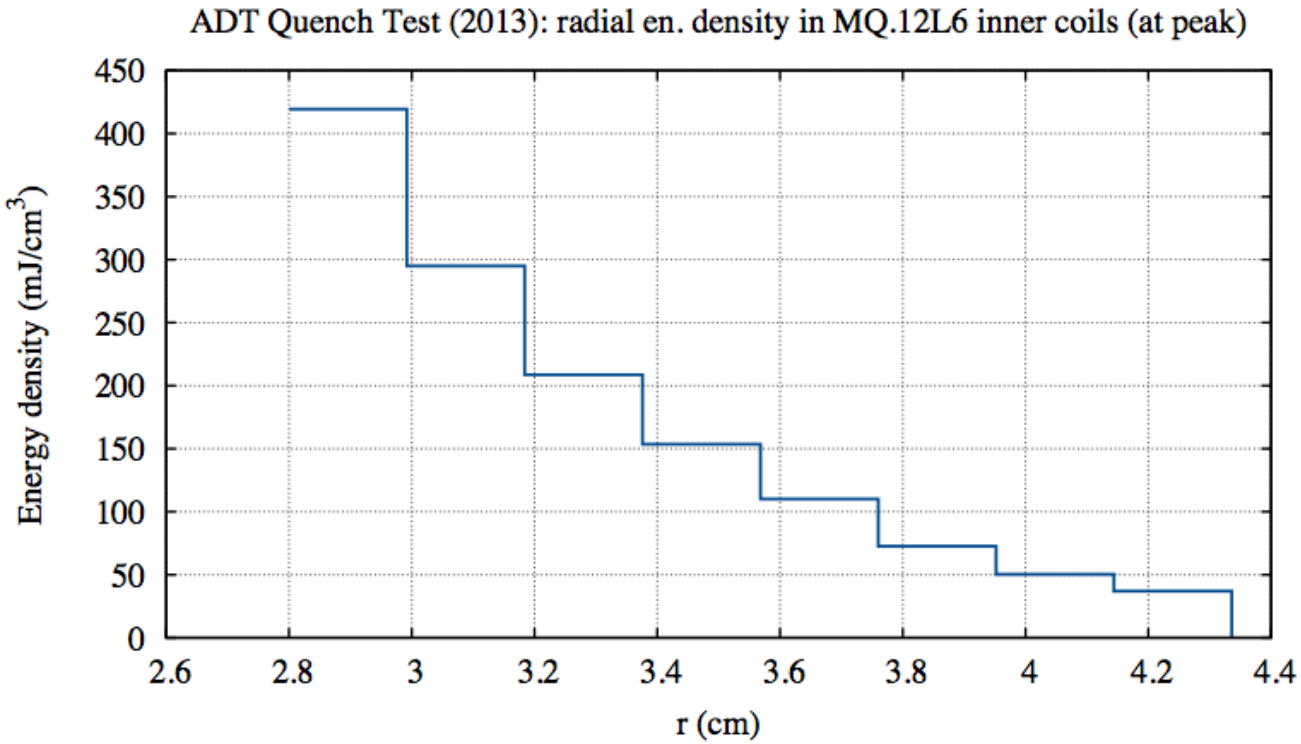
23.08.2013, QTAWG meeting

Analysis of quench limits for ADT fast quench test

FLUKA input

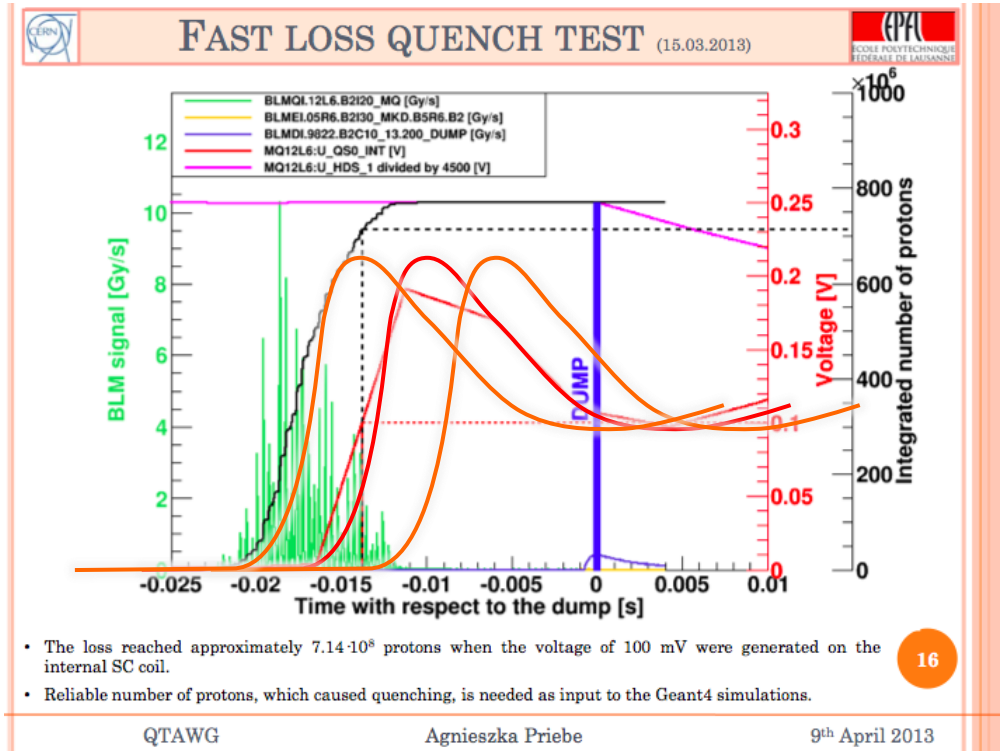
- Integrated energy deposition



source: A. Lechner, N. Shetty, FLUKA

Upper bound for quench limit

- Due to the large uncertainties only an upper bound of 420 mJ/cm^3 can be obtained from the FLUKA analysis.



Lower bound for quench limit

- The preceding test with ~1/2 the bunch intensity did not result in a quench. From FLUKA we obtain a lower bound of 200 mJ/cm^3.

BUNCH INTENSITIES

- Operation with very low intensity bunches (difficult)
- Intensity measurement error ≈ $0.1 \cdot 10^8$ protons

Bunch	RF Bucket	Bunch number	Bunch intensity before excitation [10^8 p+]	ADT gain [%]	BLM level (of electronic limit) [%]
1	1	1	15 (not excited)	-	-
2	2001	201	1.89-1.98 (oscillating)	400	42
3	4001	401	1.97	400	35
4	6001	601	2.00	200	Below warning
5	8911	892	4.00	200	28
6	10911	1092	8.20	200	51 (quench-QPS)
7	12911	1292	15 (not excited)	-	-
8	14911	1492	15 (not excited)	-	-
9	17851	1786	15 (not excited)	-	-
10	19851	1986	15 (not excited)	-	-

- The greater the ADT is, the faster losses occur.
- The gain was decreased to avoid BLM beam dumping.

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QTAWG Agnieszka Priebe 9th April 2013

QP3 model results - disclaimer

- Note that the model of the He cooling in the millisecond range is not validated by experiment (experiments in that range are exceedingly difficult). Numerous free parameters!

Model assumptions QP3/Thea/ZeroDee

Parameter	QP3	Thea	ZeroDee	sensitivity
B (var./const.)	var.	var.	const.	
T (var./const.)	var.	var.	const.	
W (var./const.)	var.	var.	const.	
A_{He} (var./const.)	var.	var.	const.	high
HeBath (var./const.)	var.	var.	const.	high
magneto resistivity (yes/no)	yes	yes	yes	medium
excl. quenchino (yes/no)	yes	yes	yes	low@4TeV
BC. (periodic/ isotherm. after length)	periodic	iso. at 2 m	n/a	
Long. He heat conductivity (yes/no)	no	yes	n/a	

Comparison in progress

Model Parameters QP3/Thea/ZeroDee

Parameter	QP3	Thea	ZeroDee	sensitivity
TF [T/A]	0.0184-0.0052			high
$I_{cab\ [A]}$	6250 A			high
A_{he} [mm^2]	0.015-0.089*	0.035**		high
HeBath (var./const.)	var.	const.	const.	high
RRR	150	150	n/a	medium
Heat pulse (lin./rect., duration)	rect., 10 ms	rect., 10 ms	rect., 10 ms	high
aKap [$W/m^2/K^3$]	200			low
aFB_II [$W/m^2/K$]	1000			low
aNC [$W/m^2/K$]	500			low
aNB [$W/m^2/K$]	50000			low
aFB_I [$W/m^2/K$]	500			high

*… corresponds to 100% filling of voids

**… corresponds to 50% avg. filling of voids

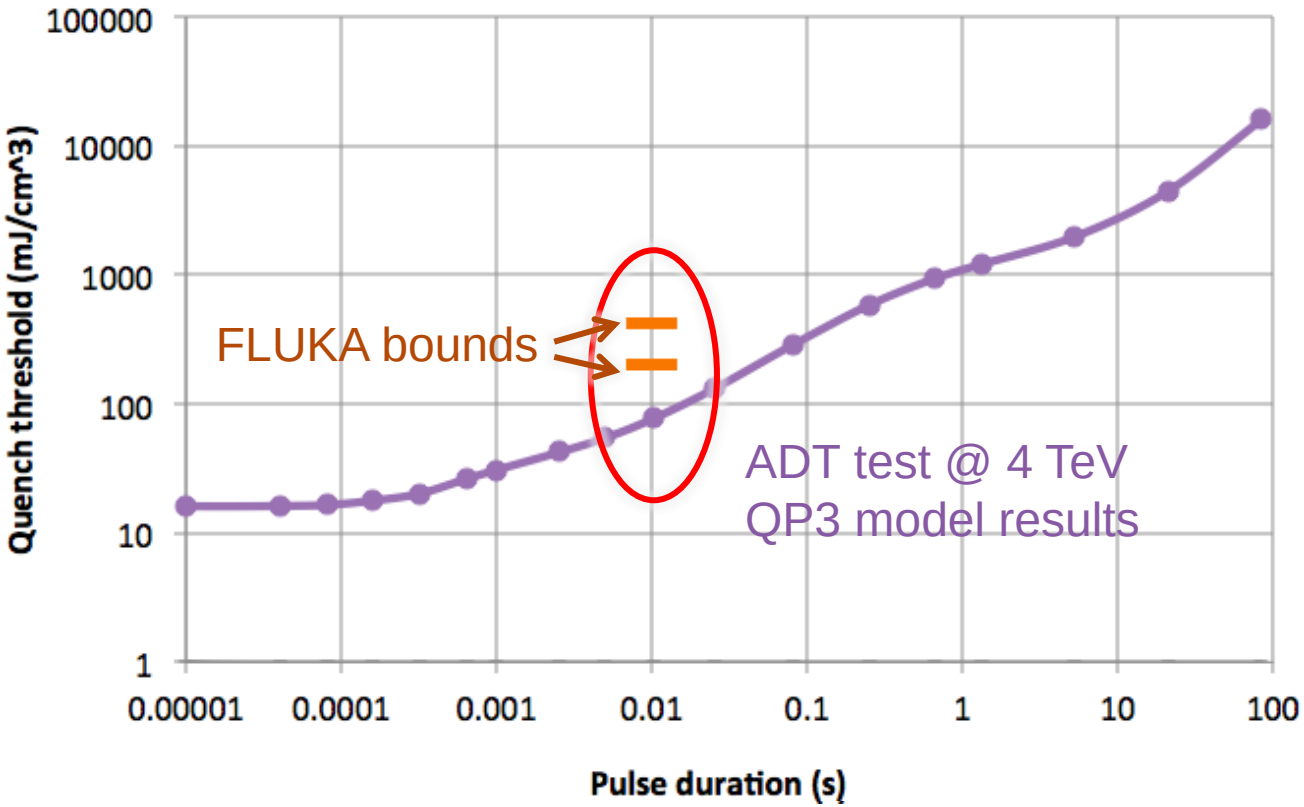
Comparison in progress

QP3 model results

- The computed quench limit with the above parameters is 75 mJ/cm^3 peak on the inner radius.
- Variation of parameters gives an uncertainty within the model of ±40 mJ/cm^3.

Impact of updated model parameters

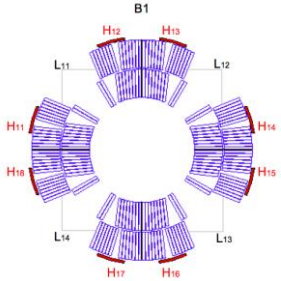
- Adjustments: Filling 100% of voids with helium (rather than 35%)
- Increasing film-boiling (in He I) heat conductivity from 200 to 500 W/m^2/K.



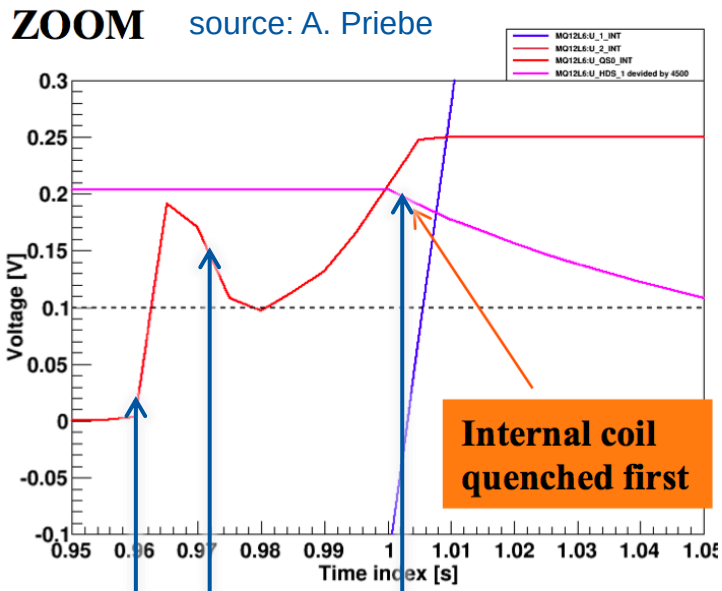
Conclusion

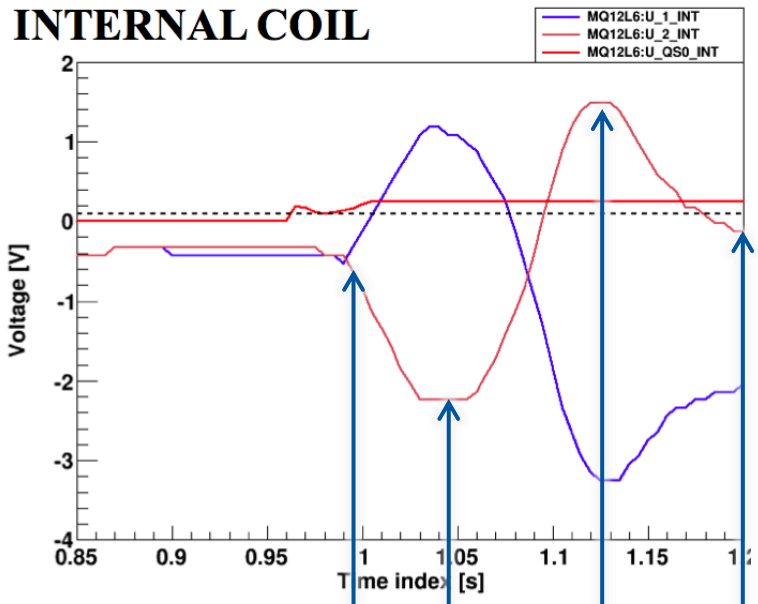
- Parametric studies will continue to find a realistic parameter set.
- How large is the uncertainty in the FLUKA values?

Interpreting QPS PM file



- 2+2 poles are compared to compute U_QSO.





quench in half 1

heater firing

almost symmetric quench in half 2

beginning of current decay

diode opens

heaters effective

reduced diode forward voltage

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