

INTRODUCTION

LUXE meeting

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January 20th 2021





CONTENT

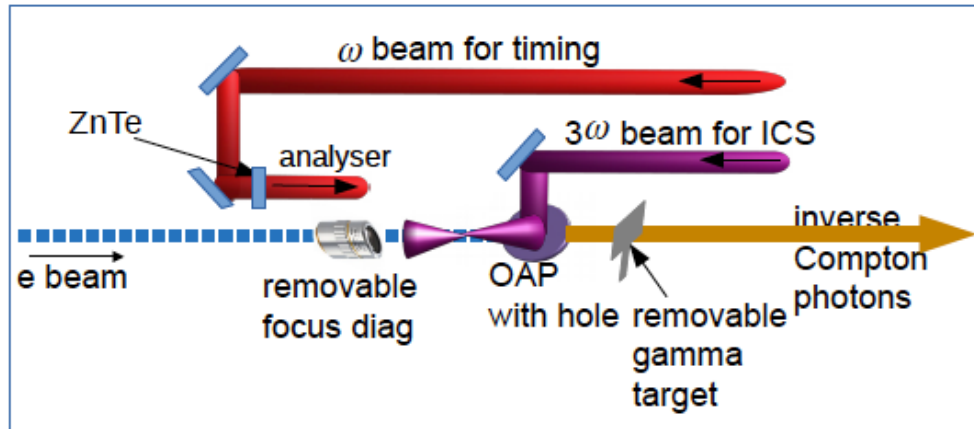
- **Comments on photon-laser running**
- **Schedule**
- **Selected new results shown in CDR**
- **Conclusions**



PHOTON-LASER RUNNING

E/PHOTON-LASER HYBRID SETUP

Target chamber:
move target or inject 3ω laser beam



Detectors at IP: movable

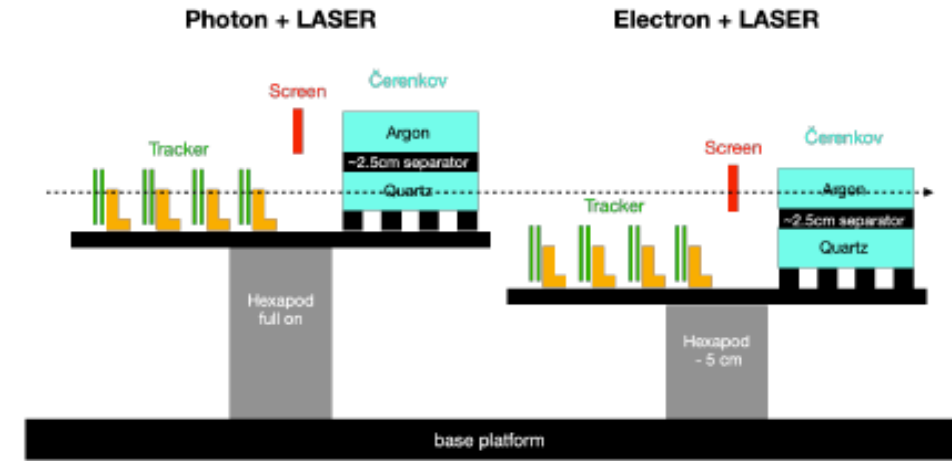
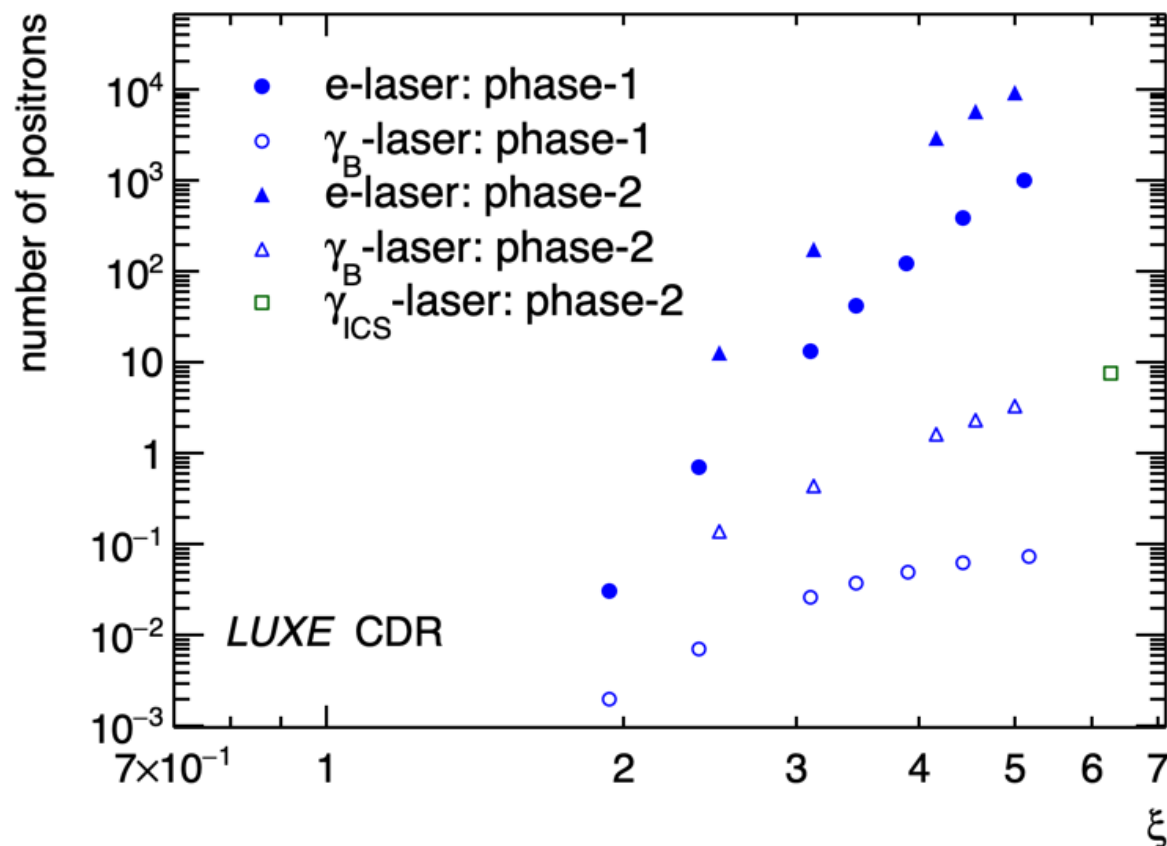


Figure 6.30. Sketch of the hybrid IP detector setup for option 2. Shown are the tracker and the Cherenkov detector on a stage that moves vertically depending on whether γ -laser or e -laser data taking is desired.

- **Operationally: always start with e-laser setup**
 - Then: establish good overlap of beam+laser, then insert target/ 3ω laser, then move detectors
 - Detector technology different due to different signal/background conditions
 - Is rather complicated => need engineering to figure out how to do this (w/o enhancing background)

MONTÉ CARLO: POSITRON PRODUCTION



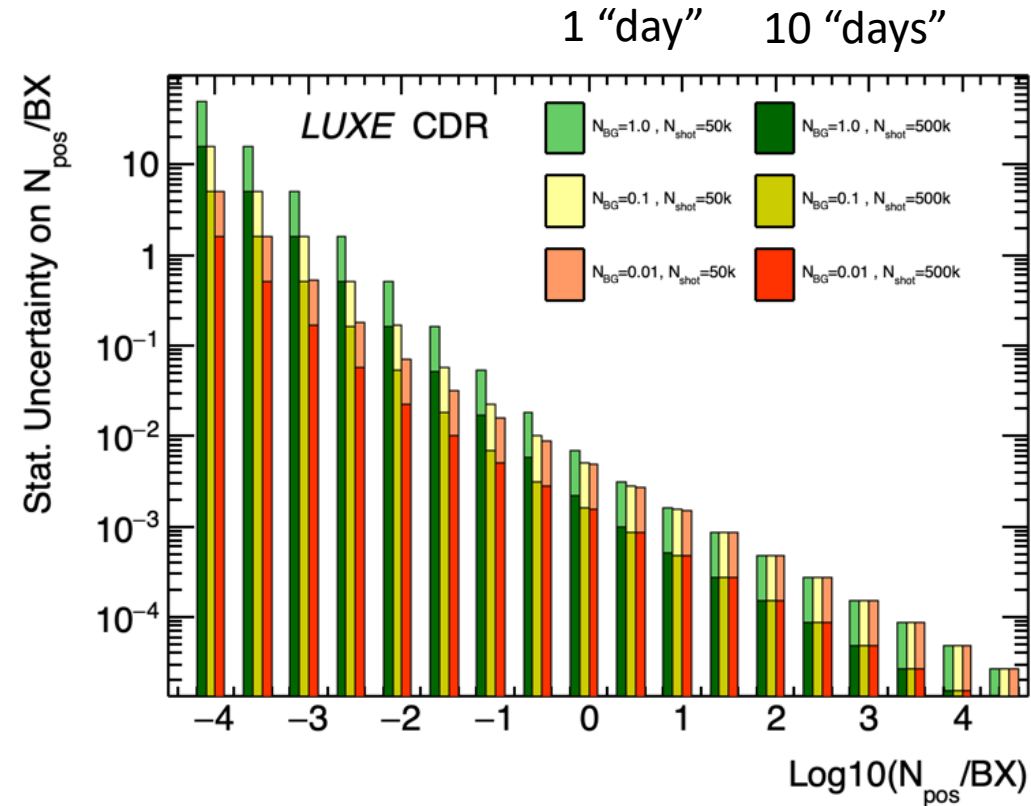
- **Rates of positrons higher for e-laser process**

- Positron production rate < 0.1 /laser shot for gamma-laser JETI40

- **Strategy:**

- e-laser as primary/initial process to study Compton and trident
 - Also enables BSM physics
- Photon-laser unique w.r.t. other facilities

UNCERTAINTY ESTIMATE



- Can probe rates as low as ~ 0.01 with $<10\%$ accuracy if background below ~ 0.1
- Rates of 0.001 difficult but obtainable with $N_{\text{BG}} < 0.01$ and 10 days $\Rightarrow$ should be our “goal”
- For rates > 1 a single day is sufficient to get %-level accuracy



SCHEDULE

DISCUSSION

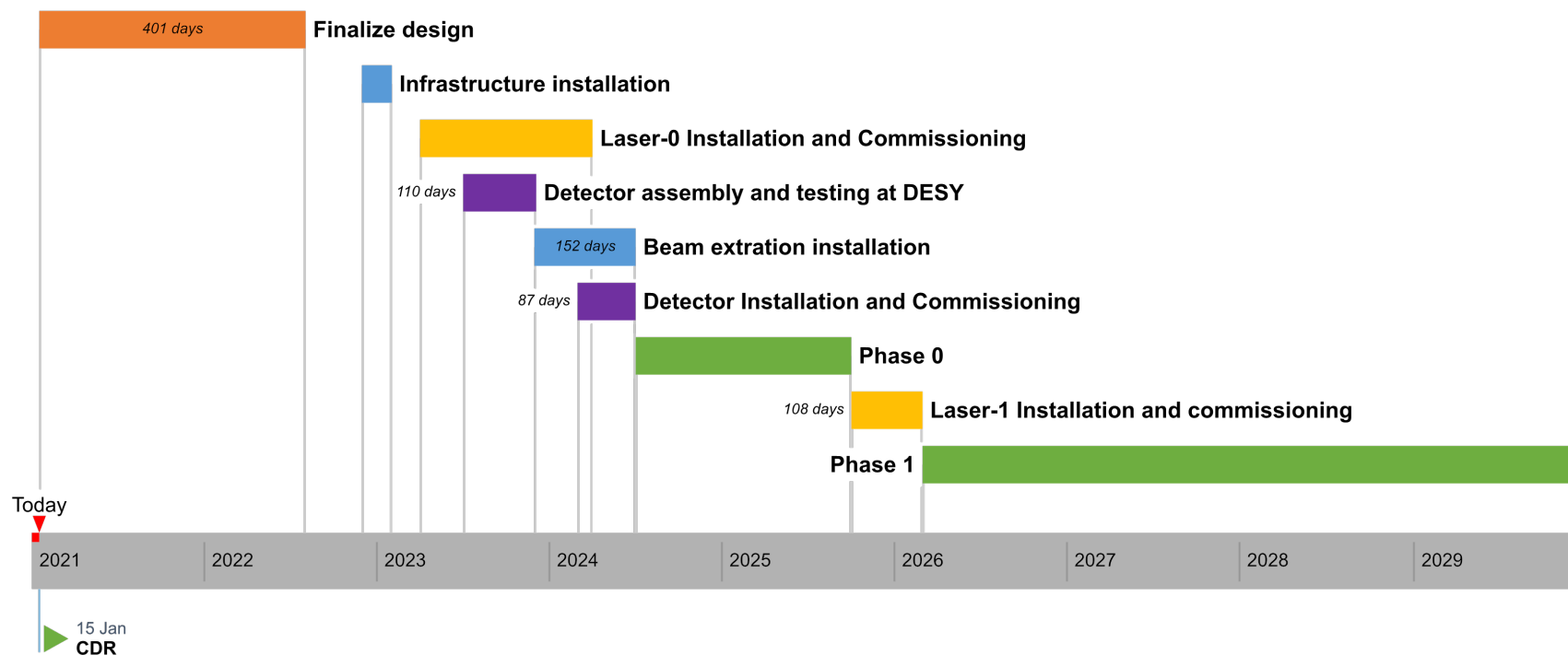
• Desirable

1. That we have both e-laser and gamma-laser running in phase-0
 - a. e-laser is simpler and prerequisite for gamma-laser
 - b. gamma-laser is unique (e.g. w.r.t. E144 experiment)
 - c. We have a “hybrid setup” so we can on the fly” change between running modes
2. We would like phase-I to start asap
 - a. Only then we get really into regime of critical field
 - b. Again we want to get there before the competition

• Constraints

1. Beamline construction in 2024 (6m shutdown)
 - this is the only longer shutdown foreseen for now, otherwise there are annual 5-6 week shutdowns
2. Starting in 2030 the construction of 2nd fan
 - Unclear if there will be any longer shutdown before then
3. When everything is working QED physics programme can normally done within 1-10 days per focus point
 - But many “add-ons” possible but all can be done also with more powerful laser
4. Need to be able to construct all aspects in time
 - resource loaded schedule needed

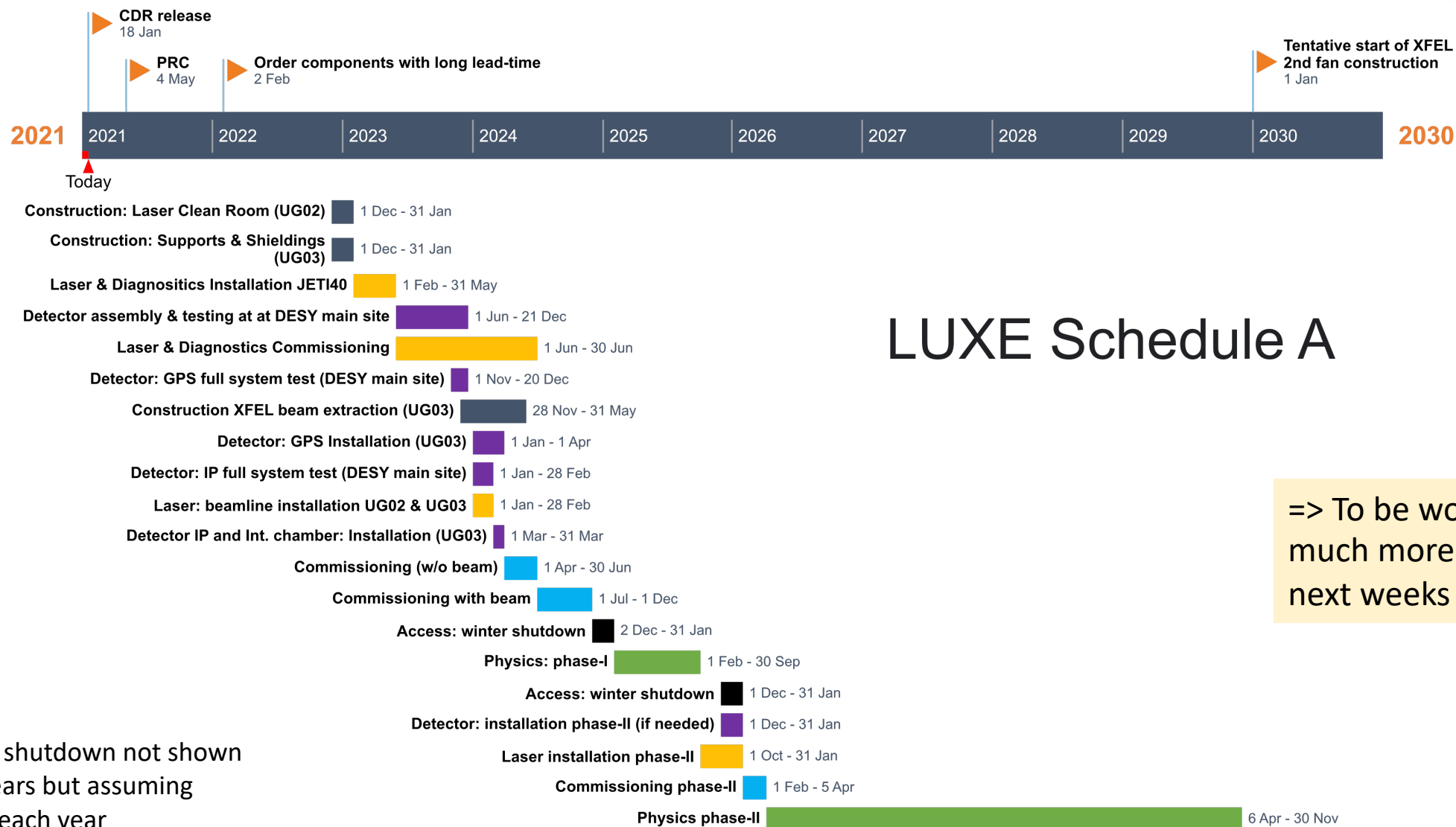
SCHEDULE



- Phase-0: 1 years data taking
 - 12 months includes commissioning of EU.XFEL and LUXE
 - Shared by e-laser and gamma-laser, e.g. 3 months each and 3 months extra
- Phase-I: 4 years starting 2026
 - About 40 months for commissioning + physics



MORE DETAILS ON SCHEDULE



LUXE Schedule A

=> To be worked out in much more detail in the next weeks

*Winter shutdown not shown for all years but assuming present each year

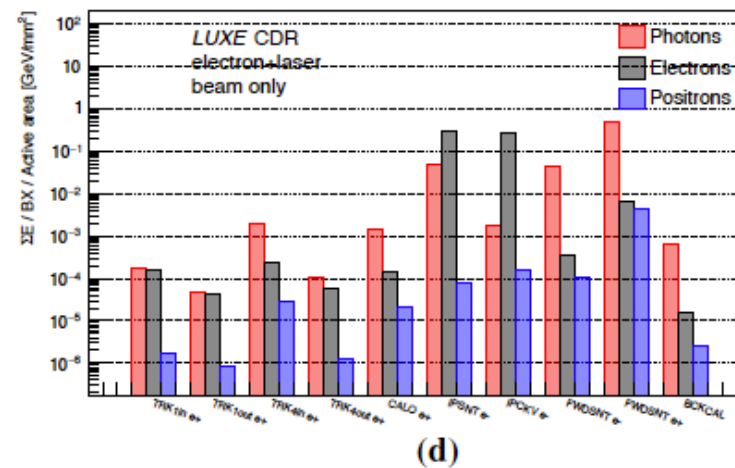
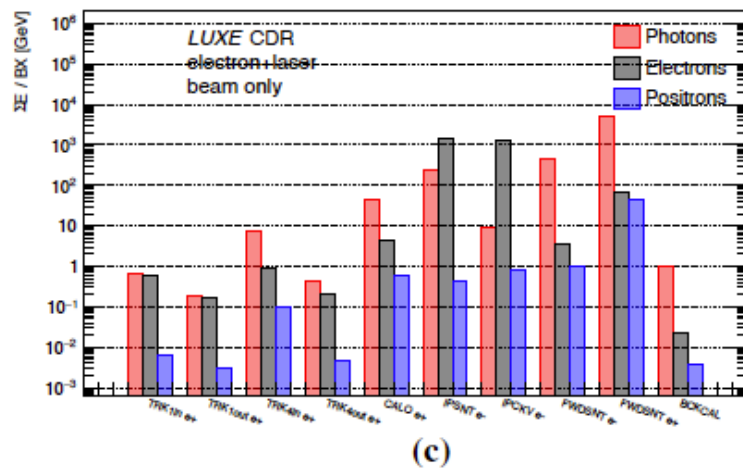
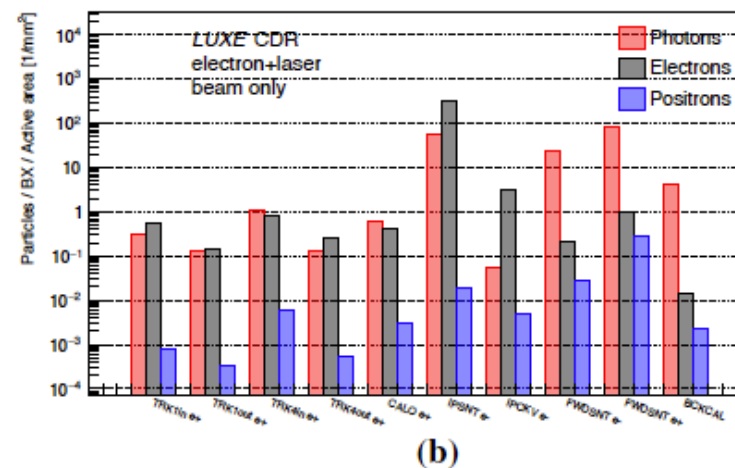
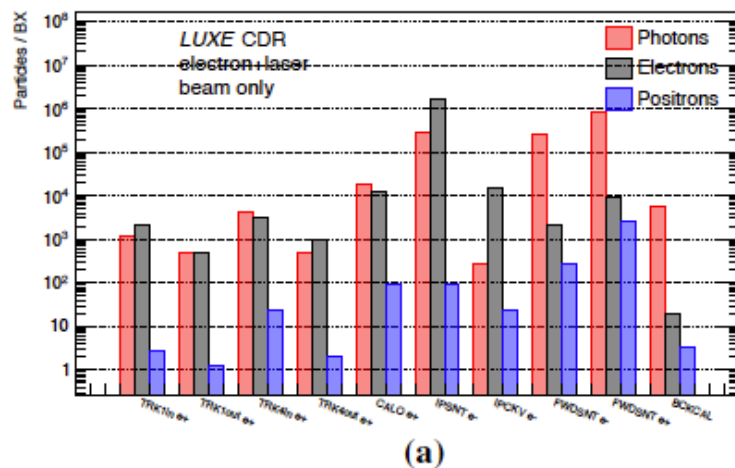


UPDATED RESULTS IN CDR

**There were some updates in the last weeks that were not yet
presented here**

BACKGROUND SIMULATION

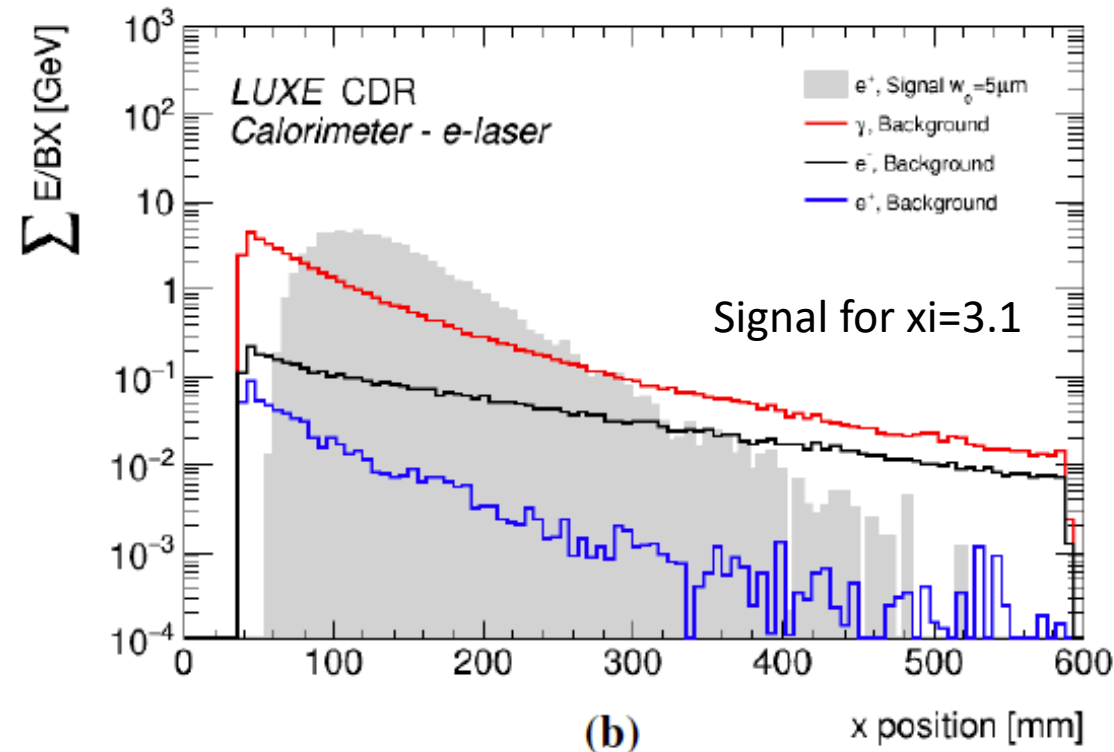
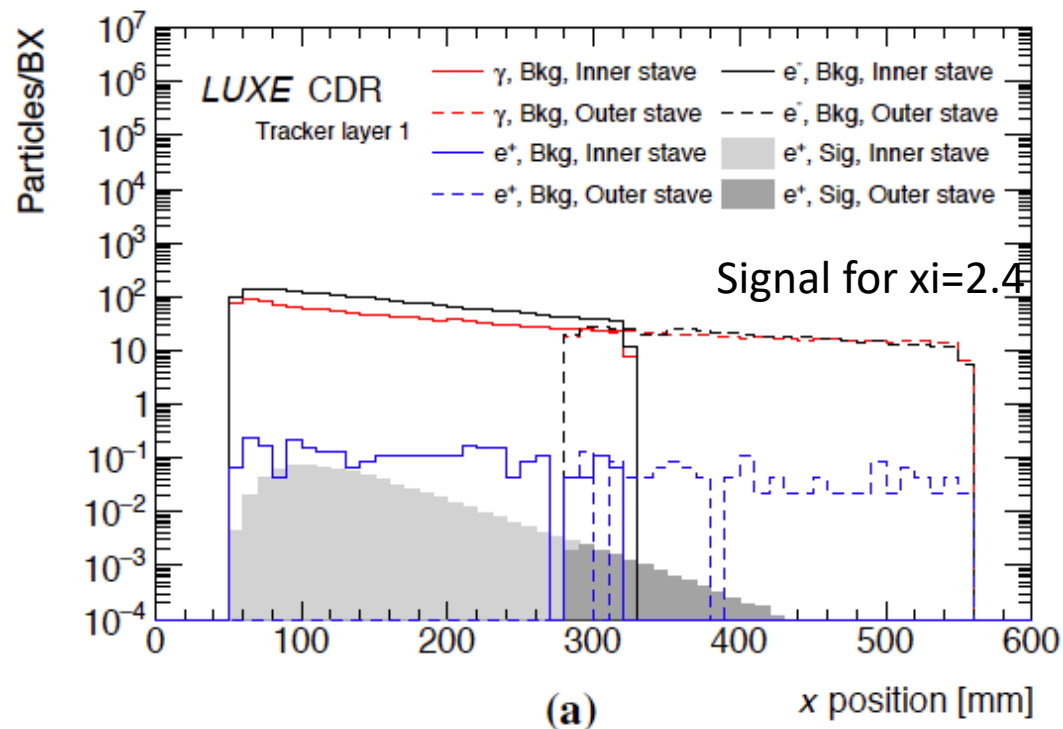
- A lot of work done in the last days and weeks to improve shielding in IP area



Sasha et al.

TRACKER & CALORIMETER SIGNAL/BACKGROUND

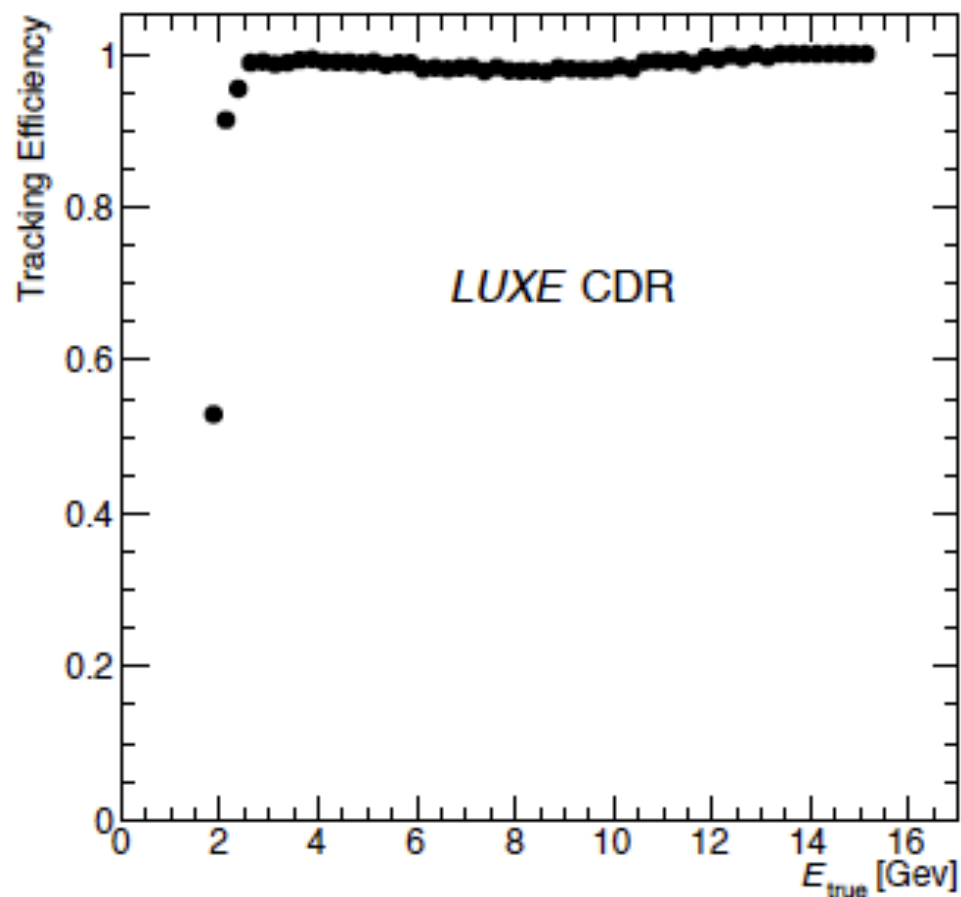
Arka, Noam



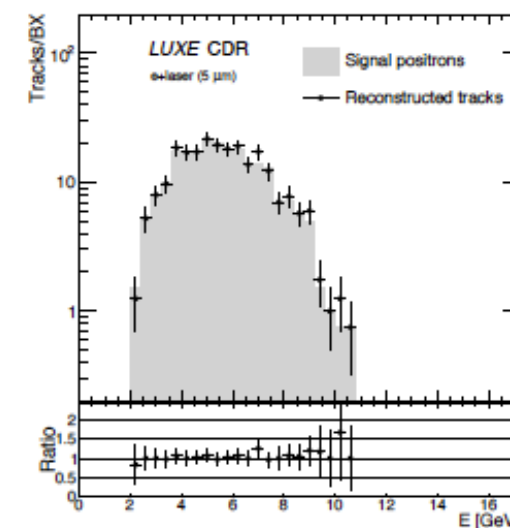
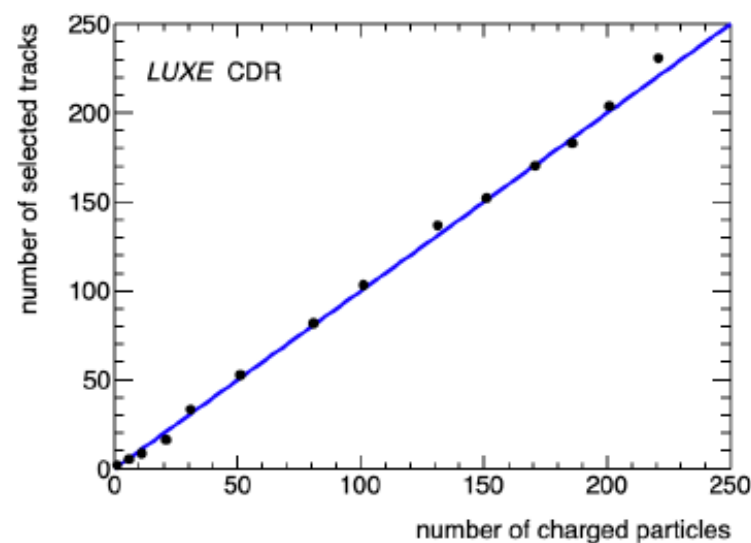
- **Signal at face value rather small compared to background**
 - Motivation for using the chosen technologies as they are powerful for rejecting background

TRACKER PERFORMANCE

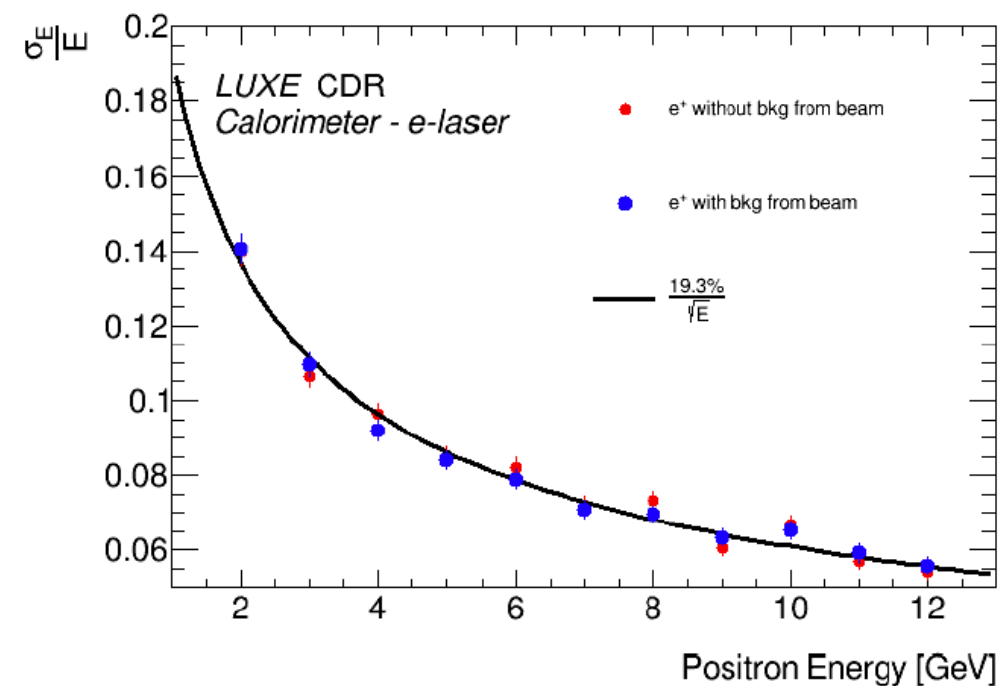
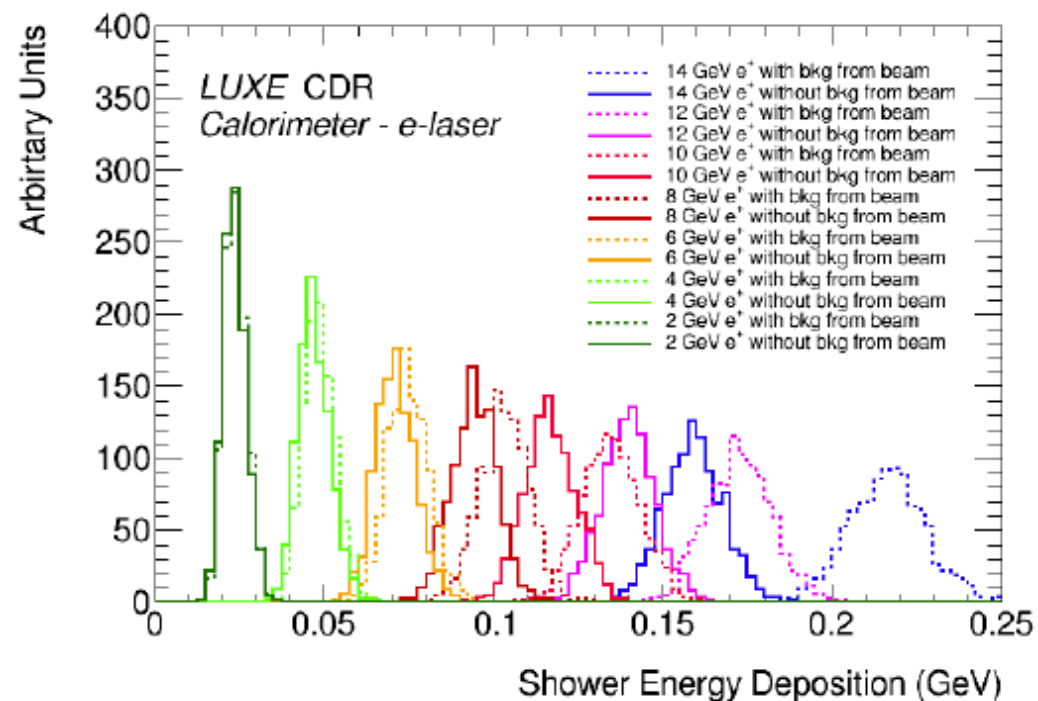
Arka, Noam



selection	<i>e</i> -laser	γ -laser	
	N_{pos}	N_{pos}	N_{ele}
Pre-selection	9.3 ± 0.2	1.7 ± 0.2	1.8 ± 0.2
3 hits	1.06 ± 0.08	0.17 ± 0.07	< 0.1
4 hits	< 0.02	< 0.1	< 0.1



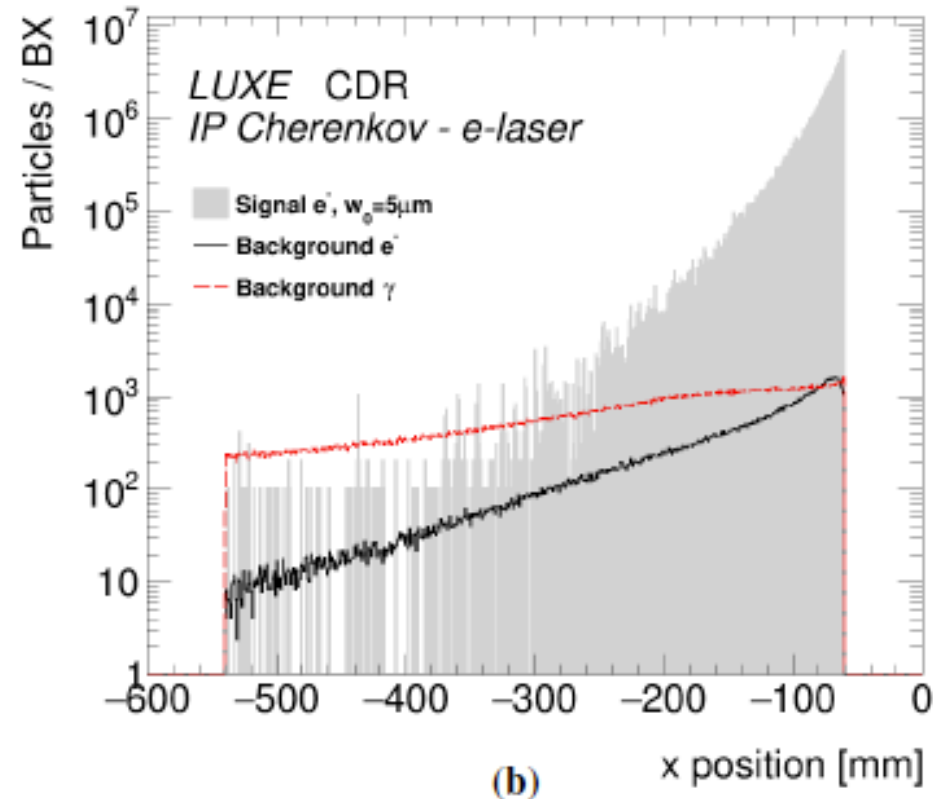
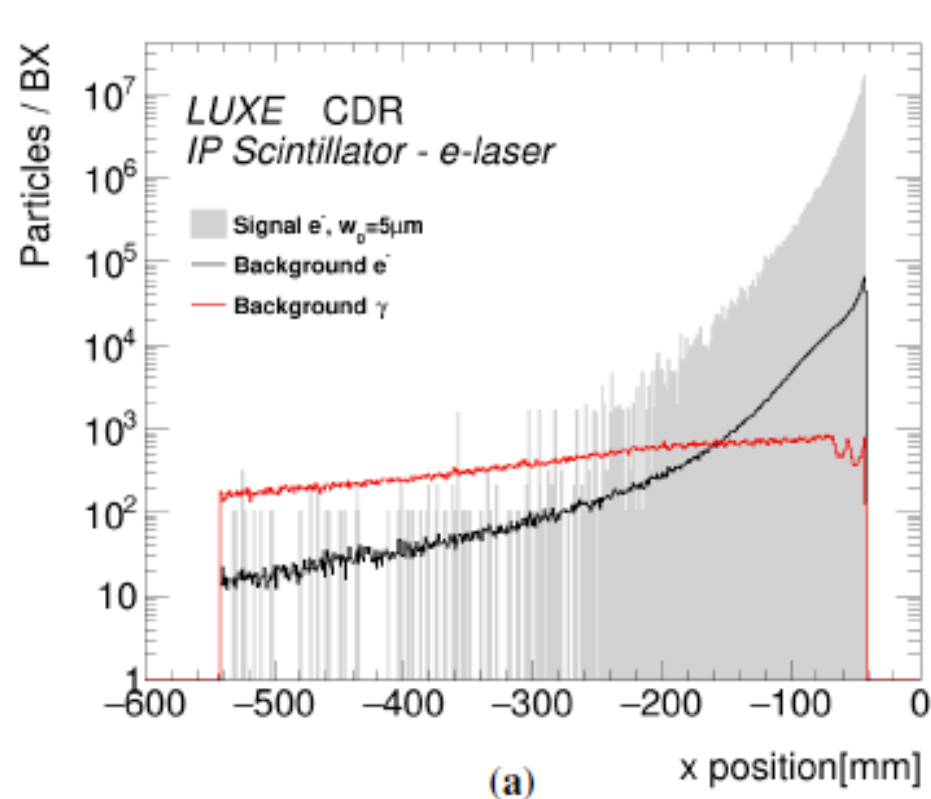
CALORIMETER PERFORMANCE



**Resolution can be maintained also in presence of background
after addition of shielding**

*Louis, Halina,
Sasha, Shan*

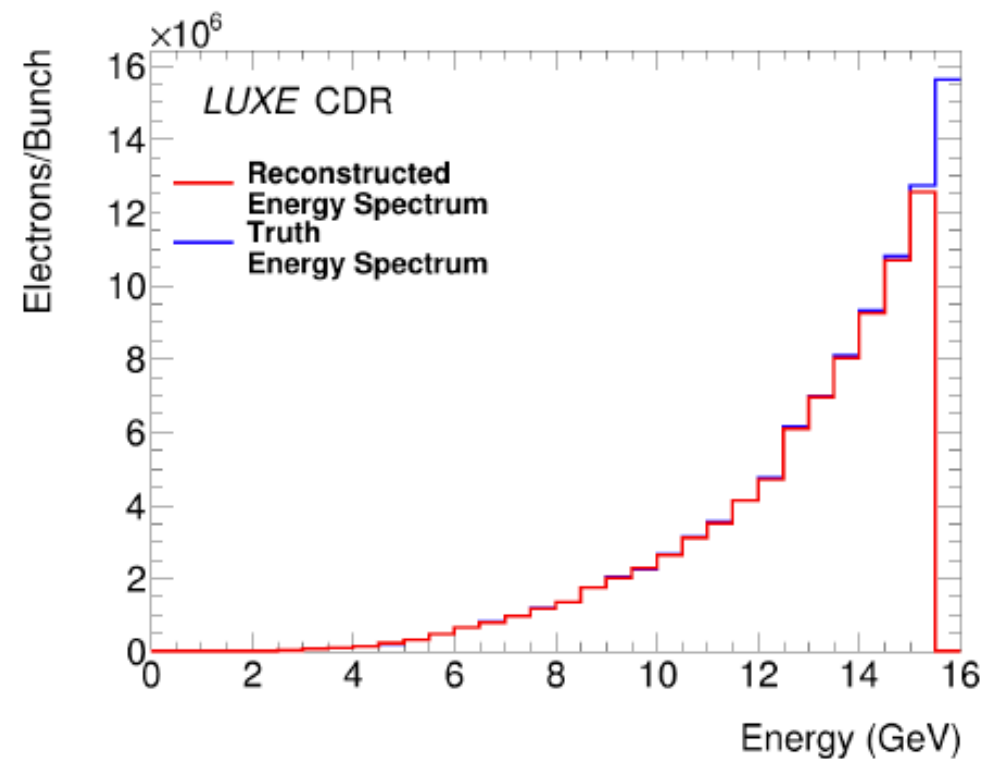
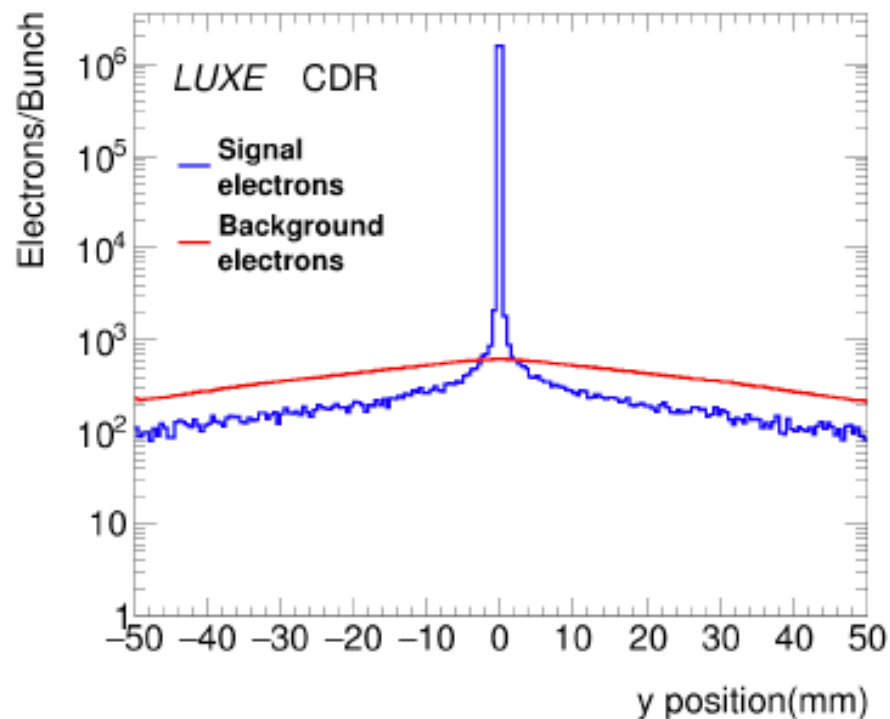
IP SCINTILLATOR & CHERENKOV SIGNAL/BACKGROUND



- Signal / background $> 100/1 \Rightarrow$ pretty good!

John, Ruth

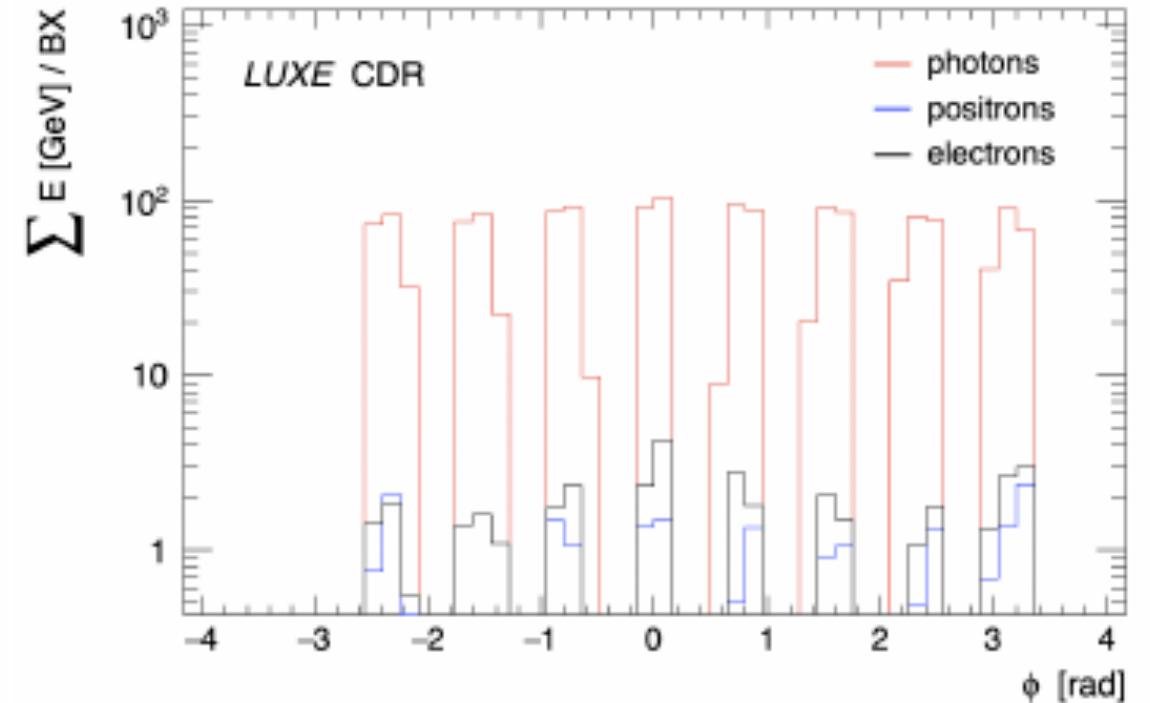
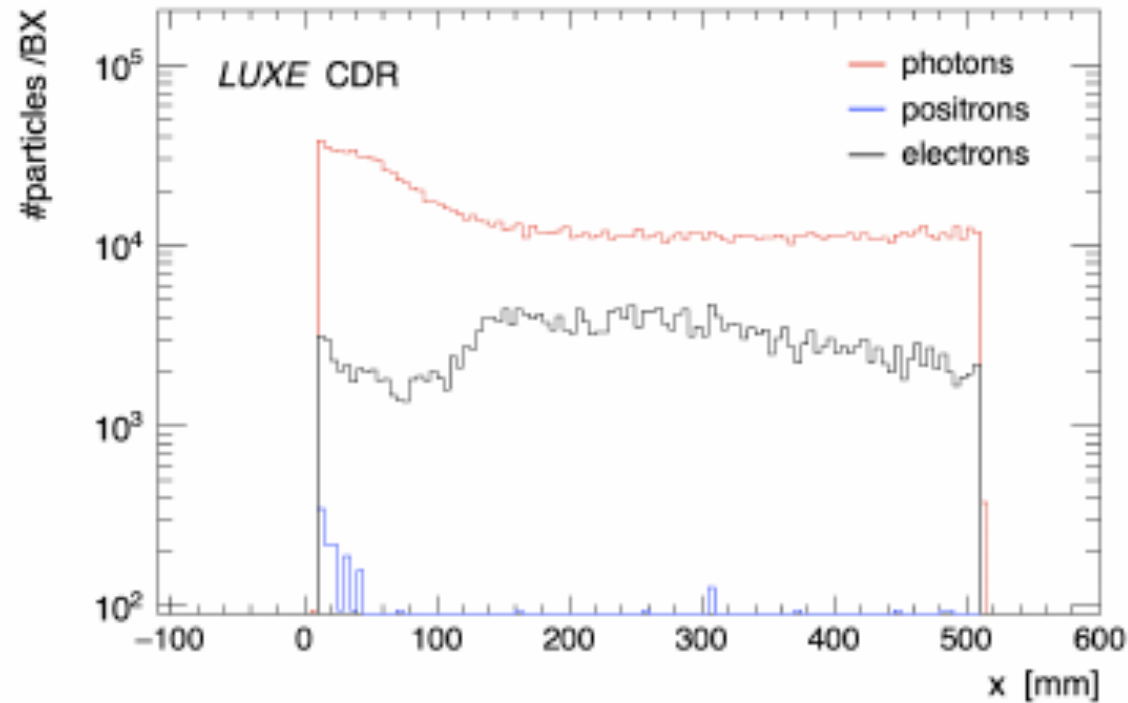
IP SCINTILLATOR: NEW PLOTS



- Background can very effectively be rejected and measured with sidebands in vertical direction

John H,
Matthew

FWD SCINTILLATOR & CALORIMETER BACKGROUND



*Kyle, Gianluca,
Maryna*

- **Background dominated by photons**
 - Even though for scintillator photons yield lower signal, still likely dominant background

GAMMA PROFILER

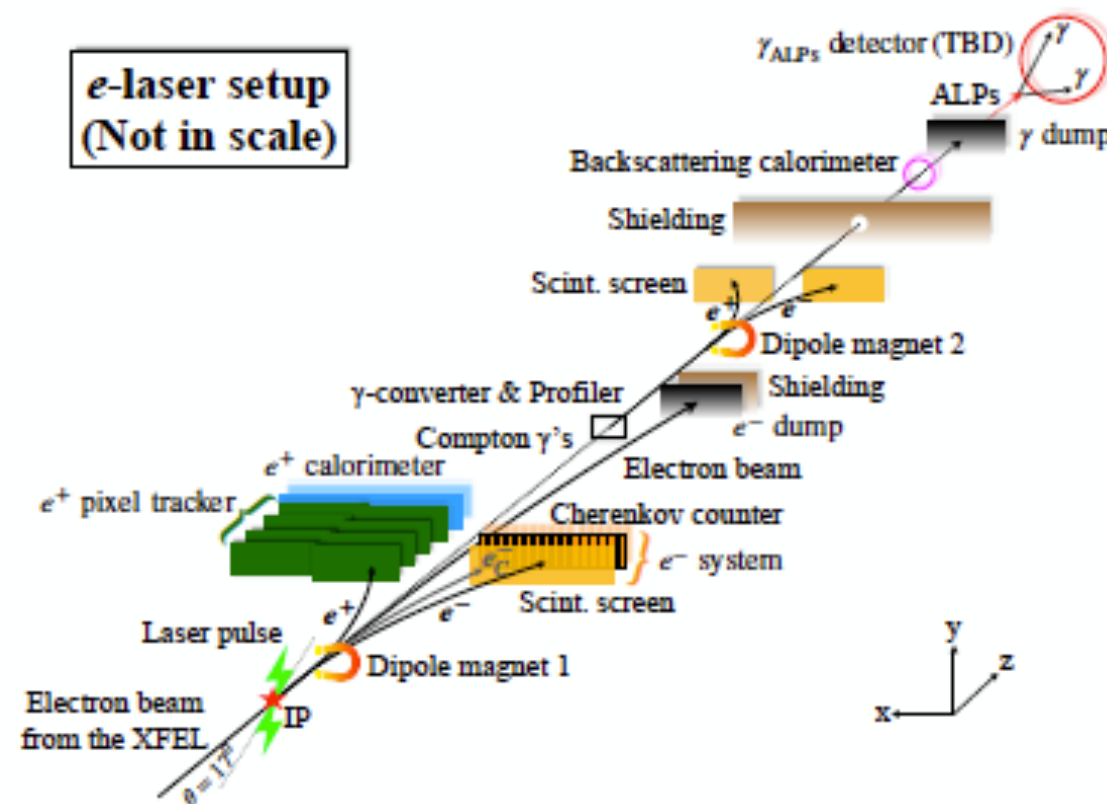
- **Added gamma profile made of sapphire strips**

- Goal: measure 2D profile of photon beam to measure expected elliptical shape
- For E=16.5 GeV at z=6m from IP:

$$\sigma_x = \max(1, \xi) \times 180 \mu\text{m}$$

$$\sigma_y = 180 \mu\text{m}$$

- Aim: 5 μm resolution to obtain independent measure of ξ



M. Bruschi et al. => talk at next meeting



IONISATION DOSE

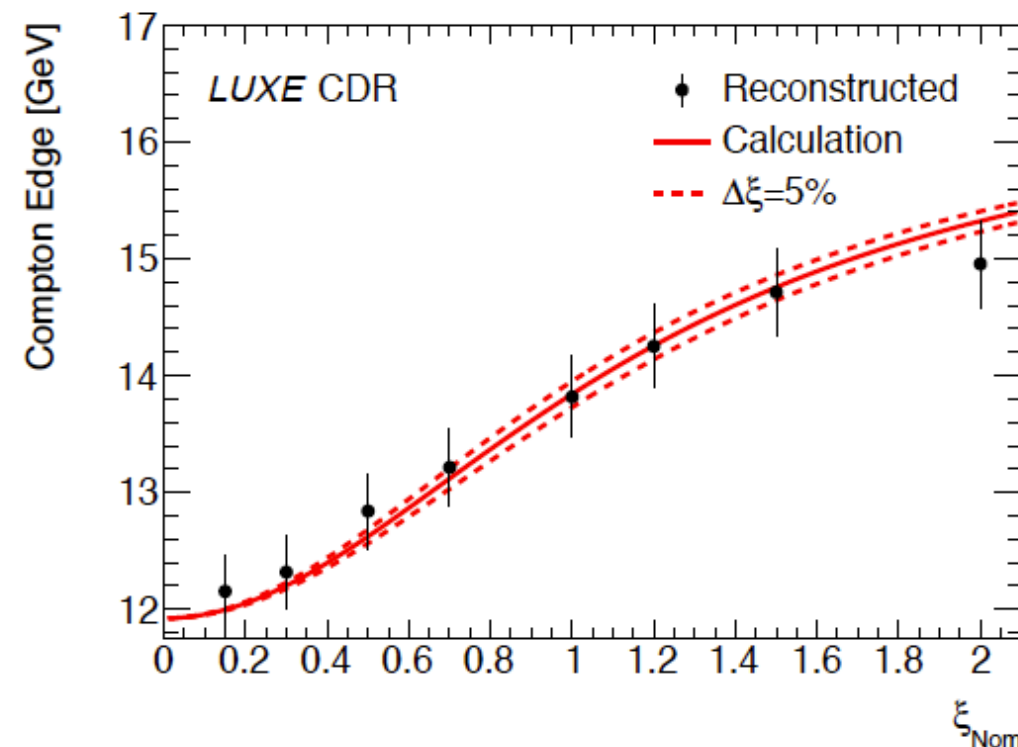
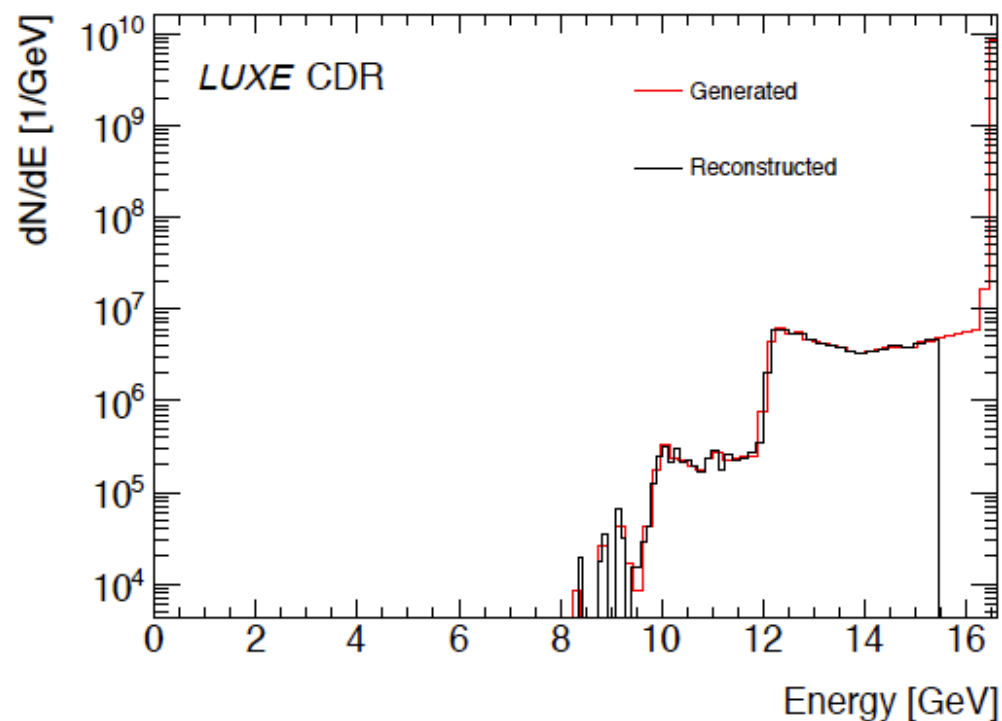
Maryna et al.

Detector	avg. annual dose [Gy]	tolerable dose [Gy]
IP Pixel tracker	1 – 15	$27 \cdot 10^3$
IP Calorimeter	0.3 – 3	10^6
IP Scintillator	$(0.6 – 30) \cdot 10^3$	10^8
PDS GadOx Scintillator	12.5	10^8
PDS LYSO Scintillator	10^4	$10^4 – 10^7$
PDS Gamma Profiler	$< 10^7$	10^7
PDS Backscatter Calorimeter	0.7	300

- Annual does ~ tolerable in all cases but in some cases margin low

COMPTON SHIFT

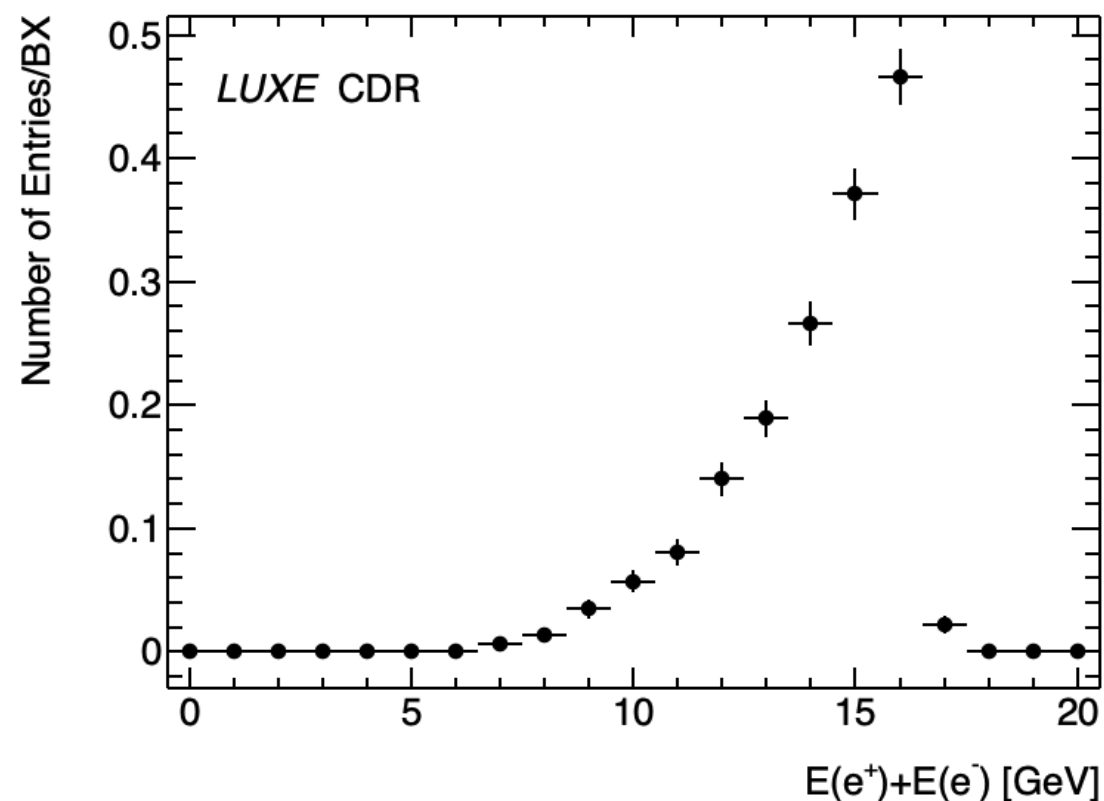
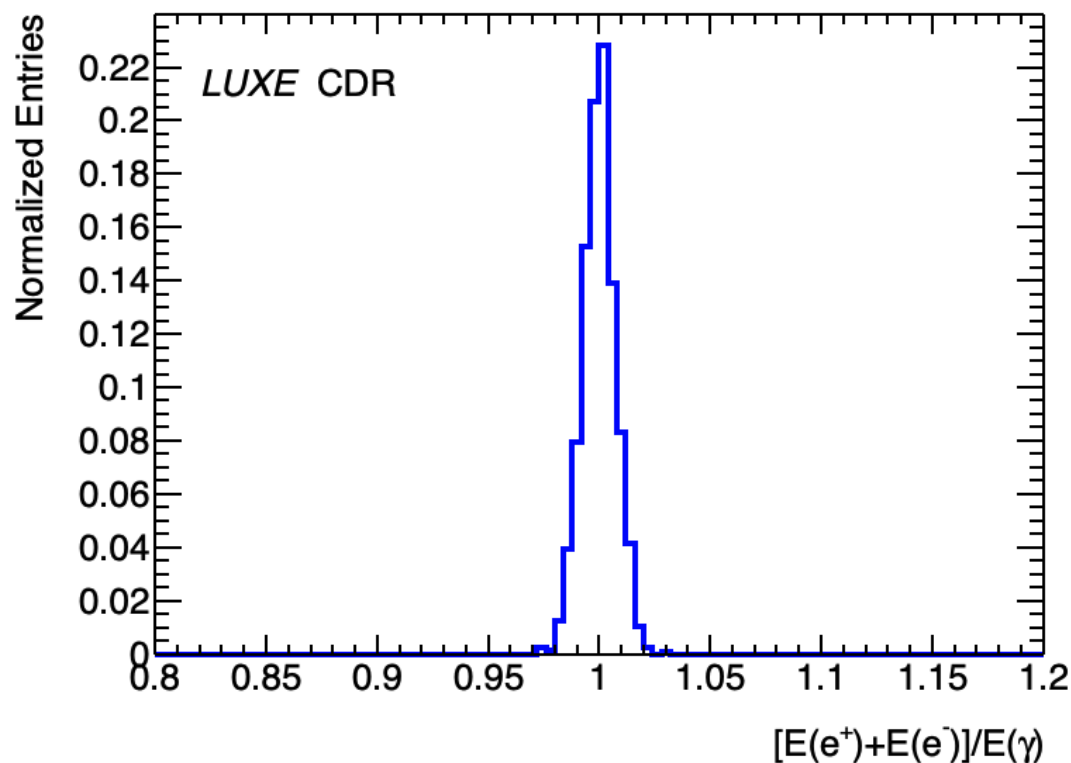
Ruth, Tom, Ben



- **Results updated to use PTARMIGAN MC instead of IPstrong MC**
 - Good agreement between reconstructed and true edge position
 - Includes 2.5% uncertainty on energy scale

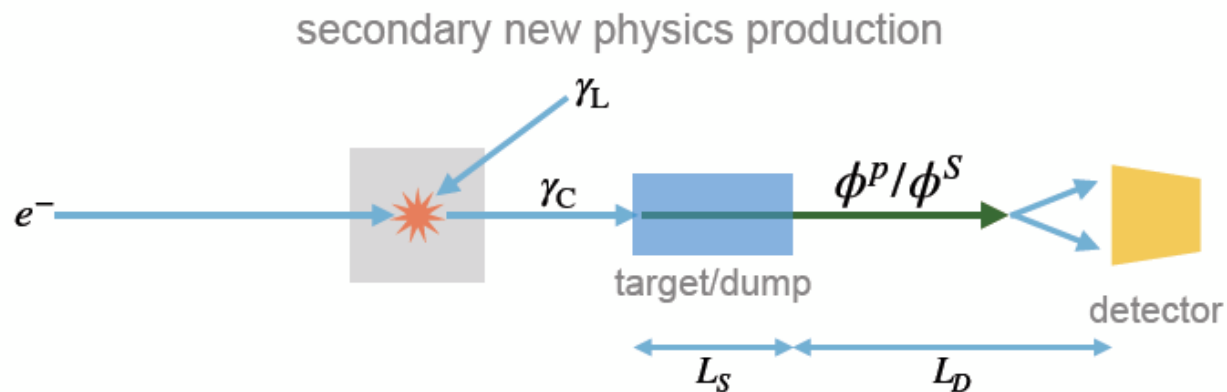
PHOTON ENERGY SPECTRUM

- **Low rate for gamma-laser have benefits too!**
 - Can uniquely match electron and positron if there is only one of each!
 - Thus can reconstruct energy of the pair!

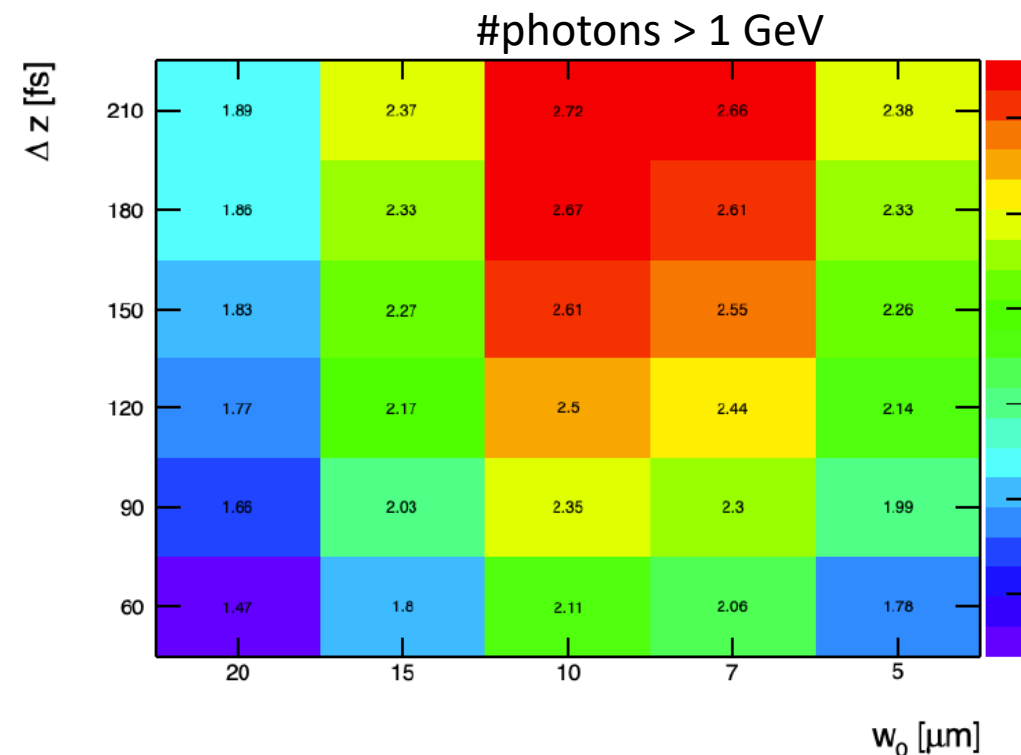


BSM PHYSICS CASE

- Consider two running scenarios:
 - Phase-0, 25ns pulse, $w_0=6.5\mu\text{m}$: “the least we can do”
 - Phase-I, 120ns pulse, $w_0=10\mu\text{m}$: somewhat optimal
- In reality will have sensitivity at nearly all ξ values

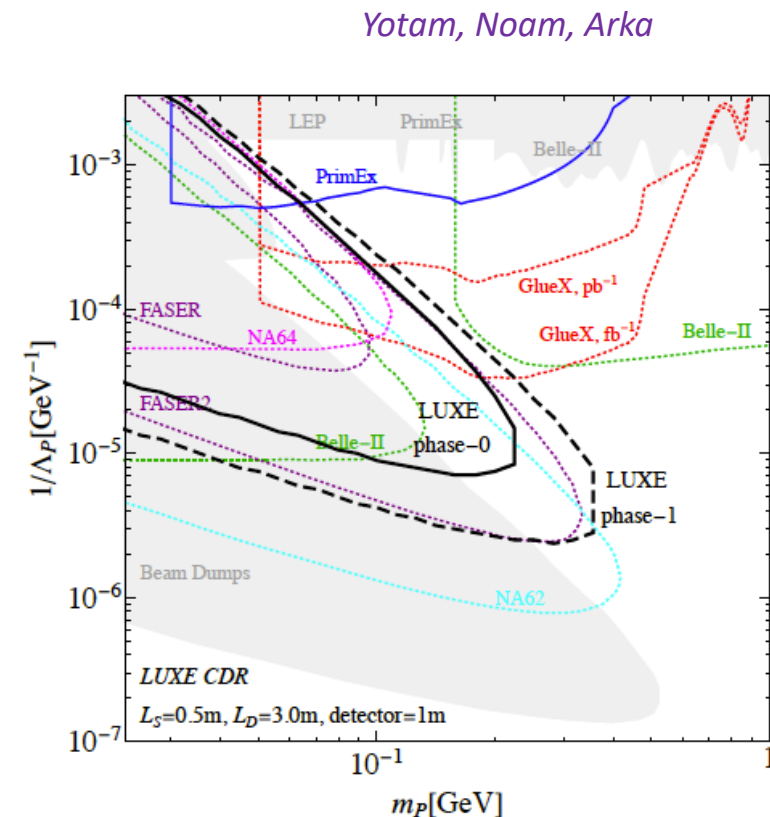
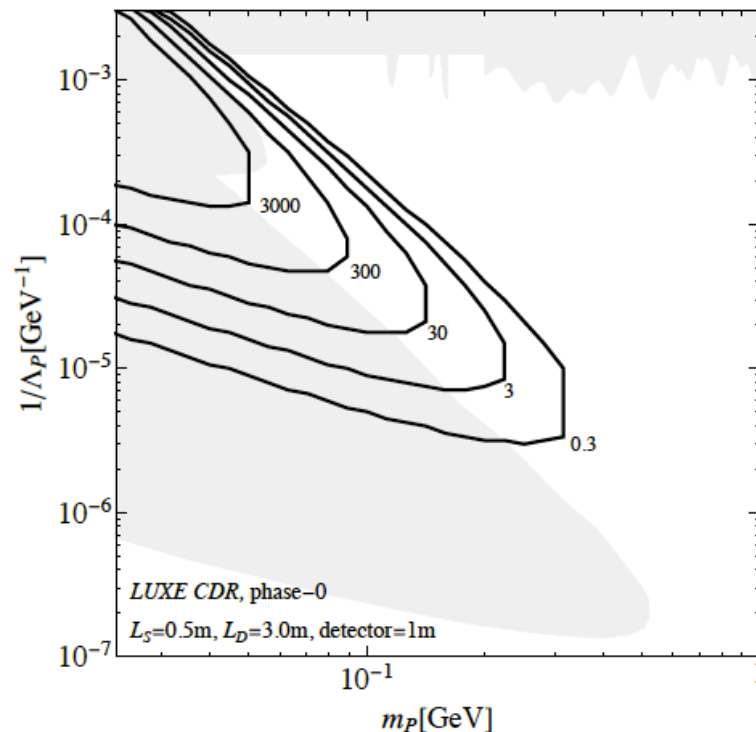
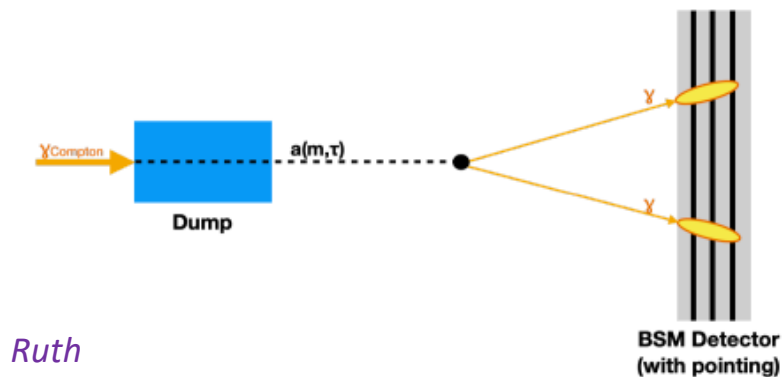


Using PTARMIGAN to optimize
flux (Tom Blackburn)



BSM PHYSICS CASE

Need detector to detect and measure key parameters:
mass and **lifetime** ($\sim 1/\text{coupling}$)



- Competitive with other ongoing/planned experiments

LUXE IN 2021

- **2021 is a very important year for LUXE: Plan**
 - Submit CDR on January 15th to PRC so that PRC launches review
 - Review will include people from PRC (HEP expertise), LAC (laser) and XFEL.EU
 - This is currently being setup by DESY FH director
 - Review should conclude by PRC meeting (May 4/5)
 - Based on this DESY directorate to decide on allocation of resources and priority w.r.t. other projects
 - Main constraint is that the installation needs to happen in 2024

CONCLUSIONS

- **Thanks to everyone for the hard work to finalize the CDR!**
 - Many results were updated in the last weeks and days
 - I presented just some highlights today but LUXE meetings in following weeks will show in more detail the progress
 - Also, thanks to all those reading and commenting
- **We have sent a draft in time so a review is being launched**
 - It does not yet contain the schedule and resources. Finalizing these now and can then update the draft before making it public (end of this month I hope)
 - Also, found a few small issues which I am fixing => if you find any, just email me.
- **More detailed planning of schedule starting now, including milestones, risks etc. for all components**



FINI!