Robust:
"Road Upgrade of Standards" GRD1-2002-70021.

Injury criteria. New severity index.

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Injury criteria.

- EN 1317 should evaluate barrier performance using standard tests. This evaluation procedure contains the use of severity indices (ASI, THIV). Experience has shown that using these evaluation procedures, barrier performance has strongly improved since the introduction of EN1317.

- One of the proposals that ROBUST project has evaluated is the use of injury criteria from instrumented dummies as an alternative to severity indices for the evaluation of barrier performance.

- For this purpose, biomechanical and vehicle data from TB11 tests that included a Hybrid III instrumented dummy were collected and analyzed.

- The data acquired were:
  - Vehicle centre of gravity acceleration and yaw rate time histories
  - Neck load time histories
  - Dummy head acceleration time histories.

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Dummy measurement.

- **23 test with instrumented dummies.**

Asi traditional	Filtered ASI	THIV	time of fligth	PHD	Dummy neck [N]					HIC
	12	m/s	s	g	fx	fy	fz	mx	mm	
1.266	1.232	31.396	0.205	12.441	4345.022	6215.263	27016.983	563.935	164.666	4397.334
0.961	0.923	24.278	0.266	20.035	4543.865	497.347	355.837	28.334	6.906	2615.130
1.181	1.077	33.238	0.165	16.609	1132.592	1261.030	4206.066	12.344	22.896	2168.279
1.246	1.053	26.513	0.188	19.176	708.472	428.201	2108.938	258.228	31.270	808.003
1.221	1.034	28.131	0.400	14.998	13324.291	3431.745	2716.512	313.679	91.961	797.722
1.023	0.921	22.920	0.200	13.724	357.371	111.991	1439.040	110.669	12.004	264.725
1.178	1.161	31.732	0.412	13.428	6104.017	2464.865	426.990	336.467	58.309	173.480
1.088	1.022	27.017	0.186	20.570	896.562	467.728	440.396	282.822	34.080	158.436
1.385	1.390	26.726	0.301	9.266	2893.959	3596.304	6667.535	243.572	63.640	109.335
0.880	0.787	20.968	0.207	22.486	16479.758	12237.168	18400.351	355.198	222.747	97.299
1.535	1.481	31.954	0.362	18.937	16411.693	11395.574	4802.487	338.539	184.443	73.995
0.965	0.910	23.405	0.406	25.880	4004.911	4681.881	6049.787	471.641	86.852	66.324
1.022	1.012	22.632	0.197	16.416	988.598	365.141	1073.543	40.476	3.703	60.497
0.899	0.894	25.590	0.192	11.183	657.018	566.598	313.619	40.476	9.145	60.046
1.284	1.355	23.603	0.328	10.693	2150.836	1906.525	4127.568	311.608	55.858	55.435
0.764	0.760	21.935	0.201	9.176	341.626	208.938	556.515	182.600	21.975	52.242
1.095	1.038	28.715	0.184	12.967	451.416	98.816	533.437	102.472	11.653	50.105
0.958	0.857	25.306	0.195	13.841	135.088	459.574	681.519	16.191	3.788	49.394
1.089	1.139	27.796	0.179	9.547	1332.458	245.526	1296.696	16.191	3.160	41.355
0.941	0.898	23.710	0.196	6.569	323.325	132.960	381.092	275.929	28.606	37.238
0.918	0.859	23.613	0.249	17.446	449.799	142.924	98.345	104.818	7.653	29.300
0.879	0.875	21.043	0.204	15.383	309.823	387.021	520.736	305.634	37.106	11.680
0.540	0.431	13.764	0.447	12.156	12036.512	10722.842	7139.453	325.505	223.203	8.660

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Dummy measurement. Observations.

- **None of the tests failed the neck criteria.**
- **3 of 23 with HIC values exceeding limit of 1000.**

Asi traditional	Filtered ASI	THIV	time of fligth	PHD	Dummy neck [N]					HIC
	12	m/s	s	g	fx	fy	fz	mx	mm	
1.266	1.232	31.396	0.205	12.441	4345.022	6215.263	27016.983	563.935	164.666	4397.334
0.961	0.923	24.278	0.266	20.035	4543.865	497.347	355.837	28.334	6.906	2615.130
1.181	1.077	33.238	0.165	16.609	1132.592	1261.030	4206.066	12.344	22.896	2168.279

- **Limit exceeded for more than 2 times**
- **Second test not acceptable for PHD value (PHD has been cancelled)**
- **Third test not acceptable for THIV value**

Dummy measurement. Observations.

- ## Two tests refers to the same barrier:

Asi traditional	Filtered ASI	THIV		time of fligth	PHD	Dummy neck [N]					HIC
		12	m/s	s	g	fx	fy	fz	mx	mm	
1.181	1.077	33.238		0.165	16.609	1132.592	1261.030	4206.066	12.344	22.896	2168.279
1.178	1.161	31.732		0.412	13.428	6104.017	2464.865	426.990	336.467	58.309	173.480

Type of Test	Barrier Type	Post Spacing or Unit Length (m)	Significant Heights of barrier (cm)	Actual Weight (Tonnes) (inc. dummy(s))	Actual Speed (Km/h)	Actual Impact Angle (deg)	Vehicle Contained?	Barrier did not break?	Vehicle was not penetrated?	Barrier was not breached?	Vehicle remained upright?	Vehicle met the CEN box criteria?	Max permanent/static deflection (m)	Dynamic Deflection (m)	Working Width (m)	Working Width Class
TB11	B1	1.5	90-140	0.887	100.12	20	YES	YES	YES	YES	YES	YES	0.17	0.25	0.85	W3
TB11	B1	1.5	90-140	0.888	101.59	20	YES	YES	YES	YES	YES	YES	0.12	0.25	0.85	W3

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Dummy measurement. Correlation.

- **ASI-HIC correlation**

- **THIV-HIC correlation**

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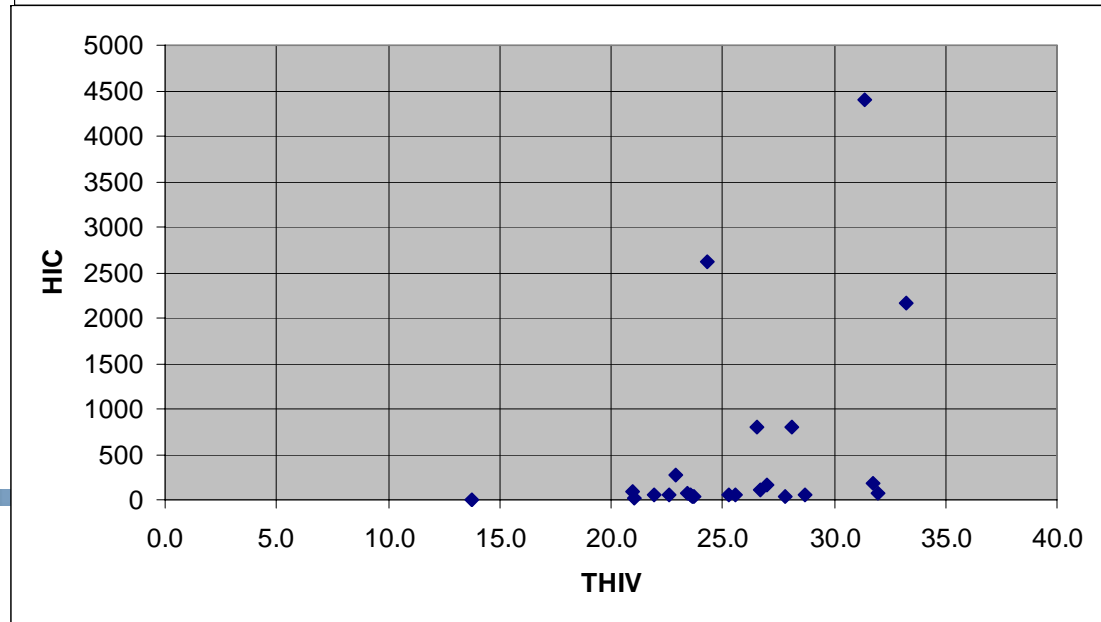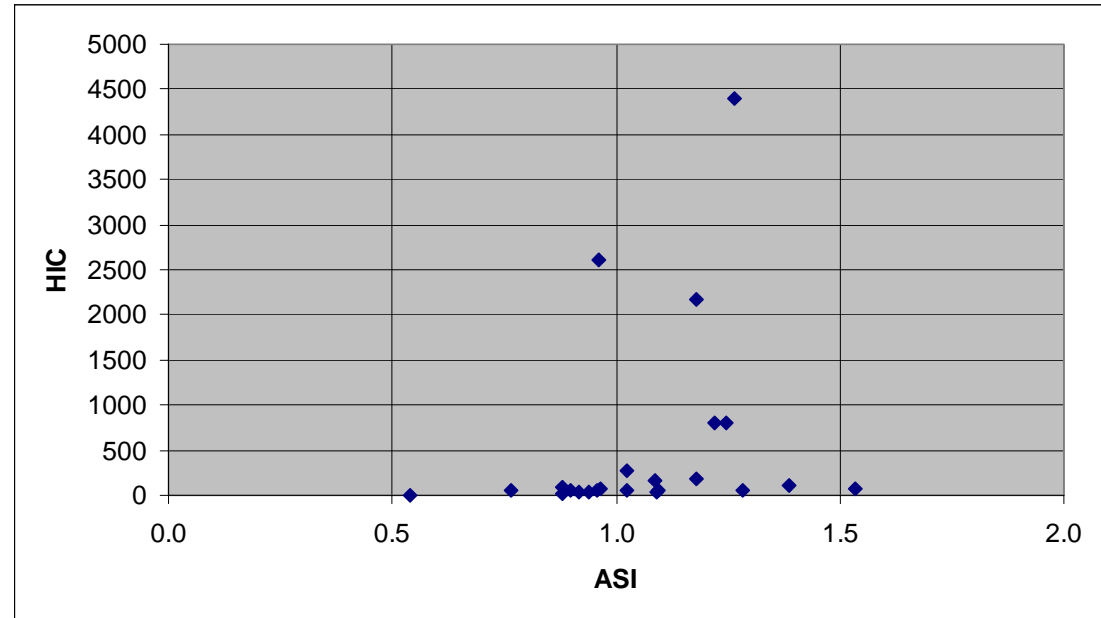
Dummy measurement.

- The size of the data set is not statistically large enough to draw any final conclusions.

- Even if we have only 3 tests with HIC >1000 this means that we had strong impacts of the head. We must take care of this problem.

- EN1317-2 tests are fronto-lateral impacts and currently no specific dummies are available for this type of impact. Tests have only been performed with Hybrid III dummy that has been developed for frontal-only impacts.

- When analysing the HIC criterion in one case the same barrier produced completely different HIC values.

- A high value of HIC can only be seen if there is a direct impact between the head of the dummy and the barrier (this can be seen with other methods).

- Dummy measurements can be heavily influenced by differences in the vehicle behaviour and structure.

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Dummy measurement.

- **Severity indices are used to rank and compare barrier performances; HIC not seems to be suitable for this ranking.**

- **Other dummy-based injury criteria that are used in crash safety, such as chest deflection, lumbar spine loads, etc. were not analyzed in this task due to unavailability of data.**

- **We should be able to distinguish between impacts between dummy head and the barrier (to be evaluated) and dummy head and vehicle interior (related to the internal structure).**

- **These observations lead to the fact that, at present, dummies should not be proposed alone to evaluate the performance of a barrier.**

- **The acquisition of dummy data is suggested so as to acquire information for future revisions of EN1317.**

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New concept

- **From previous consideration:**

  – **Use global information (vehicle acceleration)**

  – **ASI-THIV approach**

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ASI

$$ASI(t) = \sqrt{\left(\frac{\bar{a}_x}{a_{x\,\lim}}\right)^2 + \left(\frac{\bar{a}_y}{a_{y\,\lim}}\right)^2 + \left(\frac{\bar{a}_z}{a_{z\,\lim}}\right)^2}$$

$$a_{x\,\lim} = 12g \quad a_{y\,\lim} = 9g \quad a_{z\,\lim} = 10g$$

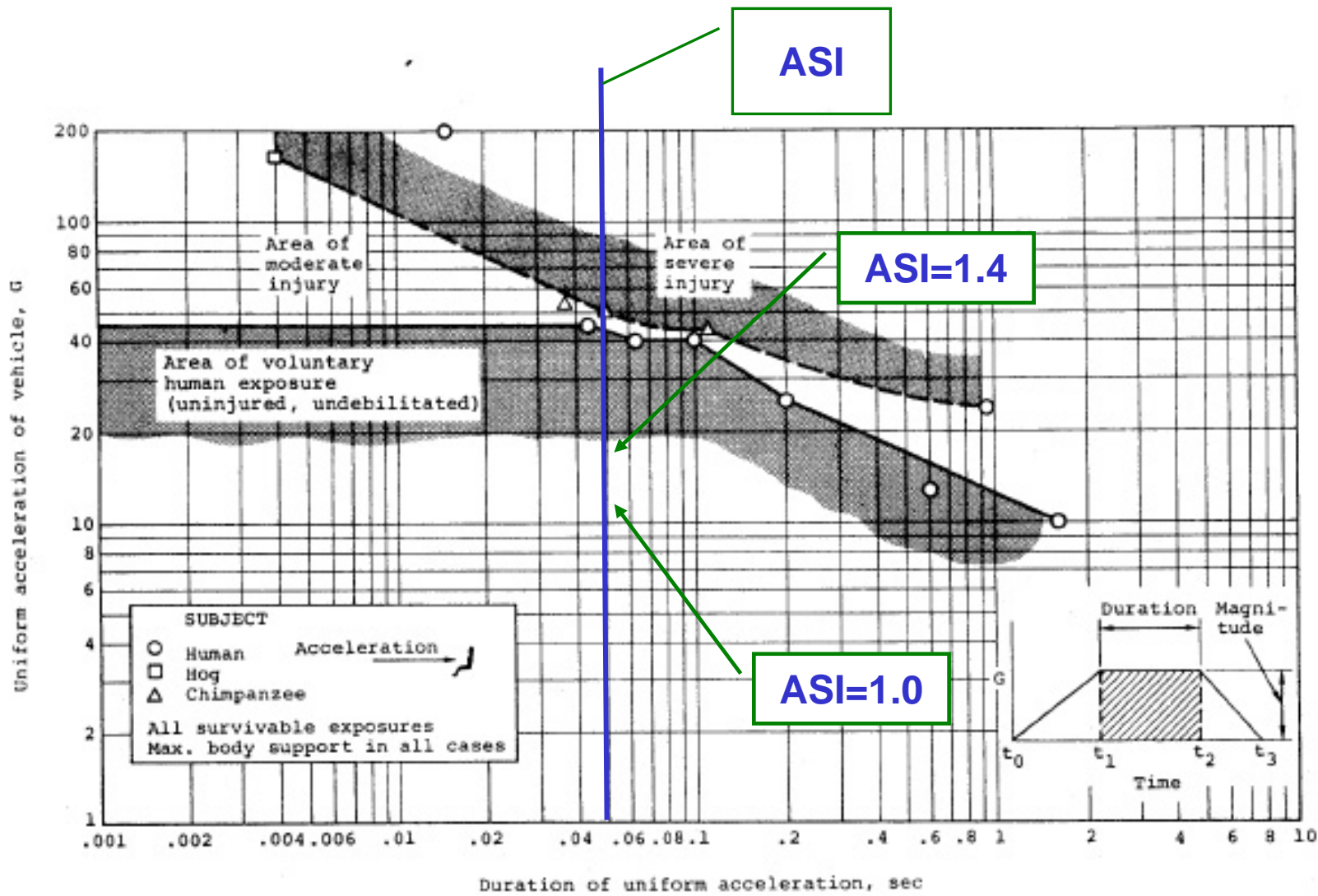- **Acceleration limits are constants but, if compared to Einband curves, they should be frequency dependent.**
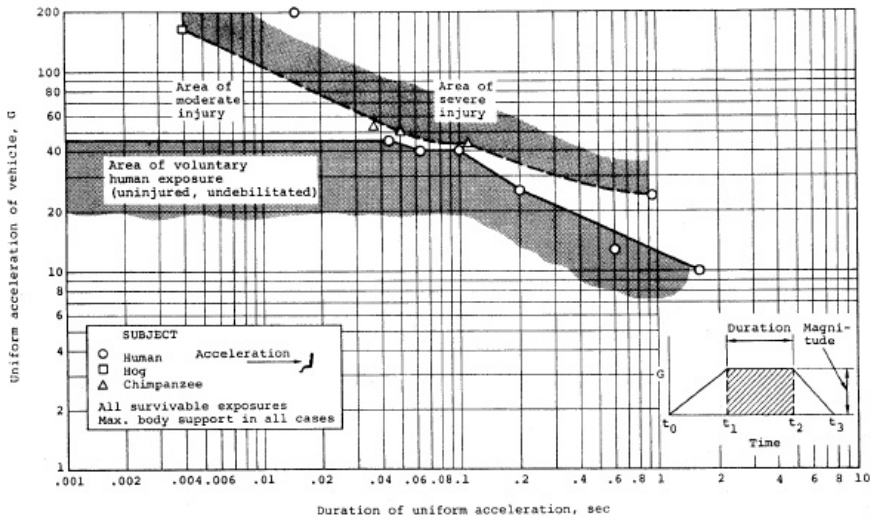
FIGURE 9. DURATION AND MAGNITUDE OF SPINEWARD ACCELERATION ENDURED BY VARIOUS SUBJECTS. (FROM REFERENCE 13)
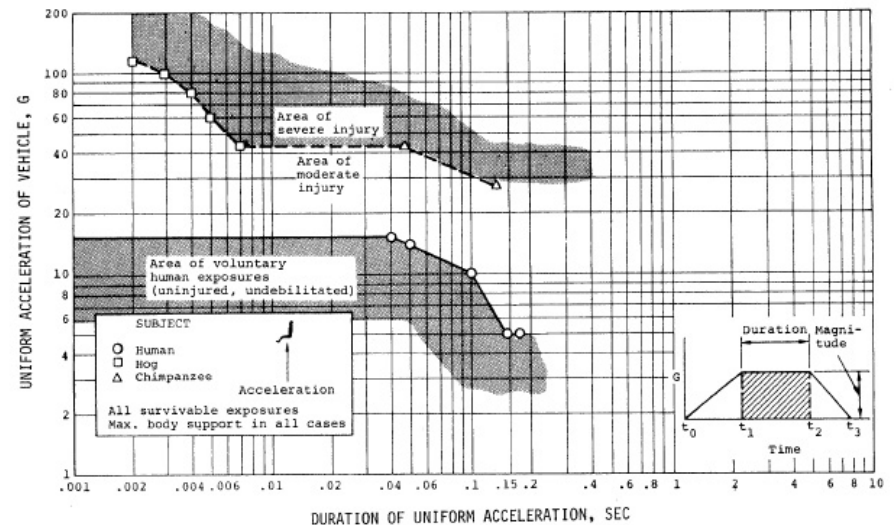
FIGURE 11. DURATION AND MAGNITUDE OF HEADWARD ACCELERATION ENDURED BY VARIOUS SUBJECTS. (FROM REFERENCE 13)
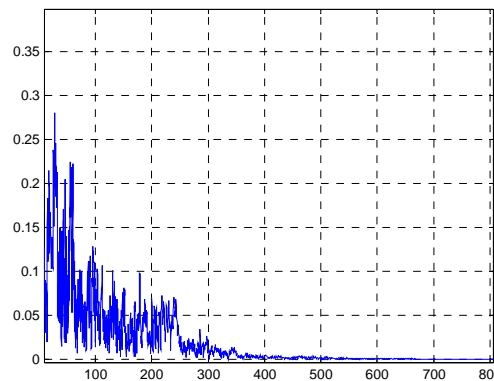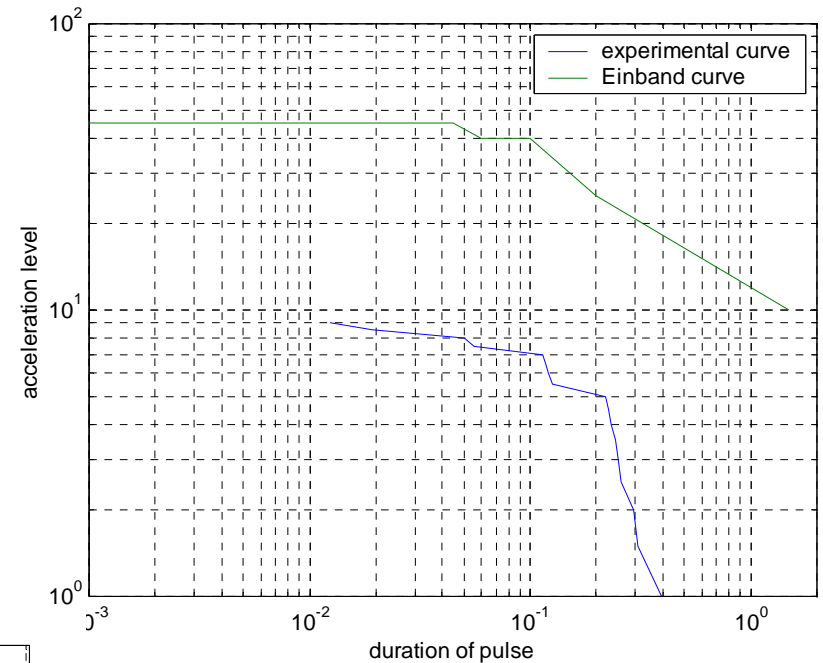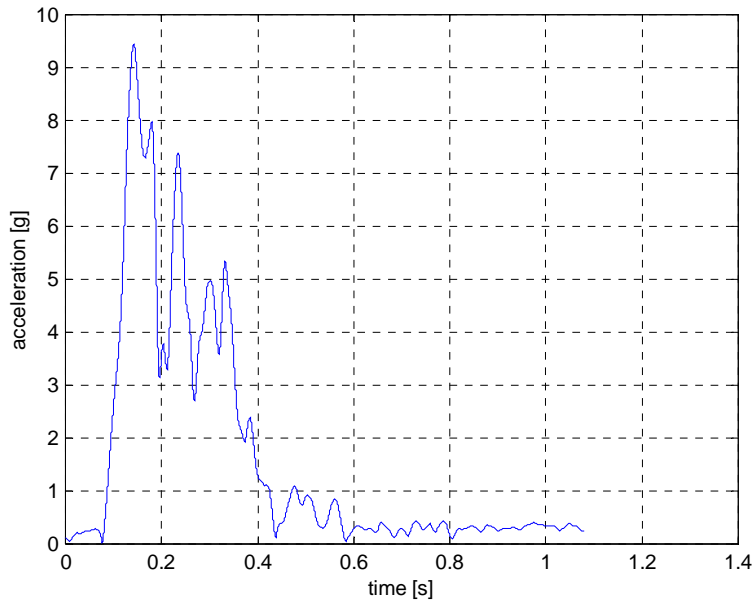
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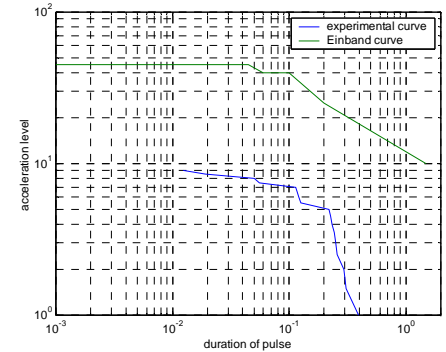
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Current activity

- **Procedure to create Einband plots of real test:**

Frequency domain

Pulse duration domain

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Activity

- **These experimental Einband curve have been created for different directions (few data for y directions).**

- **Problems:**
  - **Each point of the Einband curve is a limit.**
  - **How to take into account the cumulative effect.**

- **Current activity:**
  - **Evaluate integrals of normalized curves (curves normalized with respect to the Einband ones)**

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Conclusion on severity indices.

- **Voluntary evaluation of dummy measurement for future revision.**
- **Modification of ASI formula.**
- **Cancellation of PHD.**
- **New concept under development.**

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Questions?

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