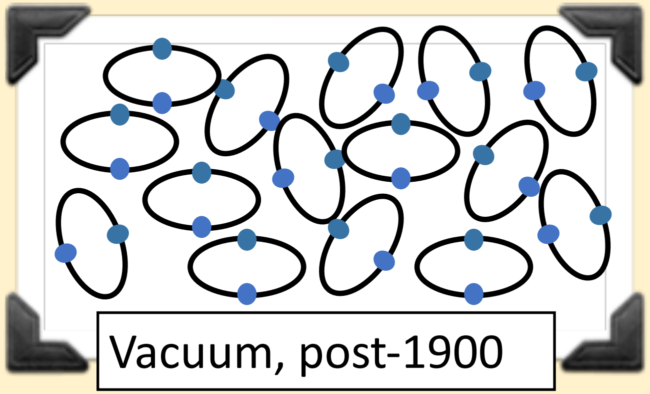
Classical Theory:

- "space devoid of matter"
- "space-time region where all elements of stress-energy tensor are zero"
  → no momentum, energy, particles or fields



Quantum (Field) Theory:

- "state with lowest energy"
- average is zero, but <u>variance non-zero</u>
- vacuum consists of virtual particles
  → can be charged, couple to fields



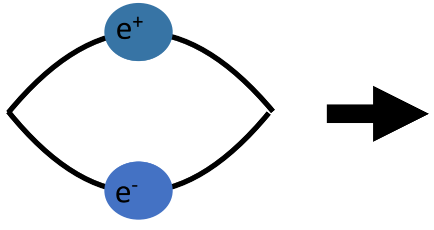
With LUXE we want to boil the vaccum

THE CRITICAL FIELD

Presence of strong external field:

- work by field over Compton wavelength > than two rest masses of particles→ Schwinger-Limit

Schwinger limit: $\varepsilon_{crit} = \frac{m_e^2 c^3}{\hbar e} \simeq 1.3 \cdot 10^{18}\ \mathrm{V/m}$



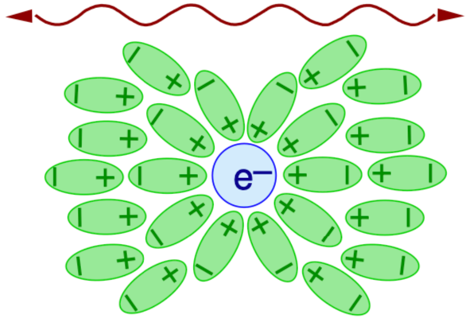
$E_{\text{field}} < 2m_e$ $E_{\text{field}} > 2m_e$

1) Field-Induced Pair Creation:

- pair production from vacuum $P \propto exp\left(-\pi \frac{\varepsilon_{crit}}{\varepsilon}\right)$

2) Modified Compton Spectrum:

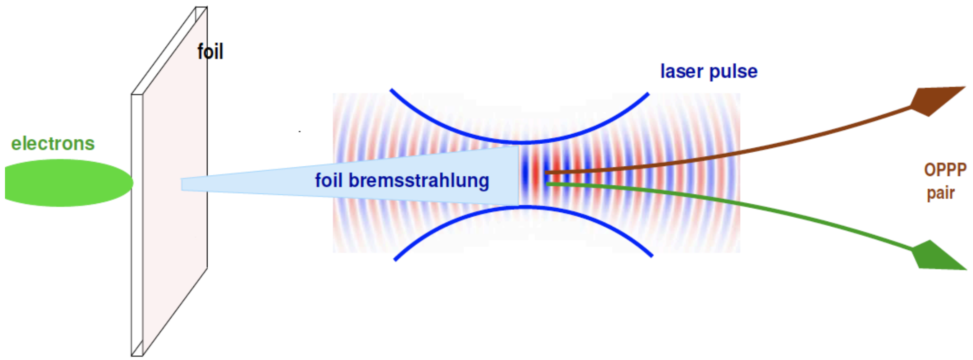
- electron becomes "dressed" => larger effective m_e



LASER AND PHOTON BEAM

- **Use laser to generate electric field**
- **Use high energy electron beam**

$$\xi = \frac{e\varepsilon_L}{m_e\omega_L c} \propto I_{Laser} \qquad \chi \approx \gamma \frac{\varepsilon_L}{\varepsilon_{crit}} \propto \sqrt{I_{Laser}} E_{beam}$$



EU.XFEL E_{beam} up to 17.5 GeV
=> $\gamma = 34{,}000$

- **Laser intensity required to reach Schwinger field ($\chi \sim 1$):**

Photon energy	I_{Laser} [W/cm2]
1 eV	$2\text{x}10^{29}$
1 GeV	$\sim 10^{22}$
10 GeV	$\sim 10^{20}$

=> Much beyond currently achievable values
=> State-of-the-art laser needed (~10 PW)
=> Can use well-tested laser technology (~100 TW)

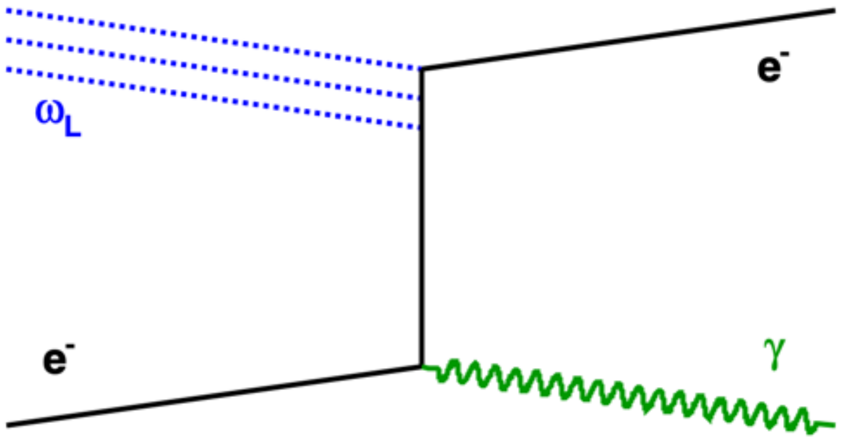
DESY is uniquely positioned to reach critical field in well controlled environment with local infrastructure

MAIN PROCESSES OF INTEREST

Compton

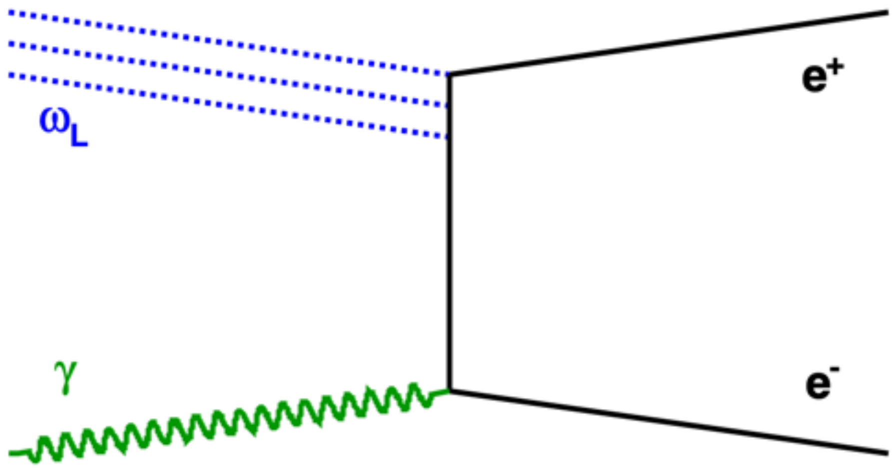
$$e^- + n\omega_L \to e^- + \gamma$$

Low-energy photons from laser



Breit-Wheeler: pair production

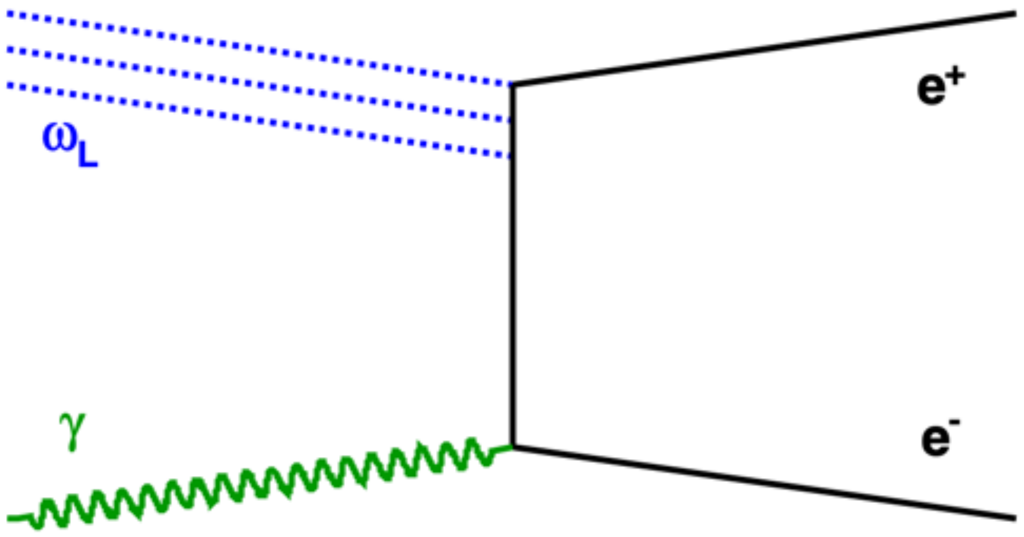
$$\gamma + n\omega_L \to e^+e^-$$

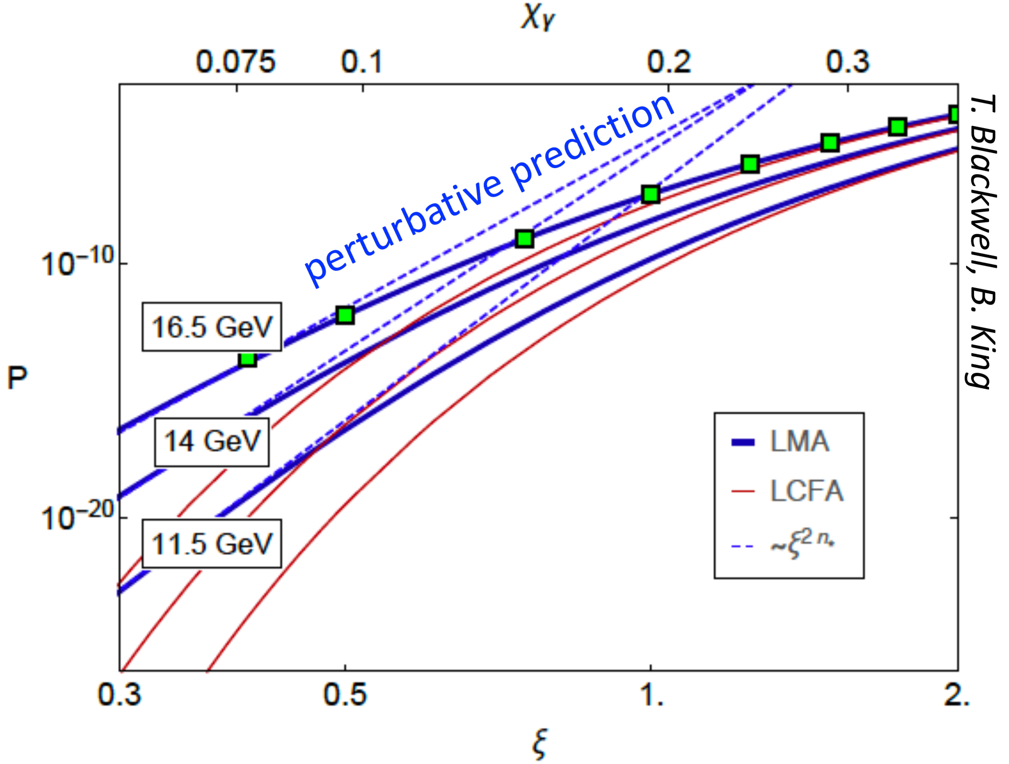


High energy electron or photon interacts with laser

- Also higher order process "trident": $e^- + n\omega_L \to e^-e^+e^-$
- E144 experiment probed $e^- + n\omega_L$ process in perturbative regime
- LUXE first to directly probe $\gamma + n\omega_L \to e^+e^-$ [γ from Brem or inverse Compton]

ABSORBING LIGHT WITH LIGHT



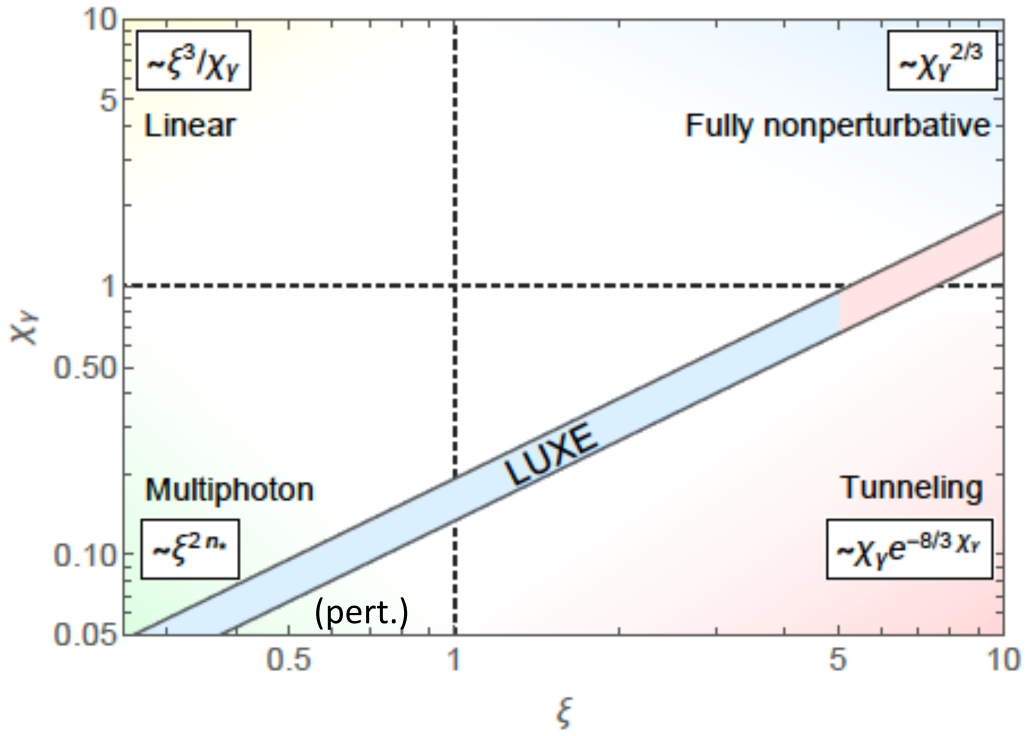


- **Prediction for rate of positrons per laser shot**

$\xi \ll 1$: $R_{e^+} \propto \xi^{2n} \propto I^n$ ☚ Perturbative regime: strong rise, follows power-law

$\xi \gg 1$: $R_{e^+} \propto \chi_\gamma \exp\left(-\frac{8}{3\chi_\gamma}\right)$ ☚ Non-perturbative regime: departure from power-law

GOALS OF LUXE EXPERIMENT AND LOI



Goal: Probe quantum physics in novel regime

- Be the first experiment to pioneer QED in critical field regime in electron- and photon-laser interactions
- Observe transition from perturbative to non-perturbative regime
- Make precise measurements to challenge theoretical predictions

Letter of Intent for the LUXE Experiment

H. Abramowicz[1], M. Altarelli[2], R. Assmann[3], T. Behnke[3], Y. Benhammou[1], A. Borysov[3], M. Borysova[4], R. Brinkmann[3], F. Burkart[3], O. Davidi[8], W. Decking[3], N. Elkina[5], H. Harsh[5], A. Hartin[6], I. Hartl[3], B. Heinemann[3,7], T. Heinzl[9], N. Tal Hod[8], M. Hoffmann[3], A. Ilderton[9], B. King[9], A. Levy[1], J. List[3], A. R. Maier[10], E. Negodin[3], G. Perez[8], I. Pomerantz[1], A. Ringwald[3], C. Rödel[5], M. Saimpert[3], F. Salgado[5], G. Sarri[11], I. Savoray[8], T. Teter[5], M. Wing[6], and M. Zepf[5,11,12]

arXiv: 1909.00860
Sept. 2nd 2019

38 people,
12 institutions

MAJOR NEW DEVELOPMENTS SINCE APRIL PRC

- **Laser**
  - Plan to use existing 40 TW laser in initial phase
  - Major developments on infrastructure and technical feasibility
    - Included visit of XS1 building with laser experts
- **Experimental area**
  - Revised design to ensure technical feasibility
    - CAD drawings and Geant4 simulation
  - Detector strategy and design optimised
  - Background estimates ongoing (Geant4, FLUKA)
- **Physics Case**
  - More realistic simulations of SF QED processes (ongoing)
  - New BSM physics case
- **Work ongoing on *Conceptual Design Report***
  - At present: 57 authors from 22 institutions

Conceptual Design Report for the LUXE Experiment

DRAFT

H. Abramowicz[1], U. Acosta[2,3], M. Altarelli[4], R. Aßmann[5], Z. Bai[6,7], T. Behnke[5], Y. Benhammou[1], T. Blackburn[8], S. Boogert[9], O. Borysov[5], M. Borysova[10], R. Brinkmann[5], F. Burkart[5], K. Büßer[5], N. Cavanagh[11], O. Davidi[6], W. Decking[5], A. Fedotov[11], K. Fleck[12], J. Hallford[13], A. Hartin[13], B. Heinemann[*5,14], T. Heinzl[15], L. Helary[5], N. Tal Hod[6], M. Hoffmann[5,14], X. Huang[5,14], A. Ilderton[15], R. Jacobs[5], B. Kämpfer[2,3], B. King[15], H. Lahno[1], A. Levy[1], I. Levy[16], J. List[5], W. Lohmann[†5], T. Ma[17], E. Negodin[5], G. Perez[6], I. Pomerantz[1], R. Prasad[5], F. Quéré[18], A. Ringwald[5], S. Rykovanov[19], A. Sävert[20], A. Santra[6], G. Sarri[11], S. Schmitt[5], D. Seipt[20], M. Shchedrolosiev[1,5], Y. Soreq[21], S. Tang[15], T. Teter[20], D. Thoden[5], G. Torgrimsson[3], M. Wing[12], and M. Zepf[20,22]

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LASER: JETI-40 LASER BY UNI JENA

- **Institut für Optik und QE of University of Jena (M. Zepf et al.):**
  - Intends to lend LUXE their 40 TW laser!
- **Queens University of Belfast (G. Sarri et al.):**
  - Intends to provide oscillation and synch box for this laser

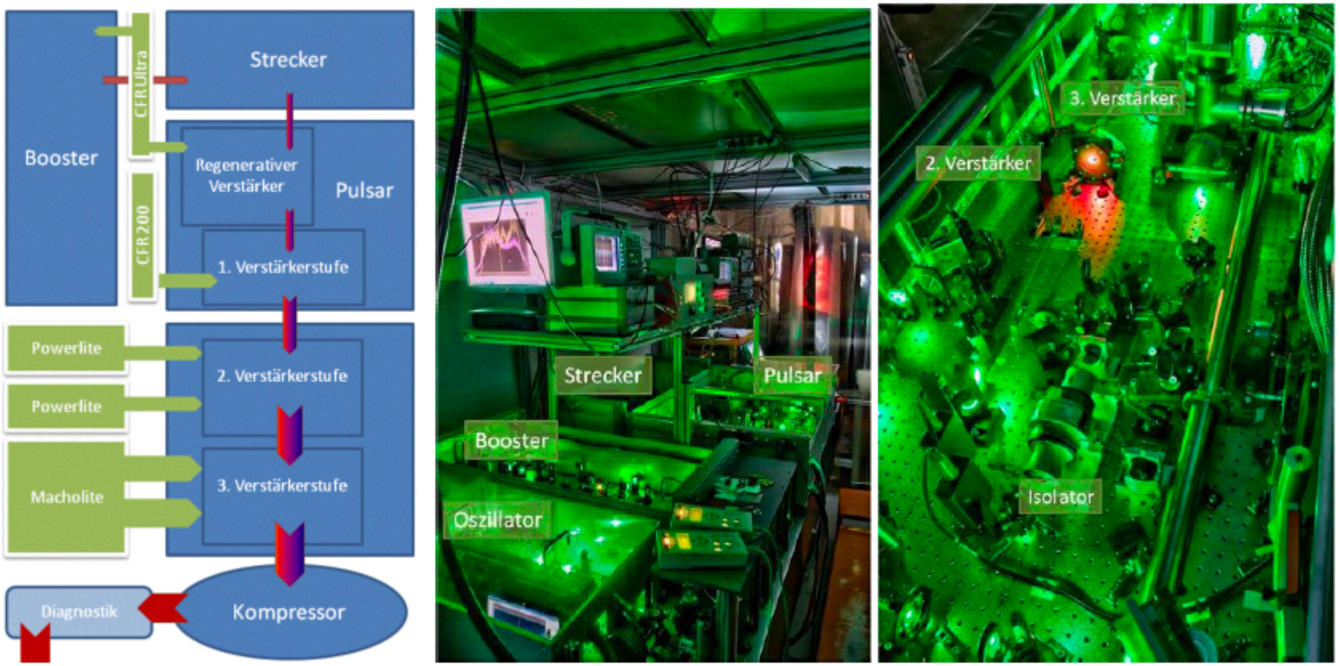
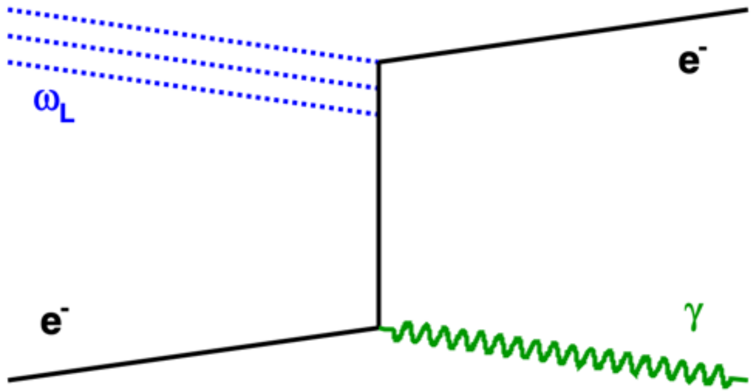
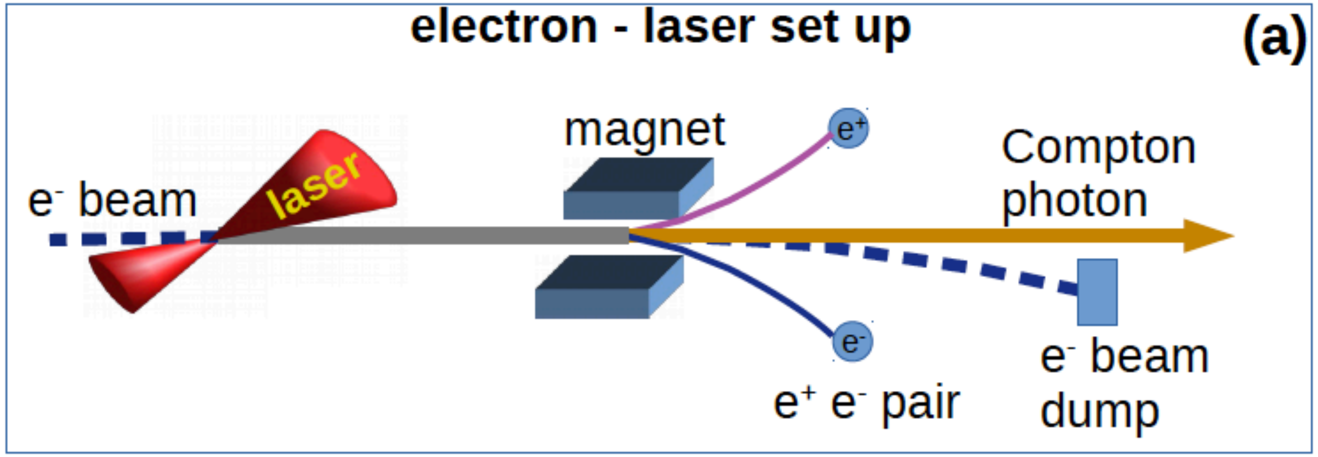
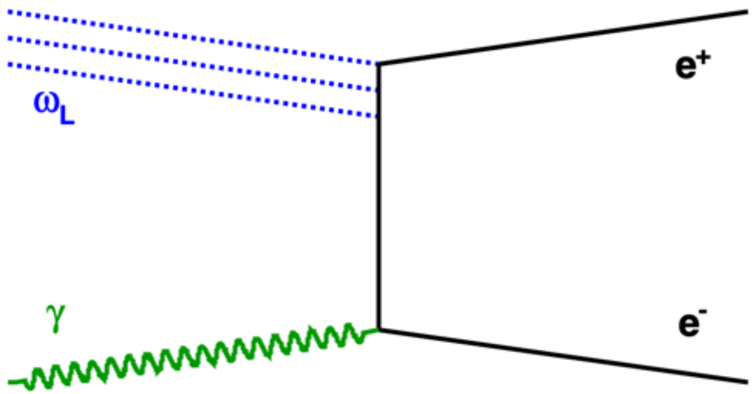


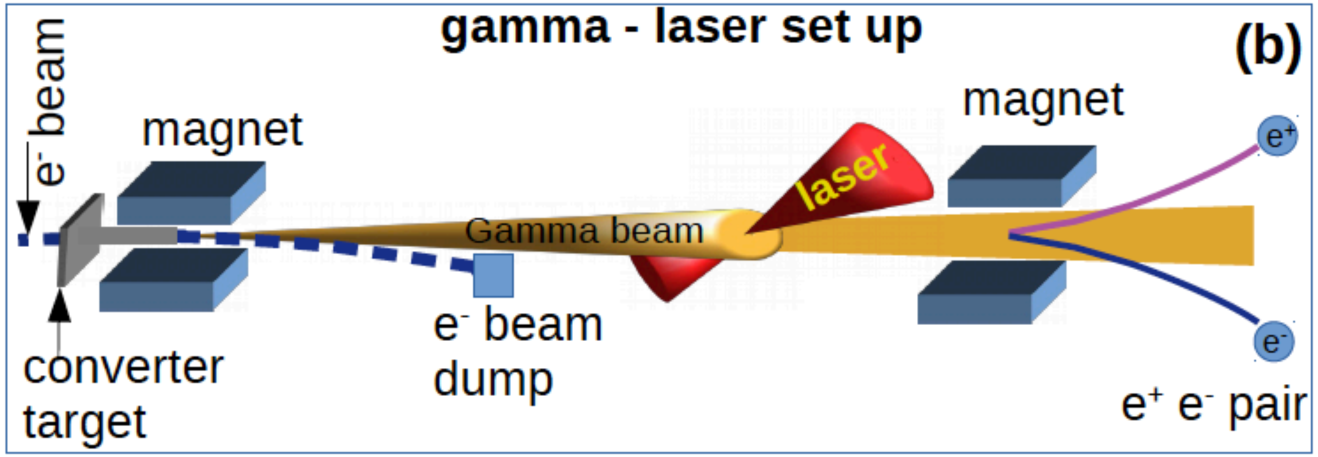
Figure 22. Schematic of the JETI system highlighting major assemblies. Current Installation of JETI-40 at the University of Jena. Front-end is shown in centre and power amplifiers right.

SCHEMATIC LAYOUTS OF EXPERIMENT



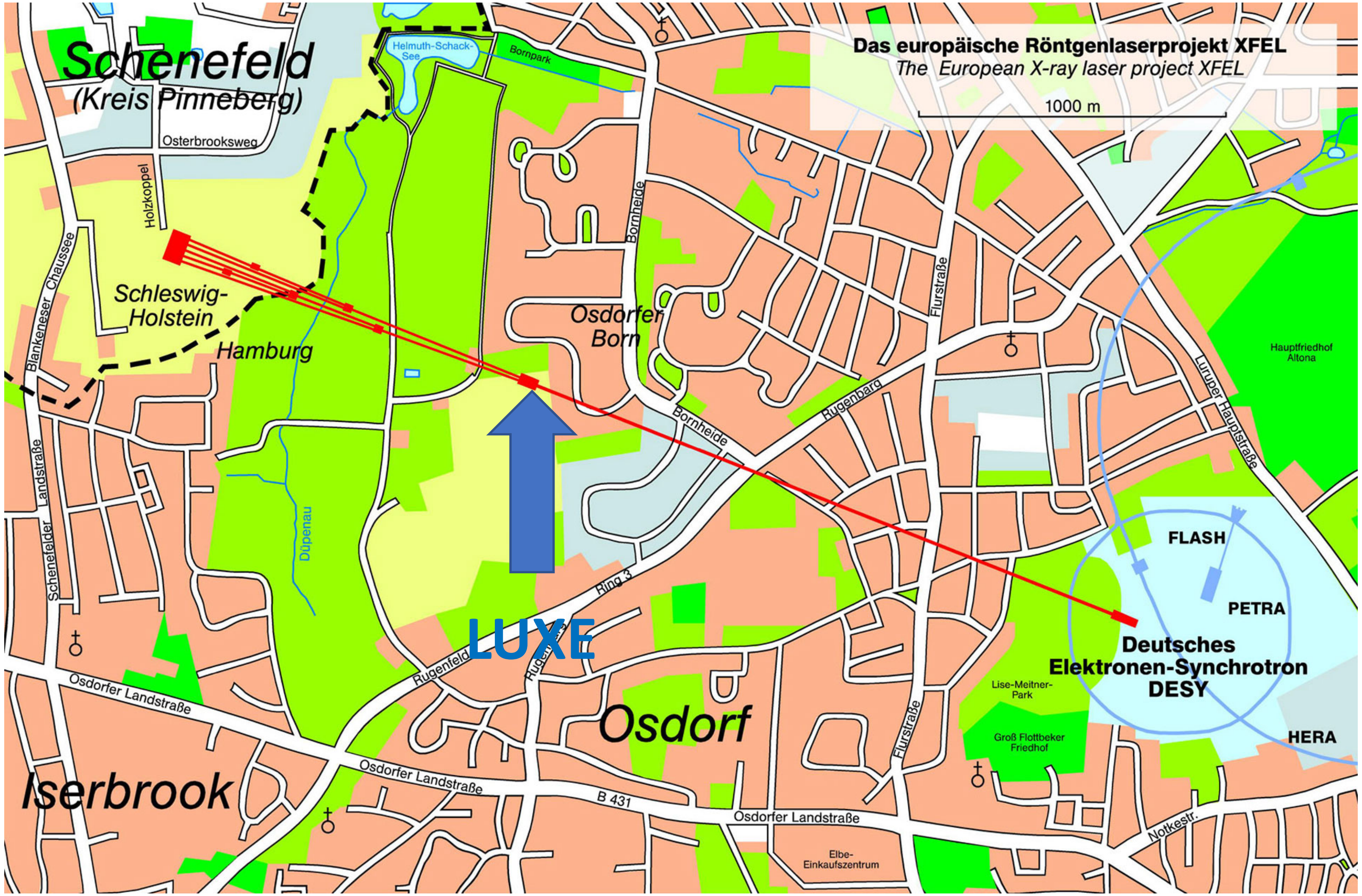


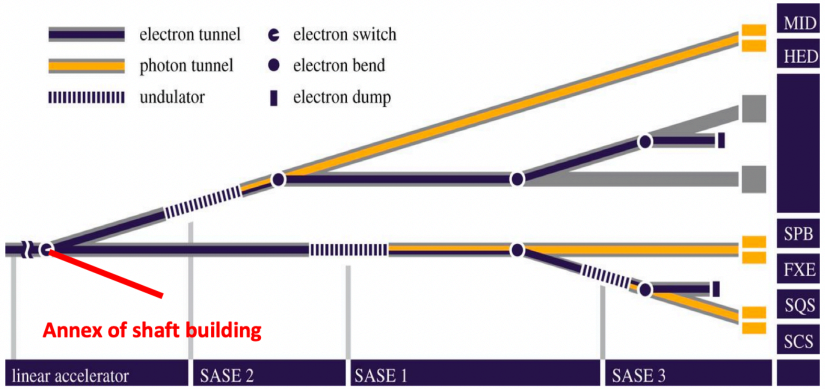




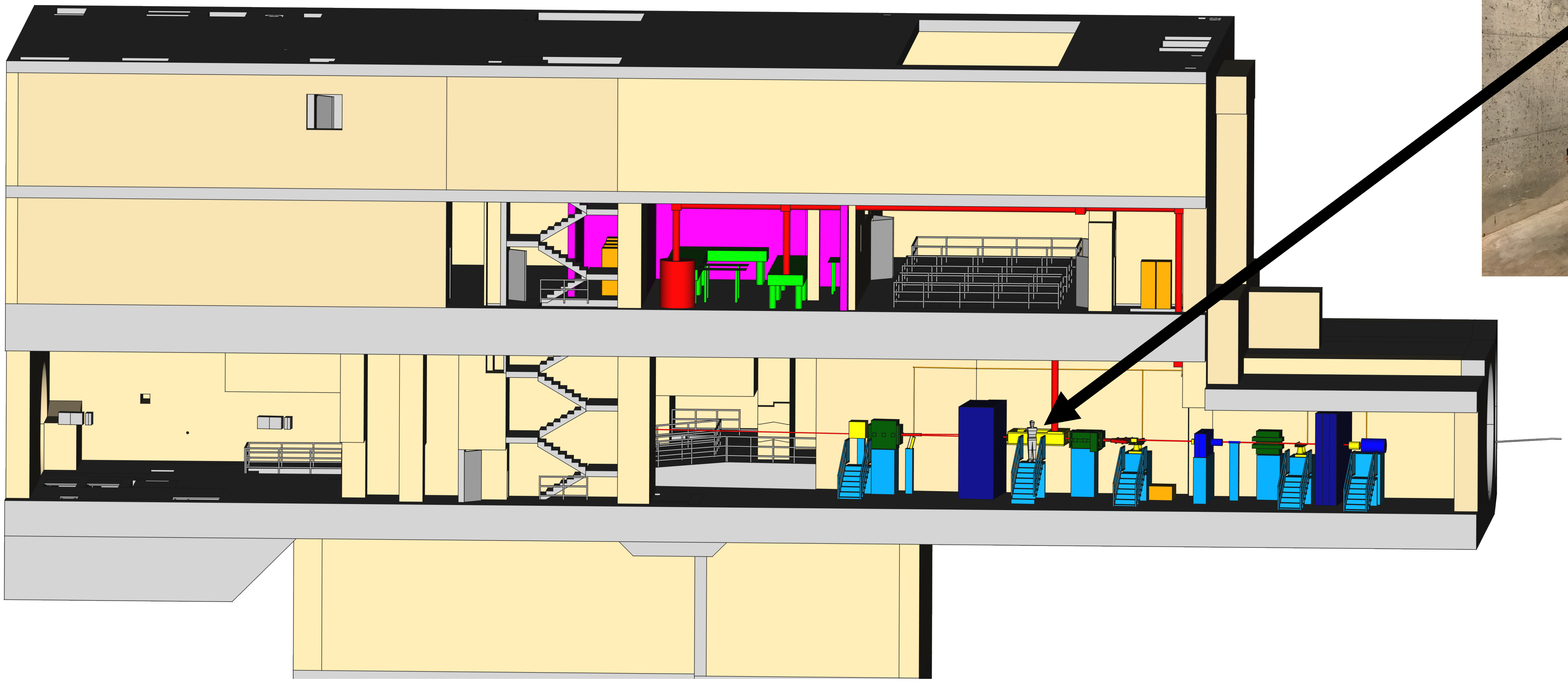
Detectors (not shown) need to measure electrons, positrons and photons

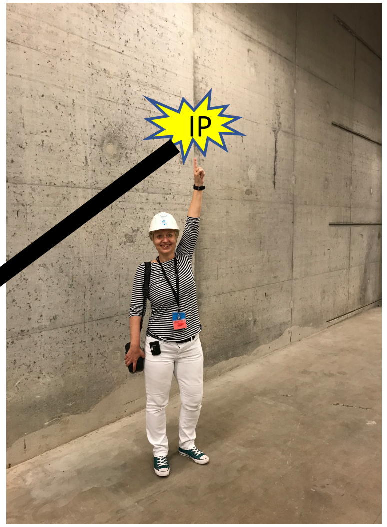
LOCATION OF EXPERIMENT





XS1 BUILDING

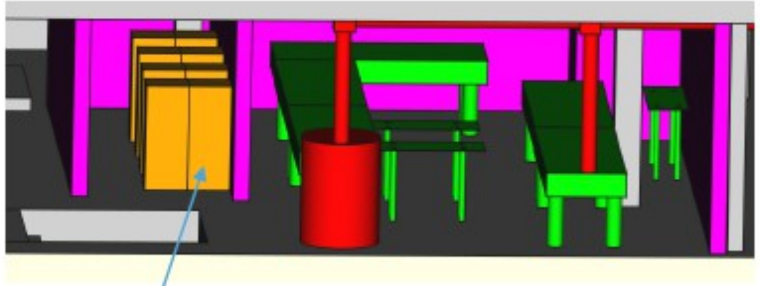




LASER CLEAN ROOM

Designed to host

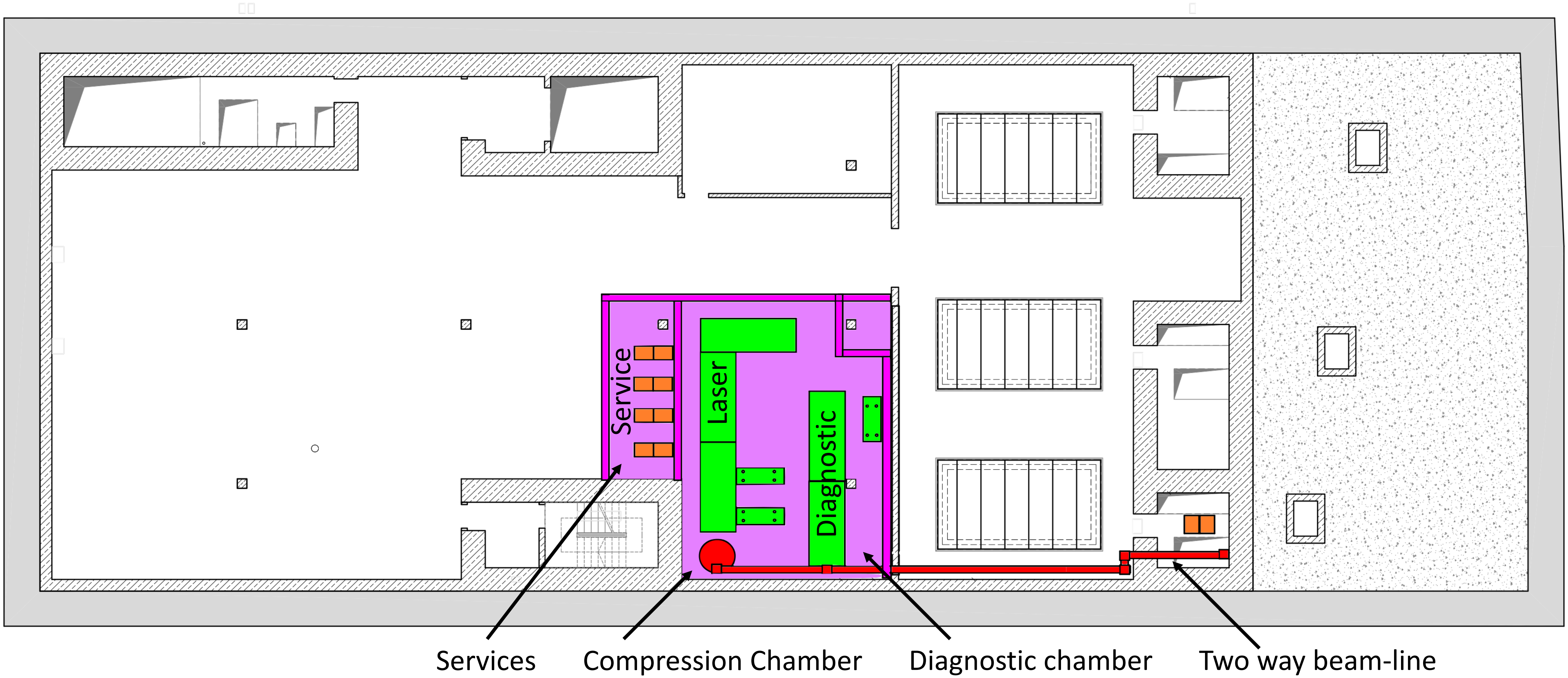
- JETI-40 laser
- 350 TW laser (later)
- Diagnostics



- Room dimensions ~105m2.
- Use layout described in CDR.
  - Nexus table (4*1.5m).
  - Electrical cabinet (0.8*0.6*2m)

Clean room class: iso6

LAYOUT OF LASER INSTALLATION

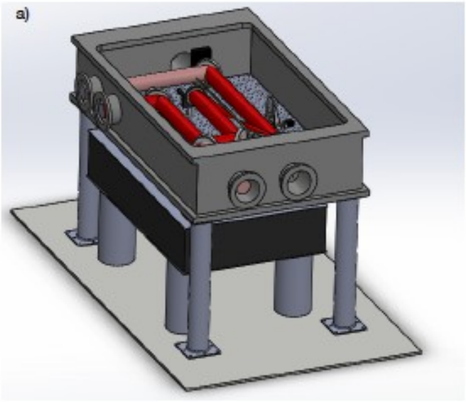


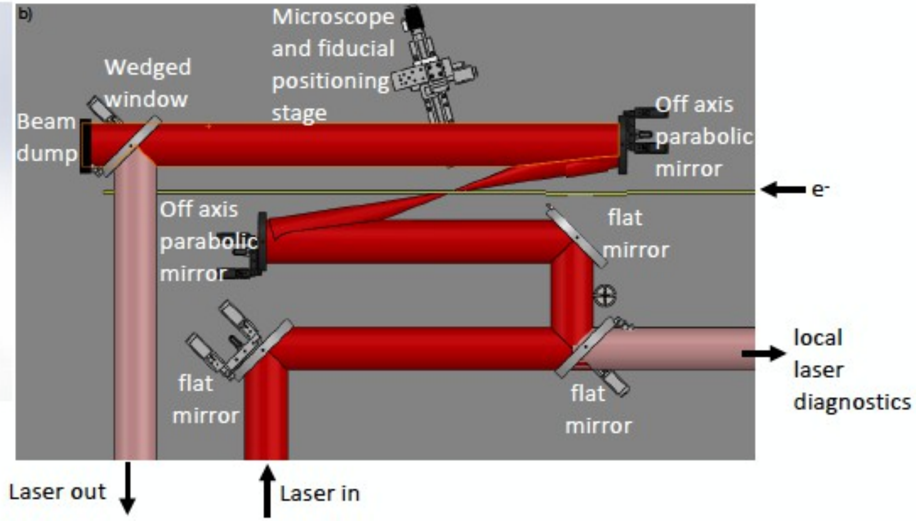
LASER BEAMLINE

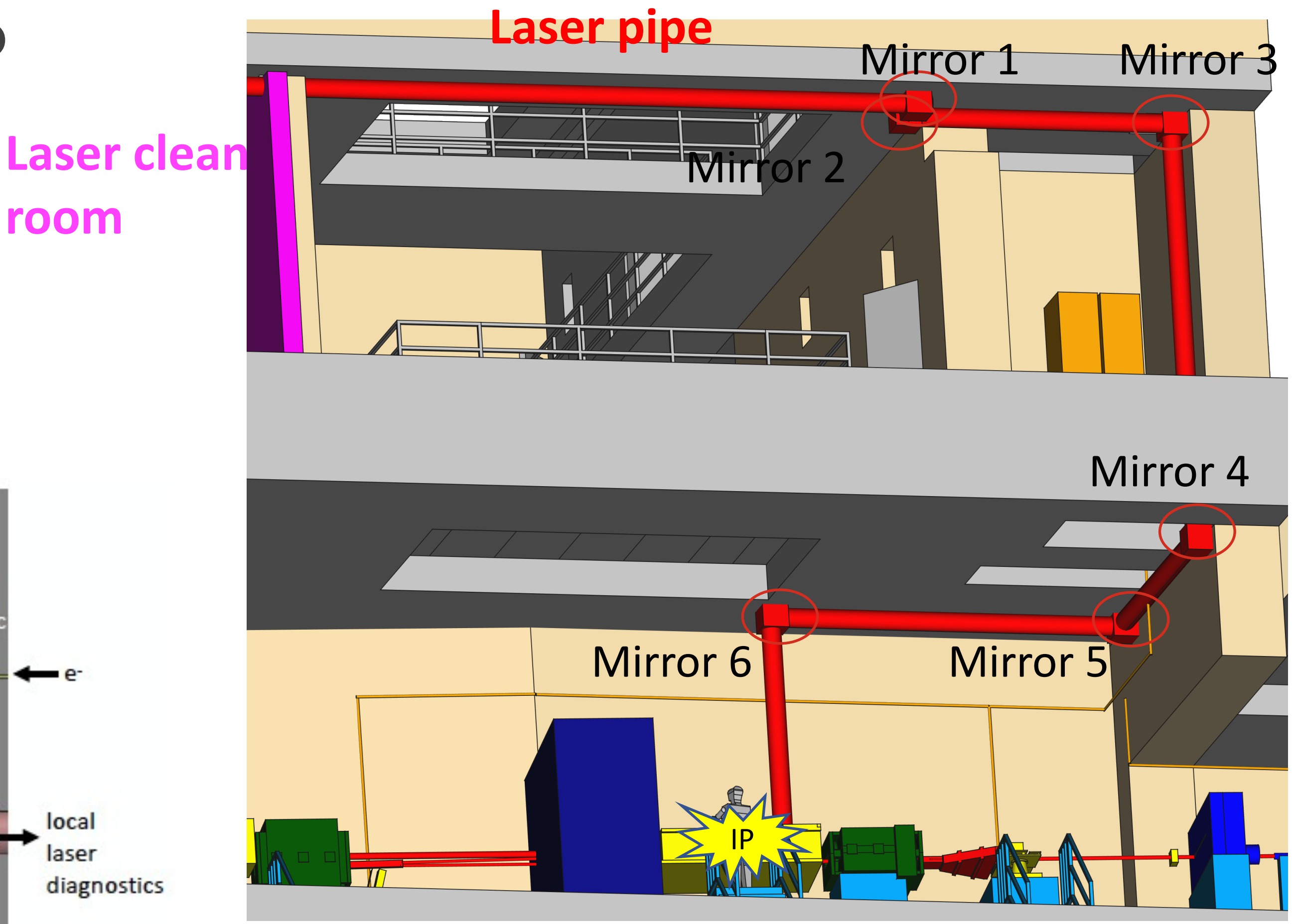
Laser guided from laser clean room to IP via 40 m long pipe and six mirrors

Final focusing done just before IP via dedicated chamber

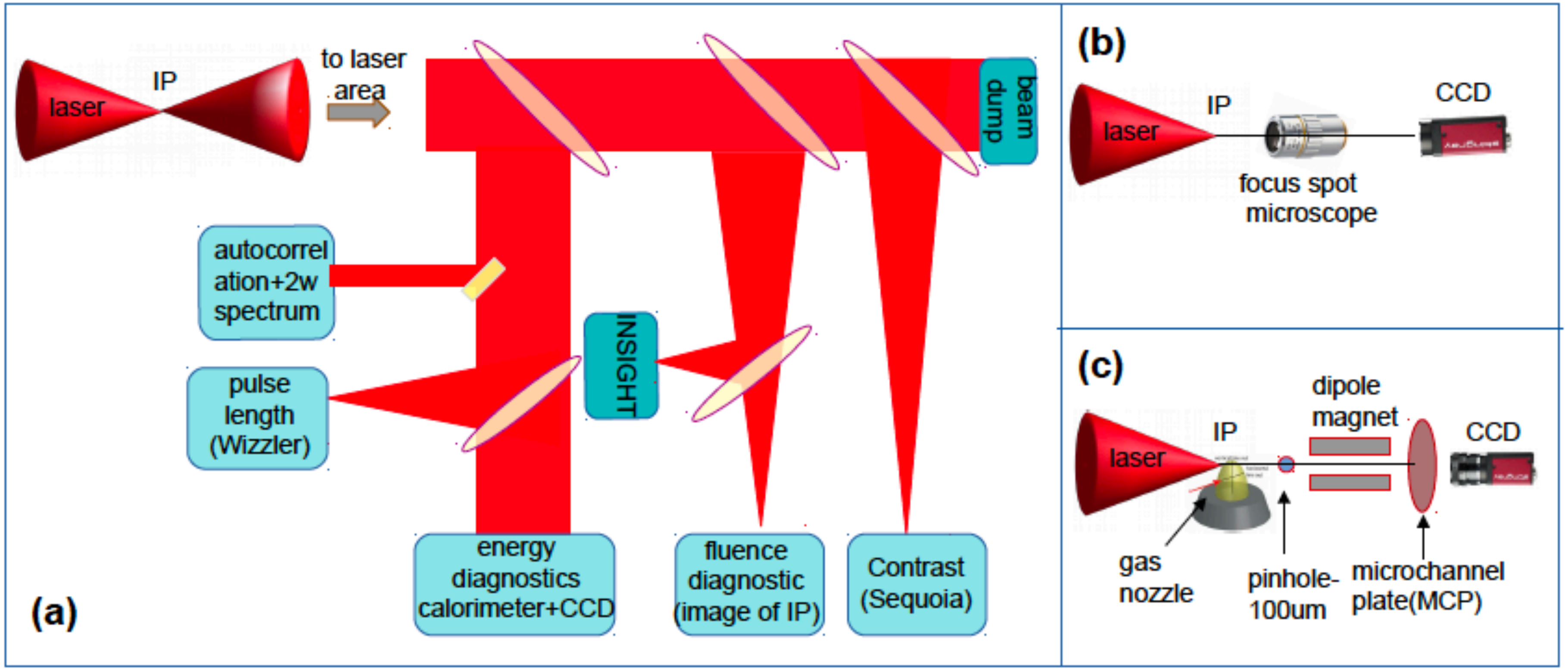
Designed by I. Pomerantz (Tel Aviv U)







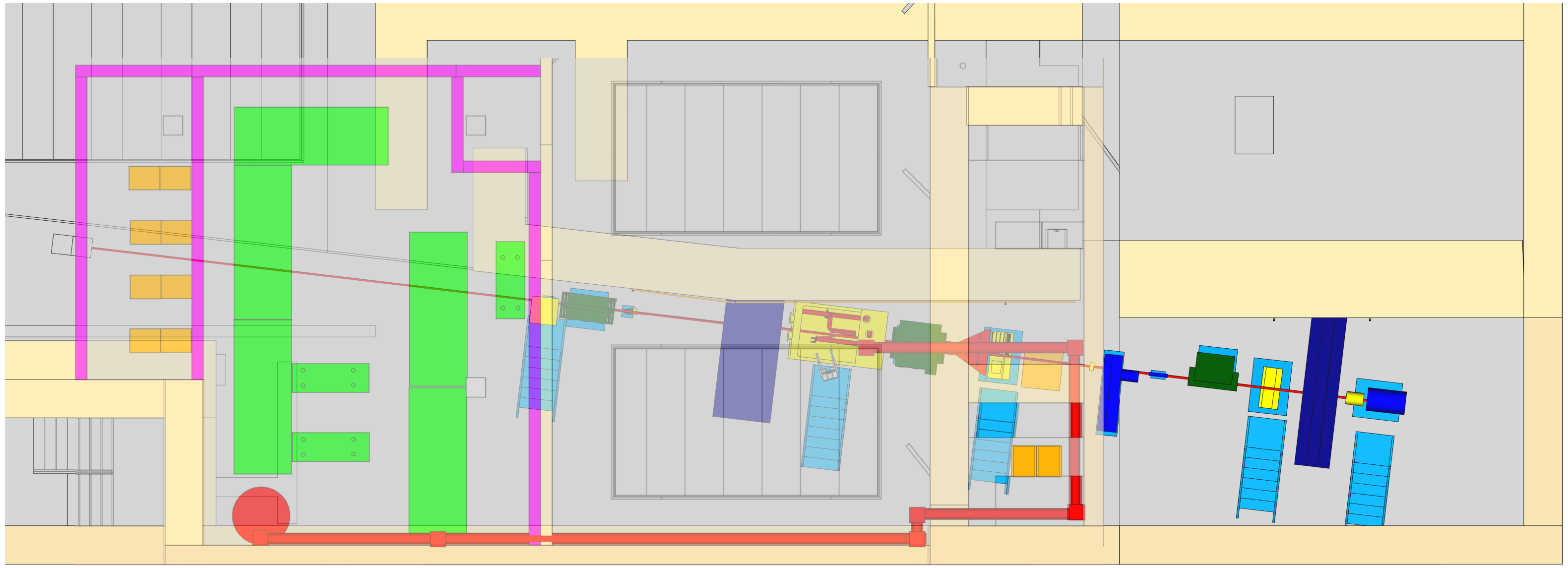
LASER DIAGNOSTICS

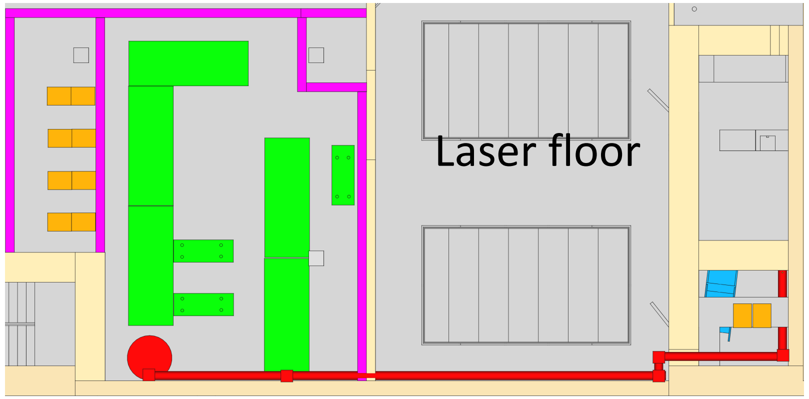


Need 3D characterization of laser: energy, pulse length and spot size

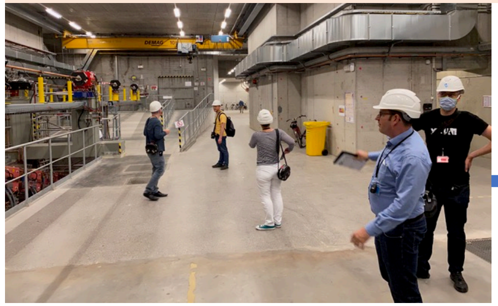
- Goal: 5% on intensity => plan many (partially redundant) measurements
- Resources from Helmholtz-Innovationspool to develop diagnostics tools with current lasers (e.g. JETI200)

TOP VIEW OF EXPERIMENT

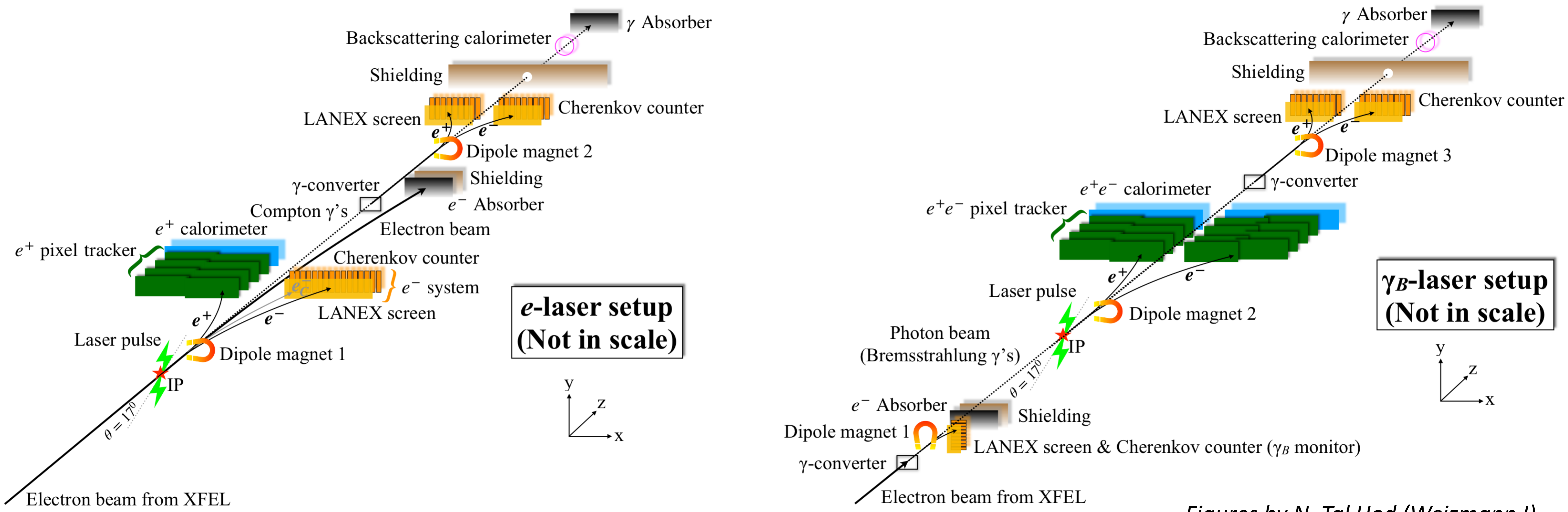




Visit of XS1 annex (June 2020)



LAYOUTS OF EXPERIMENT: e- and γ_B-laser modes

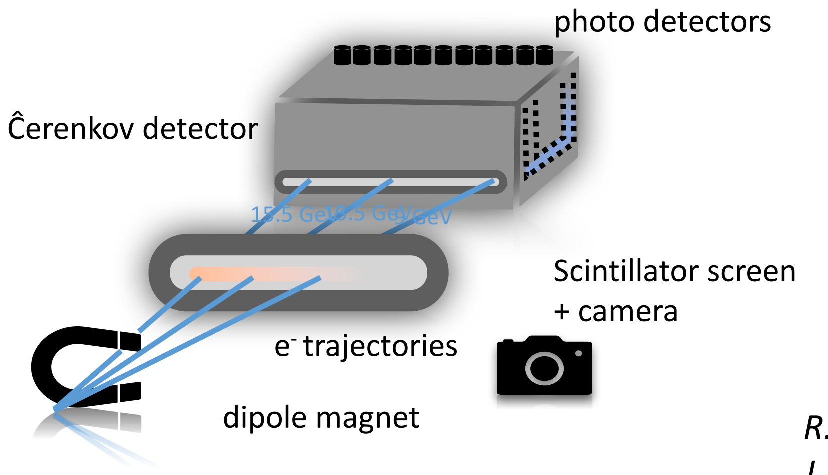


Figures by N. Tal Hod (Weizmann I)

- Goal: Detection of electrons, positrons and photon fluxes and measure their energy spectra
- Particle fluxes vary between ~0.01 and 10^9 (in different locations) per laser shot!
  - Use technologies adapted to respective fluxes of signal and background

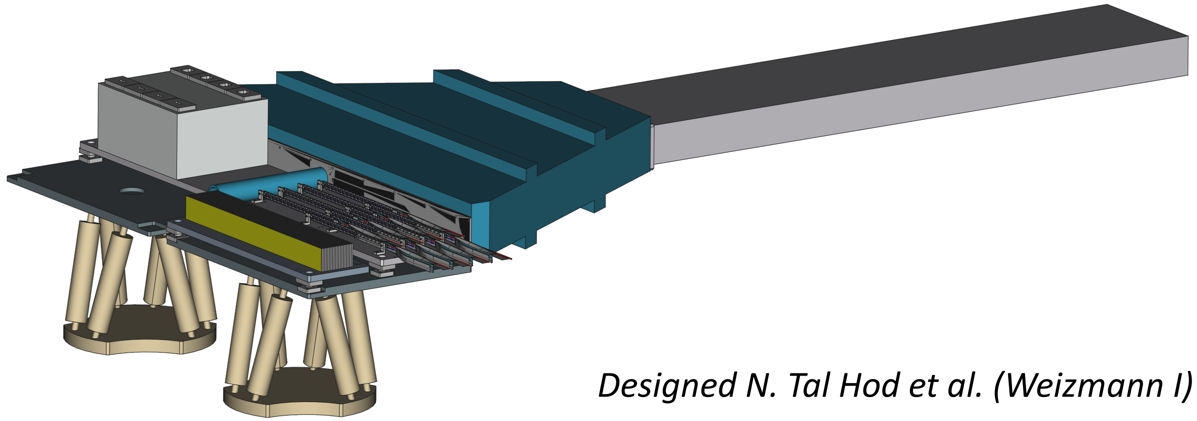
DETECTORS

- **High rate regions:**
  - Cerenkov detectors
  - Scintillaton screens
- **Low rate regions**
  - Silicon pixel detectors
  - High granularity calorimeters



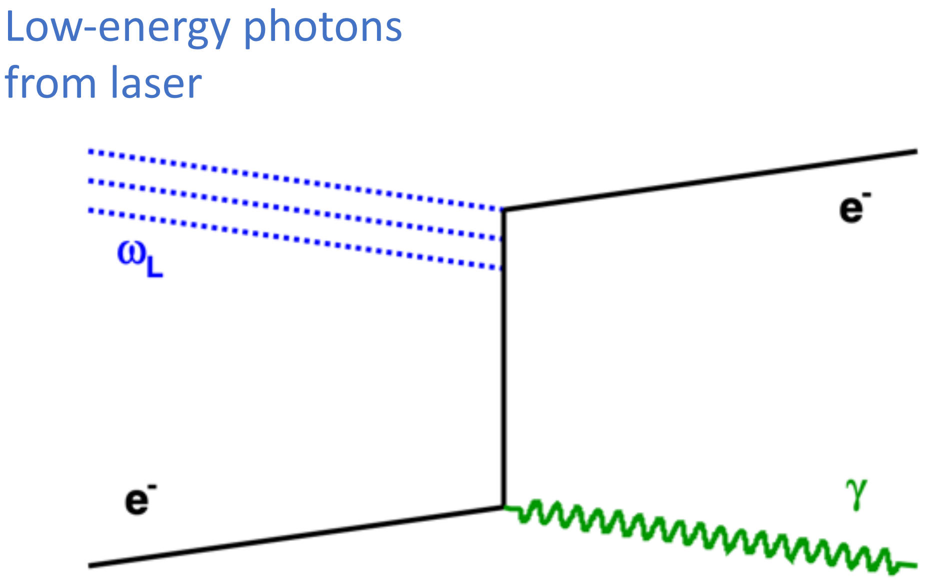
R. Jacobs, J. List (DESY),
J. Hallford, M. Wing (UCL)

Two complementary technologies used in each case for cross-calibration, reduction of syst. uncertainties

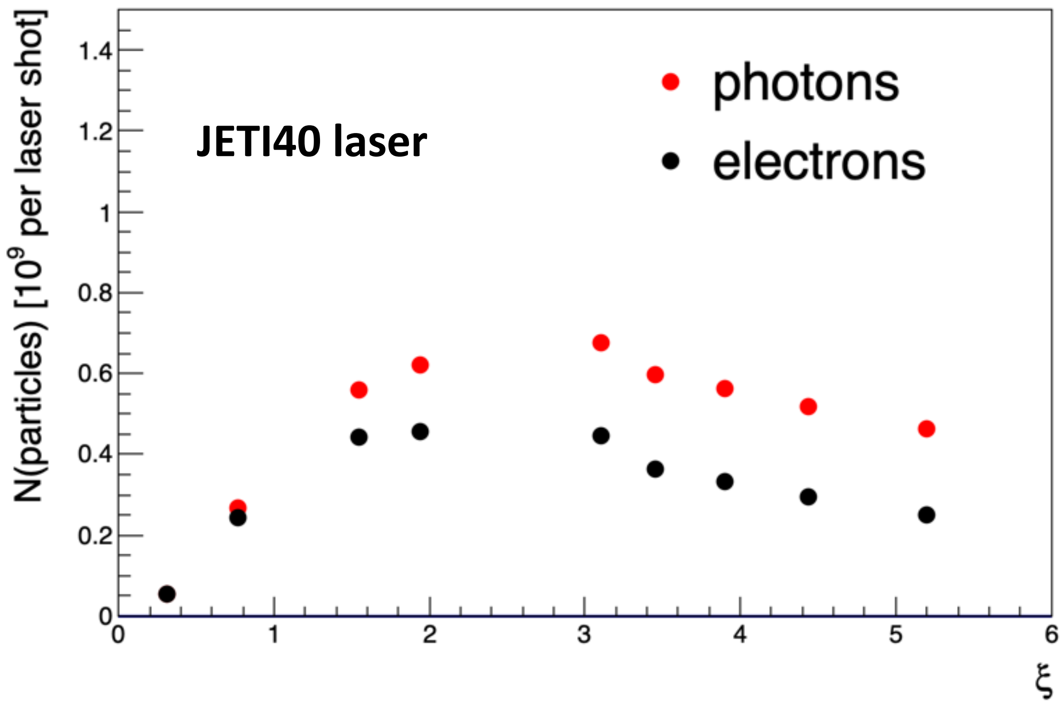


Designed N. Tal Hod et al. (Weizmann I)

E-LASER MODE: COMPTON SCATTERING



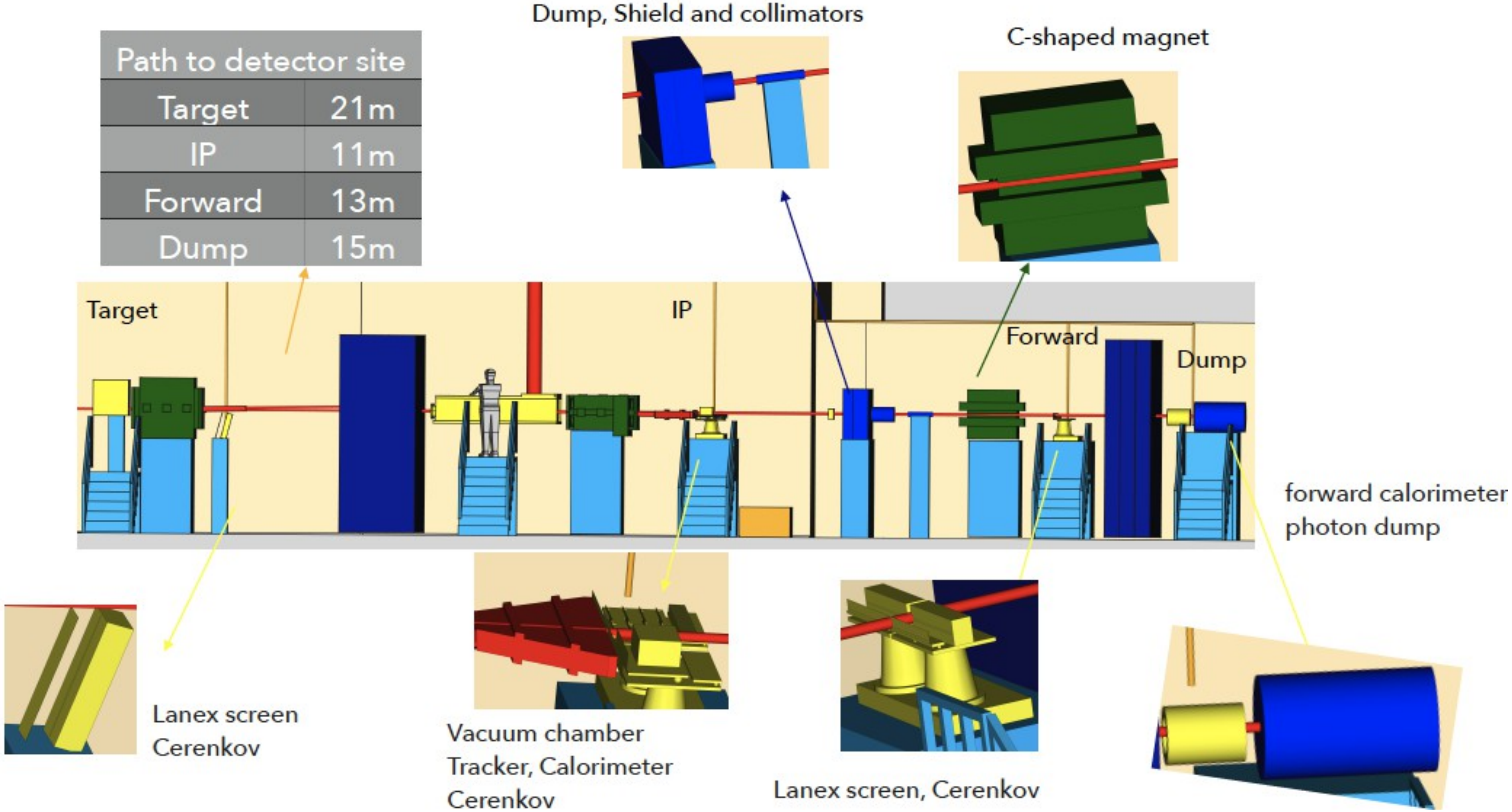
$$e^- + n\omega_L \rightarrow e^- + \gamma$$



- Expect ~10^9 electrons and photons per laser shot
  - Chose detectors that can cope with this high rate => Cerenkov & Scintillator
- Using custom Monte Carlo generator by A. Hartin (UCL) to guide design of detectors
  - Cross-checks by other theorists involved ongoing (Gothenburg, Plymouth, Skoltech, MEPHI, Jena)

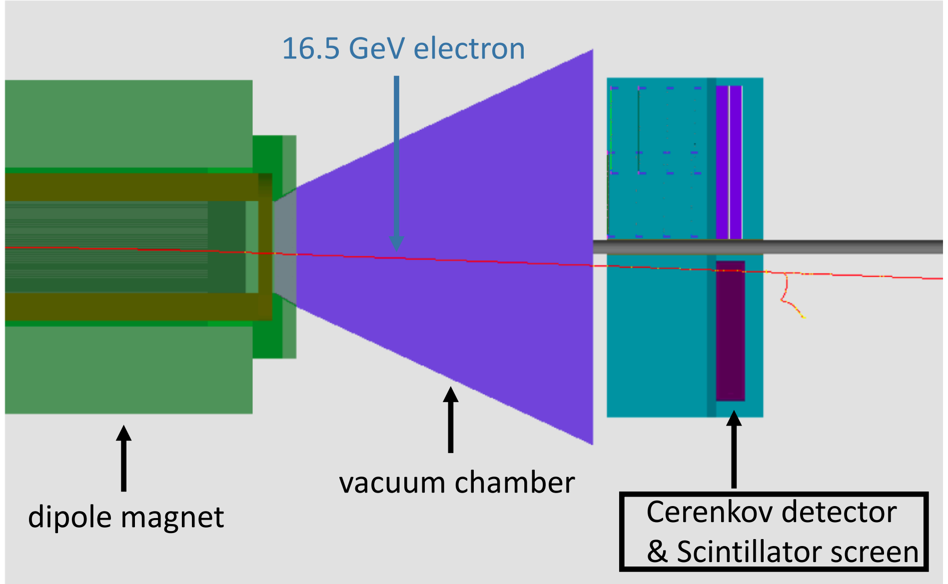
INSTRUMENTATION OF BEAMLINE

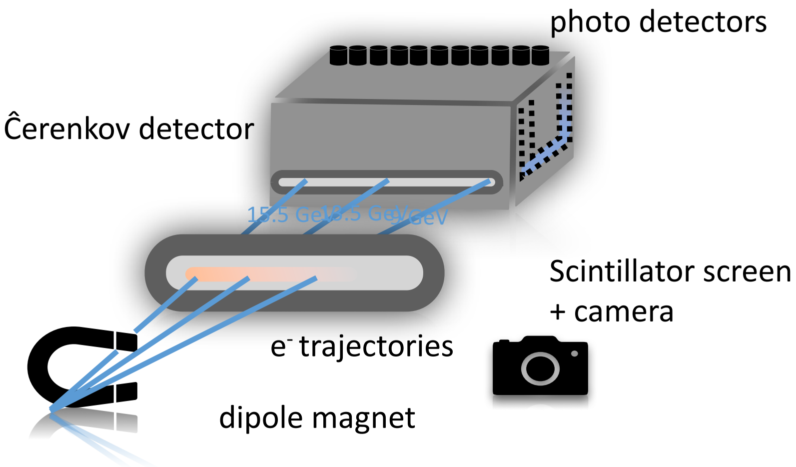
Path to detector site	
Target	21m
IP	11m
Forward	13m
Dump	15m



Laser and beam synchronised via existing and working system to 10 fs

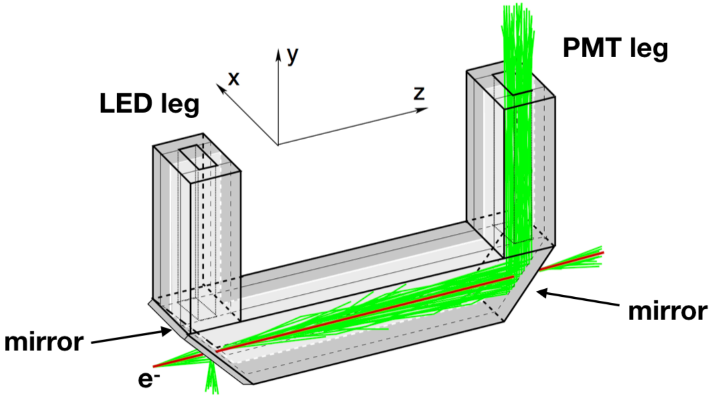
HIGH RATE REGIONS: CERENKOV AND SCINTILLATORS





R. Jacobs, J. List (DESY), J. Hallford,M. Wing (UCL)

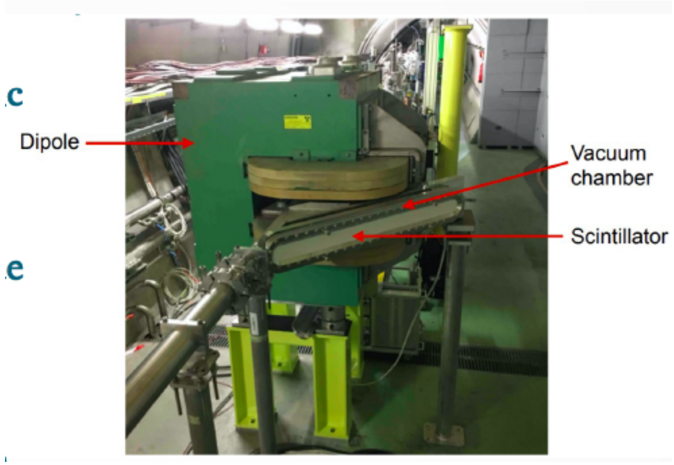
- **Two complementary technologies:**
  - Gaseous (Ar) Ĉerenkov detectors and scintillator (GADOX) screen
- **Ĉerenkov detectors**
  - Fine segmentation (1mm) => SiPM
  - Low refractive index gas (Ar) and optical filter to reduce light yield
  - Based on prototype for ILC polarimetry

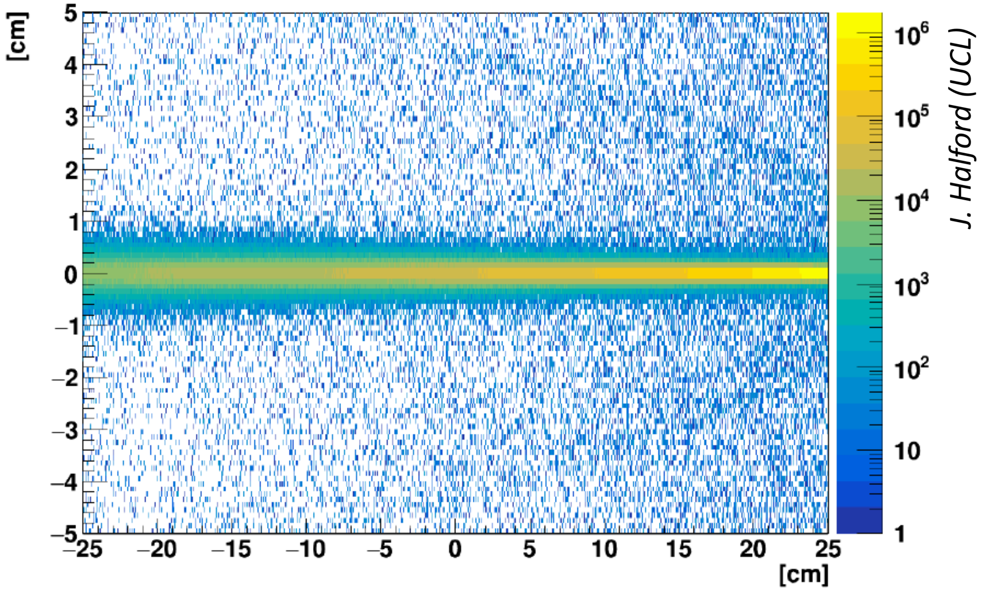


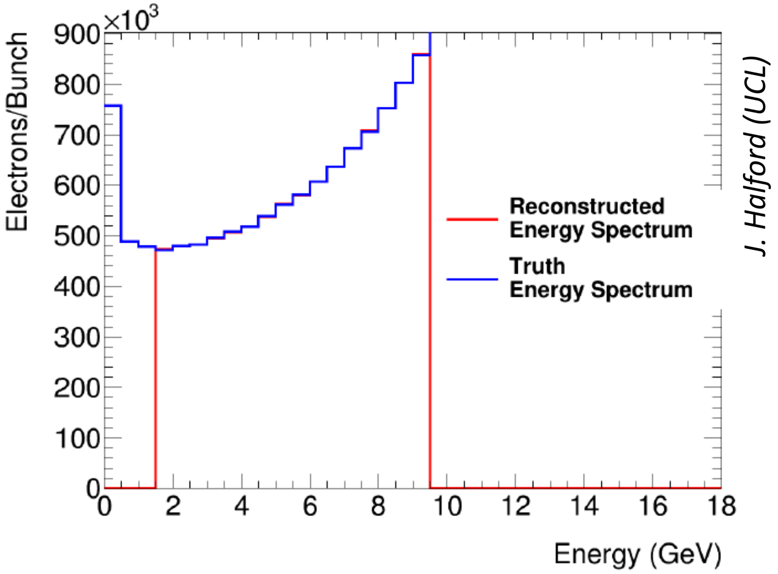
SCINTILLATOR SCREEN

Basic principle

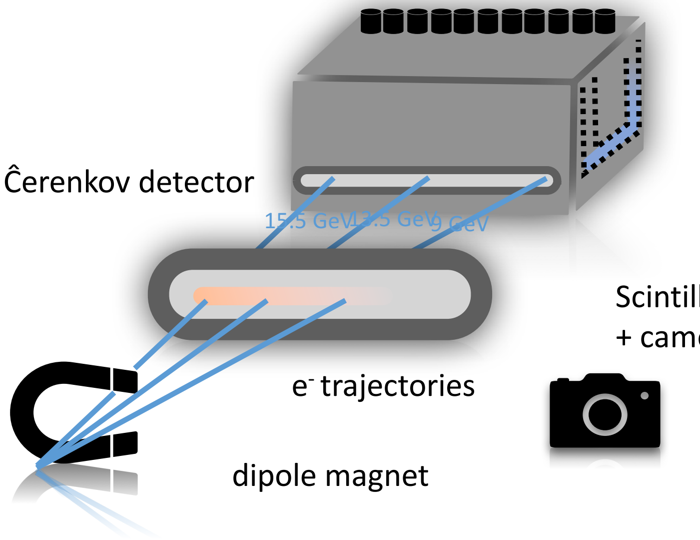
- Camera takes pictures of scintillation light
- Position determines energy
- Measure particle flux vs energy
- Used e.g. by AWAKE experiment at CERN



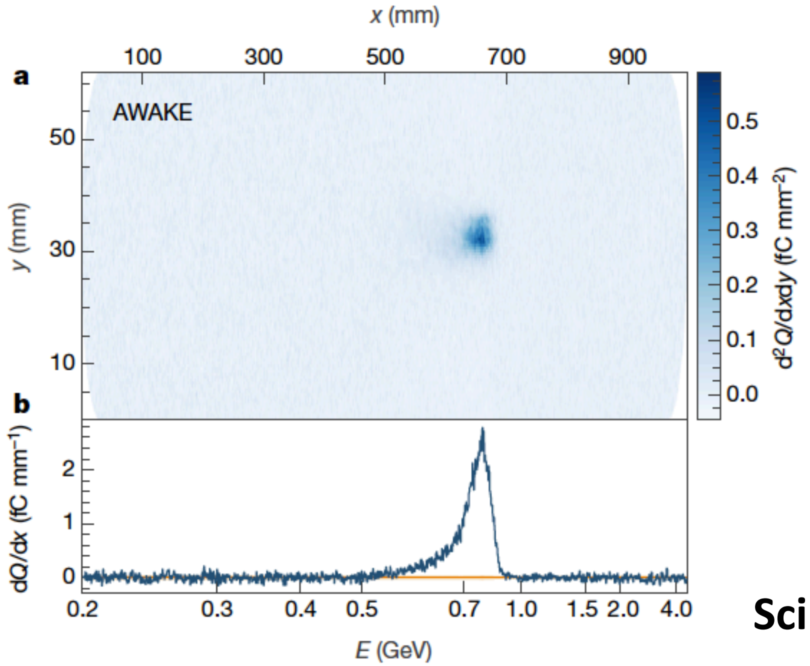




ČERENKOV-DETECTOR AND SCINTILLATOR SCREEN

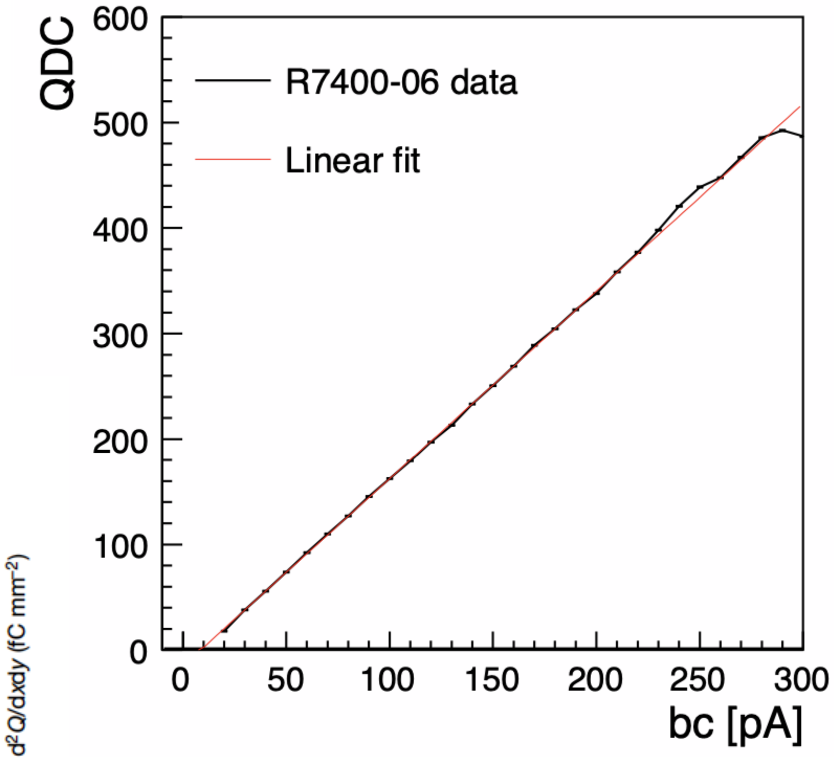


AWAKE Coll., *Nature* **561,** 363–367 (2018)
https://www.nature.com/articles/s41586-018-0485-4



Scintillator screen: energy spectrum

Čerenkov: linearity vs current

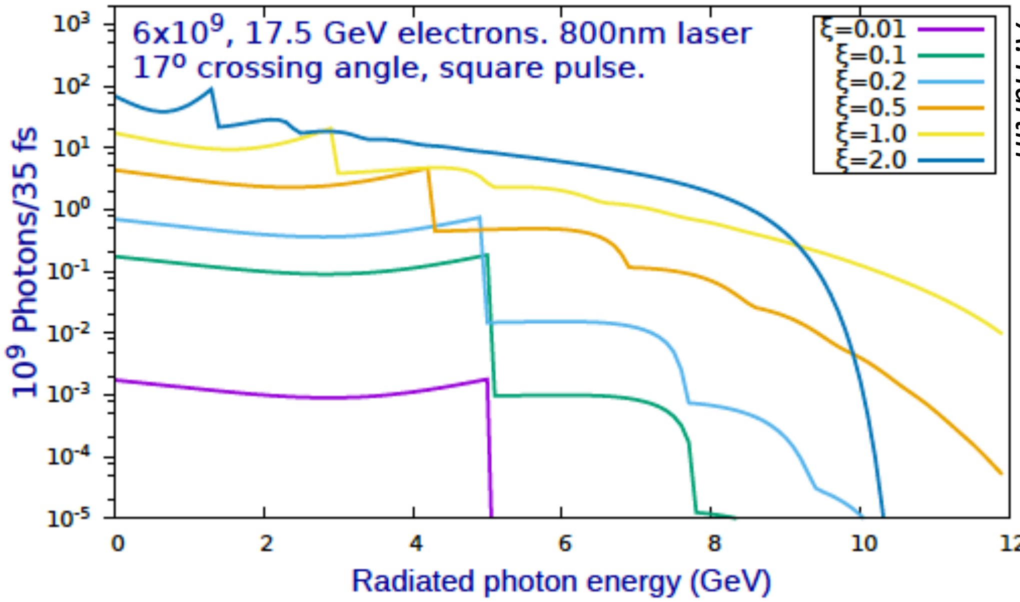


Thesis: C. Bartels
https://bib-pubdb1.desy.de/record/88522/files/Thesis.pdf

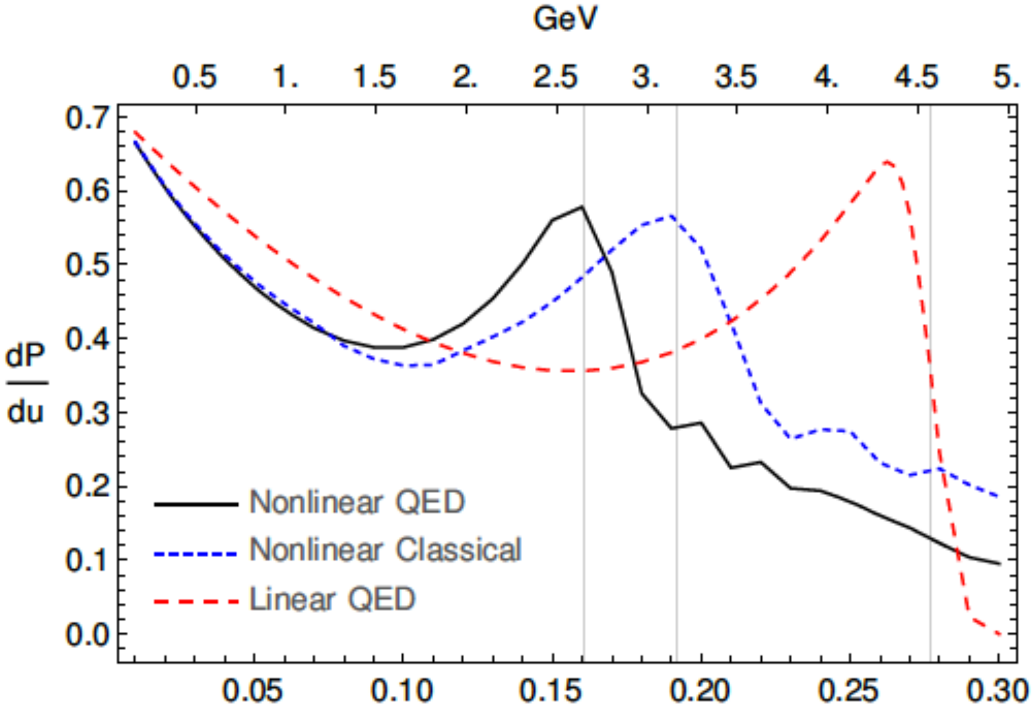
COMPTON-EDGE SHIFT

Compton energy spectrum modified:

- Compton edges shifted to lower energies as electrons acquires an effective mass:
  $$m_* = m\sqrt{1 + \xi^2}$$



A. Hartin

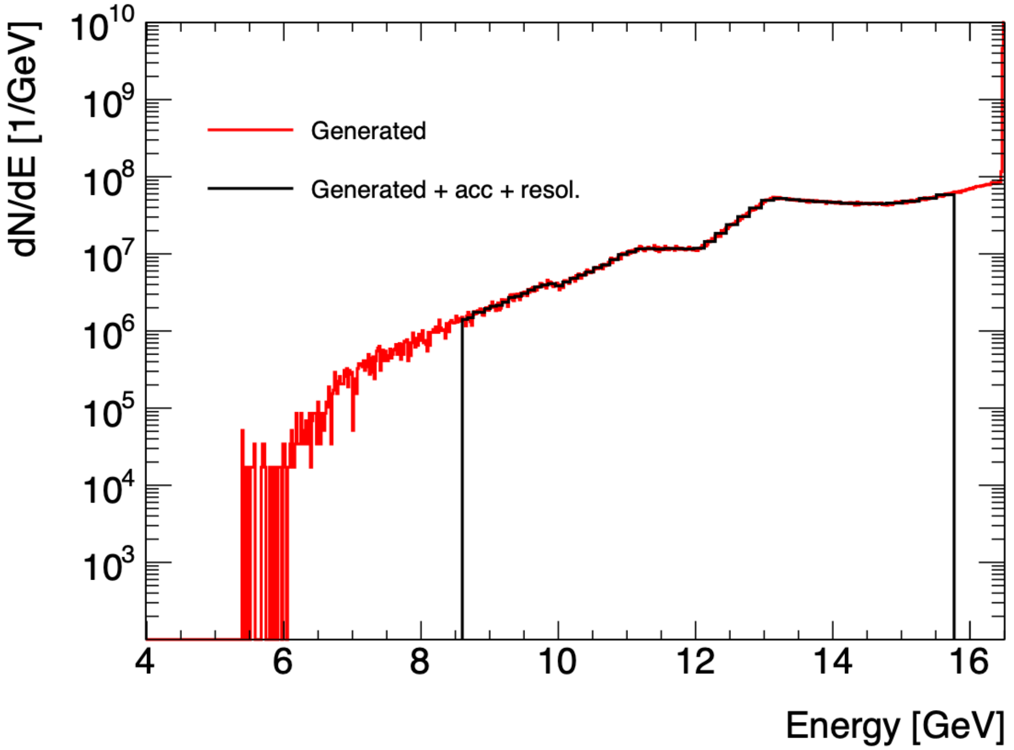


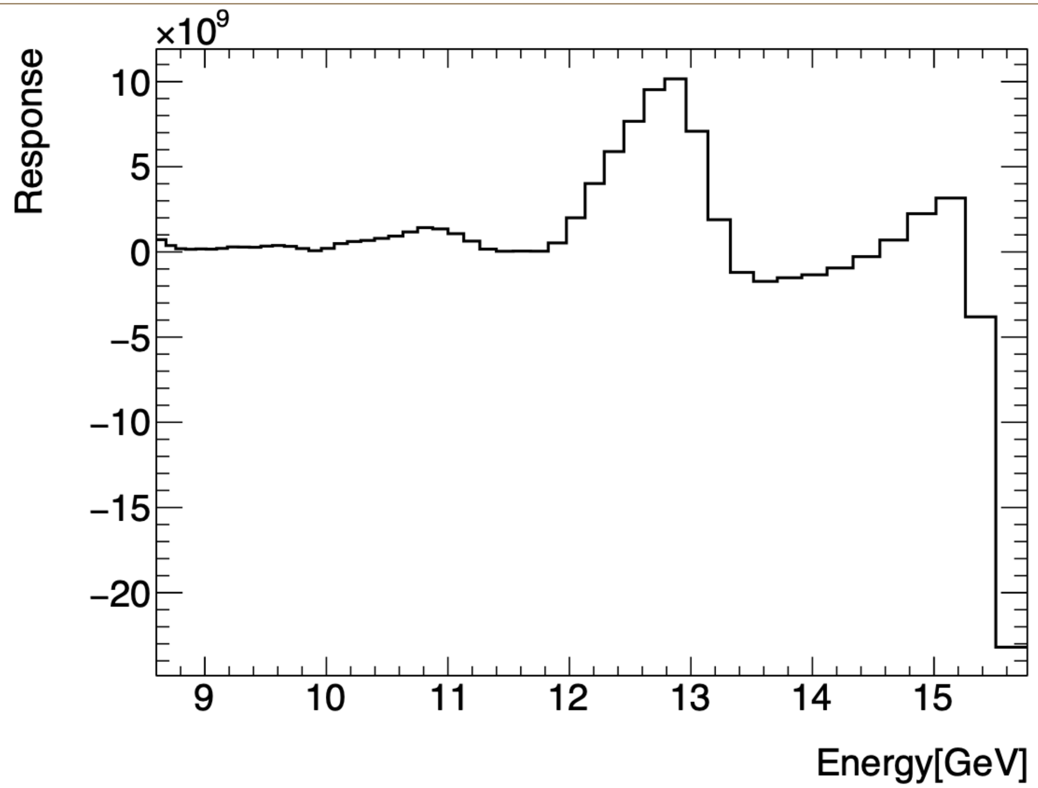
B. King, S. Tan

u=E(photon)/E(e-beam)

=> Goal: measure these edges

COMPTON-EDGE ANALYSIS: RECONSTRUCTION

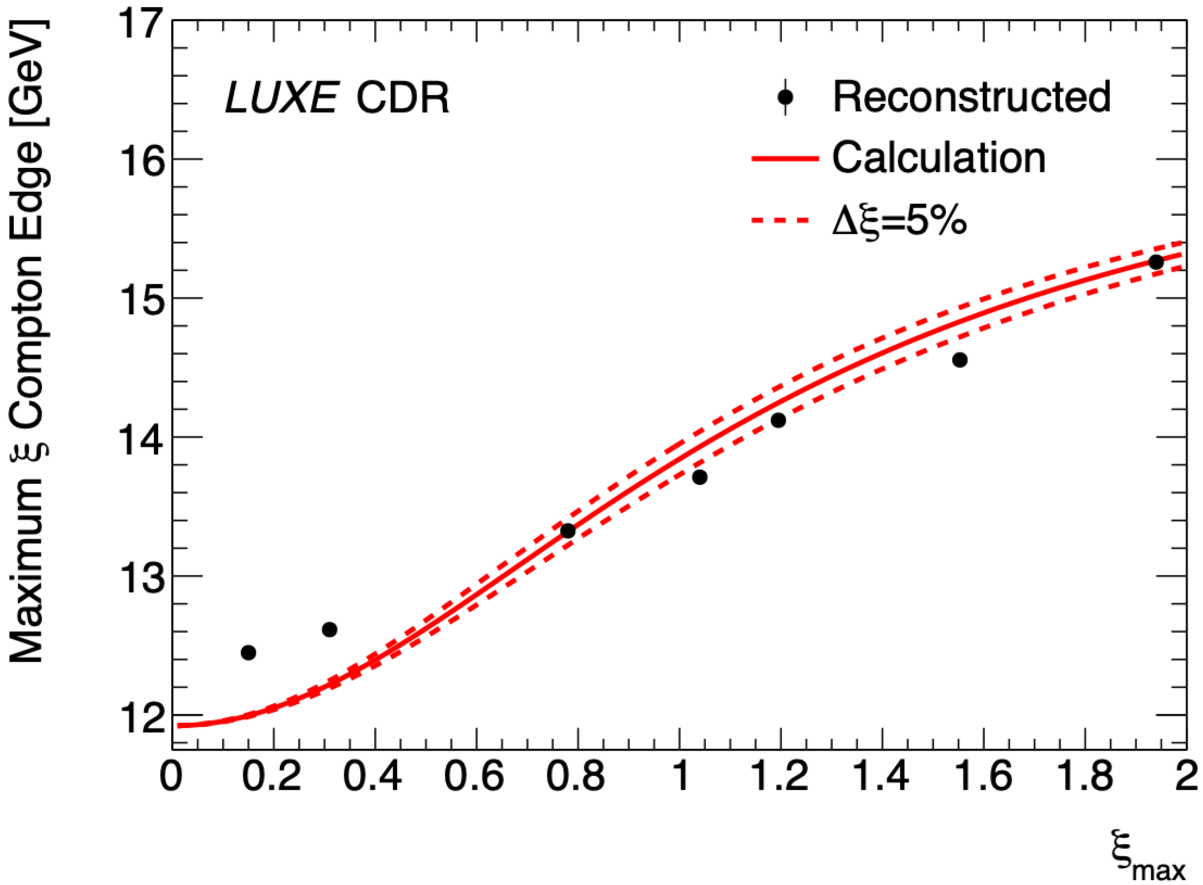




R. Jacobs, J. List

- Gaussian laser pulse: superposition of different ξ → edges overlay in spectrum
- Position and shape of edges sensitive to dependence of nonlinear Compton cross-section on ξ
- Edge reconstruction vis Finite Impulses Response Filter (FIR) → max. in response = edge position

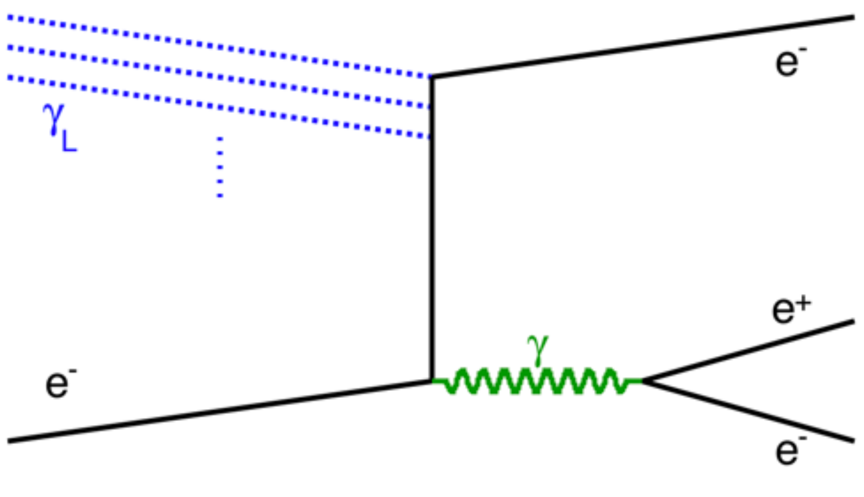
COMPTON-EDGE ANALYSIS: SIMULATED RESULT



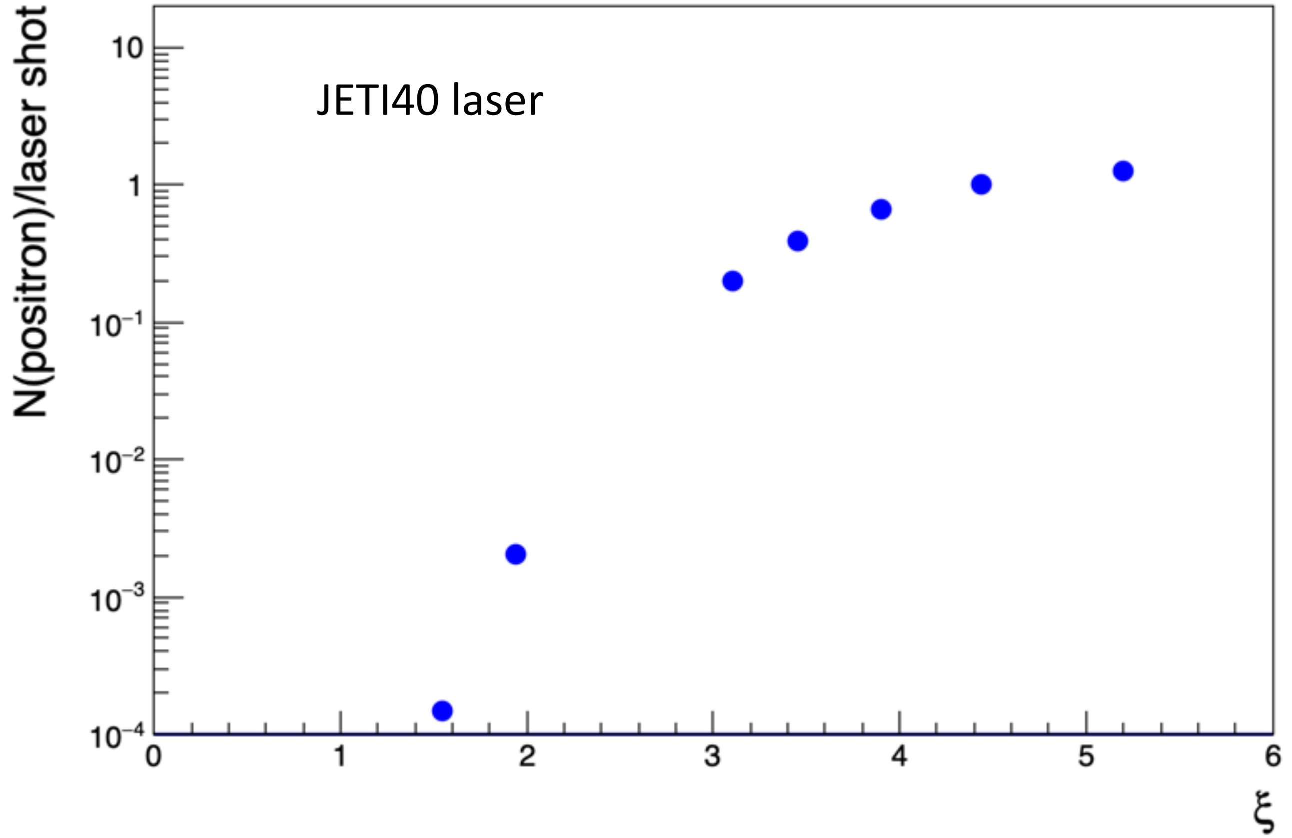
R. Jacobs, B. King

First harmonic kink position (edge of maximum ξ) as a function of ξ_{max} compared to theory prediction

E-LASER MODE: TRIDENT PRODUCTION

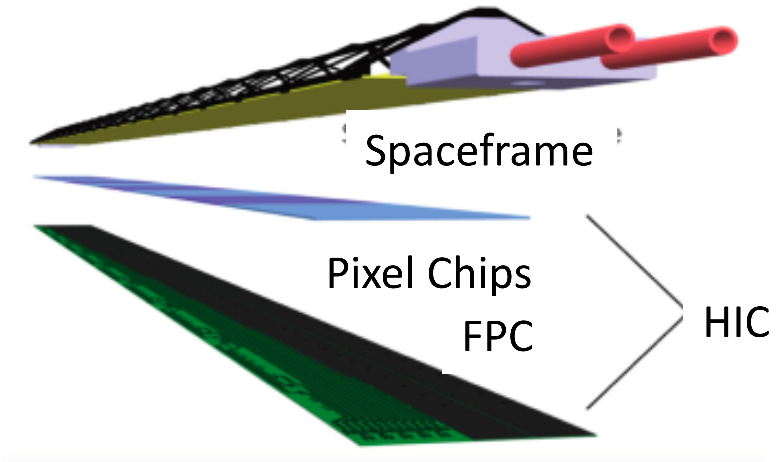


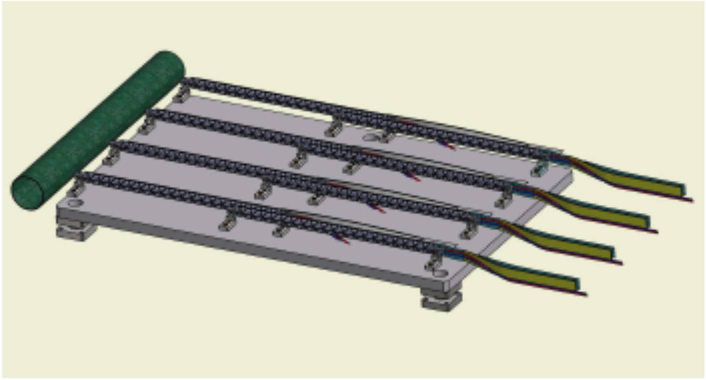
$$e^- + n\omega_L \rightarrow e^- + e^+ + e^-$$

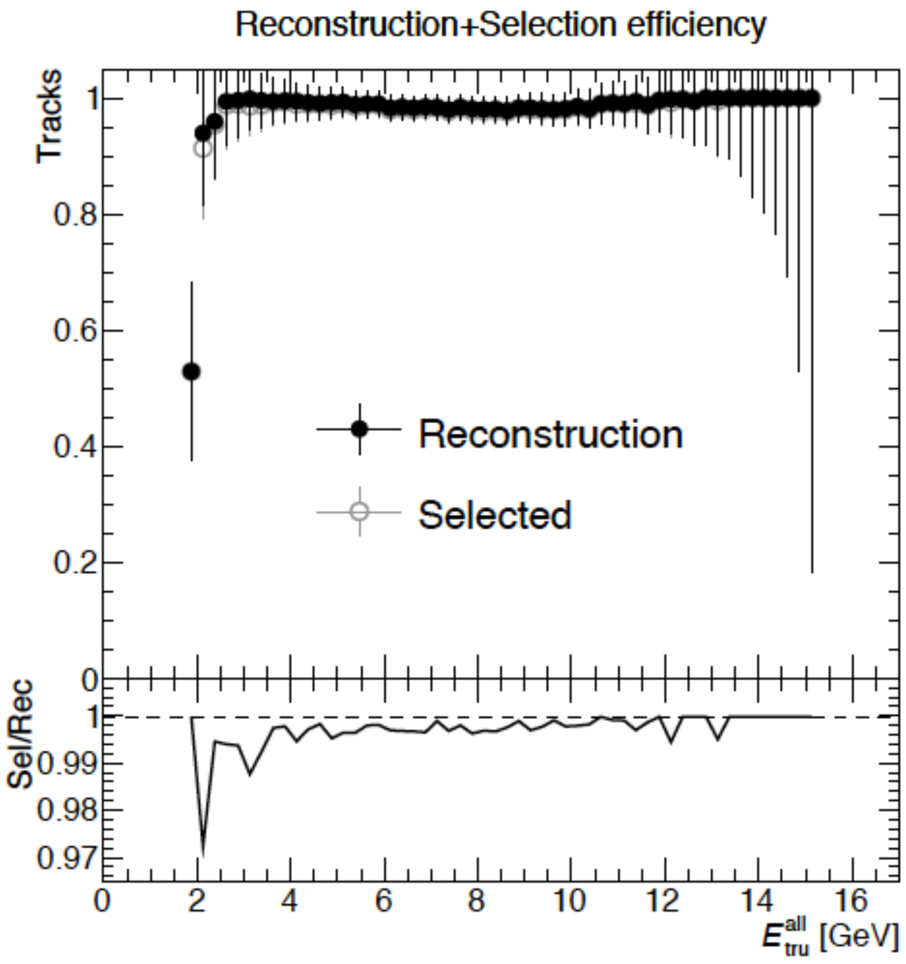


- Expect ~1 e^+e^- pair per laser shot
- Important to have good means to reject background
  - Background simulation and analysis in progress

TRACKER





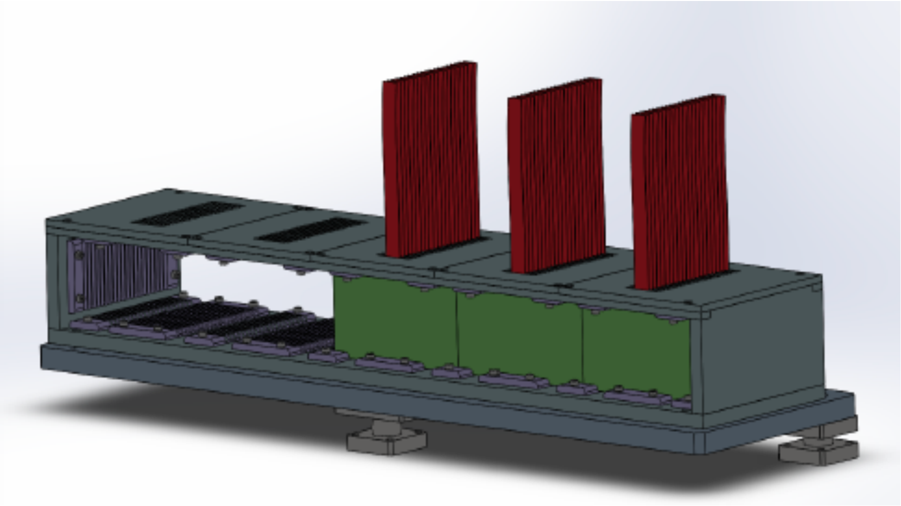


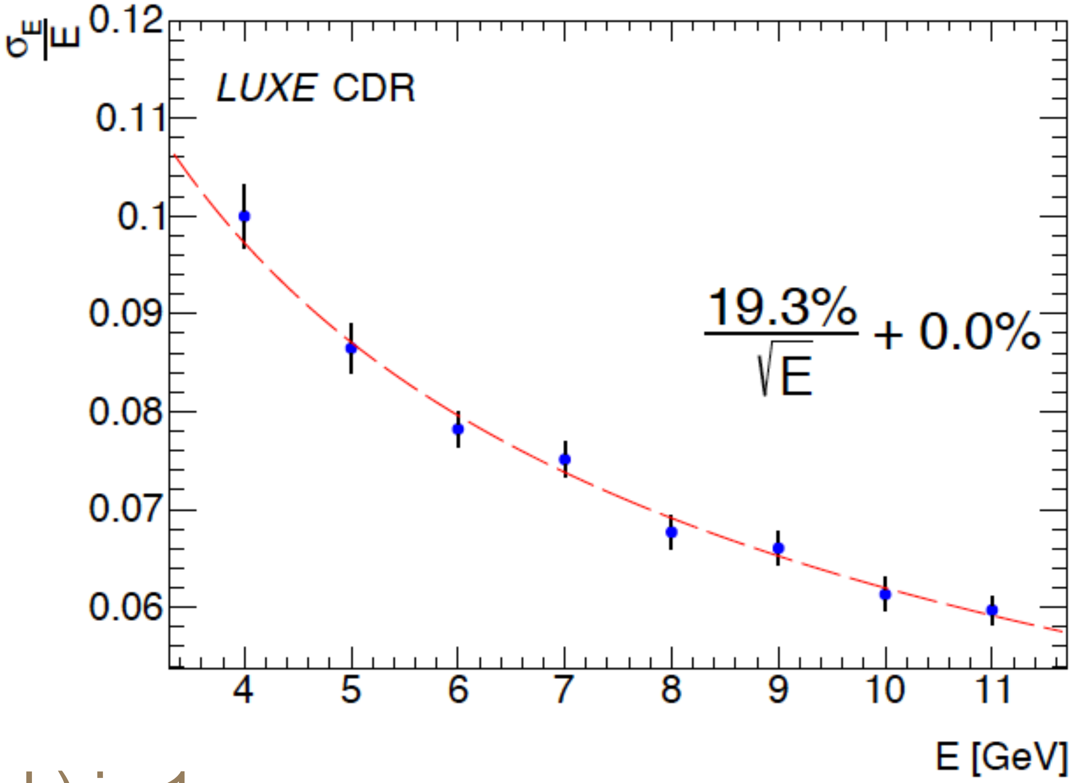
Four layers of ALPIDE silicon pixel sensors

- Sensors developed for ALICE tracker upgrade
- Acceptance x efficiency>98% for E>2 GeV
- Momentum resolution: 0.3%

N. Tal Hod, A. Santra (Weizmann I)

CALORIMETER





High granularity calorimeter

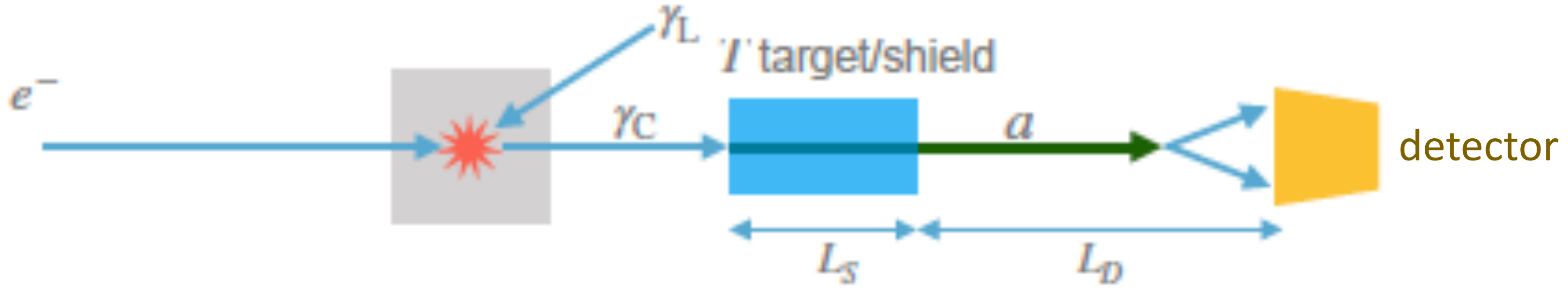
- 20 layers of 3.5 mm thick tungsten plates
- Silicon sensors (5x5 cm^2 pads, 320 μm thick) in 1mm gaps between plates
- Readout via FLAME ASIC (developed for FCAL)
- Resolutions: $\frac{\sigma_E}{E} = \frac{19.3\%}{\sqrt{E/GeV}}$, $\sigma_x = 0.78\,mm$

H. Abramowicz, Y. Benhammou, A. Levy (Tel Aviv U), W. Lohmann (DESY,Aachen) , M. Idzik (Crocow AGP) et al.

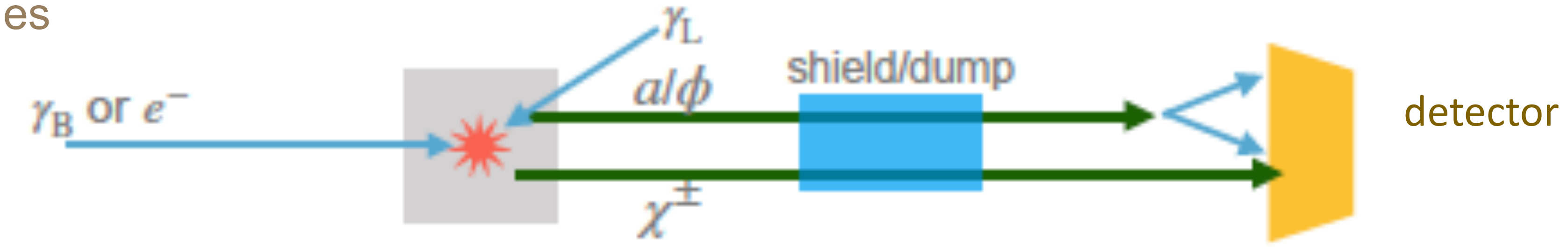
BSM PHYSICS

Three ideas being explored at present

1. Use high photon flux from strong-field Compton process for beam dump type experiment => neutral particles that couple to photons (axion-like particles)



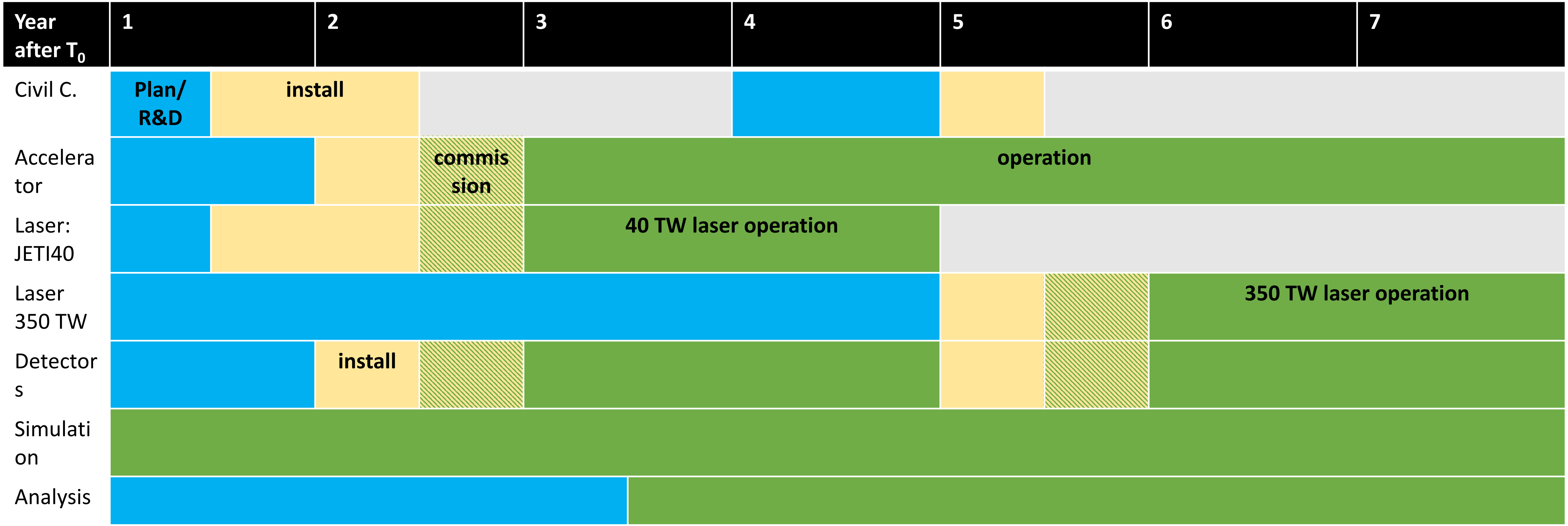
2. Produce directly neutral particles at IP => neutral particles that decay to photons or electrons
3. Milli-charged particles



G. Perez, Y. Soreq et al., to be published

=> Prel. Indications are that sensitivity promising

DRAFT SCHEDULE

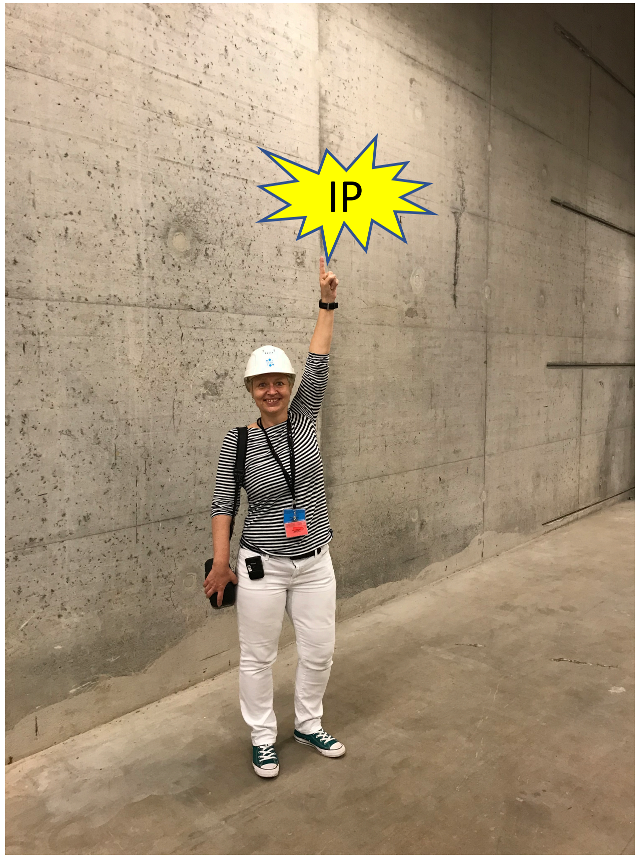


T_0=approval of project

Technically driven schedule, subject to schedule of EU.XFEL & identifying funding

CONCLUSIONS

- **Significant progress on all aspects of the experiment since Spring**
  - Much more realism included than in LOI!
  - Simulation results not quite ready yet
- **We still think the experiment is doable and find it even more exciting now**
  - Collaboration is strong and growing
  - Responsibilities shared and largely defined
- **CDR draft now planned for end of 2020**
  - Will include preliminary costing
  - Would then very much welcome a review



M. Peskin at Snowmass 20/21:
"…the motivation of exploring the $\chi > 1$ regime is very strong"

BACKUP

LASER PARAMETERS

	40 TW, 8μm	40 TW, 3μm	300 TW, 3μm
Laser energy after compression (J)	1.2	1.2	9
Percentage of laser in focus (%)		40	
Laser energy in focus (J)	0.48	0.48	3.6
Laser pulse duration (fs)		30	
Laser focal spot FWHM (μm)	8	3	3
Peak intensity in focus ($\times 10^{20}$ Wcm^{-2})	0.21	1.5	11
Dimensionless peak intensity, ξ	2.3	6.2	16
Laser repetition rate (Hz)		1	
Electron-laser crossing angle (rad))		0.35	

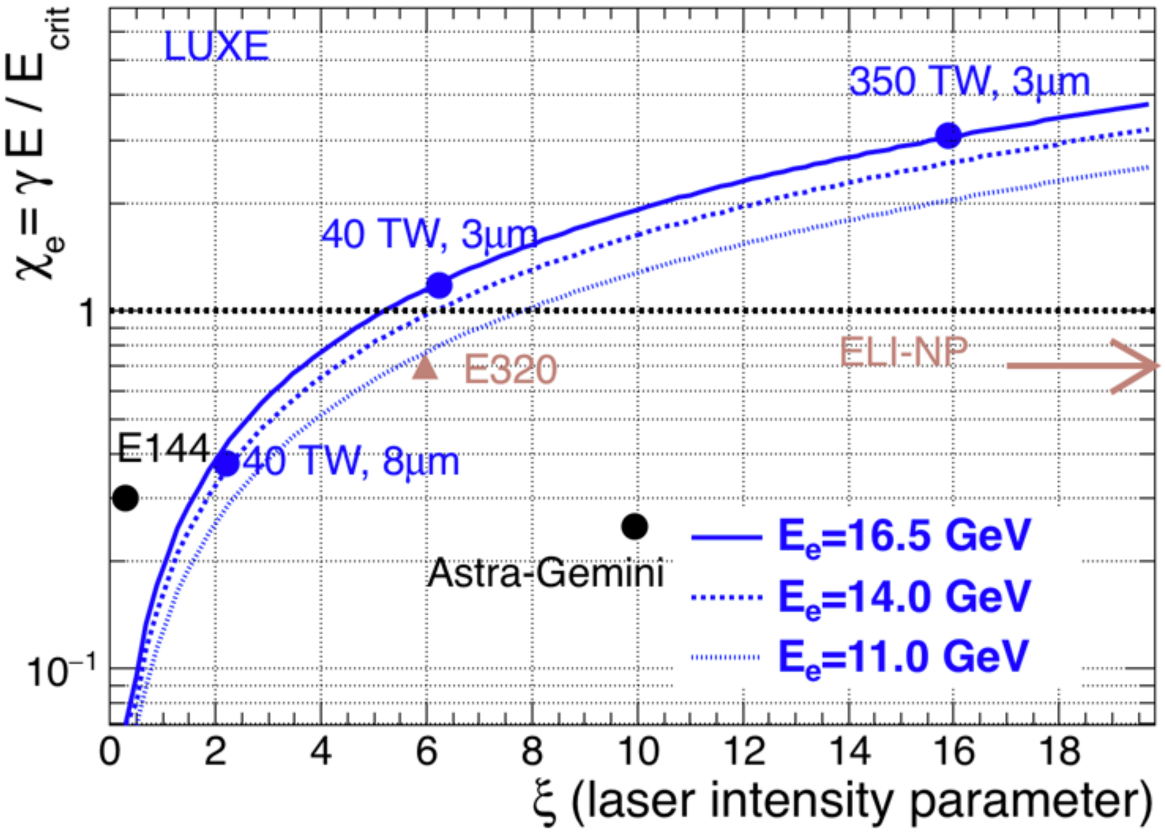
Quantum parameter			
χ_e for $E_e = 14.0$ GeV	0.37	1	2.6
χ_e for $E_e = 16.5$ GeV	0.44	1.18	3.07
χ_e for $E_e = 17.5$ GeV	0.47	1.26	3.26

- Laser Parameters are not pushing the state-of-the-art today.
- Focus is on stability rather than maximum power

COLLABORATION

- **France:**
  - LIDYL, CEA Saclay: Laser diagnostics
- **Germany:**
  - DESY: accelerator, infrastructure, Cerenkov detector, Laser diagnostics, photon detection system, simulation, DAQ
  - HI Jena and U. of Jena: Laser & diagnostics
  - HZDR, TU Dresden: theory, simulation, diagnostics
- **Israel:**
  - Tel Aviv U: calorimeter, interaction chamber
  - Weizmann Inst. of Sciences: tracker, BSM theory
  - Technion: BSM theory
- **Poland:**
  - AGH Cracow: Calorimeter electronics
- **Russia:**
  - Skoltech: simulation
  - JINR Dubna: calorimeter
- **Sweden:**
  - U of Gothenburg: simulation
- **Ukraine:**
  - KINR: photon detection system
- **United Kingdom:**
  - Queen's U of Belfast: Laser aspects, photon detection system
  - U College London: simulation, DAQ, scintillator screen
  - Royal Holloway U London: simulation, accelerator
  - U of Plymouth : theory, simulation

PARAMETER SPACE



Intensity parameter:

$$\xi = \sqrt{4\pi\alpha}\left(\frac{\mathcal{E}_L}{\omega_L m_e}\right) = \frac{m_e \mathcal{E}_L}{\omega_L \mathcal{E}_{cr}}$$

Quantum parameters:

$$\chi_e = (1+\cos\theta)\frac{E_e}{m_e}\frac{\mathcal{E}_L}{\mathcal{E}_{cr}}$$

$$\chi_\gamma = (1+\cos\theta)\frac{E_\gamma}{m_e}\frac{\mathcal{E}_L}{\mathcal{E}_{cr}}$$

Collision angle θ: 17.2 degrees

- LUXE has good chance to be first to actually break into $\chi > 1$ regime
- And only experiment proposed to directly explore photon-laser interactions

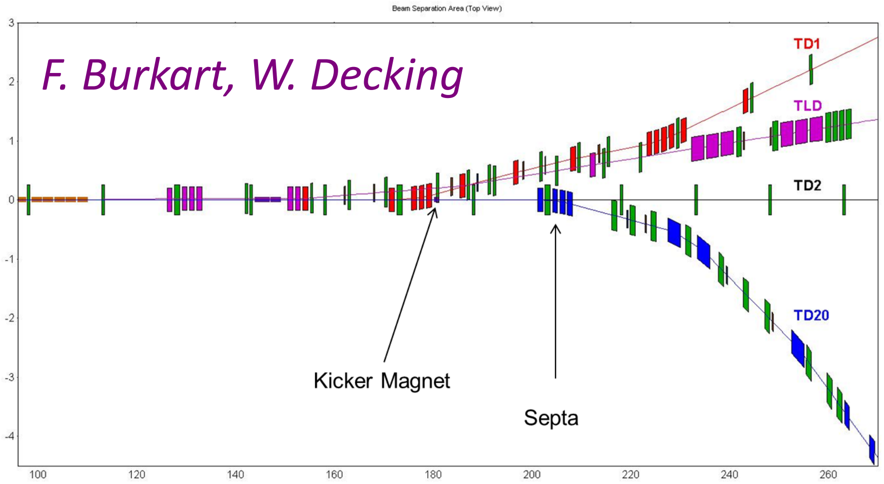
BEAMLINE LAYOUT

Design of magnets for beam extraction and then beam transfer to LUXE

- Most magnets use design already operating today in XFEL.EU
- New fast kicker magnets

Installation requires

- 5 weeks for extraction
- 7 weeks for transfer line



XTD20 Electron Beam Transfer Line

Conceptual Design Report

Editors: Florian Burkart, Winfried Decking

with input from: R. W. Assmann, R. Brinkmann, F. Burkart, W. Decking, H. Eckoldt, N. Golubeva, B. Heinemann, M. Huening, L. Knebel, M. Koerfer, B. Krause, D. Lenz, L. Lilje, C. Martens, M. Scheer, M. Schmitz, F. Obier, R. Platzer

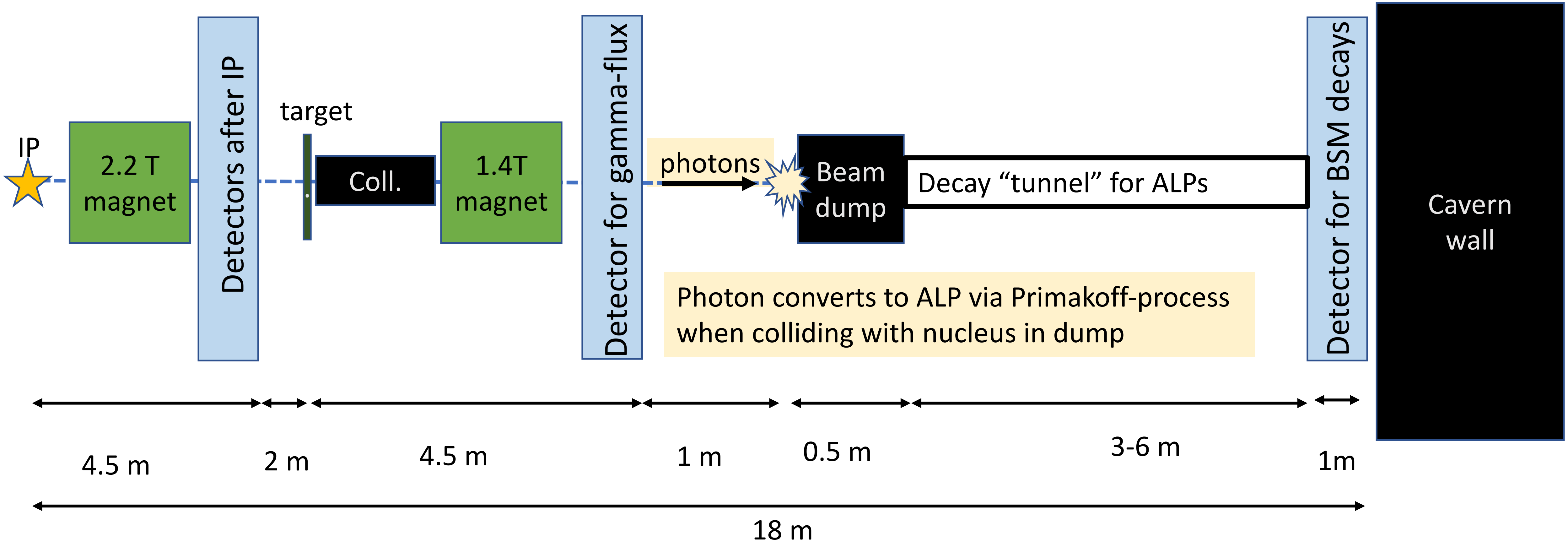
August 2019

XFEL.EU MAC

Machine Advisory Committee (MAC) of XFEL.EU met late October

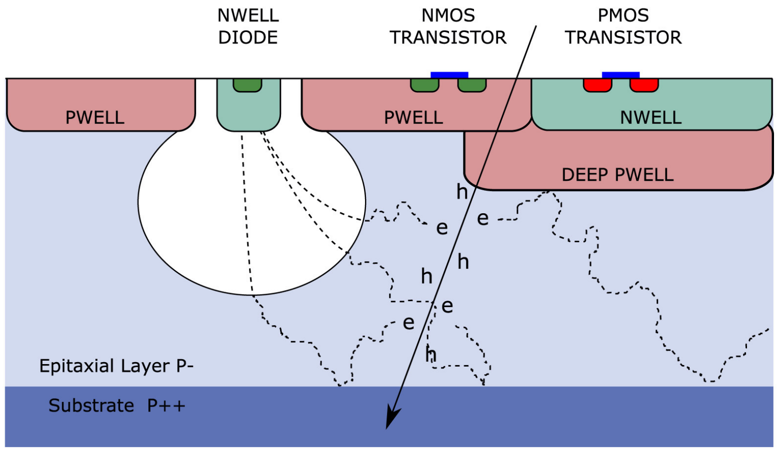
- W. Decking presented plans for beamline towards LUXE (CDR)
- Conclusions by MAC positive: "*The MAC believes that the design outlined in the extraction line CDR should meet the requirements of the LUXE experiment.* ***Risks (either for LUXE, or for regular XFEL operations) appear small, and can be managed. All the major issues have been considered,*** *and addressed appropriately, though one possible remaining issue that should be looked at is achieving the beam stability needed to ensure good overlap between electron and photon beams during collision be managed. Possible alternative configurations, such as locating the experiment after the undulators, have been considered and found to have significant disadvantages.*"

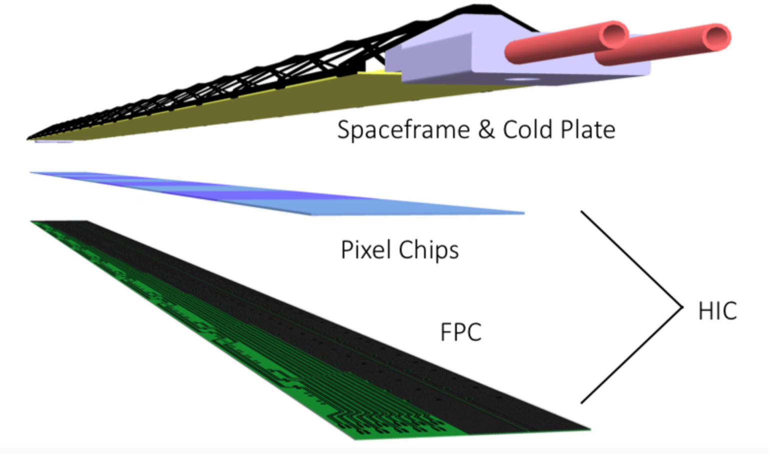
SCHEMATIC LAYOUT FOR BSM



- Have ~3-6 m space before the final wall for decay + detector: physics $\propto \exp(-L)$
- Use as "beam dump experiment" => detector technology still to be decided

SILICON DETECTORS





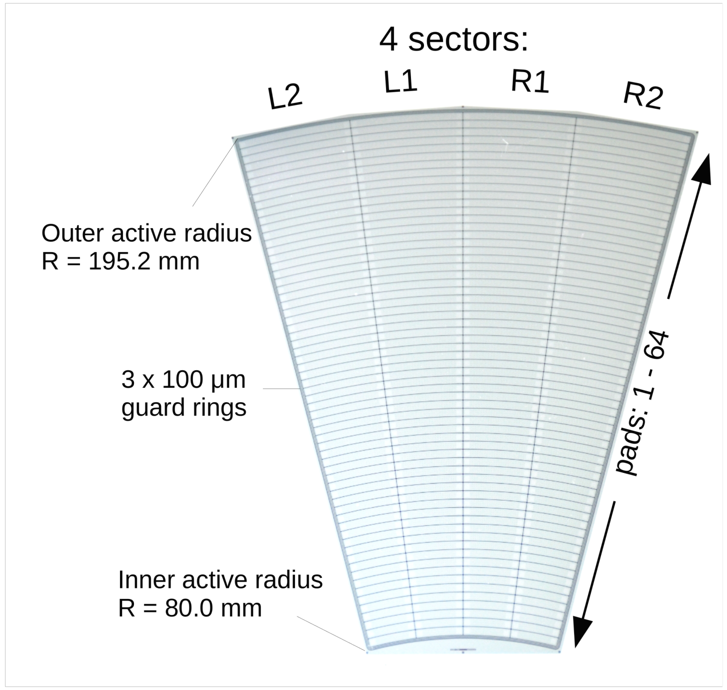
ALPIDE pixel detectors

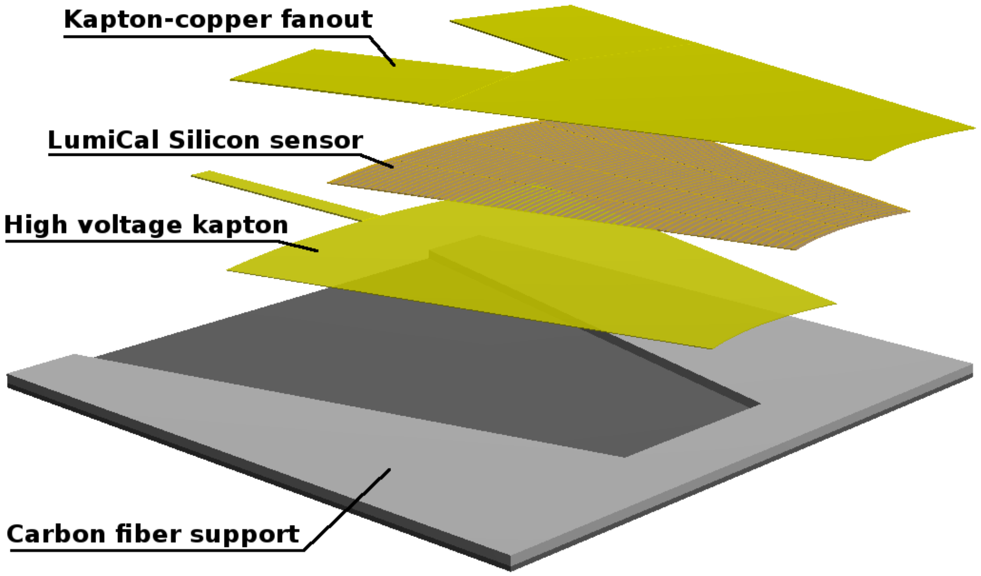
N. Hod (Weizmann Inst.)

- Developed by ALICE collaboration
- Staves of 27 cm length; sensor size 1.5x1.5 cm^2
  - Achieve full coverage with two staves placed next to each other
- Pixel size: 27 x 29 μm^2 => Spatial resolution ~5 μm
- Plan to use four layers staggered behind each other

Redundant tracking possible, important for beam background rejection

CALORIMETERS



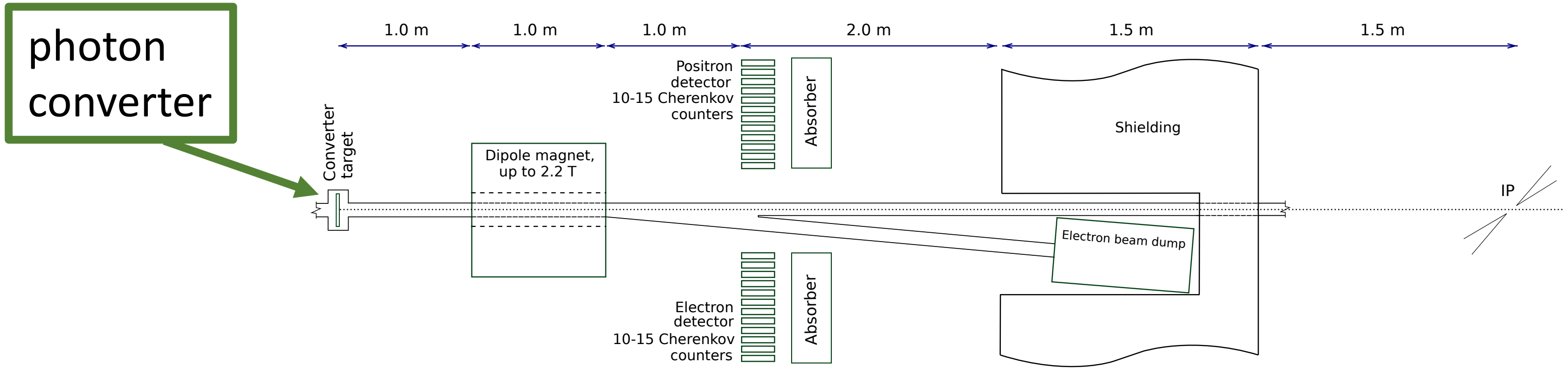


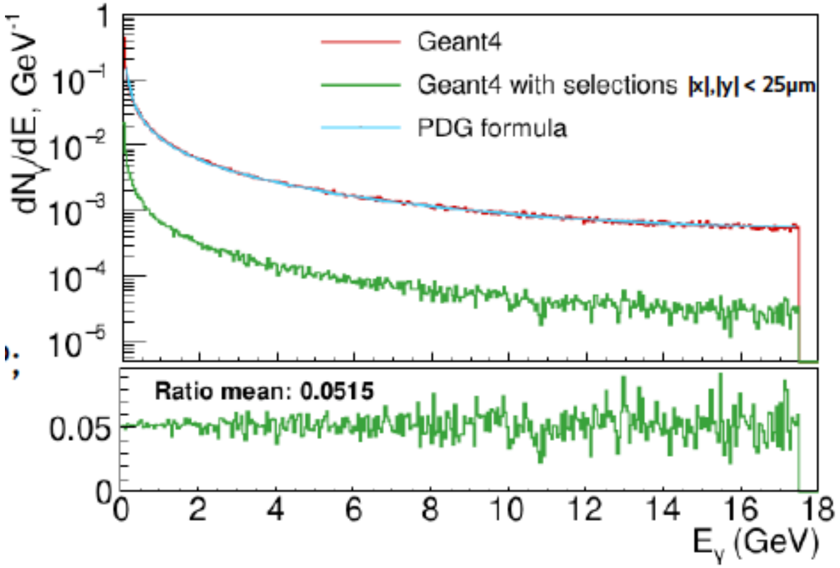
Y. Benhammou, H. Abramowicz, A. Levy (Tel Aviv U)

High granularity silicon Tungsten calorimeter

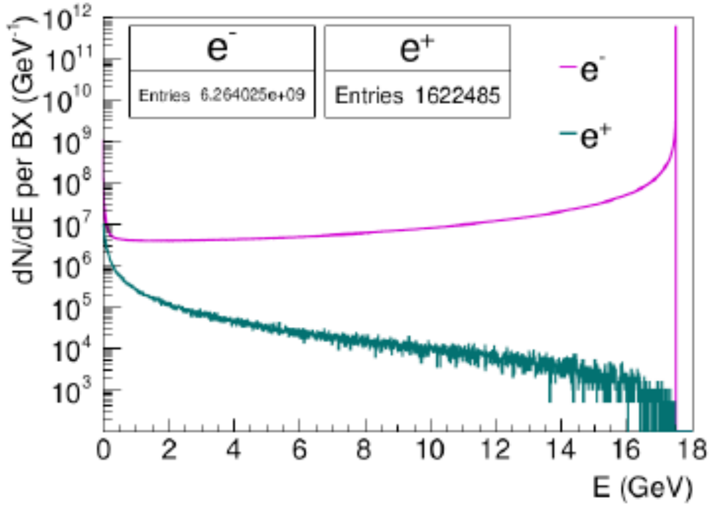
- Developed for luminosity measurement at linear colliders (LUMICAL)
- 20 tungsten absorber plates (3.5mm), Si layers in gaps (320 µm)
- Geometry adapted to fit needs of LUXE (~50cm long, vertical spread <1mm)
- Moliere radius 8 mm, Prototyped and test beam measurements available

HIGH-ENERGY PHOTON FLUX



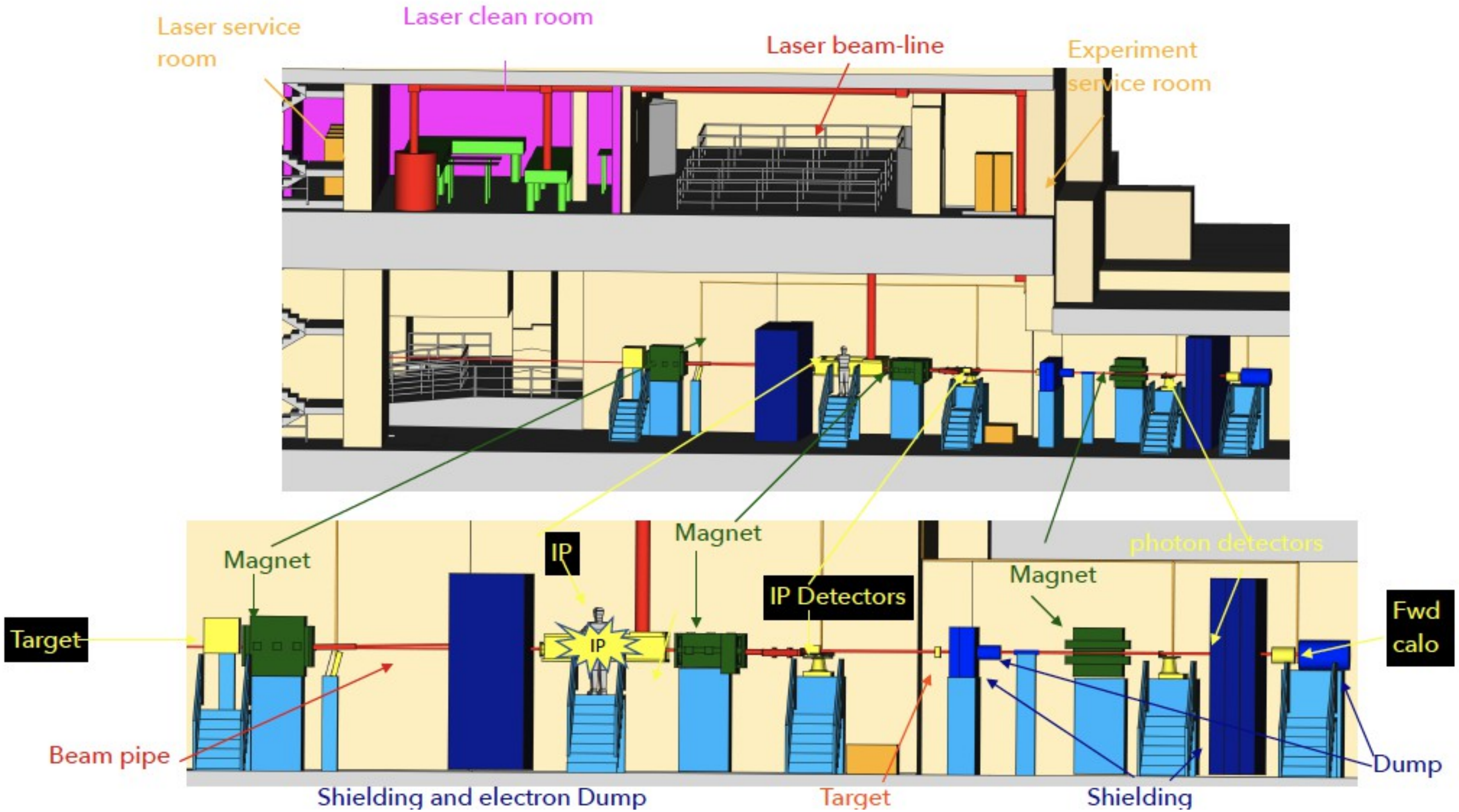


- **Simulation of converter using Geant4**
  - Tungsten Target with 0.01 X_0 (35 μm) => 1% at IP
- **Spectrum of photon energies important to know**
  - Measure by observing electrons and positrons right after dipole magnet
- **Particle detection**
  - 2T magnet followed by array of Cherenkov detectors measures flux vs impact position => energy spectrum

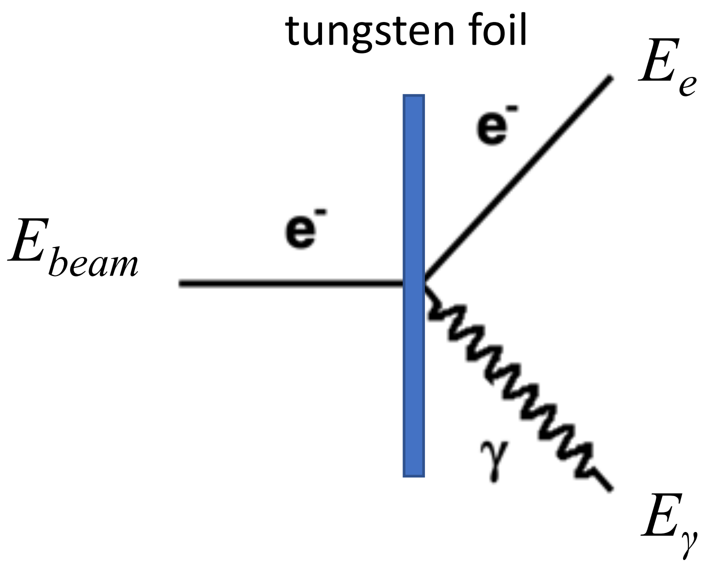


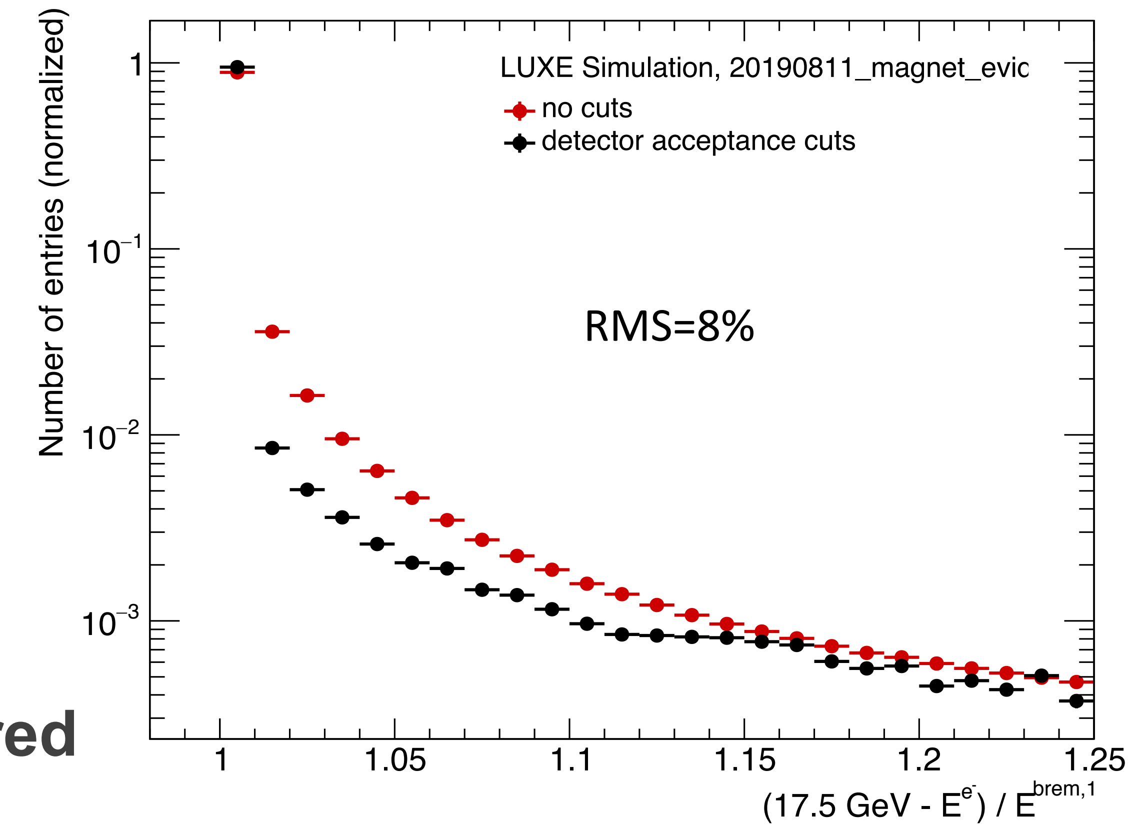
O. Borysov, DESY

GENERAL OVERVIEW: XS1 BUILDING



PHOTON ENERGY MEASUREMENT





M. Saimpert, DESY

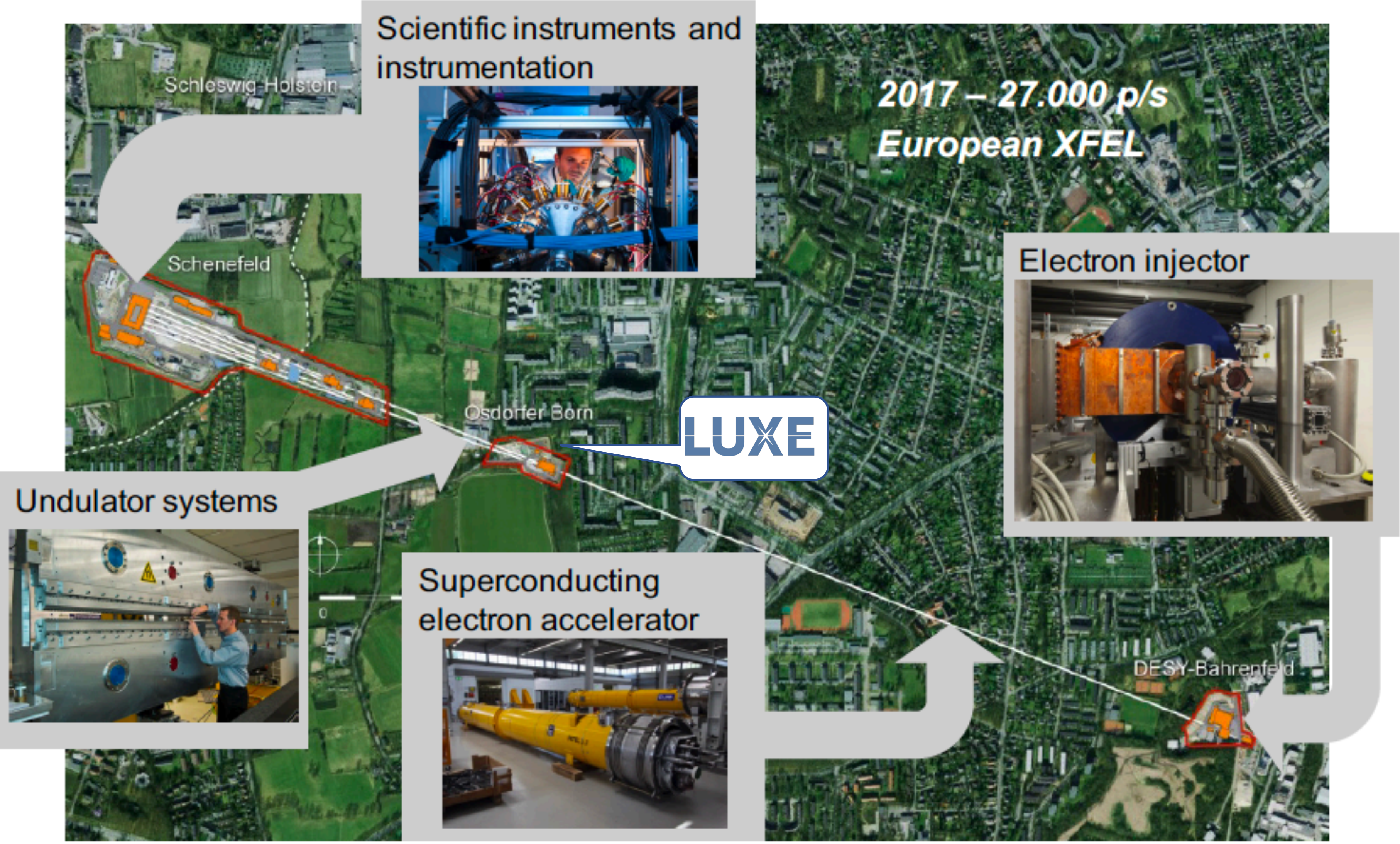
Photon energy determined from measured electron energy to within ~10%:

$$E_\gamma = E_{beam} - E_e$$

WHY EXPLORE STRONG-FIELD QED?

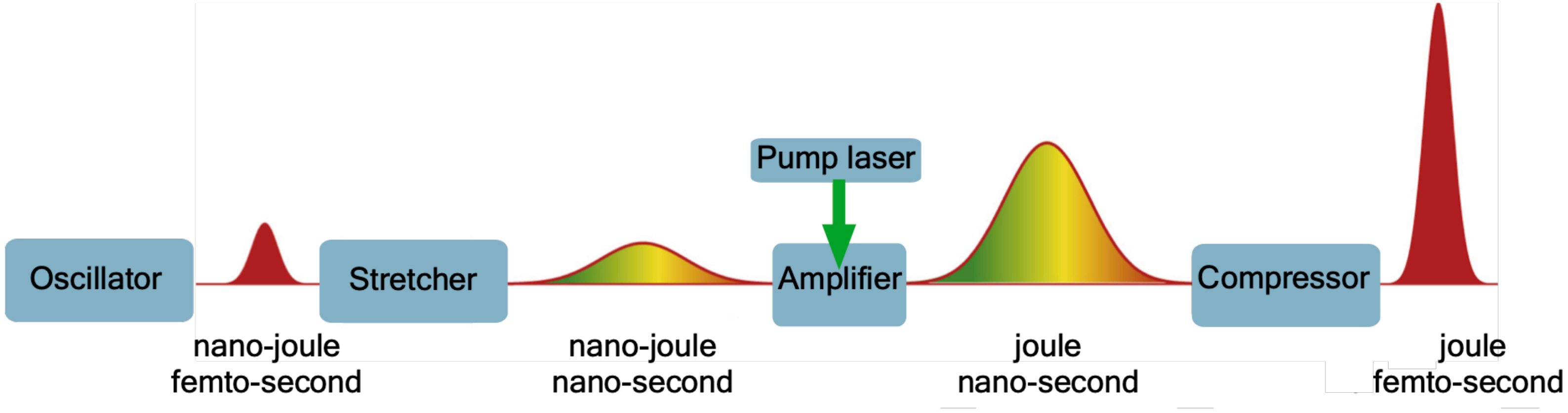
- **Relevant to numerous phenomena in our Universe**
  - Astrophysics:
    - Hawking radiation, surface of neutron stars (magnetars), early Universe
  - Condensed matter and atomic physics (nuclei with Z>137)
  - Accelerator physics: high energy e^+e^- colliders
- **Main goals:**
  - Testing theoretical predictions in novel regime
    - gain deeper understanding of quantum physics
  - Measure transition from perturbative to non-perturbative regime
    - could teach us about other non-perturbative regimes, e.g. understanding confinement [Gribov, hep-ph/9902279]
- **Schwinger field has never been reached experimentally in clean environment**
  - Exciting to be the first to explore this … we might be surprised what we find!

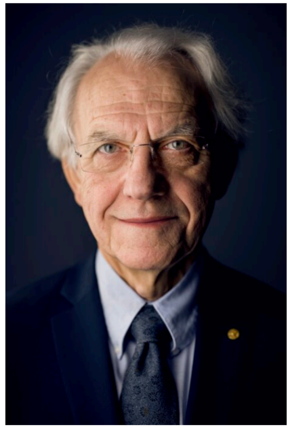
LOCATION



Scientific instruments and instrumentation
2017 – 27.000 p/s
European XFEL
Schleswig-Holstein
Schenefeld
Osdorfer Born
LUXE
Electron injector
Undulator systems
Superconducting electron accelerator
DESY-Bahrenfeld

LASER TECHNOLOGY





Gérard Mourou

Prize share: 1/4

Donna Strickland

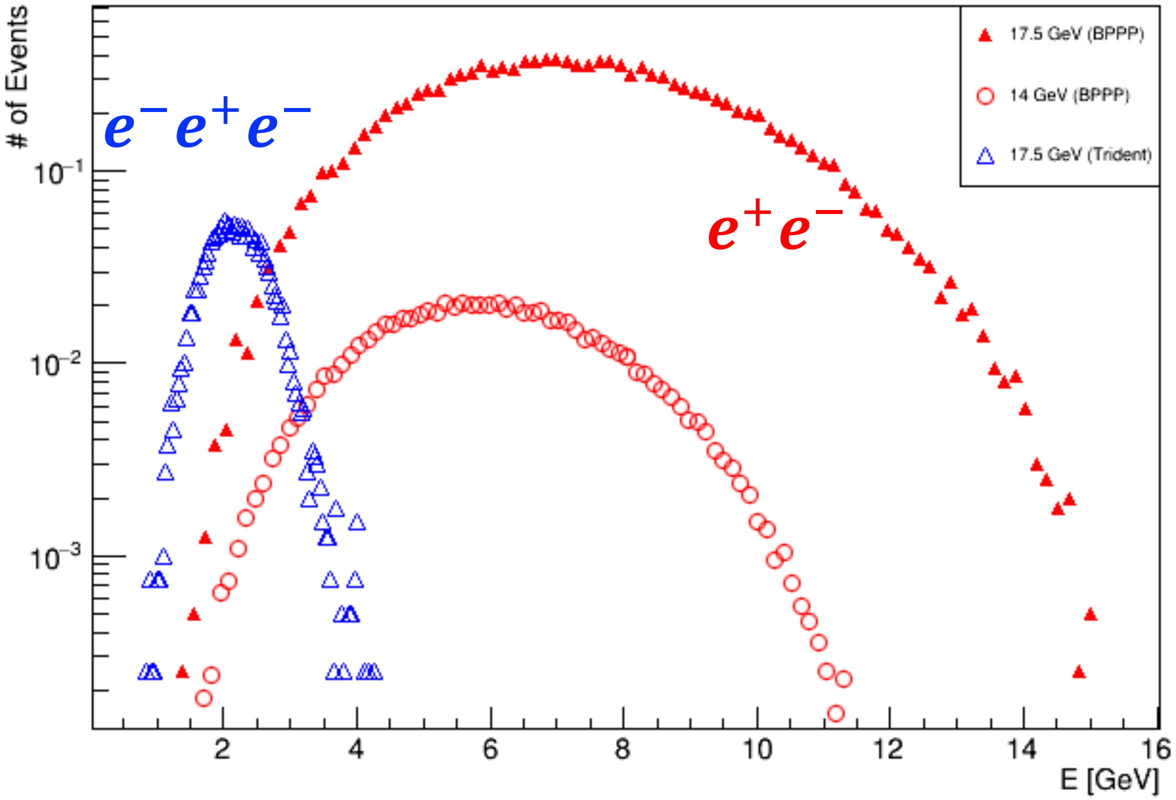
Prize share: 1/4

- **Use Chirped Pulse Amplification (CPA) technique**
  - Half of the NP 2018 shared by Gerard Mourou and Donna Strickland for "for their method of generating high-intensity, ultra-short optical pulses."
- **Ti:Sa laser with 800 nm wavelength**
- **Energy focussed in time and space => high int.**
- **Laser diagnostics system required**
  - Goal: precision ~5%

SIMULATION RESULTS

- ***Monte Carlo simulation of expected signatures used***
  - *By A. Hartin, UCL*
- ***Energy spectrum ranges between 1 and 15 GeV***
  - *Energies significantly lower for trident process*
- ***For trident process uses "two-step" process only***
  - *Calculation of one-step trident ongoing*

Positron Energy Spectrum



A. Hartin (UCL), M. Hoffmann (DESY)

POSITRON RATE VS LASER INTENSITY

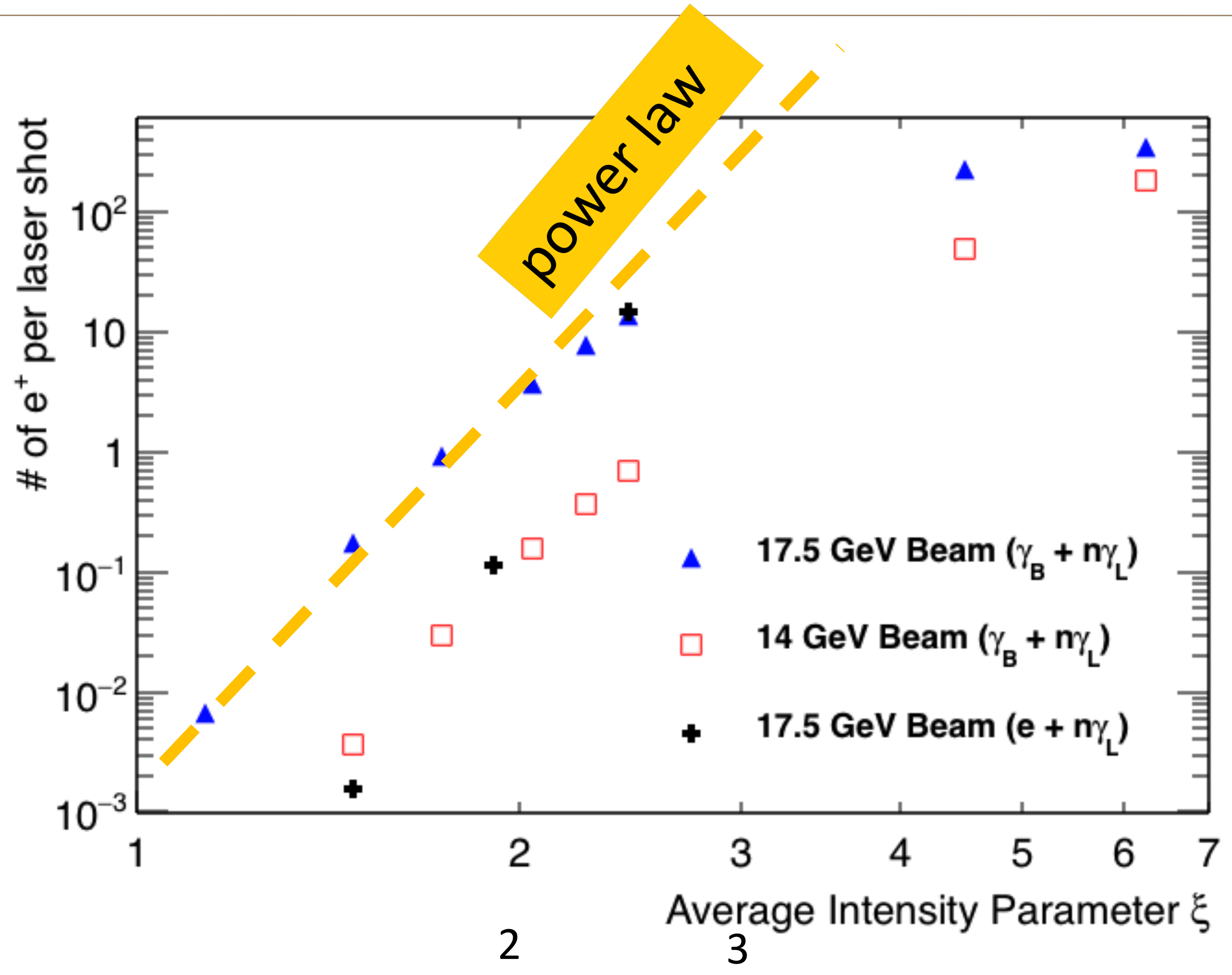
Main result of experiment

Low laser intensity

- Encounter power-law behaviour

High intensity

- Should observe deviation from power-law behaviour
- Aim to quantify by extracting coefficient



A, Hartin (UCL), M. Hoffmann (DESY)

THANKS!!

DESY directorate:

- DESY Strategy Fund funded many of studies presented here

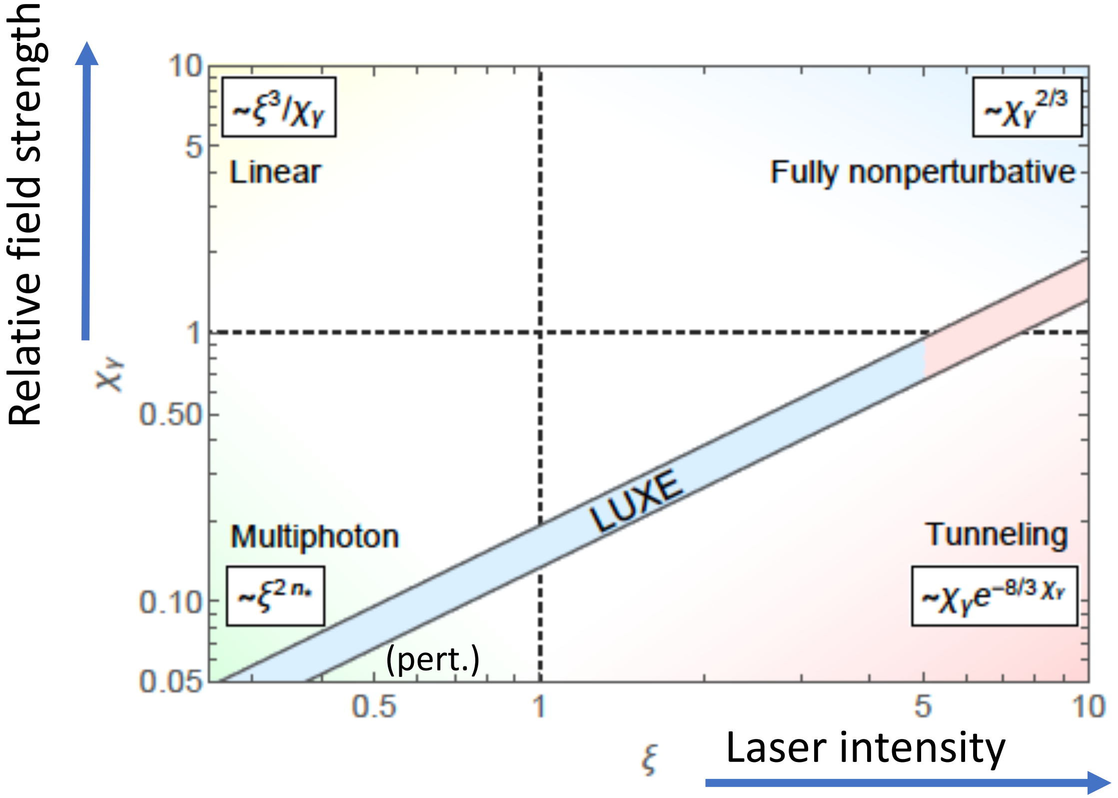
DESY technical groups:

- MVS (Vacuum Modification)
- MIN (Kicker, Beam Dump)
- D3 (radio protection advice)
- MEA (installation and Magnets)
- ZM1 (Construction Input)
- MKK (Power/Water)
- IPP (CAD integration)

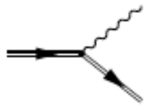
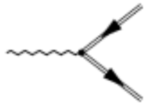
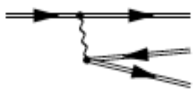
DESY divisions

- MXL, MPY, MPY1 (from M), FLC (from FH)

LUXE PARAMETER SPACE: THEORY VIEW



three processes at LUXE

LUXE Candidate Processes		
	Nonlinear Compton	$e^{\pm} \to e^{\pm} + \gamma$
	Nonlinear Breit-Wheeler	$\gamma \to e^- e^+$
	Nonlinear trident	$e^{\pm} \to e^{\pm} + e^- e^+$

LUXE will probe three different regimes as the laser intensity is varied

- Dedicated teams for calculations and simulations contributing to LUXE
- All results based on custom simulations (A. Hartin, UCL)
  - Cross-checks by other theorists involved ongoing (Gothenburg, Plymouth, Skoltech, MEPHI, Jena)

SNOWMASS SESSION: HIGH FIELD PHYSICS WITH INTENSE ELECTRON AND LASER BEAMS

Contribution list | Timetable

Oct. 7th 2020

Wed 07/10

Print | PDF | Full screen | Detailed view | Filter

13:00	Schwinger field physics	Michael Peskin	Zoom 20	13:00 - 13:10
	SLAC E-320 experiment	Sebastian Meuren	Zoom 20	13:10 - 13:15
	LUXE experiment	Beate Heinemann	Zoom 20	13:15 - 13:20
	One-sliders		Zoom 20	13:20 - 13:23

More interesting issues concern modeling and emergent behavior:

The pairs in the e+e- plasma created by Schwinger fields are produced coherently. What is the effect of this quantum coherence ? Are there prominent plasma modes enhanced by this effect ? Is there nonlinear pattern formation ?

This is an unexplored regime, so we should expect surprises.

Fascinating nonlinear phenomena arise from coherent effects in high-harmonic X-ray generation and from spinodal decomposition in alloys and polymer solutions. Why not here?

Thus, the motivation to explore the $\chi > 1$ regime is very strong.

M. Peskin